Environmental Sensitivity Atlas for Lake Erie (Including the Welland Canal) and the Niagara River Shorelines

Environment Canada
Environmental [illegible]ection Branch
[illegible]rio Region

Environnement Canada
Direction générale de la protection de l'environnement
région de l'Ontario

Legend

ESI* Ranking

Shoreline Habitats

Bedrock or Impermeable Shores

1a(1a) Exposed Bedrock Bluff less than 1 metre elevation

1b(1a) Exposed Bedrock Bluff 1-5 metre elevation

1c(1a) Exposed Bedrock Bluff greater than 5 metre elevation

2(1b) Retaining Wall/Harbour Structure/Breakwaters

3(2) Shelving Bedrock

Unconsolidated Sediment Shores

4(3) Exposed Sediment Bluff

5a(4) Sand Beach: Depositional

5b(4) Sand Beach: Erosional or Transitory

6(4) Sand Barrier With Lagoon

7a(6a) Pebble Beach

7b(6a) Pebble/Cobble Beach

7c(6a) Cobble Beach

8(6b) Rip Rap

9(6a) Boulder Beach

10(5) Mixed Beach (% by sediment in DOE Database)

Vegetated Shores

11(9a) Low Vegetated Bank (Grass or Trees)

12(9b) Delta Mud Flat

13a(10a) Fringing Wetland

13b(10b) Broad Wetland

* ESI - Canadian Environmental Sensitivity Index (USA ESI Ranking follows in brackets) Higher numbers indicate greater sensitivity.

Biological Resources

Fish

Area of Seasonal Fish Spawning

Location of Seasonal Fish Migration

Birds

Migratory Waterfowl

Colonial Nesting Birds (total nests - all species)

Wading Birds (total nests - all species)

Shore Birds

Raptors

Shore Associated Mammals

Furbearers (such as Muskrat, Mink, and Beaver)

Human-Use Resources

High Recreational Usage

Marinas and Small Craft Harbours

Anchorage Sites

Residential, Recreational or Cottage Use

High-Use Recreational Beach

Recreational Dive Site

Resource Extraction

Water Intakes - Industrial

Water Intakes - Municipal

Outfall

Commercial Fisheries Activity

Special Status Areas

Highly Sensitive Classified Feature (within 2km)

First Nation/Native American Reservation

National Park/National Forest

Provincial/State Park, Wilderness Area or Nature Reserve/State Forest

Conservation Area or Municipal Park

Environmentally Sensitive Area*

Area of Natural and Scientific Interest*

Area of Ecological Significance (e.g. Wetland)

Dune Formations

* As identified by Ontario Ministry of Natural Resources or Conservation Authorities

Countermeasures

Access Site (for land vehicles)

Approach Concerns

Exposed Rock

Coast Guard Light Station

Boat Launch: Excellent

Boat Launch: Good

Boat Launch: Poor

Helicopter Landing Site

Staging Area: Excellent

Staging Area: Good

Staging Area: Poor

Automated Weather Stations

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Copies may be obtained from:

Environment Canada
Environmental Protection Branch - Ontario Region
4905 Dufferin St., Downsview, Ontario
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Environmental Sensitivity Atlas for Lake Erie (Including the Welland Canal) and the Niagara River Shorelines

Prepared by:

Environment Canada
Environmental Protection Branch
Ontario Region
Canadian Coast Guard

United States Coast Guard
District 9
United States National
Oceanic and Atmospheric Administration

1994

These maps are not to be used for navigational purposes.

Acknowledgements

Environment Canada's Environmental Protection Branch, Ontario Region, the National Oceanic and Atmospheric Administration, and the United States Coast Guard - District 9 would like to express their appreciation for the time and effort of all those who contributed to the development of the Environmental Sensitivity Atlas for Lake Erie (Including the Welland Canal) and the Niagara River Shorelines. Appendix A has a list of these agencies and contact persons for the data they contributed.

We would particularly like to acknowledge the extensive help we received from the following: the Ontario Ministry of Natural Resources District Offices along Lake Erie (including the Welland Canal) and the Niagara River Shorelines; Ray Amell of Canadian Coast Guard's Prescott Base; the Great Lakes Response Corporation (PIMEC, Inc.); Jacqui Michel of Research Planning, Inc.; the Ontario Ministry of the Environment and Energy, and the Environmental Conservation Branch of Ontario Region. Elements of base topographic maps showing on each atlas page have been reproduced with Natural Resources Canada's (NRC) permission.

This project was funded by Environment Canada, with support from Canada's Green Plan. Substantial funding assistance for atlas development for the Connecting Channels was provided by the Great Lakes Response Corporation (PIMEC, Inc.). The Canadian Coast Guard made a significant contribution in the form of helicopter time and crews.

Atlas and Supplement Project Team

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Table of Contents

1.0 Introduction

The **"Environmental Sensitivity Atlas for Lake Erie (Including the Welland Canal) and the Niagara River Shorelines"** is a publication designed for use in response to marine spills of oil and other hazardous materials. This Atlas will allow responders to work from a common basis to rapidly identify the resources at risk during a spill. Information in the Atlas will assist decision makers to quickly assign priorities for protection measures.

The Atlas focuses on the Canadian shoreline of Lake Erie from Amherstburg at the mouth of the Detroit River to Fort Erie at the mouth of the Niagara River. Both sides of the Welland Canal are covered in the study area. Both the Canadian and United States shorelines of the Niagara River are also included in this Environmental Sensitivity Atlas. The Canadian and United States shorelines of the Detroit River west of the area studied in this atlas can be found in the "Environmental Sensitivity Atlas for the St. Clair River, Lake St. Clair and Detroit River Shorelines" (DOE 1994). The Lake Ontario shoreline adjacent to the outflow of the Niagara River and Welland Canal is contained in the "Environmental Sensitivity Atlas for Lake Ontario's Canadian Shoreline" (DOE 1993) and "Lake Ontario Atlas: Sensitivity of Coastal Environments and Wildlife to Spilled Oil" (RPI 1993). The United States shoreline of Lake Erie can be found in "Lake Erie Atlas: Sensitivity to Coastal Environments and Wildlife to Spilled Oil" (RPI 1985).

This project is a collaboration of Environment Canada's (DOE) Ontario Region office of the Environmental Protection Branch (EPB-OR), Transport Canada's Canadian Coast Guard (CCG) Central Region office, United States Coast Guard (USCG) District 9 and the United States National Oceanic and Atmospheric Administration (NOAA).

Two versions of this information have been produced; a softbound (paper) Atlas, and a hardbound (vinyl) Supplement to the Great Lakes Annex of the Canada-United States Joint Marine Pollution Contingency Plan for Spills of Oil and Other Noxious Substances. A limited number of copies of the hardbound Supplements have been produced. This version is designed for the day to day operational use by several agencies and organizations which have major spill related jurisdictional responsibilities, or deal with environmental emergencies on the Great Lakes on numerous occasions.

The Supplement is designed to complement the Joint Marine Pollution Contingency Plan, which contains additional spill response information such as spill response personnel and procedures. The Supplement differs from the Atlas only in its requirement for field durability, and the addition of several types of spill response countermeasures and highly classified sensitivity information that are critical to spill response decision makers.

The softbound version of the Atlas was prepared for broad distribution to assist agencies and companies in spill preparedness and response. While it will be useful for resource management in general, this Atlas has been designed primarily to assist spill responders.

Numerous references are made in this publication to the Atlas, and to the Supplement. These references indicate the two versions described above. Both versions have been generated from Environment Canada's master database, which is the major product of the project. All data which has been collected and represented on the maps reside digitally in an electronic desktop environmental sensitivity mapping system, similar to a Geographic Information System (GIS). This system will readily allow additions or changes to the database so that updated versions of the Atlas can be released periodically. More importantly, the system will allow for enhanced spill response management at the time of a spill.

Work is underway to create a 'user friendly' Graphical User Interface for the system. Simultaneous viewing of shoreline video and the corresponding GIS screen is also under development.

The electronic desktop environmental sensitivity mapping system is a continually evolving system. EPB-OR welcomes additional information and updates that could enhance the master database. For questions, suggestions or concerns about this publication or the master database, please contact:

Regional Environmental Emergencies Coordinator (REEC)
Environmental Emergencies Section
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2.0 Project Background

In April 1994, EPB-OR asked many agencies to assist in the development of the Environmental Sensitivity Atlas for Lake Erie (Including the Welland Canal) and the Niagara River Shorelines. EPB-OR received an excellent response, with many agencies and communities expressing interest or cooperating to provide data and expertise. American agencies agreed that this project was an excellent opportunity to pool resources and create an international product for the Niagara River area.

The Lake Erie/Niagara River project consisted of six major phases; digital base map preparation, data collection, data digitizing, legend definition, data overlay layer creation, and finally, Atlas layout design.

During the data collection phase in 1994, videotaped helicopter shoreline surveys were made of the entire study area, which facilitated the completion of shoreline classification, and identification of many countermeasure features. Biological and human-use resources data were assembled from reviews of existing information provided by partner agencies, as well as from site visits and reviews of video tapes. Copies of the video tapes are available by contacting the Ontario Region Environmental Emergencies Section at 416-739-4994.

Environment Canada was given access to various agencies' resource information. Appendix A has a list of these agencies and the data they contributed. This resource information was subsequently transcribed and digitized to suit the electronic requirements of the production process.

A great deal of care was directed to the selection of legend features and symbols which would serve the immediate needs of spill responders on the Great Lakes and the Connecting Channels. Specific electronic layers were created to present geomorphological, cultural, biological and human-use information.

With input from many response experts, the project team designed the Atlas to convey critical information to a spill responder in a concise, straightforward manner, with a minimum of extraneous detail. Before final publication, these map pages for Lake Erie and the Niagara River were reviewed extensively (for both accuracy and utility) by the key response and resource agencies instrumental in its development and future use.

2.1 Regional Approach within a National and International Framework

Every effort has been made to ensure that the Ontario Region master database will be compatible with the recommendations of DOE's National Sensitivity Mapping Program, which is currently being developed.

Close coordination with national and international sensitivity mapping programs was essential for this project because shorelines and sensitive resources for both the American and Canadian sides of the Connecting Channels were mapped. Environment Canada was responsible for the ranking classification of both United States and Canadian shorelines. Since somewhat different shoreline sensitivity ranking and colour schemes are used in the United States, the Atlas legend includes both Environmental Sensitivity Index (ESI) rankings.

The United States Coast Guard (USCG) and National Oceanic and Atmospheric Administration (NOAA) provided all of the sensitive biological and human-use resource information for the United States. This information was obtained through a combination of reviewing existing ESI atlases (produced in 1983 and 1985) and the new sensitive resource annexes from the Area Contingency Plans covering each Connecting Channel's U.S. side (produced in 1993). All of this international information now resides digitally within Environment Canada's master database used to create this atlas (see Section 3.0).

All of the sensitive resource data have been presented using Canadian Great Lakes map symbology methods. However, joint development work with NOAA and USCG has ensured that data and sensitivity representation is similar to Atlas production underway for the American shorelines of the Great Lakes. Close cooperation with Canadian Coast Guard and United States Coast Guard operational officers dictated many of the design layout features of the Atlas and Supplement. For all Connecting Channels atlas work, Environment Canada, NOAA and USCG have all collaborated closely to ensure the international utility of the atlases.

3.0 Environment Canada's Desktop Environmental Sensitivity Mapping System

The maps in this publication have been generated from Environment Canada's electronic desktop environmental sensitivity mapping system. The system currently employs MapInfo™ software and MapBasic™ programming language to overlay sensitivity and countermeasure data on electronic base maps.

To show all data at once on paper maps would impact on the clarity and utility of the publication. The specific resource agency information supplied to Environment Canada in the data collection phase of this project has been entered into a comprehensive master database. Some of the data provided are more appropriate as background information, and will remain in the master database but will not be present on paper maps. Information in this database will be readily available to responders (EPB-OR Environmental Emergency Duty Officer at 416-346-1971 in Canada or NOAA Scientific Support Coordinator at 206-526-6317 in the United States) during a spill. This database will also form an appendix to the Supplement version.

For base maps, National Topographic System (NTS) digital map sheets at a scale of 1:50,000 have been used to create the digital Canadian shorelines for Lake Erie, the Niagara River and the Welland Canal. The digital U.S. shoreline of the Niagara River was created from United States Geological Survey (USGS) Quad Maps (scale of 1:24,000). On each map page of the publication, reference is made to the relevant NTS or USGS Quad map sheet(s) covering that portion of shoreline displayed. Elements of Canadian base topographic maps showing on each atlas page have been reproduced with Natural Resources Canada's permission. Once data overlays (or 'layers') are added to the base maps, the assembled Atlas information is printed at a scale of 1:50,000, covering the entire 639 kilometres of Lake Erie's Canadian shore (including islands), 96 kilometres along both sides of the Welland Canal, and the 171 kilometres (107 miles) of the Niagara River shoreline (58 km Canadian; 113 km or 71 miles American), on a total of 48 map pages.

The system displays a latitude/longitude graticule superimposed over each map, with hatch marks for every minute of latitude or longitude, and darker hatch marks for every five minutes. A full degree is denoted by the thickest mark. Arrows in the corners of each map page point to the exact location of the displayed coordinates. This system has created maps employing an unprojected latitude and longitude coordinate system.

4.0 Nature of Data

4.1 Data Collection and Levels of Confidence

EPB-OR staff contacted or made visits to all contributing partner agencies between April and August 1994. Existing and new data sets were gathered or surveyed for the project. For collection of existing data, relevant maps, publications and databases were reviewed, and pertinent information transcribed then digitized by Environment Canada. A new shoreline classification scheme, most suitable for spill response on the Great Lakes and Connecting Channels, defines nineteen (19) different shoreline habitats and their U.S. equivalents. This was the major component of new information specifically surveyed for this project.

Data in digital form existed for only a few Legend features for Lake Erie and the Niagara River. To some degree, data availability on the Great Lakes and Connecting Channels has dictated definition of Legend features and the manner they are displayed on the maps. To use a crosshatched or coloured polygon to represent an area implies a level of certainty regarding the boundaries of that area. Such detailed boundary accuracy was not always available at the time of the data collection phase of the project.

For example, since fish spawning activity information was often supplied for general areas rather than for specific areas or points, a decision was made to use a point symbol, but one defined as an area, hence the Legend feature 'Area of Seasonal Fish Spawning'. This works well considering that the source information does not allow for the rigorous definition of exact boundaries of all fish activity; it more customarily identifies general areas of observed activity, or of suitable habitat. For spill response, it can be assumed that activity occurs in the general vicinity of each fish spawning symbol, with more specific information often being found in the 'Notes' column when available.

Fish spawning and migration data for the study area were often based more on suitable habitat identification than recent specific activity observations. Consultations with local resource experts can assist in defining boundaries more specifically at the time of a spill.

The majority of the Canadian bird information is based on recent, thorough surveys by the Canadian Wildlife Service, Royal Ontario Museum, and the Ontario Ministry of Natural Resources, and is quite accurate and up to date. 'Shore Associated Mammal' information is based on observations, or identification of suitable habitats. 'High Recreational Usage', and 'Resource Extraction' features are based on documented surveys. Prior to publication, these locations were thoroughly reviewed and modified by local individuals familiar with the different shoreline regions of the study area.

For 'Special Status Areas', polygon boundaries have been digitized as provided by various agencies and are considered accurate and up to date. 'Countermeasures' symbols were placed following joint CCG - USCG - NOAA - EPB-OR video review sessions and helicopter and ground surveys during July 1994. These symbols were then reviewed for accuracy and modified where necessary by local experts familiar with the areas involved.

The geomorphology of 100 percent of the Canadian shorelines of Lake Erie and the Welland Canal and both the Niagara River shorelines was newly classified by the Project Geomorphologist during the 1994 helicopter survey which was undertaken specifically for this project. Videotapes were filmed during these surveys and then reviewed to confirm the shore classifications that comprise the 'Shoreline Habitat' layer of information. The confidence level for these data is excellent.

These 'Shoreline Habitat' classifications are an excellent guide for responders at the time of a spill. On-site examination (or 'ground truthing') will ensure that any minor discrepancies are identified during spill response.

5.0 Atlas Design and Function

5.1 Symbology and Use of Colour

Each Legend 'feature' represents a different 'layer' of information. These features have been defined by three types of symbols: point symbols, line symbols, and areas, or polygons. A municipal water intake is an example of a point symbol, a Shoreline Habitat classification is a line symbol, and a National Park is an example of an area or polygon, with defined boundaries.

Colour has been used to provide a richness in display and to denote differences among similar symbols, such as an excellent and a poor boat launch. It also distinguishes different shoreline classifications. To assist users in discerning one shoreline colour from another, a removable Legend guide has been included with the Atlas in a pocket attached to the back cover. If required, users may line up this card over the shoreline habitat in question to determine the exact colour code for any given habitat.

During spill response, photocopying and facsimile transmission form a large part of information transfer. Each of the symbols chosen are unique (with only a few exceptions) so that black and white reproductions of the Atlas pages will result in minimal information loss.

For Shoreline Habitats, colours are the best manner to convey this key information without obscuring other valuable data on the maps. In situations where colour cannot be conveyed, the electronic system can produce maps showing Shoreline Habitats by Environmental Sensitivity Index (ESI) number, rather than colour, to meet those needs.

5.2 Sensitivity Ranking

Much international work has gone into determining environmental sensitivity ranking schemes. It is a very complex undertaking. Shoreline habitats, biological, cultural and human-use resources all form an intricate system with many different potential impacts at the time of an oil spill. Some ranking schemes endeavour to weigh many factors and values to come up with a single numerical ranking indicating relative sensitivities of all resources in question. From this ranking, protection and clean up priorities are assigned when deploying limited response equipment and available resources. Alternatively, some atlases limit information to identifying the location of resources at risk without ranking them.

Some sensitivities are readily identified and ranked, such as shoreline habitats. Other resources' relative sensitivities can be completely dependent on circumstances surrounding the spill itself. During any significant spill, a consultation among spill response experts will consider those spill-specific circumstances before coming up with the set of protection and clean up priorities appropriate for that particular incident.

Taking this into consideration, the Environmental Sensitivity Atlas (and Supplement) for Lake Erie (Including the Welland Canal) and the Niagara River Shorelines ranks 'Shoreline Habitats' in order of increasing sensitivity based on factors such as oil residence time, cleaning potential and exposure to natural removal processes. A full description of the 'Shoreline Habitats' used in this Atlas is contained in Section 9.0.

Environment Canada's newly revised Ontario Region classification scheme for shoreline habitats differs somewhat from that used on Environmental Sensitivity Index (ESI) maps of other United States Great Lakes shores. For this and other newly completed Great Lakes Connecting Channel atlases, the American equivalent to Canadian shoreline habitat rankings is noted (see Section 9.1). The United States shoreline habitat rankings are listed below:

United States ESI Ranking	Shoreline Habitat Description
1A	Exposed Rocky Cliffs
1B	Exposed, Solid Man-made Structures
2	Shelving Bedrock Shores
3	Eroding Scarps in Unconsolidated Sediments
4	Sand Beaches
5	Mixed Sand and Gravel Beaches
6A	Gravel Beaches
6B	Riprap Revetments
7	Exposed Flats
8A	Sheltered Scarps in Bedrock
8B	Sheltered, Solid Man-made Structures
9A	Sheltered, Vegetated Low Banks
9B	Sheltered Sand/Mud Flats
10A	Fringing Wetlands
10B	Extensive Wetlands

Features such as 'Biological Resources' and 'Human-Use Resources' are identified on the maps, but are not specifically ranked in relation to one another. Broad terms such as low, moderate or high priority are used in the 'Notes' column on many map pages to give an indication of relative sensitivity, and relative sensitivities are broadly discussed in the text of Section 7.0, but the final priorizing decisions will be made by qualified response experts at the time of the spill.

6.0 Description of Atlas Legend Features

A colour example of the Environmental Sensitivity Atlas legend is shown in Figure 1. Figure 2 identifies standard features appearing on the base maps in the Atlas and Supplement. A definition of each Environmental Sensitivity Atlas legend feature follows in Sections 6.1 through 6.4. Section 9.0 defines the Shoreline Habitats found in the Atlas.

The size of the symbols in the legend do not represent the exact size shown on the individual maps, due to space constraints.

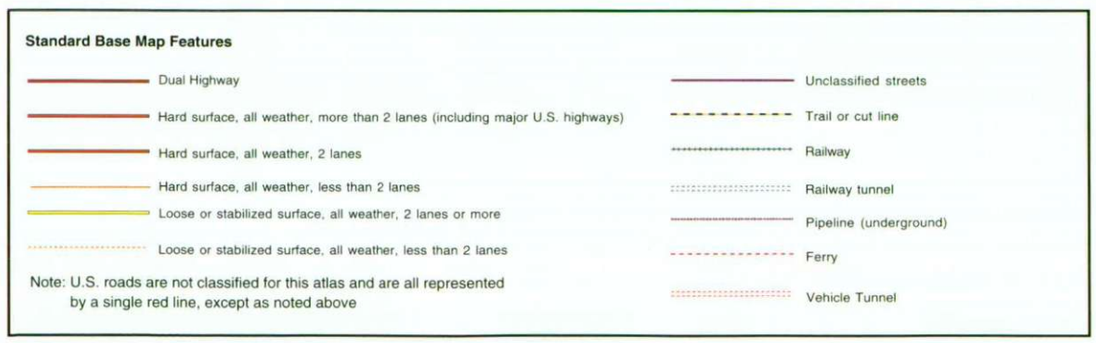


Figure 2: Standard Cartographic Legend for Base Maps

Figure 1: Environmental Sensitivity Atlas Legend

6.1 'Notes'

One current constraint of the electronic desktop mapping system is that it does not allow the use of symbology to identify both species and their seasonality in a clear, easily understood manner. The central objective of the Environmental Sensitivity Atlas for Lake Erie (Including the Welland Canal) and the Niagara River Shorelines is to present mapped sensitivity information that may be readily understood at a glance by spill responders.

To achieve this objective, the 'Notes' column on the side of each map page was used to display species and seasonality information, when available. The symbol on the maps for 'Notes' is a red exclamation point with a white number inside it. Each numbered 'Note' symbol on a map corresponds to the same number in the 'Notes' column for that page. These 'Notes' also highlight important site-specific facts or concerns for the responder including approach concern descriptions (foreshore flats, rocky reefs or submerged vegetation). The 'Notes' are anecdotal. They can be expanded in future Atlas updates as more sensitivity information becomes available.

6.2 Biological Resources

Biological Resources include broad groupings entitled Fish, Birds and Shore Associated Mammals. While specific species information is valuable to the responder, the 'top layer' of an Atlas should provide a straightforward initial indication of the general biological activity in an area. The responder can quickly get a sense of local sensitivities without deciphering complex symbology, or cross-referenced tables of data. This latter detail will be required, but it can reside in the 'hidden layers' of the master database, for use by responders in consultation with local resource experts at the time of a spill.

A limited amount of data was available for rare plants along the Lake Erie and Niagara River shorelines. Rare plants are highly sensitive to human activity, and to some degree, to oiling. Reported locations have been described in the 'Notes' column. Consult with local offices of the Ontario Ministry of Natural Resources or New York Department of Environmental Conservation (NYDEC) for additional information.

6.2.1 Fish

'Area of Seasonal Fish Spawning' and 'Location of Seasonal Fish Migration'

In the Lake Erie and Niagara River Atlas, the available data collected focused mainly on known areas of spawning and migration activity for fish species having commercial or recreational value. Site-specific information on non-commercial or non-sport fish species was not readily available during data collection for Lake Erie and the Niagara River. As more information becomes available, it will be incorporated into the master database, and in Atlas updates. The Ontario Ministry of Natural Resources' Lake Erie Fisheries Station notes that the entire Canadian shoreline of Lake Erie, including Pelee Island, may be considered an 'Area of Seasonal Fish Spawning' and 'Location of Seasonal Fish Migration'. The spawning season is variable with runs from April to December. The inshore zone is used as nursery areas for many fish species. In addition to spawning migrations, many fish species move along the shoreline seasonally, and some species migrate the length of the lake (OMNR, pers. comm., 1994). Symbols and Note entries have been used to denote locations on the map where specific fish activity was identified during the data collection phase of the project.

As explained in Section 4.1, to use a polygon to represent an area implies a level of certainty regarding the boundaries of that area. Since fish spawning activity information was supplied for general areas, a point symbol defined as an area is used. The symbol for 'Area of Seasonal Fish Spawning' is used to denote habitats such as fish spawning streams, reefs and beaches, and also locations where sensitive life stages (egg, larvae and juvenile) are concentrated. For 'Location of Seasonal Fish Migration', the symbol is typically placed at the mouth of a river or stream known to be used for migration.

For spill response, it can be assumed that activity occurs in the general vicinity of each fish symbol, with more specific information often being found in the 'Notes' column when available. Consultations with local resource experts can assist in defining boundaries more specifically at the time of a spill. In times of an environmental emergency, the Atlas symbols will provide critical initial information regarding fish spawning and fish migration.

The following species and seasonality information for Lake Erie and the Niagara River is derived from information supplied by the various District Offices of the Ontario Ministry of Natural Resources (OMNR) and Freshwater Fishes of Canada (Scott and Crossman 1973). This general information will complement details found on the individual maps.

Sport fishing species in the study area include: smallmouth, largemouth, rock and white bass; yellow and white perch; northern pike and walleye; lake and rainbow trout; coho and pink salmon; and rainbow smelt. There are commercial catches of yellow perch, rainbow smelt, lake whitefish and walleye in Lake Erie.

Carp, bluegill, alewife, freshwater drum, black and white crappie, channel catfish, pumpkinseed, brown bullhead and white sucker are also present in the study area in various locations.

The sea lamprey migrates up streams with a sand, gravel and rubble substrate in spring and early summer to spawn. Significant populations have been found in the Great Lakes. The sea lamprey population in Lake Erie is lower than other Great Lakes due to a warmer average water temperature and fewer suitable spawning rivers (Scott and Crossman 1973).

Spawning activity for walleye occurs around the Pelee Island area of Lake Erie and in the Connecting Channels during the spring, often over boulder or coarse gravel shoals.

Yellow perch spawn in the spring in the shallows of the lake.

Rainbow smelt spawn in the lake in spring. Important spawning areas for smelt include beaches and shoals in water depths of less than 3 metres.

Lake whitefish congregate in the Pelee Island area in November and December in shallow water (usually at depths of less than 8 metres) to spawn, often over a hard or stony bottom.

Coho salmon spawning runs occur in early September to early October in Lake Erie, followed by October to November spawning in swift water of shallow gravelly areas of river tributaries.

Lake trout in Lake Erie spawn in the fall on rocky shoals in shallow water in the Pelee Island area.

Lake Erie is an important area for smallmouth bass sport fishing success. Smallmouth bass spawn in late spring to early summer in 0.5 to 6 metres of water on a sandy, gravel or rocky bottom of the lake, usually near the protection of rocks or logs.

Northern pike are spring spawners over flooded margins of rivers, marshes or large bays of Lake Erie.

6.2.2 Birds

Areas requiring protection in the event of an oil spill include staging areas for migrating birds, breeding colony sites, foraging areas of breeding birds, important wetlands along the shore, and endangered species habitats. Through a combination of Notes and symbols, these areas have been identified, or the information is available in the master database whenever such data were supplied for the study area.

'Migratory Waterfowl'

This category is comprised of both migrants and breeders which are present in the study area for at least part of the year. Species include those found on shoreline wetlands and sheltered waters such as Canada geese and various dabbling ducks (including green-winged teal, pintail, wigeon, black duck, gadwall, shoveler, mallard, wood duck and blue-winged teal), plus those species of more open water such as loons, grebes and diving ducks (including common goldeneye, scaup, old squaw, bufflehead, ring-necked duck, redhead and canvasback). Often the 'Notes' column will identify critical staging areas, feeding areas or wetlands for these migratory waterfowl.

'Colonial Nesting Birds (total nests - all species)', and 'Wading Birds (total nests - all species)'

Regarding colonial waterbirds, the information presented in this Atlas was obtained as part of a program to census all gulls, terns, cormorants, herons and egrets nesting on the Great Lakes during 1989 to 1991. This program was carried out simultaneously in Canada and the U.S. In Canada the program was coordinated and supervised by Environment Canada's Canadian Wildlife Service (CWS).

CWS is preparing a number of Technical Reports, which together will constitute the "Atlas of Colonial Waterbirds Nesting on the Canadian Great Lakes". The CWS Technical Reports will provide detailed information, compare present (1989-91) breeding distribution and abundance data with data for earlier years, and discuss the census findings in a biological context.

The Technical Reports will also deal with the relative scarcity of different species and habitats, and their needs for conservation. For more information on the "Atlas of Colonial Waterbirds Nesting on the Great Lakes", please contact Dr. Hans Blokpoel, Canadian Wildlife Service (see Appendix A under 'Bird Information').

There are numerous species of colonial waterbirds that nest regularly on the Great Lakes with several of these species nesting in the study area: herring gulls, double-crested cormorants, great blue herons, black-crowned night herons, ring-billed gulls, and common terns, Caspian terns and Forster's terns (both rare along Lake Erie and the Niagara River).

Cormorants are large, dark-plumaged birds with long necks and long bills with a sharp hook at the tip. Terns are small to medium sized, light coloured birds with forked tails and long narrow wings. Gulls are medium sized birds with long wings and rounded tails. Wading birds such as the Great Blue Heron are easily recognized by their distinctive long legs, neck, and bill.

All nesting locations in Canada were acquired from the 1989 to 1991 CWS census, and the Royal Ontario Museum's (ROM) ongoing "Ontario Nest Records Scheme" established prior to 1900. Nesting locations in the U.S. were obtained from the original "Lake Erie Atlas: Sensitivity of Coastal Environments and Wildlife to Spilled Oil" (RPI), compiled in 1983, in which information from the U.S. Fish and Wildlife Service was used.

Two symbols are used to indicate nesting colonies of waterbirds. One symbol, a gull in flight ('Colonial Nesting Birds'), represents nesting locations for gulls, terns and cormorants. The other symbol, a standing heron ('Wading Birds'), represents nesting or breeding and feeding areas used by herons and egrets.

Where they occur on the individual map pages, these two symbols are followed by a number representing the total number of nests for all species at that location. The species-specific nest numbers are available in the master database. The total nests number was used for a quick reference to give responders an order of magnitude idea of site-specific occurrence of the category; for instance, less than 10 nests is a lower priority; 10 to 100 is of higher priority; and over 100 nests is a high priority concentration.

Of course, number of nests is not the only consideration in setting spill response priorities, but this information will assist responders in initial assessments. Responders will typically be interested in protecting the most vulnerable resources, rather than focussing strictly on the greatest numbers. The numbers are provided only as a guideline for deploying limited resources; in the event of a spill, the appropriate experts will be consulted for specific species information that may change priorities. When a 'Wading Bird' or 'Colonial Nesting Bird' symbol occurs without a number in brackets, it either represents a feeding or foraging location, or a site for which the number of nests was not available.

'Shore Birds'

This category includes species such as sandpipers and plovers which are small, active birds with short to medium length legs and bills. They can be found nesting or feeding on sand and gravel beaches along Lake Erie and the Niagara River during the ice free season.

'Raptors'

The two most important raptor species found along the Lake Erie and Niagara River shorelines are osprey and bald eagles. The maps show general locations of nest sites. The bald eagle is an endangered species (CWS) in Ontario, and a threatened species in the U.S. Exact nesting locations of bald eagles remain classified in the master database for use by responders during an environmental emergency. The Long Point National Wildlife Area has been the site of an ongoing bald eagle reintroduction study by Environment Canada and the Ontario Ministry of Natural Resources and is currently a bald eagle nesting area for nine pairs of bald eagles (Environment Canada SOE Fact Sheet No. 93-3). The peregrine falcon is a very rare migrant in the study area.

6.2.3 Shore Associated Mammals

'Furbearers (such as Muskrat, Mink and Beaver)'

This biological grouping includes mammals such as otters, muskrats, or beavers that are known to occur along the shorelines of the Great Lakes and Connecting Channels and their tributary rivers. Wetlands are the most important habitat for these species. Several species, such as muskrat, beaver and mink have local economic importance.

The 'Notes' column will also periodically make reference to shore associated mammals. Larger mammals, such as moose and bears, occasionally come to the shore but their locations cannot be pinpointed on the maps. Rather, a general comment can be made to alert responders to be prepared for possible encounters with these mammals during shore clean up activities. Oiled carcasses should be removed from shores whenever practical to prevent their ingestion by mammals or raptors such as bears, wolves or eagles.

Note that no symbol was used to denote reptiles and amphibians. Relatively few species of reptiles and amphibians are associated with the shorelines of the Great Lakes and Connecting Channels. Water snakes and several species of turtles that use wetlands are likely to be found in various shoreline habitats (Owens et al., 1992). There was a limited amount of information available for reptiles and amphibian distribution (specific information can be obtained from Environment Canada's Environmental Conservation Branch at 905-336-4843). Where specific information was provided, the 'Notes' column includes a reference to a specific reptile or amphibian species. Both reptiles and amphibians are at risk during an oil spill, but mapping their distribution would not be practical because of their mobility and widespread occurrence. As they are dependent on water, especially wetlands (Owens et al., 1992), the Atlas identifies these wetland habitats. By protecting these areas against oiling, reptile and amphibian populations will be taken into account, along with birds, fish, and mammals.

6.3 Human-Use Resources

Human-Use Resources are features that have a heightened sensitivity or value because of their use or importance to humans. Locations with these symbols will typically have higher protection and clean up priorities associated with them. These features include areas of high recreational usage, economic benefit or special status (cultural, scientific or ecological importance).

6.3.1 High Recreational Usage

'Marinas and Small Craft Harbours'

In order for a facility to receive the 'marina' symbol, it must have fuel, docking, parking and telephone facilities. Small Craft Harbours, under the jurisdiction of the Department of Fisheries and Oceans, are also included.

'Anchorage Sites'

These sites offer suitable and secure anchorage for small watercraft. They are often located in sheltered bays or inlets.

'Residential, Recreational or Cottage Use'

This symbol indicates the presence of cottages, seasonal or permanent dwellings, resorts, campgrounds, picnic areas, or trailer parks. Residential 'clusters' were often grouped together and denoted as a single symbol.

'High-Use Recreational Beach'

These areas have a heightened sensitivity during the summer months.

'Recreational Dive Site'

These locations have been identified using the guidebook "Dive Ontario!" which draws heavily on information from the Ontario Underwater Council, and from U.S. and Canadian diving clubs.

6.3.2 Resource Extraction

'Water Intakes - Industrial'

This symbol denotes locations where water is extracted from Lake Erie or the Niagara River for industrial, non-food related uses. Contact numbers when available for these industries are provided in the 'Notes' column and should be used to advise that water intakes should be shut down or monitored if threatened by a spill. Any telephone numbers noted in the Atlas are subject to change and should be verified regularly.

'Water Intakes - Municipal'

This symbol denotes locations where water is extracted from Lake Erie or the Niagara River for community use for drinking water or food processing. Contact numbers for these intakes are provided in the 'Notes' column and should be used to advise that water intakes should be shut down or monitored if threatened by a spill. Any telephone numbers noted in the Atlas are subject to change and should be verified regularly.

'Outfall'

This symbol denotes locations of municipal and industrial water outfalls discharging into Lake Erie or the Niagara River. Though outfalls are not water resource extraction elements, they are associated with water-use operations. Contact numbers when available for these industries are provided in the 'Notes' column. For mystery spills, water outfalls should be checked as a possible source of the discharge or release.

'Commercial Fisheries Activity'

Commercial fishing for yellow perch and walleye is a significant economic resource along the shores of Lake Erie. The activity is most dependent on that area within two kilometres of the shoreline (Scott and Crossman 1973). Note that commercial fishing is restricted in a one kilometre radius around every stream or river mouth on the lake. The Ontario Ministry of Natural Resources' Lake Erie Fisheries Station notes that commercial fisheries activity occurs along the entire Canadian shoreline of Lake Erie, including Pelee Island. Fishermen are allowed to set nets in shallow water and as close to the beaches as possible (OMNR, pers. comm., 1994).

The 'Commercial Fisheries Activity' symbol was used whenever such activity was specifically identified in source data either for shore activity such as a primary fish processing facility, or areas along the shores where commercial fishing activity takes place, including harvesting and stocking. Individual map pages identify specific commercial and recreational fishing areas. Generally though, this activity can occur anywhere on Lake Erie unless otherwise noted (for instance, restricted areas). No commercial fish farms were identified on Lake Erie or the Niagara River. More specific Commercial Fisheries Activity data may be added to the database as they become available.

6.3.3 Special Status Areas

These are areas where implementation of protection measures and/or assessment of the effects of oil spills are considered a high priority, especially for those locations within Special Status Areas that are vulnerable to oiling or responder activities.

'Highly Sensitive Classified Feature (within 2 km)'

Certain information sets of a restricted nature due to the high biological, cultural or physical sensitivity of the features described are given this symbol. Endangered species information and archaeological sites are two examples. Exact locations and details are maintained in Environment Canada's master database, but agencies providing the source data did so only with the understanding that this information would not be made readily available, except to responders.

In the event of a spill, responders will report all occurrences of this symbol in an affected area. By reporting the number inside the symbol, they will receive the appropriate information and response advice from EPB's Environmental Emergencies Duty Officer (416-346-1971) and the agency that provided the source data, so that they can effectively implement proper protection and clean up measures.

'First Nation/Native American Reservation'

In Canada, Aboriginal people living on a reserve are referred to as a First Nation. In the U.S., the reserve is known as a Native American Reservation. There are no First Nations or Native American Reservations identified along the Canadian shoreline of Lake Erie and the Welland Canal, nor on the shorelines of the Niagara River. Where First Nations are identified in other Great Lakes atlases, a reference is made in the 'Notes' column in each case advising responders to contact the local First Nation/Native American Reservation Chief and advise him/her when responding to a spill in their local area or when a spill threatens to impact their shorelines or water intakes.

'National Park/National Forest'

National Parks (including National Heritage Sites) are managed by Heritage Canada's Canadian Parks Service in Canada. Point Pelee National Park is located near Kingsville on Lake Erie. National Forests and Parks in the United States are managed by the Department of the Interior. In both countries, these areas are identified by a polygon symbol on the map pages. This category may include underwater parks, although none are present in the study area.

'Provincial/State Park, Wilderness Area or Nature Reserve/State Forest'

Provincial Parks, Nature Reserves or Wilderness Areas are areas representing different classes of Provincial Parks under the jurisdiction of the Ontario Ministry of Natural Resources in Canada. In the U.S., spills affecting State Parks and State Forests are under the jurisdiction of the New York State Department of Environmental Conservation.

Whenever possible, the 'Notes' column addresses sensitive features specific to the identified area with appropriate contact numbers. In several cases, this polygon is used on the Great Lakes to represent National Wildlife Areas (NWA) administered by the Canadian Wildlife Service. Big Creek NWA and Long Point NWA along Lake Erie are examples.

'Conservation Area or Municipal Park'

These are areas along the shoreline managed either by Conservation Authorities or local municipalities, and may include urban recreation areas. Orange polygons marked on the maps without an associated name represent municipal parks in most cases.

'Environmentally Sensitive Area'

These are areas designated by various Conservation Authorities, or sensitive areas identified by the Ontario Ministry of Natural Resources in series such as their Sensitive Area Reports (SAR). They have especially sensitive features which are identified in the 'Notes' column.

'Area of Natural and Scientific Interest'

An Area of Natural and Scientific Interest (ANSI) is designated by the Ontario Ministry of Natural Resources in Canada. An ANSI as defined in Canada is an "area of land and water containing natural landscapes or features which have been identified as having values related to protection, natural heritage appreciation, scientific study or education."

> "Where ANSIs occur on public lands managed by the Ministry, it will ensure that the land uses and activities which occur, provide for the protection of the identified values."
>
> "On private lands, the Ministry will, through cooperation with others, attempt to ensure that landowners are aware of significant features on their properties and seek the owner's cooperation in protecting such features." (OMNR, 1983)

Site-specific information for ANSIs is detailed in the 'Notes' column. There are no equivalent officially designated areas of this type in the United States.

'Area of Ecological Significance (e.g. Wetland)'

Significant wetland areas along the shores of Lake Erie and the Niagara River have been identified by several agencies providing source data. Their particular sensitivities are represented by a combination of Biological Resources symbols and entries in the 'Notes' column. These areas defined by polygons are in addition to the broad and fringing wetland habitats that have been identified along the shore as part of the shoreline geomorphological classification (Shoreline Habitats). The polygons are used to show the extent of the most significant wetland areas.

> "Wetlands support many species of water-associated terrestrial animals. Waterfowl (ducks, geese and swans) and herons are dependent on wetlands, primarily during migration and nesting periods. Many species of amphibians are especially dependent on wetlands throughout their annual cycles. Several species of mammals use wetlands during parts of their annual cycles, but a few, such as muskrats, beaver and mink, are essentially year-round inhabitants. Lakeshore and connecting channel marshes in particular, provide critical feeding, nesting, rearing and moulting habitats for a wide variety of waterbirds and waterfowl." (Owens et al., 1992).

In Ontario, wetlands can be distinguished by Class or Type. In 1985 the Ontario Ministry of Natural Resources and the Canadian Wildlife Service introduced an evaluation system to classify Ontario wetlands (Southern Ontario Wetland Evaluation System 1985) which was updated in 1992 (OMNR 1992). The system identifies four main components: biological, social, hydrological and special features. Each component is assessed and assigned a total value up to 250 points, making the highest possible score 1000 points. The biological component studies the productivity, diversity and overall size of the wetland. The social component includes an assessment of the valued resource products, recreational activity, aesthetics, educational value, proximity to

urban areas, ownership and size with regard to the social aspects. The hydrological component examines the connection to a large waterbody, flow stabilization, potential for water quality improvement and erosion control. The fourth component identified as special features includes presence of rare, threatened or endangered flora and fauna, fish habitat, waterfowl nesting, migratory bird staging and also ecological age (succession stage).

The value for each of the four components is summed and a total score is assigned. Based on this score, the Wetland Class is designated according to the following:

Class 1 - 700 or more total points (or 3 of the 4 components score higher than 200)
Class 2 - 650 - 700 (or 2 of the 4 components score higher than 200)
Class 3 - 600 - 650 (or 1 of the 4 components score higher than 200)
Class 4 - 550 - 600 (or all 4 components score higher than 100)
Class 5 - 500 - 550 (or 3 of the 4 components score higher than 100)
Class 6 - 450 - 500 (or 2 of the 4 components score higher than 100)
Class 7 - all others not included above

Provincially significant wetlands include Classes 1, 2 and 3. The objective of this Atlas is to identify all available data on wetland boundaries. The Notes column will also identify wetland class, when that information is available. For further information on wetland classes, contact OMNR.

For a discussion of the different Types of wetlands present on the Great Lakes, see Appendix D of Environment Canada's "Oil Spill Shoreline Clean Up Assessment Team (SCAT) Manual for the Ontario Great Lakes and St. Lawrence River Shorelines", or consult the local office of the Ontario Ministry of Natural Resources. In the United States, contact the New York State Department of Environmental Conservation.

Areas with unique or regionally or seasonally significant habitats (e.g. migratory stopovers) are also considered to be Areas of Ecological Significance.

'Dune Formations'

This line symbol denotes areas along the shore where vegetated or unvegetated sand dunes exist. Their sensitivity is outlined in the 'Notes' column for responders. Damage to vegetation on dunes can lead to further dune erosion.

6.4 Countermeasures

'Access Site (for land vehicles)'

This symbol identifies locations where a good road is close enough to the shore, and an existing trail is adequate to walk to the water and drag boom and light equipment for response purposes. Note that any access over private property will require permission from the landowner before response activities commence at that location. The same applies to the use of private boat launches. Comments regarding private property are noted on the Supplement version and in the master database.

'Approach Concerns: Foreshore Flats/Rocky Reefs/Submerged Vegetation'

Approach concerns may indicate the presence of foreshore flats, rocky reefs or submerged vegetation (seasonal variation). These markings denote some of the features that will be of concern to responders when approaching a shore from the water. These markings are meant to reinforce existing navigational aids and charts, not replace them.

The submergent vegetation beds located along Lake Erie and the Niagara River represent more than an approach concern. Responders should make efforts to protect the submergent vegetation beds as they are critical habitats for numerous aquatic species and important feeding areas for fish populations (OMNR, 1994).

'Exposed Rock'

This marking denotes a feature that will be of concern to responders during response activity. These markings are meant to reinforce existing navigational aids and charts, not replace them.

'Coast Guard Light Station'

This symbol shows the approximate location of manned or unmanned Canadian or United States Coast Guard light station installations. Equipment and facility details vary by location; full information is maintained in the master database. Often, facilities such as helicopter pads and buildings will also be identified by their own corresponding symbol. Contact CCG Operations Centre at 800-265-0237 (519-337-6360) or USCG District 9 at 216-522-4404 for further information regarding available facilities.

'Boat Launch: Excellent'

A boat launch is rated "excellent" if it has a large, firm surface ramp into deep water, is protected from waves, has good road access, and has sufficient space for manoeuvring large trailers. Docks to accomodate large boats must also be present.

'Boat Launch: Good'

A "good" boat launch has a solid ramp for small vessels leading into deep water.

'Boat Launch: Poor'

A "poor" boat launch symbol marks a site where a ramp of gravel exists, or merely a trail over the beach. Such sites may need additional work before being useable for response efforts. Certain additional locations have been described in the 'Notes' column as suitable sites for dragging small craft over the sand or cobble beach, but these have not received boat launch symbols.

'Helicopter Landing Site'

Only designated sites with proper pads for helicopters up to the 'B212' (or equivalent) size are noted. Pilots will advise on other acceptable landing sites, as required, during response to a spill.

'Staging Area: Excellent'

Staging areas are locations for setting up and deploying response equipment and for establishing command centres or outposts. Before a staging area is rated "excellent", it must have large parking and storage space, a building suitable for operational headquarters, adequate power and telephone, road and water access, and docking facilities.

'Staging Area: Good'

A "good" staging area has road and water access, telephone, power, parking space, and facilities adequate enough to establish a small or secondary command post/headquarters.

'Staging Area: Poor'

A "poor" staging area is in a more remote location, and is probably the only site available. It will have road and water access, as well as space for a command post trailer.

'Automated Weather Stations'

These locations have been identified in Canada by DOE's Atmospheric Issues Division or by NOAA in the United States to give an indication of the nearest station to a given spill. Portable emergency equipment is available for site specific weather reporting in case of an environmental emergency. Contact DOE's Ontario Region Environmental Emergencies Duty Officer (416-346-1971) or NOAA's Scientific Support Coordinator (206-526-6317) to make the appropriate arrangements.

Additional Countermeasures Note:

The Supplement version of this Atlas includes additional layers of information for use by spill response experts, as outlined below:

'Equipment Depot' and 'Boom Storage Site (Marine Emergency Response Trailer)'

Great Lakes Response Corporation (PIMEC, Inc.), Canadian Coast Guard and United States Coast Guard response equipment depots and boom storage sites (Marine Emergency Response Trailers) are identified on the appropriate map page in the 'Notes' column of the atlas, and as symbols in the Supplement. Contact CCG Operations Centre at 800-265-0237 (519-337-6360) or USCG District 9 at 216-522-4404 for further information regarding available equipment.

'Location of Collection and Recovery Site'

These locations mark areas where oil will likely collect naturally, and where clean up and recovery operations could be carried out, for instance on sand beaches or platform rock. In some cases, booms could be used to direct oil to these locations to facilitate clean up and recovery and protect more sensitive adjacent shores.

'Suggested Boom Deployment'

These markings show only suggested positioning of boom. They do not give boom length requirements. Estimated boom length requirements, however, are listed in the master database. The master database will describe the use for the boom, i.e., whether deflection, exclusion or containment booming should be used, or suggest the sealing of a culvert in a causeway.

These boom deployments are only suggestions for countermeasures. The actual deployment of boom during an environmental emergency will be guided by spill response experts, following a prompt review of the circumstances related to the actual spill.

7.0 Sensitivities of Biological Resources; Vulnerability to Spilled Oil on the Great Lakes and Connecting Channels

This section includes direct quotes or summaries of information from the Canadian Wildlife Service and the Natural Resource Response Guide Series produced for the U.S. National Oceanic and Atmospheric Administration (NOAA) by Research Planning, Inc. (RPI). Such guides, along with local resource experts, may be consulted to obtain specific information regarding life history, habitat preferences, behaviour, and other ecological factors that influence sensitivity to spilled pollutants.

A short description of the sensitivity to spilled oil or hazardous materials will follow for the biological groupings of fish, birds and shore associated mammals. Prior to discussing individual biological groupings, a few definitions will assist responders in determining the expected impact of spills.

Aromatic hydrocarbons are a major group of cyclic petroleum hydrocarbons such as benzene and toluene that are moderately soluble in water and are generally highly toxic to aquatic organisms. **Refined oil** is the product of distillation of crude oil into light or heavy components. Light refined oils include gasoline, kerosene, diesel oil, and individual components such as benzene or toluene. Heavy refined oils include fuel oil Numbers 4 (Heating Oil), 5, and 6 (Bunker C). The **water-soluble fraction (WSF)** is that portion of an oil that is soluble in water under equilibrium conditions. The water-soluble fraction of petroleum hydrocarbons is composed mostly of aromatic hydrocarbons, such as benzene or toluene (NOAA, 1987).

7.1 Fish

Regarding fish, the adverse impacts associated with spills of crude and refined oils are primarily caused by the chemical toxicity of the water-soluble fraction.

> "The WSF is the portion of oil that marine fish are most likely to be exposed to during an oil spill. Oils that are relatively soluble in water will be more likely to cause toxic effects to fish. For this reason, refined petroleum products (especially gasoline) present a much more severe threat to open-water marine fish than do crude oils."

> "A review of experimental and accidental oil spills shows that...the average concentrations of oil likely to be encountered by open-water fish are about 100 to 10,000 times lower than the acute toxicity values of most petroleum hydrocarbons. Therefore, an oil slick floating on the water surface is unlikely to affect adult fish, but there is some potential for toxic effects to...eggs and larvae" (RPI, 1987).

Toxic effects may also occur as a result of direct contamination of the shallow habitats used by fish and it is therefore important to identify critical fish habitats.

> "Such contamination may result in acute short term toxic effects from the oil or long term effects from residual hydrocarbons that are persistent in sediments. Heavy refined oils (including Heating Oil and Bunker C) contain a high proportion of these hydrocarbons known to cause chronic contamination of shorelines. This type of contamination can cause toxic effects to fish species that spawn in shallow areas, and these effects may occur long after the spawning sites were initially exposed to oil" (RPI, 1987).

According to the Ontario Ministry of Natural Resources, all wetlands along the shores of Lake Erie and the Niagara River are considered critical fish habitat which should be given high priority for protection (pers. comm., OMNR, 1992). Other areas of critical fish habitat such as spawning beds and migration routes are identified throughout Lake Erie and the Niagara River on the individual maps.

Much of the data represented in the Atlas refers to anadromous fish. These are fish species that live in brackish (slightly salty) or salt water as adults and ascend freshwater coastal rivers to spawning and nursery grounds. Many freshwater fish such as lake sturgeon, walleye, trout and salmon are considered to be anadromous fish in the Great Lakes where they ascend tributary rivers during spawning.

> "All anadromous species are considered to be at moderate to high risk from oil and hazardous materials spills occurring in navigable waters due to their dependence on certain nearshore and shallow water habitats for critical stages of their life cycle" (RPI, 1987).

Adult fish are at moderate risk during spawning runs since they must pass through nearshore areas where spills are likely to pose a significant threat of toxic exposure.

> "Eggs and larvae are at a high risk of exposure at spawning areas. These life stages are unable to avoid waterborne pollutants due to poor swimming ability or dependence on certain habitats such as gravel streambeds. Spills that result in contamination of bottom sediments pose the most serious threat to anadromous fish populations because eggs of many species adhere to or are buried in sediments. Salmonids are probably the most sensitive to contamination of spawning areas because their eggs are spawned in shallow waters, and they remain in the sediments for many months prior to hatching and downstream migration" (RPI, 1987).

Juvenile fish are dependent on shallow, nearshore nursery areas. This places them at a moderate to high risk of exposure to toxic concentration of pollutants during spills.

7.2 Birds

> "Most of the negative effects of oil spills on marine birds are the result of the birds coming into direct contact with floating oil. Exposure of birds to oil has the primary effect of fouling the plumage. Oil causes disruption of the fine structure of the small strands that form the feathers, causing loss of their water-repellent characteristics. The plumage of oiled birds also becomes matted, allowing water to penetrate to the body surface, which results in chilling and hypothermia as well as a loss of buoyancy" (RPI, 1988).

Some bird species are more vulnerable to oil spills than others.

> "Presumably, those species that are able to leave the water and thereby reduce or avoid hypothermia (such as gulls, wading birds, and some waterfowl) are more tolerant to oil" (RPI, 1988).

> "Oiled birds can also readily ingest oil during preening. The effects of ingested oil include anemia, pneumonia, intestinal irritation, kidney damage, altered blood chemistry, decreased growth, and decreased production and viability of eggs" (RPI,, 1988).

Direct exposure of eggs to oil has the greatest potential for reproductive damage. Exposure to very small quantities of oil during the early stages of incubation are most toxic. Oiled adult birds can easily transfer toxic doses to eggs.

Certain behavioral characteristics of birds can increase their vulnerability to impacts of oil spills. "Feeding, flocking and roosting behaviours of many species result in repeated or prolonged diving into or sitting on the water surface where contact with floating oil is possible" (RPI, 1988).

There have been various indices developed to determine relative sensitivities of birds to oil. These typically consider factors such as range, population, habits, mortality, and annual exposure in a given region (RPI, 1988).

As discussed in Section 5.2, such factors will be taken into account by local resource experts at the time of a spill. For the purposes of this Atlas, some considerations have been listed to give a general idea of relative sensitivities.

The following paragraphs summarize the vulnerability of the various bird categories symbolized in the Atlas legend. Again, the Canadian Wildlife Service and NOAA's Natural Resource Response Guide for Marine Birds (by RPI) are the main sources for this information.

7.2.1 Migratory Waterfowl

The vulnerability of waterfowl to spilled oil is highly variable, depending primarily on habitat preference. Geese and many diving ducks are highly vulnerable because they tend to concentrate in large flocks on relatively exposed offshore and nearshore waters during migration. Dabbling ducks are less vulnerable due to their preference for more protected coastal wetlands. Loons and grebes (water birds) are highly adapted to an aquatic existence and rarely leave the open water where they are present during much of the year. This increases their vulnerability to an oil spill, but they do not form large flocks. They tend to occur in small groups or as scattered individual birds.

7.2.2 Colonial Nesting Birds

> "The most significant offshore terrestrial animal resources at risk from an oil spill are nesting colonies of gulls, terns, and cormorants. Although colonies on the Great Lakes are widely scattered, an oil spill could have a significant effect if large colonies are within the spill zone" (Owens et al., 1992).

For the Environmental Sensitivity Atlas for Lake Erie (Including the Welland Canal) and the Niagara River Shorelines", as noted in Section 6.2.2, the Colonial Nesting Birds category includes gulls, terns and cormorants. Only one species of cormorant nests on the Great Lakes and Connecting Channels. Terns and cormorants are highly vulnerable in that they feed on fish and are therefore forced to use waterbodies for foraging. Cormorants are true divers (i.e. they dive from the surface of the water and swim underwater pursuing their prey), whereas terns plunge dive from the air. The feeding behaviour of diving birds such as cormorants results in regular entry into the water, increasing their vulnerability to spilled oil. On the other hand, terns and cormorants tend to roost on islands, structures, etc., rather than on the water itself.

> "These birds do not form large flocks or roost on the water, so mass mortalities are not likely" (RPI, 1988).

Gulls (ringbills and herring) often feed on sources such as dumps or farm fields, but they also forage along the shores of the Great Lakes, catching fish by plunge diving, as terns do. Surface feeding birds such as gulls...

> "...often form large flocks that regularly roost on the open water. This behaviour can result in large kills from spilled oil, but based on numerous case histories, impacts to these birds are usually not severe. This is due in large part to their highly adaptable nature. Gulls are well known for their ability to exploit a wide range of habitats and food sources and they also are relatively prolific breeders. They are readily able to avoid oil spills, and their populations can recover from mortalities if they occur" (RPI, 1988).

The breeding season varies for colonial waterbird species. Gulls usually return to the colonies before snow and ice has melted, but terns normally return several weeks later (feeding exclusively on fish, they need to be assured of open water). In the Lake Erie and Niagara River shoreline areas most activities at the nesting colonies will take place during May through August.

7.2.3 Wading Birds

Herons, egrets and cranes have much lower vulnerability to floating oil because they are rarely immersed in the water and do not flock or roost on the water. For this reason they are identified separately on the maps, even though herons and egrets are also considered to be colonial waterbirds. Herons and egrets stalk shallow pools, immersing only their heads to catch prey. These types of birds tend to avoid oiled areas, but responders must be aware of the possibility of contamination or loss of their food sources in the water column of shallow, sheltered waters (RPI, 1988). On Lake Erie and the Niagara River shorelines, most activities at the nesting colonies will take place during May through August.

7.2.4 Shore Birds

Most shorebirds have low to moderate vulnerability to spilled oil. They are rarely immersed in water and are unlikely to encounter spilled oil. They do not form large staging flocks along the Lake Erie and Niagara River shorelines. At certain times in other areas (for instance, on Lake Ontario), their habit of flocking by the thousands to a limited number of specific locations (very shallow, productive waters) increases their vulnerability, due to the impact that oil spills could have on their highly localized food source (on which they are heavily reliant).

7.2.5 Raptors

Bald eagles are considered to be highly vulnerable in the event of an oil spill. Although they rarely enter the water and are unlikely to be oiled, they have a small population and a very long recovery rate. "Osprey are much more marine oriented and will capture fish directly from the water. They are ranked as moderately vulnerable (lower than bald eagles) because they are more common and more widely distributed than bald eagles" (RPI, 1988). For both of these species, consumption of oiled prey is a concern.

7.2.6 Bird Seasonality

When such information is available, the 'Notes' column on individual map pages gives site specific descriptions of seasonality. In the following table, a general description is provided for species occurring on the Lake Erie and Niagara River shorelines.

Table 1A: Lake Erie Bird Seasonality: Colonial Waterbirds

				Category			Abundance		
Species	Period present on Lake Erie	Breeding Season Δ	Nest Location	Migrant	Summer Resident	Winter Visitor	Common	Uncommon	Rare
Double-crested Cormorant	Late March to October	April to August	On ground and in trees (islands and peninsulas).	√	√		√		
Great Blue Heron	March to December	April to August	In trees (islands and mainland)	√	√	√		√	
Black-crown Night Heron	April to September	April to July	In trees and bushes (islands)	√	√			√	
Herring Gull	March to December	April to July	On ground (islands)	√	√	√	√		
Ring-billed Gull	February to December	April to July	On ground (islands)	√	√	√	√		
Common Tern	April to October	May to July	On ground (islands)	√	√			√	
Caspian Tern	April to May and July to August		On ground (islands)	√					√
Forster's Tern	April to August	May to July	In marshes	√	√				√

Δ From establishing nesting territories through fledgling chicks. (Canadian Wildlife Service, 1994)

Table 1A: Niagara River Bird Seasonality: Colonial Waterbirds

				Category			Abundance		
Species	Period present on Niagara River	Breeding Season Δ	Nest Location	Migrant	Summer Resident	Winter Visitor	Common	Uncommon	Rare
Double-crested Cormorant	April to October	Don't breed	On ground and in trees (islands and peninsulas).	√				√	
Great Blue Heron	March to December	April to August	In trees (islands and mainland)	√	√	√		√	
Black-crown Night Heron	April to September	April to July	In trees and bushes (islands)	√	√			√	
Herring Gull	All year	April to July	On ground (islands)	√	√	√	√		
Ring-billed Gull	All year	April to July	On ground (islands)	√	√	√	√		
Common Tern	April to October	May to July	On ground (islands)	√	√			√	
Caspian Tern	April to May and July to August		On ground (islands)	√					√

Δ From establishing nesting territories through fledgling chicks. (Canadian Wildlife Service, 1994)

Table 1B: Lake Erie and Niagara River Bird Seasonality: Waterfowl, Shorebirds, Raptors

Species	Status	Period Present on Lake Erie
Common Loon	Common migrant and occasional breeder	Very common throughout migration (March to May, August to November)
Gallinules	Common migrants; common breeders	Breeding birds present during ice-free period
Grebe species	Common migrants; rare breeders	Migration (March to May, September to November)
Canada Goose	Very common migrant; extremely common local breeder	Migration (March, April, October and November) Resident "giant" Canada Geese present year round
Dabbling Ducks (including green-winged teal, pintails, wigeon, black ducks, gadwall, shoveler)	Very common migrants; uncommon breeders	Migration (March, April, September to November) Black Ducks - year round
Dabbling Ducks (including mallard, wood duck and blue-winged teal)	Extremely common migrants; very common local breeding	Migration (March, April, September to November) Mallards - year round
Diving Ducks (including scaups, oldsquaw, common goldeneye, buffleheads, ring-necked ducks, redheads, canvasbacks)	Very common migrants and winter residents; very rare breeders	Some present year round; most common (September to May); Migration (March, April, October and November)
Shorebirds (including sandpipers and plovers)	Locally common migrants; common breeders	During ice-free period (March to November)
Bald Eagles	Local resident; locally common breeders on Long Point	Year round
Osprey	Common migrant and rare breeder	During ice-free period (March to November)
Peregrine Falcon	Very rare migrant	Migration (April, May, October and November)

(Canadian Wildlife Service, 1994)

7.3 Shore Associated Mammals

A shore associated mammal's exposure to spilled oil can result in a significant reduction in the insulative property of its fur. Once exposed to oil, a mammal's grooming activity may lead to ingestion of oil. (RPI, 1989).

8.0 Sensitivities of Human-Use Resources; Vulnerability to Spilled Oil on the Great Lakes and Connecting Channels

Factors to consider when establishing sensitivities of Human-Use Resources include economic value, resource 'replaceability', risk to public health, and cultural/archaeological value.

No rigorous ranking scheme has been employed for these features, as discussed in Section 5.2. Broad terms such as "highly valued" have been used in the 'Notes' column to give an indication of the level of priority likely to be assigned to a Human-Use Resource during spill response.

9.0 Shoreline Habitats and Associated Countermeasures

9.1 Lake Erie and Niagara River Shoreline Habitat Classification Scheme

The Canadian shoreline of Lake Erie (Including the Welland Canal) and the Niagara River shorelines have been classified as shown below. The Canadian Environmental Sensitivity Index (ESI) number for each shoreline type indicates the sensitivity ranking of that type. The equivalent United States ESI is also listed to aid U.S. agencies and responders familiar with the "Sensitivity of Coastal Environments and Wildlife to Spilled Oil" Atlas series prepared by Research Planning, Inc. In both classification schemes the higher numbers indicate greater relative sensitivity to the impacts of an oil spill. Colours range from "coldest" (blue) for 'Exposed Bedrock Bluff', shore type 1a to "hottest" (red) for 'Broad Wetland', shore type 13b.

Response priorities will be finalized at the time of a spill. The fact that a Broad Wetland is denoted in red does not necessarily mean that it would be boomed ahead of all other areas. Spill-specific circumstances will dictate actual protection measures.

U.S. ESI Ranking	Can ESI Ranking	
		Bedrock or Impermeable Shores
1a	1a	Exposed Bedrock Bluff less than 1 metre elevation
1a	1b	Exposed Bedrock Bluff 1-5 metre elevation
1a	1c	Exposed Bedrock Bluff greater than 5 metre elevation
1b	2	Retaining Wall/Harbour Structure/Breakwaters (Anthropogenically modified shore)
2	3	Shelving Bedrock
		Unconsolidated Sediment Shores
3	4	Exposed Sediment Bluff
4	5a	Sand Beach: Depositional
4	5b	Sand Beach: Erosional or Transitory
4	6	Sand Barrier with Lagoon
6a	7a	Pebble Beach
6a	7b	Pebble/Cobble Beach
6a	7c	Cobble Beach
6b	8	Rip Rap (Anthropogenically modified shore)
6a	9	Boulder Beach
5	10	Mixed Beach (% by sediment in DOE Database)
		Vegetated Shores
9a	11	Low Vegetated Bank (Grass or Trees)
9b	12	Delta Mud Flat
10a	13a	Fringing Wetland
10b	13b	Broad Wetland

9.2 Shoreline Habitat Characteristics and Appropriate Countermeasures

In this section, the major physical characteristics of each Shoreline Habitat will be discussed. A photograph is provided for each shoreline type present in the study area, depicting a typical example on Lake Erie or the Niagara River. Expected oil behaviour and residence time for each Shoreline Habitat will be described. Suggestions for appropriate clean up methods for each shore type will be made.

The following shoreline characteristics will be addressed:

i) Shoreline Morphology - includes a description of shoreline width, slope and characteristic topography, component sediment type(s), and the wave/littoral drift environment. Littoral drift is sedimentary material that is transported in the littoral (coastal) zone under the influence of waves and currents.

ii) Shoreline Sensitivity - includes oil residence time, natural oil removal processes/rate, and the impact to immediate flora and terrestrial fauna.

iii) Clean Up Operations - involves identifying effective clean up methods for each shoreline type, as well as indicating potential environmental hazards that the clean up operation may pose.

In general, in the Great Lakes the water volume and distances between shores are insufficient to "absorb" large quantities of oil. Oil moved off one shoreline will likely reappear on an adjacent shore. Environment Canada recommends cleaning any oil deposits which can be removed safely and without causing further habitat damage.

All of the clean up methods outlined are suggestions only. Each has certain implications or drawbacks that must be weighed on a site by site basis by spill response experts at the scene of a spill. **All clean up methods employed require measures to ensure the collection and proper disposal of oil as it is liberated from the shore.**

Additional information on shoreline protection and clean up is addressed in the Environment Canada video **"Great Lakes Shoreline Protection and Clean Up."** Contact Chromavision International Inc. (613-748-5335) for ordering details.

9.2.1 Bedrock or Impermeable Shores

1a. Exposed Bedrock Bluff
less than 1 metre elevation (No photograph available)

1b. Exposed Bedrock Bluff
1-5 metre elevation

1c. Exposed Bedrock Bluff
greater than 5 metre elevation

ESI 1a, 1b, and 1c. Exposed Bedrock Bluff (U.S. ESI 1a)

The combination of resistant bedrock surfaces, little sediment, steep slopes, and a constant, high wave energy environment make exposed bedrock bluffs the least sensitive shoreline to oiling. This shoreline type is rare in the study area. Chicken Island in western Lake Erie has shore type 1a. Shoreline habitat 1b is present at Fort George National Historic Park near the Lake Ontario opening of the Niagara River. The Niagara Falls area exhibits extensive stretches of shoreline habitat 1c.

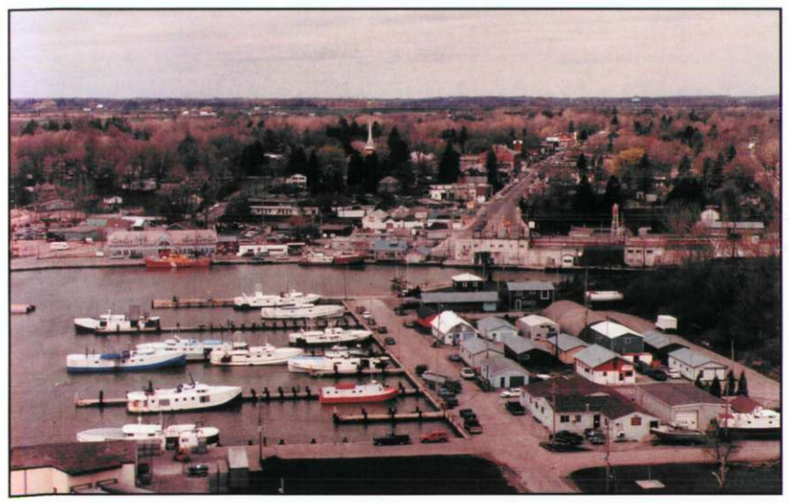
If the stranded oil is below the normal limit of wave action, it would persist for only a few days to weeks. If shoreline oiling occurred during a storm event then the material would be stranded and unaffected by normal wave action, until the recurrence of a subsequent storm event of similar magnitude. Lower bluffs (< 1 m elevation) are generally more sensitive since they usually have rough surfaces, containing many fractures and depressed pockets. Oil may collect within these surfaces and persist for up to several seasons.

Bedrock bluff shorelines are not especially biologically sensitive due to scant flora and terrestrial fauna.

Bedrock bluff shorelines with a heightened Human-Use value or bluffs which were oiled during storm events, will likely require remedial clean up measures. Low-pressure hosing and manual oil scraping are the preferred clean up methods. Steam cleaning and/or high-pressure hosing may be considered for the most resistant rock surfaces.

Access to these shores is often poor by land and hazardous by water, especially below Niagara Falls. Bedrock bluff shorelines in locations without heightened Human-Use value may be permitted to self-clean through natural abrasion processes, if manual removal is unsafe or logistically impossible.

All clean up methods employed require measures to ensure the collection and proper disposal of oil as it is liberated from the shore.



ESI 2. Retaining Wall/Harbour Structure/Breakwaters (U.S. ESI 1b)

When artificial shorelines are created through construction, the shoreline is designated as Retaining Wall/Harbour Structure/Breakwaters. Retaining walls are usually small isolated features used to protect private property from bank erosion. They are composed of wood pilings, structural steel, asphalt, or concrete. When concentrated in near-continuous stretches (such as along large ports) they are termed harbour structures. Rip rap material encased within wire netting can be used to front shorelines, resulting in a vertical shore classified as harbour structure.

Retaining wall/harbour structure shores are not particularly sensitive to oil, or clean up operations. This shoreline type commonly supports very little plant or animal life, except for bird use along the structure's upper portions. There is minimal oil persistence along sections exposed to regular waves, but long term oil persistence is possible along sheltered sections.

Hard, durable harbour structure surfaces permit the use of high-pressure hosing or steam cleaning for clean up. Recently spilled oil can be effectively cleaned by means of low-pressure hosing. Ships docked along harbour facilities will similarly require all traces of oil residue removed from their hulls before leaving the port.

All clean up methods employed require measures to ensure the collection and proper disposal of oil as it is liberated from the shore.

ESI 3. Shelving Bedrock (U.S. ESI 2)

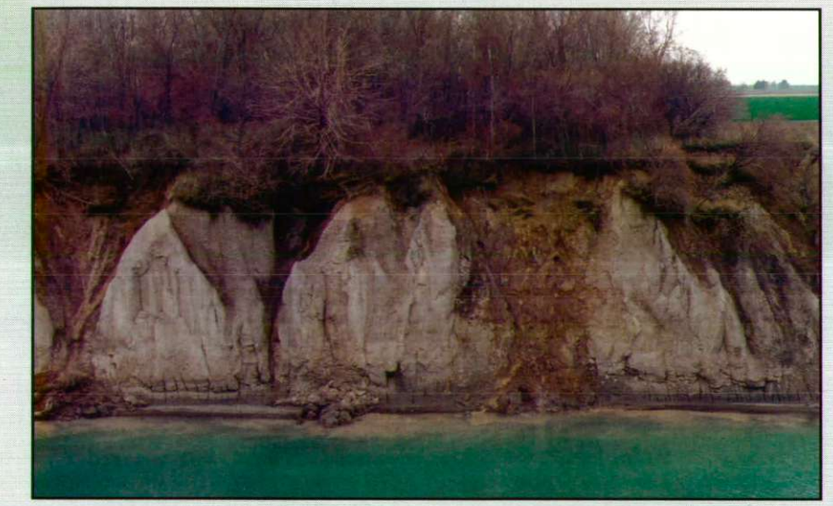
Shelving bedrock shores are wide, flat expanses of bedrock, at or immediately below normal water levels. This shoreline type is fairly common in the study area, especially at the Lake Erie entrance to the Niagara River.

Generally, shelving bedrock shores are lower energy wave environments than bedrock bluff shores. Waves could carry oil across the full width of the shelf.

Continued wave exposure would likely readily cleanse oil from the lower reaches of the shelf. Oil deposited during a storm would be stranded above normal water levels and would be naturally cleansed only during storms of similar magnitude.

Inaccessible shelving bedrock shores may naturally self-clean (perhaps within two seasons). Other shores, including those with high aesthetic or recreational value, will likely require remedial clean up measures. Oil which collects within depressed regions of the shelf may be cleaned manually or by sump/pump removal. Stranded deposits could be removed by low or high-pressure hosing or steam cleaning for the most resistant rock surfaces. Shelving bedrock shores which support high populations of birds, especially nesting sites, should be cleaned manually to minimize disturbance.

All clean up methods employed require measures to ensure the collection and proper disposal of oil as it is liberated from the shore.



9.2.2 Unconsolidated Sediment Shores

Unconsolidated sediment shores differ from bedrock shores in that the material is loose and non-cemented.

ESI 4. Exposed Sediment Bluff (U.S. ESI 3)

These bluffs are predominantly erosional forms, carved by wind, wave and surface water erosion. They form where accumulations of glacial material border the shoreline and are exposed to direct wave action. Lake Erie's Canadian shore has many long sections of exposed sediment bluff. There is little biological activity along these bluffs.

Shoreline sections are commonly steep and relatively narrow (< 4 metres). Very high, wide sections of unconsolidated material are common along the Lake Erie shore.

Spilled oil would be deposited along the lowest portion of the bluff, where wave energy is high, and the oil would be self-cleaned within days or weeks through wave abrasion. Oil deposited during storms may be stranded above this level and may persist until manually removed or subsequent storm surges self-clean the area.

The clean up of stranded oil along unconsolidated sediment bluffs is made difficult by the lack of a shore zone beach, steep bluff slopes, and the ease of bluff erosion. Heavy machinery would be unable to access high or extensive sediment bluff sections. The removal of material at the base of the bluff could promote slumping or landsliding; a serious hazard to clean up crews, and land owners residing on the crest of the bluff. Similarly the use of low/high-pressure hosing or steam cleaning could remove sufficient sediment to induce slope failure.

In the case of small sediment bluffs where shore zone access is available, manual clean up is recommended. Very steep or high sediment bluff sections are generally not accessible; in these instances it is recommended that the oil deposit naturally self-clean.

All clean up methods employed require measures to ensure the collection and proper disposal of oil as it is liberated from the shore.

ESI 5a. Sand Beach: Depositional (U.S. ESI 4)

Depositional sand beaches occur in this area where wave deposited sand has accumulated, often in coves or other sheltered environments or as part of a major depositional feature (e.g. Point Pelee). On a depositional beach, the gross annual amount of sediment entering the system exceeds the gross annual amount of sediment leaving the system (positive net annual sediment budget). Offshore regions tend to be shallow and uniformly sloping, frequently with shore-parallel underwater bars.

Several major depositional beaches are found along the north shore of Lake Erie. For example, the southeast end of Long Point is comprised of depositional sand beaches backed by a series of parallel sand dunes.

Biological activity typically includes the presence of shorebirds, and sand beaches are often of high recreational value.

Spilled oil would be deposited along the upper limit of wave action. Heavy or viscous oil rarely penetrates more than 2 centimetres, though with higher temperatures or lighter oil, penetration depth will likely increase.

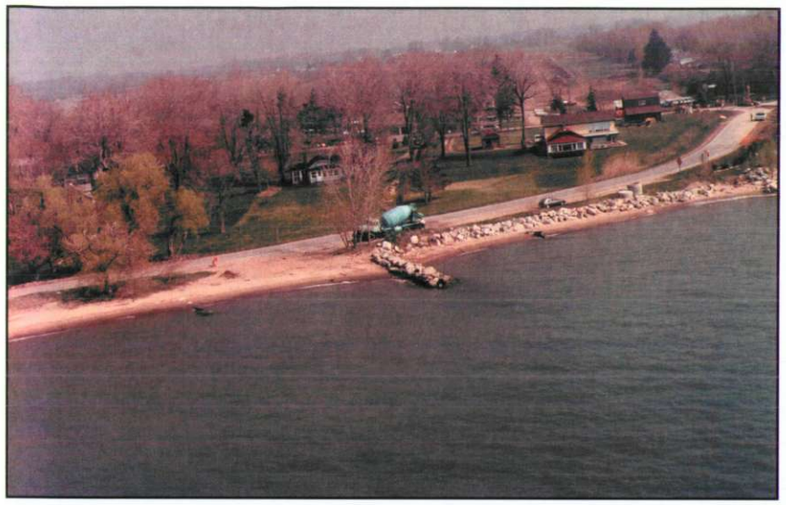
If water levels were normal the stranded oil deposit may be buried by subsequent storm beach deposits. It is important to locate and remove oil before subsequent burial, when possible. When buried, stranded oil can persist for decades, requiring regular clean up for several years, as the deposits resurface.

In times of elevated water levels, oil may be stranded above the normal swash zone if not removed by clean up teams, where it could weather to form an "asphalt pavement". Eroded asphalt pavement material is often deposited over a wide area as small "tar balls".

Sand beaches, due to their shallow slopes, load bearing capacity, lack of vegetation, and many access roads often permit the use of heavy machinery such as graders/scrapers. Note that sediment removal must be minimized; if too much sand is removed, the beach may be destabilized, causing accelerated beach erosion.

Beach cleaning machines may be used to remove stray tar ball deposits from affected beaches. On very narrow beaches, or those without road access, manual raking is a slow but effective method.

All clean up methods employed require measures to ensure the collection and proper disposal of oil as it is liberated from the shore.



ESI 5b. Sand Beach: Erosional or Transitory (U.S. ESI 4)

Both erosional and transitory sand beaches are present along the Lake Erie shoreline, although most are erosional. On an erosional beach, the gross annual amount of sediment leaving the system exceeds the gross annual amount of sediment entering the system (negative net annual sediment budget). For the purposes of spill response, an erosional beach at any given point in time behaves in the same manner as a depositional beach, except that buried oil will likely resurface more often.

Transitory beaches tend to form in areas with a neutral or near zero net annual sediment budget. During times of normal water levels, sediment may collect in small coves or wave-cut notches to form a poorly defined beach. Such deposits are transient and are regularly removed during storms.

Transitory sand beaches are extremely narrow and often quite steep. Offshore regions are often very deep, permitting waves to break very close to the shoreline.

Oil deposited on a transitory sand beach during times of normal water level is apt to be quickly eroded during the next major storm surge, and transported down drift (likely within one season) to strand elsewhere, likely as sediment-laden "tar balls".

Clean up operations along transitory sand beaches are complicated by the lack of access roads, and the mobility of the beach material. Where clean up can be very quickly undertaken, manual raking of the beach is recommended.

Clean up should not be attempted along transitory beaches which occupy wave-cut notches in unconsolidated sediment bluffs. The danger of bluff slumping to clean up crews, as well as the risk to property owners at the crest of the bluff, is too great. In this environment natural self-cleaning should be allowed, though down drift locations are likely to be affected by tar balls which wash ashore.

ESI 6. Sand Barrier with Lagoon (U.S. ESI 4)

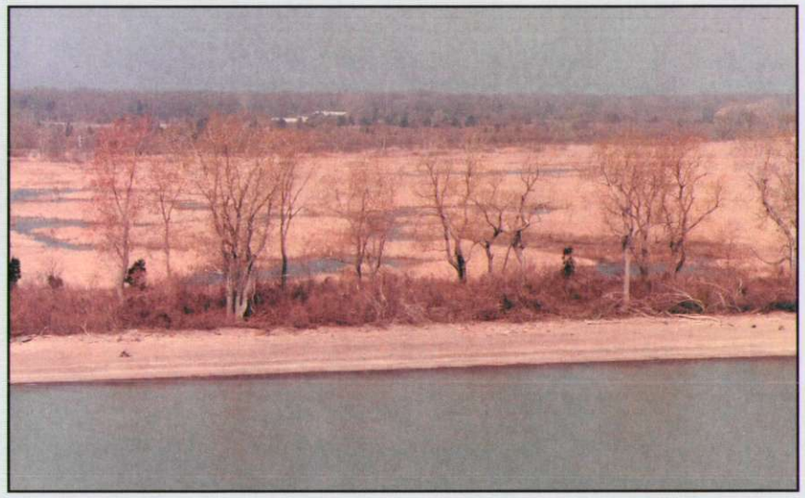
This shore type occurs where littoral drift causes a smooth barrier of sand to form and effectively seal a cove. Coves containing a stream typically have a very small opening (the "outlet") in the sand barrier. The backwater cove which forms is termed a lagoon. This shoreline type is fairly common in the study area, for instance at Fox Lagoon on Pelee Island, or the south side of Long Point.

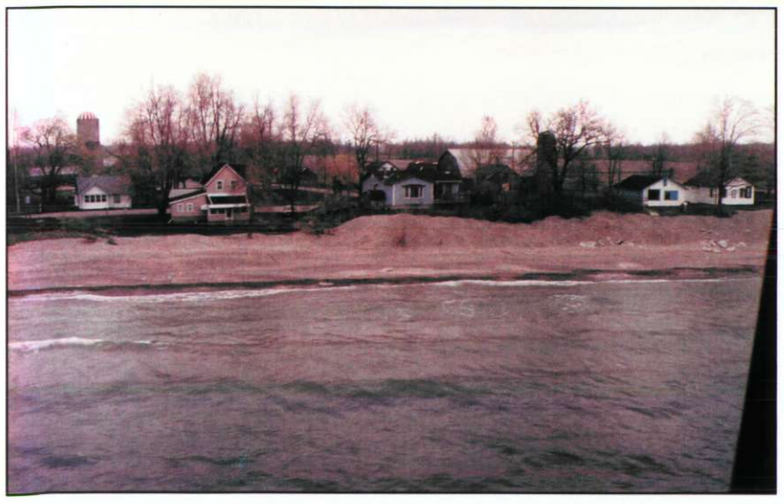
The thin, low sand barrier protects the lagoon from wave action, and a wetland often develops. Such wetlands are especially sensitive to disturbances of the protective sand barrier.

The impact of an oil spill on the sand barrier would be similar to that for a depositional sand beach. It is unlikely that oil could cross the barrier through wave washover or beach erosion. Oil could, however, enter the lagoon if waves cross the outlet, which is likely in storm events.

In the event of a spill, boom should be deployed to seal the barrier outlet, and diversion booms used to deflect oil from the sand barrier. Small outlets could be closed with a sediment dyke or sand bags. Heavy machinery should not be employed for clean up. The removal of sand during clean up, compaction of sand by machinery, plus the potential of vegetation disturbance along the barrier crest could result in extensive barrier erosion and the inundation of the lagoon environment. In this instance manual raking of affected shorelines is the only acceptable clean up method, except in those cases where close supervision ensures minimal sediment removal or compaction.

All clean up methods employed require measures to ensure the collection and proper disposal of oil as it is liberated from the shore.





ESI 7a. Pebble Beach (U.S. ESI 6a)

Pebble beaches are shore accumulations of coarse sediment (0.2-4 cm diameter) that form in a higher energy wave environment compared to sand beaches. Pebble beaches are characteristically narrower and steeper than sand beaches; widths of 2-5 metres are common in the Great Lakes. However, pebble beaches are uncommon along Lake Erie and the Niagara River shorelines.

Oil will penetrate a pebble beach to occupy the spaces between pebbles; penetration depths of 0.5 metres have been observed. Very light oil, though able to penetrate the sediment, would be washed through the beach sediment and into the lake by wave action. Heavy oil may remain on the surface and, after weathering, cement pebble grains to form asphalt pavement.

On a pebble beach, where the sediment moves more readily with wave action, subsequent storms tend to bury oil stranded high on the beach. Oil buried at a depth of 0.5 metres or more could persist for years before natural abrasion by wave action removed the deposit.

Sensitive flora and fauna may be adversely affected by oil on shore and in the water column, for instance when certain fish species are spawning along these shores, or if organisms ingest oil or become coated in oil.

Most pebble beaches are thin, relatively steep and lack easy road access, so use of heavy machinery is restricted. The load bearing capacity of pebble beaches can often support light equipment such as bobcats. Physical breaking or tilling using long tynes dragged through the pebble can be effective in bringing oil nearer to the surface for self-cleaning and weathering.

Low-pressure flushing with a header deluge may assist in moving light oil through the sediment to the water's edge for collection. The use of steam cleaning and low or high-pressure hosing should be avoided on pebble beaches, since they temporarily reduce the viscosity of the oil and could drive oil deeper through the pebble material, making removal more difficult. Pebble beaches must be water flushed (header deluge) quickly, while the spilled oil is still fresh. Otherwise, the oil will be present in the substrate for a much longer time.

Manual cleaning can be an effective clean up option. Responders must be careful to minimize sediment removal.

All clean up methods employed require measures to ensure the collection and proper disposal of oil as it is liberated from the shore.

ESI 7b. Pebble/Cobble Beach (U.S. ESI 6a)

Pebble/cobble beaches are uncommon along the Lake Erie and Niagara River shorelines. They consist of a mixture of pebbles (0.2-4 cm diameter) and larger cobble material (4.5-25 cm). Generally pebble/cobble beaches are narrower and steeper than pebble beaches; widths of 2-3 metres are common.

Oil may rapidly penetrate into the spaces between pebble/cobble sediment. Even heavy oil may penetrate to a depth of 1 m or more, where it can persist for years before natural abrasion by wave action would remove the deposit.

Very light oil, though able to penetrate the sediment, would be washed through the beach sediment and into the lake by wave action. Heavy or viscous oil may remain on the surface and, after weathering, cement pebble/cobble material to form an asphalt pavement.

Sensitive flora and fauna may be adversely affected by oil on shore and in the water column, for instance when certain fish species are spawning along these shores, or if organisms ingest oil or become coated in oil.

Most pebble/cobble beaches are very thin, relatively steep, and do not have easy road access, so use of heavy machinery is restricted. The load bearing capacity of pebble/cobble beaches may support light equipment such as bobcats. If the cobbles are not too large, physical breaking or tilling using long tynes dragged through the sediment can be effective in bringing oil nearer to the surface for self-cleaning and weathering.

Low-pressure flushing with a header deluge may assist in moving light oil through the sediment to the water's edge for collection. The use of steam cleaning and low or high-pressure hosing should be avoided on pebble/cobble beaches, since they temporarily reduce the viscosity of the oil and could drive oil deeper through the shore material, making removal more difficult. Pebble/cobble beaches must be water flushed (header deluge) quickly, while the spilled oil is still fresh. Otherwise, the oil will be present in the substrate for a much longer time.

Manual cleaning can be an effective clean up option. Responders must be careful to minimize sediment removal.

All clean up methods employed require measures to ensure the collection and proper disposal of oil as it is liberated from the shore.

ESI 7c. Cobble Beach (U.S. ESI 6a)

Cobble beaches are rare along the Lake Erie and Niagara River shorelines. This shore type is made up of well sorted sediment clasts, 4.5-25 cm in diameter.

Cobble beaches are generally narrower and steeper than pebble/cobble beaches; widths of 2 metres or less are common. Cobble-sized material cannot pack tightly, permitting oil to rapidly infiltrate cobble sediment.

Large amounts of stranded heavy oil are likely to penetrate to a depth of 1 metre or more, where it can persist for years before natural abrasion by wave action would remove the deposit. Very light oil, though able to penetrate the sediment, would be washed through the beach sediment and into the lake by wave action. Heavy or very viscous oil may remain on the surface, and, after weathering, cement cobble clasts to form an asphalt pavement.

Sensitive flora and fauna may be adversely affected by oil on shore and in the water column, for instance when certain fish species are spawning along these shores, or if organisms ingest oil or become coated in oil.

Most cobble beaches are extremely thin, steep, and rarely have easy road access, so use of heavy machinery is very restricted. The load bearing capacity of cobble beaches may support light equipment such as bobcats. If the cobbles are not too large, physical breaking or tilling using long tynes dragged through the sediment can be effective in bringing oil nearer to the surface for self-cleaning and weathering.

Low-pressure flushing with a header deluge may assist in moving light oil through the sediment to the water's edge for collection. The use of steam cleaning, and low or high-pressure hosing should be avoided on cobble beaches, since they temporarily reduce the viscosity of the oil and could drive oil deeper through the shore material, making removal more difficult. Cobble beaches must be water flushed (header deluge) quickly, while the spilled oil is still fresh. Otherwise, the oil will be present in the substrate for a much longer time.

Manual cleaning can be an effective clean up option. Responders must be careful to minimize sediment removal.

ESI 8. Rip Rap (Anthropogenically Modified Shore) (U.S. ESI 6b)

When natural shorelines are mantled with debris to protect the shore from wave-induced bank erosion, the resulting shoreline is termed rip rap. Rip rap usually takes the form of large, coarse material which is inexpensive and locally available. This may include roughly quarried stone, scrap wood, damaged concrete castings, or clay pipe refuse.

Most rip rap shores are narrow and fairly steep. Wave energy within these locales tends to be high (hence the need for rip rap).

Rip rap can be an important substrate for some bird and fish activity.

The large blocks often used in rip rap behave as a boulder beach in terms of oil penetration, having large interstitial pockets between blocks that can retain oil if not thoroughly cleaned. For these reasons, certain rip rap shores may be a priority for protection measures.

In most cases, good road access permits the use of several forms of heavy equipment. In some cases, the large, blocky nature of rip rap permits the use of high-pressure hosing or steam cleaning without significantly endangering (through erosion) the underlying protected shoreline.

Recently spilled oil can often be effectively cleaned by low-pressure hosing. Small spills can be cleaned by employing manual labour and scraping the rip rap, or through the use of sorbent material to remove pooled oil.

All clean up methods employed require measures to ensure the collection and proper disposal of oil as it is liberated from the shore.

ESI 9. Boulder Beach (U.S. ESI 6a)

Boulder beaches are rare along the Lake Erie and Niagara River shorelines. Boulder beaches are accumulations of large boulders (25+ centimetres diameter), the smaller sediments having been washed away by wave action in the high energy environment.

Boulder beaches are extremely narrow and often quite steep; beach widths of 2 metres or less are common.

Boulder beach sediment, due to its large size, cannot pack densely. Light oil, when washed onshore, will rapidly penetrate boulder sediment and be washed through the beach sediment and returned to the lake by wave action. Abrasion by breaking waves and a very permeable sediment combine to remove trapped light oil relatively quickly.

Large amounts of oil are likely to penetrate to a depth of 1 metre or more, and oil could remain trapped between boulders from where it will seep out over time if not cleaned. Very viscous oil may remain on the surface, and adhere to boulders where it will eventually weather and form an asphalt pavement.

Sensitive flora and fauna may be adversely affected by oil on shore and in the water column.

Since boulder beaches are extremely thin, steep, and rarely have easy road access, the use of heavy machinery for clean up operations is severely limited. Where possible, steam cleaning or low/high-pressure hosing may be effective in speeding the removal of recently stranded oil. Due to the permeable nature of boulder beaches, oil buried to a great depth (+0.5 metres) can be effectively removed by these methods.

If these methods are not feasible, isolated boulder beaches may be considered for self-cleaning through wave abrasion, as long as adjacent sensitive shores are protected. Boulder beaches with sensitive features or high Human-Use value may be cleaned manually, using aids such as sorbent pads and scrapers.

All clean up methods employed require measures to ensure the collection and proper disposal of oil as it is liberated from the shore.

ESI 10. Mixed Beach (% by sediment in DOE Database) (U.S. ESI 5)

No photograph available.

Mixed beaches are fairly common along the Lake Erie and Niagara River shorelines, for instance along the shores west of Erieau.

They are accumulations of very poorly sorted sediment including large amounts of coarse sediment (boulders and cobbles), and some finer materials (e.g. sand). The percentage of component sediment types in each shore's case is expressed in descending order (e.g. boulders-70%; cobbles-30%) in Environment Canada's master database.

Mixed beaches are typically shallow sloped, very small (less than 100 metres in length), fairly wide, and restricted to pockets/coves between headlands, in well-sheltered, low energy wave environments. The sheltered wave environment permits the finer sediment to remain and fill the spaces between larger cobble/boulder sized material.

Oil washed ashore along mixed beaches with finer sediment is unlikely to penetrate much; this sediment limits the downward movement of oil. Only very light oils could penetrate this material. Since the sheltered wave environment limits the oil's removal by wave abrasion, deposits of oil are likely to persist for a long time on the surface of mixed beaches. Heavier oils could slowly weather to form asphalt pavements.

Sensitive flora and fauna may be adversely affected by oil on shore and in the water column, for instance if organisms ingest oil or become coated in oil.

Heavy machinery can be quite destructive to the beach surface; the sheltered wave environment ensures beach damage will not quickly be repaired by natural deposition and reworking of shoreline sediments.

On newly deposited oil, low-pressure hosing and flushing, and manual clean up with shovels, pitchforks, and sorbent pads can be effective. Sump/pump operations can be effective on thick accumulations of oil on the beach surface.

All clean up methods employed require measures to ensure the collection and proper disposal of oil as it is liberated from the shore.

9.2.3 Vegetated Shores

Shorelines dominated by vegetation are common features in sheltered environments along the Lake Erie and Niagara River shorelines. Coves protected by peninsulas, or the leeward edges of major islands often are dominated by vegetated shores.

ESI 11. Low Vegetated Bank (Grass or Trees) (U.S. ESI 9a)

Low vegetated banks are sheltered environments nearly covered in vegetation, with no erosive bluffs or exposed sediment immediately above the waterline; vegetation covers all land surfaces along the shore. Low vegetated bank shorelines are distinguished from broad and fringing wetland shores by the absence of aquatic vegetation.

Most low vegetated shorelines exist in low wave energy environments.

Generally gentle in slope, these shores include environments such as forests, meadows, fields and lawns.

Due to the very low energy environment, stranded oil is unlikely to be removed naturally. The impact of spilled oil can be effectively reduced if there is time to manually spread sorbent material along the shore prior to oiling.

Great care must be taken not to harm the vegetation during clean up, since it serves to stabilize the banks. Low-pressure flushing and hosing may be used to remove recently stranded oil as long as smaller vegetation species are not apt to be damaged, and if topsoil will not be removed by the process. Runoff water must be collected and removed. This method may drive residual oil into soil, complicating clean up operations.

An on-site expert is recommended for supervision during clean up.

All clean up methods employed require measures to ensure the collection and proper disposal of oil as it is liberated from the shore.

ESI 12. Delta Mud Flat (U.S. ESI 9b)

No photograph available.

No deltaic mud flat shorelines are present in the study area.

ESI 13a. Fringing Wetland (U.S. ESI 10a)

Fringing wetlands are a type of vegetated shoreline containing an abundance of aquatic vegetation. They are usually much smaller than broad wetlands. Along the Lake Erie and Niagara River shorelines, marsh communities are the most common form of fringing wetland. Characteristically, they are restricted to shallow water coves protected from wind or waves. They closely border the shore to form a narrow belt of aquatic vegetation offshore. The shores along Big Creek and Knapps Island near Holiday Beach Conservation Area contain excellent examples.

Oil spills pose a serious threat to fringing wetlands, which are highly valued for their importance as significant fauna habitats (nesting and spawning sites of various, often endangered species), or for the sensitive flora they contain.

Oil spilled in fringing wetlands could persist for years since wave abrasion processes are absent. The use of floating barrier booms at the mouth of coves, or deflection booms updrift of fringing wetlands could reduce oil damage to these sensitive environments.

All wetland environments are extremely sensitive to destructive clean up practices, especially when vegetation or sediment is removed, since wetland regeneration happens very slowly. The use of heavy equipment is potentially more hazardous to the wetland community than the spill itself due to the risk of vegetation destruction, compaction of organic matter, grinding of oil into marsh soil, and the spreading of oil adhered to equipment surfaces to uncontaminated wetland regions.

Low-pressure flushing and hosing, and manual use of sorbents are the safest clean up methods. Usually road access does not exist; clean up crews would likely have to be transported to and from the site by small flat-bottomed boats. The use of low-pressure hosing to herd thin sheens of oil away from vegetation and towards deeper water (where it may be collected by skimming) is one method that has been effective.

Cutting oiled vegetation should only be considered as a last resort where large amounts of persistent oil are stranded in areas sheltered from natural removal processes, and where sensitive biological resources are at risk of being affected by the residual oil. Cutting does not improve vegetative recovery in most cases. Great care must be taken not to damage or trample roots.

An on-site expert is recommended for supervision during clean up.

All clean up methods employed require measures to ensure the collection and proper disposal of oil as it is liberated from the shore.

ESI 13b. Broad Wetland (U.S. ESI 10b)

Broad wetlands are vegetated shorelines which contain an unusual abundance of diverse aquatic vegetation. Along the Lake Erie and Niagara River shorelines, marsh communities are the most common form of broad wetland.

Broad wetlands are usually quite large (1 to 2 km long), and occupy shallow water coves (often containing creek outlets) protected from wind or wave action in very low energy environments. They may extend into bay waters for hundreds of metres. The north side of Long Point is an excellent example of an extensive broad wetland.

Oil spills pose a serious threat to broad wetlands, which are highly valued for their importance as significant fauna habitats (nesting and spawning sites of various, often endangered species), or for the sensitive flora they contain.

Oil spilled in broad wetlands could persist for years since wave abrasion processes are absent. The use of floating barrier booms at the mouth of coves, or deflection booms updrift of broad wetlands could reduce oil damage to these sensitive environments. In very dense wetlands, oil is unlikely to penetrate past the outer edge of the vegetation.

All wetland environments are extremely sensitive to destructive clean up methods, especially when vegetation or sediment is removed or damaged, since wetland regeneration happens very slowly. The use of heavy equipment is potentially more hazardous to the wetland community than the spill itself due to the risk of vegetation destruction, compaction of organic matter, grinding of oil into marsh soil, and the spreading of oil adhered to equipment surfaces to uncontaminated wetland regions.

Low-pressure flushing and hosing, and manual use of sorbents are the safest clean up methods. Usually road access does not exist; clean up crews would likely have to be transported to and from the site by small flat-bottomed boats. The use of low-pressure hosing to herd thin sheens of oil away from vegetation and towards deeper water (where it may be collected by skimming) is one method that has been effective.

Cutting oiled vegetation should only be considered as a last resort where large amounts of persistent oil are stranded in areas sheltered from natural removal processes, and where sensitive biological resources are at risk of being affected by the residual oil. Cutting does not improve vegetative recovery in most cases. Great care must be taken not to damage or trample roots. An on-site expert is recommended for supervision during clean up.

All clean up methods employed require measures to ensure the collection and proper disposal of oil as it is liberated from the shore.

10.0 Lake Erie, Welland Canal and Niagara River: Physical Overview

Lake Erie: Lake Erie is the shallowest, most southerly and warmest of the Canadian Great Lakes (maximum depth is 62 m with an average depth of 19 m). The greatest width of Lake Erie is 80.5 kilometres. Lake Erie's Canadian shoreline length from the Niagara River to the Detroit River is 639 kilometres (including islands). The primary inflow of water to Lake Erie is from the Detroit River at the west end of the lake, with the main outflow through the Niagara River (DFO, 1986).

The maximum fetch (the area of open water over which waves are generated by wind) is approximately 300 kilometres (Owens 1979). The coast is characterized by eroding cliffs (5-20 metres in height) and by three large depositional features (Point Pelee, Rondeau and Long Point) that have extensive beach-dune and marsh systems (Owens 1979). Approximately 21% of the Canadian shoreline of Lake Erie is protected by man-made structures (landfill, armourstone, seawalls and groynes) (Boyd 1981).

Most of the area surrounding the lake is either urbanized or farmed, although Lake Erie does contains a number of important wetland areas including Long Point and Point Pelee. Based on geological characteristics, Lake Erie can be divided into three basins: western, central and eastern. The shallow western basin has a mean depth of only 7.4 m and contains many shoals, reefs and islands. The western basin is thought to have the most important fish spawning and nursery grounds in the entire lake; it is also a principal recreation area. The central basin is the largest of the basins, and has a mean depth of 18.5 m. the eastern basin is the deepest, with a mean depth of 24.4 m (Owens, et al., 1992).

Lake Erie, which is shallow and elongated, is especially vulnerable to wind set-up/set-down fluctuations (storm surge effects) that produce large differences in water level at the eastern and western ends of the lake. This fact has implications for spills, as set-up can result in oil being beached above the normal wave swash zone.

Along the Canadian shoreline of Lake Erie there are several natural gas facilities (Port Alma, Morpeth, Port Stanley, Port Dover, Mohawk Point, Shisler Point) which are connected to several underwater pipelines (active and abandoned) and wellheads on the lake bottom in the Canadian waters of Lake Erie. Each wellhead is marked by a wellhead marker buoy. Other information buoys identify the location of pipeline components that protrude up from the lake bottom. Oil and gas drilling towers are also present in the lake. Additional information regarding natural gas extraction and specific locations of wellheads and pipelines can be obtained from the Ontario Ministry of Natural Resources, Petroleum Resources Section at 519-426-7650 or by consulting DFO Marine Navigation Charts. Damage to facilities can be extremely hazardous because the natural gas is under pressure, contains toxic chemicals and is flammable (DFO, 1986).

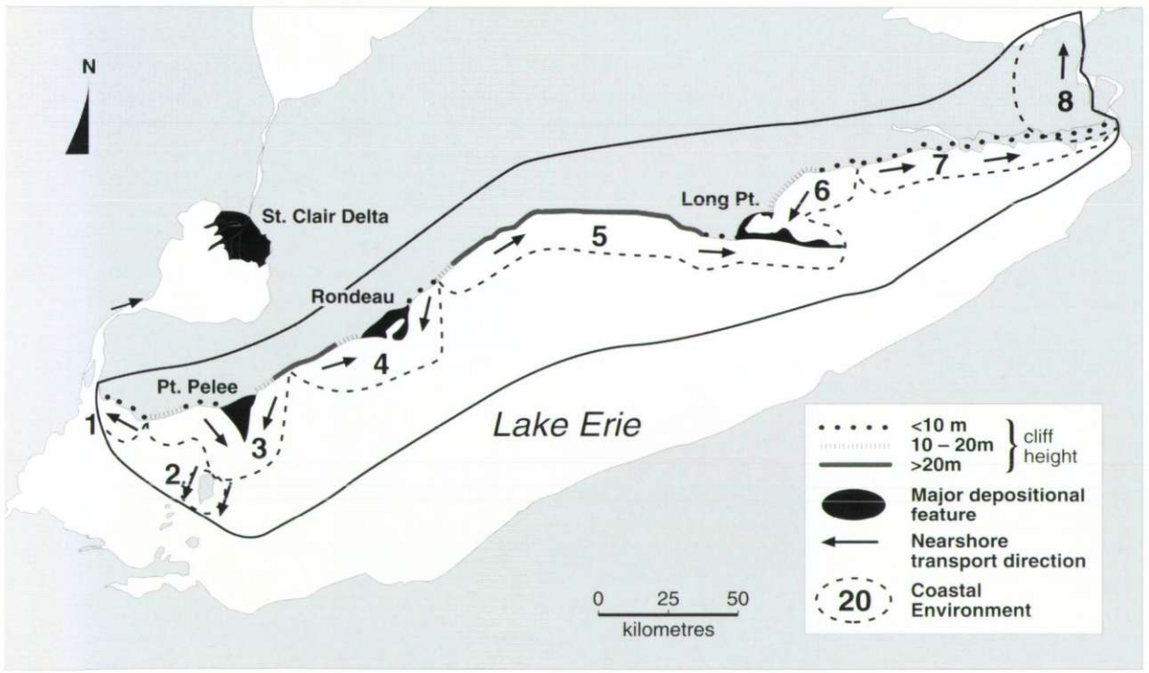


Figure 3: Coastal Environments and Primary Shore-Zone Transport Direction of Lake Erie Canadian Shoreline (Owens, 1979)

Large portions of the Lake Erie Canadian shoreline are part of what are defined as Primary Areas of Response (PAR) under the Canada Shipping Act amendments of 1995. Both the Nanticoke PAR and the Sarnia PAR encompass regions of the Lake Erie shore. These areas are highlighted for enhanced preparedness against spills due to the higher risk of incidents associated with these areas. Contact Canadian Coast Guard - Central Region for more information on PARs.

Welland Canal: The Welland Canal crosses 44 kilometres in a general north to south direction from St. Catharines (Port Weller Harbour) on Lake Ontario to Port Colborne Harbour on Lake Erie. The original Welland Canal was built in 1824 to 1829 and has been reconstructed three times to allow ship traffic to bypass Niagara Falls. The shoreline length of the canal, including both sides, is approximately 88 kilometres, and vessels are raised 100m using eight different locks to overcome the height of the Niagara escarpment. The canal banks consist largely of man-made materials and in the lower (northern) section, concrete blocks and natural sediments characterize much of the canal shore. The channel is generally 100 m wide and the banks are continuously affected by ship wakes (Owens 1979).

Table 2: Coastal Environments of Lake Erie Canadian Shoreline

		Coastal Zone			
Subdivision	Relief and Geology	Shore-Zone Character	Beach Charater	Fetch, Wave Exposure and Ice	Sediment Availability And Transport
1. Northwest Coast	Low relief (<10 m) : un-consolidated sediments rest on bedrock that outcrops below lake level	Straight coast of eroding cliffs that give way to low beaches in extreme western section	Low, narrow beaches of sand, pebble, cobble sediments	Very sheltered coast, maximum fetch 50 km; shore-zone ice up to 4 months/year	Limited supply; transport to the west
2. Pelee Island	Low relief (<3 m) : bedrock (limestone) outcrops mantled by clay-silt sediments and by marshes	Small island with either low bedrock cliffs fronted by beach deposits with sand foreland at southern end of the island, or barrier beaches backed by marsh dykes	Low, narrow beaches of sand, pebble, cobble sediments; west coast protected by artificial structures; some limestone outcrops in the shore zone	West coast is sheltered (max. fetch 50 km); east coast exposed to 300 km fetch but lower energy because winds are from southwest; shore-zone ice up to 4 months/year	Limited supply; transport predominantly towards southern end of the island
3. Point Pelee System	Cliffs 10–20 m, of predominantly clay-silt sediments; foreland developed on moraine ridge	Straight coasts of eroding cliffs with large triangular foreland that is migrating slowly to the west	Beaches adjacent to cliffs are narrow or absent; west coast Pelee – wide, sand beach; east coast – narrow, eroding sand beach	West-facing coasts have short fetch (max. 75 km); east-facing coasts more exposed (max. fetch 300 km) and higher wave energy levels; shore-zone ice up to 4 months/year	Eroded cliff sediments transported towards Pelee from west and east; eastern shore is a zone of bypassing with net accretion on west coast of Pelee
4. Rondeau System	Relief 10–20 m in cliffed sections; sediments in cliffs predominantly clay-silt size; foreland developed on moraine ridge	Straight coasts of eroding cliffs with large triangular foreland that is migrating slowly to the east	Beaches adjacent to cliffs are narrow or absent; west coast Rondeau – narrow, eroding sand beach; east coast – wide, accreting, sand beach	West-facing coasts exposed to waves out of southwest (fetch 100 km); east-facing coasts more sheltered despite longer fetch because winds are westerly; shore-zone ice up to 4 months/year	Eroded cliff sediments transported towards Rondeau from west and east; western shore is a zone of bypassing with net accretion on east coast of Rondeau
5. Long Point System	Relief 10–40 m in cliffed sections; cliff sediments are variable – include silts, clays and sands; spit developed on moraine ridge	Straight coast of eroding cliffs and long (40 km) flying spit that is extending to east and migrating to north	Beaches adjacent to cliffs are narrow or absent; Long Point beaches are generally sandy, narrrow and eroding; except in accreting eastern section where beach widens and is backed by dunes	Exposed, high wave energy coast, maximum fetch 250 km; shore-zone ice up to 4 months/year	Eroded cliff sediments transported to east; bypass central section of spit to accumulate in eastern areas
6. Long Point Bay – Turkey Point System	Backshore relief up to 40 m in cliffed section with unconsolidated sand and some clay-silt sediments; spit and large embayment in lee of Long Point spit	Sheltered bay and spit system with eroding cliffs in Inner Bay and to east of Turkey Point; extensive marshes on north Long Point and in Inner Bay	Beaches are generally narrow except on the east coast of Turkey Point	Sheltered coast, maximum fetch to the east (100 km); shore-zone ice up to 4 months/year	Eroded cliff sediments transported to southwest and accumulate at Turkey Point; elsewhere sediments are scarce
7. Northeast Coast	Relief decreases from maximum of 40 m in west to less than 10 m in eastern half; sedimentary rocks outcrop east of Peacock Point	Eroding clay-silt cliffs (10–20 m) give way to bedrock headlands with beaches in embayments	Beaches narrow or absent except in easterly embayments; here wide, sand beaches developed, often backed by dunes	Exposed, high energy coast with maximum fetch of 300 km to the southwest; some local sheltering due to the headlands in eastern section; shore-zone ice up to 4 months/year	West to east transport of eroded sediments; zones of accumulation on west sides of headlands in eastern section; elsewhere sediments are scarce
8. Welland Canal – Niagara River	Low backshore relief; canal has man-made shore, river cuts through bedrock outcrops and crosses resistant dolomite escarpment	River bank or man-made shorelines	Beaches absent or narrow and low with sand-pebble sediments	Low-energy riverine or channel systems; shore-zone ice up to 4 months/year	Sediments are scarce, transported by river currents to north

(Owens, 1979)

Niagara River: The Niagara River joins Lake Erie and Lake Ontario. The entire shoreline length is 171 kilometres (107 miles); 58 kilometres (36 miles) along the Canadian shore and 113 kilometres (71 miles) along the U.S. side. The river banks are a mixture of man-made structures, bedrock outcrops and beaches of poorly sorted sediments. From Lake Erie to Lake Ontario, the water level drops 99 m (326 ft); approximately one half of the drop occurs at Niagara Falls. The flow over the Falls is regulated by a series of five power plant diversions (Owens 1979). The average discharge of water from the river is nearly 7,000 cubic metres per second, and represents about 85% of the total inflow to Lake Ontario (Masse and Murthy 1990). The water current above the falls is approximately 7 to 9 knots and the river is shallow and rocky. The water current below the falls ranges from 3.6 to 4.5 knots. These swift currents, and the obvious hazard of the Falls complicates safe and effective spill response efforts on the river.

10.1 Water Circulation and Shoreline Transport

In the event of a spill, wind and wave conditions must be monitored to assist in predicting the trajectory of a contaminant. When the trajectory and destination of a spill have been defined, the target shoreline should be assessed for shoreline transport. While overviews of circulation are not necessarily reliable measures of transport, the following information will assist response decision makers in assessing spill impact.

Longshore sediment transport is the mechanism by which sediment material is moved parallel to the coast (by wave-induced processes). Figure 3 shows the coastal environments and primary shore-zone transport directions for the Lake Erie (including the Welland Canal) and Niagara River Shorelines region. Table 2 summarizes the main features of each of the eight subdivisions in Figure 3.

Another important consideration on the Great Lakes and Connecting Channels is the historical, annual and storm variation in water levels. This will partially dictate which part of the shore will be oiled during a spill event. A Great Lakes Water Level Bulletin is published each month by the Canadian Hydrographic Service. It includes a six month forecast of water levels. Exact water levels during a response to a spill can be obtained from Environment Canada by phoning 905-336-4581.

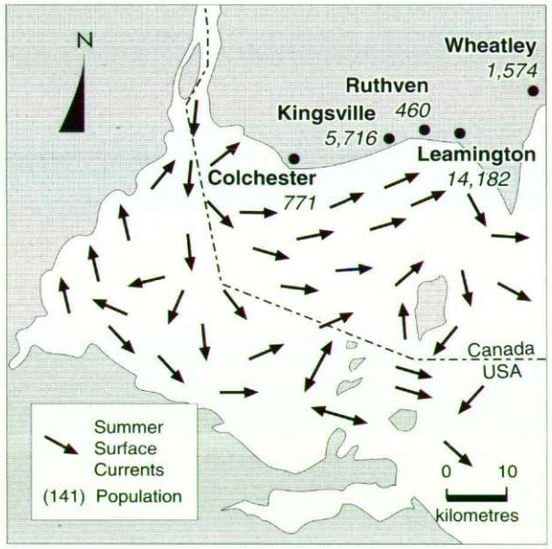


Figure 4b: Lake Erie Western Basin Surface Currents (Fisheries and Oceans, 1986) (Population Data Source: Statistics Canada Census, 1991)

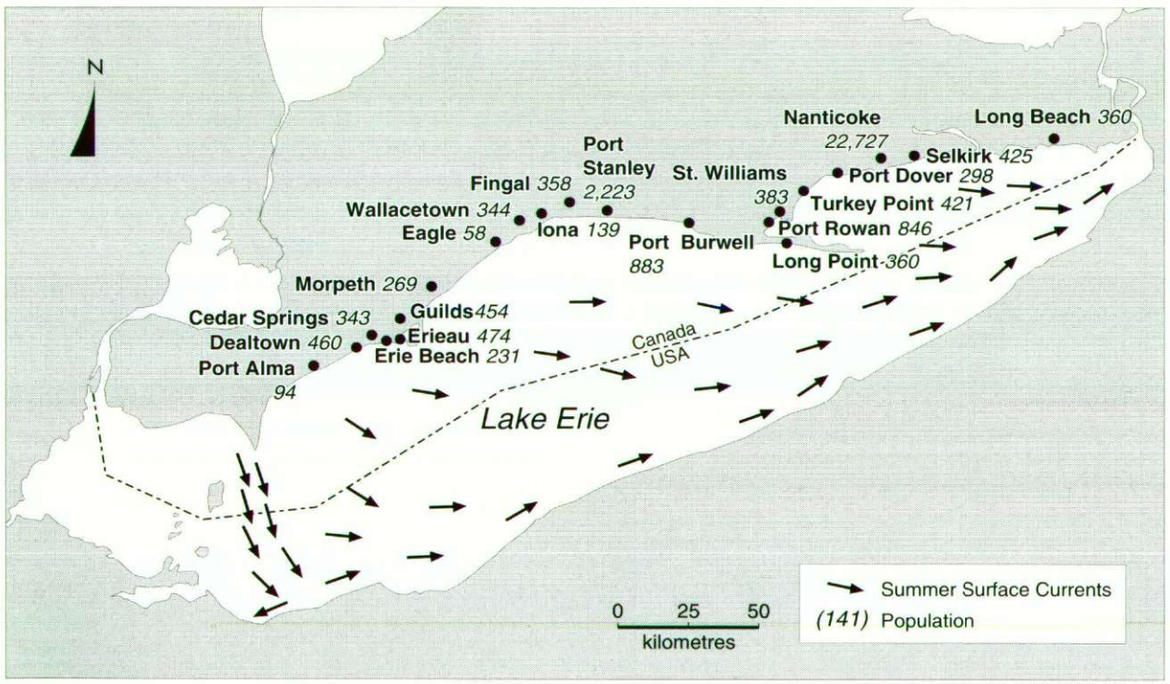


Figure 4a: Lake Erie Overview, and Central and Eastern Basins Surface Currents (Fisheries and Oceans, 1986) (Population Data Source: Statistics Canada Census, 1991)

Wind driven currents form the dominant surface circulation on open water in the Great Lakes, while river currents and wind effects combine to form circulation patterns where Connecting Channels interact with open lake water. The general pattern of the surface water circulation in the central and eastern basins of Lake Erie is west to east (see Figure 4a) and surface water circulation in the western basin is affected by the flow of water exiting the Detroit River and circling in the basin (see Figure 4b). Within 5 kilometres of the Niagara River, the hydraulic currents of the river predominate and a unidirectional flow towards the head of the river replaces the wind driven currents (DFO, 1986). The general direction of surface flow in the Niagara River and Welland Canal is from south to north.

Maximum water surface temperatures on Lake Erie and the Niagara River typically reach 24°C by late summer (Saulesleja, 1986).

Figure 4 also gives general information such as the location of communities with their populations.

10.2 Ice Cover

Initial ice formation begins in the western end of Lake Erie and in Long Point Bay normally during the third week of December. Ice growth and spread accelerate in January with ice coverage generally attaining its maximum extent (90%) in February. In a mild year, ice will cover approximately 25% of Lake Erie's surface, while during severe winters, 100% coverage can occur. In sheltered harbours and bays, ice grows to a thickness of 25 to 45 cm during a normal winter. Ridging and windrows of ice can achieve aggregate ice thicknesses in excess of 20 metres during a single winter storm." (Saulesleja, 1986).

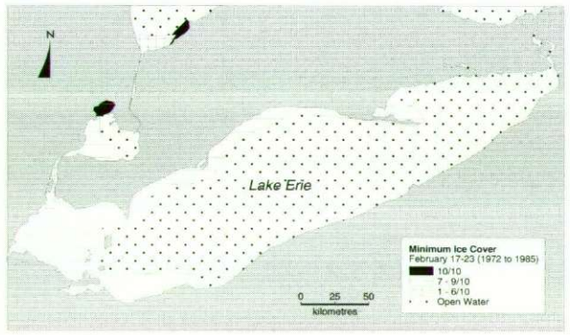


Figure 5a: Lake Erie Minimum Ice Cover (Saulesleja, 1986)

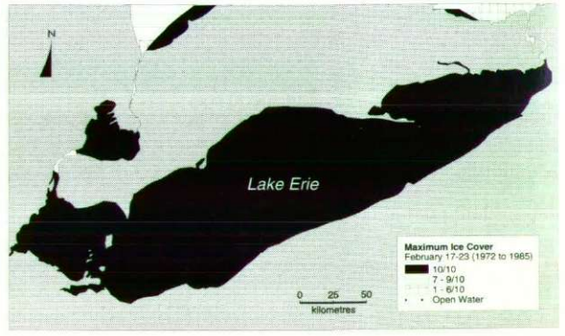


Figure 5b: Lake Erie Maximum Ice Cover (Saulesleja, 1986)

"Break up normally begins near the beginning of March with the lake becoming mostly open water by the third week of April. The eastern end of the lake is usually the last area to clear. Ice has persisted in the Buffalo area as late as the middle of May."

During the winter months ice jams at the Niagara River entrance. Ice booming from December to April prevents the movement of ice down the river. A second natural ice bridge forms at the gorge below the Falls which at times has reached 24 m above the river level (Owens 1979).

The average maximum and minimum ice coverage on Lake Erie, at the normal time of greatest ice coverage, is shown in Figures 5a and 5b, for the period of 1972 to 1985.

10.3 Wind and Waves for Lake Erie

The prevailing winds for the Lake Erie basin are from the southwest parallel to the long axis of the lake, so that maximum fetch distances (up to 300 kilometres) coincide with the prevailing and dominant winds. Figures 6a and 6b show the mean wind speed and direction information for Lake Erie in summer and winter, respectively. Wave energy levels increase from west to east in the lake (Owens 1979). Winter wave heights on Lake Erie exceed 1 metre 65% of the time, with rare maximums of 4 to 8 metres possible. Summer wave heights exceed 1 metre only 35% of the time, with rare maximums of 3 to 5 metres possible. On Lake Erie and the Connecting Channels, responders should note that passing vessels will also create waves from their wakes.

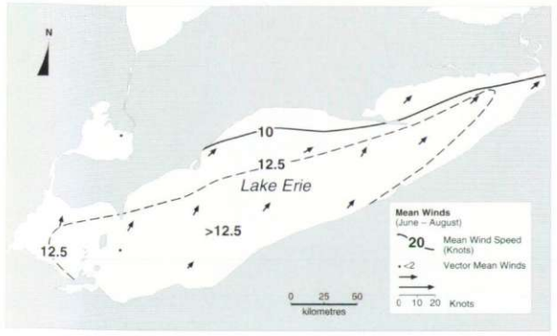


Figure 6a: Lake Erie Summer Wind Information (Saulesleja, 1986)

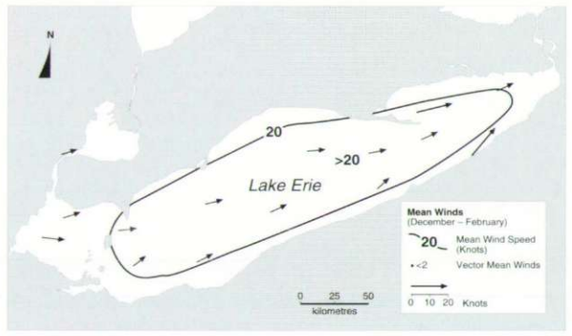
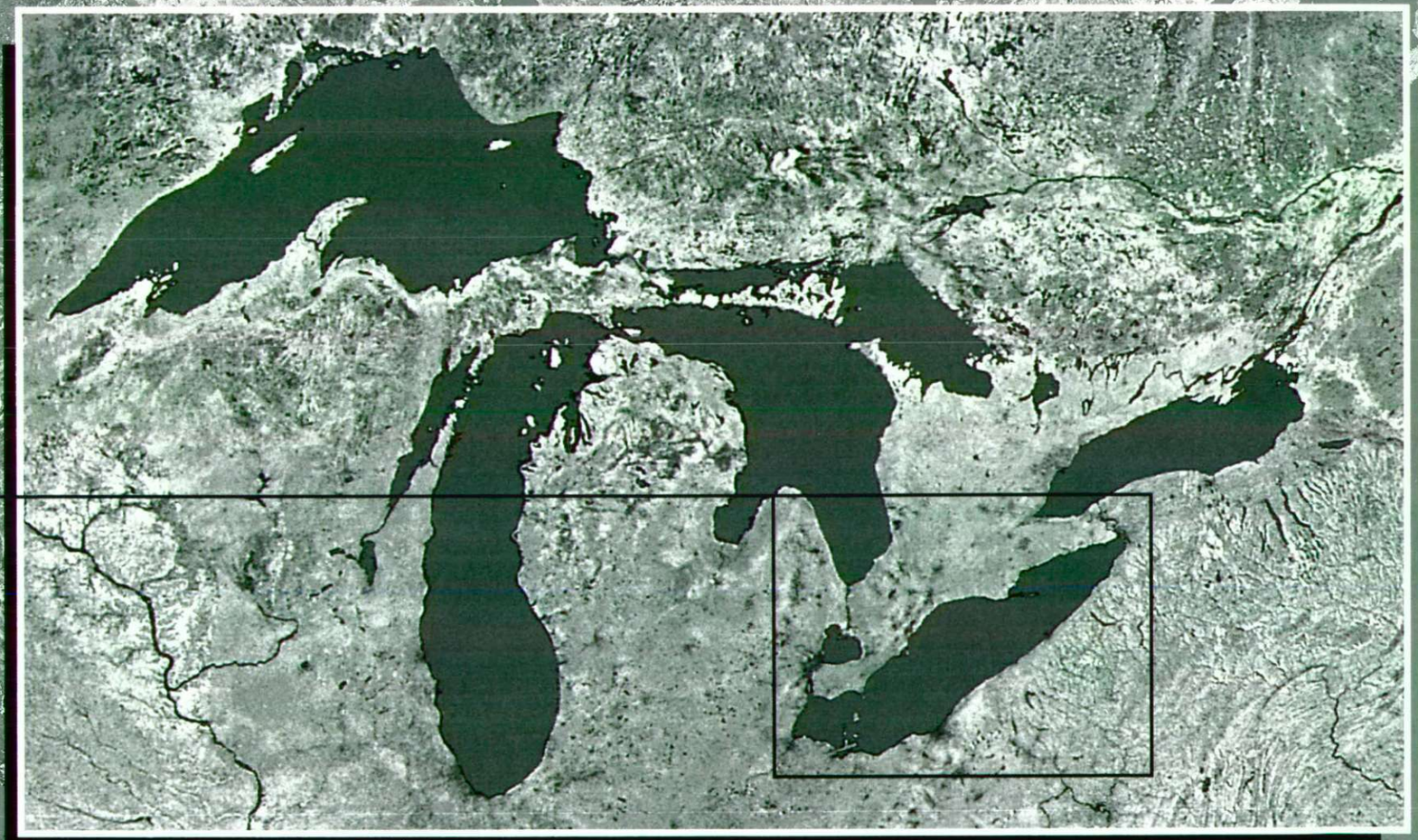


Figure 6b: Lake Erie Winter Wind Information (Saulesleja, 1986)

Environmental Sensitivity Maps for Lake Erie (Including the Welland Canal) and the Niagara River Shorelines



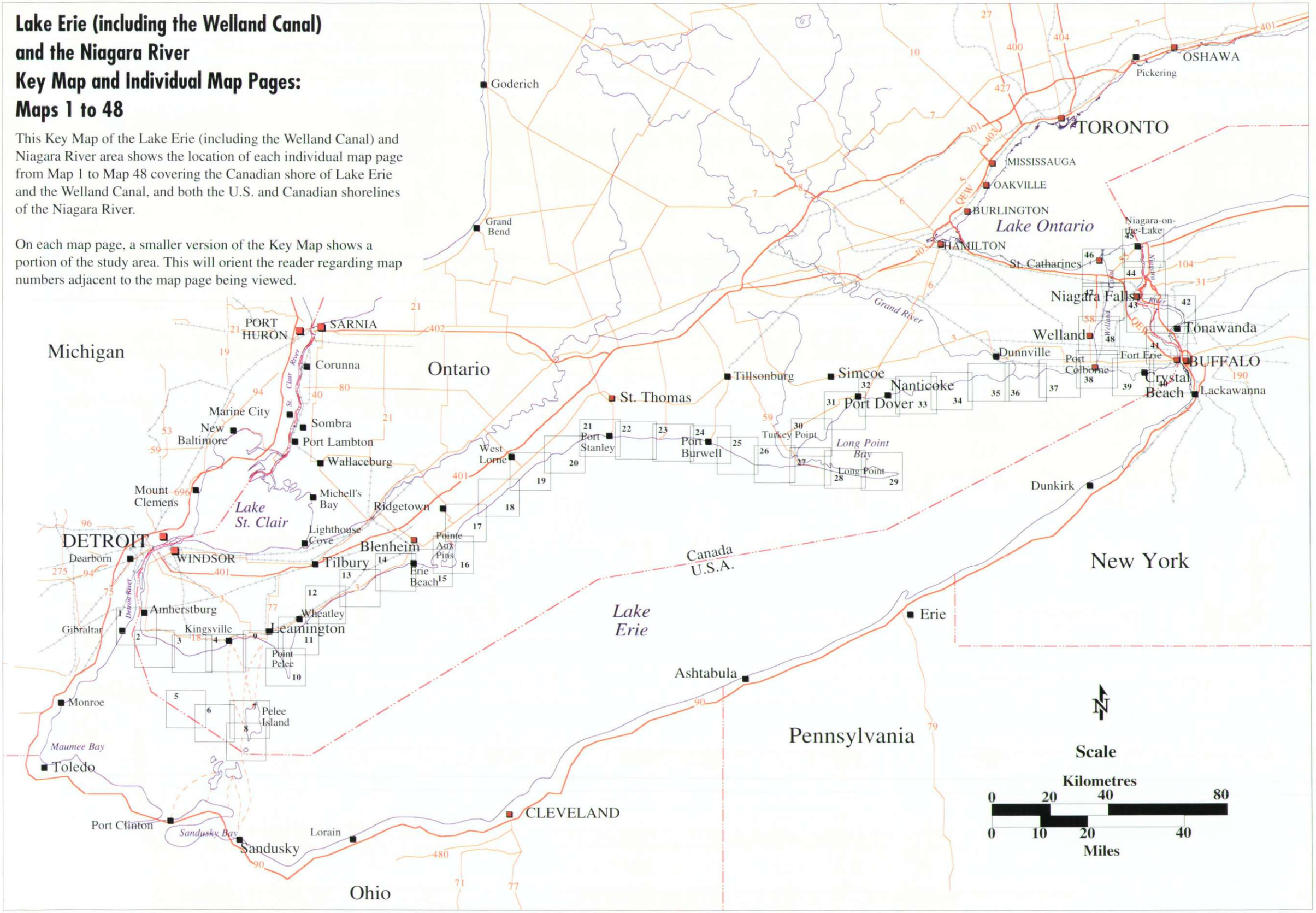
Environment Canada
Environmental Protection Branch
Ontario Region

Environnement Canada
Direction générale de la protection de l'environnement
région de l'Ontario

Lake Erie (including the Welland Canal) and the Niagara River Key Map and Individual Map Pages: Maps 1 to 48

This Key Map of the Lake Erie (including the Welland Canal) and Niagara River area shows the location of each individual map page from Map 1 to Map 48 covering the Canadian shore of Lake Erie and the Welland Canal, and both the U.S. and Canadian shorelines of the Niagara River.

On each map page, a smaller version of the Key Map shows a portion of the study area. This will orient the reader regarding map numbers adjacent to the map page being viewed.



NOTES

A red exclamation point symbol is used on the maps to catch the responder's attention.

1. Fort Malden National Historic Park covers three sites; sites one and two can be found on the mainland in Amherstburg. Site three is located on the southwest end of Bois Blanc Island - Call (519) 736-5416. Bois Blanc is also a well known spawning area for white bass. Most of the white bass fishery is concentrated in this area. Amherstburg Canadian Coast Guard Base- Call (519) 736-5449 or 1-800-265-0237 (24 hours). Response equipment is maintained at this base.

2. Town of Gibraltar Municipal Water Intake - Call (313) 676-3952 or Gibraltar Police Dept. after hours at (313) 676-1022. Waterfowl use is extremely high in the water south of Celeron Island.

3. This offshore area is an open lake staging area for diving ducks (Scaup, Mergansers) during the peak migration period of mid-October to late November. Concentrations may be in the thousands during these periods and in late March. Mann's Marsh is a class 2 wetland that contains an abundant assortment of natural vegetation. It is surrounded by a variety of land uses which provide excellent wildlife habitat for various species. The site contains harvestable timber, various commercial fish species, snapping turtles and fur bearers (muskrat, raccoon, mink, red fox). Hunting activity is moderate in the fall. The site is adjacent to Lake Erie but separated by a barrier beach. A number of provincially significant animal and plant species can be found in the marsh including Black-crowned Night Heron, Great Egret, Eastern Fox Snake and Swamp Rose mallow. The marsh also provides locally significant winter cover for deer. There are several sandy beaches in this area of Lake Erie which are both public and provincially owned. There is smelt spawning all along these beaches in spring.

4. Pointe Mouillée State Game Area is considered a highly sensitive habitat for a wide variety of fish and wildlife species.

42° 8' 2" N
83° 13' 9" W

42° 8' 2" N
83° 3' 14" W

Obtain permission from private property owners prior to crossing private property, access sites, or boat launches.

DETROIT EDISON COMPANY
MONSANTO COMPANY
MCLOUTH STEEL CORP.
Grosse Ile Free Bridge
Grosse Ile
Grosse Ile Municipal Airport
Calf Island
Fox Island
Elba Island
Powder House Island
Meso Island
Sugar Island
Stony Island
Livingston Channel
Crystal Bay
Bois Blanc Island
Fort Malden National Historic Site
Amherstburg
Trenton Channel
Gibraltar
Edmond Island
Horse Island
Gibraltar Bay
Hickory Island
Celeron Island
Detroit River
Sugar Island Cut
Michigan
Ontario
U.S.A.
Canada
Amherstburg Harbour
Amherstburg Channel
Sturgeon Bar Island
Milleville Beach
Silver Creek
Pointe Mouillée State Game Area
Lake Erie
Amherst Pointe
Bar Point
Sunset Beach
Mann's Marsh
Willow Beach
Willowood
Bailey's Beach
Big Creek
Knapps Island
Big Creek Marsh ANSI&ESA
Lakewood Beach

Scale
Kilometres 0 0.5 1 2
Miles 0 0.5 1
1:50,000

Map 1

Contains Sections From NTS and USGS Maps:
40J/3 and 42083

December 1994

For Environmental Sensitivity information for the shores of the Detroit River, see Environment Canada's 1994 publication, "Environmental Sensitivity Atlas for the St. Clair River, Lake St. Clair and Detroit River Shorelines".

For the U.S. shore of Lake Erie, see NOAA's "Lake Erie Atlas: Sensitivity of Coastal Evironments and Wildlife to Spilled Oil" (RPI,1985).

42° 1' 1" N
83° 13' 9" W

42° 1' 1" N
83° 3' 14" W

42° 3' 49" N
83° 8' 37" W

42° 3' 49" N
82° 58' 42" W

Amherst Pointe

Amherst Pointe

Bar Point

Bar Point

Sunset Beach

Detroit River

Mann's Marsh

Willow Beach

Willowood

Bailey's Beach

3

Big Creek

Knapps Island

Big Creek Marsh ANSI&ESA

4

5

Hwy. 18

Malden Centre

Obtain permission from private property owners prior to crossing private property, access sites, or boat launches.

Holiday Beach Provincial Park

Holiday Beach Conservation Area

Lakewood Beach

For Environmental Sensitivity information for the shores of the Detroit River, see Environment Canada's 1994 publication, "Environmental Sensitivity Atlas for the St. Clair River, Lake St. Clair and Detroit River Shorelines".

For the U.S. shore of Lake Erie, see NOAA's "Lake Erie Atlas: Sensitivity of Coastal Evironments and Wildlife to Spilled Oil" (RPI,1985).

The Meadows

Comet

Levergood Beach

Belcreft Beach

Ambassador Beach

Ontario
Michigan

Canada
U.S.A.

Map 2

Contains Sections From NTS and USGS Maps:
40J/3, 40J/2, 40G/15 and 42083

Scale
Kilometres
0 0.5 1 2
0 0.5 1
Miles
1:50,000

Lake Erie

41° 56' 48" N
83° 8' 37" W

41° 56' 48" N
82° 58' 42" W

NOTES

A red exclamation point symbol is used on the maps to catch the responder's attention.

3 This offshore area is an open lake staging area for diving ducks (Scaup, Mergansers) during the peak migration period of mid-October to late November. Concentrations may be in the thousands during these periods and in late March. Mann's Marsh is a class 2 wetland that contains an abundant assortment of natural vegetation. It is surrounded by a variety of land uses which provide excellent wildlife habitat for various species. The site contains harvestable timber, various commercial fish species, snapping turtles and fur bearers (muskrat, raccoon, mink, red fox). Hunting activity is moderate in the fall. The site is adjacent to Lake Erie but separated by a barrier beach. A number of provincially significant animal and plant species can be found in the marsh including Black-crowned Night Heron, Great Egret, Eastern Fox Snake and Swamp Rose mallow. The marsh also provides locally significant winter cover for deer. There are several sandy beaches in this area of Lake Erie which are both public and provincially owned. There is smelt spawning all along these beaches in spring.

5 Big Creek Marsh is an Environmentally Sensitive Area, with parts designated as Areas of Natural and Scientific Interest. It supports a major concentration of dabbling ducks (Mallard, Wood Duck, Black Duck) during the fall migration in late September through to winter freeze up, peaking in late October to early November. Observed numbers are up to 10,000. The marsh is also a spring staging area. Big Creek Marsh is the largest in Essex County and is considered a Class 2 wetland. Since the Big Creek watershed is predominantly agricultural, with little forest coverage, run-off of topsoil and pollutants is a major problem. Significant tracts of relatively undisturbed lowland and upland forest are associated with Big Creek Marsh. White tailed deer inhabit the forest. Many examples of rare plants and wildlife are present; most notably the Small- Flowered Hemicorpha, a small sedge which grows on moist sand and is not found elsewhere in Ontario. Portions of the Big Creek Wetland are owned by the Ontario Ministry of Natural Resources and the Essex Region Conservation Authority (Big Creek Conservation Area) - Call (519) 776-5209.

NOTES

A red exclamation point symbol is used on the maps to catch the responder's attention.

6 Lypps Beach wetland is designated as a Provincially Significant Wetland and as an Environmentally Sensitive Area. It has a combination of wetland vegetation with a diverse surrounding, providing excellent wildlife habitat for a variety of species. It contains a number of resources with potential economic value, including furbearers, commercial fishing activity, and harvestable timber. It also supports three provincially significant species. There is smelt spawning all along the beaches of this part of Lake Erie in spring.

7 Harrow Colchester - Municipal Water Treatment Plant Intake - Call (519) 738-3038. Scattered groupings of diving ducks (Scaup, Bufflehead, Goldeneye, Merganser) are present during fall (October to December) and spring (March and April) migration. Numbers can be in the thousands.

8 The Oxley Poison Sumac Swamp is designated as a Provincially Significant Wetland (Wooded Swamp). A high number of rare species, plants, and animals are present in this small area. Fox Creek is designated as a Provincially Significant Wetland. It contains a number of resources with economic potential, including commercial fishing activity and furbearers. Four provincially significant species exist here. There is smelt spawning all along the beaches of this part of Lake Erie in Spring.

42° 2' 56" N
82° 59' 24" W

42° 2' 56" N
82° 49' 29" W

Pleasant Valley

Hwy. 18

Harrow

East Harrow

Obtain permission from private property owners prior to crossing private property, access sites or boat launches.

Cedar Creek

Comet

Seymour Beach

Ambassador Beach

Lypps Beach

Fox Creek

Oxley

Colchester

Littles Point

Klie's Beach

Lake Erie

Map 3

Contains Sections From NTS and USGS Maps:
40J/2 and 40G/15

Scale
Kilometres
0 0.5 1 2
0 0.5 1
Miles
1:50,000

41° 55' 54" N
82° 59' 24" W

41° 55' 54" N
82° 49' 29" W

42° 3' 6" N
82° 51' 2" W

Obtain permission from private property owners prior to crossing private property, access sites or boat launches.

42° 3' 6" N
82° 41' 7" W

Wigle Creek

Mill Creek

Hwy. 18

Kingsville

New California

Arner

Cedar Creek

Cedar Creek Conservation Area

Linden Beach

Cedarhurst Park

Cedar Beach

8

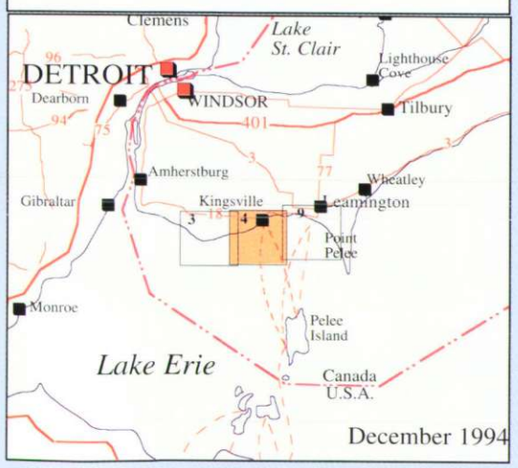
9

10

M

Map 4

Contains Sections From NTS and USGS Maps:
40J/2 and 40G/15



Lake Erie

N

Scale
Kilometres
0 0.5 1 2
0 0.5 1
Miles
1:50,000

41° 56' 5" N
82° 51' 2" W

41° 56' 5" N
82° 41' 7" W

NOTES

A red exclamation point symbol is used on the maps to catch the responder's attention.

8 The Oxley Poison Sumac Swamp is designated as a Provincially Significant Wetland (Wooded Swamp). A high number of rare species, plants, and animals are present in this small area. Fox Creek is designated as a Provincially Significant Wetland. It contains a number of resources with economic potential, including commercial fishing activity and furbearers. Four provincially significant species exist here. There is smelt spawning all along the beaches of this part of Lake Erie in Spring.

9 Scattered grouping of diving ducks (Scaup, Bufflehead, Goldeneye, Mergansers) are present during fall (October to December) and spring (March to April) migration. Numbers can be in the thousands. Canada Geese also use this area for loafing and may number in the hundreds. Many of the sand beaches in this area have perpendicular rip-rap groynes. The Cedar Creek Area of Natural and Scientific Interest is a large rich wetland with species present such as Spotted Sandpiper, Belted Kingfisher, Great Egret, Green-backed Heron, Great Blue Heron, Red Squirrel, Snowshoe Hare, Beaver, Otter, Southern Flying Squirrel, Ermine, Mink, Opossum and Eastern Chipmunk.

10 Kingsville is an active centre for commercial fisheries activity (catch unloading and processing) and is a departure point for Pelee Island by ferry - call (519) 724-2115 for information.

NOTES

A red exclamation point symbol is used on the maps to catch the responder's attention.

11 East Sister Island Provincial Nature Reserve is a designated Environmentally Sensitive Area and an Area of Natural and Scientific Interest. It is inhabited by the Yellow-crowned Night Heron, Cattle Egret, Herring Gull, Great Blue Heron, Great Egret, Black-crowned Night Heron and Double- crested Cormorant. It is also a migratory stopover for birds. This island supports provincially and nationally significant rare plants and fauna, including the Kentucky Coffee Tree.

41° 52' 38" N
83° 0' 50" W

41° 52' 38" N
82° 50' 58" W

Middle Sister Island

(2218)

Lake Erie

North Harbour Island

(41)

East Sister Island Provincial Nature Reserve

East Sister Island

(1715)

(3271)

11

Ontario

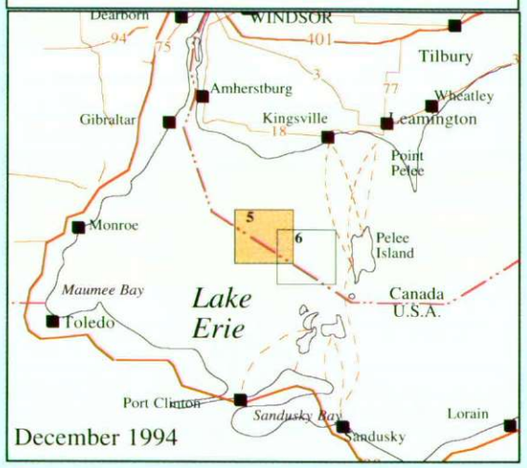
Ohio

Canada

U.S.A.

Map 5

Contains Sections From NTS and USGS Maps:
40G/15



December 1994

Scale
Kilometres
0 0.5 1 2
0 0.5 1
Miles
1:50,000

41° 45' 37" N
83° 0' 50" W

41° 45' 37" N
82° 50' 58" W

41° 50' 3" N
82° 53' 48" W

41° 50' 3" N
82° 43' 56" W

North Harbour Island

(41)

East Sister Island Provincial Nature Reserve

East Sister Island

11

(1715)

(3271)

Lake Erie

Hen Island

(210)

12

Chick Island

Big Chicken Island

Little Chicken Island

(174)

Ontario
Ohio

Canada
U.S.A.

N

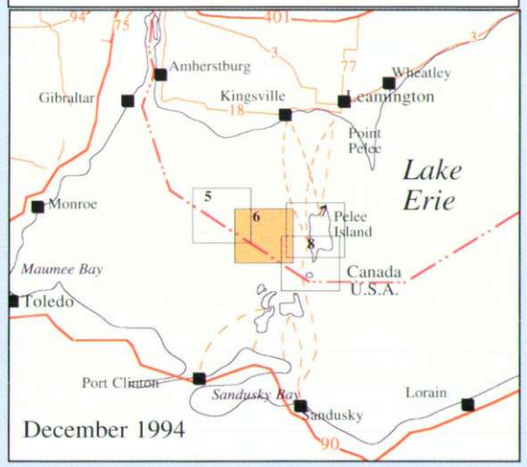
Scale
Kilometres
0 0.5 1 2
0 0.5 1
Miles
1:50,000

41° 43' 1" N
82° 53' 48" W

41° 43' 1" N
82° 43' 56" W

Map 6

Contains Sections From NTS and USGS Maps:
40G/15 and 40G/10



NOTES

A red exclamation point symbol is used on the maps to catch the responder's attention.

11 East Sister Island Provincial Nature Reserve is a designated Environmentally Sensitive Area and an Area of Natural and Scientific Interest. It is inhabited by the Yellow-crowned Night Heron, Cattle Egret, Herring Gull, Great Blue Heron, Great Egret, Black-crowned Night Heron and Double- crested Cormorant. It is also a migratory stopover for birds. This island supports provincially and nationally significant rare plants and fauna, including the Kentucky Coffee Tree.

12 Big Chicken Island is designated an Environmentally Sensitive Area. It is one of three cormorant colonies in Lake Erie. There are huge zebra mussel beds surrounding the Chicken Islands. This is an important area for staging ducks (mainly Scaup); Fall concentrations can exceed 10,000.

NOTES

A red exclamation point symbol is used on the maps to catch the responder's attention.

13 Sheridan Point is designated an Environmentally Sensitive Area because of the presence of rare amphibian, reptile, and plant species. It is also a significant historical attraction site. Contact the Township Clerk at (519) 724-2931. Smelt, Walleye and Yellow perch are present all along the Pelee Island and Middle Island shores.

14 Red Cedar Savannah is designated an Environmentally Sensitive Area. It supports the Blue Racer snake, an endangered species found on Pelee Island. Ferry service is available from West Dock to Kingsville and Leamington - Call (519) 724-2115.

15 Fish Point is a Provincial Nature Reserve that has National and Provincial Significance. It is designated as an Environmentally Sensitive Area and an Area of Natural and Scientific Interest due to the presence of 56 rare plants and various endangered flora and fauna. Fish Point is a migratory stopover for Herons and Egrets. Blue Racers, Foxes, and Squirrels inhabit the inland zone. Road travel should be kept to a minimum. The area is owned by the private sector and by the Ontario Ministry of Natural Resources.

16 Stone Road Alvar is a designated Area of Natural and Scientific Interest and Environmentally Sensitive area because of the unique vegetation community, including rare plants, at the southern limits of their range. It is managed by the Essex Region Conservation Authority, and is valued for research and its aesthetic qualities.

17 Middle Point is designated an Environmentally Sensitive Area because of its high number of rare species with national significance.

18 Lighthouse Point is designated an Environmentally Significant Area and an Area of Natural and Scientific Interest because of its highly significant communities and the rare species that it supports. Lighthouse Point, a Provincial Nature Reserve, is a migratory stop over and provides feeding and resting habitat for migratory waterfowl, wading birds, raptors (Great-horned Owl) and shore birds. There are dune beaches and savannah communities.

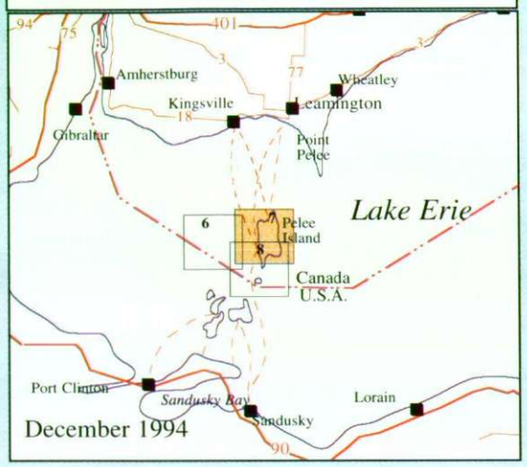
19 Spill responders should take note that there is a vehicle ferry dock located at Scudder, providing service to Kingsville and Leamington - Call (519) 724-2115.

41° 50' 46" N
82° 45' 12" W

41° 50' 46" N
82° 35' 19" W

Map 7

Contains Sections From NTS and USGS Maps:
40G/15 and 40G/10



(48) Lighthouse Point
(3)
Lizard Point
Sheridan Point
North Bay
Scudder
Middle Point
Obtain permission from private property owners prior to crossing private property, access sites or boat launches.
Pelee Island Airfield
Pelee Island
Cedar Savannah ESA
West Dock
Stone Road Alvar Conservation Area
Mill Point
Pelee Island South
Fish Point Provincial Nature Reserve
South Bay
Mosquito Point
Mosquito Bay
(22)

Lake Erie

Scale
Kilometres
0 0.5 1 2
0 0.5 1
Miles
1:50,000

41° 43' 44" N
82° 45' 12" W

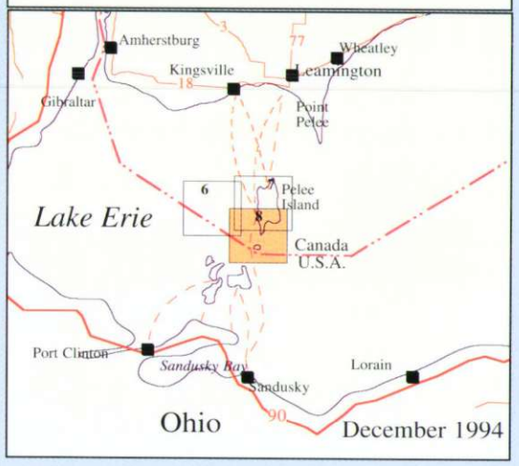
41° 43' 44" N
82° 35' 19" W

41° 46' 33" N
82° 46' 2" W

41° 46' 33" N
82° 36' 10" W

Map 8

Contains Sections From NTS and USGS Maps:
40G/15 and 40G/10



Lake Erie

Pelee Island Airfield

Pelee Island

Cedar Savannah ESA

West Dock

Stone Road Alvar Conservation Area

Mill Point

Pelee Island South

Fish Point Provincial Nature Reserve

South Bay

Mosquito Point

Mosquito Bay

(22)

Fox Lagoon

Ontario
Ohio

(3372)

(237)

Middle Island

Canada
U.S.A.

N

Scale
Kilometres
0 0.5 1 2
0 0.5 1
Miles
1:50,000

41° 39' 32" N
82° 46' 2" W

41° 39' 32" N
82° 36' 10" W

NOTES

A red exclamation point symbol is used on the maps to catch the responder's attention.

14 Red Cedar Savannah is designated an Environmentally Sensitive Area. It supports the Blue Racer snake, an endangered species found on Pelee Island. Ferry service is available from West Dock to Kingsville and Leamington - Call (519) 724-2115.

15 Fish Point is a Provincial Nature Reserve that has National and Provincial Significance. It is designated as an Environmentally Sensitive Area and an Area of Natural and Scientific Interest due to the presence of 56 rare plants and various endangered flora and fauna. Fish Point is a migratory stopover for Herons and Egrets. Blue Racers, Foxes, and Squirrels inhabit the inland zone. Road travel should be kept to a minimum. The area is owned by the private sector and by the Ontario Ministry of Natural Resources.

16 Stone Road Alvar is a designated Area of Natural and Scientific Interest and Environmentally Sensitive area because of the unique vegetation community, including rare plants, at the southern limits of their range. It is managed by the Essex Region Conservation Authority, and is valued for research and its aesthetic qualities.

20 Middle Island is designated an Environmentally Significant Area and an Area of Natural and Scientific Interest. It supports 56 nationally and provincially significant species including rare plants, and various fauna.

NOTES

A red exclamation point symbol is used on the maps to catch the responder's attention.

21 The Union Water Supply System (Drinking Water Treatment Plant) Intake at Union supplies drinking water for the communities of Kingsville, Union, Essex and Leamington and for food processing at H.J. Heinz Co. in Leamington - Call (519) 326-4447.

22 H.J. Heinz Co. operates the intake at Leamington for water use in food processing - Call (519) 326-5862 (Power Plant 24 hours). Leamington Wastewater Treatment Plant has two outfalls at Leamington - Call (519) 326-7101. The sand shores west of Seacliffe are marked by sheet steel and rip-rap groynes. Scattered groupings of diving ducks (Scaup, Bufflehead, Goldeneye, Merganser) are present for several kilometres along the Seacliffe shores during fall (October to December) and spring (March to April) migration. Numbers can be in the thousands. Leamington is a departure point for Pelee Island by ferry - Call (519) 724- 2115 for information.

23 Sturgeon Creek is classified as a Class 3 wetland. It is comprised of diverse vegetation and is an excellent habitat for a variety of wildlife species. It has economic value represented by commercial fishing activity and the presence of furbearers. It also hosts three provincially significant wildlife species and two provincially significant plant species.

24 Point Pelee National Park is designated as an Area of Natural and Scientific Interest because it is representative of a variety of vegetation. The ANSI boundaries coincide with the National Park boundaries. The Park is a waterfowl staging area and a migratory bird stopover. The entire shoreline of the park is composed of sand beach with a vegetated back dune area and forested dune area enclosing a cattail marsh. The Lake Pond marsh area is a Class 1 wetland. The entire park is a RAMSAR site of international significance (according to the RAMSAR Convention on the Conservation of Wetlands of International Importance). Highly sensitive and rare reptiles, amphibians, birds, and plants are present on or near all shoreline areas. Contact the Heritage Centre for any bird sightings at (519) 724-2291. The entire west side of Point Pelee hosts a variety of recreational opportunities, including hiking trails, viewing platforms and picnic areas. Fish spawning (including smelt) occurs along the sandy shores of this part of Lake Erie during spring. The interior marshland at the northern portion of Point Pelee National Park has a concentration of dabbling ducks (Mallard, Black Duck, Green-winged Teal, Wood Duck) during spring and fall migration periods.

42° 3' 49" N
82° 41' 56" W

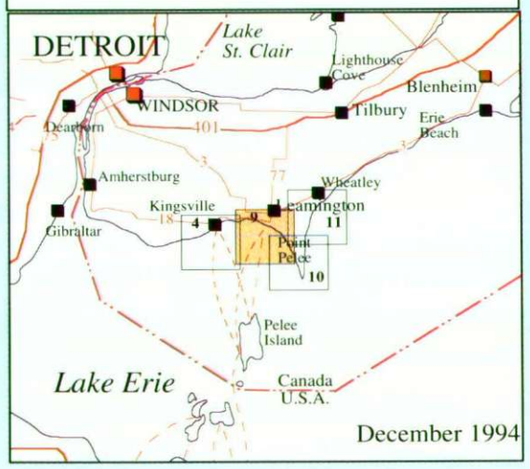
42° 3' 49" N
82° 32' 2" W

Ruthven
Union
Leamington
CNR
Hwy. 3
Sturgeon Creek
Hwy. 18
Seacliffe
Cherry Lane Estates
Belle Point
Stink Creek
Pigeon Bay
Point Pelee National Park
Sanctuary
Sanctuary Pond
Northwest Beach
Lake Erie

Obtain permission from private property owners prior to crossing private property, access sites or boat launches.

Map 9

Contains Sections From NTS and USGS Maps:
40J/2 and 40G/15



Scale
Kilometres
0 0.5 1 2
0 0.5 1
Miles
1:50,000

41° 56' 48" N
82° 41' 56" W

41° 56' 48" N
82° 32' 2" W

42° 0' 31" N
82° 36' 21" W

42° 0' 31" N
82° 26' 27" W

Marentette Beach

Marentette Beach

Point Pelee National Park

Sanctuary Pond

Buck Pond

West Cranberry Pond

East Cranberry Pond

Lake Erie

Sanctuary

Northwest Beach

Lake Pond

Orlando Pond

(29)

Camp Henry

The Dunes

Sleepy Hollow

Round Pond

Redhead Pond

Pioneer

Black Willow Beach

White Pine

East Beach

West Beach

East Point Beach

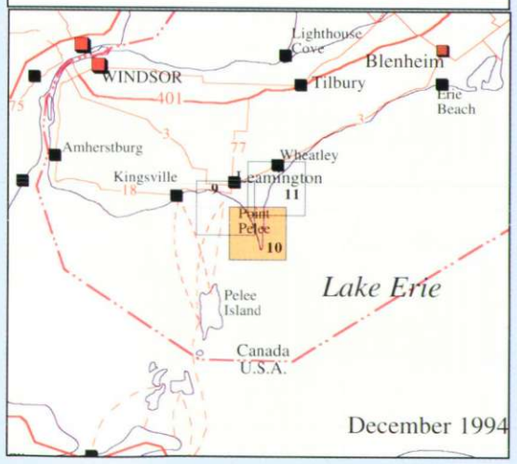
Point Pelee

41° 53' 29" N
82° 36' 21" W

41° 53' 29" N
82° 26' 27" W

Map 10

Contains Sections From NTS and USGS Maps:
40J/2, 40J/1 and 40G/15



December 1994

Scale
Kilometres
0 0.5 1 2
0 0.5 1
Miles
1:50,000

NOTES

A red exclamation point symbol is used on the maps to catch the responder's attention.

24 Point Pelee National Park is designated as an Area of Natural and Scientific Interest because it is representative of a variety of vegetation. The ANSI boundaries coincide with the National Park boundaries. The Park is a waterfowl staging area and a migratory bird stopover. The entire shoreline of the park is composed of sand beach with a vegetated back dune area and forested dune area enclosing a cattail marsh. The Lake Pond marsh area is a Class 1 wetland. The entire park is a RAMSAR site of international significance (according to the RAMSAR Convention on the Conservation of Wetlands of International Importance). Highly sensitive and rare reptiles, amphibians, birds, and plants are present on or near all shoreline areas. Contact the Heritage Centre for any bird sightings at (519) 724-2291. The entire west side of Point Pelee hosts a variety of recreational opportunities, including hiking trails, viewing platforms and picnic areas. Fish spawning (including smelt) occurs along the sandy shores of this part of Lake Erie during spring. The interior marshland at the northern portion of Point Pelee National Park has a concentration of dabbling ducks (Mallard, Black Duck, Green-winged Teal, Wood duck) during spring and fall migration periods.

25 Concentrations of diving ducks (Scaup, Merganser) along both shores of Point Pelee National Park can approach 10,000 during the fall. Scaup usage has increased due to the amount of zebra mussels available. Other diving ducks such as Bufflehead and Goldeneye are also present in fall. Spring concentration of diving ducks are limited. Point Pelee National Park Warden Services offices are located near Black Willow Beach. Responders should beware of strong currents at the tip of Point Pelee.

26 Spill responders should note that natural gas wells and pipelines are submerged along the east coast of Point Pelee. For emergencies contact the Ontario Ministry of Natural Resources 24 hour number at (519) 426-7650.

NOTES

A red exclamation point symbol is used on the maps to catch the responder's attention.

27 Hillman Marsh Conservation Area is designated as a Provincially Significant Wetland and an Environmentally Sensitive Area. It is a well known migratory stopover. The Spotted Turtle and Eastern Fox Snake are found here. The Conservation Area has a sand/pebble recreational beach. Concentrations of dabbling ducks and Canada Geese are present in the marsh in fall and spring.

28 Omstead Foods Ltd. fish and vegetable processing facility water Intake and Outfalls - Call (519) 825-4611. The intakes also feed the Wheatly Drinking Water Treatment Plant. Romney Wastewater Treatment Plant Outfall - Call (519) 825-4326. The shores in this area are frequently marked with sheet steel groynes.

29 Wheatly Provincial Park is designated as an Area of Natural and Scientific Interest because it supports a provincially significant deciduous forest, and various rare species. The west and east branches of West Two Creeks form a wetland complex known as Wheatly Two Creeks Wetland (Provincially Significant).

42° 6' 19" N
82° 33' 13" W

42° 6' 19" N
82° 23' 18" W

Wheatley

Hwy. 3

Wheatley Provincial Park

West Two Creeks

Kopegaron Woods Conservation Area

Muddy Creek

Holiday Harbour

Elnidale

Hillman Marsh Conservation Area

Hillman Creek

Lake Erie

Obtain permission from private property owners prior to crossing or using private property, access sites or boat launches.

Marentette Beach

Marentette Beach

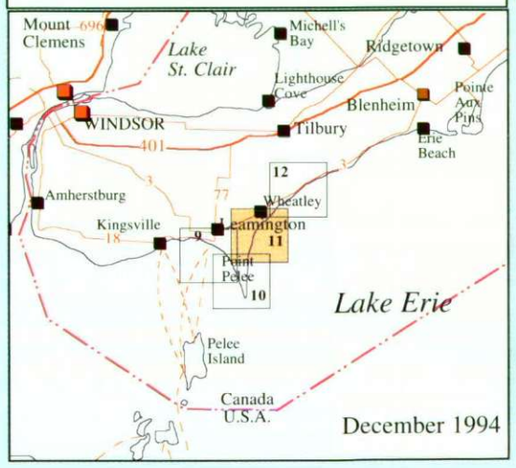
Point Pelee National Park

41° 59' 18" N
82° 33' 13" W

41° 59' 18" N
82° 23' 18" W

Map 11

Contains Sections From NTS and USGS Maps:
40J/2, 40J/1 and 40G/15



December 1994

Scale
Kilometres
0 0.5 1 2
0 0.5 1
Miles
1:50,000

42° 12' 8" N
82° 26' 33" W

42° 12' 8" N
82° 16' 37" W

Stevenson

Obtain permission from private property owners prior to crossing or using private property, access sites or boat launches.

CNR

Coatsworth

Renwick

Hwy. 3

Lake Erie

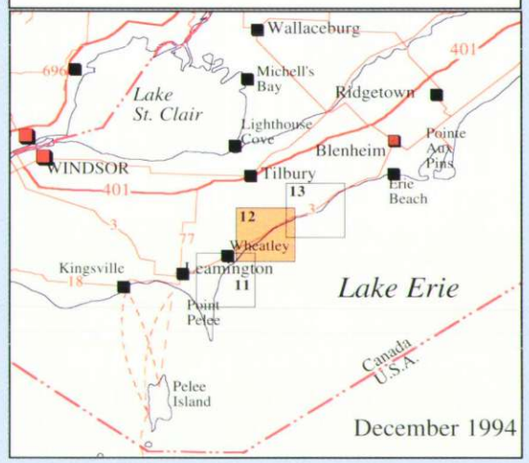
Scale
Kilometres
0 0.5 1 2
0 0.5 1
Miles
1:50,000

42° 5' 7" N
82° 26' 33" W

42° 5' 7" N
82° 16' 37" W

Map 12

Contains Sections From NTS and USGS Maps:
40J/1



NOTES

A red exclamation point symbol is used on the maps to catch the responder's attention.

NOTES

A red exclamation point symbol is used on the maps to catch the responder's attention.

30 Port Alma Municipal Drinking Water Intake - Call (519) 689-7747. Spill responders should note that natural gas wells and pipelines are submerged between Port Alma and Port Crewe. - Call the Ontario Ministry of Natural Resources at (519) 426-7650. There is smelt spawning all along the shores of this part of Lake Erie in spring.

42° 15' 16" N
82° 18' 11" W

42° 15' 16" N
82° 8' 15" W

Merlin

CNR

Obtain permission from private property owners prior to crossing or using private property, access sites or boat launches.

Glenwood

Hwy. 3

Port Crewe

Port Alma

30

Lake Erie

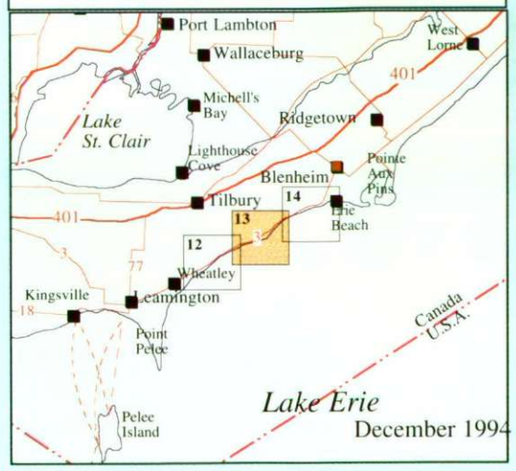
Scale
Kilometres
0 0.5 1 2
0 0.5 1
Miles
1:50,000

42° 8' 15" N
82° 18' 11" W

42° 8' 15" N
82° 8' 15" W

Map 13

Contains Sections From NTS and USGS Maps:
40J/1 and 40J/8



42° 18' 13" N
82° 9' 28" W

42° 18' 13" N
81° 59' 31" W

CNR

Hwy. 40

Hwy. 3

Obtain permission from private property owners prior to crossing or using private property, access sites or boat launches.

Blenheim Airfield

Cedar Springs

Erie Beach

Sandison

Dealtown

Ouvry

Lake Erie

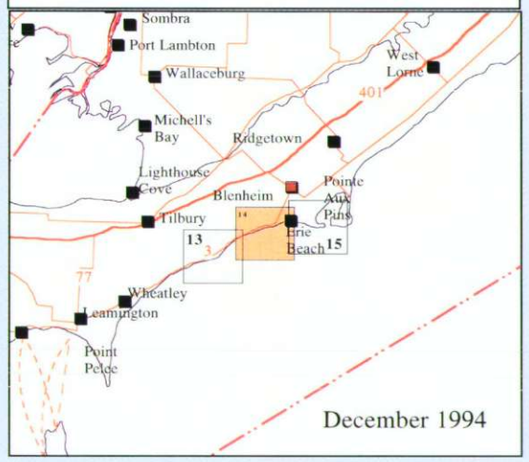
31

32

Scale
Kilometres
0 0.5 1 2
0 0.5 1
Miles
1:50,000

Map 14

Contains Sections From NTS and USGS Maps:
40J/1, 40J/8 and 40I/5



December 1994

42° 11' 12" N
82° 9' 28" W

42° 11' 12" N
81° 59' 31" W

NOTES

A red exclamation point symbol is used on the maps to catch the responder's attention.

31 Raleigh Township Wastewater Treatment Outfall - Call (519) 676-3514. Blenheim Municipal Drinking Water Treatment Plant Intakes - Call (519) 676-3514. There is smelt spawning all along the shores of this part of Lake Erie in spring.

32 This one intake serves both the Kent County Municipal Drinking Water Treatment Plant and the Erieau Erie Beach Municipal Drinking Water Treatment Plant - Call (519) 676-3514. The mixed beaches in this area are largely sand with some pebble and backed by exposed sediment bluffs.

NOTES

A red exclamation point symbol is used on the maps to catch the responder's attention.

33 Commercial fishing activity occurs at the mouth of Rondeau Bay for Bass, Perch, Walleye, and Salmon. The mixed beaches from Erieau West are mainly sand with some pebble, marked by sheet steel groynes, and pockets of rip-rap and retaining wall.

34 Rondeau Provincial Park is a designated ANSI because of rare and endangered species which inhabit the park. The Rondeau sand spit (Pointe aux Pins) contains unique combinations of habitat including beaches, dunes, upland forests, grasslands, wet meadows, wet or flooded woods, marshes, ponds and fields. One third of the land is protected as a Nature Reserve Zone, which includes a major wetland inhabited by various waterfowl species, including major fall migration concentrations of dabbling ducks (Mallard, Black Duck, Wood Duck, Greened-winged Teal, Ringed-necked Ducks) also present in spring. Many provincially significant plants are found in Rondeau, including Tulip-tree, Pawpaw, Kentucky Coffee Tree, Orchids, Sassafras, and various sedges such as the Swamp Rose Mellow (designated as vulnerable). Eight of the 124 bird species listed as nesting in Rondeau Park are designated as threatened or vulnerable: Cooper's Hawk, Red-shouldered Hawk, Least Bittern, King Rail, Caspian Tern, Loggerhead Shrike, Prothonotary Warbler, and Henslow Sparrow. The endangered Bald Eagle and other raptors also nest here. Amphibians and reptiles include the Eastern Hognose Snake, Eastern Spring Soft-shell Turtle (threatened), Blanding's Turtle, Spotted Turtle and Fowler's Toad (both vulnerable). Mammals present include White-tailed Deer, Raccoon, Skunk, Muskrat, Coyote, Bat, Meadow Vole, Deer Mice, Southern Bog Lemming, American Badger and Virginia Opossum and Eastern Fox (both Provincially significant). The mixed beach shores of Rondeau are mainly sand with some pebble.

35 The wetland components along these shores are known as the Northwest Shore Rondeau Bay Wetland Complex (Provincially Significant). The Rondeau Bay Wetlands are important fish spawning and nursery areas for up to 19 species, including Gizzard Shad, Sunfish, White Crappie, Black Redhorse (threatened), Pugnose Shiner and Spotted Gar (both vulnerable). The Bay's open water is used by major fall migration and spring concentrations of diving ducks (Scaup, Canvasback, Redhead, Bufflehead, Goldeneye) numbering in many thousands. Rondeau Bay is a multi-use area, with duck hunting, ice fishing and other seasonal human-use activities with recreational, social, educational and economic value.

42° 19' 2" N
82° 0' 36" W

42° 19' 2" N
81° 50' 39" W

Hwy 3

Raglan

Shrewsbury

Rondeau Bay

Obtain permission from private property owners prior to crossing or using private property, access sites or boat launches.

Blenheim Airfield

Erie Beach

Posts Point

Shirely Point

Erieau

Rondeau Provincial Park and Nature Reserve

Pointe Aux Pins

(14)

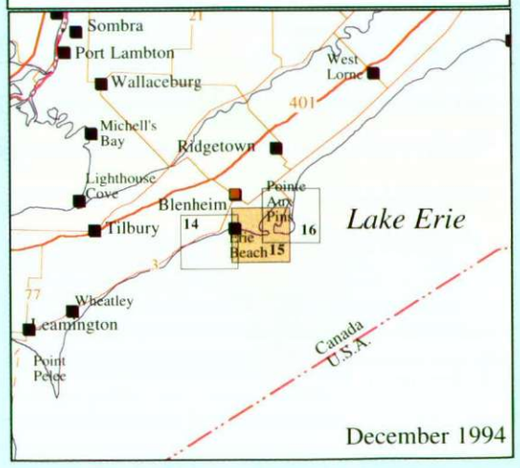
(250)

Lake Erie

Scale
Kilometres
0 0.5 1 2
0 0.5 1
Miles
1:50,000

Map 15

Contains Sections From NTS and USGS Maps:
40J/1, 40J/8 and 40I/5



December 1994

42° 12' 0" N
82° 0' 36" W

42° 12' 0" N
81° 50' 39" W

42° 21' 32" N
81° 55' 24" W

42° 21' 32" N
81° 45' 26" W

New Scotland

Hwy. 51

22

(450)

Rondeau Bay Estates

Rondeau Park

(2)

Raglan

35

Rondeau Bay

Shrewsbury

36

Lake Erie

Obtain permission from private property owners prior to crossing or using private property, access sites or boat launches.

Rondeau Provincial Park and Nature Reserve

21

Pointe Aux Pins

20

Posts Point

Shirely Point

Erieau

(14)

(250)

34

33

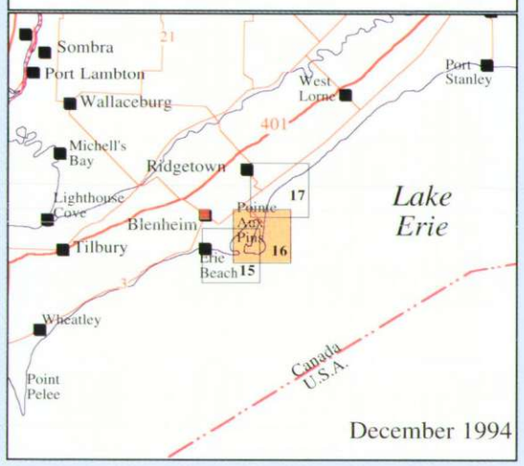
42° 14' 30" N
81° 55' 24" W

42° 14' 30" N
81° 45' 26" W

Scale
Kilometres
0 0.5 1 2
0 0.5 1
Miles
1:50,000

Map 16

Contains Sections From NTS and USGS Maps:
40I/5



December 1994

NOTES

A red exclamation point symbol is used on the maps to catch the responder's attention.

33 Commercial fishing activity occurs at the mouth of Rondeau Bay for Bass, Perch, Walleye, and Salmon. The mixed beaches from Erieau West are mainly sand with some pebble, marked by sheet steel groynes, and pockets of rip-rap and retaining wall.

34 Rondeau Provincial Park is a designated ANSI because of rare and endangered species which inhabit the park. The Rondeau sand spit (Pointe aux Pins) contains unique combinations of habitat including beaches, dunes, upland forests, grasslands, wet meadows, wet or flooded woods, marshes, ponds and fields. One third of the land is protected as a Nature Reserve Zone, which includes a major wetland inhabited by various waterfowl species, including major fall migration concentrations of dabbling ducks (Mallard, Black Duck, Wood Duck, Greened-winged Teal, Ringed-necked Ducks) also present in spring. Many provincially significant plants are found in Rondeau, including Tulip-tree, Pawpaw, Kentucky Coffee Tree, Orchids, Sassafras, and various sedges such as the Swamp Rose Mellow (designated as vulnerable). Eight of the 124 bird species listed as nesting in Rondeau Park are designated as threatened or vulnerable: Cooper's Hawk, Red-shouldered Hawk, Least Bittern, King Rail, Caspian Tern, Loggerhead Shrike, Prothonotary Warbler, and Henslow Sparrow. The endangered Bald Eagle and other raptors also nest here. Amphibians and reptiles include the Eastern Hognose Snake, Eastern Spring Soft-shell Turtle (threatened), Blanding's Turtle, Spotted Turtle and Fowler's Toad (both vulnerable). Mammals present include White-tailed Deer, Raccoon, Skunk, Muskrat, Coyote, Bat, Meadow Vole, Deer Mice, Southern Bog Lemming, American Badger and Virginia Opossum and Eastern Fox (both Provincially significant). The mixed beach shores of Rondeau are mainly sand with some pebble.

35 The wetland components along these shores are known as the Northwest Shore Rondeau Bay Wetland Complex (Provincially Significant). The Rondeau Bay Wetlands are important fish spawning and nursery areas for up to 19 species, including Gizzard Shad, Sunfish, White Crappie, Black Redhorse (threatened), Pugnose Shiner and Spotted Gar (both vulnerable). The Bay's open water is used by major fall migration and spring concentrations of diving ducks (Scaup, Canvasback, Redhead, Bufflehead, Goldeneye) numbering in many thousands. Rondeau Bay is a multi-use area, with duck hunting, ice fishing and other seasonal human-use activities with recreational, social, educational and economic value.

36 Sand dunes extend along the east side adjacent to Lake Erie. Responders should take care not to damage vegetation stabilizing the sand dunes. Spill responders should note that natural gas wells and pipelines are submerged at Rondeau Park. For emergencies call the OMNR at (519) 426-7650 (24 hours). Migrating ducks (Scaup, Mergansers) concentrate offshore, especially during fall.

NOTES

A red exclamation point symbol is used on the maps to catch the responder's attention.

37 Morpeth Creek is a designated Environmentally Sensitive Area because traces of Carolinian species are present. Migrating diving ducks (Scaup, Mergansers) concentrate offshore in the area especially during the fall. Yellow Perch spawn along the shore between Rondeau and Port Stanley. Smelt spawning occurs along sandy shores in this area in spring. The mixed beach at Morpeth is mainly sandy, with some pebble, and backed by sediment bluffs.

38 The Kent/Elgin Shoreline Area of Natural and Scientific Interest is a primarily forested area located on the boundary of Elgin and Kent Counties. Numerous species of birds inhabit the area. The Elgin-Kent County shoreline is regarded to be particularly important as a day-use, feeding and perching area for the Bald Eagle (endangered species). Many mammals are located in the area, including the Southern Bog Lemming (vulnerable in Ontario) and the American Badger (uncommon in Ontario), which sometimes locates its den in the eroding bluffs of the shoreline. Of the many rare plant species in the area, only four are found along the eroding bluffs: Ghost Pipe, Cancer Root, Canada Hawkweed and Hairy Rock-Cress. All together, this undeveloped shoreline, several large woodlands and a cropland form a belt of natural habitat, resulting in the Area of Natural and Scientific Interest designation. This ANSI is threatened by development.

42° 27' 26" N
81° 52' 22" W

42° 27' 26" N
81° 42' 24" W

Ridgetown

Palmyra

Kent/ Elgin Shoreline ANSI

24

38

Obtain permission from private property owners prior to crossing or using private property, access sites or boat launches.

Hwy. 21

Klondike Hill

Morpeth Creek

Hwy. 3

Morpeth

23

37

Lake Erie

New Scotland

Hwy. 51

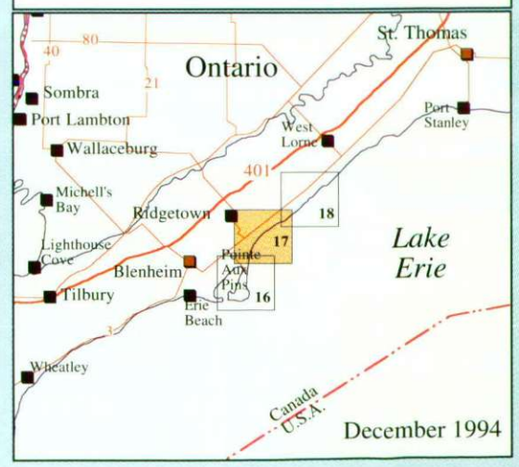
42° 20' 25" N
81° 52' 22" W

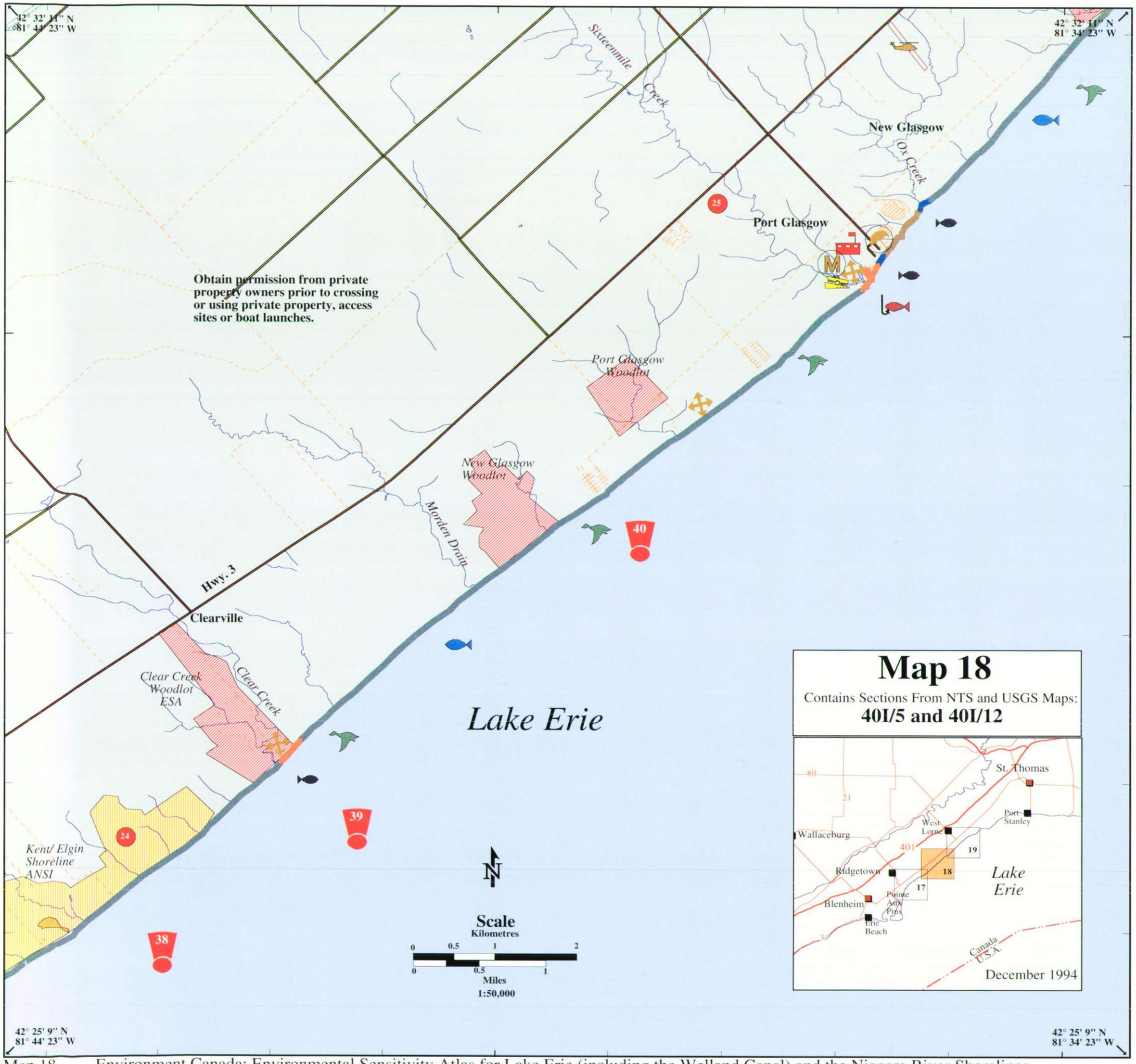
42° 20' 25" N
81° 42' 24" W

Scale
Kilometres
0 0.5 1 2
0 0.5 1
Miles
1:50,000

Map 17

Contains Sections From NTS and USGS Maps:
40I/5





Map 18

Contains Sections From NTS and USGS Maps:
40I/5 and 40I/12

December 1994

NOTES

A red exclamation point symbol is used on the maps to catch the responder's attention.

38 The Kent/Elgin Shoreline Area of Natural and Scientific Interest is a primarily forested area located on the boundary of Elgin and Kent Counties. Numerous species of birds inhabit the area. The Elgin-Kent County shoreline is regarded to be particularly important as a day-use, feeding and perching area for the Bald Eagle (endangered species). Many mammals are located in the area, including the Southern Bog Lemming (vulnerable in Ontario) and the American Badger (uncommon in Ontario), which sometimes locates its den in the eroding bluffs of the shoreline. Of the many rare plant species in the area, only four are found along the eroding bluffs: Ghost Pipe, Cancer Root, Canada Hawkweed and Hairy Rock-Cress. All together, this undeveloped shoreline, several large woodlands and a cropland form a belt of natural habitat, resulting in the Area of Natural and Scientific Interest designation. This ANSI is threatened by development.

39 Clear Creek Woodlot is designated an Environmentally Sensitive Area. The Creek has a Rainbow Trout run in spring, as do Sixteen Mile Creek and Ox Creek further east.

40 Aldborough Township (Clearville to east of Eagle) is one of the few townships in southern Ontario that still has fairly large tracks of woodlands and wetlands available for wildlife habitat. New Glasgow Woodlot is designated an Environmentally Sensitive Area. It supports various raptors. Port Glasgow Woodlot is designated an Environmentally Sensitive Area because it contains a large variety of ferns. The woodlot is in danger of being cleared. Yellow Perch spawn along the shores from Rondeau to Port Stanley. Loafing Mallard Ducks and Canada Geese make scattered use of these shores, as do Mergansers and Goldeneye Ducks in spring.

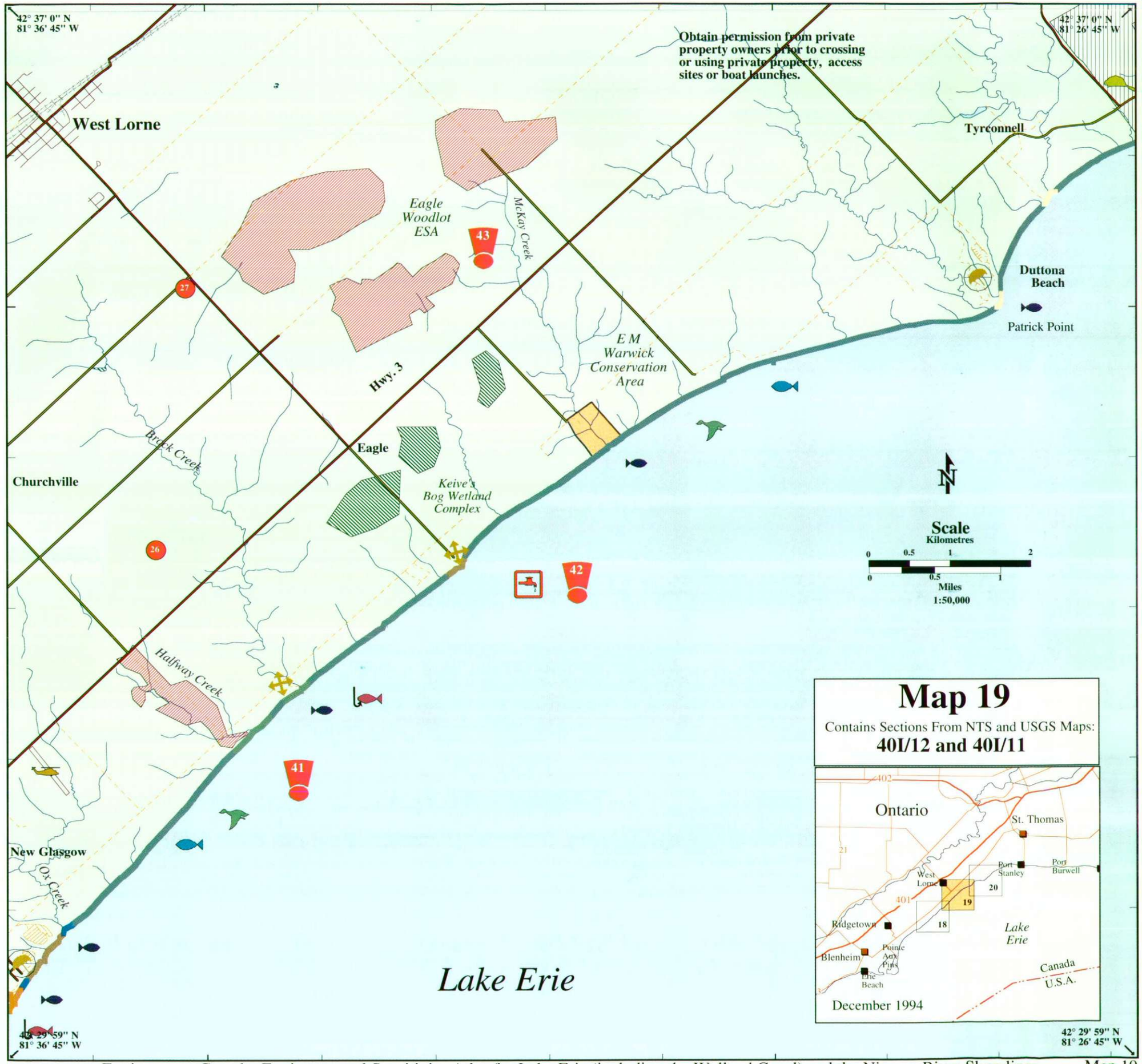
NOTES

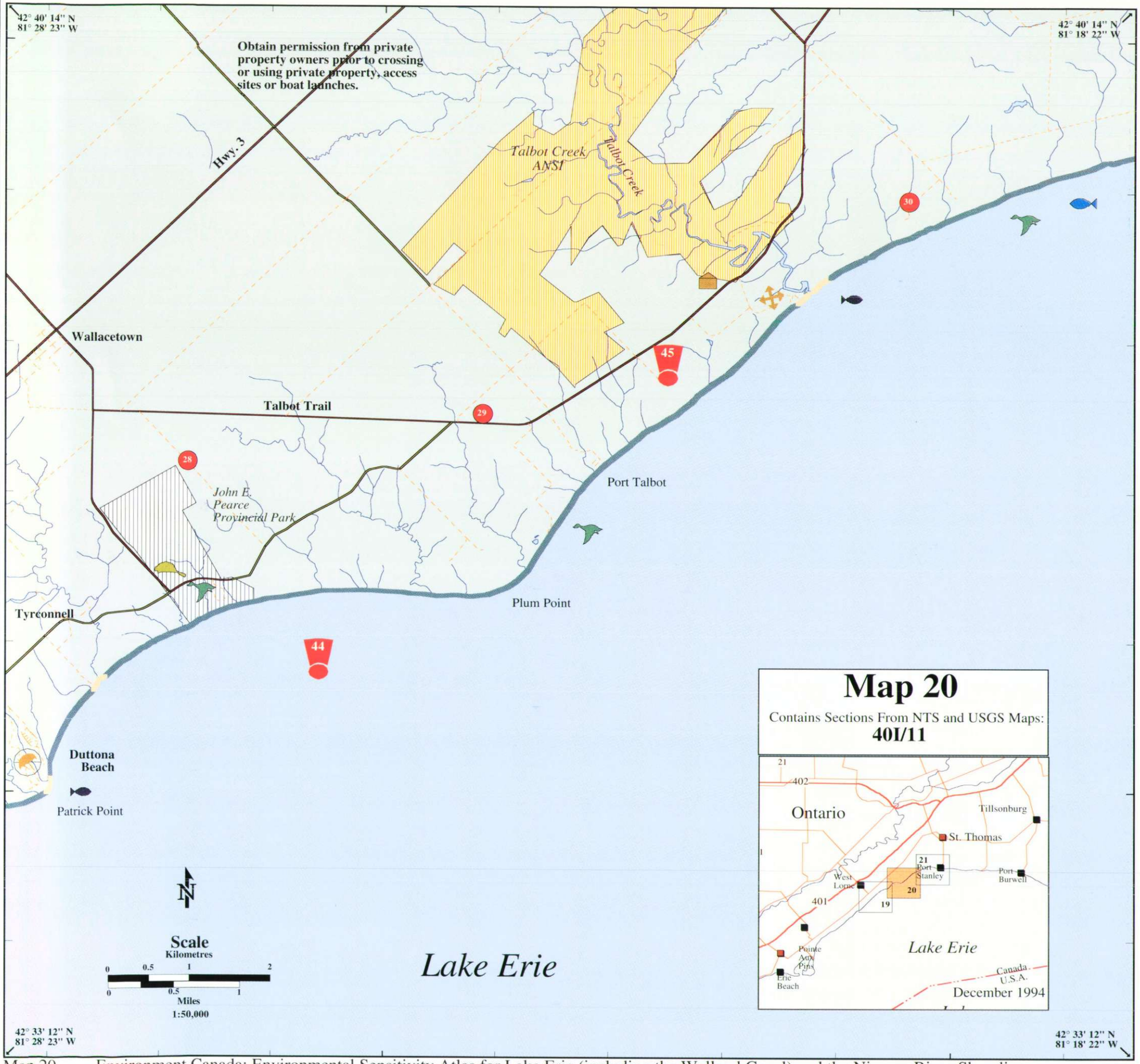
A red exclamation point symbol is used on the maps to catch the responder's attention.

41 Halfway Creek is a designated Environmentally Sensitive Area. Large scale clearing of the ravine slopes must be prevented as it would cause severe erosion. There is a commercial fishing base at the creek entrance to the lake. Yellow Perch spawn along the shores from Rondeau to Port Stanley. Loafing Mallard Ducks and Canada Geese make scattered use of these shores, as do Mergansers and Goldeneye Ducks in spring.

42 West Lorne Drinking Water Treatment Plant Intake - Call (519) 768-1820.

43 Eagle Woodlot is designated as an Environmentally Sensitive Area because it supports a wet swampy wood, mixed with a deciduous forest.





Map 20

Contains Sections From NTS and USGS Maps:
40I/11

NOTES

A red exclamation point symbol is used on the maps to catch the responder's attention.

44 John E. Pearce Provincial Park is approximately 68 hectares in size and supports a wide diversity of flora and fauna. Upland and lowland deciduous forests present a good example of Carolinian vegetation. Fifteen of the plant species found in the Park are considered rare, although only the Broad Beach Fern is considered vulnerable. Of the many bird species in the Park, none are considered endangered, threatened or vulnerable. Mammals and amphibian/reptile species are found in the Park; there is the possibility that Soft Shell Turtles may nest on the beach during years of low lake levels. The Eastern Spiny Softshell Turtle is considered threatened in Ontario. In the general area, there is a marina proposed at the road end south of Tyrconnell. The exposed sediment bluffs all along these shores to Port Burwell are very high, often exceeding 30 metres, and with limited beach access. Yellow Perch spawn along the shores from Rondeau to Port Stanley. Loafing Mallard Ducks and Canada Geese make scattered use of these shores, as do Mergansers and Goldeneye Ducks in spring.

45 Talbot Creek is designated an Area of Natural and Scientific Interest as it is a large, natural representation of upland forests and valley habitats. The Historic Talbot Estates are located near the Talbot Trail. Talbot Creek has limited access due to several small tributary steams and a complicated topography. A marina has been proposed for the creek mouth.

NOTES

A red exclamation point symbol is used on the maps to catch the responder's attention.

46 Port Stanley Drinking Water Treatment Plant Intake - Call (519) 782-3101. Port Stanley is a federal harbour and a populated area with active tourism. Significant fishing interests are present for Salmonids, Bass, Channel Catfish and Pike, and the town is a commercial fisheries base. Yellow Perch spawn along these shores. Loafing Mallards Ducks and Canada Geese make scattered use of these shores, as do Mergansers and Goldeneye Ducks in the spring.

47 Hawk Cliff is designated an Environmentally Sensitive Area due to a wide variety of habitats. Mammals present include Cottontail, Jackrabbit, Red Fox, Raccoon and Woodchuck. Eagles are often present. It is the first hawk migration observation point in North America and acts as a focal point for other migratory birds. It is an international raptor bird banding site. The exposed sediment bluffs all along these shores to Port Burwell are very high and have limited beach access. Elgin Area Drinking Water Treatment Plant Intake - Call (519) 782-3101.

42° 43' 16" N
81° 19' 46" W

42° 43' 16" N
81° 9' 45" W

Fingal

Beaver Creek

Union

Obtain permission from private property owners prior to crossing or using private property, access sites or boat launches.

Kettle Creek

Hwy. 4

Little Creek

Conservation Area, Port Stanley

Port Stanley

Orchard Beach

Hawk Cliff

Erie Rest

Grand Canyon

Grimmonds Beach

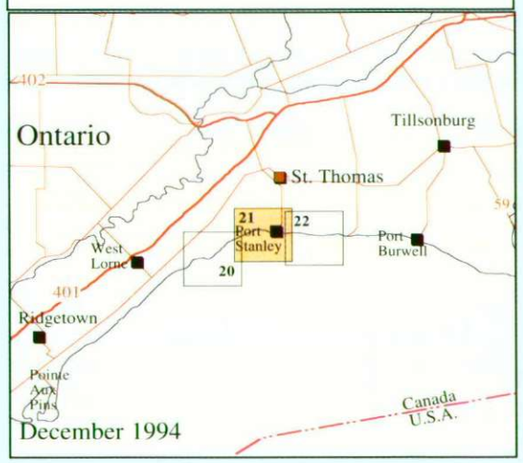
31

47

46

Map 21

Contains Sections From NTS and USGS Maps:
40I/11



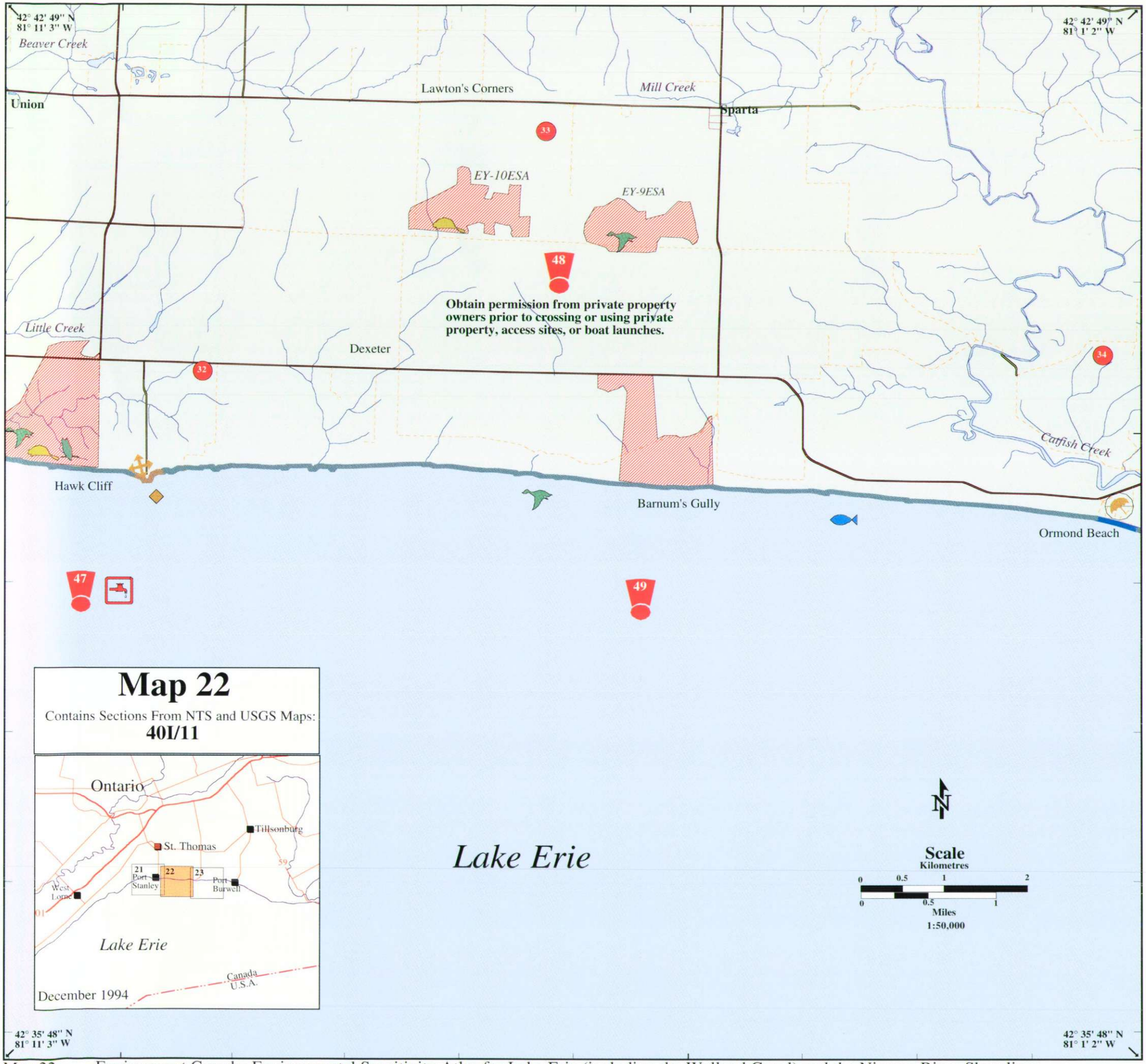
December 1994

Lake Erie

Scale
Kilometres
0 0.5 1 2
0 0.5 1
Miles
1:50,000

42° 36' 15" N
81° 19' 46" W

42° 36' 15" N
81° 9' 45" W



Map 22

Contains Sections From NTS and USGS Maps:
40I/11

NOTES

A red exclamation point symbol is used on the maps to catch the responder's attention.

47 Hawk Cliff is designated an Environmentally Sensitive Area due to a wide variety of habitats. Mammals present include Cottontail, Jackrabbit, Red Fox, Raccoon and Woodchuck. Eagles are often present. It is the first hawk migration observation point in North America and acts as a focal point for other migratory birds. It is an international raptor bird banding site. The exposed sediment bluffs all along these shores to Port Burwell are very high and have limited beach access. Elgin Area Drinking Water Treatment Plant Intake - Call (519) 782-3101.

48 Environmentally Sensitivity Area, EY-10, is a wetland that provides habitat for a variety of species including the provincially significant (and endangered) Peregrine Falcon during migration. Environmentally Sensitive Area, EY-9, consists of a woodlot and a wetland. This site is a locally significant waterfowl area. EY-9 also lies within a migratory corridor and is occasionally used by migrating Peregrine Falcons. Both areas are managed by the Kettle Creek Conservation Authority.

49 Barnum's Gulley is an Environmentally Sensitive Area because it is an excellent example of mass wasting and other geomorphological processes. It is a good representation of rare processes. Barnum's Gully is a high erosion area. The exposed sediment bluffs all along these shores to Port Burwell are very high, with limited or no beach access. Loafing Mallard Ducks and Canada Geese make scattered use of these shores, as do Mergansers and Goldeneye Ducks in spring. Smelt spawning occurs along sandy shores in this area of Lake Erie in spring.

NOTES

A red exclamation point symbol is used on the maps to catch the responder's attention.

50 Port Bruce is a populated area with a federal harbour. The town is a base for commercial and recreational fishing activity, and there are several public and private beaches, making the town a tourism area.

51 Spill responders should note that natural gas wells and pipelines are submerged south of Port Bruce. For emergencies, contact the Ontario Ministry of Natural Resources at (519) 426-7650 (24 hours).

52 The exposed sediment bluffs all along these shores to Port Burwell are very high, with limited beach access. Smelt spawning occurs along sandy shores of this area of Lake Erie in spring. Loafing Mallard Ducks and Canada Geese make scattered use of these shores, as do Mergansers and Goldeneye Ducks in spring.

42° 42' 28" N
81° 1' 57" W

42° 42' 28" N
80° 51' 56" W

Candyville

Copenhagen

Grovesend

Lakeview

Obtain permission from private property owners prior to crossing or using private property, access sites, or boat launches.

Silver Creek

Slater's Gulley

Catfish Creek

Hwy. 73

Port Bruce

Ormond Beach

Port Bruce Provincial Park

Waneeta Beach

34

35

50

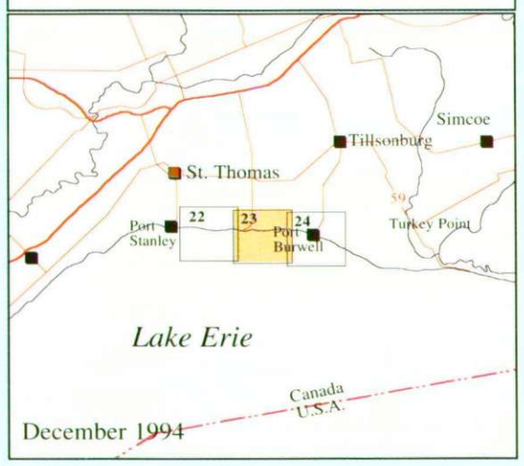
51

52

Lake Erie

Map 23

Contains Sections From NTS and USGS Maps:
40I/11 and 40I/10



December 1994

N

Scale
Kilometres
0 0.5 1 2
0 0.5 1
Miles
1:50,000

42° 35' 26" N
81° 1' 57" W

42° 35' 26" N
80° 51' 56" W

42° 42' 6" N
80° 52' 51" W

42° 42' 6" N
80° 42' 50" W

Big Otter Creek

CPR

Vienna

Lakeview

Obtain permission from private property owners prior to crossing or using private property, access sites, or boat launches.

Hwy. 19

36

38

37

Iroquois Beach Provincial Park

South Otter Creek

Hemlock Creek

Port Burwell

M

52

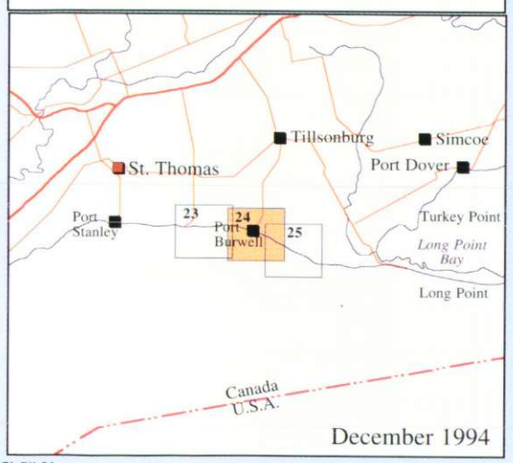
53

Talbot Trail

Lake Erie

Map 24

Contains Sections From NTS and USGS Maps:
40I/10



December 1994

Scale
Kilometres
0 0.5 1 2
0 0.5 1
Miles
1:50,000

42° 35' 5" N
80° 52' 51" W

42° 35' 5" N
80° 42' 50" W

NOTES

A red exclamation point symbol is used on the maps to catch the responder's attention.

52 The exposed sediment bluffs all along these shores to Port Burwell are very high, with limited beach access. Smelt spawning occurs along sandy shores of this area of Lake Erie in spring. Loafing Mallard Ducks and Canada Geese make scattered use of these shores, as do Mergansers and Goldeneye Ducks in spring.

53 Port Burwell Wastewater Treatment Plant Outfall - Call (519) 874-4761.

NOTES

A red exclamation point symbol is used on the maps to catch the responder's attention.

54 Sand Hills Park is an area of sand cliff with perched dunes. The exposed sediment bluffs all along these shores are high, with limited beach access. Loafing Mallard Ducks and Canada Geese make scattered use of these shores, as do Mergansers and Goldeneye Ducks in spring.

42° 40' 3" N
80° 46' 18" W

42° 40' 3" N
80° 36' 18" W

South Otter Creek

Hemlock Creek

Talbot Trail

Fairground

Cultus

Obtain permission from private property owners prior to crossing or using private property, access sites, or boat launches.

Hemlock

Talbot Trail

Houghton Centre

Clear Creek

Sand Hills Park

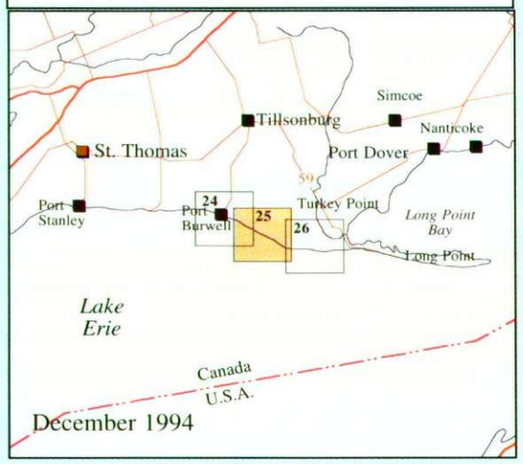
Jacksonburg

The Sand Hills

Lake Erie

Map 25

Contains Sections From NTS and USGS Maps:
40I/10



December 1994

Scale
Kilometres
0 0.5 1 2
0 0.5 1
Miles
1:50,000

54

42° 33' 1" N
80° 46' 18" W

42° 33' 1" N
80° 36' 18" W

42° 38' 32" N
80° 37' 19" W

42° 38' 32" N
80° 27' 19" W

Hwy. 24

Hwy. 59

Cultus

South Walsingham
Sand Ridges ANSI

Backus
Conservation
Area and ANSI

Big Creek

Rowan
Mills

Erie
View

Port Royal

Clear Creek

Obtain permission from private property owners prior to crossing or using private property, access sites, or boat launches.

Big Creek
Marsh

Old Creek

Clear
Creek

Hahn Marsh

Lee Brown Marsh
Conservation Area

55

56

57

58

59

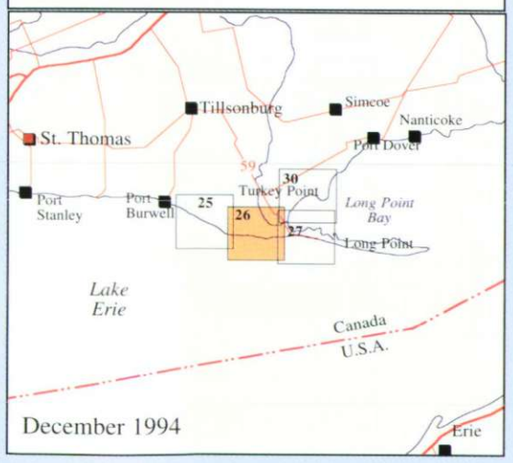
39

40

41

Map 26

Contains Sections From NTS and USGS Maps:
40I/10 and 40I/9



December 1994

Lake Erie

Scale
Kilometres
0 0.5 1 2
0 0.5 1
Miles
1:50,000

42° 31' 30" N
80° 37' 19" W

42° 31' 30" N
80° 27' 19" W

NOTES

A red exclamation point symbol is used on the maps to catch the responder's attention.

55 Spill responders should note that natural gas wells and pipelines are submerged from Clear Creek to Long Point. For emergencies, contact the Ontario Ministry of Natural Resources at (519) 426-7650 (24 hours).

56 South Walsingham Sand Ridges Area of Natural and Scientific Interest is a diverse area with sand ridges and lowland forest adjoining the Big Creek Floodplain.

57 Big Creek Floodplain Area of Natural and Scientific Interest represents the natural floodplain communities of river valley system and it supports a diversity of habitats and wildlife.

58 Backus Woods Conservation Area is an Area of Natural and Scientific Interest because it is an excellent example of deciduous forest.

59 The Hahn Marsh and Big Creek Marsh combine to form the Big Creek National Wildlife Area (NWA) managed by the Canadian Wildlife Service. The two marshes are separated by private land and Long Point Region Conservation Authority property. The NWA is an ANSI and ESA due to its large diversity of habitats and wildlife (birds, fish, reptiles and mammals). Its large wetland is a major stopover for migratory waterfowl, and supports a colony of Great Egrets. Waterfowl hunting is prevalent in fall. The NWA's long barrier beach is a nesting site for turtles and a basking area for snakes (including threatened species). The NWA is an important spawning and nursery area for fish, especially Pike and Carp.

NOTES

A red exclamation point symbol is used on the maps to catch the responder's attention.

59 The Hahn Marsh and Big Marsh combine to form the Big Creek National Wildlife Area (NWA) managed by the Canadian Wildlife Service. The two marshes are separated by private land and Long Point Region Conservation Authority property. The NWA is an ANSI and ESA due to its large diversity of habitats and wildlife (birds, fish, reptiles and mammals). Its large wetland is a major stopover for migratory waterfowl, and supports a colony of Great Egrets. Waterfowl hunting is prevalent in fall. The NWA's long barrier beach is a nesting site for turtles and a basking area for snakes (including threatened species). The NWA is an important spawning and nursery area for fish, especially Pike and Carp.

60 Port Rowan Water Treatment Plant Outfall/Intake - Call (519) 587-4911. Inner Bay is a major staging area for diving ducks.

61 Spill responders should note that natural gas wells and pipelines are submerged in Inner Bay and along Long Point. Call OMNR at (519) 426-7650 (24 hour).

62 Long Point, the longest spit in the Great Lakes, is a Class 1 wetland, a designated ANSI, Provincial Park, World Biosphere Reserve (UNESCO), RAMSAR site (Convention on Conservation of Wetlands of International Importance) and National Wildlife Area (NWA). It is the site of the Long Point Bird Observatory (east tip). Long Point's various habitats support a variety of plants and wildlife. The Long Point NWA boundaries include the entire area from Squires Ridge east almost to the tip of the spit, as well as a section between Long Point Provincial Park and Long Point Company's property. Long Point is an internationally important area for migratory birds, waterfowl and songbirds. It is a major waterfowl staging area during migration with fall (September to December) peaks of 150,000 and spring (March to April) peaks of 70,000 waterfowl. Long Point is the first major spring stopover for thousands of migrating Tundra Swans. The uplands are on the major spring and fall migration corridor for passerine songbirds. The Inner Bay is an important spawning and nursery area for Pike, Smelt, Yellow Perch, Smallmouth Bass and other fish. White-tailed Deer are abundant on Long Point. Rare or threatened reptiles (including various snakes, turtles and toads) are also present here, as is the Meadow Crayfish, one of Canada's rarest invertebrates. Bats, Dragonflies and Monarch Butterflies also use Long Point as a migratory stopover. Along with the Lake St. Clair Marshes, Long Point is the most important wetland area in Ontario. Call the Park Warden at (519) 586-2133 during spills.

42° 38' 5" N
80° 28' 36" W

42° 38' 5" N
80° 18' 35" W

Obtain permission from private property owners prior to crossing or using private property, access sites, or boat launches.

Inner Bay

Port Rowan

Big Creek Marsh

Coletta Bay

Becker's Channel

Old Cut Channel

Old Cut Point

Dickinson Creek

Sturgeon Bay

Velocity Creek

Long Point

Long Point Provincial Park

Old Cut

Little Rice Bay Point

Little Rice Bay

Thoroughfare Point

Big Rice Bay Point

Big Rice Bay

The Cottages

Shanty Pond

Peter's Pond

Sunk Marsh

(1) (3) (4) (6) (6) (12)

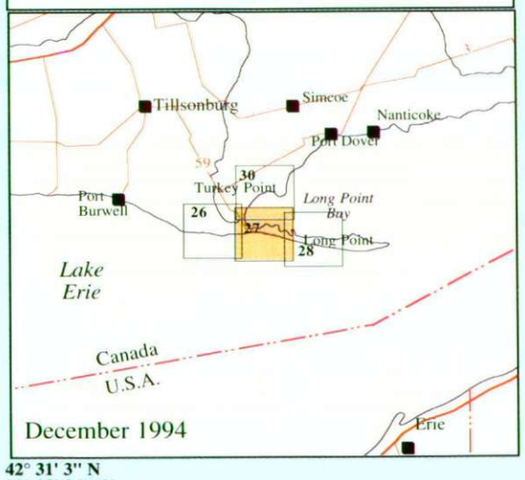
59 60 61 62

42 41

M

Map 27

Contains Sections From NTS and USGS Maps:
40I/9



Lake Erie

N

Scale
Kilometres
0 0.5 1 2
0 0.5 1
Miles
1:50,000

42° 31' 3" N
80° 28' 36" W

42° 31' 3" N
80° 18' 35" W

42° 37' 27" N
80° 20' 13" W

42° 37' 27" N
80° 10' 13" W

Long Point Bay

63

Pottohawk Point

Scoffie's Creek

Ryersons Island

Obtain permission from private property owners prior to crossing or using private property, access sites, or boat launches.

61

(1)

The Cottages

Big Rice Bay Point

Cottage Creek

Island Pond

Big Rice Bay

Shanty Pond

First Island Outlet

Second Island

Second Island Pond

Peter's Pond

Second Island Outlet

Snow Island

Irish Channel

Sunk Marsh

Wood Duck Alley

Oak Ridges

Mallard's Pond

66

Umbrella Pond

Doctor's Inlet

65

Courtright Ridge

Helmer's Pond

Willow Creek

62

Squires Ridge

(2)

43

Cedar Creek Ridge

Cedar Creek

Townsend Ridge

Bouck Pond

Little Creek Ridges

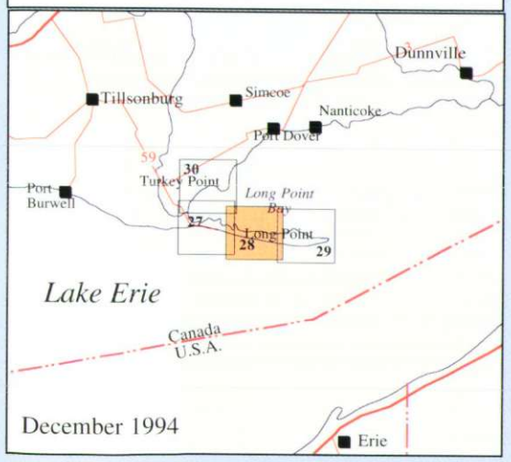
Long Point

64

Lake Erie

Map 28

Contains Sections From NTS and USGS Maps:
40I/9



December 1994

Scale
Kilometres
0 0.5 1 2
0 0.5 1
Miles
1:50,000

42° 30' 26" N
80° 20' 13" W

42° 30' 26" N
80° 10' 13" W

NOTES

A red exclamation point symbol is used on the maps to catch the responder's attention.

61 Spill responders should note that natural gas wells and pipelines are submerged in Inner Bay and along Long Point. Call OMNR at (519) 426-7650 (24 hour).

62 Long Point, the longest spit in the Great Lakes, is a Class 1 wetland, a designated ANSI, Provincial Park, World Biosphere Reserve (UNESCO), RAMSAR site (Convention on Conservation of Wetlands of International Importance) and National Wildlife Area (NWA). It is the site of the Long Point Bird Observatory (east tip). Long Point's various habitats support a variety of plants and wildlife. The Long Point NWA boundaries include the entire area from Squires Ridge east almost to the tip of the spit, as well as a section between Long Point Provincial Park and Long Point Company's property. Long Point is an internationally important area for migratory birds, waterfowl and songbirds. It is a major waterfowl staging area during migration with fall (September to December) peaks of 150,000 and spring (March to April) peaks of 70,000 waterfowl. Long Point is the first major spring stopover for thousands of migrating Tundra Swans. The uplands are on the major spring and fall migration corridor for passerine songbirds. The Inner Bay is an important spawning and nursery area for Pike, Smelt, Yellow Perch, Smallmouth Bass and other fish. White-tailed Deer are abundant on Long Point. Rare or threatened reptiles (including various snakes, turtles and toads) are also present here, as is the Meadow Crayfish, one of Canada's rarest invertebrates. Bats, Dragonflies and Monarch Butterflies also use Long Point as a migratory stopover. Along with the Lake St. Clair Marshes, Long Point is the most important wetland area in Ontario. Call the Park Warden at (519) 586-2133 during spills.

63 The Long Point Company owns private property from Big Rice Bay to Helmer's Pond. Call (519) 586-2442 prior to crossing private property.

64 Major daytime concentrations of Canvasback Ducks (up to 40,000) gather in this area during migration.

65 There is only one recreational beach use area, at Squire's Ridge (open from the second weekend of April until Labour Day weekend), where going ashore is permitted within the Long Point NWA.

66 Wildlife viewing and fishing is permitted up to the posted boundary of the NWA from the second weekend of April until Labour Day. Scattered flocks of Diving Ducks are present off shore during migration.

NOTES

A red exclamation point symbol is used on the maps to catch the responder's attention.

66 Wildlife viewing and fishing is permitted up to the posted boundary of the NWA from the second weekend of April until Labour Day. Scattered flocks of Diving Ducks are present off shore during migration.

67 Long Point, the longest spit in the Great Lakes, is a Class 1 wetland, a designated ANSI, Provincial Park, World Biosphere Reserve (UNESCO), RAMSAR Site (Convention on Conservation of Wetlands of International Importance) and National Wildlife Area (NWA). It is the site of the Long Point Bird Observatory (east tip). Long Point's various habitats support a variety of plants and wildlife. The Long Point NWA boundaries include the entire area from Squires Ridge east almost to the tip of the spit, as well as a section between Long Point Provincial Park and Long Point Company's property. Long Point is an internationally important area for migratory birds, waterfowl and songbirds. It is a major waterfowl staging area during migration with fall (September to December) peaks of 150,000 and spring (March to April) peaks of 70,000 waterfowl. Long Point is the first major spring stopover for thousands of migrating Tundra Swans. The uplands are on the major spring and fall migration corridor for passerine songbirds. The Inner Bay is an important spawning and nursery area for Pike, Smelt, Yellow Perch, Smallmouth Bass and other fish. White-tailed Deer are abundant on Long Point. Rare or threatened reptiles (including various snakes, turtles and toads) are also present here, as is the Meadow Crayfish, one of Canada's rarest invertebrates. Bats, Dragonflies and Monarch Butterflies also use Long Point as a migratory stopover. Along with the Lake St. Clair Marshes, Long Point is the most important wetland area in Ontario. Call the Park Warden at (519) 586-2133 during spills.

68 Spill responders should note that natural gas wells and pipelines are submerged at Long Point. For emergencies, call the Ontario Ministry of Natural Resources at (519) 674-2830 (24 hours). OMNR and Transport Canada own land at the tip of Long Point.

42° 37' 6" N
80° 11' 15" W

42° 37' 6" N
80° 1' 15" W

Long Point Bay

Obtain permission from private property owners prior to crossing or using private property, access sites, or boat launches.

Scale
Kilometres
0 0.5 1 2
0 0.5 1
Miles
1:50,000

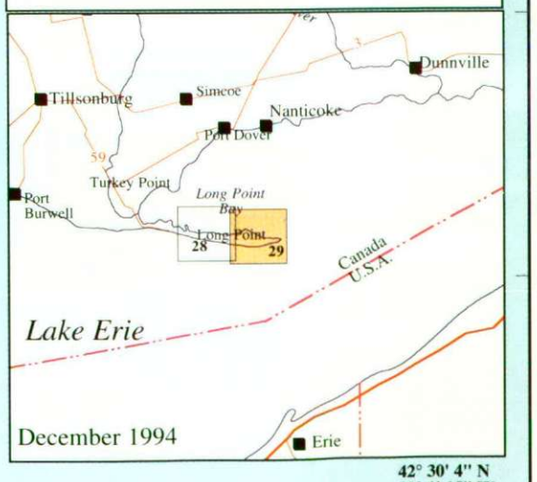
Lake Erie

66 67 68

Bluff Point
Bluff Marsh
Bluff Pond
44
Little Creek Ridges
Little Creek
Burnt Ridges
Anderson Pond
Gravelly Bay
The Home
Duncan's Pond
Allen's Ridge
Otter Ridge
Long Pond
45

Map 29

Contains Sections From NTS and USGS Maps:
40I/9



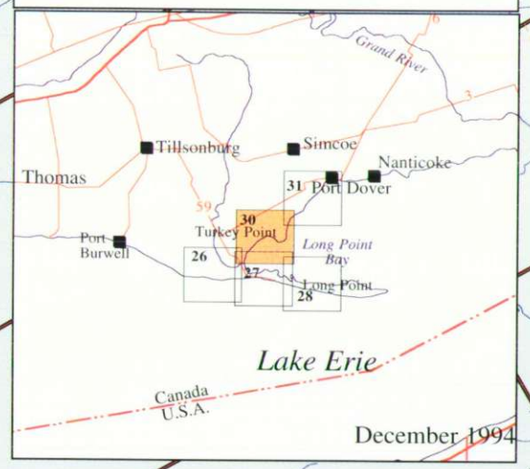
December 1994

42° 30' 4" N
80° 11' 15" W

42° 30' 4" N
80° 1' 15" W

Map 30

Contains Sections From NTS and USGS Maps:
40I/9



42° 43' 27" N
80° 28' 21" W

42° 43' 27" N
80° 18' 20" W

Normandale Creek

Turkey Point Provincial Park

Hwy. 24

Mud Creek

Ungers Corner

St.Williams

Turkey Point

Turkey Point Marsh

Little Bay

South Bay

Deep Hole Point

Bob Wood's Point

Indian Creek Point

Backus Conservation Area and ANIS

Port Rowan

Inner Bay

Obtain permission from private property owners prior to crossing or using private property, access sites, or boat launches.

Scale
Kilometres
0 0.5 1 2
0 0.5 1
Miles
1:50,000

42° 36' 25" N
80° 28' 21" W

42° 36' 25" N
80° 18' 20" W

NOTES

A red exclamation point symbol is used on the maps to catch the responder's attention.

58 Backus Woods Conservation Area is an Area of Natural and Scientific Interest because it is an excellent example of deciduous forest.

60 Port Rowan Water Treatment Plant Outfall/Intake - Call (519) 587-4911. Inner Bay is a major staging area for diving ducks.

69 Streams flowing into Inner Bay carry Smallmouth Bass, Pike, Smelt and Yellow Perch, as well as Rainbow Trout in the spring and fall.

70 Turkey Point is designated a Natural Environmental Zone, an Area of Natural and Scientific Interest, and a Provincial Park with national and international significance. It is protected under Ontario's Wilderness Areas Act because of its highly sensitive wetland. Spill responders should contact the Park Warden at (519) 426-3239.

71 Turkey Point Provincial Park Intake - Call (519) 426-3239. There is an Ontario Ministry of Natural Resources Fish Hatchery up Normandale Creek.

NOTES

A red exclamation point symbol is used on the maps to catch the responder's attention.

71 Turkey Point Provincial Park Intake - Call (519) 426-3239. There is an Ontario Ministry of Natural Resources Fish Hatchery up Normandale Creek.

72 Spooky Hollow is designated an Area of Natural and Scientific Interest because of its large diverse natural area with river valley habitats. It supports various unusual species. Part of Spooky Hollow is protected by the Hamilton Naturalist Club. Spooky Hollow extends slightly into the Fisher-Cornell Conservation Area. This offshore area has spring concentrations of Scaup, Bufflehead and Mergansers. The Scaup are in large flocks containing hundreds of birds. In fall Scaup here can number up to 7,000 birds.

73 Lower Young Creek is designated an Area of Natural and Scientific Interest because of its diverse wildlife habitats. At Norfolk Conservation Area, there is a drinking water intake for a large camping area - Call (519) 428-4623 or (519) 428-1460.

74 Port Dover Municipal Water Treatment Plant Outfall/Intake - Call (519) 587-4911. Spill responders should note that natural gas wells and pipelines are submerged from Normandale to Port Dover. For emergencies contact the Ontario Ministry of Natural Resources at (519) 426-7650 (24 hours). Port Dover is a local centre for commercial fishing activity and tourism. Great Lakes Response Corporation maintains response equipment at Port Dover.

42° 48' 26" N
80° 20' 14" W

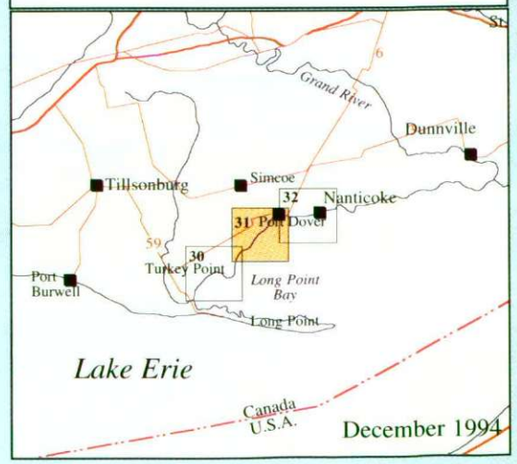
42° 48' 26" N
80° 10' 13" W

Port Dover
Port Dover Park
Woodhouse Acres
Hay Creek
Halfway House Corner
Hwy. 6
Hay Creek Conservation Area
Vittoria-Sowden Conservation Area
Vittoria
Young Creek
Lower Young Creek Valley ANSI
Avalon Park
Wolley's Point
Port Ryerse
Norfolk Conservation Area
Hwy. 24
Long Point Bay
74
73
72
71
Obtain permission from private property owners prior to crossing or using private property, access sites, or boat launches.
Spooky Hollow ANSI
Fisher's Creek
Fisher-Cornell Conservation Area
Normandale Creek
Fisher's Glen
Normandale
Turkey Point Provincial Park
Turkey Point
Lake Erie

Scale
Kilometres
0 0.5 1 2
0 0.5 1
Miles
1:50,000

Map 31

Contains Sections From NTS and USGS Maps:
40I/9 and 40I/16



December 1994

42° 41' 24" N
80° 20' 14" W

42° 41' 24" N
80° 10' 13" W

42° 50' 52" N
80° 11' 53" W

42° 50' 52" N
80° 1' 50" W

Catfish Creek

Nanticoke Creek

Black Creek

Marburg

Shand's Corner

Hwy. 6

Obtain permission from private property owners prior to crossing or using private property, access sites, or boat launches.

Imperial Oil Refinery

Dogs Nest

Stelco Inc. Erie Works

Nanticoke

Settling Ponds

Nanticoke TGS

Hickory Beach

Fairie's Creek

Port Dover

Port Dover Park

Woodhouse Acres

Vaughan Survey

Crescent Bay

Sandy Cove

Nanticoke Harbour

Keadon Park

Kitchen's Point

74

75

76

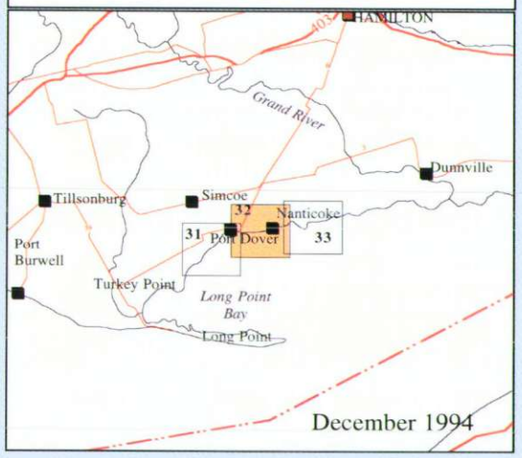
Long Point Bay

Lake Erie

Scale
Kilometres
0 0.5 1 2
Miles
0 0.5 1
1:50,000

Map 32

Contains Sections From NTS and USGS Maps:
40I/9 and 40I/16



December 1994

42° 43' 51" N
80° 11' 53" W

42° 43' 51" N
80° 1' 50" W

NOTES

A red exclamation point symbol is used on the maps to catch the responder's attention.

74 Port Dover Municipal Water Treatment Plant Outfall/Intake - Call (519) 587-4911. Spill responders should note that natural gas wells and pipelines are submerged from Normandale to Port Dover. For emergencies contact the Ontario Ministry of Natural Resources at (519) 426-7650 (24 hours). Port Dover is a local centre for commercial fishing activity and tourism. Great Lakes Response Corporation maintains response equipment at Port Dover.

75 Stelco Incorporated Erie Works Outfall (also has two outfalls on Nanticoke Creek) - Call (519) 587-4541. Stelco draws water from the Central Haldimand Norfolk Municipal Intake. Scaup (Diving Ducks) concentrate along this shore area during fall migration (October, November) and can number in the thousands.

76 Central Haldimand Norfolk Municipal Water Treatment Plant Intake - Call (519) 587-4565. Ontario Hydro's Nanticoke Thermal Generating Station Intake/Outfall - Contact 24 hour number at (519) 587-2201. Spill responders should note that the average flow is 3 million gallons per minute. Imperial Oil Ltd. Outfall - Call (519) 587-7000 (24 hours). Nancare Co-op is an industry co-op (7 companies) maintaining response equipment for emergencies within the Nanticoke Harbour area. The spill response contact for the three largest members, Stelco, Imperial Oil and Ontario Hydro is (519) 587-2201 (Ontario Hydro). Overwintering birds, as well as fall concentrations of Diving Ducks (Scaup, Merganser, Bufflehead and Goldeneye) gather in the hot water outfall discharge area. Observed numbers can reach 6000. Spill responders should note that natural gas wells and pipelines are submerged from Nanticoke Harbour to Peacock Point. For emergencies contact the Ontario Ministry of Natural Resources at (519) 426-7650 (24 hours).

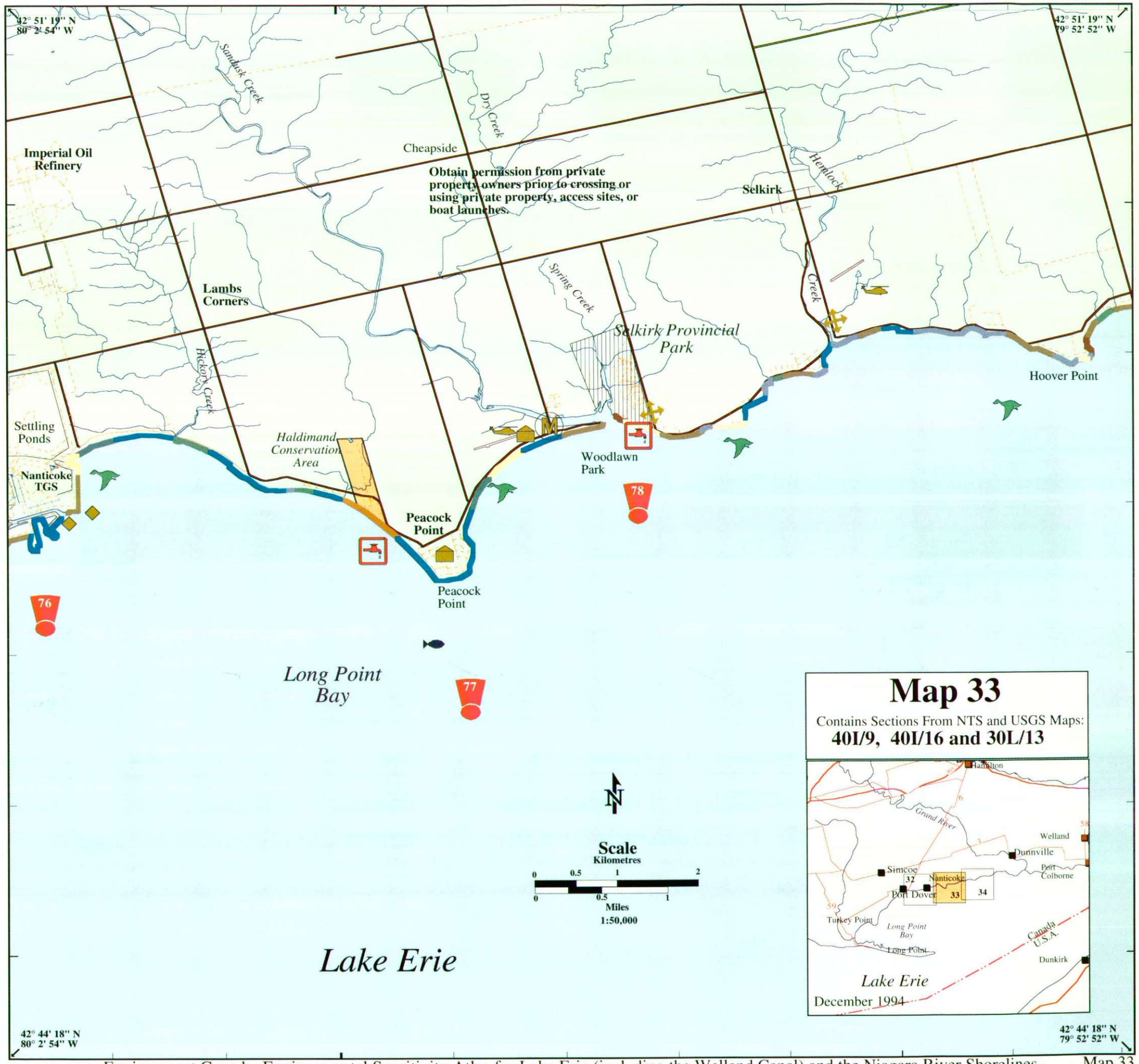
NOTES

A red exclamation point symbol is used on the maps to catch the responder's attention.

76 Central Haldimand Norfolk Municipal Water Treatment Plant Intake - Call (519) 587-4565. Ontario Hydro's Nanticoke Thermal Generating Station Intake/Outfall - Contact 24 hour number at (519) 587-2201. Spill responders should note that the average flow is 3 million gallons per minute. Imperial Oil Ltd. Outfall - Call (519) 587-7000 (24 hours). Nancare Co-op is an industry co-op (7 companies) maintaining response equipment for emergencies within the Nanticoke Harbour area. The spill response contact for the three largest members, Stelco, Imperial Oil and Ontario Hydro is (519) 587-2201 (Ontario Hydro). Overwintering birds, as well as fall concentrations of Diving Ducks (Scaup, Merganser, Bufflehead and Goldeneye) gather in the hot water outfall discharge area. Observed numbers can reach 6000. Spill responders should note that natural gas wells and pipelines are submerged from Nanticoke Harbour to Peacock Point. For emergencies contact the Ontario Ministry of Natural Resources at (519) 426-7650 (24 hours).

77 Diving Ducks (Scaup, Mergansers, Bufflehead, Goldeneye) are present in scattered flocks all along these shorelines during the fall migration (October to December). Scaup can number in the thousands. Spill Responders should note that natural gas wells and pipelines are submerged east of Peacock Point. For emergencies contact the Ontario Ministry of Natural Resources at (519) 426-7650 (24 hours). Haldimand Conservation Area Drinking Water Intake - call (519) 428-4623 or (905) 776-2700. The Peacock Point area is a location of seasonal fish migration for Northern Pike, Largemouth Bass, Walleye, Bluegill, Yellow Perch, Smallmouth Bass, Rock Bass, Black Crappie, Rainbow Trout, Pink Coho and Chinook Salmon.

78 Selkirk Provincial Park Drinking Water Intake - Call (905) 776-2600.



Map 33

Contains Sections From NTS and USGS Maps:
40I/9, 40I/16 and 30L/13

December 1994

42° 52' 2" N
79° 54' 18" W

Hemlock Creek

Obtain permission from private property owners prior to crossing or using private property, access sites, or boat launches.

Sweet Corners

Wardells Creek

42° 52' 2" N
79° 44' 15" W

Evans Creek

Rainham Centre

Talbot Trail

Gates Creek

Evans Point

Miller Bay

Featherstone

Featherstone Point

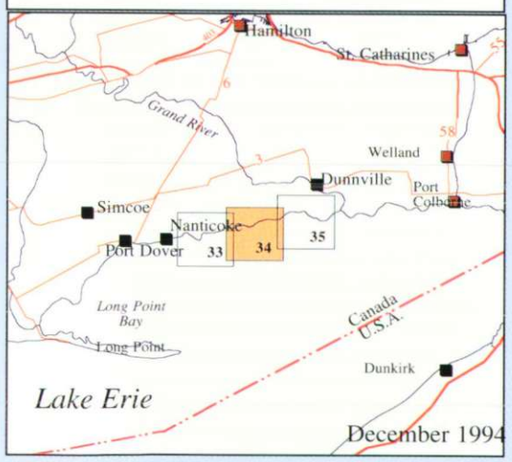
79

Hoover Point

Lake Erie

Map 34

Contains Sections From NTS and USGS Maps:
30L/13



Scale
Kilometres

Miles
1:50,000

42° 45' 1" N
79° 54' 18" W

42° 45' 1" N
79° 44' 15" W

NOTES

A red exclamation point symbol is used on the maps to catch the responder's attention.

79 Spill responders should note that natural gas wells and pipelines are submerged in this area. For emergencies contact the Ontario Ministry of Natural Resources at (519) 426-7650 (24 hours). Diving Ducks (Scaup, Merganser, Bufflehead, Goldeneye) are present in scattered flocks all along these shorelines during the fall migration (October to December). Scaup can number in the thousands.

NOTES

A red exclamation point symbol is used on the maps to catch the responder's attention.

79 Spill responders should note that natural gas wells and pipelines are submerged in this area. For emergencies contact the Ontario Ministry of Natural Resources at (519) 426-7650 (24 hours). Diving Ducks (Scaup, Merganser, Bufflehead, Goldeneye) are present in scattered flocks all along these shorelines during the fall migration (October to December). Scaup can number in the thousands.

80 Commercial fishing activity is significant along this shoreline of Lake Erie. Smallmouth Bass spawn off Low Point and Blott Point in late May to early July.

81 Dunnville Municipal Water Treatment Plant Intake - Call (519) 587-4911.

42° 53' 39" N
79° 45' 27" W

42° 53' 39" N
79° 35' 24" W

Talbot Trail

Byng

South Cayuga

Obtain permission from private property owners prior to crossing or using private property, access sites, or boat launches.

Mazi Drain

Blott Point

James N. Allen Park Reserve

Evans Point

Low Point

Grant Point

81

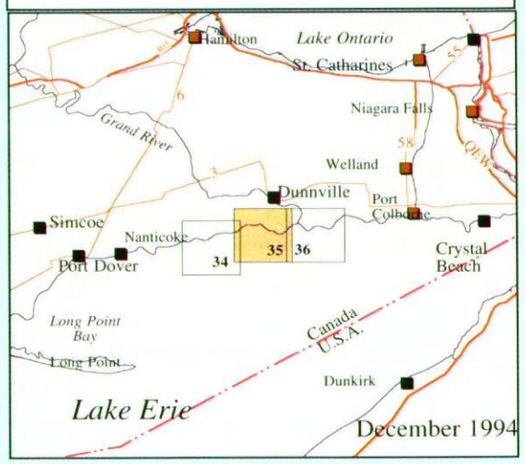
80

79

Lake Erie

Map 35

Contains Sections From NTS and USGS Maps:
30L/13



N

Scale
Kilometres
0 0.5 1 2
0 0.5 1
Miles
1:50,000

42° 46' 37" N
79° 45' 27" W

42° 46' 37" N
79° 35' 24" W

42° 53' 39" N
79° 36' 28" W

42° 53' 39" N
79° 26' 26" W

Grand River

Broad Creek

Mazi Drain

Stromness

Pleasant Beach

Canadian National Railway

Hoover Ck

Lowbanks

Moulton Bay

Obtain permission from private property owners prior to crossing or using private property, access sites, or boat launches.

83

M

(12)

Port Maitland

Splatt Bay

Rock Point Provincial Park

Mohawk Bay

Connor Bay

82

Rock Point

84

Mohawk Island

(2272)

Mohawk Point

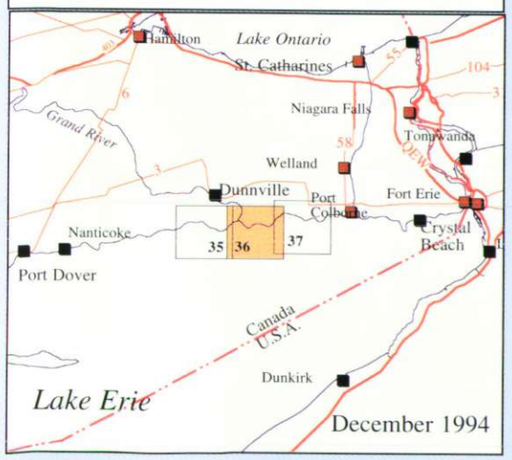
85

42° 46' 37" N
79° 36' 28" W

42° 46' 37" N
79° 26' 26" W

Map 36

Contains Sections From NTS and USGS Maps:
30L/13 and 30L/14



Lake Erie

Scale
Kilometres
0 0.5 1 2
0 0.5 1
Miles
1:50,000

NOTES

A red exclamation point symbol is used on the maps to catch the responder's attention.

82 Rock Point Provincial Park Drinking Water Intake - Call (905) 774-6642. The limestone shelf around Rock Point offers a feeding area for many shorebirds, some of which are considered rare in Canada. The mixed beach along Rock Point Provincial Park is mainly sand with some pebble, it is a popular recreational site. Perch spawn in spring along Rock Point. Diving Ducks (Scaup, Mergansers, Bufflehead, Goldeneye) are present in scattered flocks all along these shorelines during the fall migration (October to December). Scaup can number in the thousands. The Common Loon is also present in Connor Bay. Perch spawn all along the west shore of Connor Bay in late May to early July. Bufflehead and Catfish spawn at the mouth of the Grand River, which is a migration location for Trout, Smelt, Walleye and Smallmouth Bass. McKeil Marine (associated with Great Lakes Response Corporation) maintains boom on their vessel "Toledo" based at Port Maitland - Call (905) 528-4780. Commercial fishing activity is significant along these Lake Erie shores.

83 International Mineral and Chemicals Outfall - Call (905)774-7681. There are early fall concentrations of Mallards and Blue-winged Teal in the Dunnville Marshes on the Lower Grand River. In late fall, some Mallards number in the hundreds.

84 Mohawk Island is designated as a National Wildlife Area administered by the Canadian Wildlife Service. The site is a nesting area for Ring-billed Gulls, Herring Gulls and Double-crested Cormorants in large numbers. There are some small concentrations of Mallards, Black Ducks and Scaup during the fall migration. Migrating shorebirds also use this Island. Public use of the Island includes bird watching from August to March but the area is closed to the public from April 1 to July 31 due to the nesting season of the fish-eating birds. Perch and Smallmouth Bass spawn in spring around the shores of Mohawk Island.

85 Spill responders should note that natural gas wells and pipelines are submerged in this area. For emergencies contact the Ontario Ministry of Natural Resources at (519) 426-7650 (24 hours).

NOTES

A red exclamation point symbol is used on the maps to catch the responder's attention.

85 Spill responders should note that natural gas wells and pipelines are submerged in this area. For emergencies contact the Ontario Ministry of Natural Resources at (519) 426-7650 (24 hours).

86 Harold Mitchell Nature Reserve, contained within the boundaries of the Long Beach Conservation Area, is classified as an Environmentally Sensitive Area because it contains the largest remaining stand of Hemlock trees along the shore of Lake Erie. It is owned by the Niagara Falls Nature Club. It is an excellent breeding area for waterfowl. Diving Ducks (Scaup, Merganser, Bufflehead, Goldeneye) are present in scattered flocks along these shorelines during the fall migration period (October to December). Scaup can number in the thousands.

87 Morgan's Point is designated as an Environmentally Sensitive Area because it is an important stopover point for migrating passerines. A few of the species present are Great Blue Heron, Black Tern and Spotted Sandpiper. The Point supports a wide variety of soil types and many rare species of vegetation. It is the site of many cottage residences. Smelt spawn in spring around the Point and in Sunset Bay.

Map 37

Contains Sections From NTS and USGS Maps:
30L/14

Obtain permission from private property owners prior to crossing or using private property, access sites, or boat launches.

Lake Erie

Scale
Kilometres
0 0.5 1 2
0 0.5 1
Miles
1:50,000

42° 47' 20" N
79° 28' 13" W

42° 47' 20" N
79° 18' 11" W

42° 56' 3" N
79° 19' 15" W

42° 56' 3" N
79° 9' 12" W

Wainfleet Marsh Bog ANSI

Wainfleet Marsh

Welland Canal

Hwy. 140

Hwy. 58

Humberstone Marsh

Humberstone

Port Colborne

Hwy. 3

Gasline

Hwy. 3

Quarry Ponds

CNR

Wainfleet Wetlands Conservation Area

Port Colborne Municipal Park

Nickel Beach Woodlot ESA

Weaver Road Woodlot ESA

Centennial Municipal Park

Silver Bay

Lorraine

Reebs Bay

Rathfon Point

Camelot Beach

Gravelly Bay

Sugar Loaf Pt

(43,622)

(3,580)

Nickel Beach

Lorraine Bay

Cassaday Point

Pine Crest Point

Whitemans Point

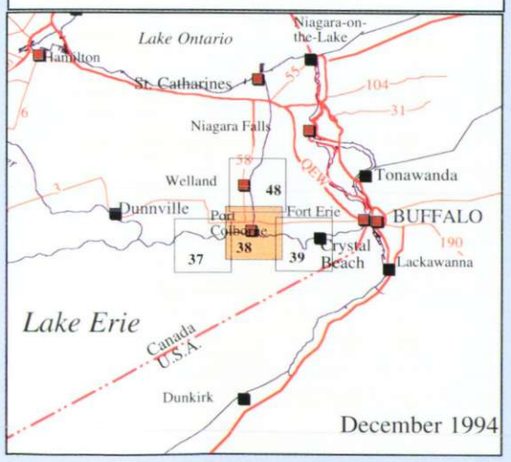
Cedar Bay

Silver Bay

Near Point

Map 38

Contains Sections From NTS and USGS Maps:
30L/14



Obtain permission from private property owners prior to crossing or using private property, access sites, or boat launches.

Lake Erie

Scale
Kilometres
0 0.5 1 2
0 0.5 1
Miles
1:50,000

42° 49' 2" N
79° 19' 15" W

42° 49' 2" N
79° 9' 12" W

NOTES

A red exclamation point symbol is used on the maps to catch the responder's attention.

88 Wainfleet Marsh is designated as an ANSI and ESA due to its variety of furbearers and waterfowl It is an active feeding area for colonial waterbirds and a nesting area for the American Bittern. It is also considered an International Biological Program site because of the rare plant species it supports. The wetlands are a popular recreation site. Spill responders should note that a warm water fishery is located on the site.

89 Port Colborne marks the start of the Welland Canal, linking Lake Erie with Lake Ontario for commercial shipping. Commercial fishing activity occurs along the shore of Lake Erie from Sugar Loaf Point to Nickel Beach. Species spawning in spring and summer at the mouth of the Welland Canal include Muskellunge, Smallmouth and Largemouth Bass, Northern Pike, Yellow Perch and BlackCrappie. Diving Ducks (Scaup, Merganser, Bufflehead, Goldeneye) are present in scattered flocks all along these shorelines during the fall migration (October to December). Scaup can number in the thousands.

90 Inco Metals Incorporated Outfall/Intake - Call (905) 835-6300. West Side Water Pollution Control Plant Outfall - Call (905) 834-7277. Seaway Water Pollution Control Plant Outfall - Call (905) 834-6973.

91 Casco Company Intake/Outfall - Call (905) 835-8220.

92 Nickel Beach Woodlot is classified as an ESA because of the aesthetic value of its sand dunes. The dunes along Lake Erie's shoreline are sensitive to wind erosion, especially if the vegetation is disturbed. This site is used extensively in the summer for scientific research and conservation education. Wildlife species in the area include such birds as Red-tailed Hawks and Downey Woodpeckers, and various mammals Smallmouth Bass spawn in spring along Nickel Beach, Cassaday Point and in Lorraine Bay.

93 Weaver Road Woodlot is designated an Environmentally Sensitive Area because of the various wildlife and rare species it supports.

94 Spill responders should note that natural gas wells and pipelines are submerged in this area. For emergencies, call the OMNR at (519) 426-7650 (24 hour).

95 Parts of Humberstone Marsh are designated as an ANSI, given the nature of this unique biological area. It supports rare plant species and extensive wildlife in its excellent forest and marsh habitats.

NOTES

A red exclamation point symbol is used on the maps to catch the responder's attention.

94 Spill responders should note that natural gas wells and pipelines are submerged in this area. For emergencies, call the OMNR at (519) 426-7650 (24 hour).

96 Shisler Point Woods is classified as an Environmentally Sensitive Area because the forested dunes present are a unique geomorphological feature in Ontario. The west side of Point Abino is an important fall staging area for Scaup numbering up to 4000.

97 Point Abino is classified as an Area of Natural and Scientific Interest, an Area of Ecological Significance, and as an Environmentally Sensitive Area. The sand dunes at Point Abino support a virgin forest and are considered a unique geomorphological and biological feature in Ontario. It is recognized as part of the International Biological Program (IBP) because of the various high quality wildlife communities it supports. As well, many of the plants and wildlife are provincially significant. Point Abino is highly accessible during the winter and summer seasons. Spill responders should note that some portions are privately owned and access permission must be obtained prior to crossing. Diving Ducks (Scaup, Mergansers, Bufflehead, Goldeneye) are present in scattered flocks all along these shorelines during the fall migration (October to December). Scaup can number in the thousands.

98 Crystal Beach Drinking Water Treatment Plant Outfall/Intake - Call the Region of Niagara at (905) 685-1571. Yellow Perch and Smelt spawn in spring along the shores of Abino Bay.

99 Wavecrest Bush is classified as an Area of Natural and Scientific Interest and an Environmentally Sensitive Area because of the high diversity of biological communities and geomorphological features present. It is an International Biological Program (IBP) refuge area.

Map 39

Contains Sections From NTS and USGS Maps:
30L/14

December 1994

42° 55' 5" N
79° 1' 26" W

Fort Erie Airfield

QEW

Fort Erie

Buffalo

42° 55' 5" N
78° 51' 23" W

Edgewood Park

Hwy. 3

Oakhill Forest

Crescent Park

Crescent Estates ESA

Helena Road Woodlot ESA

CNR

Buffalo Heights

Rose Hill Estates

54

Fort Erie Beach

104

Bird Island

(300)

Crescent Beach

Erie Beach

Horseshoe Reef

Waverly Beach

Wavecrest Bush ESA

Bertie Bay

102

Ontario

New York

Times Beach

101

Windmill Point

100

99

Lake Erie

Obtain permission from private property owners prior to crossing or using private property, access sites, or boat launches.

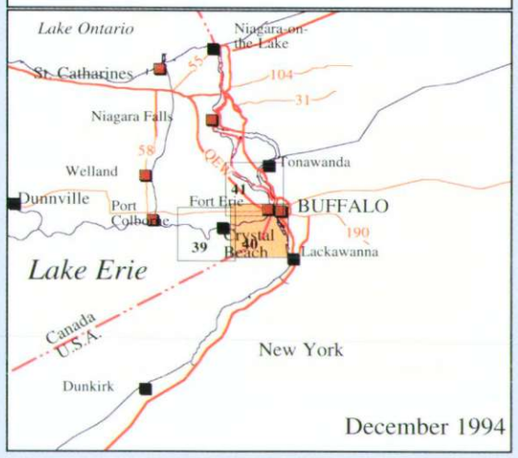
Canada

U.S.A.

103

Map 40

Contains Sections From NTS and USGS Maps:
30L/14, 30L/15 and 42078



December 1994

N

Scale
Kilometres
0 0.5 1 2
0 0.5 1
Miles
1:50,000

For Environmental sensitivity information for the United States shore of Lake Erie, see NOAA's "Lake Erie Atlas: Sensitivity of Coastal Environments and Wildlife to Spilled Oil" (RPI, 1985).

42° 48' 3" N
79° 1' 26" W

42° 48' 3" N
78° 51' 23" W

NOTES

A red exclamation point symbol is used on the maps to catch the responder's attention.

99 Wavecrest Bush is classified as an Area of Natural and Scientific Interest and an Environmentally Sensitive Area because of the high diversity of biological communities and geomorphological features present. It is an International Biological Program (IBP) refuge area.

100 Rosehill Municipal Water Treatment Plant Intake - Call 1-800-263-7215. Smallmouth Bass spawn in spring east of Windmill Point and at Fort Erie Beach. Diving Ducks (Scaup, Merganser, Bufflehead, Goldeneye) are present in scattered flocks all along these shorelines during the fall migration (October to December). Scaup can number in the thousands. Recently, concentrations of ducks have been wintering in this area.

101 Crescent Estates and Helena Road Woodlots are designated Environmentally Sensitive Areas because their woodlots provide suitable habitat for various wildlife species.

102 Erie Beach is designated an Environmentally Sensitive Area due to the various vegetation and plant species present. Residential use is high along this shoreline.

103 Buffalo River Improvement Corporation Intake - Call (716) 675-1317 (24 hour). The company maintains a boom storage site with 1000 feet of boom. The Buffalo Small Boat Harbour nearby maintains 1000 feet of boom. Bethlehem Steel Intake - Call (716) 821-3969. The company maintains a boom storage site with a small amount of boom. US Coast Guard Station MSO Buffalo maintains response equipment on site - Call (716) 846-4168. Nearby, Times Beach is a major wetland area providing refuge to a large number of species of birds (some endangered). The area is completely closed off from the harbour by a stone rip rap dike.

104 City of Buffalo Drinking Water Intake - Call (716) 851-4724 (24 hour). Township of Tonawanda Drinking Water Intake - Call (716) 877-4453. Historic Fort Erie is located on the Canadian side just north of Fort Erie Beach. There is recreational swimming and beach use at "Baby Hole" just north of the bridge on the Canadian side. The Niagara River is a late fall concentration area for Diving Ducks (Scaup, Mergansers, Bufflehead, Goldeneye); numbers can exceed 20,000. Many of these ducks also winter along the River, along with Oldsquaw and some Canvasback. To expedite movement of resources across the border during a response effort, responders should call the Fort Erie Peace Bridge Authority at (905) 871-1272.

NOTES

A red exclamation point symbol is used on the maps to catch the responder's attention.

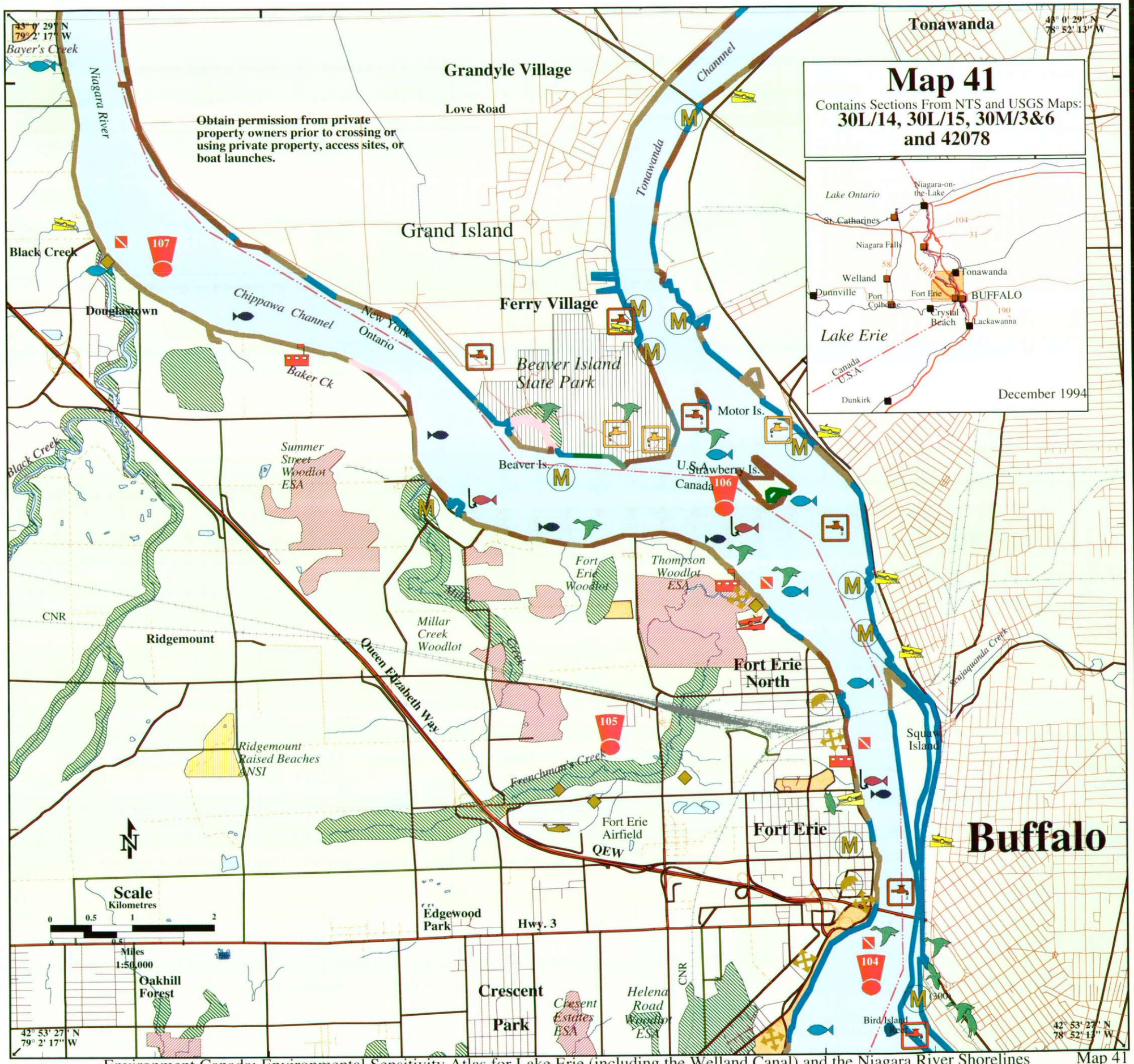
104 City of Buffalo Drinking Water Intake - Call (716) 851-4724 (24 hour). Township of Tonawanda Drinking Water Intake - Call (716) 877-4453. Historic Fort Erie is located on the Canadian side just north of Fort Erie Beach. There is recreational swimming and beach use at "Baby Hole" just north of the bridge on the Canadian side. The Niagara River is a late fall concentration area for Diving Ducks (Scaup, Mergansers, Bufflehead, Goldeneye); numbers can exceed 20,000. Many of these ducks also winter along the River, along with Oldsquaw and some Canvasback. To expedite movement of resources across the border during a response effort, responders should call the Fort Erie Peace Bridge Authority at (905) 871-1272.

105 Canadian Oxy-Chemicals Outfall - Call (905) 871-3206. Fleet Industry Outfall - Call (905) 871-2100 ext. 534. Anger Avenue Water Pollution Control Plant Outfall - Call the Region of Niagara (905) 685-1571. Thompson Woodlot is designated as an Environmentally Sensitive Area as it provides a suitable habitat for deer and waterfowl and is a recharge area for Frenchman's Creek. Frenchman's Creek, Miller Creek and Black Creek are provincially significant fisheries areas. Summer Street Woodlot is and Environmentally Sensitive Area due to its forest vegetation, recreation uses and its presence of Deer, Raccoons, Raptors and Songbirds. Miller Creek is designated an Environmentally Sensitive Area because of the various rare plant species it supports. The northern area is part of the International Biological Program.

106 Spill responders should be aware of the important fish spawning area for Muskellunge (May and June), and Northern Pike located at Strawberry Island. From mid-November to April, major concentrations of Canada Geese and Diving Ducks (Goldeneye, Mergansers, Bufflehead, Canvasback) winter in the area between Beaver Island State Park, Strawberry Island and the Canadian shore.

Township of Tonawanda Drinking Water Intakes - Call (716) 877-4453. Nimo/Dunlop Industrial Water Intakes - Call (716) 879-8271. Vandewater Drinking Water Treatment Plant Intakes - Call (716) 873-8884. Grand Island Drinking Water Intakes - Call (716) 773-9641. Chevrolet Plant Industrial Water Intake - Call (716) 879-5220. Dupont Corporation Industrial Water Intakes - Call (716) 876-4420. Beaver Island State Park has several small wetland areas used by resident waterfowl for breeding. The sheltered cove behind Beaver Island is a year-round waterfowl area which can be protected with boom.

107 Stevensville Lagoon Outfall - Call 1-800-263-7215. The Niagara Parkway, a public area encompassing untouched gorge face and a manicured parkland, runs all along the Canadian side of the River.

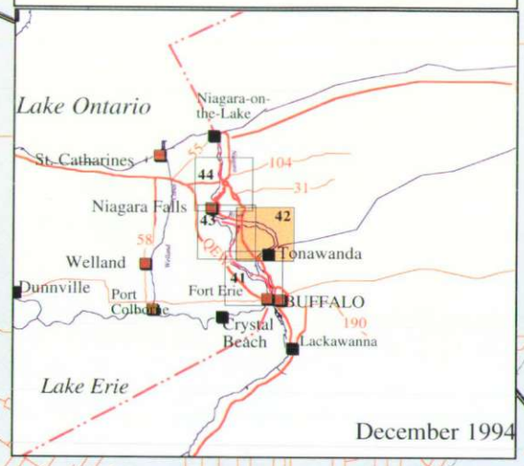


Map 41

Contains Sections From NTS and USGS Maps:
30L/14, 30L/15, 30M/3&6 and 42078

Map 42

Contains Sections From NTS and USGS Maps:
30L/15, 30M/3&6, 43078 and 43079



43° 6' 8" N
79° 0' 24" W

43° 6' 8" N
78° 50' 19" W

Scale
Kilometres
0 0.5 1 2
Miles
0 0.5 1
1:50,000

Bergholtz Creek
Cayuga Creek
Little River
Cayuga Island
Tonawanda Channel
Buckhorn Island
Burnt Ship Creek
Buckhorn Island State Park
Woods Cr
East River Road
Niagara River
Ontario
New York
Grand Island
Grand Island Boulevard
I-190
Gun Creek
Little Six Mile Creek
Big Six Mile Creek
Whitehaven Road
Spicer Creek
Grandyle Village
Love Road
Tonawanda Channel
Tonawanda
North Tonawanda
Gratwick Waterfront Park
Little River
Tonawanda Is.
Erie Canal
Two Mile Creek
I-290

Obtain permission from private property owners prior to crossing or using private property, access sites, or boat launches.

42° 59' 6" N
79° 0' 24" W

42° 59' 6" N
78° 50' 19" W

NOTES

A red exclamation point symbol is used on the maps to catch the responder's attention.

108 Holiday Farms Outfall - No discharge. City of Tonawanda Drinking Water Intakes - Call (716) 693-2666. City of North Tonawanda Drinking Water Intakes - Call (716) 695-8536. Lockport Drinking Water Intakes - Call (716) 439-6726.

109 Niagara County Drinking Water Intakes by Buckhorn Island - Call (716) 283-9414. The Grand Island Tributaries (Woods Creek and Gun Creek) provide important spawning and nursery areas for fish such as Northern Pike. Burnt Ship Creek on Grand Island is a very important year-round wetland area. In summer, resident waterfowl breed here; in winter, it is a sanctuary for migrating waterfowl. Buckhorn Island is an extremely significant waterfowl feeding, nesting and wintering area, especially for Diving Ducks. It is also a productive area for fish populations. The Buckhorn Marsh the largest emergent marsh on the U.S. shore of the Niagara River, is an important Canada Geese, Puddle Duck and waterbird breeding and feeding area from March to December. The Buckhorn Weir is a Ring-billed Gull nesting area, and the only Double-crested Cormorant nesting area (April to August) on the U.S. side of the River. Common Terns nest in the power cribs. Contact Buffalo DEC at (716) 851-7010.

110 The Niagara River is a late fall concentration area for Diving Ducks (Scaup, Mergansers, Bufflehead, Goldeneye); numbers can exceed 20,000. The fast-flowing, ice-free waters north of Navy Island have major wintering concentrations of Goldeneye, Bufflehead and Mergansers and some Oldsquaw and Canvasback.

NOTES

A red exclamation point symbol is used on the maps to catch the responder's attention.

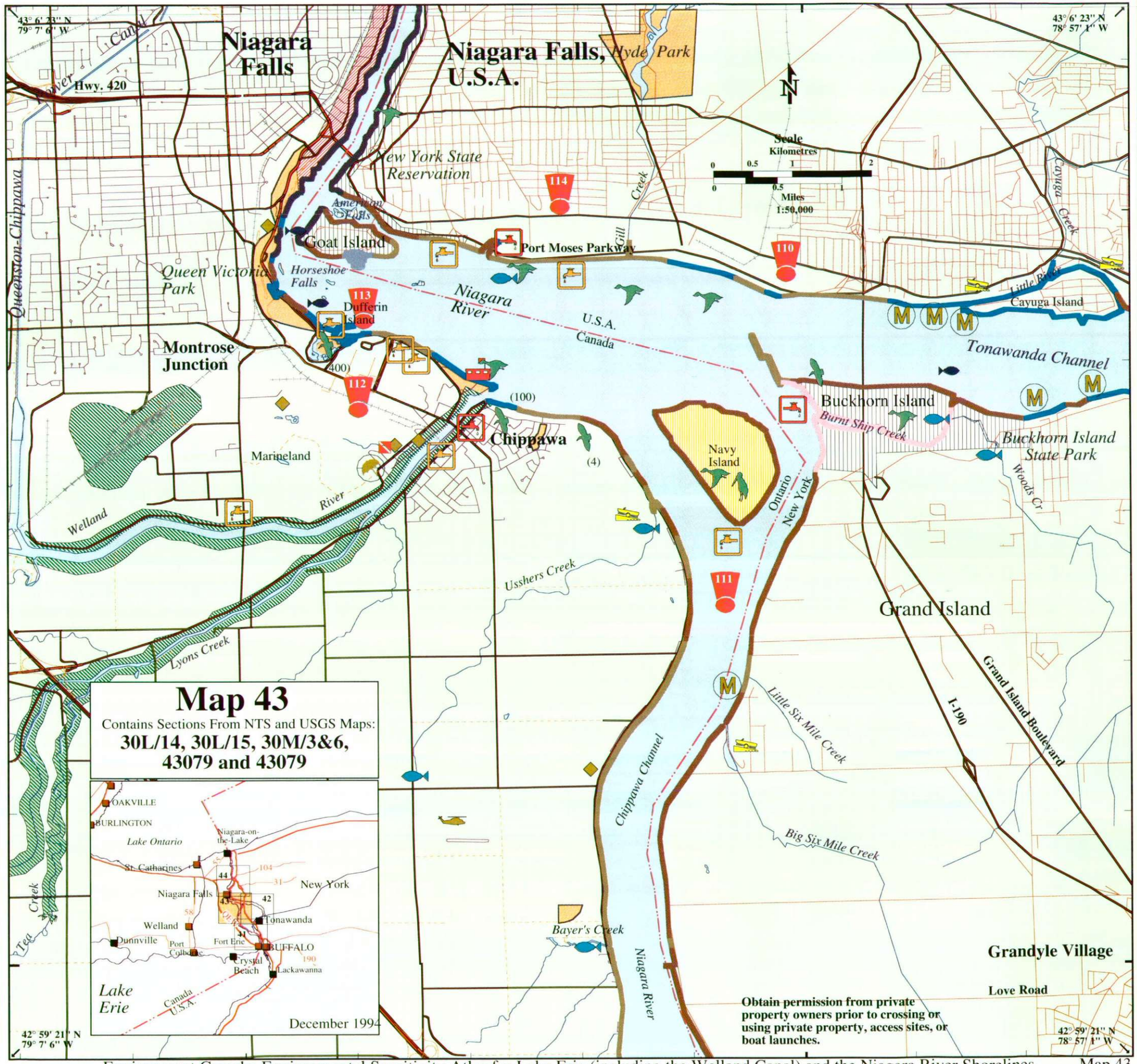
110 The Niagara River is a late fall concentration area for Diving Ducks (Scaup, Mergansers, Bufflehead, Goldeneye); numbers can exceed 20,000. The fast-flowing, ice-free waters north of Navy Island have major wintering concentrations of Goldeneye, Bufflehead and Mergansers and some Oldsquaw and Canvasback.

111 Occidental Chemical Water Intakes - Call (905) 871-3206. Navy Island is federal land leased to the Niagara Parks Commission for camping and day-use recreations. It is an Area of Natural and Scientific Interest requiring high priority protection. It is the only remaining example of a large, natural river shoreline community in the upper Niagara River. Private residences along the upper Niagara River have submerged water intakes and should be notified to close them when necessary.

112 Sir Adam Beck Hydro Generating Station Intakes - Call (905) 357-0322, ext. 756. Niagara Falls Drinking Water Treatment Plant Intake - Call (905) 354-2754. Norton Company Outfalls/Intake - Call (905) 295-4311, ext. 236. Washington Mills Electro Minerals (Can.) Inc. Outfall/Intake - Call (905) 357-5500.

113 Dufferin Island is designated as an Environmentally Sensitive Area because of its distinctive and unusual landforms. It supports a rare and diverse plant community. Due to the easy accessibility and physiological features, this area is used for scientific research and conservation education. Ontario Power Corp. Industrial Intake/Outfall - Call (905) 357-0322. The Niagara Parkway, a public area encompassing untouched gorge face and a manicured parkland, runs all along the Canadian side of the Niagara River. Near Dufferin Island there is a control dam running perpendicular into the River. On Goat Island, several hundred Mallards concentrate year-round due to feeding by humans.

114 New York Power Authority Industrial Water Intake - Call (716) 285-3211. Niagara Falls Municipal Water Treatment Plant Intake - Call (716) 772-7241. Washington Mills/ Carborundum Industrial Intake - Call (716) 278-6763. For Cross-border response activity, call the Rainbow Bridge at (905) 354-5641 (24 hours).



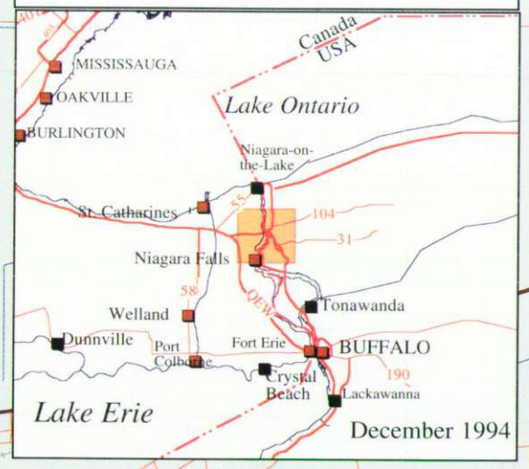
Map 43

Contains Sections From NTS and USGS Maps:
30L/14, 30L/15, 30M/3&6, 43079 and 43079

Obtain permission from private property owners prior to crossing or using private property, access sites, or boat launches.

Map 44

Contains Sections From NTS and USGS Maps:
30M/3&6 and 43079



43° 12' 33" N
78° 57' 32" W

43° 12' 33" N
79° 7' 38" W

Obtain permission from private property owners prior to crossing or using private property, access sites, or boat launches.

Stella Niagara

Niagara Parkway ESA

Ontario
New York

Niagara Parkway

Creek Road

Lewiston

Zuk's Zone ESA

Queenston

Brydges State Artpark

Upper Mountain Road

Fish Creek

Hwy. 405

Ontario Hydro Reservoir

Reservoir

St. David's Buried Valley ANSI

Fireman's Park ESA

Niagara Parks Botanical Gardens

ROBERT MOSES POWER PLANT

POWER PLANT

I-190

Niagara Gorge

Saunders Settlement Road

Niagara Glen

Devil's Hole State Park

Reservoir State Park

The Whirlpool

Devil's Hole Rapids

Whirlpool State Park

Whirlpool Rapids

Witmer Road

Lockport Road

Niagara Falls

Niagara Falls, U.S.A.

Hyde Park

Hwy. 420

Canal

N

Scale
Kilometres
0 0.5 1 2
0 0.5 1
Miles
1:50,000

43° 5' 32" N
79° 7' 38" W

43° 5' 32" N
78° 57' 32" W

NOTES

A red exclamation point symbol is used on the maps to catch the responder's attention.

115 Several portions of the shoreline are major feeding areas for Gulls (tens of thousands) in the autumn and winter. The Niagara River is reputed to have the largest concentration of numbers and varieties of Gulls (13 species) in North America in November. There is also a large resident flock of Canvasback Ducks that reside and feed above the Falls for most of the autumn and winter. To expedite movement of resources across the border during a response effort, responders should call the Whirlpool Bridge Authority at (905) 285-8116 (24 hours).

116 Cytech Canada Inc. Outfalls/Intake - Call (905) 374-5849. Stamford/ Niagara Sewage Treatment Plant Outfall - Call 1-800-263-7215.

117 The entire Niagara Gorge is designated as an Environmentally Sensitive Area and as an Earth Sciences Area of Natural and Scientific Interest because it is unique in Ontario and Canada and has a high aesthetic value. Its physiographic and geomorphological features, including the gorge, marshes and escarpment, host a variety of rare plant species and support a diverse vegetational community. In Ontario, the Northern Dusky Salamander is found only in the Niagara Gorge.

118 Sir Adam Beck Hydrogenerating Station Number 1 and Number 2 Outfall - Call 1-800 -263-7215. The Niagara River is a late fall concentration area for Diving Ducks (Scaup, Mergansers, Bufflehead, Goldeneye); numbers can exceed 20,000. Many of these ducks also winter along the River, along with Oldsquaw and some Canvasback. To expedite movement of resources across the border during a response effort, responders should call the Lewiston -Queenston Bridge Authority at (905) 262-4823 (24 hours).

119 Bruce Trail at Queenston Heights is designated as an Area of Natural and Scientific Interest because its land exemplifies the glacial era of the Lake Iroquois shoreline. It is one of the most diverse forest regions in the Niagara area and hosts both rare plants and trees. It also serves as an important wildlife area. Bald Eagles feed and roost along the Niagara River in this general area. At Queenston, there is recreational fishing activity in the Niagara River for Smelt, Perch, Bass, Salmon and Trout.

120 There is provincially significant commercial fishery activity in the Lower Niagara River. Farmers in this area draw water from the Niagara River for irrigation. Call the Town of Niagara-On-The-Lake at (905) 468-3266 for notification.

NOTES

A red exclamation point symbol is used on the maps to catch the responder's attention.

121 Niagara-On-The-Lake area farmers use water from the Niagara River for irrigation. Contact the Town of Niagara- On-The-Lake at (905) 468-3266 for notification. Several portions of the shoreline are major feeding areas for Gulls (tens of thousands) in the autumn and winter. The Niagara River is reputed to have the largest concentration of numbers and varieties of Gulls (13 species) in North America in November. The Niagara River is a late fall concentration area for Diving Ducks (Scaup, Mergansers, Bufflehead, Goldeneye); numbers can exceed 20,000. Many of these ducks also winter along the River, along with Oldsquaw and some Canvasback. Flocks of wintering Oldsquaw along the lower Niagara River can number up to 6000 birds.

122 Niagara-On-The-Lake Municipal Water Treatment Plant Intake - Call 1-800-263-7215. Seasonal fish spawning occurs near the mouth of the Niagara River. Commercial and sport fishing have seasonal significance in this area. There is also concentrated recreational boating at the mouth of the Niagara River.

123 Four Mile Creek Bay (U.S.) wetland estuary is a feeding and breeding habitat for Herons and waterfowl. It has significant spawning runs of Salmonid in the spring and fall.

124 Niagara-On-The-Lake Municipal Wastewater Treatment Plant Outfall - Call 1-800-263-7215. Four Mile Creek Estuary is classified as an Area of Natural and Scientific Interest. This marsh area is a feeding habitat for provincially and regionally significant bird species and supports provincially significant plant species. The Four Mile Creek Wetland is an active feeding site for wading birds, a habitat for fur bearing mammals and provides winter cover for Cottontail Rabbits. This wetland supports seasonal fish spawning and is important for commercial fish harvesting activities. Seasonal fish spawning occurs along the shore of Lake Ontario from Four Mile Creek to Mississauga Point: White Sucker, Brown Bullhead and Pumpkinseed in spring. Rainbow Trout spawn in Four Mile Creek in spring.

43° 18' 24" N
79° 8' 1" W

Lake Ontario

43° 18' 24" N
78° 57' 55" W

For environmental sensitivity information for the Canadian shoreline of Lake Ontario, see Environment Canada's 1993 publication, "Environmental Sensitivity Atlas for Lake Ontario's Canadian Shoreline".

For environmental sensitivity information for the United States shore of Lake Ontario, see NOAA's "Lake Ontario Atlas: Sensitivity of Coastal Environments and Wildlife to Spilled Oil" (RPI, 1993).

N

Scale
Kilometres
0 0.5 1 2
Miles
0 0.5 1
1:50,000

New York
Ontario
U.S.A
Canada

Four Mile Point
Mississauga Beach
Mississauga Point
Fort Niagara Beach
Fort Niagara State Park
Fourmile Creek State Park
Cake Road
Youngstown
McFarland Point
Four Mile Pond
Two Mile Pond
Two-Mile-Four Mile Creek ANSI & ESA
Four Mile Creek
Two Mile Creek
Sloma Drain
Hwy. 55
McFarland Park
Fort George National Historical Park
Niagara Parkway ESA
Niagara-on-the-Lake
Bergen Drain
Virgil
Virgil Reservoir Conservation Area
Thomson Drain
Niagara Parkway
Niagara River
Lower River Road
Joseph Davis State Park
Robert Moses Parkway
Creek Road
Stella Niagara
Fourmile Creek

124 123 122 121

57 56

Obtain permission from private property owners prior to crossing or using private property, access sites, or boat launches.

43° 11' 22" N
79° 8' 1" W

43° 11' 22" N
78° 57' 55" W

Map 45

Contains Sections From NTS and USGS Maps:
30M/3&6 and 43079

43° 14' 50" N
79° 17' 39" W

For environmental sensitivity information for the Canadian shoreline of Lake Ontario, see Environment Canada's 1993 publication, "Environmental Sensitivity Atlas for Lake Ontario's Canadian Shoreline".

43° 14' 58" N
79° 7' 33" W

Lake Ontario

Scale
Kilometres
0 0.5 1 2
0 0.5 1
Miles
1:50,000

Port Weller Harbour
Eight Mile Pond
Gates Port
Weller Beach
Municipal Beach
Port Weller East
McNab
Weller Park
Port Weller
Butkin Drain
Bergen Drain
Six Mile Creek
Airport Drain
Michigan Beach
Welland Canal
Port Dalhousie
St. Catharines
Carlton Park
Niagara District Airport
Hwy. 55
Martindale Pond ESA
Martindale Pond
Barnesdale
Henley
QEW
Facer
Twelve Mile Creek
Homer
Martindale Heights
Montebello
Old Glenridge
Old Glenridge Park
CNR
Western Hill
Merritton
Marsdale

Obtain permission from private property owners prior to crossing or using private property, access sites, or boat launches.

43° 7' 49" N
79° 17' 39" W

43° 7' 49" N
79° 7' 33" W

Map 46

Contains Sections From NTS and USGS Maps:
30M/3&6

NOTES

A red exclamation point symbol is used on the maps to catch the responder's attention.

125 Eight Mile Creek Wetland is an active feeding site for wading birds, a habitat for furbearing mammals and provides winter cover for rabbits and weasels. Spawning and commercial harvesting of coarse fish occur here.

126 Martindale Pond Marsh is an Environmentally Sensitive Area due to its variety of vegetation and the fact that it is a habitat for feeding and nesting waterfowl and wading birds such as Mallard Ducks, Great Blue Heron, and a variety of marsh birds including Black Terns, Swallows, and Red-winged Blackbirds. The marsh also supports seasonal fish spawning. Seasonal fish spawning occurs in Twelve Mile Creek: Rainbow Trout in spring; Brown Trout, Coho Salmon and Chinook Salmon in fall; Brook Trout in late fall. For the Wastewater Treatment Plant Outfall at Port Dalhousie, call the Region of Niagara at 1-800-263-7215.

127 General Motors of Canada Outfall/Intake - Call (905) 641-6156. Domtar Fine Papers Outfall/Intake - Call (905) 680-3228. Kimberly Clark of Canada Outfall/Intake - Call (905) 680-3000.

NOTES

A red exclamation point symbol is used on the maps to catch the responder's attention.

127 General Motors of Canada Outfall/Intake - Call (905) 641-6156. Domtar Fine Papers Outfall/Intake - Call (905) 680-3228. Kimberly Clark of Canada Outfall/Intake - Call (905) 680-3000.

128 For the De Cew Municipal Water Treatment Plant Intake serving St.Catharines, Thorold, Niagara-On- The-Lake and the eastern end of Lincoln - Call (905) 684-5353.

129 Hayes Dana Drive Train Division Outfall/Intake - Call (905) 680-3579.

130 Geon Canada Inc. Outfall/Intake - Call (905) 357-3131. Cytech Canada Inc. Outfall/Intake - Call (905) 356-9000.

131 Port Robinson Duck Ponds are considered an Environmentally Sensitive Area that serves a vital ecological function to the surrounding area as a concentration point and migratory stopover for various wildlife species. It supports a variety of both wildlife habitats and rare species and is suitable for scientific research. Port Robson Municipal Water Treatment Plant Intake - Call 1-800-263-7215.

43° 8' 30" N
79° 17' 40" W

43° 8' 30" N
79° 7' 35" W

Merritton

Marsdale

Thorold

Ten Mile Creek

DeCew Falls Escarpment ESA

DeCew Falls

Lake Moodie

Lake Gibson

Canal

Thorold South

Beaver Dams Creek

Short Hills Provincial Park

Short Hills

Hwy. 406

Old Welland

Hwy. 20

Black Horse Corner

CNR

Allanburg

St.Johns Conservation Area

Turners Corners

Welland Canal

Hwy. 58

Port Robinson

Thompsons Creek

Welland River

Fraser

Grassy Brook

Fonthill

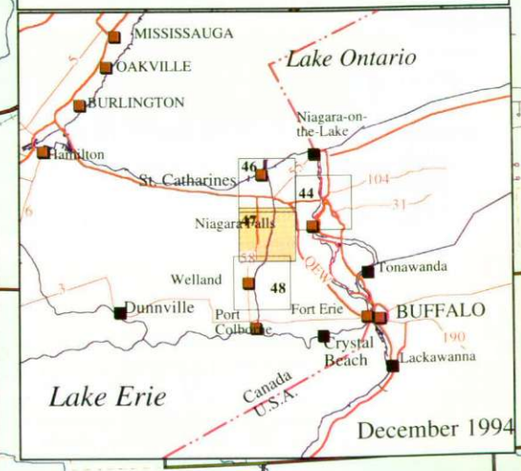
Kunda Park

Mont

Scale
Kilometres
0 0.5 1 2
0 0.5 1
Miles
1:50,000

Map 47

Contains Sections From NTS and USGS Maps:
30L/14 and 30M/3&6



December 1994

Obtain permission from private property owners prior to crossing or using private property, access sites, or boat launches.

43° 1' 28" N
79° 17' 40" W

43° 1' 28" N
79° 7' 35" W

43° 2' 19" N
79° 18' 38" W

Fonthill

Kunda Park

Ridgeville

Pelham Corners

Welland

Obtain permission from private property owners prior to crossing or using private property, access sites, or boat launches.

Grassy Brook

43° 2' 19" N
79° 8' 34" W

Scale
Kilometres
0 0.5 1 2
0 0.5 1
Miles
1:50,000

Cooks Mills

Lyons Creek

Old Welland Canal

Dain City

Hwy. 58

Welland Canal

Hwy. 140

Mud Lake Conservation Area

Wainfleet Marsh Bog ANSI

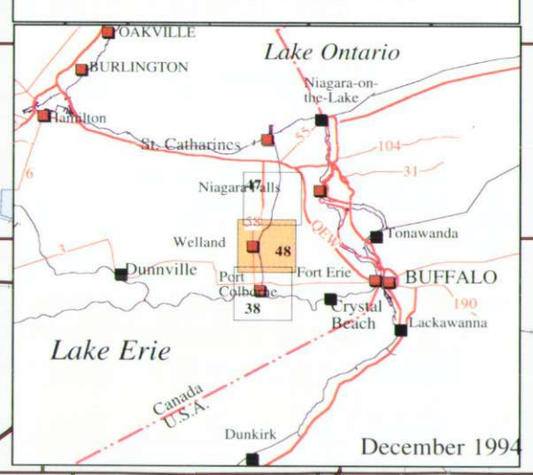
42° 55' 17" N
79° 18' 38" W

Humberstone Marsh

42° 55' 17" N
79° 8' 34" W

Map 48

Contains Sections From NTS and USGS Maps:
30L/14 and 30M/3&6



NOTES

A red exclamation point symbol is used on the maps to catch the responder's attention.

88 Wainfleet Marsh is designated as an ANSI and ESA due to its variety of furbearers and waterfowl It is an active feeding area for colonial waterbirds and a nesting area for the American Bittern. It is also considered an International Biological Program site because of the rare plant species it supports. The wetlands are a popular recreation site. Spill responders should note that a warm water fishery is located on the site.

91 Casco Company Intake/Outfall - Call (905) 835-8220.

95 Parts of Humberstone Marsh are designated as an ANSI, given the nature of this unique biological area. It supports rare plant species and extensive wildlife in its excellent forest and marsh habitats.

131 Port Robinson Duck Ponds are considered an Environmentally Sensitive Area that serves a vital ecological function to the surrounding area as a concentration point and migratory stopover for various wildlife species. It supports a variety of both wildlife habitats and rare species and is suitable for scientific research. Port Robson Municipal Water Treatment Plant Intake - Call 1-800-263-7215.

132 Welland Municipal Water Treatment Plant Outfall/Intake - Call 1-800-263-7215. Atlas Specialty Steels Outfall/Intake - Call (905) 735-5661.

133 Lyons Creek is designated as an Area of Natural and Scientific Interest because it supports a variety of waterfowl, raptors and colonial birds. There is also significant fish population located here, and is inhabited by numerous furbearers.

134 Union Carbide Canada Limited Outfalls/Intake - Call (905) 732-6121.

Appendix A

Data Sources

Source agencies for data used in the creation of the Environmental Sensitivity Atlas for Lake Erie (Including the Welland Canal) and the Niagara River Shorelines are listed below.

A.1 Biological Resources

A.1.1 Bird Information

Colonial Waterbird Nesting Sites

Environment Canada, Canadian Wildlife Service, 49 Camelot Drive, Nepean, Ontario, K1A 0H3 (613) 952-2410. Contacts - Dr. Hans Blokpoel and Gaston Tessier

Environment Canada, Canadian Wildlife Service - Habitat Conservation, 152 Newbold Court, London, Ontario. N6E 1Z7 (519) 681-9486. Contacts - Gary McCullough and Norm North

Royal Ontario Museum Contact - Dr. Jim Dick, Department of Ornithology, Ontario Nest Records Scheme

Waterfowl, Raptor, and Shorebird Data

Environment Canada, Canadian Wildlife Service, 49 Camelot Drive, Nepean, Ontario, K1A 0H3. (613) 952-0931. Contact - Joe Carreiro

Environment Canada, Canadian Wildlife Service - Habitat Conservation, 152 Newbold Court, London, Ontario. N6E 1Z7 (519) 681-9486. Contacts - Gary McCullough and Norm North

Environment Canada, Canadian Wildlife Service, 152 Newbold Court, London, Ontario. N6E 1Z7. (519) 681-0980. Contact - D. Dennis, Waterfowl Specialist

Ducks Unlimited 1-800-665-DUCK

Long Point Bird Observatory - P. O. Box 106, Port Rowan, Ontario. N0E 1M0 (519) 586-3531. Contacts - Raptor Information - Ron Ridout, Bird Migration Specialist - John McCracken, Waterfowl Specialist - Dr. Richard Knapton

Ontario Ministry of Natural Resources Offices:

Chatham Area Office, Contact - Don Hector, P.O. Box 168 - 123 Richmond St., Chatham, ON N7M 5L8, phone - 519-354-7340

Aylmer District Office, 353 Talbot St. W., Aylmer, ON, N5M 2S8, phone - 519-773-9241. Contact: Pud Hunter

Simcoe Area Office, Contact - Dave Reid, 548 Queensway, Simcoe, ON N3Y 4T2, phone - 519-426-7650

Fonthill Area Office, Contact - Ann Yagi, P.O. Box 1070, Fonthill, ON L0S 1E0, phone - 905-892-2656

Ontario Ministry of Environment and Energy - Cambridge (519-622-8150), London (519-661-2200) and Welland (905-732-4850) offices

National Museum of Canada

Royal Ontario Museum Flora and Fauna (including rare) information, historic data (geological, meteorological)

Royal Ontario Museum Contact - Dr. Jim Dick, Department of Ornithology, Ontario Nest Records Scheme

A.1.2 Fish Information

Ontario Ministry of Natural Resources, Lake Erie Fisheries Station, RR #2, Wheatly, Ontario. N0P 2P0. 519-825-4684. Contact: Joseph Leach

Canada Centre for Inland Waters, Fish and Ocean Charts, Burlington, Ontario. (905) 366-4549

Ontario Ministry of Natural Resources Offices:

Chatham Area Office, Contact - Don Hector, P.O. Box 168 - 123 Richmond St., Chatham, ON N7M 5L8, phone - 519-354-7340

Aylmer District Office, 353 Talbot St. W., Aylmer, ON, N5M 2S8, phone - 519-773-9241. Contact: Pud Hunter

Simcoe Area Office, Contact - Dave Reid, 548 Queensway, Simcoe, ON N3Y 4T2, phone - 519-426-7650

Fonthill Area Office, Contact - Ann Yagi, P.O. Box 1070, Fonthill, ON L0S 1E0, phone - 905-892-2656

Ontario Ministry of Environment and Energy - Cambridge (519-622-8150), London (519-661-2200) and Welland (905-732-4850) offices

A.1.3 Shore Associated Mammals

Ontario Ministry of Natural Resources Offices:

Chatham Area Office, Contact - Don Hector, P.O. Box 168 - 123 Richmond St., Chatham, ON N7M 5L8, phone - 519-354-7340

Aylmer District Office, 353 Talbot St. W., Aylmer, ON, N5M 2S8, phone - 519-773-9241. Contact: Pud Hunter

Simcoe Area Office, Contact - Dave Reid, 548 Queensway, Simcoe, ON N3Y 4T2, phone - 519-426-7650

Fonthill Area Office, Contact - Ann Yagi, P.O. Box 1070, Fonthill, ON L0S 1E0, phone - 905-892-2656

A.2 Countermeasures

Transport Canada, Canadian Coast Guard, Prescott District, Prescott, Ontario. (613) 925-2865 (Ext. 258). Contact - Ray Amell

The following USCG - MSO - Buffalo (address below) personnel participated in joint Countermeasures determination sessions:

James McDowell

Mike Evanish

Brad Homan

Frank Shelly

Don Kast

United States Coast Guard - Marine Safety Office, Room 1111, Federal Building, 111 West Huron Street, Buffalo, New York. 14202-2395. (716) 846-4168. Contact: James McDowell

National Oceanographic and Atmospheric Administration, 1240 East 9th Street, Cleveland, Ohio. 44199. (216) 522-7760. Contact: Ken Barton

United States Coast Guard, District 9, 1240 East Ninth Street, Cleveland, Ohio. 44199-2060. 216-522-3994. Contact: Laurie Perry

Great Lakes Response Corporation (PIMEC, Inc.), 291 St. Clair Parkway, Corunna, Ontario. N0N 1G0. (519) 862-2281. Contact - Chuck Bailey, Dave Engleson

Environment Canada, Regional Environmental Emergencies Coordinator, Environmental Protection Branch - Ontario Region, 25 St. Clair Avenue East, 7th Floor, Toronto, Ontario. M4T 1M2. (416) 973-1059. Contact: Philip Baker

Environment Canada, Environmental Emergencies Officers, Environmental Protection Branch - Ontario Region, 25 St. Clair Avenue East, 7th Floor, Toronto, Ontario. M4T 1M2. Contact: Steve Clement - (416) 973-1061; Sheelagh Hysenaj - (416) 973-5854

Weather Information

Atmospheric Environment Service - Meterological Station Sites, Meterological Data (wind, temperature, precipitation etc.) 4905 Dufferin Street, Downsview, Ontario.

A.3 Human-Use Resources

A.3.1 High Recreational Usage

Ontario Ministry of Natural Resources Offices:

Chatham Area Office, Contact - Don Hector, P.O. Box 168 - 123 Richmond St., Chatham, ON N7M 5L8, phone - 519-354-7340

Aylmer District Office, 353 Talbot St. W., Aylmer, ON, N5M 2S8, phone - 519-773-9241. Contact: Pud Hunter

Simcoe Area Office, Contact - Dave Reid, 548 Queensway, Simcoe, ON N3Y 4T2, phone - 519-426-7650

Fonthill Area Office, Contact - Ann Yagi, P.O. Box 1070, Fonthill, ON L0S 1E0, phone - 905-892-2656

Ontario Ministry of Environment and Energy - Cambridge (519-622-8150), London (519-661-2200) and Welland (905-732-4850) offices

Lower Thames Valley Conservation Authority, 100 Thames Street, Chatham, ON N7L 2Y8, phone - 519-354-7310. Contact: Valerie Welsh

Essex Region Conservation Authority, 360 Fairview Ave., W., Essex, ON N8M 1Y6, phone - 519-776-5209

Kettle Creek Conservation Authority, RR #8, St. Thomas, ON N5P 3T3, phone - 519-631-1270

Catfish Creek Conservation Authority, RR #5, Alymer, ON N5H 2R4, phone - 519-773-9037

Long Point Region Conservation Authority, RR #3, Simcoe, Ontario. N3K 4K2, phone - 519-428-4623. Contact: Bill Baskerville

Grand River Conservation Authority, P.O. Box 729, Cambridge, ON N1R 5W6, phone - 519-621-2761. Contact: Patricia Nash

Niagara Peninsula Conservation Authority, 2358 Centre St., Allanburg, ON L0S 1A0, phone - 905-227-1013

Anchorage Sites

Richardson's Chartbook and Cruising Guide, Richardson's Marine Publishing Inc., Streamwood, Illinois

Scuba Sites

"Dive Ontario!" publication. Contact: Cris Kohl, 16 Stanley Avenue, Chatham, Ontario. N7M 3J2 - (519) 351-1966

Small Craft Harbours

Department of Fisheries and Oceans, Canadian Centre for Inland Waters, Small Craft Harbours, Burlington, Ontario. (905) 336-4637

A.3.2 Resource Extraction

Water Intakes/Outfalls

Canadian Great Lakes Basin Intake and Outfall Atlas, Ontario Ministry of the Environment

DOE - Ontario Region Staff Inquiries

Commercial Fisheries Activity

Department of Fisheries and Oceans (DFO), Canadian Centre for Inland Waters, Burlington, Ontario. (905) 336-4637

Ontario Ministry of Natural Resources, Lake Erie Fisheries Station, Contact Joseph Leach

Natural Gas Wells and Pipelines

Ontario Ministry of Natural Resources, Petroleum Resources Section at 519-426-7650

Pembina Exploration Ltd. at 905-834-4390

A.3.3 Special Status Areas

A.3.3 Special Status Areas

Archaeological Site Information

The Ontario Ministry of Culture, Tourism and Recreation includes the following statement as a matter of standard policy with data distribution: "While the Ministry of Culture, Tourism and Recreation attempts to maintain a current and reliable database covering all known archaeological occurrences in the province, the Ministry waives responsibility for the quality, accuracy and completeness of this information and any damages which may be incurred through its use."

Heritage Policy Branch, Ontario Ministry of Culture, Tourism and Recreation, Archaeological Site Database, 77 Bloor St. West, Toronto, Ontario. (416) 314-7161, (416) 314-7790 (fax). Contact - Bernice Field

Area of Ecological Significance

Environment Canada, Canadian Wildlife Service, Nepean, Ontario. (613) 952-0931

Ontario Ministry of Natural Resources Offices:

Chatham Area Office, Contact - Don Hector, P.O. Box 168 - 123 Richmond St., Chatham, ON N7M 5L8, phone - 519-354-7340

Aylmer District Office, 353 Talbot St. W., Aylmer, ON, N5M 2S8, phone - 519-773-9241. Contact: Pud Hunter

Simcoe Area Office, Contact - Dave Reid, 548 Queensway, Simcoe, ON N3Y 4T2, phone - 519-426-7650

Fonthill Area Office, Contact - Ann Yagi, P.O. Box 1070, Fonthill, ON L0S 1E0, phone - 905-892-2656

Niagara Parks Commission, John Morley

Niagara River Public Advisory Committee, Valerie Crombie

Niagara Planning Department, Ken Forgeron, Don Campbell

Ontario Ministry of Natural Resources, L. Barbetti, Kathleen Armstrong

Areas of Natural and Scientific Interest (ANSI)

Ontario Ministry of Natural Resources - Contact - Lands Division, Areas of Natural and Scientific Interest, Ontario.

Ontario Ministry of Natural Resources, L. Barbetti, Kathleen Armstrong

Conservation Area Information

Lower Thames Valley Conservation Authority, 100 Thames Street, Chatham, ON N7L 2Y8, phone - 519-354-7310. Contact: Valerie Welsh

Essex Region Conservation Authority, 360 Fairview Ave., W., Essex, ON N8M 1Y6, phone - 519-776-5209

Kettle Creek Conservation Authority, RR #8, St. Thomas, ON N5P 3T3, phone - 519-631-1270

Catfish Creek Conservation Authority, RR #5, Alymer, ON N5H 2R4, phone - 519-773-9037

Long Point Region Conservation Authority, RR #3, Simcoe, Ontario. N3K 4K2, phone - 519-428-4623. Contact: Bill Baskerville

Grand River Conservation Authority, P.O. Box 729, Cambridge, ON N1R 5W6, phone - 519-621-2761. Contact: Patricia Nash

Niagara Peninsula Conservation Authority, 2358 Centre St., Allanburg, ON L0S 1A0, phone - 905-227-1013

Association of Conservation Authorities of Ontario, Suite 127, Times Square 380 Armour Road, Peterborough, Ontario. K9H 7L7. (705) 749-9131. Contact: Jan Street

Ministry of Natural Resources Conservation Authority Information: Contact - Phyllis Miller, Toronto, Ontario. (416) 314-1978

Dune Formation Information

Natural Resources Canada, Geological Survey of Canada, Ottawa, Ontario. (613) 995-4342

Ontario Ministry of Natural Resources, Crown Lands, 77 Wellesley St., MacDonald Block, Toronto, Ontario. M7A 2C1. (416) 314-2001

Ontario Ministry of Natural Resources, Surveys, Mapping and Remote Sensing Branch, Geographic Information Services, Topographic Data Base, 90 Sheppard Ave. East, 4th Floor, North York, Ontario. M2N 3A1. (416) 392-2510

Ministry of Northern Development and Mines, 900 Bay St., Toronto, Ontario (416) 314-3790

Ontario Geological Survey, Mines and Minerals Information Centre Library c/o Janet Heitshu, Rm. M2-17900, Bay Street, MacDonald Block, Toronto, Ontario. M7A 1C3. (416) 314-3803

Ontario Government Book Store, (Publications, road maps, and Provincial Electorial Districts), Toronto, Ontario. (416) 326-5300

Environmentally Sensitive Areas

Lower Thames Valley Conservation Authority, 100 Thames Street, Chatham, ON N7L 2Y8, phone - 519-354-7310. Contact: Valerie Welsh

Essex Region Conservation Authority, 360 Fairview Ave., W., Essex, ON N8M 1Y6, phone - 519-776-5209

Kettle Creek Conservation Authority, RR #8, St. Thomas, ON N5P 3T3, phone - 519-631-1270

Catfish Creek Conservation Authority, RR #5, Alymer, ON N5H 2R4, phone - 519-773-9037

Long Point Region Conservation Authority, RR #3, Simcoe, Ontario. N3K 4K2, phone - 519-428-4623. Contact: Bill Baskerville

Grand River Conservation Authority, P.O. Box 729, Cambridge, ON N1R 5W6, phone - 519-621-2761. Contact: Patricia Nash

Niagara Peninsula Conservation Authority, 2358 Centre St., Allanburg, ON L0S 1A0, phone - 905-227-1013

Niagara Parks Commission, John Morley

Niagara River Public Advisory Committee, Valerie Crombie

Niagara Planning Department, Ken Forgeron, Don Campbell

Ontario Ministry of Natural Resources, L. Barbetti, Kathleen Armstrong

Ontario Ministry of Natural Resources Conservation Authority Information Contact - Phyllis Miller, Toronto, Ontario. (416) 314-1978

Association of Conservation Authorities of Ontario, Contact - Jan Street, Suite 127, Times Square 380 Armour Road, Peterborough, Ontario. K9H 7L7 (705) 749-9131

First Nation/Native Land Information

Indian and Northern Affairs Canada, 25 St. Clair Avenue East, 5th Floor, Toronto, Ontario. M4T 1M2 (416) 973-6234

Ontario Ministry of Natural Resources, Native Register Population (maps of settlements - numbers, locations, resources used)

National Park/National Forests

Heritage Canada, Canadian Parks Service, Point Pelee National Park, RR #1, Leamington, Ontario. N8H 3V4. 519-322-2365. Contact: Dan Reive

Provincial/State Park, Nature Reserves or Wilderness Areas

Long Point Provincial Park, Ontario Ministry of Natural Resources, P.O. Box 99, Port Rowan, Ontario. N0E 1M0. 519-586-2133. Contact: Jeff Robinson

Fish Point Provincial Nature Reserve Park, Wheatley Provincial Park, and East Sister Island Provincial Nature Reserve: Wheatley MNR Office - 519-825-4659. Contact: Jack Sulston, Chuck Fawdry

John E. Pearce Provincial Park, Port Bruce Provincial Park, and Port Burwell Provincial Park: Port Burwell MNR Office - 519-773-9241

Selkirk Provincioal Park: London MNR Office - 519-661-2777

Rondeau Provincial park - 519-674-1750

Rock Point, and James N. Allen Park Reserve: Rock Point Office - 905-774-6643. Contact: Jacob Formsma

Turkey Point Provincial Park - 519-426-3239

For these New York State Parks, contact the Niagara Region Park Police - 716-278-1777 (24hr):

Beaver Island State Park

Whirlpool State Park

Fort Niagara State Park

Bridges State Park

Devil's Hole State Park

Reservoir State Park

New York State Reservation

Buckhorn Island State Park

A.4 Shoreline Habitats

Shoreline Classifications

Environment Canada, Environmental Emergencies Section, Environment Protection Branch - Ontario Region, (416) 973-1059.

Jeff Ollerhead (Contractor), Geomorphologist. Contact - Environment Canada

Aerial Photos

Natural Resources Canada, Air Photo Sales, Ottawa, Ontario (613) 995-4560

Ontario Ministry of Natural Resources, Aerial Mapping Service First Floor, Room # M173900 Bay St. (corner of Bay and Wellesley), Toronto, Ontario (416) 314-2001

Ministry of Natural Resources Air Photos (road, forestry and ground) 77 Wellesley St., MacDonald Block, Toronto, Ontario. M7A 2C1 (416) 314-2001

Ministry of Natural Resources Surveys, Mapping and Remote Sensing Branch, Geographic Information Services, Topographic Data Base, 90 Sheppard Ave. East, 4th Floor, North York, Ontario. M2N 3A1. (416) 392-2510

University of Toronto Mapping Library, Toronto, Ontario

University of Waterloo Map and Design Library, Environmental Studies Building 1, University of Waterloo, Waterloo, Ontario. (519) 885-1211

A.5 Base Maps and Mapping System

Digital Layer Creation and System Consulting

Environment Canada staff, Christine Rowe (Contractor - contact DOE) and Digimap Data Services Inc. (Contractor), 37 Kodiac Crescent, Unit 3, North York, Ontario.

Municipal Maps

Ontario Base Maps (OBM) 1:20,000 Ontario Ministry of Natural Resources, Topographic Mapping Section, 90 Sheppard Ave. East, 4th Floor, North York, Ontario. M2N 3A1 (416) 733-5090

Topographical Maps

Natural Resources Canada, Geological Survey of Canada, Ottawa, Ontario. (819) 564-5600

United States Geological Survey

Ontario Ministry of Natural Resources, Crown Lands (land titles, patents and leases), 77 Wellesley St., MacDonald Block, Toronto, Ontario. M7A 2C1. (416) 314-2001

Ontario Ministry of Natural Resources, Topographical Maps, 77 Wellesley St., MacDonald Block, Toronto, Ontario. M7A 2C1 (416) 314-1666

Ontario Government Book Store Publications, Ontario Road Maps and Provincial Electorial Districts, Toronto, Ontario (416) 326-6500

A.6 Main United States Data Sources

Primary biological resource information was extracted from NOAA's "Lake Erie Atlas: Sensitivity of Coastal Environments and Wildlife to Spilled Oil" (RPI, 1985), NOAA's "St. Clair River, Lake St. Clair and Detroit River Atlas: Sensitivity of Coastal Environments and Wildlife to Spilled Oil" (RPI, 1986) and NOAA's "Niagara River Atlas (U.S. shores): Sensitivity of Coastal Environments and Wildlife to Spilled Oil" (RPI, 1985). Where necessary, updates to that information were received from resource managers from the Michigan Department of Natural Resources and the New York State Department of Environmental Conservation.

Human-use, protection strategy, and sensitive area information was compiled from the USCG's Southeastern Michigan Coastal Zone Area Contingency Plan, the Western Lake Erie Area Contingency Plan and the Eastern Great Lakes Area Contingency Plan (all 1993).

Appendix B

Listing of National Topographic System (NTS) and United States Geological Survey (USGS) Map Sheets

The following NTS map sheets (1:50,000 scale) cover the Canadian shoreline of Lake Erie, the Welland Canal and the Niagara River. Elements of base topographic maps showing on each atlas page have been reproduced with Natural Resources Canada's permission.

Map Sheet	Year
30 L/13	1983
40 I/9	1983
40 J/3	1986
40 J/8	1986
40 I/11	1986
40 I/12	1986
40 I/5	1986
40 G/10	1986
40 G/15	1986
40 J/2	1986
40 I/10	1986
40 J/1	1986
30 L/14	1983
30 L/15	1983
40 I/16	1983
30 M/3 & M/6	1984

The following USGS Quad map sheets (1:24,000 scale) cover the United States shoreline of the Niagara River. The USGS map number (e.g. 43082) located in the Key Map Box on each map corresponds to the block (identified in the USGS Index to Topographic and Other Map Coverage publication) which includes the area covered by each map page.

Map Title	Map Number
Lewistown, N.Y.-Ont.	N4307.5-W7900/7.5
Fort Niagara, N.Y.-Ont.	N4315-W7900/7.5
Tonawanda West, N.Y.	N4300-W7852.5/7.5
Buffalo NW, N.Y.-Ont.	N4252.5-W7852.5/7.5
Niagara Falls, N.Y.-Ont.	N4300-W7900/7.5

Appendix C

References and Suggestions for Further Reading

Baker, Philip, 1993: "Development of an Environmental Sensitivity Atlas for Lake Superior's Canadian Shoreline Using Electronic Desktop Mapping" in Proceedings of the Sixteenth Arctic and Marine Oil Spill Program (AMOP) Technical Seminar pp. 225-254. Environment Canada, Ottawa, Ontario.

Boyd, G.L., 1981: "Canada/Ontario Great Lakes Erosion Monitoring Programme - Final Report 1973/1980" Ocean Science and Surveys, Fisheries and Oceans Canada, Burlington, Ontario, Manuscript Report Series #12.

Department of Fisheries and Oceans, 1986: "Sailing Directions - Great Lakes Volume 1" Tenth Edition, Minister of Supply and Services Canada, Ottawa, Ontario.

The Environmental Applications Group Ltd., 1987: "Lake Erie Atlas: Sensitivity of Coastal Environments and Wildlife to Spilled Oil; Supplement to the Joint Canada - United States Marine Pollution Contingency Plan for Spills of Oil and Other Noxious Substances", prepared for Environmental Protection - Ontario Region, Environment Canada, Toronto.

Environment Canada, Canadian Wildlife Service 1974: "Waterfowl Studies in Eastern Canada 1969 - 1973", Edited by Hugh Boyd. Report Series 29.

Environment Canada, Canadian Wildlife Service, 1984: "Waterfowl Studies in Ontario 1973-81", Edited by S. G. Curtis, D. G. Denis and H. Boyd, Occasional paper 54.

Environment Canada/Canadian Coast Guard, 1992: "The Oil Spill Shoreline Clean Up and Assessment Team (SCAT) Manual for the Ontario Great Lakes and St. Lawrence River Shorelines: Procedures for Assessment of Oiled Shorelines and Clean Up Options". Prepared by Owens, E. H., D.I. Little, and J.J. Young of Woodward-Clyde Consultants, Seattle, Washington.

Environment Canada, State of the Environment Reporting 1993: "Bringing the Bald Eagle Back to Lake Erie", Minister of Supply and Services Canada, Cat. No. EN1-12/93-3E

Environment Canada, Environmental Protection Branch - Ontario Region 1993: "Environmental Sensitivity Atlas for Lake Superior's Canadian Shoreline", Minister of Supply and Services Canada, Cat. No. EN40-452/1993/E

Environment Canada, Environmental Protection Branch - Ontario Region 1993: "Environmental Sensitivity Atlas for Lake Ontario's Canadian Shoreline", Minister of Supply and Services Canada, Cat. No. EN40-453/1993/E

Environment Canada, Environmental Protection Branch - Ontario Region 1994: "Environmental Sensitivity Atlas for Lake Huron's Canadian Shoreline (including Georgian Bay)", Minister of Supply and Services Canada, Cat. No. EN40-455/1994/E

Environment Canada, 1994: "Canadian Coastal Environments, Shoreline Processes and Oil Spill Cleanup" written by E.H. Owens, Owens Coastal Consultants Ltd., Environmental Protection Series Report 3/SP/5 - March 1994, Minister of Supply and Services Canada, Cat. No. En49-14/3-5E, Ottawa, Ontario.

Environment Canada, Environmental Protection Branch - Ontario Region 1995: "Environmental Sensitivity Atlas for the St. Lawrence River Shorelines", Minister of Supply and Services Canada, Cat. No. En40-455/5-1994E

Environment Canada, Environmental Protection Branch - Ontario Region 1995: "Environmental Sensitivity Atlas for the St. Marys River Shorelines", Minister of Supply and Services Canada, Cat. No. En40-455/7-1994E

Environment Canada, Environmental Protection Branch - Ontario Region 1995: "Environmental Sensitivity Atlas for the St. Clair River, Lake St. Clair and Detroit River Shorelines", Minister of Supply and Services Canada, Cat. No. En40-455/9-1994E

Goodyear, C. D., T. A. Edsall, D. M. Ormsby Dempsey, G. D. Moss and P. E. Polansky, 1982: "Atlas of the Spawning and Nursery Areas of Great Lakes Fishes", Volumes 1 to 14. Prepared for the offices of Biological Services, Fish and Wildlife Service, U.S. Department of the Interior, Washington, D. C. 20240.

Great Lakes Basin Commission, 1975a: "Great Lakes Basin Framework Study: Appendix II - Levels and Flows", Great Lakes Basin Commission, Ann Arbor, Michigan.

Gundlach, E. R., Baca, B. J., Coastal Science and Engineering Inc.,1986: "St. Clair River, Lake St. Clair, and Detroit River: A Coastal Resource Atlas; Sensitivity of Coastal Environments and Wildlife to Spilled Oil; Supplement to the Joint Canada - United States Marine Pollution Contingency Plan for Spills of Oil and Other Noxious Substances", prepared for Environmental Protection - Ontario Region, Environment Canada, Toronto.

Kleinfeldt Consultants Ltd., 1990: "Canadian Great Lakes Basin Intake/Outfall Atlas", Volume 5 (Lake Erie) and Volume 6 (Welland Canal/Niagara River) prepared for the Ontario Ministry of the Environment.

Kohl, Cris, 1990: "Dive Ontario!" pub. Cris Kohl, 16 Stanley Avenue, Chatham, Ontario. N7M 3J2.

MacLaren Plansearch Limited, 1991: "Wind and Wave Climate Atlas - Volume III - The Great Lakes". prepared by MacLaren Plansearch Ltd., for Transport Canada, Montreal, Quebec. Transport Canada Publication Number TP 10820E.

Masse, A.K. and C.R. Murthy, 1990: "Observations of the Niagara River Plume (Lake Ontario, North America)". Journal of Geophysical Research Volume 25: 16,097-16,109.

Ontario Ministry of the Environment and Energy - Ontario Ministry of Natural Resources, 1992: "Guide to Eating Ontario Sport Fish", Queen's Printer for Ontario ISSN 0826-9653, Toronto, Ontario.

Ontario Ministry of Natural Resources, 1969: Map - "Migratory Fish Location and Species"

Ontario Ministry of Natural Resources - Ontario Ministry of Municipal Affairs, 1992:"Wetlands Policy Statement - Manual of Implementation Guidelines". Queens Printer for Ontario, Toronto, Ontario.

Owens, E. H., 1979: "The Canadian Great Lakes: Coastal Environments and the Clean Up of Oil Spills", prepared for the Environmental Protection Service, Environment Canada.

Owens, E. H., 1982: "Canadian Inland Waters Coastal Environments and the Clean Up of Oil Spills", prepared for the Environmental Protection Service, Environment Canada.

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Appendix D

Acronyms and Abbreviations Used in Environmental Sensitivity Atlases

AID	Atmospheric Issues Division
ANSI	Area of Natural and Scientific Interest
CA	Conservation Authority
CCG	Canadian Coast Guard
CWS	Canadian Wildlife Service
DEC	New York State Department of Environmental Conservation
DOE	Department of Environment/Environment Canada
EPA	Environmental Protection Agency
EPB	Environmental Protection Branch
ESA	Environmentally Sensitive Area
ESI	Environmental Sensitivity Index
Ft	Feet
GIS	Geographic Information System
GLRC	Great Lakes Response Corporation
GS	Generating Station
IBP	International Biological Program
Km or km	Kilometre
M or m	Metres
MDNR	Michigan Department of Natural Resources
MSO	Marine Safety Office
NOAA	National Oceanic and Atmospheric Administration
NRC	Natural Resources Canada
NTS	National Topographic Series
OMNR	Ontario Ministry of Natural Resources
OMOEE	Ontario Ministry of Environment and Energy
OR	Ontario Region
RAP	Remedial Action Plan
REEC	Regional Environmental Emergencies Coordinator
RPI	Research Planning, Inc.
SAR	Sensitive Area Reports
Twp	Township
US	United States
USCG	United States Coast Guard
USGS	United States Geologic Survey
WSF	Water Soluble Fraction

To assist users in discerning one shoreline colour from another, a removable Legend insert has been included with the atlas. If required, users may line up this card over the shoreline habitat in question, to determine the exact colour of a given habitat.

Legend

Shoreline Habitats

ESI* Ranking

Bedrock or Impermeable Shores

- 1a(1a) Exposed Bedrock Bluff less than 1 metre elevation
- 1b(1a) Exposed Bedrock Bluff 1-5 metre elevation
- 1c(1a) Exposed Bedrock Bluff greater than 5 metre elevation
- 2(1b) Retaining Wall/Harbour Structure/Breakwaters
- 3(2) Shelving Bedrock

Unconsolidated Sediment Shores

- 4(3) Exposed Sediment Bluff
- 5a(4) Sand Beach: Depositional
- 5b(4) Sand Beach: Erosional or Transitory
- 6(4) Sand Barrier With Lagoon
- 7a(6a) Pebble Beach
- 7b(6a) Pebble/Cobble Beach
- 7c(6a) Cobble Beach
- 8(6b) Rip Rap
- 9(6a) Boulder Beach
- 10(5) Mixed Beach (% by sediment in DOE Database)

Vegetated Shores

- 11(9a) Low Vegetated Bank (Grass or Trees)
- 12(9b) Delta Mud Flat
- 13a(10a) Fringing Wetland
- 13b(10b) Broad Wetland

* ESI - Canadian Environmental Sensitivity Index (USA ESI Ranking follows in brackets) Higher numbers indicate greater sensitivity.

Biological Resources

Fish

- Area of Seasonal Fish Spawning
- Location of Seasonal Fish Migration

Birds

- Migratory Waterfowl
- Colonial Nesting Birds (total nests - all species)
- Wading Birds (total nests - all species)
- Shore Birds
- Raptors

Shore Associated Mammals

- Furbearers (such as Muskrat, Mink, and Beaver)

Human-Use Resources

High Recreational Usage

- Marinas and Small Craft Harbours
- Anchorage Sites
- Residential, Recreational or Cottage Use
- High-Use Recreational Beach
- Recreational Dive Site

Resource Extraction

- Water Intakes - Industrial
- Water Intakes - Municipal
- Outfall
- Commercial Fisheries Activity

Special Status Areas

- Highly Sensitive Classified Feature (within 2km)
- First Nation/Native American Reservation
- National Park/National Forest
- Provincial/State Park, Wilderness Area or Nature Reserve/State Forest
- Conservation Area or Municipal Park
- Environmentally Sensitive Area*
- Area of Natural and Scientific Interest*
- Area of Ecological Significance (e.g. Wetland)
- Dune Formations

* As identified by Ontario Ministry of Natural Resources or Conservation Authorities

Countermeasures

- Access Site (for land vehicles)
- Approach Concerns
- Exposed Rock
- Coast Guard Light Station
- Boat Launch: Excellent
- Boat Launch: Good
- Boat Launch: Poor
- Helicopter Landing Site
- Staging Area: Excellent
- Staging Area: Good
- Staging Area: Poor
- Automated Weather Stations

Canada