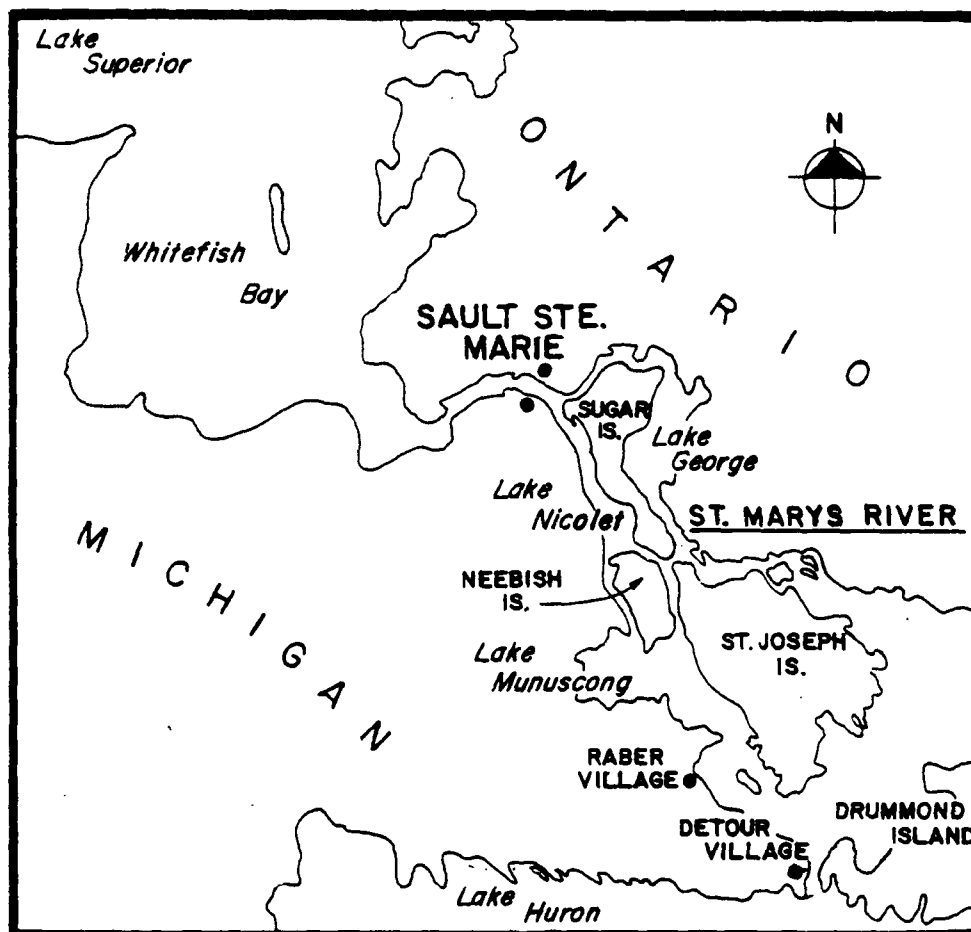


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TECHNICAL REPORT ON

WEATHER, WATER LEVELS AND FLOWS, AND
ICE CONDITIONS OF THE ST. MARYS RIVER SYSTEM
FOR EXTENDED SEASON NAVIGATION

AD-A214 003



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PREPARED FOR:
DETROIT DISTRICT
U.S. ARMY CORPS OF ENGINEERS
DETROIT, MICHIGAN

PREPARED BY:
GLOBETROTTERS ENGINEERING CORPORATION
CHICAGO, ILLINOIS

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TECHNICAL REPORT
ON WEATHER, WATER LEVELS AND FLOWS, AND
ICE CONDITIONS OF THE ST. MARYS RIVER SYSTEM
FOR EXTENDED SEASON NAVIGATION

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1. THE STUDY AND REPORT

1.1 Purpose and Authority

The purpose of the study described in this Report is to collect, identify, compile, and present the existing information on weather; water levels and discharge; and ice formation, coverage and thickness for the St. Marys River system connecting Lakes Superior and Huron. This includes the construction of wind roses for the winter periods (January to April) from 1969 to 1986, a river discharge chart, a water level chart and annual ice chart summaries (covering each week between 1 January and 15 February) exclusive of the years 1981 and 1982. The information thus compiled will provide a composite picture of the St. Marys River system on weather, water levels and discharge, and ice conditions for the proposed extended season operation of the Soo Locks for winter shipping to 31 January $\pm$ two weeks.

This study involved the collection, interpretation, interpolation, and presentation of existing data from different sources. Through contact with the Detroit District, U.S. Army Corps of Engineers and other agencies responsible for data in the St. Marys River system, available existing data were gathered, reviewed, organized and analyzed. Summaries and results of these analyses performed are included in Section 5 of this report.

The work was performed by Globetrotters Engineering Corporation under contract No. DACW35-86-D-0040, Delivery Order No. 0002 with the Department of the Army, Detroit District, Corps of Engineers.

1.2 Scope of the Study

The study limits of the St. Marys River System (which connects Lake Superior with Lake Huron) in this report are confined to the bodies of water between the upstream and downstream limits of the Federal Project in Whitefish Bay and Detour Passage, respectively. The specific study area is delineated on Figures 1 & 2.

1.3 Prior Studies and Reports

Prior studies and reports pertinent to this study report include:

a. Survey Report on Great Lakes and St. Lawrence Seaway Navigation Season Extension (Feasibility Study - 1969). This study is a preliminary investigation outlining the existing and prospective commercial vessel fleet, difficulties attending winter navigation, methodology considered to extend the navigation season, and general costs and benefits derived from winter navigation on the Great Lakes.

b. Great Lakes-St. Lawrence Seaway Navigation Season Extension Demonstration Program. This program, authorized by Section 107(b) of the River and Harbor Act of 1970 and directed by the "Winter Navigation Board", is aimed at demonstrating the practicability of extending the navigation season on the Great Lakes-St. Lawrence Seaway System.

c. Great Lakes Connecting Channels and Harbors Study by Detroit District, Corps of Engineers. This is a comprehensive survey scope study with a view to determining the advisability of further improvements in the Great Lakes Connecting Channels and Harbors in the interest of present and prospective deep-draft commerce.

d. Great Lakes Basin Framework Study, 1971. This study was conducted by the Great Lakes Basin Commission. Appendix C-9 to this report relates to commercial navigation on the Lakes.

e. Great Lakes Water Levels Study. This study, conducted under the auspices of the International Joint Commission, evaluates various alternative regulation schemes for the Great Lakes-St. Lawrence Seaway System with corresponding benefit-cost analyses for each plan. A main report titled "Regulation of the Great Lakes Water Levels" December 1973, includes seven supporting appendices, Appendix E being on "Commercial Navigation."

f. Oil Pollution Problems Associated with the Extended Navigation Season. This report was prepared for the Environmental Evaluation Work Group of the Great Lakes-St. Lawrence Seaway Navigation Season Extension Demonstration Program by W. E. Mason, Commander, U.S. Coast Guard, in 1973. The report details control techniques and problems relating to oil spills occurring with ice conditions.

g. Draft Report on Effect of Winter Navigation on Erosion of Shoreline and Structure Damages Along St. Marys River, Michigan by U.S. Army Corps of Engineers. This draft report indicates that structural damage occurs in the winter time from changing water levels, ice flows, and the action of passing ships. However, it was determined that erosion occurs all year long and that less than one mile of shoreline has erosion problems on the St. Marys River. The draft report was completed in March 1974.

h. Systems Study to Extend Navigation Season on the St. Clair-Detroit Rivers System by Acres American, Inc. for the Detroit District, Corps of Engineers, August 1974. This study including a compilation of annual ice chart summaries, is comprised of 3 volumes and discusses enabling measures necessary to extend the navigation season between Lake Huron and Lake Erie.

i. Winter Recreation and Navigation - St. Marys River System by Lake Superior State College for the Bureau of Outdoor Recreation, May 1975. The report describes some of the effects of extended season navigation on outdoor recreation, such as snowmobiling and icefishing, in the St. Marys River System.

j. Model Study of the Little Rapids Cut Area of the St. Marys River, Michigan by Acres American, Inc., Buffalo, New York, for the Detroit District, Corps of Engineers, December 1975. The purpose of this project was to perform a model study, using a physical ice hydraulic model at the Little Rapids Cut area, to assess, analyze and develop feasible solutions for the problems related to winter navigation in the Little Rapids Cut area.

k. Great Lakes-St. Lawrence Seaway Navigation Season Extension - Interim Feasibility Report. This interim report prepared in March 1976 and submitted to the Congress for information only in September 1979 (House Document 96-181) evaluates the feasibility of extended season navigation on the upper four Great Lakes to 31 January + 2 weeks using certain operational measures.

1.4 Contributing Agencies and Organizations

Data for the study were collected from various local, state, and Federal agencies in the United States. Specific data sources are referenced in the appropriate sections of this Report. Agencies contacted in the preparation of this report were as follows:

- a. U.S. Coast Guard Operation Office
Sault Ste. Marie, MI
- b. U.S. Coast Guard, Captain of the Port
Sault Ste. Marie, MI
- c. National Snow and Ice Data Center
Boulder, Colorado
- d. Eastern Upper Peninsula Transportation Authority
Sault Ste. Marie, MI
- e. National Climatic Data Center
Asheville, NC
- f. Great Lakes Hydraulics and Hydrology Branch
Detroit District, U.S. Army Corps of Engineers
- g. Operation and Maintenance Branch
Detroit District, U.S. Army Corps of Engineers
- h. Soo Area Office, Sault Ste. Marie, MI
U.S. Army Corps of Engineers

2. DESCRIPTION OF STUDY AREA

The St. Marys River, study area of this report, is a part of the Great Lakes-St. Lawrence Seaway System. However, consideration of extended season navigation includes only the upper four great lakes.

2.1 Great Lakes-St. Lawrence Seaway System

The Great Lakes-St. Lawrence Seaway system, shown on the Vicinity Map (Figure 1) extends from the westerly end of Lake Superior to the Gulf of St. Lawrence on the Atlantic Ocean, a distance of about 2,342 miles. The five Great Lakes...Superior, Michigan, Huron, Erie and Ontario...with their connecting rivers and Lake St. Clair, have a

water surface area of about 95,000 square miles. The lakes lie partly in each of the two countries, except for Lake Michigan which lies wholly within the United States. The system is bordered by eight U.S. states: Minnesota, Wisconsin, Illinois, Indiana, Michigan, Ohio, Pennsylvania and New York, and by the Province of Ontario, Canada. The total area of the Great Lakes basin, both land and water, above the easterly end of Lake Ontario is approximately 296,000 square miles of which 174,000 square miles are in the United States and 122,000 square miles are in Canada.

The winter climatic conditions of the system make navigation difficult starting in late December or early January of each year. The formation of winter ice hampers navigation in the upper four great lakes, giving rise to the need for winter-specific programs and operating procedures along the system. Specific efforts to extend the navigation season by the U.S. Army Corps of Engineers and other agencies can make navigation feasible until the mid February time frame, depending upon the specific weather condition in a given season. This extension can be made possible through icebreaking efforts, ice prevention or reduction efforts, and other means of ice control.

The upper four Great Lakes and their connecting channels have a design draft of 25.5 feet at datum. Over the entire length of the system, three connecting channels and one set of locks at Sault Ste. Marie, are traversed, lifting ships from an elevation of 576.8 feet at datum in Lake Huron to an elevation of 600 feet at datum (International Great Lakes Datum, 1955) in Lake Superior. In terms of navigation and traffic management for extended season navigation, it is the system of locks and connecting channels which are the most critical. These are:

- a. St. Marys River, including the Soo Locks, (connects Lake Superior and Lake Huron),
- b. Straits of Mackinac, (connects Lake Michigan and Lake Huron),
- c. St. Clair - Detroit Rivers System, (connects Lake Huron and Lake Erie),

Descriptive data for the upper Four Great Lakes are summarized in Table 1 and data for the connecting channels are summarized in Table 2.

2.2 The St. Marys River System

The St. Marys River system, which connects Lake Superior to Lake Huron, is the study area of this report. Location Map of the study area is shown on Figure 2.

The St. Marys River is the outlet for Lake Superior and leaves the lake at Point Iroquois, flowing in a generally southeasterly direction through several channels to Lake Huron, a distance of 63 to 75 miles, according to the route traversed. The study area of the St. Marys River (Figure 2) for this report has a length of approximately 65

TABLE 1
DESCRIPTIVE DATA FOR THE UPPER FOUR GREAT LAKES

Lake	Monthly Mean Water stages above mean sea level ^{1/} (1900-1985)			Low water datum (LWD) ^{1/}	Dimension			
	High Feet	Low Feet	Mean Feet		Length ^{2/}	Breadth ^{2/}	Maximum depth ^{2/}	Water surface area ^{2/}
Lake Superior	602.24	598.63	600.60	600.0	350	160	1,333	31,700
Lake Michigan	581.04	575.35	578.30	576.8	307	118	923	22,300
Lake Huron	581.04	575.35	578.30	576.8	206	101	750	23,000
Lake St. Clair	576.23	569.86	573.37	571.7	26	24	27.5 ^{3/}	490
Lake Erie	573.51	567.49	570.46	568.6	241	57	210	9,910

^{1/} International Great Lakes Datum, 1955. Source - Detroit District, U.S. Army Corps of Engineers.

^{2/} U.S. Coast Pilot 6, 1986, NOAA.

^{3/} Lake St. Clair has a natural depth of about 21 feet; the figure above is the depth of the navigation channel traversing Lake St. Clair. It is commonly referred to as part of the St. Clair River - Lake St. Clair - Detroit River connecting channel system.

TABLE 2

DESCRIPTIVE DATA FOR THE CONNECTING CHANNELS
OF THE UPPER FOUR GREAT LAKES

<u>Connecting Channel</u>	<u>Length</u> Miles	<u>Width</u> Feet	<u>Depth*</u> Feet	<u>Fall</u> Feet
St. Marys River	63-75	300-1500	27-30**	23.2
Straits of Mackinac	4	1250	30	nil
St. Clair River	46	700-1400	27-30	5
Lake St. Clair	17	700-800	27.5	nil
Detroit River	32	300-1260	27.5-29.5**	3

*Depth of improved navigation channel.

**Also has 21.0 feet deep channels

miles from its head in Lake Superior to its mouth at Lake Huron with a vertical fall of approximately 23.2 feet at datum. The St. Marys River may be subdivided into three distinct reaches; the upper river, the St. Marys Falls Canal, and the lower river. The upper river has a length of approximately 14 miles, from Point Iroquois, Michigan, on Lake Superior to the St. Marys Falls Canal located at Sault Ste. Marie, Michigan and Ontario. The fall on the upper river is about five tenths of a foot. The St. Marys Falls Canal covers a distance of approximately two miles. Within this two mile reach are: five navigational locks, three power canals, two bridges, the Compensating Works and the Falls. The fall in this reach is 21.7 feet at datum. The lower St. Marys River has an approximate length of 49 miles from just below the St. Marys Falls Canal, through several channels and lakes, to Detour Passage, where the river flows into Lake Huron. The fall on the lower river is 1.0 foot at datum.

The natural control of the outflow from Lake Superior was a rock ledge at the St. Marys Falls (Rapids). This natural control has been replaced by the locks, a 16 gate compensating works, and powerhouses. As a result, the outflow from Lake Superior is regulated. Of particular interest to this study of the St. Marys River System, due to habitation and ferry activity, are the Sugar, Neebish and Drummond Islands which are inhabited year-round. Transportation to these islands is provided by ferry or tug during the summer. During the winter, transportation has traditionally been over the ice, or by ferry through an established open water vessel track.

Bodies of water considered in this study for extended season navigation on the St. Marys River System include Whitefish Bay, Upper St. Marys River (above locks), Soo Harbor, Little Rapids Cut, Lake Nicolet, Middle Neebish Channel, Lake Munuscong and Detour Passage. West Neebish Channel normally remains closed during the winter period during which either a two way vessel traffic movement or a one way traffic movement in alternate directions is allowed through the Middle Neebish Channel.

Detour Passage, at the mouth of the river, extends north from Lake Huron. The west side of the passage extends from Point Detour to Gaffney Point, 4 miles north, and the east side extends from Barbed Point to Black Rock Point, 3 miles north.

Above Detour Passage, the river channel turns northwest and widens. Between Black Rock Point and the south end of St. Joseph Island, the river extends across the mouth of Potagannissing Bay. From Old Fort St. Joe Point at the south end, the river extends along the west side of St. Joseph Island for about 19 miles to Stribling Point at the north end. About 3 miles northwest of Old Fort St. Joe Point, the river narrows between Hay Point and Point aux Frenes. Munuscong Lake is the widening in the river between Point aux Frenes and the foot of Neebish Island, about 8 miles north.

Neebish Island, about 8 miles long and 4 miles wide, is in the midriver opposite the north end of St. Joseph Island. Narrow channels lead around either side of the island. Sugar Island, just north of Neebish Island, is about 15 miles long north and south and has a maximum width of about 8 miles at the north end. Lake George separates the east side of the Sugar Island from the Ontario mainland, and Lake Nicolet, through which flows the main channel of the river, is on the west side of Sugar Island. A narrow channel leads from the north end of Lake George around the north end of Sugar Island and joins with the channel that leads north from Lake Nicolet.

The river channel then extends 2 miles west between the cities of Sault Ste. Marie in Michigan and Ontario to St. Marys Falls and the canals and locks. Above the locks, the river extends 5 miles southwest to the narrows between Pointe aux Pins and Brush Point, thence west for 4 miles before turning northwest around Pointe aux Chenes and extending about 5 miles to the head of the river in Whitefish Bay.

Descriptive data for the different channels/courses of the St. Marys River System are summarized in Table 3.

2.3 General Study Area

The study area extends approximately 65 miles along the St. Marys River System between Lake Superior and Lake Huron.

One U.S. state (Michigan) and one Canadian Province (Ontario) border on the study area. On the U.S. side, the study area lies entirely within Chippewa County which has a population of 29,029 according to the 1980 census.

2.4 Major Population Centers

The major population centers within the study area are Sault Ste. Marie, and Detour Village, Michigan; and Sault Ste. Marie, Ontario. In addition, four islands: Sugar, Neebish and Drummond on the Michigan side and St. Joseph Island on the Ontario side, are also included in the study area. The population of these centers along with the census years are listed below:

Sault Ste. Marie, MI - 14,448 (1980 Census)

Detour Village, MI - 466 (1980 Census)

Sugar Island, MI - 400 (1980 Census)

Neebish Island, MI - 48 (1980 Census)

Drummond Island, MI - 746 (1980 Census)

Sault Ste. Marie, Ontario - 80,548 (1980)

TABLE 3

DESCRIPTIVE DATA FOR THE CHANNELS/COURSES
OF THE ST. MARYS RIVER SYSTEM

NAME OF CHANNEL/COURSE	LENGTH IN FEET	UP OR DOWN BOUND	WIDTH IN FEET	PROJECT DEPTH IN FEET	IGLD 1955	ADOPTED
Birch Point Course	29,500	both	2,000-4,000	30.0	599.9-600.0	1956
Point Iroquois Anchorage Area	17,000	both	250-4,300	29.0	600.0	1956
Brush Point Course	16,200	both	1,250	28.0-30.0	599.9	1956
Point Louise Turn	2,700	both	1,200	28.0	599.8	1956
Point Louise Channel	6,600	both	1,200	28.0	599.8	1956
Point Aux Pins Course	12,900	both	1,200	28.0	599.7	1956
Vidal Shoals Channel	10,700	both	1,100-1,500	28.0	599.5-599.6	1956
Locks and Canal	10,000	both	80- 110	23.1-32.0	-	1956
Bayfield Channel Course 1						
Anchorage and Maneuver Area	7,700	both	1,500-1,890	28.0	577.7	1956
Angle Courses 1 and 2	5,300	both	600-1,300	28.5	577.6-577.7	1956
Little Rapids Courses 2 and 3	20,400	both	600- 900	27.0	577.3-577.6	1956
Lake Nicolet Channel	22,000	both	300-1,500	29.0	577.2	1956
Lake Nicolet Anchorage	5,500	both	1,000	28.0	577.2	1956
Middle Neebish Channel*	96,600	up	300-600***	27.0-28.0	576.9-577.2	1956
West Neebish Channel**	85,900	down	300	27.5-28.5	576.9-577.2	1956
Lower Course 8	25,000	both	1,000	28.0	576.9	1956
Point Aux Frenes Turn	5,000	both	1,200	28.0	576.9	1956
Round Island Course	20,000	both	1,250	28.0	576.9	1956
Lime Island Channel	38,500	both	1,000-2,000	29.0	576.8	-
Pipe Island Course	17,500	down	860-1,430	29.0	576.8	-
Watson Reefs Course	6,450	down	-	30.0	576.8	-
Detour Passage	25,000	both	-	30.0	576.8	-

* Middle Neebish Channel includes Courses 5, 6, 7, 8, 9 and 10.

** West Neebish Channel includes Lower Course 4, Courses 5, 6, 7 and Upper Course 8.

*** For westerly 600 ft. width of Course 8 and for westerly 300 ft. width of remaining Middle Neebish Channel courses, project depth is 27.0 and 28.0 ft., for easterly part of Middle Neebish Channel, project depth is 21.0 ft.

Data Source - Detroit District, U.S. Army Corps of Engineers

3. COMMERCIAL NAVIGATION

3.1 Limitations on Vessel Movement

Commercial navigation through the St. Marys River System is limited by the channel depths of the river and the waterway restriction at the Soo Locks.

3.1.1 Channel Depths

Different channels/courses of the St. Marys River have different widths and navigation depths. These are depicted in the NOAA (National Oceanic and Atmospheric Administration) National Ocean Survey Charts #14882, 14883 and 14884. Approximate length, width and depth of the different channels/courses of the St. Marys River System have been summarized in Table 3 of Section 2. The channel or navigation depths referred to in this section are the federal project depths.

A series of dredged deep-draft channels lead through the St. Marys River to connect the deep water of Lake Huron with that of Lake Superior. The Corps of Engineers makes periodic bar sweeps through all the improved dredged reaches of the St. Marys River and these channels are well maintained at the project depths of minimum 27 feet. Any depths found to be less than the project depths are published in the Local Notice to Mariners.

Flow velocities in the St. Marys River vary from 1.2 fps (feet per second) to 3.2 fps. Flow velocities range in the St. Marys River are given in Table 4 at the following locations for a high discharge of 110,000 cfs (cubic feet per second) and a low discharge of 57,000 cfs respectively at the compensating works. The discharge rates that can be expected between 8 January to 15 February range from 61,000 cfs to 93,000 cfs.

TABLE 4

FLOW VELOCITIES IN THE ST. MARYS RIVER SYSTEM
(SOURCE REFERENCE b)

Location	High Flow Velocities Corresponding to 110,000 cfs Discharge	Low Flow Velocities Corresponding to 57,000 cfs Discharge
Little Rapids Cut (Course 2):	3.2 fps	2.1 fps
West Neebish Channel Light 29:	2.6 fps	1.5 fps
Six Mile Point:	2.3 fps	1.5 fps
West Neebish Channel Rock Cut (Course 6):	2.2 fps	1.2 fps
Middle Neebish Channel Dike (Course 6):	2.1 fps	1.3 fps

3.1.2 Waterway Restrictions

Waterborne traffic in the St. Marys River is restricted by the dimension of the Soo Locks. The limiting dimensions of the locks are summarized in Table 5.

TABLE 5
LIMITING DIMENSIONS OF THE SOO LOCKS
(SOURCE: SOO LOCKS INFORMATION CENTER)

Lock Name	Length Feet	Width Feet	Depth Feet	Year Constructed
MacArthur	800	80	31	1943
Poe	1,200	110	32	1968
Davis	1,350	80	23.1	1914
Sabin	1,350	90	23.1	1919
Candian Lock	900	59	16	1895

3.1.3 Laws and Regulations

The operation of commerical vessels in the St. Marys River system is subject to various legislative restraints as established by the State, Provincial, and Federal Governments in the United States and Canada. The legislative and administrative restraints for the United States are summarized in the Great Lakes Basin Framework Study 1971, Appendix 20, "Federal and State laws, Policies, and Institutional Arrangements". Typical examples of applicable legislation are the prohibition of the discharge of sewage from commercial vessels, the responsibility of vessel owners for all costs associated with the cleanup of oil spills from vessels, and vessel speed limitations in restricted channel areas.

Speed limits along the St. Marys system can be listed as follows (the speed limits indicate speed over ground between points listed):

Canadian Canal, 7 mph (6.1 knots);

Detour Reef Light and Sweets Point Light, 14 mph (12.2 knots);

Round Island Light and Point aux Frenes Light 21,
14 mph (12.2 knots);

Munuscong Lake Lighted Buoy 8 and Everens Point, 12 mph
(10.4 knots);

Everens Point and Reed Point, 9 mph (7.8 knots);

Reed Point and Lake Nicolet Lighted Buoy 62, 10 mph (8.7 knots);

Lake Nicolet Lighted Buoy 62 and Lake Nicolet Light 80, 12 mph (10.4 knots);

Lake Nicolet Light 80 and Winter Point (West Neebish Channel), 10 mph (8.7 knots);

Lake Nicolet Light 80 and Six Mile Point Range Rear Light, 10 mph (8.7 knots);

Six Mile Point Range Rear Light and lower limit of the St. Marys Falls Canal, 8 mph (7 knots) upbound, and 10 mph (8.7 knots) downbound;

Upper limit of the St. Marys Falls Canal and Point aux Pins Main Light, 12 mph (10.4 knots).

The Commander, Ninth Coast Guard District, may establish temporary speed limit regulations in the VTS (Vessel Traffic Service) area, including amendments to the speed limits.

The Detroit District, U.S. Corps of Engineers is the supervising agency in terms of protection and preservation of navigable waters for U.S. waters in the project area and its Canadian counterpart, the Canadian Hydrographic Service, Department of Fisheries and Ocean, Ottawa, Ontario is responsible for the Canadian waters.

3.2 Overall Season Navigation

3.2.1 Commodities Carried

Iron ore, grain and coal are the three major commodities that pass through the St. Marys River system. The remaining commodities - petroleum, cement, stone, sand and gravel, other bulk, and general cargo-represent a small proportion of the total tonnage.

3.2.2 Annual Traffic Volume

Annual traffic volume in terms of commodities carried through the canal at Sault Ste. Marie in 1985 and the season average of the previous 3 years are summarized in Table 6.

3.3 Extended Season Navigation

3.3.1 Recent Vessel Transits

Since 1967, shipping companies have expressed a continual interest in extending their navigation season in winter on the upper lakes portion of the Great Lakes-St. Lawrence seaway system. Prior to the Demonstration Program portion of the winter navigation study in

TABLE 6

COMMODITIES CARRIED THROUGH THE CANAL AT SAULT STE. MARIE IN 1985 &
THE SEASON AVERAGE OF THE PREVIOUS 3 YEARS
(SOURCE: SOO LOCKS INFORMATION CENTER)

Items	Westbound	Eastbound	Total	Season Average Prev. 3 Years
Wood Products	250	287,631	287,881	108,601
Pulpwood, woodpulp, paper				
Vegetable Products	13,585	13,801,191	13,814,776	18,634,427
Wheat	0	1,189,220	1,189,220	3,899,790
Barley	0	76,850	76,850	174,995
Oats	18,146	117,825	135,971	410,473
Corn	0	3,417	3,417	144,255
Rye	0	352,273	352,273	321,165
Flaxseed	11,023	11,243	22,266	20,035
Soybeans	0	417,299	417,299	936,589
Sunflower seed	23,328	379,879	403,207	579,338
Mill products, screenings				
Mineral Products				
Iron ore	96,446	39,396,325	39,492,771	35,455,806
Mfd iron, steel, pig iron	95,862	173,557	269,719	270,429
Scrap iron	10,251	43,997	54,248	69,401
Stone	1,689,399	9,615	1,699,014	1,591,812
Cement	501,931	0	501,931	439,413
Coal	4,045,759	8,373,565	12,419,324	9,749,721
Potash	0	1,907,846	1,907,846	1,827,191
Salt	283,024	0	283,024	296,034
Petroleum Products				
Gasoline	179,907	19,403	199,310	193,159
Fuel oil	185,344	14,395	199,739	276,831
Miscellaneous Merchandise	111,331	316,976	428,307	410,668
Vessel passages	5,114	3,396	8,510	9,250
Lockages	4,095	2,876	6,971	7,618
Passengers	152,874	23,134	176,008	165,668
Freight	7,265,586	66,892,807	74,158,393	75,810,133

1971, vessel operators ceased operations during the winter months from about mid-December to early April, depending upon ice and weather conditions. Progressively, the navigation season operation through the Soo Locks in the St. Marys River has been extended.

Recent data available on vessel movements and commodities carried during the 1984-85 and 1985-86 extended navigation seasons through the Soo Locks are tabulated in Tables 7 and 8, respectively.

TABLE 7

VESSEL MOVEMENTS DURING THE 1984-85 AND
1985-86 EXTENDED NAVIGATION SEASONS THROUGH THE SOO LOCKS
(SOURCE - DETROIT DISTRICT, U.S. ARMY CORPS OF ENGINEERS)

Vessels	Number of Vessels 1984-85	Number of Vessels 1985-86
U.S.	55	60
Canadian	133	108
Others	15	6
Total	203	174

TABLE 8

COMMODITIES CARRIED DURING THE 1984-85 AND
1985-86 EXTENDED NAVIGATION SEASONS THROUGH THE SOO LOCKS
(SOURCE - DETROIT DISTRICT, U.S. ARMY CORPS OF ENGINEERS)

Commodities Carried	Tonnage	
	1984-85	1985-86
Iron Ore	424,985	817,854
Manufactured Iron or Steel	9,205	
Wheat/Grain	826,113	987,475
Potash	265,866	296,347
Sunflower Seed	43,631	
Barley	98,210	
Scrap Iron	9,341	
Cement	32,389	
Mill Products	3,324	
Limestone	26,796	31,670
Misc. Products	5,278	52,320
Salt	11,647	
Coal		101,063
Total	1,756,785	2,286,729

Major shipping organizations that operate in the area include the Lake Carriers' Association, the International Association of Great Lakes Ports, and the Dominion Marine Association of Canada.

An extended navigation season will result in three principal savings to the involved shipping industries:

- a. The shippers will have a less costly water transportation alternative available for a longer period of the year, thus reducing the costs of transporting raw materials.
- b. Users of bulk commodities can reduce stockpile accumulations. The smaller stockpiles would result in smaller inventory investments and reductions in handling costs.
- c. The Great Lakes carriers can make more efficient use of their fleets. Vessels could spend less time in winter storage and more time carrying cargo.

However, significant difficulties that relate to winter navigation are the interference of ice with movement and maneuverability of vessels on the open lakes and in the connecting channels and harbors; hindrances to lock and channel operations; potential for damage to vessels, shore structures and the shoreline; and a variety of problems in navigation, vessel safety, traffic control, human needs and insurance rates.

3.3.2 Icebreaking Assistance

Icebreaking assistance in the Great Lakes region is provided by the U.S. Ninth Coast Guard District, the Canadian Coast Guard, and private firms. Icebreaking assistance may be required for winter navigation, ferry operation or flood control. This report concentrates on icebreaking assistance provided for winter navigation. The U.S. Coast Guard units are organized into four task groups for the performance of assigned icebreaking missions in the Great Lakes. These task groups along with their jurisdictional area and command are tabulated in Table 9.

Icebreaking assistance in the study area of this report is provided by the Operation Taconite group. According to needs for assistance, however, the Ninth Coast Guard District office can reassign the icebreakers from other operation groups.

Icebreakers assigned to the Operation Taconite group, with their normal deployment areas, are listed in Table 10.

TABLE 9

ICEBREAKING ASSISTANCE TASK GROUPS
(SOURCE: REFERENCE n)

Task Group Name	Jurisdictional Area	Command Unit
Operation Coal Shovel	Lake Huron from Alpena, MI southward through western Lake Erie including the St. Clair River, Lake St. Clair and Detroit River	Commander Coast Guard Group, Detroit
Operation Oil Can	Lake Michigan	Commander Coast Guard Group, Milwaukee
Operation Open Buffalo	Port of Buffalo and eastern Lake Erie	Commander Coast Guard Group, Buffalo
Operation Taconite	Lake Superior, St. Marys River, Straits of Mackinac and northern Lake Huron	Commander Coast Guard Group, Sault Ste. Marie

TABLE 10

OPERATION TACONITE ICEBREAKERS
(SOURCE: REFERENCES f and g)

Name/Class	SHP (Shaft Horse Power)	Area Normally Deployed
CGC Mackinaw (WGB83) Home Port: Cheboygan, MI	10,000	Straits of Mackinac, St. Marys River, Whitefish Bay, Lake Superior
CGC Biscayne Bay (WTGB 104) Home Port: St. Ignace, MI	2,500	Straits of Mackinac, Northern Lake Huron, St. Marys River
CGC Katmai Bay (WTGB 101) Home Port: Sault Ste. Marie, MI	2,500	Whitefish Bay, St. Marys River, Straits of Mackinac
CGC Mesquite (WLB 404) Home Port: Charlevoix, MI	1,200	Straits of Mackinac, Northern Lake Michigan, Green Bay

CGC (Coast Guard Cutter)

3.3.3 Navigation Aids

The conventional navigation aids such as buoys, ranges, lighthouses, channel markers, shore daymarks, and information services in the St. Marys River are provided and maintained by the U.S. Coast Guard. The effectiveness of these aids is, of course, dependent upon good visibility. Radio beacons (Racons) navigation aids are available at the entrance and at the mouth of the river in Whitefish Bay and Detour Passage, respectively. A Loran system in Lake Superior and Lake Huron provide additional navigation aids in the general area.

During extended season navigation, ice conditions make the use of normal buoys unacceptable. Summer buoys are removed from the waterways when ice cover begins to form. Ice cover tends to drag the buoy anchor off position and frozen spray on the buoy itself may eventually cause it to be unstable and capsize. During the winter period, most lighted floating aids to navigation are withdrawn from service and only major fixed aids and unlighted marker buoys remain to guide the vessels. A listing of the navigation aids can be found in the the Coast Guard Light List.

3.3.4 Effect on Stable Ice Cover

The extension of the navigation season in recent years has meant that vessels' tracks have been cut through stable ice cover. Sufficient data for the entire reach of the St. Marys River are not available for a detailed evaluation of the effects on ice cover.

In the St. Marys River system, the Whitefish Bay ice condition is heavily affected by the predominant northwesterly wind, whereas the protected reaches of the St. Marys River are not. Because it is not affected by wind, the channel tracks in the river remain fairly well defined and a stable ice sheet exists outside the channel.

To help stabilize the ice cover in Soo Harbor at Sault Ste. Marie, Michigan/Ontario and thus moderate ice problems in Little Rapids Cut, and to act as an aid to winter navigation, an ice boom with a 250-foot wide navigation channel opening is placed annually at the head of Little Rapids Cut. The boom system has been invaluable in stabilizing the ice cover in the Soo Harbor, and has utility independent of extended season navigation.

4. FACTORS AFFECTING EXTENDED SEASON NAVIGATION

4.1 Ice Conditions

4.1.1 Type and concentration

A variety of ice conditions occur on the St. Marys River system. These conditions vary from stable winter ice cover to open water. The coverage and thickness of ice in the river is affected by various elements, including air temperature, wind, cumulative freezing degree days, the presence or absence of the ice boom, and whether or not navigation is continuing.

At the upper end of the St. Marys River in Whitefish Bay, ice forms rapidly and the prevailing northwesterly wind jams and packs the lake ice in this area. An average thickness of 14 inches with a maximum thickness of more than 48 inches may be reached. Usually, thin ice develops in December increasing to 12-18 inches by mid-February and 24-30 inches in March (References b, g and o).

At the lower end of the river in Detour Passage, an average thickness of 17 inches with a maximum thickness of more than 48 inches may be reached.

In the protected reaches of the St. Marys River between the Soo Locks and the upper end of Lake Nicolet, average ice thickness ranges from 9.5 inches to 23 inches with a maximum of 28 inches (Reference e). The rest of the lower part of the St. Marys River follows more or less the same pattern of ice conditions. Because the St. Marys River is not much affected by wind, the channel track in the river remains fairly well defined and a stable ice sheet exists outside the channel. The broken pieces of ice accumulate on the edges of the shipping channels and may retard flow (becoming concentrated in bottleneck locations). In certain reaches of the river around mid-January, brash ice may accumulate up to four feet in thickness (Reference g).

4.1.2 Ice Jams

Under normal winter conditions, sufficient ice cover develops in Soo Harbor in late December to form an ice bridge at the head of Little Rapids Cut (a 600 foot wide channel between Sugar Island and the mainland of Michigan). Increased ice movement into the Little Rapids Cut is normally halted. On occasion, however, ice movement can interfere with ongoing ferry operations between Sugar Island and the mainland, block navigation in the channel, and increase chances of ice jams in the lower cut. To moderate these ice problems, an ice boom has been deployed to help stabilize the ice conditions in the Soo Locks and Little Rapids Cut, the most critical areas of the St. Marys River system for extended season navigation.

The placement of ice booms has helped to stabilize the ice cover above the Little Rapids Cut with less ice from Soo Harbor entering and building in the river below the cut, thereby reducing the amount of broken ice collecting on the edge of the Lake Nicolet ice field (Reference e).

The remainder of the system, upstream to Whitefish Bay, and downstream through Lake Nicolet and Lake Munuscong to Detour Passage, can remain open for extended periods given sufficient vessel traffic to keep navigation tracks open. However, when brash ice does develop, considerable vessel activity may be required under certain weather conditions to keep the vessel tracks open.

Ice bridges or ice jams, (due to transient ice formations) can have an effect on water elevation both upstream and downstream of the ice jam. The principal problems associated with this type of event (other than property damage) are (1) navigation impediments, principally in the area of the Sugar Island Ferry (upstream of Little Rapids Cut) and (2) potential effects on the power generation facilities at the St. Marys Falls.

5. SUMMARIES AND RESULTS OF ANALYSES

5.1 Summary

This study involved the collection, review, analyses, and presentation of existing information on weather, river discharge, and water levels, and ice formation, coverage and thickness data for the St. Marys River system. Time period of consideration is the proposed Extended Season operation of the Soo Locks for winter shipping to 31 January + 2 weeks. Data were collected, reviewed, and analyzed. Their period of record and presentation format are summarized below:

<u>Data Element</u>	<u>Period of Record</u>	<u>Presentation Format</u>
Wind Data	1969-1986 (Jan.-April)	Winter Wind Roses
Water Discharge Data	1900-1985	Average Annual & Monthly Mean Discharge Hydrographs
Water Level Data	1903-1985	Average Annual Stage Hydrograph
Ice Data	1969-1986 (Exclusive of 1981 and 1982)	Annual Ice Chart Summaries

5.2 Collection of Data

Contacts were made with appropriate agencies for the pertinent data. A listing of some of the contacts made and data obtained follows:

a. Wind data were obtained from National Climatic Data Center, Federal Building, Asheville, North Carolina, 28801-2696.

b. River discharge and water level data were obtained from River Flows Section, Great Lakes Hydraulics and Hydrology Branch, Detroit District, U.S. Army Corps of Engineers.

c. Ice data: Actual aerial photos were obtained from the Great Lakes Hydraulics and Hydrology Branch, Detroit District, U.S. Army Corps of Engineers. Supplemental information and ice charts were obtained from the National Snow and Ice Data Center, Boulder, Colorado, 80302, and also from available reports.

d. Other data relating to icebreaking, vessel operation, and aids to navigation were obtained from the U.S. Coast Guard at Sault Ste. Marie, Michigan.

5.3 Results of Analyses

5.3.1 Wind

The wind data required to be analyzed for the study area include

the winter periods (for the months of January to April) 1969 to 1986. The wind observation station nearest to the study area is the National Weather Service station #14847 at Sault Ste. Marie, Michigan, located at the City-County Airport. The wind data available for the station are on a 3-hourly basis except for the periods of 1973-1977 and 1982-1986, for which hourly data are available. For uniformity, wind data on a 3-hourly basis were requested from the National Climatic Data Center for the Sault Ste. Marie Station for the entire period of record under consideration. Data were obtained in a machine-readable form and processed by computer. Data available included wind direction (in tens of degrees from north) and wind speed (as whole numbers in knots). Data received in 18 files (one for each year) were combined in one file and then analyzed, using a relational data base program. A total of 17312 data records were analyzed using sorting and counting routines.

Analyses included:

- a. Grouping the wind data according to 16 compass directions into wind speed groups of calm, 0-3, 4-12, 13-15, 16-18, 19-24, 25-31 and greater than 31 knots.
- b. Frequency of occurrence of each compass direction according to speed group and mean speed.
- c. Extreme speed according to 16 compass directions.
- d. Mean of extreme annual speed according to 16 compass directions.

Results of the analyses are presented in Table 11 as wind tabulation and on Figure 3 as winter wind roses. Three wind roses are presented. One gives the frequency distribution by direction and the mean velocity. The second gives the mean maximum 3-hourly wind velocity by direction and the third gives the extreme maximum 3-hourly wind speed by direction.

The wind roses show that winds are predominantly from the NW occurring 18.9 percent of the time at an average speed of 10 knots, (or 11.2 mph). The maximum value of the mean maximum 3-hourly wind is 26 knots (29.9 mph) from the NW with the extreme value of the maximum 3-hourly wind being 34 knots (39.1 mph) from the SW.

Computer printouts of the wind data analyses are included in Appendix A.

5.3.2 River Discharge and Water Levels

The St. Marys River discharge and water level data for the period 1900 to 1985 were obtained from the River Flows Section, Great Lakes Hydraulics and Hydrology Branch, Detroit District, U.S. Army Corps of Engineers. Average annual mean discharge of the St. Marys River for the period of record is presented in tabular form in Table 12 and graphical form on Figure 4. The highest annual mean discharge of 109,000 cfs was in the year 1951 with an average monthly highest discharge

TABLE 11

WIND TABULATION
SAULT STE. MARIE #14847
1969-1986 (JAN. TO APRIL)

Direction	Speed Group Knots												Total	Av. Wind Speed Knots (1 Knot = 1.15 Miles)		
	0-3		4-12		13-15		16-18		19-24		25-31				Greater Than 31	
	No. of Obs.	Frequency	No. of Obs.	Frequency	No. of Obs.	Frequency	No. of Obs.	Frequency	No. of Obs.	Frequency	No. of Obs.	Frequency				
N	39	.2	421	2.4	77	.5	14	.1	3	0	0	0	0	554	3.2	3
NNE	54	.3	599	3.5	78	.5	8	0	3	0	0	0	0	742	4.3	8
NE	51	.3	331	1.9	31	.2	4	0	1	0	0	0	0	418	2.4	7
ENE	116	.7	622	3.6	29	.2	8	0	0	0	0	0	0	775	4.5	6
E	236	1.4	1575	9.1	88	.5	25	.2	7	0	1	0	0	1932	11.2	6
ESE	187	1.1	1698	9.8	337	1.9	123	.7	32	.2	0	0	0	2377	13.7	9
SE	126	.7	747	4.3	86	.5	28	.2	6	0	1	0	0	994	5.7	7
SSE	83	.5	383	2.2	23	.1	3	0	1	0	0	0	0	493	2.8	6
S	89	.5	306	1.8	15	.1	3	0	0	0	0	0	0	413	2.4	5
SSW	51	.3	284	1.7	18	.1	5	0	1	0	0	0	0	359	2.1	6
SW	70	.4	513	2.9	51	.3	15	.1	10	.1	2	0	1	662	3.8	8
WSW	77	.4	624	3.6	64	.4	10	.1	6	0	0	0	0	781	4.5	7
W	99	.6	535	3.1	37	.2	11	.1	4	0	1	0	0	687	4.0	7
WNW	66	.4	815	4.7	156	.9	79	.5	54	.3	4	0	0	1174	6.8	9
NW	143	.8	2125	12.3	606	3.5	264	1.5	108	.6	30	.2	1	3277	18.9	10
NNW	57	.3	587	3.4	117	.7	30	.2	15	.1	1	0	0	807	4.7	9
Calms														867	5.0	
Total														17312	100.0	

TABLE 12

AVERAGE ANNUAL DISCHARGE (THOUSAND CFS)
OF THE ST. MARYS RIVER (1900-1985)

<u>Year</u>	<u>Discharge</u>	<u>Year</u>	<u>Discharge</u>	<u>Year</u>	<u>Discharge</u>	<u>Year</u>	<u>Discharge</u>
1900	82	1925	62	1950	97	1975	82
1901	78	1926	54	1951	109	1976	71
1902	69	1927	76	1952	93	1977	71
1903	72	1928	87	1953	94	1978	85
1904	79	1929	73	1954	84	1979	88
1905	82	1930	64	1955	65	1980	77
1906	82	1931	51	1956	70	1981	73
1907	79	1932	61	1957	61	1982	71
1908	76	1933	58	1958	64	1983	89
1909	66	1934	77	1959	78	1984	86
1910	63	1935	89	1960	85	1985	86
1911	56	1936	76	1961	64	1900- 1985	Average Mean 76
1912	62	1937	68	1968	63		
1913	70	1938	91	1963	62		
1914	70	1939	91	1964	84		
1915	71	1940	60	1965	96		
1916	94	1941	68	1966	84		
1917	84	1942	73	1967	79		
1918	67	1943	95	1968	93		
1919	57	1944	80	1969	96		
1920	72	1945	83	1970	76		
1921	55	1946	75	1971	102		
1922	47	1947	89	1972	99		
1923	54	1948	67	1973	76		
1924	53	1949	64	1974	78		

of 127,000 cfs in August 1951. The lowest annual mean discharge of 47,000 cfs was in the year 1922 with an average monthly lowest discharge being 42,000 cfs in September 1926. The long-term annual average discharge of the St. Marys River for the period of record was 76,000 cfs. The highest long-term monthly discharge of 84,000 cfs was in August and September. The lowest long-term discharge of 66,000 cfs was in March. Of particular interest for this report are the discharges for the months of January and February. Monthly mean discharges of the St. Marys River (1900-1985) for the months of January and February are presented in Table 13 and on Figure 5. The long-term monthly mean discharges for the months of January and February are 68,000 cfs and 67,000 cfs, respectively. The highest monthly mean discharges for the months of January and February were 93,000 cfs in 1971 and 92,000 cfs in 1969, respectively. The lowest monthly mean discharges were 44,000 cfs and 45,000 cfs in 1912, respectively.

The water levels of the Great Lakes depend on the water balance between the quantity of water entering and leaving the lakes. Short-term local water level fluctuations, lasting from a few hours to several days, may occur due to meteorological disturbances in the form of winds, and differences in barometric pressure.

Lake Superior's water level has been regulated since 1921. Since then, several control plans have been in effect for determining the outflow. Beginning in October 1979, the outflow has been determined in accordance with Regulation Plan 1977 described in detail in "Regulation of Lake Superior, Plan 1977. Report to the International Joint Commission by the International Lake Superior Board of Control, May 1981". Plan 1977 was designed to satisfy the Orders of Approval issued by the International Joint Commission to provide benefits on a system-wide basis. The Regulation Plan calls for the manipulation of Lake Superior outflows (withir certain maximum and minimum limitations) in such a manner as to keep the levels of Lakes Superior and Michigan-Huron at the same relative position with respect to their long-term monthly means. To accomplish this, a relationship was developed between the Lake Superior outflow, and the Lakes Superior and Michigan-Huron beginning-of-month water levels. The Plan also employs a forecast of future outflows to minimize the number of gate movements in the Compensating Works and to maintain a relatively steady flow in the St. Marys River.

Monthly mean water levels of the Great Lakes (1900-1983) are shown on Figure 6 and long term fluctuations of the Great Lakes water levels are shown on Figure 7.

Average annual water levels of the St. Marys River for the period 1903-1985 are presented on Figure 8. The highest average annual water level for the period of record was 581.84 in 1952. The lowest average annual water level was 577.78 in 1963.

Of particular interest for this report are the water levels of the St. Marys River for the months of January and February. The highest monthly mean water levels for the months of January and February were 582.45 in 1917 and 582.42 in 1985, respectively. The lowest monthly mean water levels were 577.26 and 577.76 in 1964, respectively.

TABLE 13

MONTHLY MEAN DISCHARGES (THOUSAND CFS)
OF THE ST. MARYS RIVER (1900-1985)
FOR JANUARY AND FEBRUARY

<u>Year</u>	<u>Discharge</u>		<u>Year</u>	<u>Discharge</u>		<u>Year</u>	<u>Discharge</u>		<u>Year</u>	<u>Discharge</u>	
	Jan.	Feb.		Jan.	Feb.		Jan.	Feb.		Jan.	Feb.
1900	79	77	1925	55	54	1950	63	66	1975	87	85
1901	79	75	1926	59	57	1951	82	80	1976	70	69
1902	66	62	1927	72	72	1952	84	82	1977	61	61
1903	64	61	1928	75	75	1953	74	72	1978	78	77
1904	72	68	1929	69	55	1954	74	72	1979	68	67
1905	78	71	1930	55	55	1955	62	62	1980	75	75
1906	82	76	1931	49	51	1956	74	74	1981	67	67
1907	74	71	1932	53	58	1957	67	66	1982	45	45
1908	75	70	1933	49	47	1958	71	71	1983	81	82
1909	67	61	1934	58	60	1959	66	67	1984	81	76
1910	67	63	1935	70	62	1960	74	72	1985	70	70
1911	55	50	1936	65	65	1961	67	67			
1912	56	54	1937	64	64	1962	64	65			
1913	62	60	1938	62	62	1963	62	65	Mean	68	67
1914	70	69	1939	62	63	1964	59	68			
1915	67	67	1940	64	65	1965	86	84			
1916	71	70	1941	62	62	1966	77	77			
1917	89	86	1942	83	67	1967	71	72			
1918	66	64	1943	60	64	1968	69	69			
1919	58	56	1944	68	58	1969	83	92			
1920	60	59	1945	75	74	1970	68	83			
1921	56	57	1946	74	74	1971	93	83			
1922	44	45	1947	75	75	1972	81	73			
1923	50	51	1948	76	75	1973	75	57			
1924	54	53	1949	57	57	1974	76	75			

5.3.3 Ice Conditions

The first step in the summarization of ice data for the St. Marys River system was centered around the analysis of oblique aerial photographs taken in the 1969-1986 time period except for the years 1981 and 1982. These were taken at various locations along the waterway. The time coverage of the aerial photographs for the St. Marys River System is shown in Table 14.

TABLE 14

TIME COVERAGE OF THE AERIAL PHOTOGRAPHS FOR THE ST. MARYS RIVER SYSTEM ICE CONDITIONS

Period 1969-1986 (Excluding 1981 and 1982)
Jan. 1 to Feb. 15 +

Years	Weeks						
	1	2	3	4	5	6	7
	Jan 1-7	Jan 8-14	Jan 15-21	Jan 22-28	Jan 29 Feb 4	Feb 5-11	Feb 12-18
1969	1-7			1-25			2-13
1970			1-18				
1971		1-12		1-23		2-7	
1972			1-17&19	1-28	1-31&2-1	2-7	
1973	1-3	1-8	1-20		1-30		
1974	1-4	1-12			2-1&5	2-9	
1975			1-20	1-22	1-31	2-11	
1976		2-8					
1977			2-15				
1978	1-3	1-12		1-27	2-2	2-7	2-13
1979	1-5	1-10	1-18	1-28		2-9	2-17
1980	1-3		1-15		1-29	2-6	
1983						2-9	
1984			1-18			2-8	2-16
1985	1-3		1-15	1-28			
1986	1-3	1-13			1-31		

The oblique aerial photographs were used for ice cover estimation of the St. Marys River. While points of reference were easily identified between the photographs and points along the system map for ice cover estimation, ice thickness was difficult to ascertain with accuracy. The depth problem (or ice thickness) was made difficult because of a lack of "ground truth" data with which to calibrate the visual observations. Nonetheless, these photographs were used as the main data source for the ice charts. Comparison to other published records (discussed in the following pages) did substantiate most of the interpretations, providing the ground truth. Specific use of published data is explained in detail in later paragraphs. As no scale controls were available, the extent of ice coverage was estimated based on visual observation of the aerial photographs, since the use of such tools as a planimeter was infeasible. However, these over-flights were made during the

months of January and February when the ice coverage was already established and areal coverage of the ice was almost complete. The only coverage question dealt with the appropriate measure of coverage to assign in cases where on-going navigation was obviously responsible for ice breakup in many of the photographs. Many of the nine tenths scores on the ice charts reflect the results of continual vessel activity along the waterway. In the absence of vessel activity, the score would have been ten tenths in the majority of the cases.

The location of aerial views (for determining location or reach) was done using the lake survey charts by NOAA "Soundings in Feet, United States-Great Lakes, Michigan". The following specific charts were used:

14882 - St. Marys River - Detour Passage to Munuscong Lake;

14883 - St. Marys River - Munuscong Lake to Sault Ste. Marie;

and 14884 - St. Marys River - Head of Lake Nicolet to Whitefish Bay.

For ice chart summaries, the St. Marys River system was divided into the following reaches:

Whitefish Bay
Upper St. Marys River
Soo Harbor
Little Rapids Cut
Lake Nicolet
Middle Neebish Channel
Lake Munuscong
and Detour Passage

These are indicated, along with approximate river miles, on the ice charts. The zero river mile was established at the Soo Locks (as indicated on Figure 2).

The ice charts prepared from photo interpretation were compared to the records from the following three reports:

- "Ice Thickness and Stratigraphy at Nearshore Locations on the Great Lakes (English Units)", Frederick E. Sleator, Great Lakes Environmental Research Laboratory, Ann Arbor, Michigan, July, 1978, NOAA Data Report ERL GLERL-1-1. (Covers the entire Great Lakes for the period 1969-77).
- "Summary of Great Lakes Weather and Ice Conditions, Winter 1978-79", B.H. De Witt, et al, Great Lakes Environmental Research Laboratory, Ann Arbor, Michigan, August, 1980. (Covers the entire Great Lakes for the period 1978-79).

- "Operations and Studies, St. Marys River, Soo Harbor and Little Rapids Cut Ice Conditions and Ice Boom Operations, winter of 1984-85", Detroit District, Corps of Engineers, December 1985. (Covers the Soo Harbor and Little Rapids Cut reaches for the period 1969-85).

While numerous other publications were reviewed for content and applicability (References b, g and k in particular), these three publications played vital roles in the comparison of interpretation of the oblique aerial photographs and creation of the ice charts for the St. Marys River system, specifically. The first two publications were used at this first stage of interpretation because of their broader geographic coverage, giving some uniform ground truth measure of ice thickness along the entire length of the St. Marys River system. The third report was used for comparison of the ice conditions (both coverage and thickness) for the specific reaches of the St. Marys River in the vicinity of Little Rapids Cut.

These sources provided valuable ground truth information for the verification of photo interpretations. In fact, they were generally supportive of the interpretations made, with a few exceptions, and ice chart scores were modified to reflect ice observations from these secondary sources. The modifications made were of a minor nature. One station, station 314 at Detour Passage, was almost contradictory in many cases. While the photographs indicated open water in the waterway, the published ice data from the secondary sources indicated significant winter ice build-up. It was assumed that this discrepancy was due to location of the measurement station (as many stations are near-shore and not indicative of the main body of the channel). In those cases, secondary data sources were ignored and ice conditions estimated from the aerial photographs were used. This provides a better measure of channel conditions.

With the exception of Detour Passage, the Sleator publication supported the visual observations made using the photographs for the periods covered. Ice condition codes normally reflected mature ice coverage (mainly codes 6 and 7) and visual codes supported almost consistent winter ice build-up along the shore, once again indicating that the overflights were performed during periods when the ice formation was almost complete and the transition stages of freezing were over.

Following the comparison of the photo interpretations to the thickness data, ice charts were obtained for the St. Marys system from the National Snow and Ice Data Center, Boulder, Colorado, operated for the National Environmental Satellite Data and Information Service, NOAA, by the Cooperative Institute for Research in Environmental Sciences, University of Colorado. These ice charts cover the period from 1974 to 1984. They reflect the NOAA-NWS and U.S. Coast Guard observations. These charts were used for further comparison of the observations made using the photographs. That gave some additional controls or cross checks on the interpretations. In most cases, the observations were confirmed. In some cases, observations/interpretations on ice thickness were modified based on these ice charts, but, in an overwhelming number

of cases, the different data sources continued to be complementary. Information on percent of ice coverage was almost identical, the only exception being the thickness data at Detour Passage, discussed in preceding paragraphs.

The results of these efforts are shown as the Annual Ice Chart Summaries on Figures 9-24. The basic ice charts reflect the results of the interpretation of the aerial photographs for the reaches and the period of coverage. The first set of overlays reflects the findings from the secondary sources, not covered by the aerial photographs. The second set of overlays for the years 1969, 1970, 1971, 1972 and 1986 reflects interpolation/extrapolation of the missing data from both the aerial photographs and the secondary data sources.

6. REFERENCES

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- b. "United States Coast Pilot 6, Great Lakes: Lakes Ontario, Erie, Huron, Michigan and Superior and St. Lawrence River", U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service, April 1986.
- c. "Captain of the Port Sault Ste. Marie, Michigan, Sub-regional Oil and Hazardous Substances Contingency Plan", U.S. Coast Guard, March 1986.
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- i. "St. Marys River Oil/Toxic Substance Spill Study, Current Velocities and Directions 1980-1983", Detroit District, Corps of Engineers December 1984.
- j. "Report 6-St. Marys River Ferry Study", Passenger Transportation Planning Section, Michigan Department of Transportation, September 1984.
- k. "Great Lakes Ice Atlas", NOAA, Great Lakes Environmental Research Laboratory, July 1983.

l. "Regulation of Lake Superior Plan 1977 Development, Description and Testing", Report to the International Joint Commission by the International Lake Superior Board of Control, May 1981.

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n. "Ninth Coast Guard District Ice Breaking Operations Plan Annex to CCGDNINE Operation Plan NR1-(FY)", November 1978.

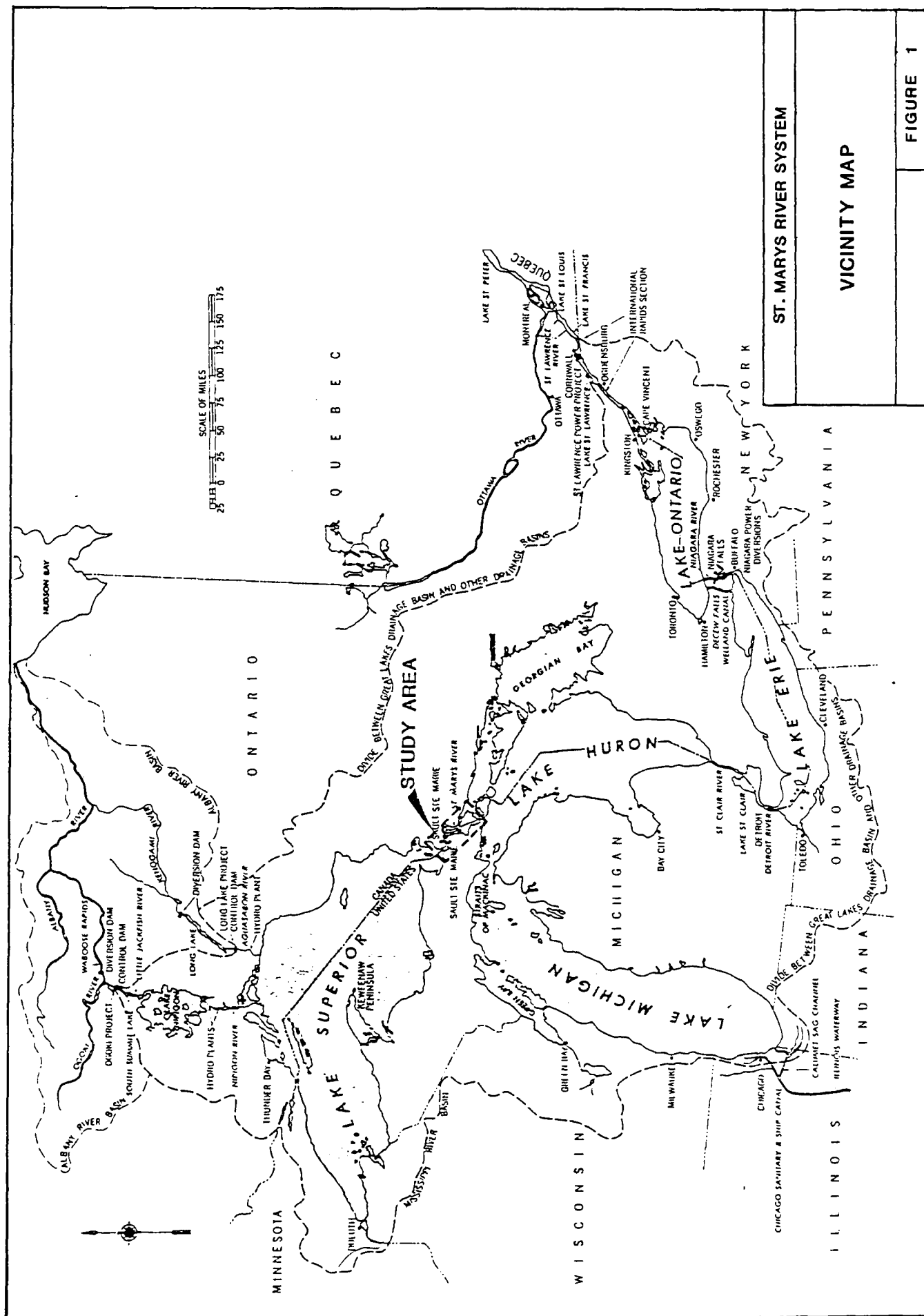
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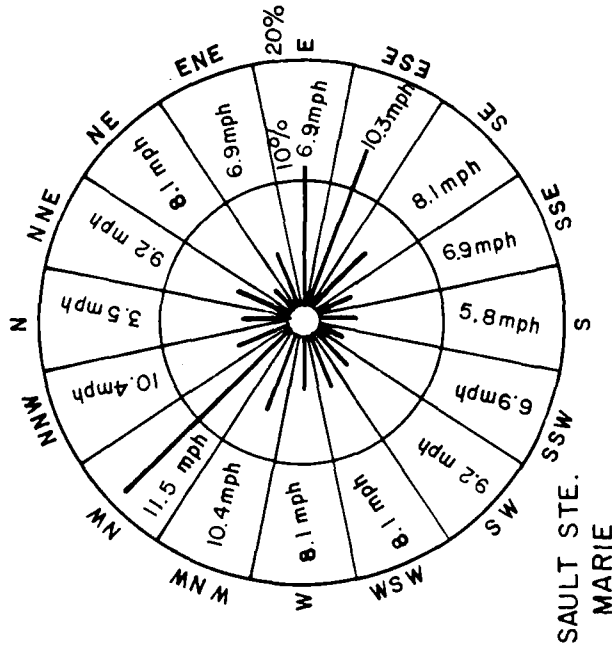
s. "Great Lakes Basin Framework Study," by Great Lakes Basin Commission, 1971.



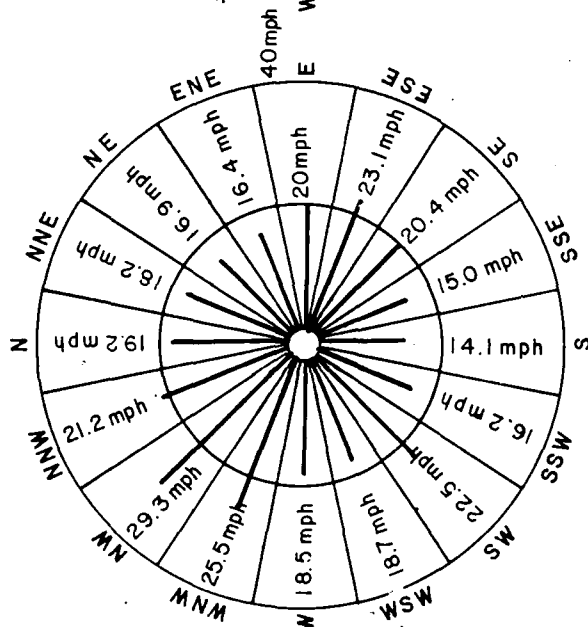


303

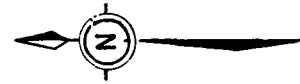
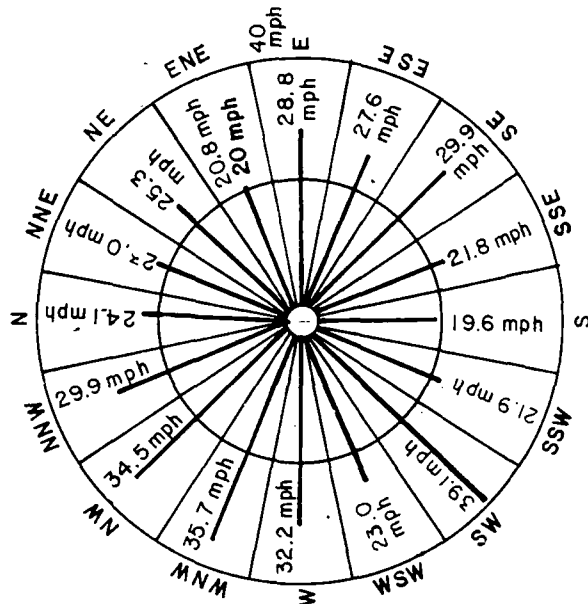
FREQUENCY AND MEAN VELOCITY



MEAN MAXIMUM VELOCITY



EXTREME MAXIMUM VELOCITY



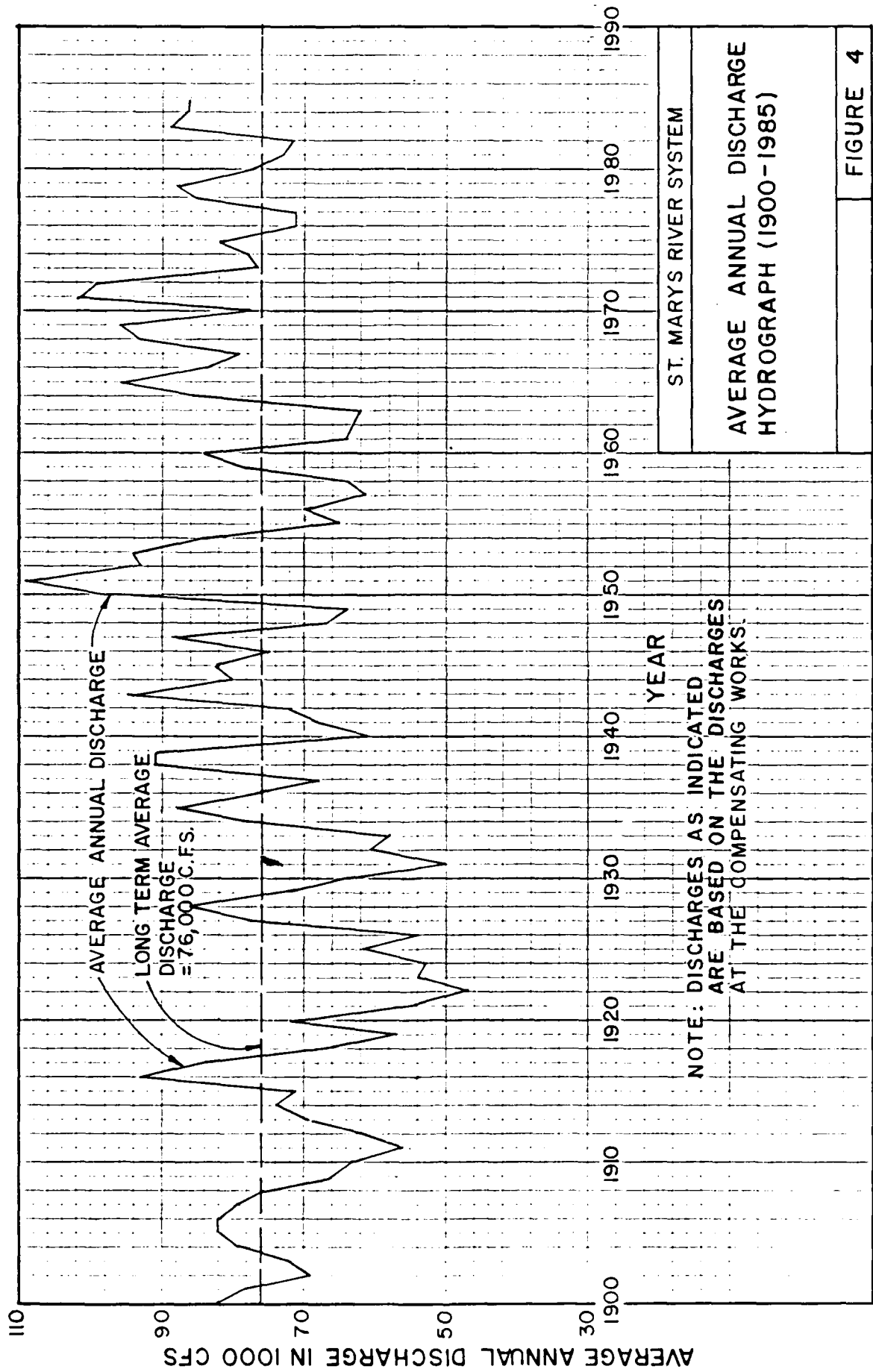
NOTES:

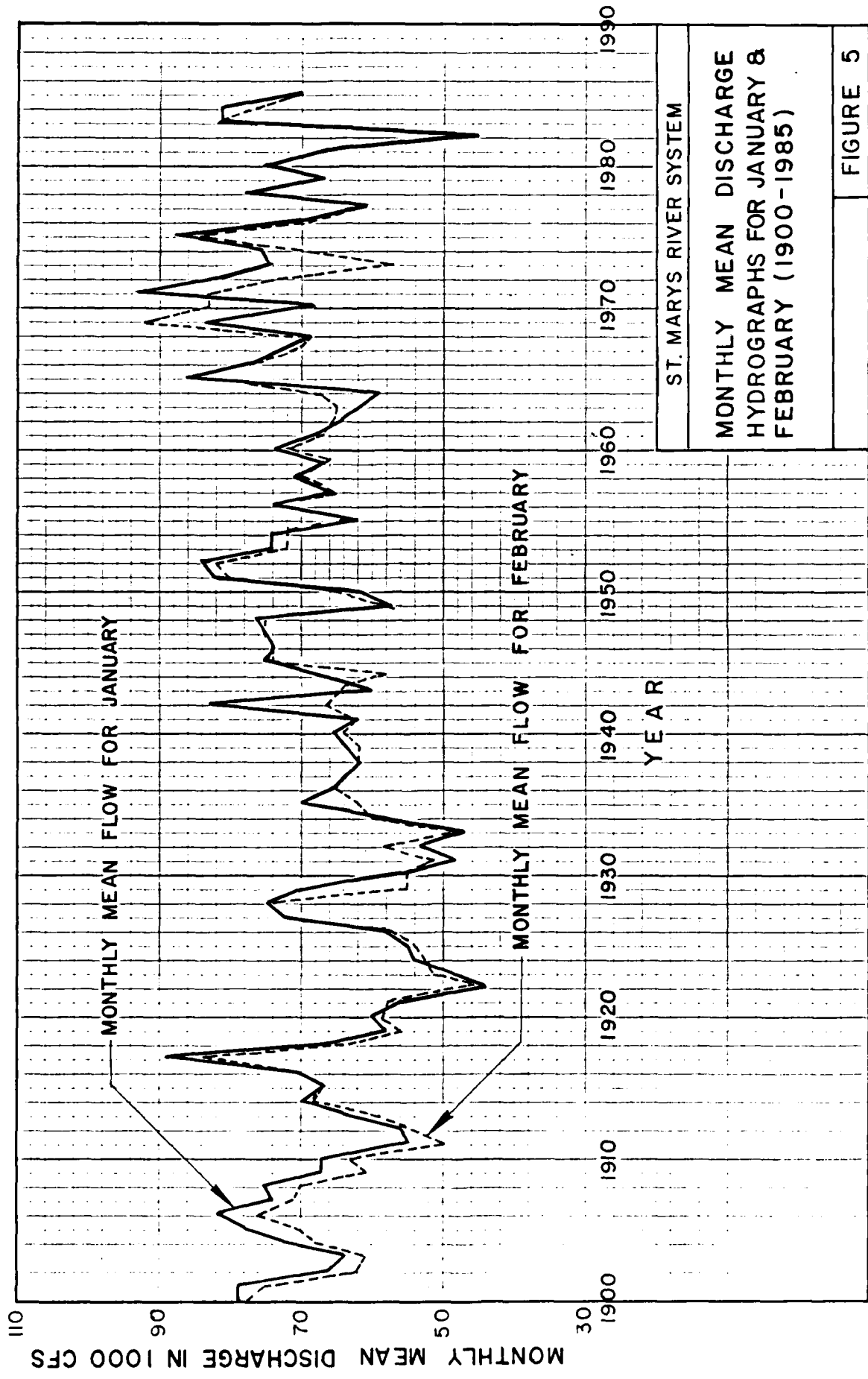
1. PERIOD OF RECORD 1969 - 1986 (3 HOURLY)
SAULT STE. MARIE STATION NO. 14847
2. DATA FOR THE MONTHS OF JANUARY, FEBRUARY, MARCH, APRIL WERE USED FOR THE CONSTRUCTION OF THE WIND ROSE.
3. THE MEAN MAXIMUM VELOCITY IS THE AVERAGE OF THE MAXIMUM THREE HOUR VELOCITIES FOR EACH YEAR OF RECORD, WITH THE EXTREME MAXIMUM VELOCITY BEING THE LARGEST THREE HOUR VELOCITY FOR THE PERIOD.
4. 5% OF THE OBSERVATIONS WERE CALM.

ST. MARYS RIVER SYSTEM

WINTER WIND ROSES

FIGURE 3





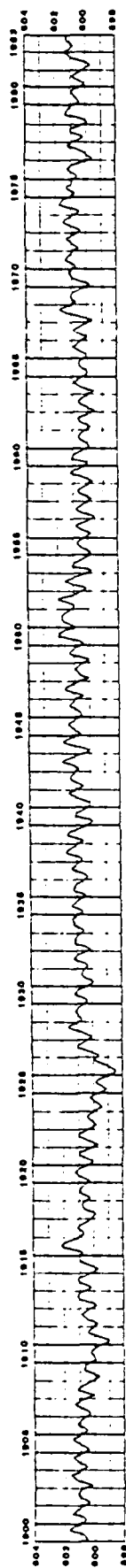
ST. MARYS RIVER SYSTEM

MONTHLY MEAN DISCHARGE
HYDROGRAPHS FOR JANUARY &
FEBRUARY (1900-1985)

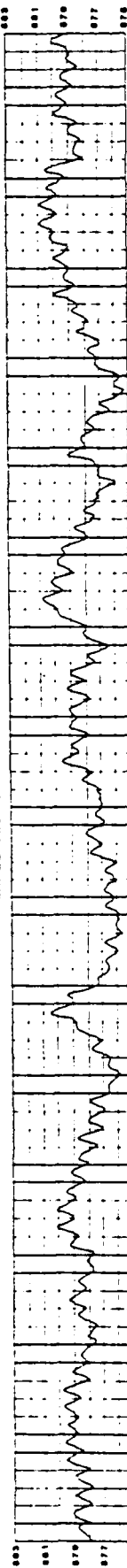
FIGURE 5

MONTHLY MEAN WATER LEVELS OF THE GREAT LAKES 1900-1983

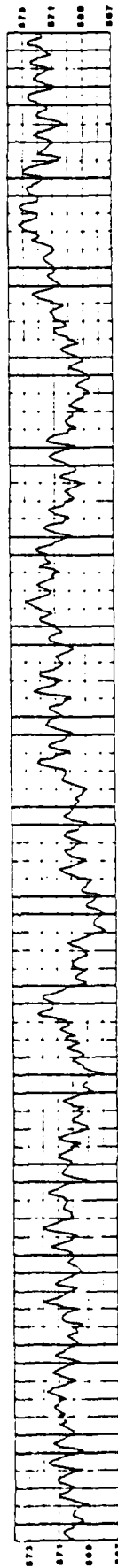
LAKE SUPERIOR



LAKE MICHIGAN-HURON



LAKE ERIE



LAKE ONTARIO

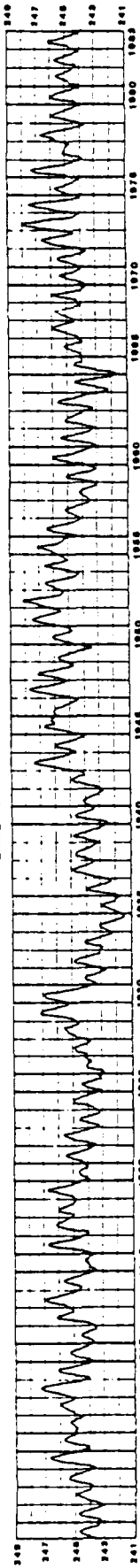


FIGURE 6

LONG TERM FLUCTUATIONS

ANNUAL AVERAGE GREAT LAKES WATER LEVELS

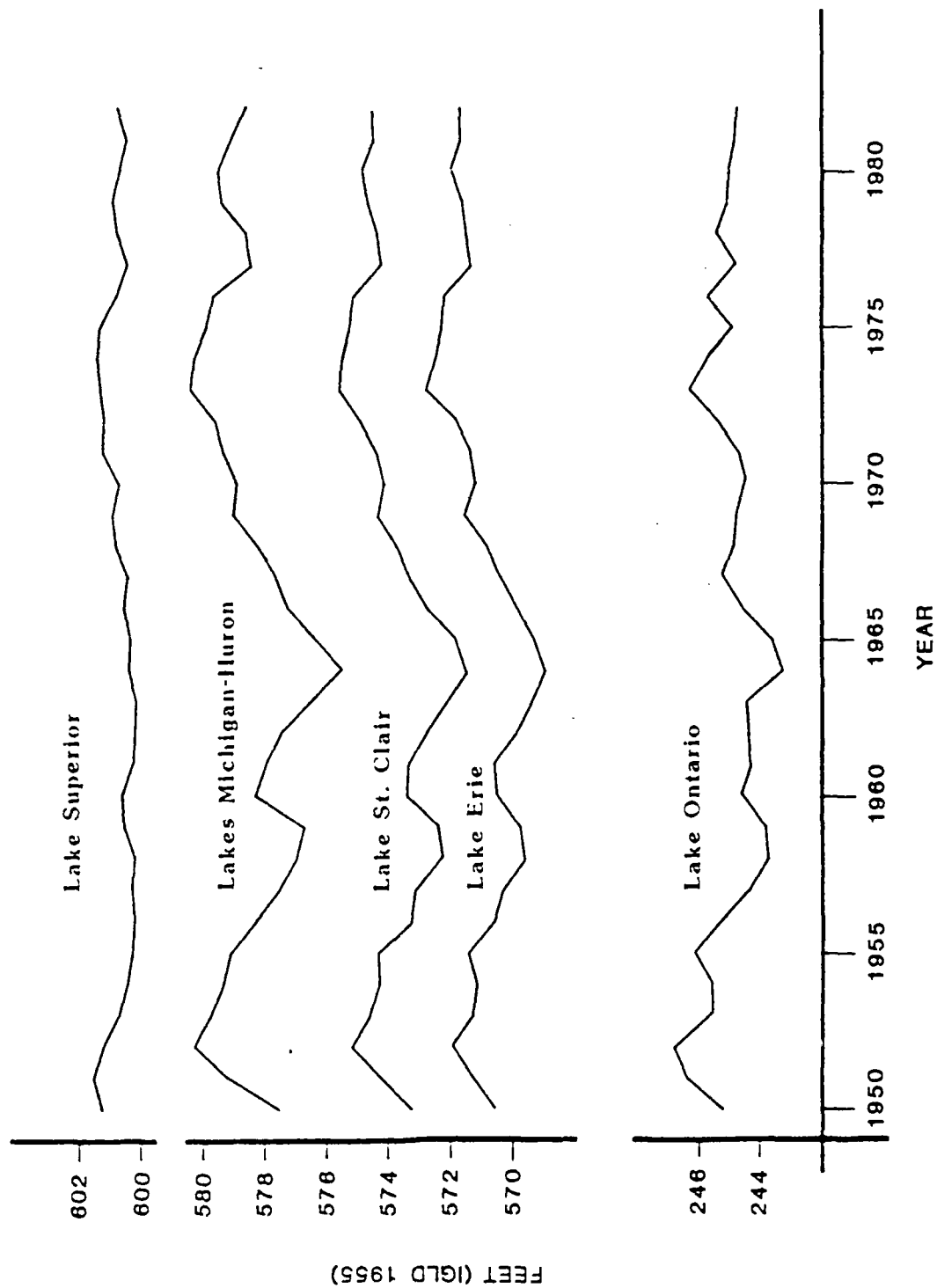
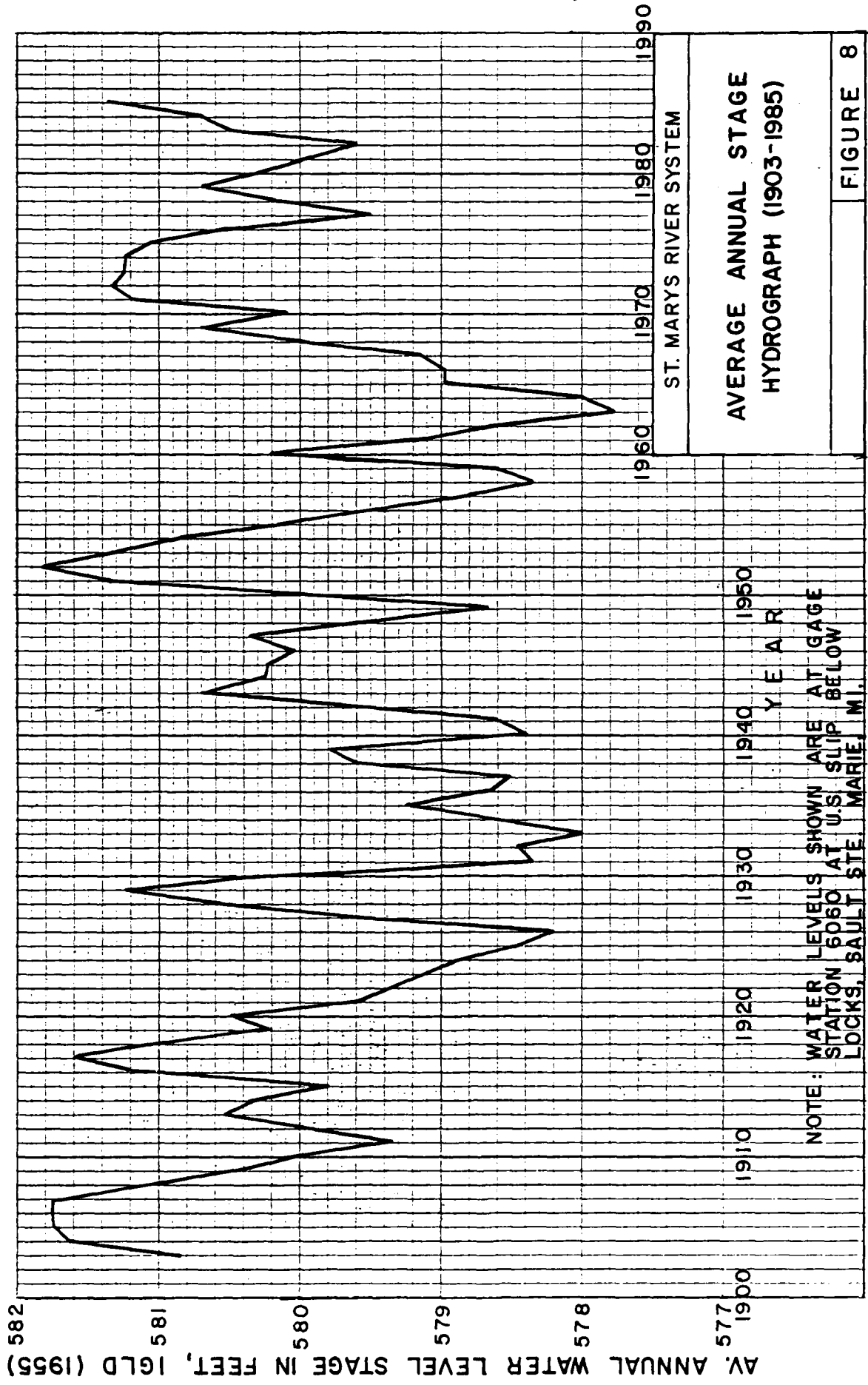
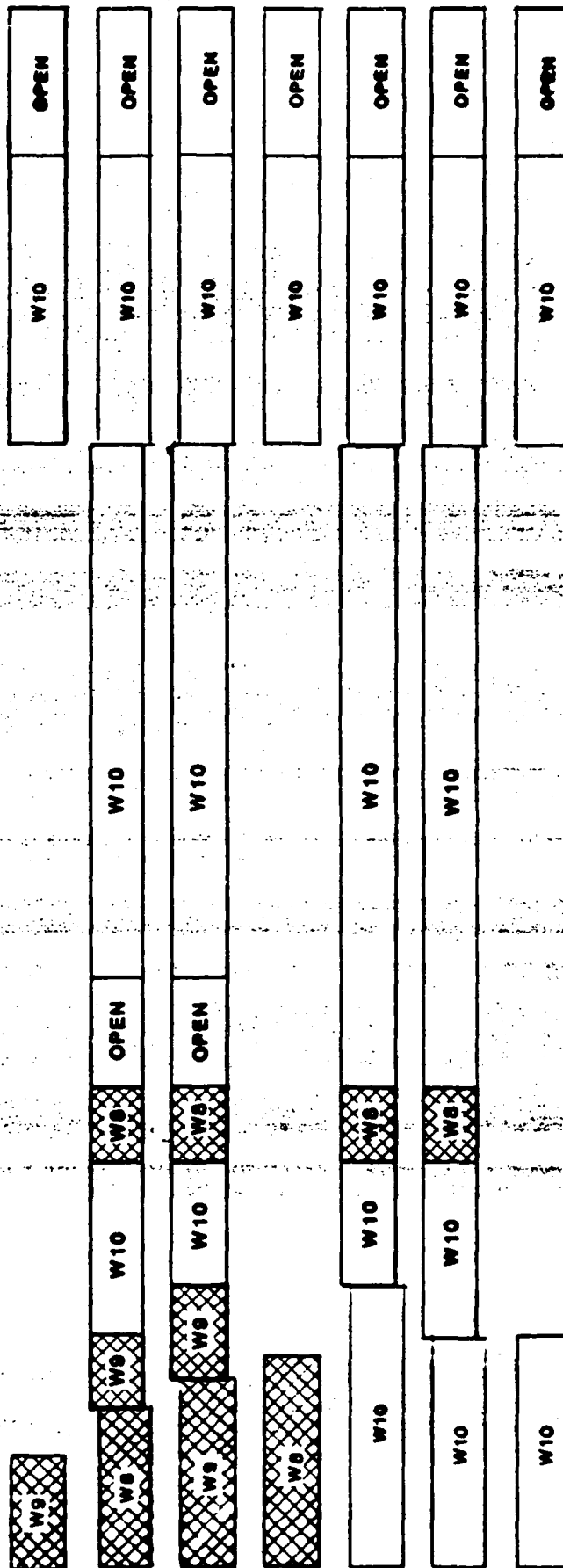
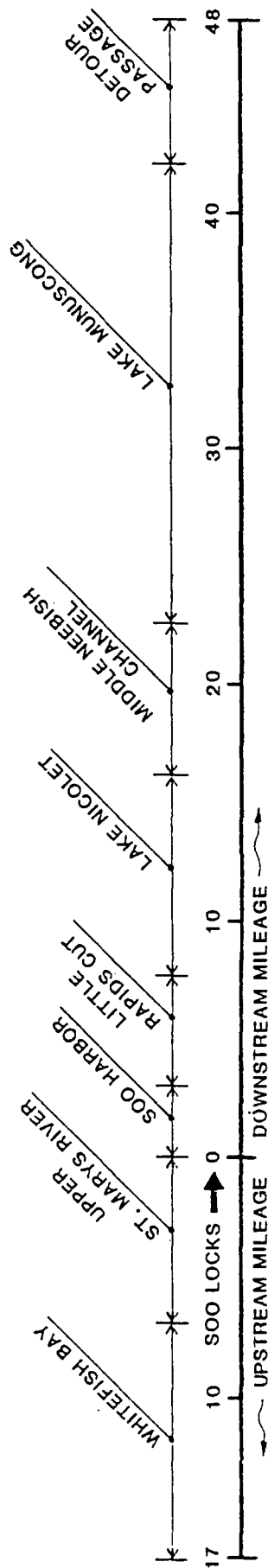


FIGURE 7





1969 ANNUAL ICE CHART SUMMARY



JAN 7

JAN 14

JAN 21



JAN 28

FEB 4



FEB 11

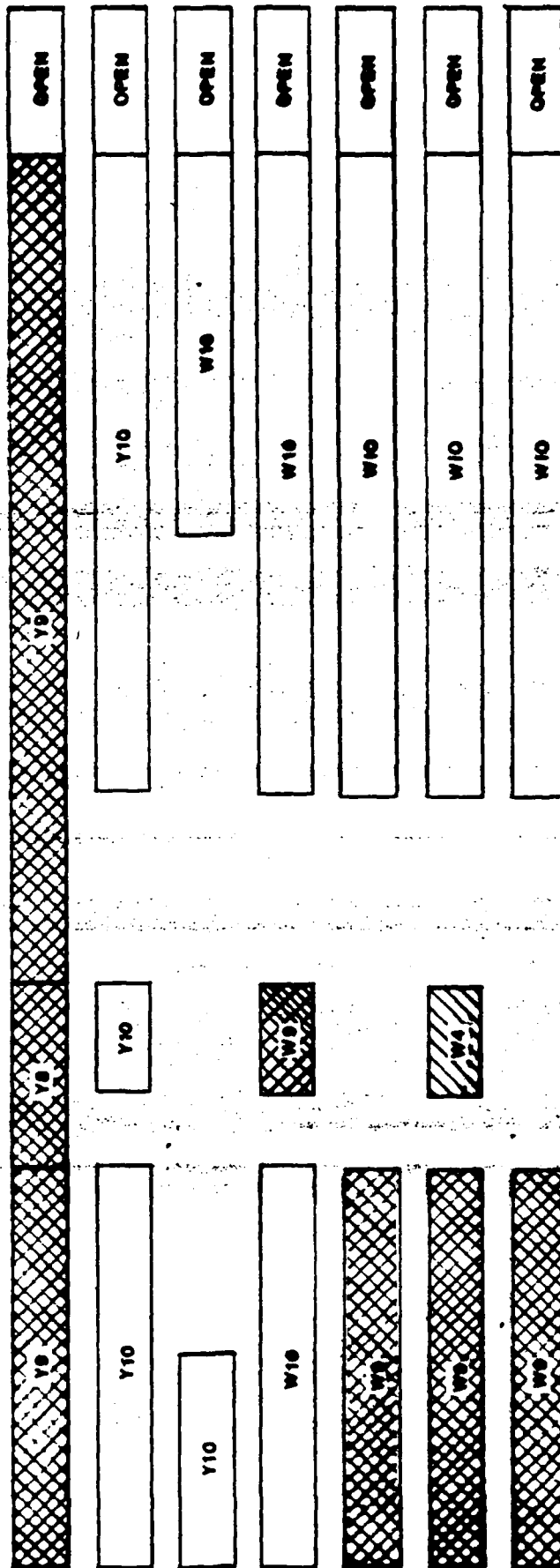
LEGEND

- Y - YOUNG ICE, 2" - 7" THICK
- W - WINTER ICE GREATER THAN 7" THICK
- BR - BRASH ICE
- OPEN - OPEN WATER
- SUBSCRIPTS - ICE CONCENTRATIONS IN TENTHS
- BLANK AREAS - NO OBSERVATIONS
- 10/10 CONCENTRATION
- 7/10 TO 9/10 CONCENTRATION
- 4/10 TO 6/10 CONCENTRATION
- 1/10 TO 3/10 CONCENTRATION

ST. MARYS RIVER SYSTEM

1969
ANNUAL ICE CHART SUMMARY

FIGURE 9



Y10

Y10

W7

W10

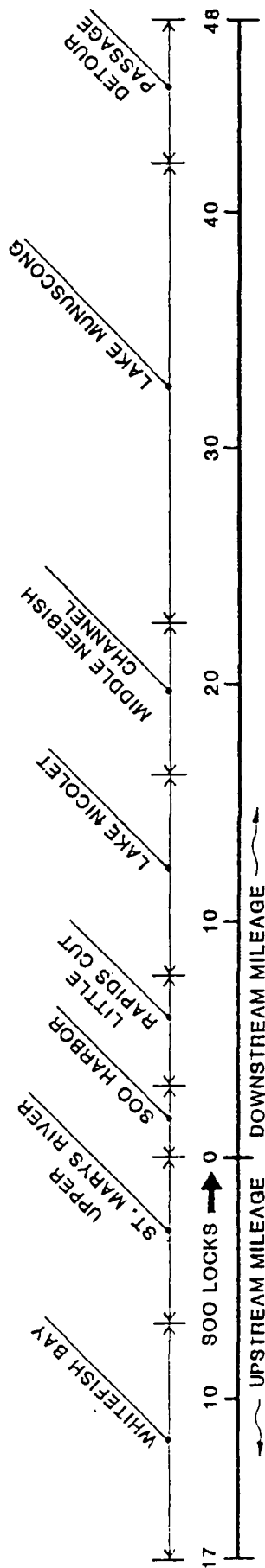
W7
W4
W8

W8

W7

W8
W7

1970 ANNUAL ICE CHART SUMMARY



JAN 7

JAN 14

JAN 21

JAN 28

FEB 4

FEB 11

FEB 18

WEEK OF



LEGEND

- Y - YOUNG ICE, 2'-7" THICK
- W - WINTER ICE, GREATER THAN 7" THICK
- BR - BRASH ICE
- OPEN - OPEN WATER
- SUBSCRIPTS - ICE CONCENTRATIONS IN TENTHS
- BLANK AREAS - NO OBSERVATIONS

10/10 CONCENTRATION

7/10 TO 9/10 CONCENTRATION

4/10 TO 6/10 CONCENTRATION

1/10 TO 3/10 CONCENTRATION

ST. MARYS RIVER SYSTEM

1970
ANNUAL ICE CHART SUMMARY

FIGURE 10

OPEN	Y4	Y7	OPEN
------	----	----	------

Y9

Y9	OPEN
----	------

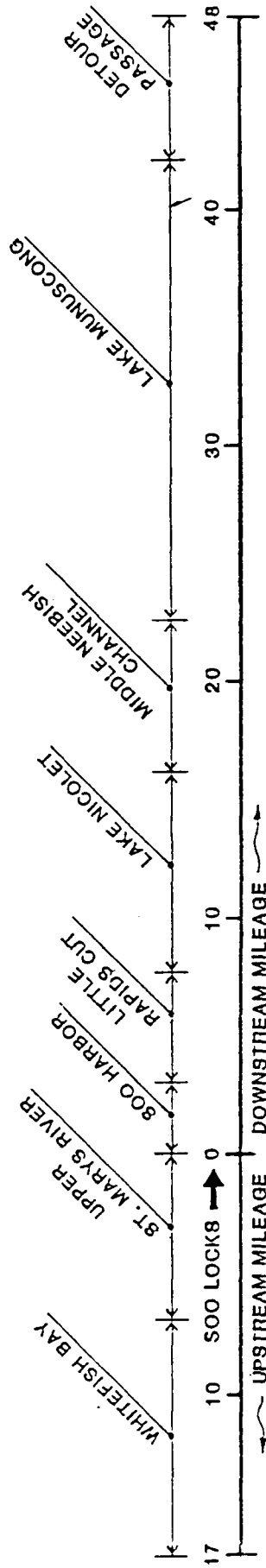
W10	OPEN
-----	------

Y9

Y9	OPEN
----	------



1971 ANNUAL ICE CHART SUMMARY



JAN 7

JAN 14

JAN 21

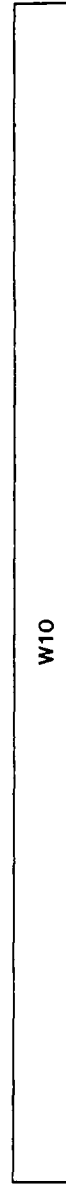
JAN 28

FEB 4

FEB 11

FEB 18

WEEK OF



LEGEND

- Y - YOUNG ICE, 2" - 7" THICK
- W - WINTER ICE, GREATER THAN 7" THICK
- BR - BRASH ICE
- OPEN - OPEN WATER
- SUBSCRIPTS - ICE CONCENTRATIONS IN TENTHS
- BLANK AREAS - NO OBSERVATIONS

- 10/10 CONCENTRATION
- 7/10 TO 9/10 CONCENTRATION
- 4/10 TO 6/10 CONCENTRATION
- 1/10 TO 3/10 CONCENTRATION

ST. MARYS RIVER SYSTEM

1971
ANNUAL ICE CHART SUMMARY

FIGURE 11

OPEN	Y9	OPEN	Y9	OPEN
------	----	------	----	------

OPEN	W9	OPEN	W9	OPEN
------	----	------	----	------

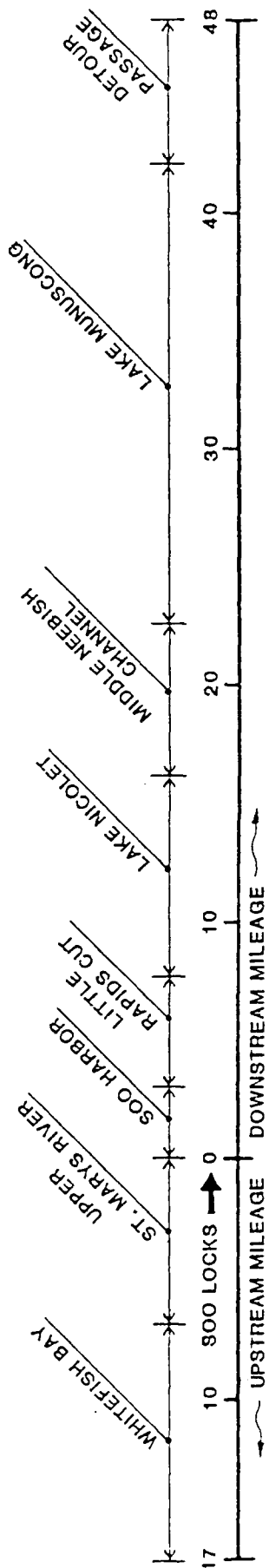
Y7	W9
----	----

W9	W10	OPEN
----	-----	------

W10

W10	W8	W4	W10	OPEN
-----	----	----	-----	------

1972 ANNUAL ICE CHART SUMMARY



JAN 7

JAN 14

WEEK OF

JAN 21	OPEN	W9	W6	OPEN	W9	W10	Y10	OPEN
--------	------	----	----	------	----	-----	-----	------

JAN 28

OPEN	W9
------	----

FEB 4

W10	OPEN	W9	W10	Y10	OPEN
-----	------	----	-----	-----	------

FEB 11

W9	W10	Y10	OPEN
----	-----	-----	------

FEB 18

LEGEND

- Y - YOUNG ICE, 2"-7" THICK
- W - WINTER ICE, GREATER THAN 7" THICK
- BR - BRASH ICE
- OPEN - OPEN WATER
- SUBSCRIPTS - ICE CONCENTRATIONS IN TENTHS
- BLANK AREAS - NO OBSERVATIONS

10/10 CONCENTRATION

7/10 TO 9/10 CONCENTRATION

4/10 TO 6/10 CONCENTRATION

1/10 TO 3/10 CONCENTRATION

ST. MARYS RIVER SYSTEM

1972
ANNUAL ICE CHART SUMMARY

OPEN

Y9 OPEN

W9 OPEN

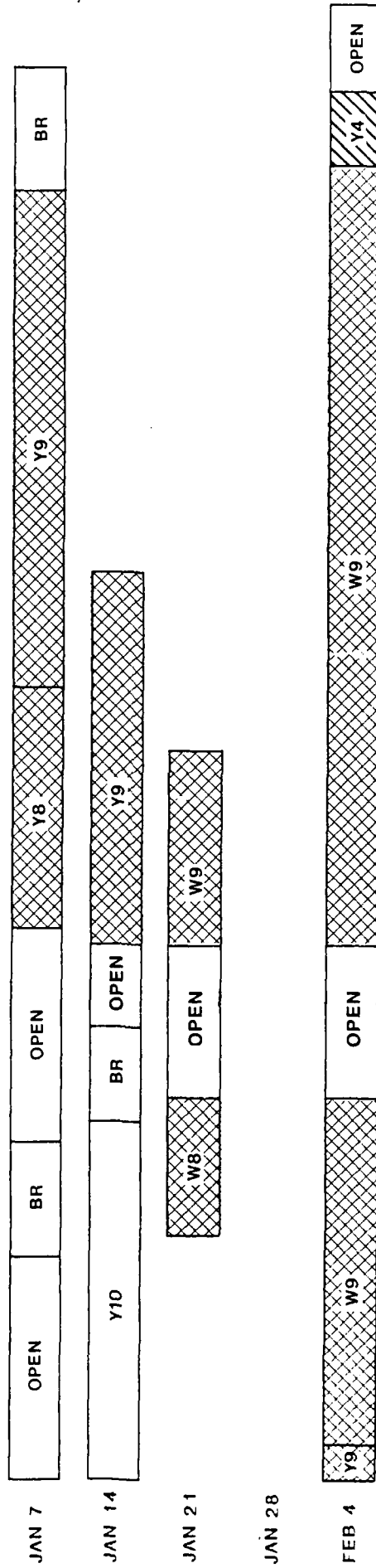
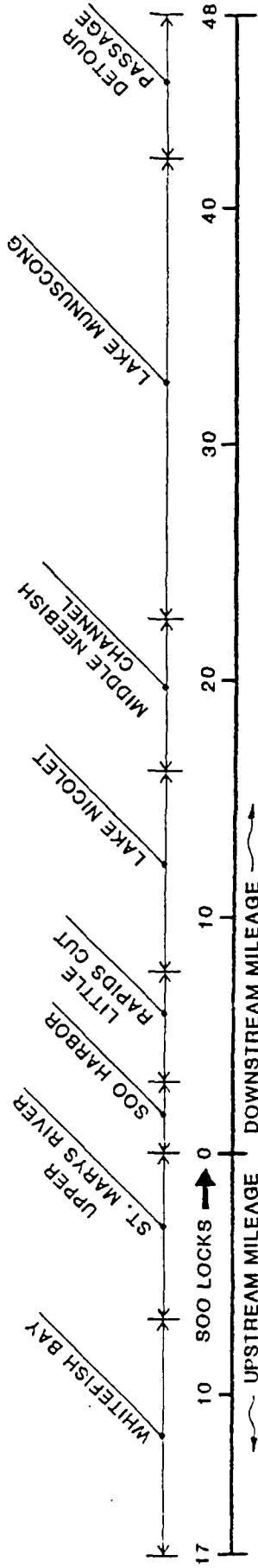
Y10

Y9 W9 OPEN W9 W9 OPEN W9

W9 OPEN W10 OPEN

W9 Y10 Y6 W10 OPEN

1973 ANNUAL ICE CHART SUMMARY



LEGEND

- Y - YOUNG ICE, 2"-7" THICK
 - W - WINTER ICE, GREATER THAN 7" THICK
 - BR - BRASH ICE
 - OPEN - OPEN WATER
 - SUBSCRIPTS - ICE CONCENTRATIONS IN TENTHS
 - BLANK AREAS - NO OBSERVATIONS
- | | |
|--------------------|----------------------------|
| [Blank] | 10/10 CONCENTRATION |
| [Cross-hatched] | 7/10 TO 9/10 CONCENTRATION |
| [Diagonal lines] | 4/10 TO 6/10 CONCENTRATION |
| [Horizontal lines] | 1/10 TO 3/10 CONCENTRATION |

ST. MARYS RIVER SYSTEM

1973
ANNUAL ICE CHART SUMMARY

Y10	OPEN	Y10	OPEN
-----	------	-----	------

Y10	OPEN	Y10	OPEN
-----	------	-----	------

OPEN

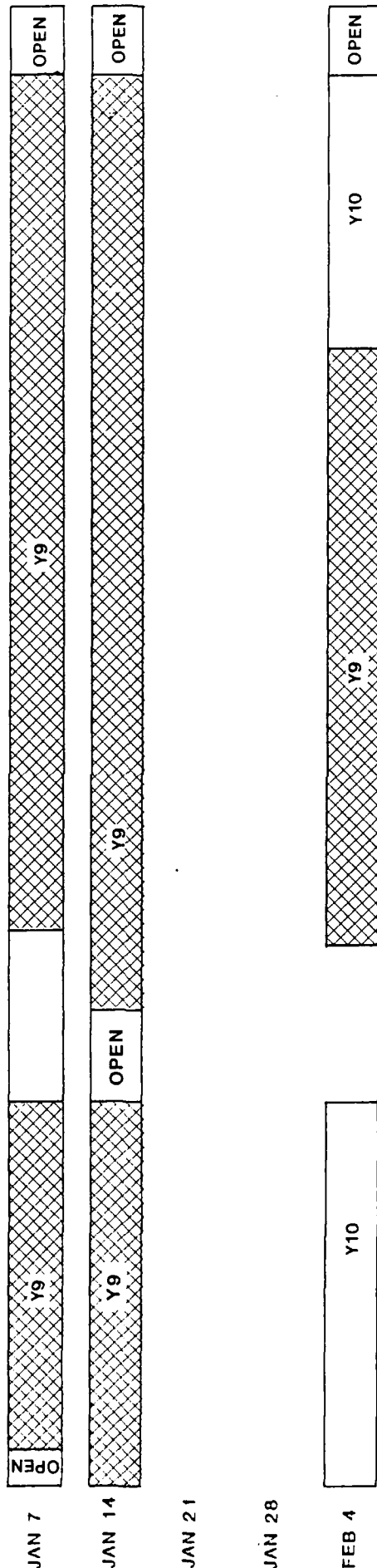
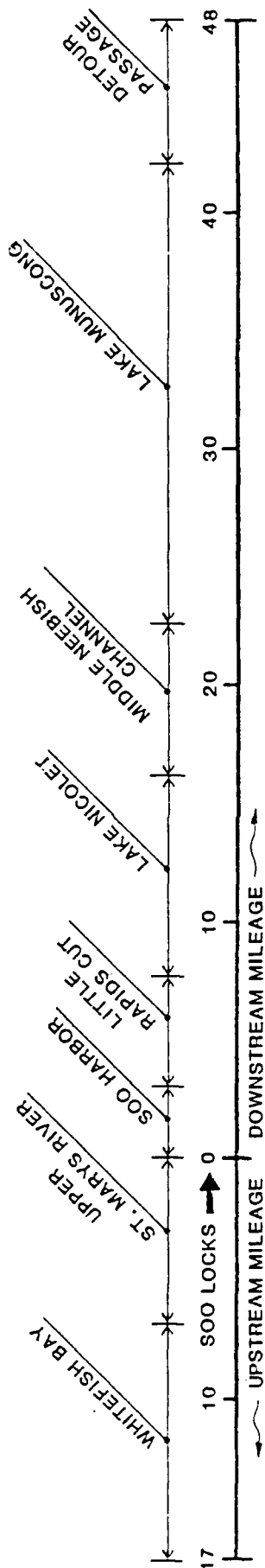
W10

W10

W10

W10

1974 ANNUAL ICE CHART SUMMARY



LEGEND

- Y - YOUNG ICE, 2" - 7" THICK
- W - WINTER ICE, GREATER THAN 7" THICK
- BR - BRASH ICE
- OPEN - OPEN WATER
- SUBSCRIPTS - ICE CONCENTRATIONS IN TENTHS
- BLANK AREAS - NO OBSERVATIONS

10/10 CONCENTRATION

7/10 TO 9/10 CONCENTRATION

4/10 TO 6/10 CONCENTRATION

1/10 TO 3/10 CONCENTRATION

ST. MARYS RIVER SYSTEM

1974
ANNUAL ICE CHART SUMMARY

OPEN

OPEN Y8 OPEN

Y8 OPEN Y8 OPEN

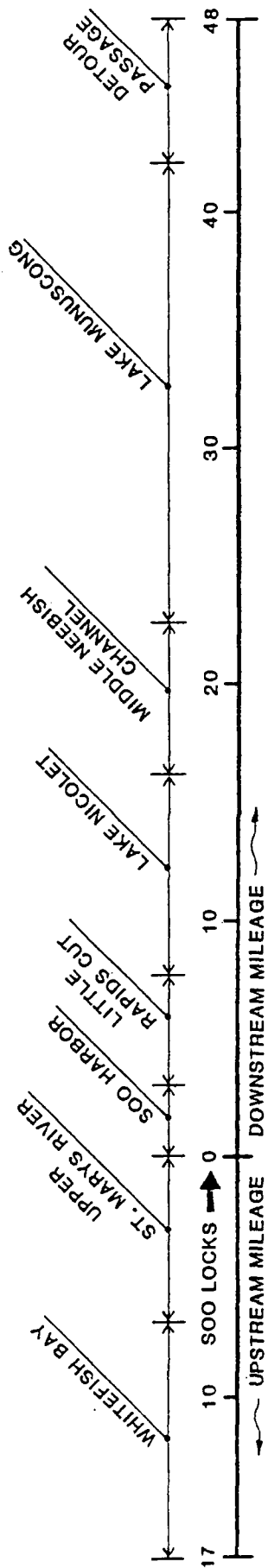
Y8

Y10

Y10 Y8

Y10 OPEN W10 Y8

1975 ANNUAL ICE CHART SUMMARY



JAN 7

JAN 14

JAN 21

JAN 28

FEB 4

FEB 11

FEB 18

WEEK OF

Y9	OPEN	W9	Y9	OPEN
OPEN	Y9	OPEN	Y10	OPEN

Y9	OPEN
----	------

LEGEND

- Y - YOUNG ICE, 2"-7" THICK
- W - WINTER ICE, GREATER THAN 7" THICK
- BR - BRASH ICE
- OPEN - OPEN WATER
- SUBSCRIPTS - ICE CONCENTRATIONS IN TENTHS
- BLANK AREAS - NO OBSERVATIONS

10/10 CONCENTRATION

7/10 TO 9/10 CONCENTRATION

4/10 TO 6/10 CONCENTRATION

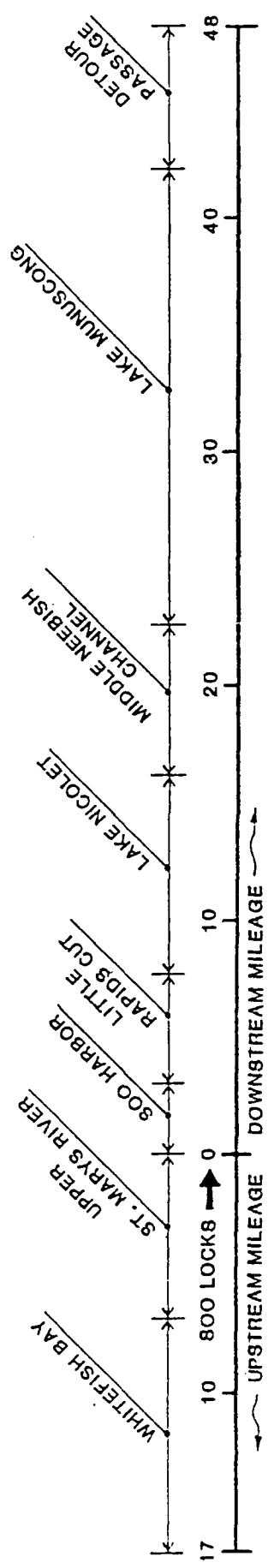
1/10 TO 3/10 CONCENTRATION

ST. MARYS RIVER SYSTEM

1975
ANNUAL ICE CHART SUMMARY

OPEN	Y9	Y10	OPEN
Y9	Y7	Y10	Y7
Y10	Y8	W10	Y9
W10	Y8	W10	Y10
W10	Y8	W10	
W10		W10	
W10	W8	W10	Y8

1976 ANNUAL ICE CHART SUMMARY



JAN 7
 JAN 14
 JAN 21
 JAN 28
 FEB 4
 FEB 11
 FEB 18

WEEK OF



LEGEND

- Y - YOUNG ICE, 2" - 7" THICK
- W - WINTER ICE, GREATER THAN 7" THICK
- BR - BRASH ICE
- OPEN - OPEN WATER
- SUBSCRIPTS - ICE CONCENTRATIONS IN TENTHS
- BLANK AREAS - NO OBSERVATIONS

10/10 CONCENTRATION

7/10 TO 9/10 CONCENTRATION

4/10 TO 6/10 CONCENTRATION

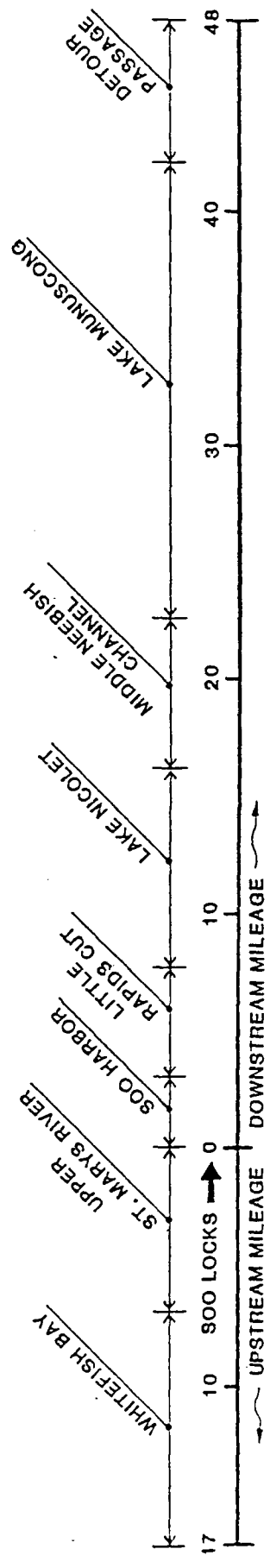
1/10 TO 3/10 CONCENTRATION

ST. MARYS RIVER SYSTEM

'1976
 ANNUAL ICE CHART SUMMARY

W10	OPEN	W10	Y9
W10	OPEN	W10	Y7
W10	Y6	OPEN	Y10
W10	Y5	OPEN	
W10	Y9	OPEN	OPEN
W10	Y8	OPEN	OPEN
		W10	OPEN

1977 ANNUAL ICE CHART SUMMARY



JAN 7

JAN 14

JAN 21

JAN 28

FEB 4

FEB 11

FEB 18

WEEK OF

W10	W7	W9	Y9	OPEN
-----	----	----	----	------

LEGEND

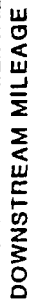
- Y - YOUNG ICE, 2" - 7" THICK
- W - WINTER ICE, GREATER THAN 7" THICK
- BR - BRASH ICE
- OPEN - OPEN WATER
- SUBSCRIPTS - ICE CONCENTRATIONS IN TENTHS
- BLANK AREAS - NO OBSERVATIONS
- 10/10 CONCENTRATION
- 7/10 TO 8/10 CONCENTRATION
- 4/10 TO 6/10 CONCENTRATION
- 1/10 TO 3/10 CONCENTRATION

ST. MARYS RIVER SYSTEM

1977
ANNUAL ICE CHART SUMMARY

Y10	W10	Y10	OPEN	W10
-----	-----	-----	------	-----

1978



JAN 14	Y10	Y9	OPEN	Y9	Y8	OPEN
--------	-----	----	------	----	----	------

WEEK OF

FEB 4	W10	W9	W8	OPEN	W9	Y9
-------	-----	----	----	------	----	----

FEB 18	W9	W8	W9	W8	W9	OPEN
						OPEN

Y - YOUNG ICE, 2" - 7" THICK
W - WINTER ICE, GREATER THAN 7" THICK
BR - BRASH ICE
OPEN - OPEN WATER
SUBSCRIPTS - ICE CONCENTRATIONS IN TENTHS
BLANK AREAS - NO OBSERVATIONS

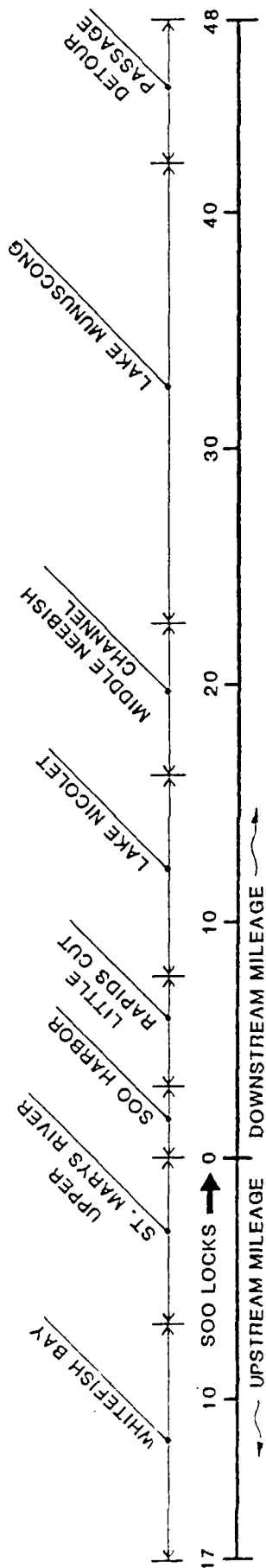
	10/10 CONCENTRATION
	7/10 TO 9/10 CONCENTRATION
	4/10 TO 6/10 CONCENTRATION
	1/10 TO 3/10 CONCENTRATION

ST. MARYS RIVER SYSTEM

1978
ANNUAL ICE CHART SUMMARY

WM

1979 ANNUAL ICE CHART SUMMARY



JAN 7	OPEN	W10	W9	OPEN	W9	OPEN
JAN 14		W10	W9	OPEN	W9	OPEN
JAN 21		W9	W9	OPEN	W9	OPEN
JAN 28		W9	Y8	OPEN	Y9	OPEN

FEB 4

FEB 11	W9	Y8	OPEN	W9	Y10
--------	----	----	------	----	-----

FEB 18	W9	Y8	OPEN	W9
--------	----	----	------	----

LEGEND

- Y - YOUNG ICE, 2" - 7" THICK
- W - WINTER ICE, GREATER THAN 7" THICK
- BR - BRASH ICE
- OPEN - OPEN WATER
- SUBSCRIPTS - ICE CONCENTRATIONS IN TENTHS
- BLANK AREAS - NO OBSERVATIONS

ST. MARYS RIVER SYSTEM

1979
ANNUAL ICE CHART SUMMARY

OPEN

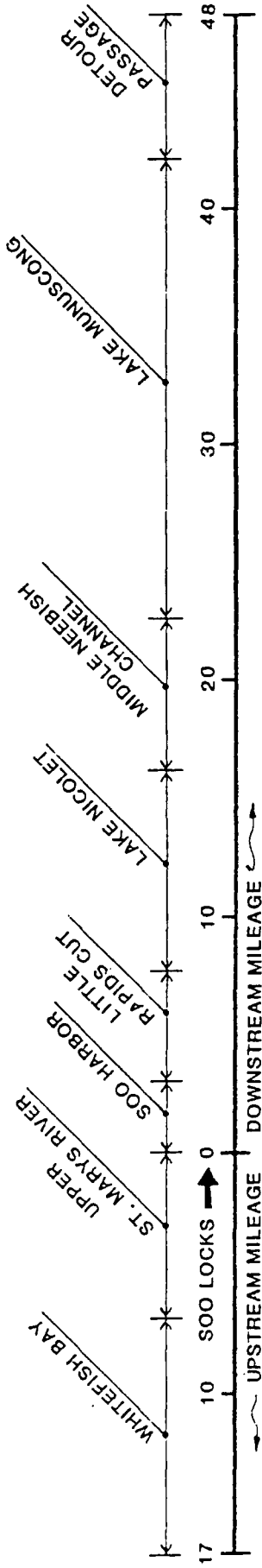
OPEN	Y10	OPEN	Y10	OPEN
------	-----	------	-----	------

Y10	OPEN	Y10	Y9
-----	------	-----	----

Y10

W10	Y7	OPEN	W10	OPEN
-----	----	------	-----	------

1980 ANNUAL ICE CHART SUMMARY



JAN 7	OPEN	Y8	Y9	
JAN 14				
JAN 21	OPEN	Y9	OPEN	OPEN
JAN 28				
FEB 4		OPEN	Y10	OPEN
FEB 11	W10	W9	W10	Y7
			OPEN	W9
			W10	Y10
			OPEN	OPEN

LEGEND

- Y - YOUNG ICE, 2"-7" THICK
- W - WINTER ICE, GREATER THAN 7" THICK
- BR - BRASH ICE
- OPEN - OPEN WATER
- SUBSCRIPTS - ICE CONCENTRATIONS IN TENTHS
- BLANK AREAS - NO OBSERVATIONS

10/10 CONCENTRATION

7/10 TO 9/10 CONCENTRATION

4/10 TO 6/10 CONCENTRATION

1/10 TO 3/10 CONCENTRATION

ST. MARYS RIVER SYSTEM

1980
ANNUAL ICE CHART SUMMARY

OPEN	Y10	OPEN
------	-----	------

OPEN	Y10	OPEN
------	-----	------

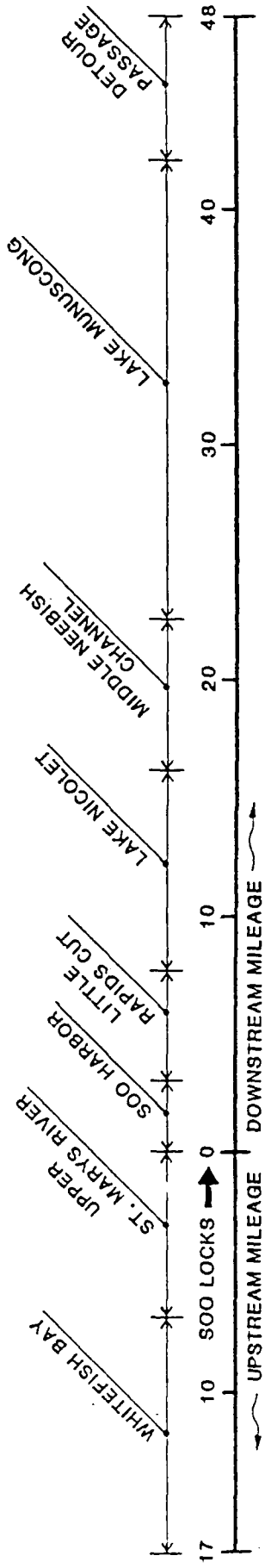
OPEN	Y10	Y9	OPEN	Y10	OPEN
------	-----	----	------	-----	------

Y10	OPEN	Y6	Y10	OPEN
-----	------	----	-----	------

Y10	OPEN	Y8	Y10	OPEN
-----	------	----	-----	------

Y10	OPEN	Y7	Y10	OPEN
-----	------	----	-----	------

1983 ANNUAL ICE CHART SUMMARY



JAN 7

JAN 14

JAN 21

JAN 28

FEB 4

FEB 11

FEB 18

WEEK OF

Y10	OPEN	Y7	Y9	OPEN
-----	------	----	----	------

LEGEND

- Y - YOUNG ICE, 2"-7" THICK
- W - WINTER ICE, GREATER THAN 7" THICK
- BR - BRASH ICE
- OPEN - OPEN WATER
- SUBSCRIPTS - ICE CONCENTRATIONS IN TENTHS
- BLANK AREAS - NO OBSERVATIONS

ST. MARYS RIVER SYSTEM

1983
ANNUAL ICE CHART SUMMARY

FIGURE 21

Y10		W10		Y10	Y6
-----	--	-----	--	-----	----

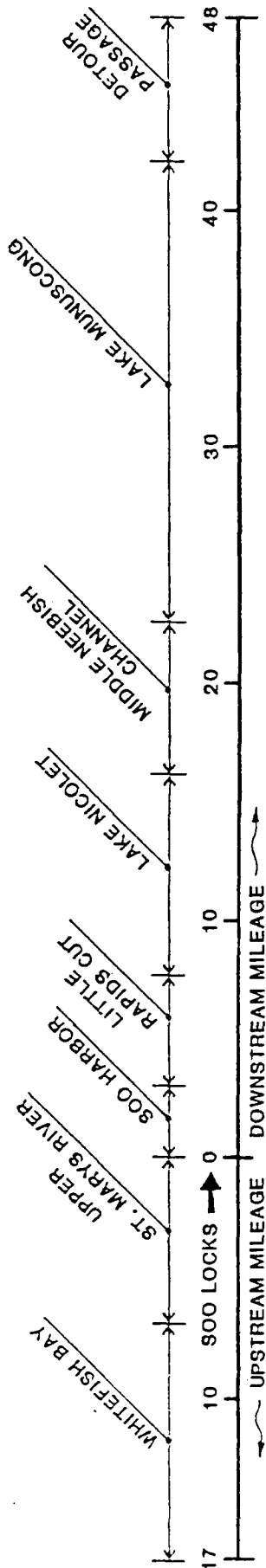
Y10	W10	Y8	Y6	OPEN	Y9
-----	-----	----	----	------	----

W10	OPEN	W10
-----	------	-----

W10	OPEN	W10
-----	------	-----

W10

1984 ANNUAL ICE CHART SUMMARY



JAN 7

JAN 14

JAN 21

JAN 28

FEB 4

FEB 11

FEB 18

WEEK OF



LEGEND

- Y - YOUNG ICE, 2" - 7" THICK
- W - WINTER ICE, GREATER THAN 7" THICK
- BR - BRASH ICE
- OPEN - OPEN WATER
- SUBSCRIPTS - ICE CONCENTRATIONS IN TENTHS
- BLANK AREAS - NO OBSERVATIONS

ST. MARYS RIVER SYSTEM

1984
ANNUAL ICE CHART SUMMARY

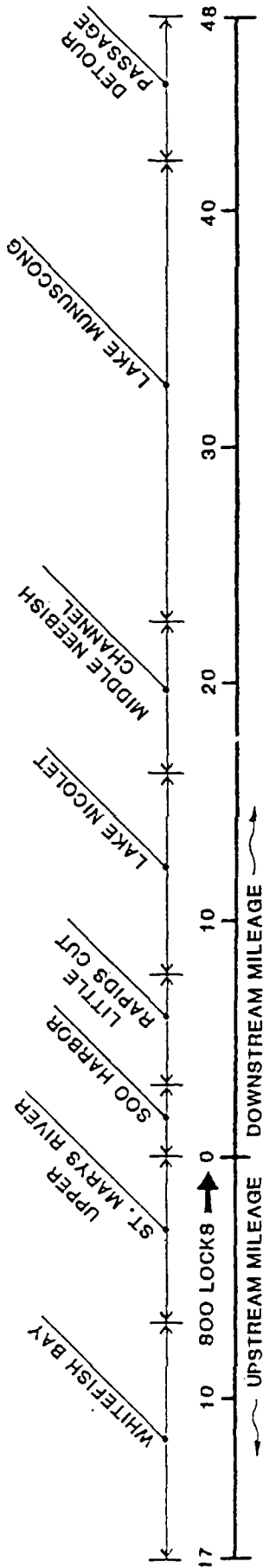
Y9	OPEN	Y10	OPEN
----	------	-----	------

Y10	Y9	OPEN	Y10	Y9
-----	----	------	-----	----

Y10	Y9	OPEN	Y10	Y9
-----	----	------	-----	----

Y10	Y9	OPEN	Y10	Y9
-----	----	------	-----	----

1985 ANNUAL ICE CHART SUMMARY



DATE	UPSTREAM MILEAGE	DOWNSTREAM MILEAGE	ICE CONCENTRATION
JAN 7	BR	Y9	OPEN
JAN 14			
JAN 21	Y10	Y6	OPEN
JAN 28	Y10	Y6	OPEN
FEB 4			
FEB 11			
FEB 18			

WEEK OF

LEGEND

- Y - YOUNG ICE, 2" - 7" THICK
- W - WINTER ICE, GREATER THAN 7" THICK
- BR - BRASH ICE
- OPEN - OPEN WATER
- SUBSCRIPTS - ICE CONCENTRATIONS IN TENTHS
- BLANK AREAS - NO OBSERVATIONS

ST. MARYS RIVER SYSTEM

1985
ANNUAL ICE CHART SUMMARY

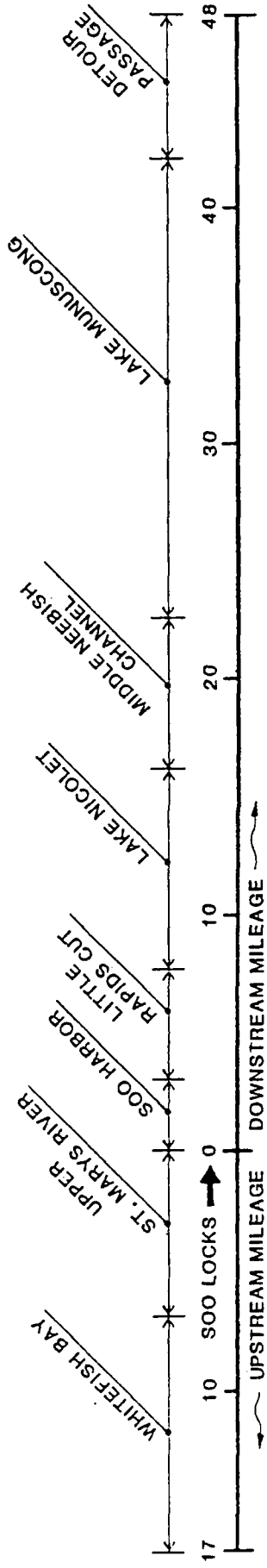
WIO	OPEN	W9	YIO
-----	------	----	-----

WIO	OPEN	W9	YIO
-----	------	----	-----

WIO	W9	OPEN	WIO
-----	----	------	-----

WIO	W9	OPEN	WIO
-----	----	------	-----

1986 ANNUAL ICE CHART SUMMARY



JAN 7	Y10	W9	W8	W9	OPEN	W9	Y9	OPEN
JAN 14	W10	OPEN	W9	Y10				

JAN 21

JAN 28

FEB 4

FEB 11

FEB 18

W10	W9	OPEN	W10	Y10
-----	----	------	-----	-----

LEGEND

- Y - YOUNG ICE, 2" - 7" THICK
- W - WINTER ICE, GREATER THAN 7" THICK
- BR - BRASH ICE
- OPEN - OPEN WATER
- SUBSCRIPTS - ICE CONCENTRATIONS IN TENTHS
- BLANK AREAS - NO OBSERVATIONS

10/10 CONCENTRATION

7/10 TO 9/10 CONCENTRATION

4/10 TO 6/10 CONCENTRATION

1/10 TO 3/10 CONCENTRATION

ST. MARYS RIVER SYSTEM

1986
ANNUAL ICE CHART SUMMARY

APPENDIX A

COMPUTER PRINTOUTS OF THE WIND
DATA ANALYSES

APPENDIX A
COMPUTER PRINTOUTS OF THE WIND
DATA ANALYSES

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Maximum Annual Speed According to 16 Compass Directions	A-17 to A-52

GLOBETROTTERS ENGINEERING CORPORATION
CHICAGO, ILLINOIS
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ANALYSES OF
WIND DATA AT SAULT STE.
MARIE STATION #14847
FOR WINTER PERIODS
(JAN. TO APRIL) FROM
1969 TO 1986

PROJECT NO. 86-175

PREPARATION OF REPORT ON WEATHER,
WATER DISCHARGE AND ICE CONDITIONS
OF ST. MARYS RIVER SYSTEM

DATE: SEPTEMBER 10, 1986
PAGE: 1 OF 16

DIRECTION OF WIND IS : N (NORTH BET 35 & 1)

AVERAGE SPEED OF WIND FOR THIS DIRECTION IS:
3

TOTAL NO. OBSERVATIONS FOR THIS WIND DIRECTION ARE:
1421

MAXIMUM SPEED FOR THIS DIRECTION IS:
21

NO. OF OBSERVATIONS FOR MAXIMUM SPEED IS:
1

FOR WIND SPEED = 0 KNOTS, NO. OF OBS. ARE :
867

FOR WIND SPEED GT 0 KNOTS AND LE 3 KNOTS. NO. OF OBS. ARE:
39

FOR WIND SPEED GE 4 KNOTS AND LE 12 KNOTS. NUMBER OF OBSERVATIONS ARE:
421

FOR WIND SPEED GE 13 KNOTS AND LE 15 KNOTS. NUMBER OF OBSERVATIONS ARE:
77

FOR WIND SPEED GE 16 KNOTS AND LE 18 KNOTS. NUMBER OF OBSERVATIONS ARE:
14

FOR WIND SPEED GE 19 KNOTS AND LE 24 KNOTS. NUMBER OF OBSERVATIONS ARE:
3

FOR WIND SPEED GE 25 KNOTS AND LE 31 KNOTS. NUMBER OF OBSERVATIONS ARE:
0

FOR WIND SPEED GT 31 KNOTS. NUMBER OF OBSERVATIONS ARE:
0

GLOBETROTTERS ENGINEERING CORPORATION
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PAGE: 2 OF 16

DIRECTION OF WIND IS : NNE (NORTH NORTHEAST BET 1 & 3)

AVERAGE SPEED OF WIND FOR THIS DIRECTION IS:

8

TOTAL NO. OBSERVATIONS FOR THIS WIND DIRECTION ARE:

742

MAXIMUM SPEED FOR THIS DIRECTION IS:

20

NO. OF OBSERVATIONS FOR MAXIMUM SPEED IS:

2

FOR WIND SPEED = 0 KNOTS. NO. OF OBS. ARE :

0

FOR WIND SPEED GT 0 KNOTS AND LE 3 KNOTS. NO. OF OBS. ARE:

54

FOR WIND SPEED GE 4 KNOTS AND LE 12 KNOTS. NUMBER OF OBSERVATIONS ARE:

599

FOR WIND SPEED GE 13 KNOTS AND LE 15 KNOTS. NUMBER OF OBSERVATIONS ARE:

78

FOR WIND SPEED GE 16 KNOTS AND LE 18 KNOTS. NUMBER OF OBSERVATIONS ARE:

8

FOR WIND SPEED GE 19 KNOTS AND LE 24 KNOTS. NUMBER OF OBSERVATIONS ARE:

3

FOR WIND SPEED GE 25 KNOTS AND LE 31 KNOTS. NUMBER OF OBSERVATIONS ARE:

0

FOR WIND SPEED GT 31 KNOTS. NUMBER OF OBSERVATIONS ARE:

0

GLOBETROTTERS ENGINEERING CORPORATION
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DIRECTION OF WIND IS : NE (NORTHEAST BET 4 & 5)

AVERAGE SPEED OF WIND FOR THIS DIRECTION IS:

7

TOTAL NO. OBSERVATIONS FOR THIS WIND DIRECTION ARE:

418

MAXIMUM SPEED FOR THIS DIRECTION IS.

22

NO. OF OBSERVATIONS FOR MAXIMUM SPEED IS:

1

FOR WIND SPEED = 0 KNOTS, NO. OF OBS. ARE :

0

FOR WIND SPEED GT 0 KNOTS AND LE 3 KNOTS. NO. OF OBS. ARE:

51

FOR WIND SPEED GE 4 KNOTS AND LE 12 KNOTS. NUMBER OF OBSERVATIONS ARE:

331

FOR WIND SPEED GE 13 KNOTS AND LE 15 KNOTS. NUMBER OF OBSERVATIONS ARE:

31

FOR WIND SPEED GE 16 KNOTS AND LE 18 KNOTS. NUMBER OF OBSERVATIONS ARE:

4

FOR WIND SPEED GE 19 KNOTS AND LE 24 KNOTS. NUMBER OF OBSERVATIONS ARE:

1

FOR WIND SPEED GE 25 KNOTS AND LE 31 KNOTS. NUMBER OF OBSERVATIONS ARE:

0

FOR WIND SPEED GT 31 KNOTS. NUMBER OF OBSERVATIONS ARE:

0

GLOBETROTTERS ENGINEERING CORPORATION
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DIRECTION OF WIND IS : ENE (EAST NORTHEAST BET 6 & 7)

AVERAGE SPEED OF WIND FOR THIS DIRECTION IS:

6

TOTAL NO. OBSERVATIONS FOR THIS WIND DIRECTION ARE:

775

MAXIMUM SPEED FOR THIS DIRECTION IS:

18

NO. OF OBSERVATIONS FOR MAXIMUM SPEED IS:

1

FOR WIND SPEED = 0 KNOTS. NO. OF OBS. ARE :

0

FOR WIND SPEED GT 0 KNOTS AND LE 3 KNOTS. NO. OF OBS. ARE:

116

FOR WIND SPEED GE 4 KNOTS AND LE 12 KNOTS. NUMBER OF OBSERVATIONS ARE:

622

FOR WIND SPEED GE 13 KNOTS AND LE 15 KNOTS. NUMBER OF OBSERVATIONS ARE:

29

FOR WIND SPEED GE 16 KNOTS AND LE 18 KNOTS. NUMBER OF OBSERVATIONS ARE:

8

FOR WIND SPEED GE 19 KNOTS AND LE 24 KNOTS. NUMBER OF OBSERVATIONS ARE:

0

FOR WIND SPEED GE 25 KNOTS AND LE 31 KNOTS. NUMBER OF OBSERVATIONS ARE:

0

FOR WIND SPEED GT 31 KNOTS. NUMBER OF OBSERVATIONS ARE:

0

GLOBETROTTERS ENGINEERING CORPORATION
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DIRECTION OF WIND IS : E (EAST BET 8 & 10)

AVERAGE SPEED OF WIND FOR THIS DIRECTION IS:

6

TOTAL NO. OBSERVATIONS FOR THIS WIND DIRECTION ARE:

1932

MAXIMUM SPEED FOR THIS DIRECTION IS:

25

NO. OF OBSERVATIONS FOR MAXIMUM SPEED IS:

1

FOR WIND SPEED = 0 KNOTS, NO. OF OBS. ARE :

0

FOR WIND SPEED GT 0 KNOTS AND LE 3 KNOTS, NO. OF OBS. ARE:

236

FOR WIND SPEED GE 4 KNOTS AND LE 12 KNOTS, NUMBER OF OBSERVATIONS ARE:

1575

FOR WIND SPEED GE 13 KNOTS AND LE 15 KNOTS, NUMBER OF OBSERVATIONS ARE:

88

FOR WIND SPEED GE 16 KNOTS AND LE 18 KNOTS, NUMBER OF OBSERVATIONS ARE:

25

FOR WIND SPEED GE 19 KNOTS AND LE 24 KNOTS, NUMBER OF OBSERVATIONS ARE:

7

FOR WIND SPEED GE 25 KNOTS AND LE 31 KNOTS, NUMBER OF OBSERVATIONS ARE:

1

FOR WIND SPEED GT 31 KNOTS, NUMBER OF OBSERVATIONS ARE:

0

GLOBETROTTERS ENGINEERING CORPORATION
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DIRECTION OF WIND IS : ESE (EAST SOUTHEAST BET 11 & 12)

AVERAGE SPEED OF WIND FOR THIS DIRECTION IS:

9

TOTAL NO. OBSERVATIONS FOR THIS WIND DIRECTION ARE:

2377

MAXIMUM SPEED FOR THIS DIRECTION IS:

24

NO. OF OBSERVATIONS FOR MAXIMUM SPEED IS:

3

FOR WIND SPEED = 0 KNOTS, NO. OF OBS. ARE :

0

FOR WIND SPEED GT 0 KNOTS AND LE 3 KNOTS, NO. OF OBS. ARE:

187

FOR WIND SPEED GE 4 KNOTS AND LE 12 KNOTS, NUMBER OF OBSERVATIONS ARE:

1698

FOR WIND SPEED GE 13 KNOTS AND LE 15 KNOTS, NUMBER OF OBSERVATIONS ARE:

337

FOR WIND SPEED GE 16 KNOTS AND LE 18 KNOTS, NUMBER OF OBSERVATIONS ARE:

123

FOR WIND SPEED GE 19 KNOTS AND LE 24 KNOTS, NUMBER OF OBSERVATIONS ARE:

32

FOR WIND SPEED GE 25 KNOTS AND LE 31 KNOTS, NUMBER OF OBSERVATIONS ARE:

0

FOR WIND SPEED GT 31 KNOTS, NUMBER OF OBSERVATIONS ARE:

0

GLOBETROTTERS ENGINEERING CORPORATION
CHICAGO, ILLINOIS
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DIRECTION OF WIND IS : SE (SOUTHEAST BET 13 & 14)

AVERAGE SPEED OF WIND FOR THIS DIRECTION IS:

7

TOTAL NO. OBSERVATIONS FOR THIS WIND DIRECTION ARE:

994

MAXIMUM SPEED FOR THIS DIRECTION IS:

26

NO. OF OBSERVATIONS FOR MAXIMUM SPEED IS:

1

FOR WIND SPEED = 0 KNOTS, NO. OF OBS. ARE :

0

FOR WIND SPEED GT 0 KNOTS AND LE 3 KNOTS, NO. OF OBS. ARE:

126

FOR WIND SPEED GE 4 KNOTS AND LE 12 KNOTS, NUMBER OF OBSERVATIONS ARE:

747

FOR WIND SPEED GE 13 KNOTS AND LE 15 KNOTS, NUMBER OF OBSERVATIONS ARE:

86

FOR WIND SPEED GE 16 KNOTS AND LE 18 KNOTS, NUMBER OF OBSERVATIONS ARE:

22

FOR WIND SPEED GE 19 KNOTS AND LE 24 KNOTS, NUMBER OF OBSERVATIONS ARE:

6

FOR WIND SPEED GE 25 KNOTS AND LE 31 KNOTS, NUMBER OF OBSERVATIONS ARE:

1

FOR WIND SPEED GT 31 KNOTS, NUMBER OF OBSERVATIONS ARE:

0

GLOBETROTTERS ENGINEERING CORPORATION
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DIRECTION OF WIND IS : SSE (SOUTH SOUTHEAST BET 15 & 16)

AVERAGE SPEED OF WIND FOR THIS DIRECTION IS:

6

TOTAL NO. OBSERVATIONS FOR THIS WIND DIRECTION ARE:

493

MAXIMUM SPEED FOR THIS DIRECTION IS:

19

NO. OF OBSERVATIONS FOR MAXIMUM SPEED IS:

1

FOR WIND SPEED = 0 KNOTS, NO. OF OBS. ARE :

0

FOR WIND SPEED GT 0 KNOTS AND LE 3 KNOTS, NO. OF OBS. ARE:

83

FOR WIND SPEED GE 4 KNOTS AND LE 12 KNOTS, NUMBER OF OBSERVATIONS ARE:

383

FOR WIND SPEED GE 13 KNOTS AND LE 15 KNOTS, NUMBER OF OBSERVATIONS ARE:

23

FOR WIND SPEED GE 16 KNOTS AND LE 18 KNOTS, NUMBER OF OBSERVATIONS ARE:

3

FOR WIND SPEED GE 19 KNOTS AND LE 24 KNOTS, NUMBER OF OBSERVATIONS ARE:

1

FOR WIND SPEED GE 25 KNOTS AND LE 31 KNOTS, NUMBER OF OBSERVATIONS ARE:

0

FOR WIND SPEED GT 31 KNOTS, NUMBER OF OBSERVATIONS ARE:

0

GLOBETROTTERS ENGINEERING CORPORATION
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DIRECTION OF WIND IS : S (SOUTH BET 17 & 18)

AVERAGE SPEED OF WIND FOR THIS DIRECTION IS:

5

TOTAL NO. OBSERVATIONS FOR THIS WIND DIRECTION ARE:

413

MAXIMUM SPEED FOR THIS DIRECTION IS:

17

NO. OF OBSERVATIONS FOR MAXIMUM SPEED IS:

1

FOR WIND SPEED = 0 KNOTS. NO. OF OBS. ARE :

0

FOR WIND SPEED GT 0 KNOTS AND LE 3 KNOTS, NO. OF OBS. ARE:

89

FOR WIND SPEED GE 4 KNOTS AND LE 12 KNOTS, NUMBER OF OBSERVATIONS ARE:

306

FOR WIND SPEED GE 13 KNOTS AND LE 15 KNOTS, NUMBER OF OBSERVATIONS ARE:

15

FOR WIND SPEED GE 16 KNOTS AND LE 18 KNOTS, NUMBER OF OBSERVATIONS ARE:

3

FOR WIND SPEED GE 19 KNOTS AND LE 24 KNOTS, NUMBER OF OBSERVATIONS ARE:

0

FOR WIND SPEED GE 25 KNOTS AND LE 31 KNOTS, NUMBER OF OBSERVATIONS ARE:

0

FOR WIND SPEED GT 31 KNOTS, NUMBER OF OBSERVATIONS ARE:

0

GLOBETROTTERS ENGINEERING CORPORATION
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DIRECTION OF WIND IS : SSW (SOUTH SOUTHWEST BET 19 & 20)

AVERAGE SPEED OF WIND FOR THIS DIRECTION IS:

6

TOTAL NO. OBSERVATIONS FOR THIS WIND DIRECTION ARE:

359

MAXIMUM SPEED FOR THIS DIRECTION IS:

19

NO. OF OBSERVATIONS FOR MAXIMUM SPEED IS:

1

FOR WIND SPEED = 0 KNOTS. NO. OF OBS. ARE :

0

FOR WIND SPEED GT 0 KNOTS AND LE 3 KNOTS. NO. OF OBS. ARE:

51

FOR WIND SPEED GE 4 KNOTS AND LE 12 KNOTS. NUMBER OF OBSERVATIONS ARE:

284

FOR WIND SPEED GE 13 KNOTS AND LE 15 KNOTS. NUMBER OF OBSERVATIONS ARE:

18

FOR WIND SPEED GE 16 KNOTS AND LE 18 KNOTS. NUMBER OF OBSERVATIONS ARE:

5

FOR WIND SPEED GE 19 KNOTS AND LE 24 KNOTS. NUMBER OF OBSERVATIONS ARE:

1

FOR WIND SPEED GE 25 KNOTS AND LE 31 KNOTS. NUMBER OF OBSERVATIONS ARE:

0

FOR WIND SPEED GT 31 KNOTS. NUMBER OF OBSERVATIONS ARE:

0

GLOBETROTTERS ENGINEERING CORPORATION
CHICAGO, ILLINOIS
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PROJECT NO. 86-175

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WATER DISCHARGE AND ICE CONDITIONS
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DIRECTION OF WIND IS : SW (SOUTHWEST BET 21 & 23)

AVERAGE SPEED OF WIND FOR THIS DIRECTION IS:

8

TOTAL NO. OBSERVATIONS FOR THIS WIND DIRECTION ARE:

662

MAXIMUM SPEED FOR THIS DIRECTION IS:

34

NO. OF OBSERVATIONS FOR MAXIMUM SPEED IS:

1

FOR WIND SPEED = 0 KNOTS, NO. OF OBS. ARE :

0

FOR WIND SPEED GT 0 KNOTS AND LE 3 KNOTS, NO. OF OBS. ARE:

70

FOR WIND SPEED GE 4 KNOTS AND LE 12 KNOTS, NUMBER OF OBSERVATIONS ARE:

513

FOR WIND SPEED GE 13 KNOTS AND LE 15 KNOTS, NUMBER OF OBSERVATIONS ARE:

51

FOR WIND SPEED GE 16 KNOTS AND LE 18 KNOTS, NUMBER OF OBSERVATIONS ARE:

15

FOR WIND SPEED GE 19 KNOTS AND LE 24 KNOTS, NUMBER OF OBSERVATIONS ARE:

10

FOR WIND SPEED GE 25 KNOTS AND LE 31 KNOTS, NUMBER OF OBSERVATIONS ARE:

2

FOR WIND SPEED GT 31 KNOTS, NUMBER OF OBSERVATIONS ARE:

1

GLOBETROTTERS ENGINEERING CORPORATION
CHICAGO, ILLINOIS
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PROJECT NO. 86-175

PREPARATION OF REPORT ON WEATHER,
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DIRECTION OF WIND IS : WSW (WEST SOUTHWEST BET 24 & 25)

AVERAGE SPEED OF WIND FOR THIS DIRECTION IS:

7

TOTAL NO. OBSERVATIONS FOR THIS WIND DIRECTION ARE:

781

MAXIMUM SPEED FOR THIS DIRECTION IS:

20

NO. OF OBSERVATIONS FOR MAXIMUM SPEED IS:

5

FOR WIND SPEED = 0 KNOTS, NO. OF OBS. ARE :

0

FOR WIND SPEED GT 0 KNOTS AND LE 3 KNOTS, NO. OF OBS. ARE:

77

FOR WIND SPEED GE 4 KNOTS AND LE 12 KNOTS, NUMBER OF OBSERVATIONS ARE:

624

FOR WIND SPEED GE 13 KNOTS AND LE 15 KNOTS, NUMBER OF OBSERVATIONS ARE:

64

FOR WIND SPEED GE 16 KNOTS AND LE 18 KNOTS, NUMBER OF OBSERVATIONS ARE:

10

FOR WIND SPEED GE 19 KNOTS AND LE 24 KNOTS, NUMBER OF OBSERVATIONS ARE:

6

FOR WIND SPEED GE 25 KNOTS AND LE 31 KNOTS, NUMBER OF OBSERVATIONS ARE:

0

FOR WIND SPEED GT 31 KNOTS, NUMBER OF OBSERVATIONS ARE:

0

GLOBETROTTERS ENGINEERING CORPORATION
CHICAGO, ILLINOIS
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DIRECTION OF WIND IS : W (WEST BET 26 & 27)

AVERAGE SPEED OF WIND FOR THIS DIRECTION IS:

7

TOTAL NO. OBSERVATIONS FOR THIS WIND DIRECTION ARE:

667

MAXIMUM SPEED FOR THIS DIRECTION IS:

28

NO. OF OBSERVATIONS FOR MAXIMUM SPEED IS:

1

FOR WIND SPEED = 0 KNOTS. NO. OF OBS. ARE :

0

FOR WIND SPEED GT 0 KNOTS AND LE 3 KNOTS. NO. OF OBS. ARE:

99

FOR WIND SPEED GE 4 KNOTS AND LE 12 KNOTS. NUMBER OF OBSERVATIONS ARE:

535

FOR WIND SPEED GE 13 KNOTS AND LE 15 KNOTS. NUMBER OF OBSERVATIONS ARE:

37

FOR WIND SPEED GE 16 KNOTS AND LE 18 KNOTS. NUMBER OF OBSERVATIONS ARE:

11

FOR WIND SPEED GE 19 KNOTS AND LE 24 KNOTS. NUMBER OF OBSERVATIONS ARE:

4

FOR WIND SPEED GE 25 KNOTS AND LE 31 KNOTS. NUMBER OF OBSERVATIONS ARE:

1

FOR WIND SPEED GT 31 KNOTS. NUMBER OF OBSERVATIONS ARE:

0

GLOBETROTTERS ENGINEERING CORPORATION
CHICAGO, ILLINOIS
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DIRECTION OF WIND IS : WNW (WEST NORTHWEST BET 28 & 29)

AVERAGE SPEED OF WIND FOR THIS DIRECTION IS:

9

TOTAL NO. OBSERVATIONS FOR THIS WIND DIRECTION ARE:

1174

MAXIMUM SPEED FOR THIS DIRECTION IS:

31

NO. OF OBSERVATIONS FOR MAXIMUM SPEED IS:

1

FOR WIND SPEED = 0 KNOTS, NO. OF OBS. ARE :

0

FOR WIND SPEED GT 0 KNOTS AND LE 3 KNOTS, NO. OF OBS. ARE:

66

FOR WIND SPEED GE 4 KNOTS AND LE 12 KNOTS, NUMBER OF OBSERVATIONS ARE:

815

FOR WIND SPEED GE 13 KNOTS AND LE 15 KNOTS, NUMBER OF OBSERVATIONS ARE:

156

FOR WIND SPEED GE 16 KNOTS AND LE 18 KNOTS, NUMBER OF OBSERVATIONS ARE:

79

FOR WIND SPEED GE 19 KNOTS AND LE 24 KNOTS, NUMBER OF OBSERVATIONS ARE:

54

FOR WIND SPEED GE 25 KNOTS AND LE 31 KNOTS, NUMBER OF OBSERVATIONS ARE:

4

FOR WIND SPEED GT 31 KNOTS, NUMBER OF OBSERVATIONS ARE:

0

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DIRECTION OF WIND IS : NW (NORTHWEST BET 30 & 32)

AVERAGE SPEED OF WIND FOR THIS DIRECTION IS:

10

TOTAL NO. OBSERVATIONS FOR THIS WIND DIRECTION ARE:

3277

MAXIMUM SPEED FOR THIS DIRECTION IS:

~~12~~ 30

NO. OF OBSERVATIONS FOR MAXIMUM SPEED IS:

1

FOR WIND SPEED = 0 KNOTS. NO. OF OBS. ARE :

0

FOR WIND SPEED GT 0 KNOTS AND LE 3 KNOTS. NO. OF OBS. ARE:

143

FOR WIND SPEED GE 4 KNOTS AND LE 12 KNOTS. NUMBER OF OBSERVATIONS ARE:

2125

FOR WIND SPEED GE 13 KNOTS AND LE 15 KNOTS. NUMBER OF OBSERVATIONS ARE:

606

FOR WIND SPEED GE 16 KNOTS AND LE 18 KNOTS. NUMBER OF OBSERVATIONS ARE:

264

FOR WIND SPEED GE 19 KNOTS AND LE 24 KNOTS. NUMBER OF OBSERVATIONS ARE:

108

FOR WIND SPEED GE 25 KNOTS AND LE 31 KNOTS. NUMBER OF OBSERVATIONS ARE:

30

FOR WIND SPEED GT 31 KNOTS. NUMBER OF OBSERVATIONS ARE:

1

GLOBETROTTERS ENGINEERING CORPORATION
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DIRECTION OF WIND IS : NNW (NORTH NORTHWEST BET 33 & 34)

AVERAGE SPEED OF WIND FOR THIS DIRECTION IS:

9

TOTAL NO. OBSERVATIONS FOR THIS WIND DIRECTION ARE:

807

MAXIMUM SPEED FOR THIS DIRECTION IS:

26

NO. OF OBSERVATIONS FOR MAXIMUM SPEED IS:

1

FOR WIND SPEED = 0 KNOTS. NO. OF OBS. ARE :

0

FOR WIND SPEED GT 0 KNOTS AND LE 3 KNOTS, NO. OF OBS. ARE:

57

FOR WIND SPEED GE 4 KNOTS AND LE 12 KNOTS, NUMBER OF OBSERVATIONS ARE:

587

FOR WIND SPEED GE 13 KNOTS AND LE 15 KNOTS, NUMBER OF OBSERVATIONS ARE:

117

FOR WIND SPEED GE 16 KNOTS AND LE 18 KNOTS, NUMBER OF OBSERVATIONS ARE:

30

FOR WIND SPEED GE 19 KNOTS AND LE 24 KNOTS, NUMBER OF OBSERVATIONS ARE:

15

FOR WIND SPEED GE 25 KNOTS AND LE 31 KNOTS, NUMBER OF OBSERVATIONS ARE:

1

FOR WIND SPEED GT 31 KNOTS, NUMBER OF OBSERVATIONS ARE:

0

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DATE: SEPTEMBER 12, 1986
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MAXIMUM SPEED OF WIND FOR EACH DIRECTION FOR THE YAEER 1969

MAXIMUM SPEED FOR THE DIRECTION NORTH (BET 35 AND 0) IS :
16

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION NORTH NORTHEAST (BET 1 AND 3) IS :
17

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION NORTHEAST (BET 4 AND 5) IS :
18

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION EAST NORTHEAST (BET 6 AND 7) IS :
13

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION EAST (BET 8 AND 10) IS :
17

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION EAST (BET 11 AND 12) SOUTHEAST IS :
20

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTHEAST (BET 13 AND 14) IS :
19

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED OF WIND FOR EACH DIRECTION FOR THE YAEK (CONT.)

DATE: SEPTEMBER 12, 1986

PAGE 2

MAXIMUM SPEED FOR THE DIRECTION SOUTH SOUTHEAST (BET 15 AND 16) IS :
13

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTH (BET 17 AND 18) IS :
11

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTH SOUTHWEST (BET 19 AND 20) IS :
15

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTHWEST (BET 21 AND 23) IS :
14

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION WEST SOUTHWEST (BET 24 AND 25) IS :
15

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
2

MAXIMUM SPEED FOR THE DIRECTION WEST (BET 26 AND 27) IS :
13

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION WEST NORTHWEST (BET 28 AND 29) IS :
20

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION NORTHWEST (BET 30 AND 32) IS :
20

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
2

MAXIMUM SPEED FOR THE DIRECTION NORTH NORTHWEST (BET 33 AND 34) IS :
18

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

A-18

GLOBSTROTTERS ENGINEERING CORPORATION
CHICAGO, ILLINOIS

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MAXIMUM SPEED OF WIND FOR EACH DIRECTION FOR THE YEAR 1970

MAXIMUM SPEED FOR THE DIRECTION NORTH (BET 35 AND 0) IS :

15

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):

1

MAXIMUM SPEED FOR THE DIRECTION NORTH NORTHEAST (BET 1 AND 3) IS :

16

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):

1

MAXIMUM SPEED FOR THE DIRECTION NORTHEAST (BET 4 AND 5) IS :

11

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):

2

MAXIMUM SPEED FOR THE DIRECTION EAST NORTHEAST (BET 6 AND 7) IS :

10

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):

2

MAXIMUM SPEED FOR THE DIRECTION EAST (BET 8 AND 10) IS :

25

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):

1

MAXIMUM SPEED FOR THE DIRECTION EAST (BET 11 AND 12) SOUTHEAST IS :

23

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):

1

MAXIMUM SPEED FOR THE DIRECTION SOUTHEAST (BET 13 AND 14) IS :

26

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):

1

MAXIMUM SPEED OF WIND FOR EACH DIRECTION FOR THE YAEK 1970 (CONT.)

DATE: SEPTEMBER 12, 1986

PAGE

MAXIMUM SPEED FOR THE DIRECTION SOUTH SOUTHEAST (BET 15 AND 16) IS :
13

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTH (BET 17 AND 18) IS :
13

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTH SOUTHWEST (BET 19 AND 20) IS :
12

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTHWEST (BET 21 AND 23) IS :
17

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
2

MAXIMUM SPEED FOR THE DIRECTION WEST SOUTHWEST (BET 24 AND 25) IS :
18

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION WEST (BET 26 AND 27) IS :
10

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
3

MAXIMUM SPEED FOR THE DIRECTION WEST NORTHWEST (BET 28 AND 29) IS :
22

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION NORTHWEST (BET 30 AND 32) IS :
26

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION NORTH NORTHWEST (BET 33 AND 34) IS :
17

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

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MAXIMUM SPEED OF WIND FOR EACH DIRECTION FOR THE YAEER 1971

MAXIMUM SPEED FOR THE DIRECTION NORTH (BET 35 AND 0) IS :
18

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
2

MAXIMUM SPEED FOR THE DIRECTION NORTH NORTHEAST (BET 1 AND 3) IS :
14

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
3

MAXIMUM SPEED FOR THE DIRECTION NORTHEAST (BET 4 AND 5) IS :
14

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION EAST NORTHEAST (BET 6 AND 7) IS :
16

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION EAST (BET 8 AND 10) IS :
20

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION EAST (BET 11 AND 12) SOUTHEAST IS :
20

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTHEAST (BET 13 AND 14) IS :
16

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED OF WIND FOR EACH DIRECTION FOR THE YAEER 1971 (CONT.)

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PA

MAXIMUM SPEED FOR THE DIRECTION SOUTH SOUTHEAST (BET 15 AND 16) IS :
14

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTH (BET 17 AND 18) IS :
17

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTH SOUTHWEST (BET 19 AND 20) IS :
18

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTHWEST (BET 21 AND 23) IS :
26

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION WEST SOUTHWEST (BET 24 AND 25) IS :
18

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION WEST (BET 26 AND 27) IS :
16

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION WEST NORTHWEST (BET 28 AND 29) IS :
24

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
2

MAXIMUM SPEED FOR THE DIRECTION NORTHWEST (BET 30 AND 32) IS :
22

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
3

MAXIMUM SPEED FOR THE DIRECTION NORTH NORTHWEST (BET 33 AND 34) IS :
21

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

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MAXIMUM SPEED OF WIND FOR EACH DIRECTION FOR THE YAEER 1972

MAXIMUM SPEED FOR THE DIRECTION NORTH (BET 35 AND 0) IS :
15

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION NORTH NORTHEAST (BET 1 AND 3) IS :
15

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
2

MAXIMUM SPEED FOR THE DIRECTION NORTHEAST (BET 4 AND 5) IS :
14

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION EAST NORTHEAST (BET 6 AND 7) IS :
16

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION EAST (BET 8 AND 10) IS :
22

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION EAST (BET 11 AND 12) SOUTHEAST IS :
19

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTHEAST (BET 13 AND 14) IS :
20

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED OF WIND FOR EACH DIRECTION FOR THE YAEK 1972 (CONT.)

DATE: SEPTEMBER 12, 1986

PA

MAXIMUM SPEED FOR THE DIRECTION SOUTH SOUTHEAST (BET 15 AND 16) IS :
14

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTH (BET 17 AND 18) IS :
16

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTH SOUTHWEST (BET 19 AND 20) IS :
14

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
2

MAXIMUM SPEED FOR THE DIRECTION SOUTHWEST (BET 21 AND 23) IS :
20

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION WEST SOUTHWEST (BET 24 AND 25) IS :
18

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION WEST (BET 26 AND 27) IS :
16

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION WEST NORTHWEST (BET 28 AND 29) IS :
20

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION NORTHWEST (BET 30 AND 32) IS :
30

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION NORTH NORTHWEST (BET 33 AND 34) IS :
26

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

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MAXIMUM SPEED OF WIND FOR EACH DIRECTION FOR THE YEAR 1973

MAXIMUM SPEED FOR THE DIRECTION NORTH (BET 35 AND 0) IS :
16

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION NORTH NORTHEAST (BET 1 AND 3) IS :
15

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
2

MAXIMUM SPEED FOR THE DIRECTION NORTHEAST (BET 4 AND 5) IS :
13

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
2

MAXIMUM SPEED FOR THE DIRECTION EAST NORTHEAST (BET 6 AND 7) IS :
14

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION EAST (BET 8 AND 10) IS :
18

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION EAST (BET 11 AND 12) SOUTHEAST IS :
20

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTHEAST (BET 13 AND 14) IS :
16

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
2

MAXIMUM SPEED OF WIND FOR EACH DIRECTION FOR THE YAEK 1973 (CONT.)

DATE: SEPTEMBER 12, 1986

FA

MAXIMUM SPEED FOR THE DIRECTION SOUTH SOUTHEAST (BET 15 AND 16) IS :
14

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTH (BET 17 AND 18) IS :
7

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTH SOUTHWEST (BET 19 AND 20) IS :
11

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTHWEST (BET 21 AND 23) IS :
17

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION WEST SOUTHWEST (BET 24 AND 25) IS :
20

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION WEST (BET 26 AND 27) IS :
14

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION WEST NORTHWEST (BET 28 AND 29) IS :
17

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
2

MAXIMUM SPEED FOR THE DIRECTION NORTHWEST (BET 30 AND 32) IS :
21

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION NORTH NORTHWEST (BET 33 AND 34) IS :
20

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

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MAXIMUM SPEED OF WIND FOR EACH DIRECTION FOR THE YAEER 194

MAXIMUM SPEED FOR THE DIRECTION NORTH (BET 35 AND 0) IS :

15

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):

1

MAXIMUM SPEED FOR THE DIRECTION NORTH NORTHEAST (BET 1 AND 3) IS :

15

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):

2

MAXIMUM SPEED FOR THE DIRECTION NORTHEAST (BET 4 AND 5) IS :

12

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):

1

MAXIMUM SPEED FOR THE DIRECTION EAST NORTHEAST (BET 6 AND 7) IS :

12

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):

4

MAXIMUM SPEED FOR THE DIRECTION EAST (BET 8 AND 10) IS :

15

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):

1

MAXIMUM SPEED FOR THE DIRECTION EAST (BET 11 AND 12) SOUTHEAST IS :

18

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):

1

MAXIMUM SPEED FOR THE DIRECTION SOUTHEAST (BET 13 AND 14) IS :

15

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):

2

MAXIMUM SPEED OF WIND FOR EACH DIRECTION FOR THE YAER 194 (CONT.)

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PAGE

MAXIMUM SPEED FOR THE DIRECTION SOUTH SOUTHEAST (BET 15 AND 16) IS :
17

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTH (BET 17 AND 18) IS :
13

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTH SOUTHWEST (BET 19 AND 20) IS :
13

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTHWEST (BET 21 AND 23) IS :
34

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION WEST SOUTHWEST (BET 24 AND 25) IS :
16

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
2

MAXIMUM SPEED FOR THE DIRECTION WEST (BET 26 AND 27) IS :
14

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION WEST NORTHWEST (BET 28 AND 29) IS :
22

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION NORTHWEST (BET 30 AND 32) IS :
27

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
2

MAXIMUM SPEED FOR THE DIRECTION NORTH NORTHWEST (BET 33 AND 34) IS :
14

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
2

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MAXIMUM SPEED OF WIND FOR EACH DIRECTION FOR THE YAEER 1975

MAXIMUM SPEED FOR THE DIRECTION NORTH (BET 35 AND 0) IS :
17

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION NORTH NORTHEAST (BET 1 AND 3) IS :
15

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION NORTHEAST (BET 4 AND 5) IS :
14

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION EAST NORTHEAST (BET 6 AND 7) IS :
14

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION EAST (BET 8 AND 10) IS :
19

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION EAST (BET 11 AND 12) SOUTHEAST IS :
20

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
3

MAXIMUM SPEED FOR THE DIRECTION SOUTHEAST (BET 13 AND 14) IS :
16

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED OF WIND FOR EACH DIRECTION FOR THE YAEF 1975 (CONT.)

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PAGE

MAXIMUM SPEED FOR THE DIRECTION SOUTH SOUTHEAST (BET 15 AND 16) IS :
15

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTH (BET 17 AND 18) IS :
16

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTH SOUTHWEST (BET 19 AND 20) IS :
18

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTHWEST (BET 21 AND 23) IS :
27

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION WEST SOUTHWEST (BET 24 AND 25) IS :
20

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION WEST (BET 26 AND 27) IS :
18

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION WEST NORTHWEST (BET 28 AND 29) IS :
23

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION NORTHWEST (BET 30 AND 32) IS :
23

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
2

MAXIMUM SPEED FOR THE DIRECTION NORTH NORTHWEST (BET 33 AND 34) IS :
21

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

GLOBETROTTERS ENGINEERING CORPORATION
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MAXIMUM SPEED OF WIND FOR EACH DIRECTION FOR THE YAEK 1976

MAXIMUM SPEED FOR THE DIRECTION NORTH (BET 35 AND 0) IS :
15

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
3

MAXIMUM SPEED FOR THE DIRECTION NORTH NORTHEAST (BET 1 AND 3) IS :
15

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION NORTHEAST (BET 4 AND 5) IS :
15

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
2

MAXIMUM SPEED FOR THE DIRECTION EAST NORTHEAST (BET 6 AND 7) IS :
14

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION EAST (BET 8 AND 10) IS :
16

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
2

MAXIMUM SPEED FOR THE DIRECTION EAST (BET 11 AND 12) SOUTHEAST IS :
21

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTHEAST (BET 13 AND 14) IS :
14

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
2

MAXIMUM SPEED OF WIND FOR EACH DIRECTION FOR THE YAEK 1976 (CONT.)

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MAXIMUM SPEED FOR THE DIRECTION SOUTH SOUTHEAST (BET 15 AND 16) IS :
14

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
2

MAXIMUM SPEED FOR THE DIRECTION SOUTH (BET 17 AND 18) IS :
14

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
2

MAXIMUM SPEED FOR THE DIRECTION SOUTH SOUTHWEST (BET 19 AND 20) IS :
15

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTHWEST (BET 21 AND 23) IS :
15

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
2

MAXIMUM SPEED FOR THE DIRECTION WEST SOUTHWEST (BET 24 AND 25) IS :
14

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION WEST (BET 26 AND 27) IS :
16

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION WEST NORTHWEST (BET 28 AND 29) IS :
31

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION NORTHWEST (BET 30 AND 32) IS :
25

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
2

MAXIMUM SPEED FOR THE DIRECTION NORTH NORTHWEST (BET 33 AND 34) IS :
15

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

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MAXIMUM SPEED OF WIND FOR EACH DIRECTION FOR THE YAEER 1977

MAXIMUM SPEED FOR THE DIRECTION NORTH (BET 35 AND 0) IS :
16

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION NORTH NORTHEAST (BET 1 AND 3) IS :
15

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION NORTHEAST (BET 4 AND 5) IS :
12

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION EAST NORTHEAST (BET 6 AND 7) IS :
16

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION EAST (BET 8 AND 10) IS :
16

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION EAST (BET 11 AND 12) SOUTHEAST IS :
22

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTHEAST (BET 13 AND 14) IS :
15

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED OF WIND FOR EACH DIRECTION FOR THE YAEER 1977 (CONT.)

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PAGE

MAXIMUM SPEED FOR THE DIRECTION SOUTH SOUTHEAST (BET 15 AND 16) IS :
13

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTH (BET 17 AND 18) IS :
12

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
2

MAXIMUM SPEED FOR THE DIRECTION SOUTH SOUTHWEST (BET 19 AND 20) IS :
13

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
2

MAXIMUM SPEED FOR THE DIRECTION SOUTHWEST (BET 21 AND 23) IS :
15

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION WEST SOUTHWEST (BET 24 AND 25) IS :
15

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION WEST (BET 26 AND 27) IS :
20

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION WEST NORTHWEST (BET 28 AND 29) IS :
24

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION NORTHWEST (BET 30 AND 32) IS :
26

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION NORTH NORTHWEST (BET 33 AND 34) IS :
16

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

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MAXIMUM SPEED OF WIND FOR EACH DIRECTION FOR THE YEAR 1978

MAXIMUM SPEED FOR THE DIRECTION NORTH (BET 35 AND 0) IS :
20

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION NORTH NORTHEAST (BET 1 AND 3) IS :
19

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION NORTHEAST (BET 4 AND 5) IS :
12

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION EAST NORTHEAST (BET 6 AND 7) IS :
15

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION EAST (BET 8 AND 10) IS :
15

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION EAST (BET 11 AND 12) SOUTHEAST IS :
20

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTHEAST (BET 13 AND 14) IS :
16

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED OF WIND FOR EACH DIRECTION FOR THE YAER 1978 (CONT.)

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MAXIMUM SPEED FOR THE DIRECTION SOUTH SOUTHEAST (BET 15 AND 16) IS :
11

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTH (BET 17 AND 18) IS :
10

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
2

MAXIMUM SPEED FOR THE DIRECTION SOUTH SOUTHWEST (BET 19 AND 20) IS :
12

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTHWEST (BET 21 AND 23) IS :
14

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION WEST SOUTHWEST (BET 24 AND 25) IS :
12

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION WEST (BET 26 AND 27) IS :
13

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
4

MAXIMUM SPEED FOR THE DIRECTION WEST NORTHWEST (BET 28 AND 29) IS :
20

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
2

MAXIMUM SPEED FOR THE DIRECTION NORTHWEST (BET 30 AND 32) IS :
30

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION NORTH NORTHWEST (BET 33 AND 34) IS :
20

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

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MAXIMUM SPEED OF WIND FOR EACH DIRECTION FOR THE YAEER *1979

MAXIMUM SPEED FOR THE DIRECTION NORTH (BET 35 AND 0) IS :
15

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION NORTH NORTHEAST (BET 1 AND 3) IS :
15

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
2

MAXIMUM SPEED FOR THE DIRECTION NORTHEAST (BET 4 AND 5) IS :
17

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION EAST NORTHEAST (BET 6 AND 7) IS :
14

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION EAST (BET 8 AND 10) IS :
16

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION EAST (BET 11 AND 12) SOUTHEAST IS :
24

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTHEAST (BET 13 AND 14) IS :
16

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
2

MAXIMUM SPEED OF WIND FOR EACH DIRECTION FOR THE YAEK #1979 (CONT.)

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PAGE

MAXIMUM SPEED FOR THE DIRECTION SOUTH SOUTHEAST (BET 15 AND 16) IS :
13

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
2

MAXIMUM SPEED FOR THE DIRECTION SOUTH (BET 17 AND 18) IS :
8

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTH SOUTHWEST (BET 19 AND 20) IS :
11

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
2

MAXIMUM SPEED FOR THE DIRECTION SOUTHWEST (BET 21 AND 23) IS :
13

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION WEST SOUTHWEST (BET 24 AND 25) IS :
15

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION WEST (BET 26 AND 27) IS :
18

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION WEST NORTHWEST (BET 28 AND 29) IS :
22

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION NORTHWEST (BET 30 AND 32) IS :
30

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
2

MAXIMUM SPEED FOR THE DIRECTION NORTH NORTHWEST (BET 33 AND 34) IS :
15

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

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MAXIMUM SPEED OF WIND FOR EACH DIRECTION FOR THE YEAR *1980

MAXIMUM SPEED FOR THE DIRECTION NORTH (BET 35 AND 0) IS :
14

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION NORTH NORTHEAST (BET 1 AND 3) IS :
15

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION NORTHEAST (BET 4 AND 5) IS :
13

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
2

MAXIMUM SPEED FOR THE DIRECTION EAST NORTHEAST (BET 6 AND 7) IS :
18

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION EAST (BET 8 AND 10) IS :
16

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION EAST (BET 11 AND 12) SOUTHEAST IS :
20

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTHEAST (BET 13 AND 14) IS :
24

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED OF WIND FOR EACH DIRECTION FOR THE YEAR *1980 (CONT.)

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MAXIMUM SPEED FOR THE DIRECTION SOUTH SOUTHEAST (BET 15 AND 16) IS :
19

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTH (BET 17 AND 18) IS :
13

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTH SOUTHWEST (BET 19 AND 20) IS :
12

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTHWEST (BET 21 AND 22) IS :
22

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION WEST SOUTHWEST (BET 24 AND 25) IS :
18

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION WEST (BET 26 AND 27) IS :
28

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION WEST NORTHWEST (BET 28 AND 29) IS :
24

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION NORTHWEST (BET 30 AND 31) IS :
24

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION NORTH NORTHWEST (BET 32 AND 33) IS :
13

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

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MAXIMUM SPEED OF WIND FOR EACH DIRECTION FOR THE YAEK *1981

MAXIMUM SPEED FOR THE DIRECTION NORTH (BET 35 AND 0) IS :
17

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION NORTH NORTHEAST (BET 1 AND 3) IS :
12

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
2

MAXIMUM SPEED FOR THE DIRECTION NORTHEAST (BET 4 AND 5) IS :
15

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION EAST NORTHEAST (BET 6 AND 7) IS :
12

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION EAST (BET 8 AND 10) IS :
11

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION EAST (BET 11 AND 12) SOUTHEAST IS :
16

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
3

MAXIMUM SPEED FOR THE DIRECTION SOUTHEAST (BET 13 AND 14) IS :
16

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
:

MAXIMUM SPEED OF WIND FOR EACH DIRECTION FOR THE YAEK *1981 (CONT.)

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PAGE

MAXIMUM SPEED FOR THE DIRECTION SOUTH SOUTHEAST (BET 15 AND 16) IS :
14

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTH (BET 17 AND 18) IS :
13

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTH SOUTHWEST (BET 19 AND 20) IS :
13

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTHWEST (BET 21 AND 23) IS :
15

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION WEST SOUTHWEST (BET 24 AND 25) IS :
14

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION WEST (BET 26 AND 27) IS :
15

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION WEST NORTHWEST (BET 28 AND 29) IS :
20

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION NORTHWEST (BET 30 AND 32) IS :
26

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION NORTH NORTHWEST (BET 33 AND 34) IS :
15

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
3

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MAXIMUM SPEED OF WIND FOR EACH DIRECTION FOR THE YAEER *1982

MAXIMUM SPEED FOR THE DIRECTION NORTH (BET 35 AND 0) IS :

17

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):

1

MAXIMUM SPEED FOR THE DIRECTION NORTH NORTHEAST (BET 1 AND 3) IS :

14

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):

1

MAXIMUM SPEED FOR THE DIRECTION NORTHEAST (BET 4 AND 5) IS :

17

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):

1

MAXIMUM SPEED FOR THE DIRECTION EAST NORTHEAST (BET 6 AND 7) IS :

16

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):

1

MAXIMUM SPEED FOR THE DIRECTION EAST (BET 8 AND 10) IS :

23

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):

1

MAXIMUM SPEED FOR THE DIRECTION EAST (BET 11 AND 12) SOUTHEAST IS :

24

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):

2

MAXIMUM SPEED FOR THE DIRECTION SOUTHEAST (BET 13 AND 14) IS :

21

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):

2

MAXIMUM SPEED OF WIND FOR EACH DIRECTION FOR THE YAEK *1982 (CONT.)

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PAGE

MAXIMUM SPEED FOR THE DIRECTION SOUTH SOUTHEAST (BET 13 AND 16) IS :
16

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTH (BET 17 AND 18) IS :
10

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
4

MAXIMUM SPEED FOR THE DIRECTION SOUTH SOUTHWEST (BET 19 AND 20) IS :
16

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTHWEST (BET 21 AND 23) IS :
20

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION WEST SOUTHWEST (BET 24 AND 25) IS :
20

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION WEST (BET 26 AND 27) IS :
16

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION WEST NORTHWEST (BET 28 AND 29) IS :
30

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION NORTHWEST (BET 30 AND 32) IS :
27

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION NORTH NORTHWEST (BET 33 AND 34) IS :
20

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
2

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MAXIMUM SPEED OF WIND FOR EACH DIRECTION FOR THE YAEER *1983

MAXIMUM SPEED FOR THE DIRECTION NORTH (BET 35 AND 0) IS :
15

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION NORTH NORTHEAST (BET 1 AND 3) IS :
16

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION NORTHEAST (BET 4 AND 5) IS :
15

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION EAST NORTHEAST (BET 6 AND 7) IS :
16

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION EAST (BET 8 AND 10) IS :
17

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION EAST (BET 11 AND 12) SOUTHEAST IS :
15

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
6

MAXIMUM SPEED FOR THE DIRECTION SOUTHEAST (BET 13 AND 14) IS :
15

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
2

MAXIMUM SPEED OF WIND FOR EACH DIRECTION FOR THE YAEK *1983 (CONT.)

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PAGE

MAXIMUM SPEED FOR THE DIRECTION SOUTH SOUTHEAST (BET 15 AND 16) IS :
15

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTH (BET 17 AND 18) IS :
14

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
2

MAXIMUM SPEED FOR THE DIRECTION SOUTH SOUTHWEST (BET 19 AND 20) IS :
14

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
2

MAXIMUM SPEED FOR THE DIRECTION SOUTHWEST (BET 21 AND 23) IS :
18

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION WEST SOUTHWEST (BET 24 AND 25) IS :
13

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
2

MAXIMUM SPEED FOR THE DIRECTION WEST (BET 26 AND 27) IS :
15

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION WEST NORTHWEST (BET 28 AND 29) IS :
16

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION NORTHWEST (BET 30 AND 32) IS :
20

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION NORTH NORTHWEST (BET 33 AND 34) IS :
14

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

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MAXIMUM SPEED OF WIND FOR EACH DIRECTION FOR THE YAEF *1984

MAXIMUM SPEED FOR THE DIRECTION NORTH (BET 35 AND 0) IS :
18

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION NORTH NORTHEAST (BET 1 AND 3) IS :
20

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION NORTHEAST (BET 4 AND 5) IS :
16

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION EAST NORTHEAST (BET 6 AND 7) IS :
13

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION EAST (BET 8 AND 10) IS :
14

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION EAST (BET 11 AND 12) SOUTHEAST IS :
20

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTHEAST (BET 13 AND 14) IS :
17

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
2

MAXIMUM SPEED OF WIND FOR EACH DIRECTION FOR THE YAER *1984 (CONT.)

DATE: SEPTEMBER 12. 1986

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MAXIMUM SPEED FOR THE DIRECTION SOUTH SOUTHEAST (BET 15 AND 16) IS :
12

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTH (BET 17 AND 18) IS :
12

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTH SOUTHWEST (BET 19 AND 20) IS :
19

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTHWEST (BET 21 AND 23) IS :
21

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION WEST SOUTHWEST (BET 24 AND 25) IS :
20

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
2

MAXIMUM SPEED FOR THE DIRECTION WEST (BET 26 AND 27) IS :
19

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION WEST NORTHWEST (BET 28 AND 29) IS :
25

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION NORTHWEST (BET 30 AND 32) IS :
28

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION NORTH NORTHWEST (BET 33 AND 34) IS :
18

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

GLOBETROTTERS ENGINEERING CORPORATION
CHICAGO, ILLINOIS
=====

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MAXIMUM SPEED OF WIND FOR EACH DIRECTION FOR THE YAEK *1985

MAXIMUM SPEED FOR THE DIRECTION NORTH (BET 35 AND 0) IS :
21

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION NORTH NORTHEAST (BET 1 AND 3) IS :
20

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION NORTHEAST (BET 4 AND 5) IS :
22

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION EAST NORTHEAST (BET 6 AND 7) IS :
15

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION EAST (BET 8 AND 10) IS :
20

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION EAST (BET 11 AND 12) SOUTHEAST IS :
20

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTHEAST (BET 13 AND 14) IS :
15

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED OF WIND FOR EACH DIRECTION FOR THE YAEK #1985 (CONT.)

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PAGE

MAXIMUM SPEED FOR THE DIRECTION SOUTH SOUTHEAST (BET 15 AND 16) IS :
12

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTH (BET 17 AND 18) IS :
11

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTH SOUTHWEST (BET 19 AND 20) IS :
10

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
4

MAXIMUM SPEED FOR THE DIRECTION SOUTHWEST (BET 21 AND 23) IS :
22

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
2

MAXIMUM SPEED FOR THE DIRECTION WEST SOUTHWEST (BET 24 AND 25) IS :
12

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION WEST (BET 26 AND 27) IS :
14

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION WEST NORTHWEST (BET 28 AND 29) IS :
22

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION NORTHWEST (BET 30 AND 32) IS :
28

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION NORTH NORTHWEST (BET 33 AND 34) IS :
21

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

GLOBETROTTERS ENGINEERING CORPORATION
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MAXIMUM SPEED OF WIND FOR EACH DIRECTION FOR THE YAEER *1986

MAXIMUM SPEED FOR THE DIRECTION NORTH (BET 35 AND 0) IS :
20

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION NORTH NORTHEAST (BET 1 AND 3) IS :
17

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION NORTHEAST (BET 4 AND 5) IS :
14

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION EAST NORTHEAST (BET 6 AND 7) IS :
12

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION EAST (BET 8 AND 10) IS :
13

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
4

MAXIMUM SPEED FOR THE DIRECTION EAST (BET 11 AND 12) SOUTHEAST IS :
19

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTHEAST (BET 13 AND 14) IS :
19

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED OF WIND FOR EACH DIRECTION FOR THE YAEK *1986 (CONT.)

DATE: SEPTEMBER 12, 1986

PAGE

MAXIMUM SPEED FOR THE DIRECTION SOUTH SOUTHEAST (BET 15 AND 16) IS :
13

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
2

MAXIMUM SPEED FOR THE DIRECTION SOUTH (BET 17 AND 18) IS :
11

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTH SOUTHWEST (BET 19 AND 20) IS :
17

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION SOUTHWEST (BET 21 AND 23) IS :
22

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION WEST SOUTHWEST (BET 24 AND 25) IS :
15

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION WEST (BET 26 AND 27) IS :
14

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION WEST NORTHWEST (BET 28 AND 29) IS :
17

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
2

MAXIMUM SPEED FOR THE DIRECTION NORTHWEST (BET 30 AND 32) IS :
26

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1

MAXIMUM SPEED FOR THE DIRECTION NORTH NORTHWEST (BET 33 AND 34) IS :
19

NO. OBS. FOR MAX. SPEED FOR THIS DIRECTION IS (ARE):
1