

U.S. DEPARTMENT OF COMMERCE  
National Oceanic and Atmospheric Administration  
Environmental Research Laboratories

TRAVEL TIMES IN THE GREAT LAKES CONNECTING CHANNELS\*

by

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Open File Report

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## 1. INTRODUCTION

The Great Lakes connecting channels are used extensively for navigation, and a large number of industrial concerns and municipalities are located there, as well. Thus, there is a risk of oil and other spills in these channels. Because of concern about this risk, in January 1982 the Director of the Great Lakes Environmental Research Laboratory (GLERL) requested that travel time tables be prepared for the St. Clair and Detroit Rivers in support of GLERL staff on the Joint Regional Response Team. The travel time tables for these two rivers were prepared the following month. These tables, classified as preliminary, indicate travel times for the normal flows. In March 1982 the request was broadened to include all five connecting channels of the Great Lakes and other connected waterways, namely, the Illinois River complex (Illinois Waterway). A survey of the available information on travel times indicated there is adequate information at various agencies (U.S. Army Corps of Engineers, U.S. Coast Guard, and Illinois State Water Survey) for the St. Marys, St. Clair, Detroit, and Niagara Rivers and for the lower Illinois Waterway (the Illinois River proper below the confluence of the Des Plaines and Kankakee Rivers). There is inadequate information on travel times for the St. Lawrence River and the upper Illinois Waterway (consisting of the Des Plaines River, the Chicago Sanitary and Ship Canal, and the Calumet Sag Channel). The survey also showed that the preliminary travel time table for the St. Clair River is sufficiently accurate for operational use, while the accuracy of a similar table for the Detroit River is questionable and should be reevaluated.

## 2. TRAVEL TIME TABLES

The initial travel time tables for the St. Clair and Detroit Rivers were developed for the mean flow conditions; available velocity data at approximately 20 locations along the St. Clair River and 15 locations along the Detroit River were used. Since the initial table for the Detroit River was found to be insufficiently accurate for operational applications, the travel times for this river were reevaluated. This time more detailed velocity information available from the Corps of Engineers (about 25 locations) was used, so the GLERL information for both of these rivers is sufficiently accurate for operational use. The final travel times determined for the St. Clair and Detroit Rivers are listed in tables 1 and 2, respectively. The river locations used in computing travel times for the two tables are shown in figures 1 and 2, respectively.

Derivation of additional travel time tables was limited to rivers for which such information was not available from other agencies, namely, the St. Lawrence River and the upper Illinois Waterway. Because these rivers represent completely regulated complex hydraulic systems with large short-term fluctuations in flows, travel time tables developed for these rivers indicate the low and high flow conditions in addition to the mean or normal flows. The GLERL St. Lawrence River one-dimensional dynamic flow model (Potok, 1978) was modified to provide detailed velocity information along the international section of the river for the preparation of travel time tables for the three flow conditions. Velocity measurements available for a limited number of locations

TABLE 1.--*St. Clair River flow time in hours--mean flow*

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1. Blue Water Bridge	0.1																			
2. Ft. Gratiot Range	0.3	0.1																		
3. Black River	1.0	0.9	0.7																	
4. Grand Trunk Tunnel	1.5	1.4	1.2	0.5																
5. Detroit Edison	2.7	2.6	2.4	1.7	1.2															
6. Head, Stag Is.	3.2	3.1	2.9	2.2	1.7	0.5														
7. Middle, Stag Is.	3.7	3.6	3.5	2.8	2.3	1.1	0.5													
8. Stag Is. Shoal Lt.	4.5	4.4	4.3	3.6	3.1	1.9	1.3	0.8												
9. Bench Mark #45	5.5	5.3	5.2	4.4	4.0	2.8	2.3	1.7	0.9											
10. St. Clair City	6.1	6.0	5.9	5.1	4.6	3.4	2.9	2.4	1.6	0.6										
11. Harts Landing	7.4	7.2	7.1	6.4	5.9	4.7	4.2	3.6	2.8	1.9	1.3									
12. Bowens Creek	7.7	7.6	7.5	6.7	6.2	5.0	4.5	4.0	3.2	2.3	1.6	0.4								
13. Clay Creek	8.4	8.3	8.1	7.4	6.9	5.7	5.2	4.6	3.9	2.9	2.3	1.0	0.7							
14. Marine City	10.0	9.8	9.7	9.0	8.5	7.3	6.8	6.2	5.4	4.5	3.9	2.6	2.2	1.6						
15. W. Fawn Is.	10.5	10.5	10.3	9.6	9.0	7.9	7.3	6.8	6.0	5.1	4.4	3.2	2.8	2.2	0.6					
16. Salt Dock Lt.	11.1	11.0	10.8	10.1	9.6	8.4	7.9	7.3	6.5	5.6	5.0	3.7	3.4	2.7	1.1	0.5				
17. Roberts Landing	12.1	12.0	11.9	11.1	10.6	9.4	8.9	8.4	7.6	6.6	6.0	4.8	4.4	3.7	2.2	1.6	1.0			
18. Algonac Lt. #18	12.7	12.6	12.4	11.7	11.2	10.0	9.5	8.9	8.1	7.2	6.6	5.3	5.0	4.3	2.7	2.1	1.6	0.6		
19. S.E. Bend Lt.	18.1	17.9	17.8	17.1	16.6	15.4	14.9	14.3	13.5	12.6	12.0	10.7	10.4	9.7	8.1	7.5	7.0	6.0	5.4	
20. Lake St. Clair	21.2	21.1	20.9	20.2	19.7	18.5	18.0	17.4	16.7	15.7	15.1	13.8	13.5	12.8	11.2	10.6	10.1	9.1	8.5	3.1

Key: 0) Ft. Gratiot Lt., 1) Blue Water Bridge, 2) Ft. Gratiot Range, 3) Black River, 4) Grand Trunk Tunnel, 5) Detroit Edison, 6) Head, Stag Is., 7) Middle, Stag Is., 8) Stag Is. Shoal Lt., 9) Bench Mark #45, 10) St. Clair City, 11) Harts Landing, 12) Bowens Creek, 13) Clay Creek, 14) Marine City, 15) W. Fawn Is., 16) Salt Dock Lt., 17) Roberts Landing, 18) Algonac Lt. #18, 19) S.E. Bend Lt.

TABLE 2.--Detroit River flow time in hours--mean flow

	0	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Head, Belle Isle	1.1													
2. Foot, Belle Isle														
A. Main Ch.	3.5	2.4												
B. West Ch.	4.3*	3.2*												
3. Auto Tunnel	4.9	3.8	1.4											
4. Ambassador Bridge	6.3	5.2	2.8	1.4										
5. Ft. Wayne	7.3	6.2	3.8	2.4	1.0									
6. Rouge River	8.4	7.3	4.9	3.5	2.1	1.1								
7. Foot, Anchorage Area	9.6	8.5	6.1	4.7	3.3	2.3	1.2							
8. Head, Trenton Ch.	10.4	9.3	6.9	5.5	4.1	3.1	2.0	0.8						
9. Foot, Grassy Is.														
A. Main Ch.	11.6	10.5	8.1	6.7	5.3	4.3	3.2	2.0	1.2					
B. Trenton Ch.	12.1	11.0	8.6	7.2	5.8	4.8	3.7	2.5	1.7					
10. Pt. Hennepin														
A. Main Ch.	12.5	11.4	9.0	7.6	6.2	5.2	4.1	2.9	2.1	0.9				
B. Trenton Ch.	13.1	12.0	9.6	8.2	6.8	5.8	4.7	3.5	2.7	1.0				
11. Fighting Is. Shoal Lt.														
A. Main Ch.	14.3	13.2	10.8	9.4	8.0	7.0	5.9	4.7	3.9	2.7	1.8			
B. Trenton Ch. (Upper Bridge)	14.8	13.7	11.3	9.9	8.5	7.5	6.4	5.2	4.4	2.7	1.7			
12. Head, Livingstone Ch.														
A. Main Ch.	16.5	15.4	13.0	11.6	10.2	9.2	8.1	6.9	6.1	4.9	4.0	2.2		
B. Trenton Ch. (Lower Bridge)	17.6	16.5	14.1	12.7	11.3	10.3	9.2	8.0	7.2	5.5	4.5	2.8		
13. Head, Bois Blanc Is.														
A. Amherstburg Ch.	17.6	16.5	14.1	12.7	11.3	10.3	9.2	8.0	7.2	6.0	5.1	3.3	1.1	
B. Livingstone Ch.	17.5	16.4	14.0	12.6	11.2	10.2	9.1	7.9	7.1	5.9	5.0	3.2	1.0	
C. Trenton Ch. (Head, Calf Is.)	18.8	17.7	15.3	13.9	12.5	11.5	10.4	9.2	8.4	6.7	5.7	4.0	1.2	
14. Lake Erie														
A. Amherstburg Ch.	19.3	18.2	15.8	14.4	13.0	12.0	10.9	9.7	8.9	7.7	6.8	5.0	2.8	1.7
B. Livingstone Ch.	19.1	18.0	15.6	14.2	12.8	11.8	10.7	9.5	8.7	7.5	6.6	4.8	2.6	1.6
C. Trenton Ch. (Foot, Celeron Is.)	20.9	19.8	17.4	16.0	14.6	13.6	12.5	11.3	10.5	8.8	7.8	6.1	3.3	2.1

\*Note: For spills occurring in the channel west of Belle Isle, add 0.8 h to downstream travel times.

Key: 0) Windmill Pt., 1) Head, Belle Isle, 2) Foot, Belle Isle, 3) Auto Tunnel, 4) Ambassador Bridge, 5) Ft. Wayne, 6) Rouge River, 7) Foot, Anchorage Area, 8) Head, Trenton Ch., 9) Foot, Grassy Is., 10) Pt. Hennepin, 11) Fighting Is. Shoal Lt., 12) Head, Livingstone Ch., 13) Head, Bois Blanc Is.

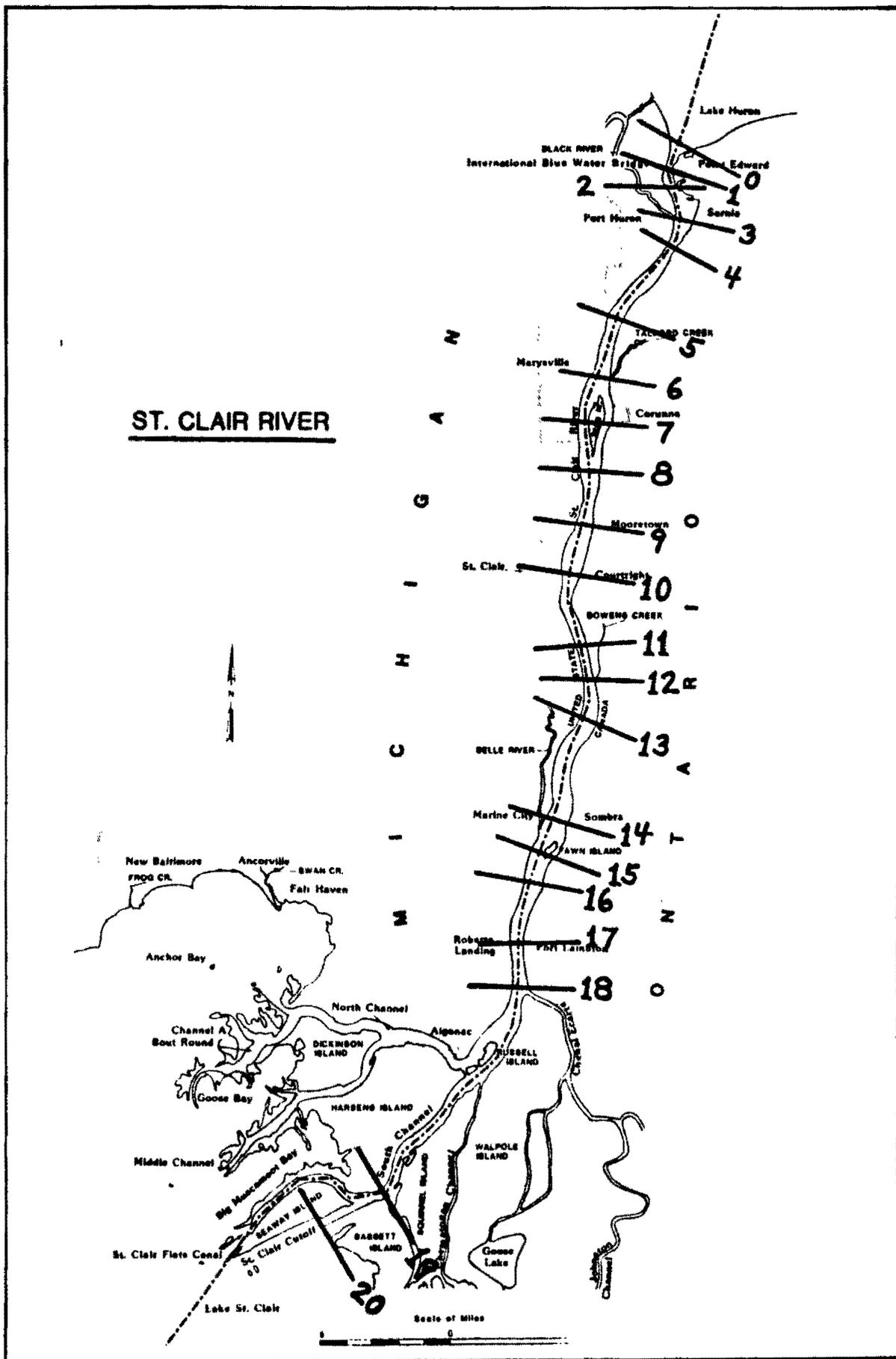


FIGURE 1.--St. Clair River travel time sections.

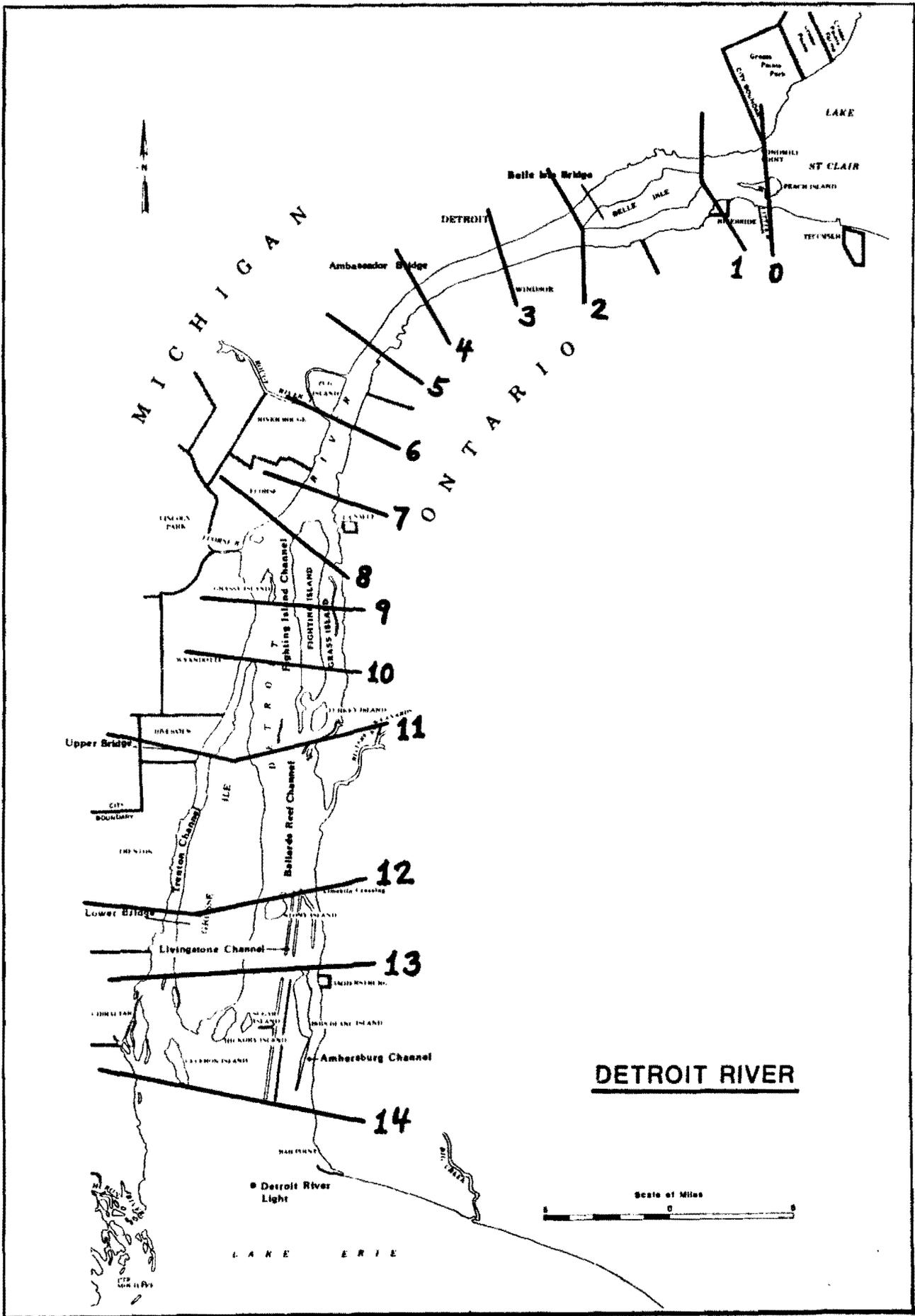


FIGURE 2.--Detroit River travel time sections.

on the St. Lawrence River were used to verify computed velocities to ensure correct travel times for listed flow conditions. The travel times determined for the low, mean, and high flow conditions of the upper St. Lawrence River are listed in tables 3a-3c, respectively, and the locations of the river sections used in the computations are shown in figure 3.

Preparation of travel time tables for the upper Illinois Waterway was started, but was subsequently found to be unnecessary and so was terminated. (See memo from J. Rodstein, dated April 25, 1983, in appendix.) A technique was developed for computing velocities in the lower Des Plaines River and the Chicago Sanitary and Ship Canal and Calumet Sag Channel, constituting the lower portion and upper branches of the upper Illinois Waterway. This technique includes an extension of the river slope method developed for the Illinois River proper by the Illinois State Water Survey (Stall and Hiestand, 1969) and velocity approximations based on estimated flows and derived cross-sectional areas. To be of practical value, these velocity estimates need verification; thus limited velocity measurements in the upper Illinois Waterway were scheduled for summer 1983. Portable current meters for this and similar work were ordered in 1982 and tested extensively during spring 1983 by the GLERL marine instrumentation laboratory. However, as indicated in the attached memo, the required information is presently available from other agencies. Consequently, development of travel time tables for the upper Illinois Waterway has been cancelled and the study terminated.

### 3. REFERENCES

- Potok, A. J. (1978): Upper St. Lawrence River hydraulic transient model, NOAA Tech. memo. ERL GLERL-24, National Technical Information Service, Springfield, Va. 22151. 101 pp.
- Stall, J. B., and Hiestand, D. W. (1969): Provisional time-of-travel for Illinois streams, Report of Investigation 63, Illinois State Water Survey, Urbana, Ill. XX pp.

TABLE 3a.--Upper St. Lawrence River time-of-travel in hours,  
low flow (188 tcfs)

	0	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Midpoint, Wolfe Is.														
a. Head, Carleton Is.	12.4													
b. The Spectacles Is.	44.8													
2. Lower Wolfe Is.														
a. Murray Bay (Main Ch.)	37.9	25.5												
b. Holiday Pt. (North Ch.)	71.7	26.9												
3. Head, Grindstone Is.														
a. Main Ch.	65.4	53.0	27.5											
b. North Ch.	141.7	96.9	70.0											
4. Foot, Grindstone Is.														
a. Main Ch.	83.2	70.8	45.3	17.8										
b. North Ch.	164.3	119.5	92.6	22.6										
5. Head, Grenadier Is.														
a. American Narrows	117.0	104.6	79.1	51.6	33.8									
b. Raft Narrows	196.5	151.7	124.8	54.8	32.2*									
6. Chippewa Pt.	134.3	121.9	96.4	68.9	51.1	17.3								
7. Brockville, Ont.	149.2	136.8	111.3	83.8	66.0	32.2	14.9							
8. Ogdensburg, N.Y.	167.8	155.4	129.9	102.4	84.6	50.8	33.5	18.6						
9. Cardinal, Ont.														
a. Main Ch.	174.0	161.6	136.1	108.6	90.8	57.0	39.7	24.8	6.2					
b. South Ch.	176.7	164.3	138.8	111.3	93.5	59.7	42.4	27.5	8.9*					
10. Morrisburg, Ont.														
a. Main Ch.	183.3	170.9	145.4	117.9	100.1	66.3	49.0	34.1	15.5	9.3				
b. Little River	184.3	171.9	146.4	118.9	101.1	67.3	50.0	35.1	16.5	10.3*				
11. Bradford Is.	191.5	179.1	153.6	126.1	108.3	74.5	57.2	42.3	23.7	17.5	8.2			
12. Head, Croil Is.	198.3	185.9	160.4	132.9	115.1	81.3	64.0	49.1	30.5	24.3	15.0	6.8		
13. Head, Long Sault Is.														
a. Main Ch.	203.5	191.1	165.6	138.1	120.3	86.5	69.2	54.3	35.7	29.5	20.2	12.0	5.2	
b. North Ch.	206.1	193.7	168.2	140.7	122.9	89.1	71.8	56.9	38.3	32.1	22.8	14.6	7.8*	
14. Midpoint, Barnhart Is.	216.2	203.8	178.3	150.8	133.0	99.2	81.9	67.0	48.4	42.2	32.9	24.7	17.9	12.7

\*For spills occurring in the following minor channels, add the corresponding value to downstream travel times--  
Raft Narrows: 79.5 h., Channel South of Galop Is.: 2.7 h., Little River (Ogden Is.): 1.0 h, Channel North of  
Croil Is.: 2.6 hrs.

Key: 0) Lake Ontario (Kingston/Cape Vincent), 1) Midpoint, Wolfe Is., 2) Lower Wolfe Is., 3) Head, Grindstone Is.,  
4) Foot, Grindstone Is., 5) Head, Grenadier Is., 6) Chippewa Pt., 7) Brockville, Ont., 8) Ogdensburg, N.Y.,  
9) Cardinal, Ont., 10) Morrisburg, Ont., 11) Bradford Is., 12) Head, Croil Is., 13) Head, Long Sault Is.

TABLE 3b.--Upper St. Lawrence River time-of-travel in hours,  
mean flow (254 cfs)

	0	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Midpoint, Wolfe Is.														
a. Head, Carleton Is.	9.4													
b. The Spectacles Is.	33.6													
2. Lower Wolfe Is.														
a. Murray Bay (Main Ch.)	28.9	19.5												
b. Holiday Pt. (North Ch.)	53.8	20.2												
3. Head, Grindstone Is.														
a. Main Ch.	49.8	40.4	20.9											
b. North Ch.	106.6	73.0	52.8											
4. Foot, Grindstone Is.														
a. Main Ch.	63.5	54.1	34.6	13.7										
b. North Ch.	123.8	90.2	70.0	17.2										
5. Head, Grenadier Is.														
a. American Narrows	89.2	79.8	60.3	39.4	25.7									
b. Raft Narrows	148.0	114.4	94.2	41.4	24.2*									
6. Chippewa Pt.	102.4	93.0	73.5	52.6	38.9	13.2								
7. Brockville, Ont.	113.8	104.4	84.9	64.0	50.3	24.6	11.4							
8. Ogdensburg, N.Y.	127.9	118.5	99.0	78.1	64.4	38.7	25.5	14.1						
9. Cardinal, Ont.														
a. Main Ch.	132.6	123.2	103.7	82.8	69.1	43.4	30.2	18.8	4.7					
b. South Ch.	134.6	125.2	105.7	84.8	71.1	45.4	32.2	20.8	6.7*					
10. Morrisburg, Ont.														
a. Main Ch.	139.5	130.1	110.6	89.7	76.0	50.3	37.1	25.7	11.6	6.9				
b. Little River	140.2	130.8	111.3	90.4	76.7	51.0	37.8	26.4	12.3	7.6*				
11. Bradford Is.	145.5	136.1	116.6	95.7	82.0	56.3	43.1	31.7	17.6	12.9	6.0			
12. Head, Croll Is.	150.5	141.1	121.6	100.7	87.0	61.3	48.1	36.7	22.6	17.9	11.0	5.0		
13. Head, Long Sault Is.														
a. Main Ch.	154.3	144.9	125.4	104.5	90.8	65.1	51.9	40.5	26.4	21.7	14.8	8.8	3.8	
b. North Ch.	156.2	146.8	127.3	106.4	92.7	67.0	53.8	42.4	28.3	23.6	16.7	10.7	5.7*	
14. Midpoint, Barnhart Is.	163.6	154.2	134.7	113.8	100.1	74.4	61.2	49.8	35.7	31.0	24.1	18.1	13.1	9.3

\* For spills occurring in the following minor channels, add the corresponding value to downstream travel times--  
Raft Narrows: 58.8 h, Channel South of Galop Island: 2.0 h, Little River (Ogden Is.): 0.7 h, Channel North of  
Croll Is.: 1.9 hrs.

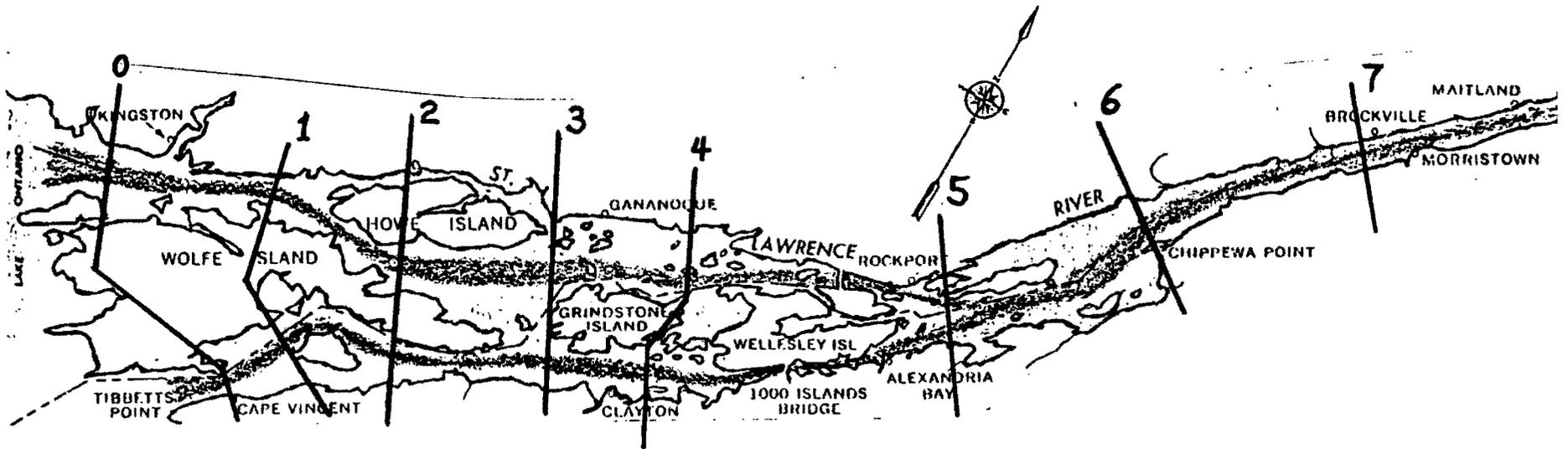
Key: 0) Lake Ontario (Kingston/Cape Vincent), 1) Midpoint, Wolfe Is., 2) Lower Wolfe Is., 3) Head, Grindstone Is.,  
4) Foot, Grindstone Is., 5) Head, Grenadier Is., 6) Chippewa Pt., 7) Brockville, Ont., 8) Ogdensburg, N.Y.,  
9) Cardinal, Ont., 10) Morrisburg, Ont., 11) Bradford Is., 12) Head, Croll Is., 13) Head, Long Sault Is.

TABLE 3c.--Upper St. Lawrence River time-of-travel in hours,  
high flow (319 tefs)

	0	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Midpoint, Wolfe Is.														
a. Head, Carleton Is.	7.8													
b. The Spectacles Is.	27.4													
2. Lower Wolfe Is.														
a. Murray Bay (Main Ch.)	24.0	16.2												
b. Holiday Pt. (North Ch.)	43.8	16.4												
3. Head, Grindstone Is.														
a. Main Ch.	41.4	33.6	17.4											
b. North Ch.	87.0	59.6	43.2											
4. Foot, Grindstone Is.														
a. Main Ch.	52.8	45.0	28.8	11.4										
b. North Ch.	101.2	73.8	57.4	14.2										
5. Head, Grenadier Is.														
a. American Narrows	74.1	66.3	50.1	32.7	21.3									
b. Raft Narrows	120.8	93.4	77.0	33.8	19.6*									
6. Chippewa Pt.	85.2	77.4	61.2	43.8	32.4	11.1								
7. Brockville, Ont.	94.7	86.9	70.7	53.3	41.9	20.6	9.5							
8. Ogdensburg, N.Y.	106.4	98.6	82.4	65.0	53.6	32.3	21.2	11.7						
9. Cardinal, Ont.														
a. Main Ch.	110.3	102.5	86.3	68.9	57.5	36.2	25.1	15.6	3.9					
b. South Ch.	111.9	104.1	87.9	70.5	59.1	37.8	26.7	17.2	5.5*					
10. Morrisburg, Ont.														
a. Main Ch.	115.9	108.1	91.9	74.5	63.1	41.8	30.7	21.2	9.5	5.6				
b. Little River	116.5	108.7	92.5	75.1	63.7	42.4	31.3	21.8	10.1	6.2*				
11. Bradford Is.	120.7	112.9	96.7	79.3	67.9	46.6	35.5	26.0	14.3	10.4	4.8			
12. Head, Croll Is.	124.7	116.9	100.7	83.3	71.9	50.6	39.5	30.0	18.3	14.4	8.8	4.0		
13. Head, Long Sault Is.														
a. Main Ch.	127.7	119.9	103.7	86.3	74.9	53.6	42.5	33.0	21.3	17.4	11.8	7.0	3.0	
b. North Ch.	129.3	121.5	105.3	87.9	76.5	55.2	44.1	34.6	22.9	19.0	13.4	8.6	4.6*	
14. Midpoint, Barnhart Is.	135.1	127.3	111.1	93.7	82.3	61.0	49.9	40.4	28.7	24.8	19.2	14.4	10.4	7.4

\*For spills occurring in the following minor channels, add the corresponding value to downstream travel times--  
Raft Narrows: 46.7 h, Channel South of Galop Is.: 1.6 h, Little River (Ogden Is.): 0.6 h, Channel North of  
Croll Island: 1.6 h.

Key: 0) Lake Ontario (Kingston/Cape Vincent), 1) Midpoint, Wolfe Is., 2) Lower Wolfe Is., 3) Head, Is., 4) Foot,  
Grindstone Is., 5) Head, Grenadier Is., 6) Chippewa Pt., 7) Brockville, Ont., 8) Ogdensburg, N.Y.,  
9) Cardinal, Ont., 10) Morrisburg, Ont., 11) Bradford Is., 12) Head, Croll Is., 13) Head, Long Sault Is.



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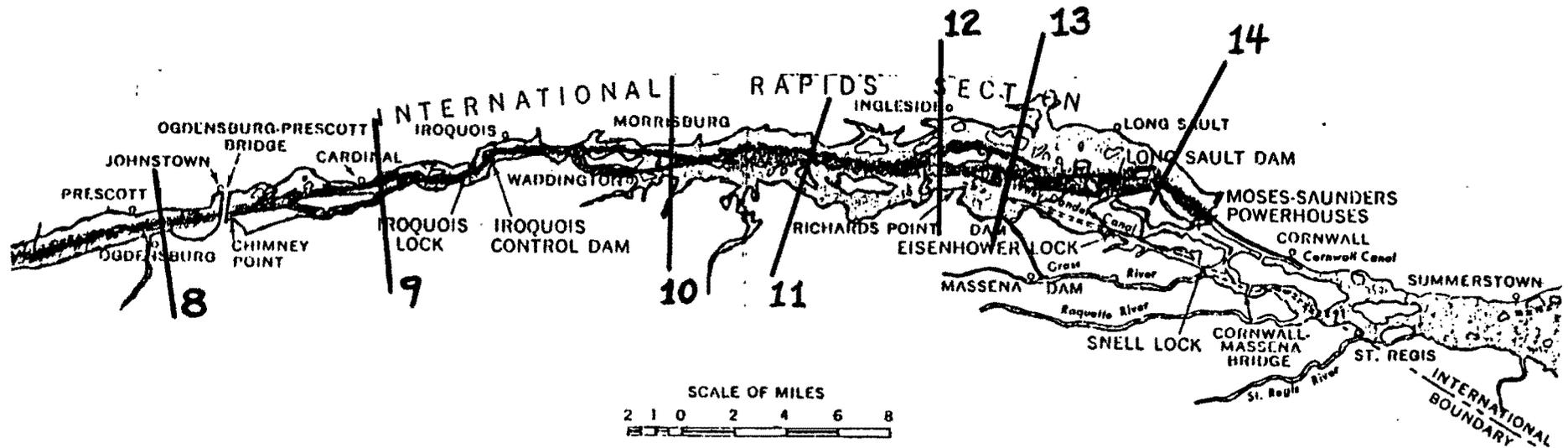


FIGURE 3.--Upper St. Lawrence River travel time sections.

Appendix--MEMO FROM J. RODSTEIN



**U.S. DEPARTMENT OF COMMERCE**  
**National Oceanic and Atmospheric Administration**  
ENVIRONMENTAL RESEARCH LABORATORIES

Great Lakes Environmental Research Laboratory  
2300 Washtenaw Avenue  
Ann Arbor, Michigan 48104

April 25, 1983

TO: Dr. Frank Quinn  
FROM: Jay Rodstein *JR*  
SUBJECT: Illinois River Hydraulic Model

Communications with the U.S. Coast Guard Chicago Marine Safety Office and Chicago Corps of Engineers indicates that there is adequate knowledge of the hydraulics of the Illinois River System. Therefore, there is no present need for your group to pursue this project.

