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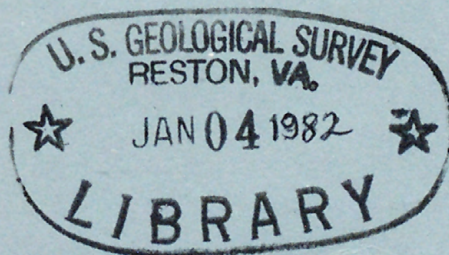
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UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

TIME OF TRAVEL OF SOLUTES IN THE VERMILION RIVER, LOUISIANA

Open-File Report 81-1065

Prepared in cooperation with the
Louisiana Department of Transportation
and Development, Office of Public Works





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By Anthony J. Calandro

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(United States
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Baton Rouge, Louisiana

1981

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FACTORS FOR CONVERTING INCH-POUND UNITS TO INTERNATIONAL SYSTEM (SI)
OF METRIC UNITS

<u>Multiply</u>	<u>By</u>	<u>To obtain</u>
cubic foot per second (ft ³ /s)	28.32	liter per second (L/s)
	0.02832	cubic meter per second (m ³ /s)
foot (ft)	0.3048	meter (m)
foot per second (ft/s)	0.3048	meter per second (m/s)
gallon per minute (gal/min)	0.06308	liter per second (L/s)
inch (in.)	2.540	centimeter (cm)
	25.40	millimeter (mm)
mile (mi)	1.609	kilometer (km)
mile per hour (mi/h)	1.609	kilometer per hour (km/h)
pound (lb)	0.4536	kilogram (kg)

TIME OF TRAVEL OF SOLUTES IN THE VERMILION RIVER, LOUISIANA

By Anthony J. Calandro

ABSTRACT

Dye-tracer studies were made in November 1978 and in June 1979 to define streamflow patterns in the Vermilion River. For the November 1978 study the tracer was injected at two locations, Surrey Street in Lafayette and about 7 miles downstream at State Highway 3073; the discharge at Surrey Street at the time of injection was 200 cubic feet per second. The two dye clouds merged at Broussard Cemetery, about 12.2 miles downstream from Surrey Street, after an elapsed time of about 270 hours. After 438 hours the dye cloud extended from the Abbeville bridge (Louisiana Highway 14 Bypass) upstream about 14.5 miles.

In June 1979, a tracer was injected into the river at Surrey Street at Lafayette; the discharge at Surrey Street at the time of injection was 375 cubic feet per second. Forty-two hours after injection the leading edge of the tracer was located at the Milton pumping plant, 14 miles downstream from the injection site. The average pumping rate of the plant during the study was 440 cubic feet per second. Ninety hours after injection, no indication of the tracer was found in the river, but the tracer was found in a rice-irrigation canal at State Highway 14, about 10 miles west of Abbeville.

INTRODUCTION

Streamflow patterns in tide-affected coastal areas are very complex, varying with flow into the system, wind direction, channel morphology, tidal stage, and direction. The standard techniques for defining the flow characteristics become less applicable than in upstream reaches. Knowledge of the flow characteristics is important when problems associated with discharge of pollutants into the stream system occur. Stage-velocity relations for sites in such environments, are very difficult if not impossible to obtain.

Dye-tracer studies can provide information on streamflow patterns in an estuarine environment to aid planners in making decisions. The purpose of this report is to summarize data collected by the U.S. Geological Survey during tracer studies made November 1978 and June 1979 of the Vermilion River below Surrey Street in Lafayette. The study was made possible by a cooperative agreement between the Geological Survey and the Louisiana Department of Transportation and Development, Office of Public Works.

DESCRIPTION OF RIVER

The Vermilion River heads at the confluence of Bayou Fusilier and Bayou Carencro along the northern border of Lafayette Parish and flows in a southerly direction for about 75 mi to its mouth at Vermilion Bay. A map of the river between Abbeville and Lafayette is shown in figure 1. The river is navigable from its mouth (near the Intra-coastal Waterway) to the city of Lafayette. Most of the low-water flow of the river is supplied from outside the basin; water is diverted from Bayou Teche through Bayou Fusilier and Ruth Canal. The flow through Bayou Fusilier is uncontrolled and depends on the relative stages of Bayou Teche and Vermilion River. The flow through Ruth Canal is regulated by gates, and the amount of diversion at low flow depends upon requirements for maintaining a minimum flow in Bayou Teche below the point of diversion. The flow of the Vermilion River is affected by tidal fluctuations at all stages and the flow direction can reverse, depending on the tide and discharge. Diversion by pumping for rice irrigation generally occurs during the period March through August.

Construction began in 1976 on a structure to divert about 1,050-1,300 ft³/s (cubic feet per second) of water from the Atchafalaya River near Krotz Springs to the Teche-Vermilion basins for municipal, industrial, and irrigation needs, and for water-quality controls. Completion of the structure is scheduled for late 1982. Streamflow patterns should change significantly when the additional water is added to the system.

DYE STUDIES ON THE VERMILION RIVER

A dye tracer, Rhodamine WT, (20 percent), was used for two studies of flow patterns of the Vermilion River. During both studies water samples were taken at the water surface for dye-tracer analysis. Samples were taken at about 48-hour intervals at downstream sites to locate the leading edge, peak concentration, and trailing edge of the dye cloud.

Study of November 1978

One hundred and fifty pounds of the dye tracer was injected into the river at Surrey Street (site A) and 100 pounds at State Highway 3073 (site B) on November 1. (See fig. 1.) The instantaneous discharge of the river at the time of dye injection was estimated to be about 200 ft³/s. However, based on stage records, the estimated mean daily discharge at Surrey Street was negative for the period November 1 through 21, except November 17, indicating a predominance of upstream flow during the period. The recorded stage indicated that tidal fluctuations caused the discharge to vary from approximately 375 ft³/s upstream to approximately 200 ft³/s downstream at Surrey Street.

According to the National Weather Service office at Lafayette, the average wind speed in the area was about 8 mi/h (miles per hour) for the period November 1 through 21; the wind was generally out of the north-northeast. About 0.36 in. of rainfall occurred at Lafayette on November 19 and 20. An additional 3.3 in. fell November 26 and 27.

Figures 1-9 show the locations of tracer clouds A and B determined by sampling during the period November 1 through 20.

On November 2 (24 hours after injection) tracer cloud A was about 1.8 mi in length, extending from Pinhook Road upstream to the Southern Pacific railroad bridge (fig. 2). Tracer cloud B was about 2.7 mi in length, extending from the pipeline near Simon Cemetery to Cobb Cemetery (fig. 2). The two clouds merged at Broussard Cemetery after an elapsed time of about 270 hours (fig. 8). On November 20, 1978, the cloud extended from the Abbeville bridge (Louisiana Highway 14 Bypass) upstream about 14.5 mi (fig. 9). The peak concentration of the merged tracer cloud at the water surface was found near Gallet Cemetery. No indication of the tracer cloud was found during an inspection on November 28, 1978.

The dye study indicates a net downstream movement of water at the surface. The best estimates of discharge at Surrey Street, made from stage records, indicate a net movement of water upstream. No data were available to determine the velocity distribution with depth to establish the extent of flow stratification. Table 1 gives locations of the tracer cloud for various elapsed times for the November 1978 injections.

Table 1.--Location of tracer clouds, November 1978 study

Date	Elapsed time after injection (hours)	Location of tracer clouds, in miles above Abbeville bridge ^{a/}					
		Cloud A			Cloud B		
		Leading edge	Peak concentration	Trailing edge	Leading edge	Peak concentration	Trailing edge
11- 1-78	4-5	24.0	24.2	24.6	14.8	16.2	16.8
11- 2-78	22-24	22.4	22.8	24.2	13.5	14.3	16.2
11 -2-78	27-28	22.4	22.8	23.8	10.5	13.0	16.3
11- 3-78	46-48	20.9	24.0	24.2	12.2	14.0	16.2
11- 5-78	96-98	20.9	21.4	24.2	11.7	13.5	15.5
11- 7-78	144-146	17.0	21.4	22.6	8.4	11.2	14.5
11- 9-78	172-174	14.0	16.5	21.4	6.0	9.6	12.2
11-13-78	268-270	(b)	(b)	20.4	6.4	(b)	(b)
11-20-78	436-438	(b)	(b)	14.5	0	(b)	(b)

^{a/} Louisiana Highway 14 Bypass.

^{b/} Clouds merged.

Study of June 1979

Fifty pounds of dye tracer was injected into the river at Surrey Street on June 28. The instantaneous discharge at the time of injection was estimated to be 375 ft³/s based on stage records. The estimated mean daily discharge varied from a low of 150 ft³/s to a high of 300 ft³/s for the period June 28 to July 2. Three pumps at the Milton pumping plant of Southdowns Lands, Inc., (fig. 10) were operating during this period; the combined average pumping rate for the period was about 440 ft³/s (table 2). No rainfall was recorded at Lafayette during the period June 28 to July 2 and the wind was generally out of the south at an average velocity of 2 mi/h.

Table 2.--Pumping rates for Milton pumping plant

Date	Discharge in gallons per minute			
	Lift, in feet	Pump no. 1	Pump no. 4	Pump no. 5
6-28-79-----	23.3	70,900	60,700	66,800
6-29-79-----	23.2	71,200	60,800	66,900
6-30-79-----	23.65	70,100	60,600	66,700
7- 1-79-----	23.67	69,900	60,500	66,500
7- 2-79-----	23.66	70,000	60,600	66,600
Average pumping rate--		70,420	60,640	66,700
Average discharge (ft ³ /s)-----		157	135	149

After an elapsed time of 18 hours, the tracer cloud was about 4.2 mi in length, and the peak concentration at the water surface was located about 3.0 mi downstream from Pinhook Road (fig. 10). Forty-two hours after injection the cloud was about 4.8 mi in length. The leading edge of the tracer cloud was located at the Milton pumping plant and the peak concentration at the water surface was located about 1.0 mi upstream from the Milton pumping plant (fig. 11). After 64 hours the tracer cloud had decreased to approximately 2.2 mi in length. The point of peak concentration at the water surface was located at Picard Cemetery and the leading edge was about 1.2 mi downstream from the Milton pumping plant (fig. 12). On July 2, 90 hours after injection, the tracer could not be detected in the river, indicating that the water containing the tracer could have been pumped from the river into the main rice irrigation canal by the Milton pumping plant. An effort was made to locate the tracer in the surrounding rice fields and canals, and the tracer was located in a rice-irrigation canal at State Highway 14, about 10 mi west of Abbeville. Table 3 shows the location of the tracer cloud for various elapsed times for the June 1979 injection.

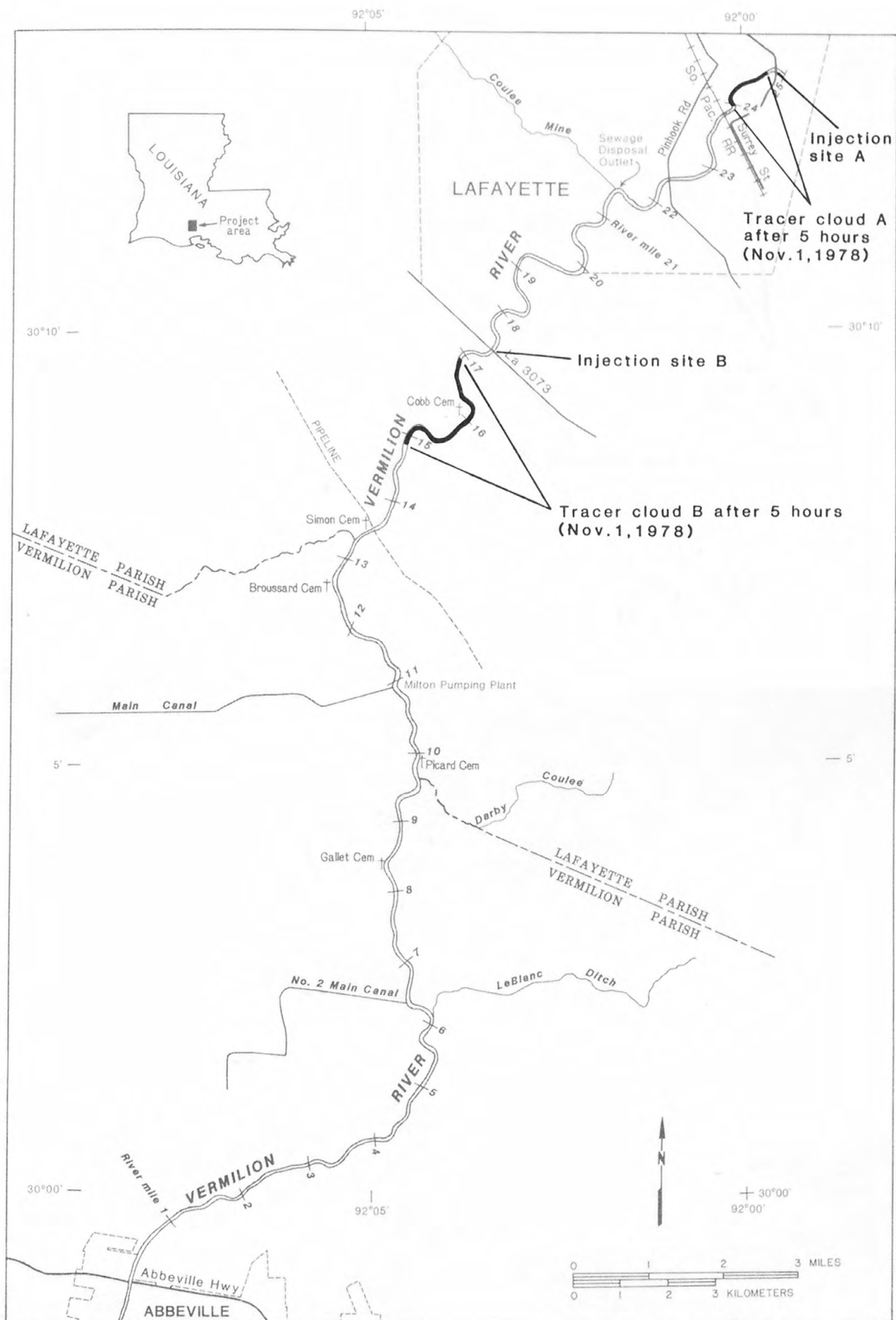
Table 3.--Location of tracer clouds, June 1979 study

Date	Elapsed time after injection (hours)	Location of tracer cloud, in miles above Abbeville bridge ^{a/}		
		Leading edge	Peak concentration	Trailing edge
6-29-79	18	17.2	19.2	21.4
6-30-79	42	10.8	12.2	15.6
7- 1-79	64	9.6	10.0	11.8

^{a/} Louisiana Highway 14 Bypass.

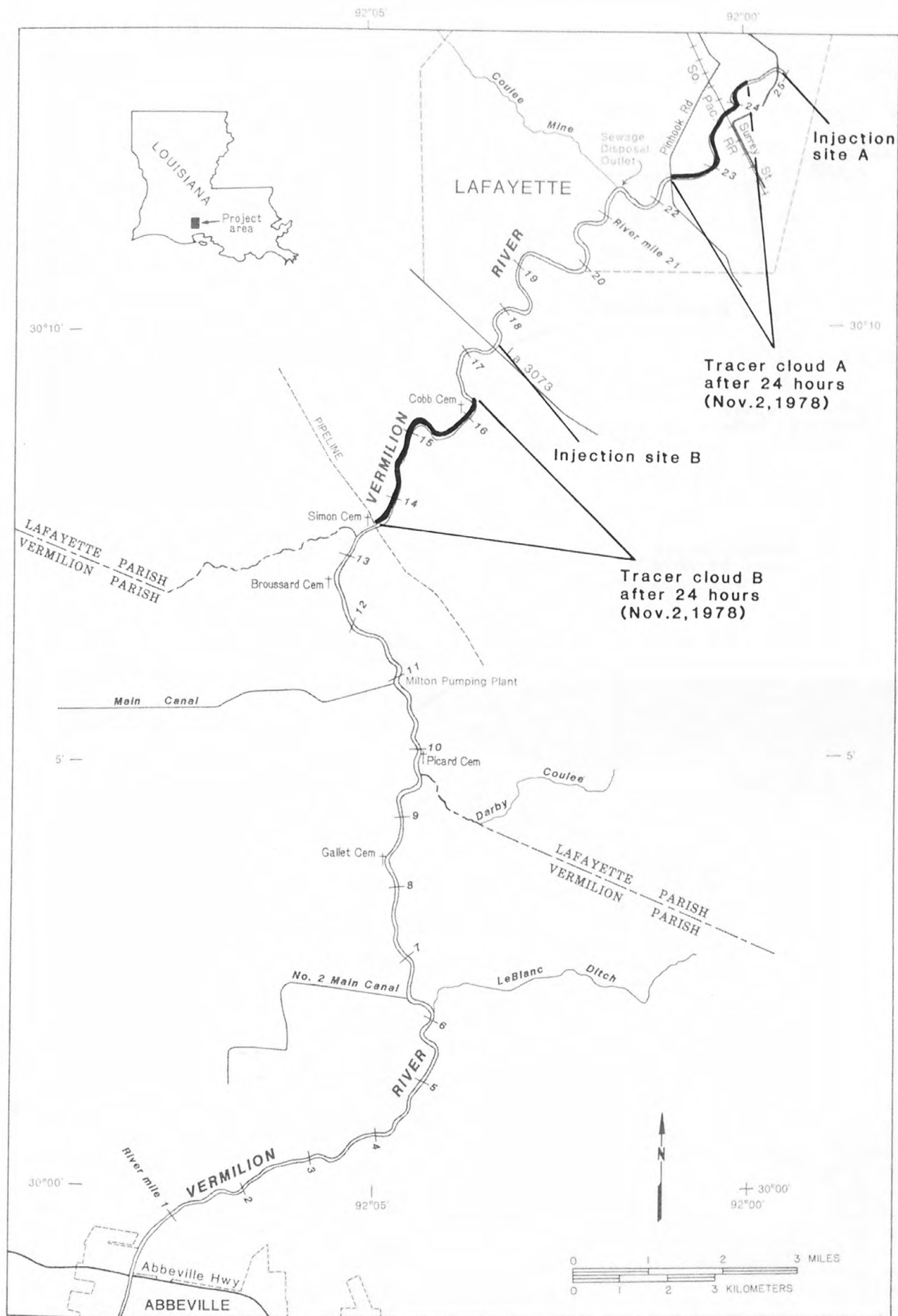
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- Jones, P. H., Hendricks, E. L., Irelan, Burdge, and others, 1956, Water Resources of southwestern Louisiana: U.S. Geological Survey Water-Supply Paper 1364, 460 p. 38 pls., 73 figs.
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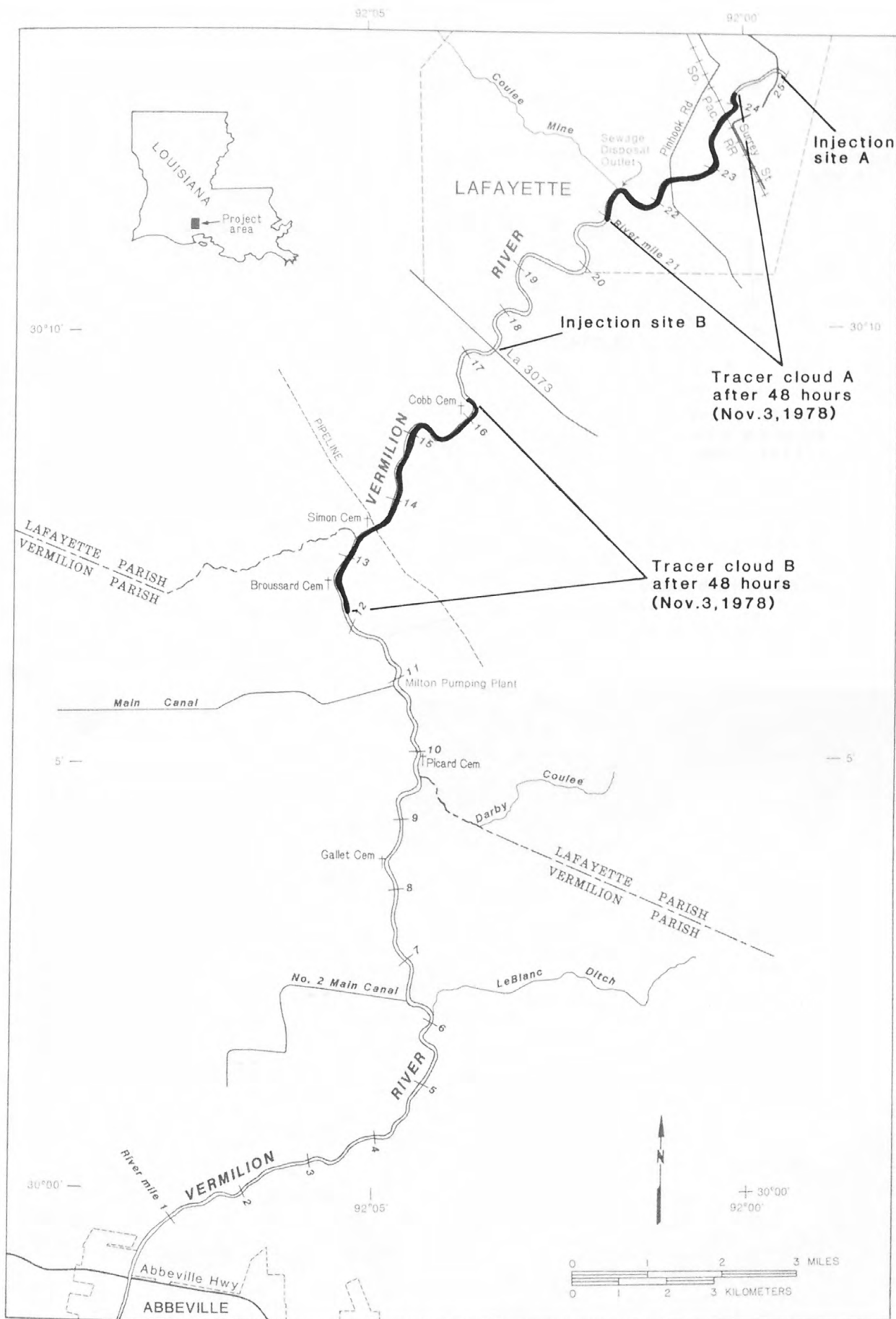
Base from U.S. Geological Survey (modified)
Lafayette, 1955 (revised 1971), and St. Martinville, 1970

Figure 1.--Location of tracer clouds after 5 hours.



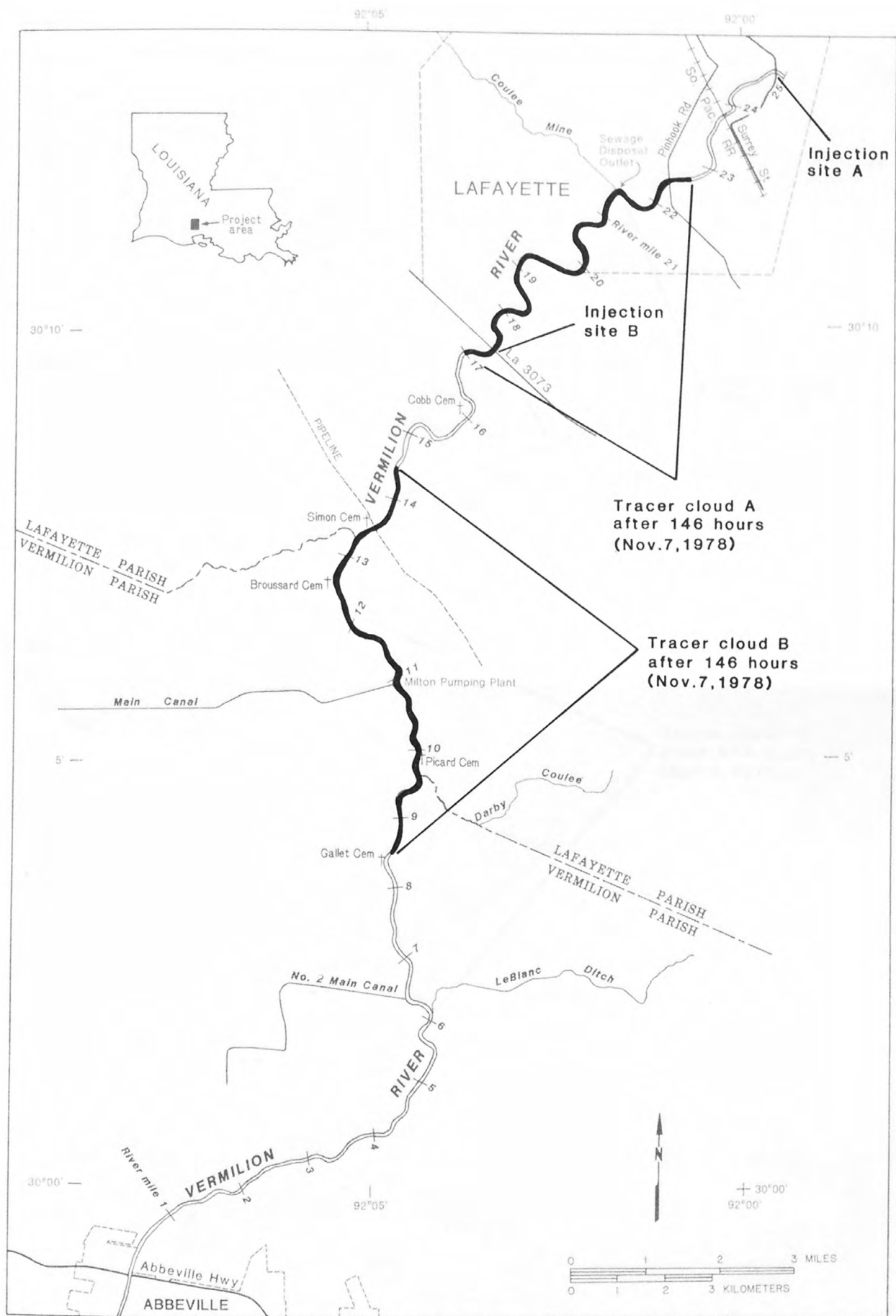
Base from U.S. Geological Survey (modified)
Lafayette, 1955 (revised 1971), and St. Martinville, 1970

Figure 2.-- Location of tracer clouds after 24 hours.



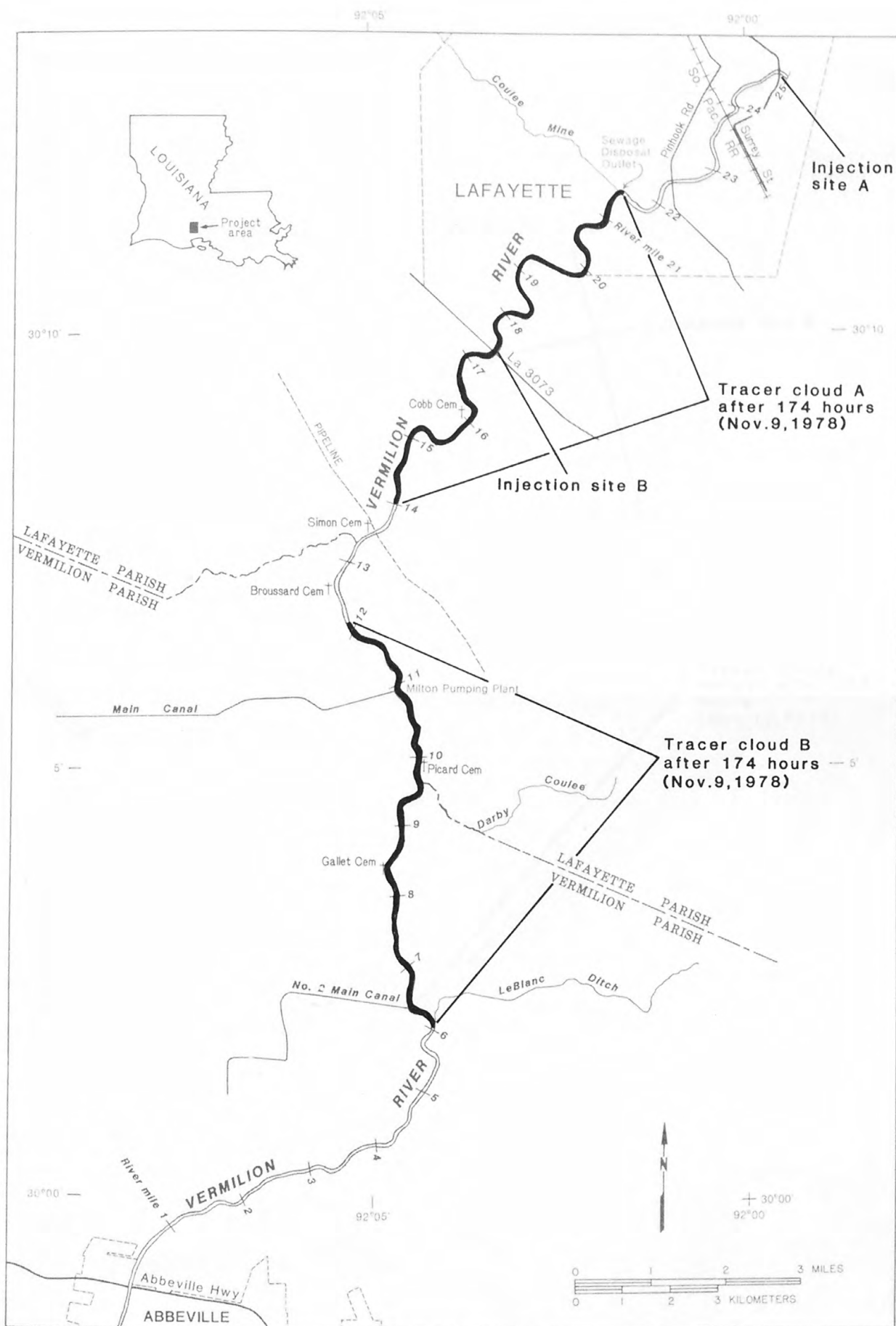
Base from U.S. Geological Survey (modified)
Lafayette, 1955 (revised 1971), and St. Martinville, 1970

Figure 4.--Location of tracer clouds after 48 hours.



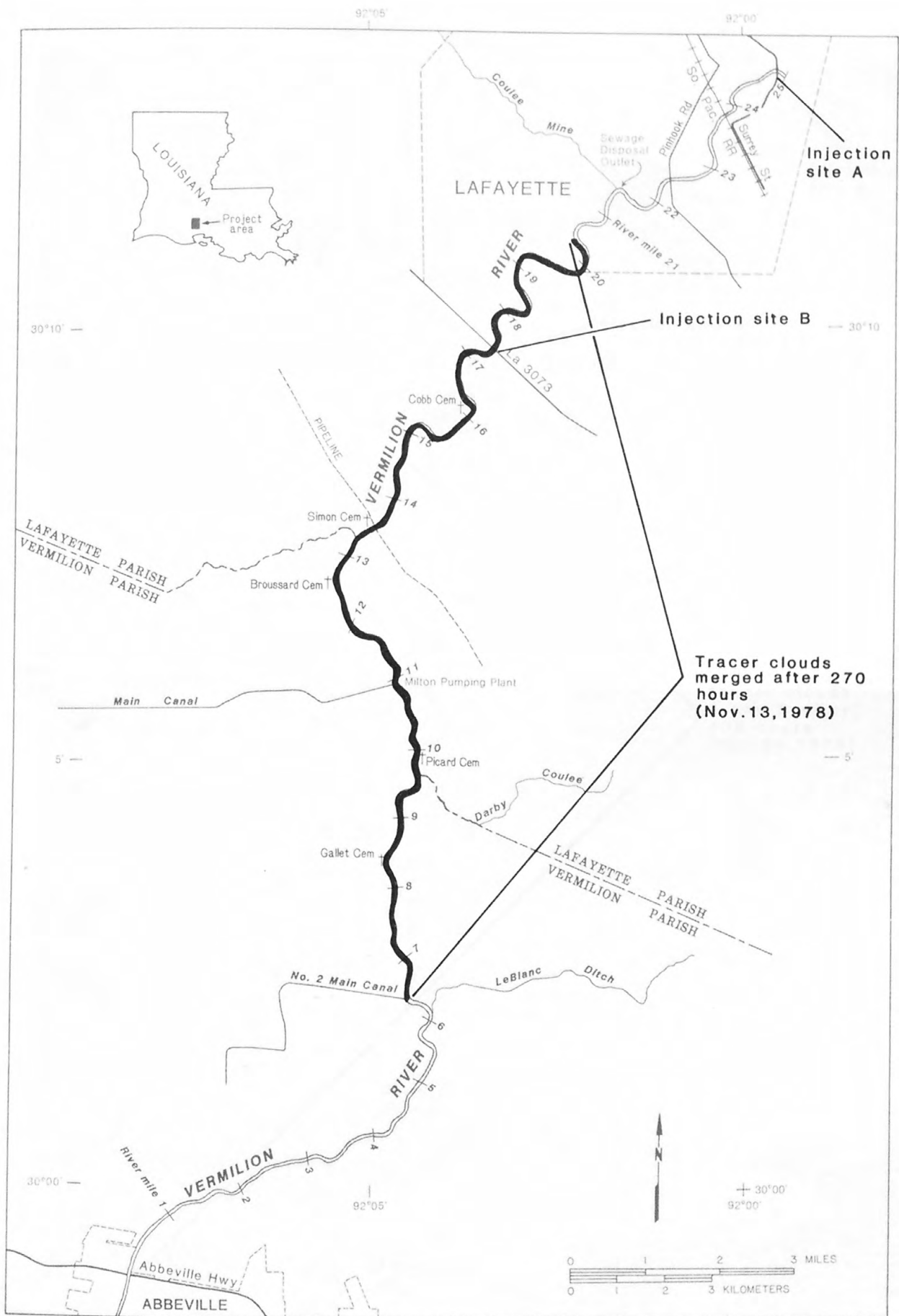
Base from U.S. Geological Survey (modified)
Lafayette, 1955 (revised 1971), and St. Martinville, 1970

Figure 6.--Location of tracer clouds after 146 hours.



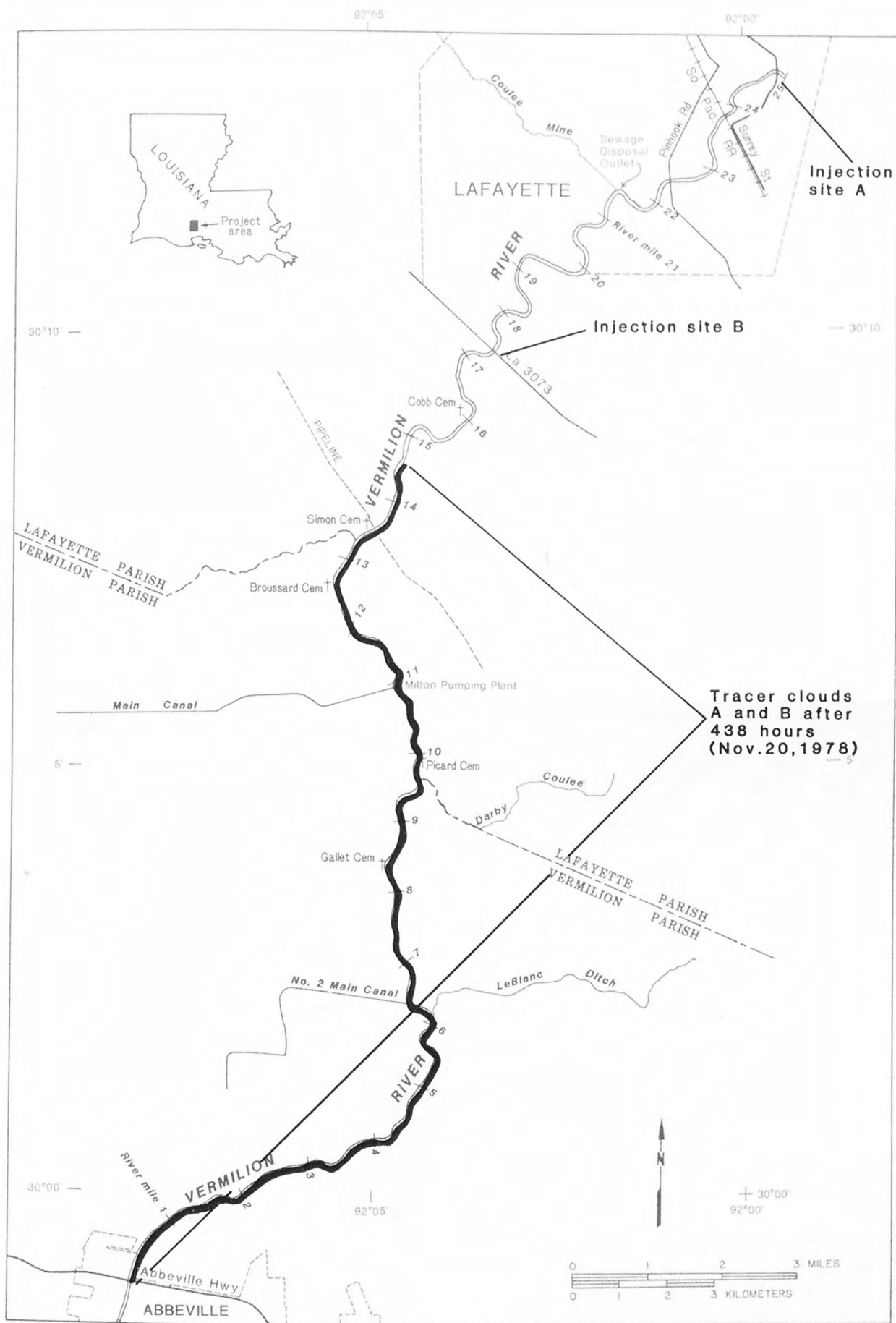
Base from U.S. Geological Survey (modified)
Lafayette, 1955 (revised 1971), and St. Martinville, 1970

Figure 7.--Location of tracer clouds after 174 hours.



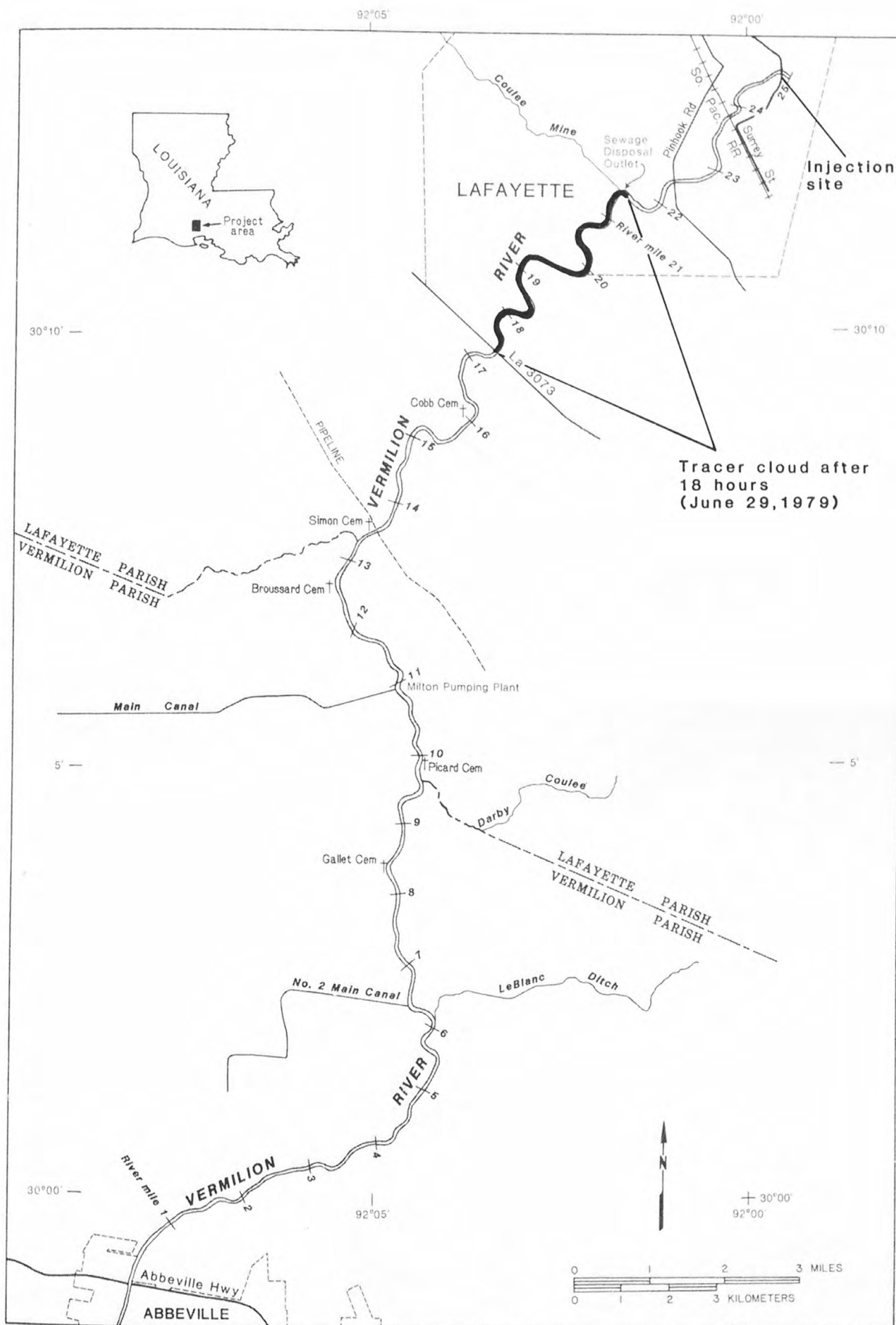
Base from U.S. Geological Survey (modified)
Lafayette, 1955 (revised 1971), and St. Martinville, 1970

Figure 8.--Location of merged tracer clouds after 270 hours.



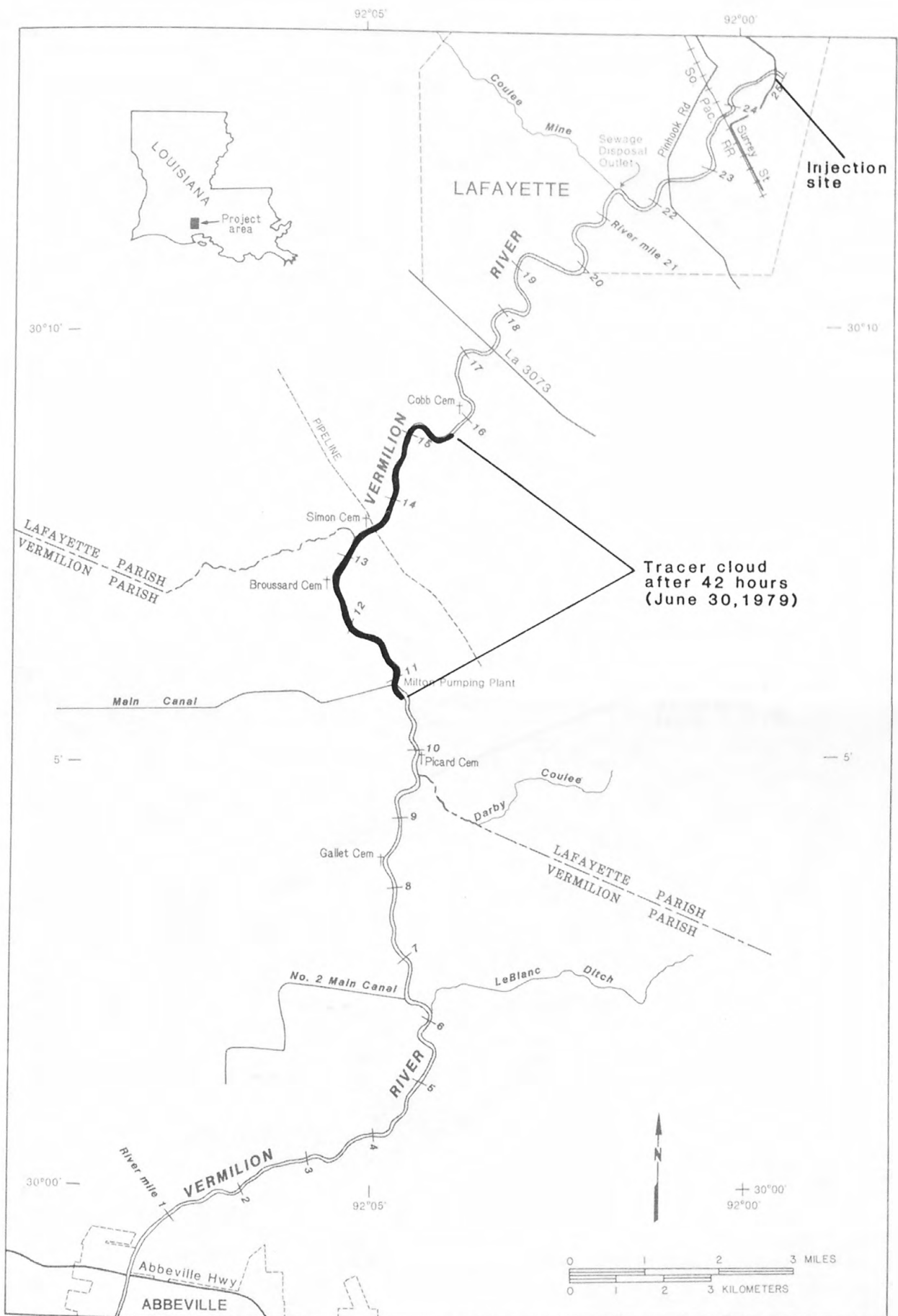
Base from U.S. Geological Survey (modified)
Lafayette, 1955 (revised 1971), and St. Martinville, 1970

Figure 9.--Location of merged tracer clouds after 438 hours.



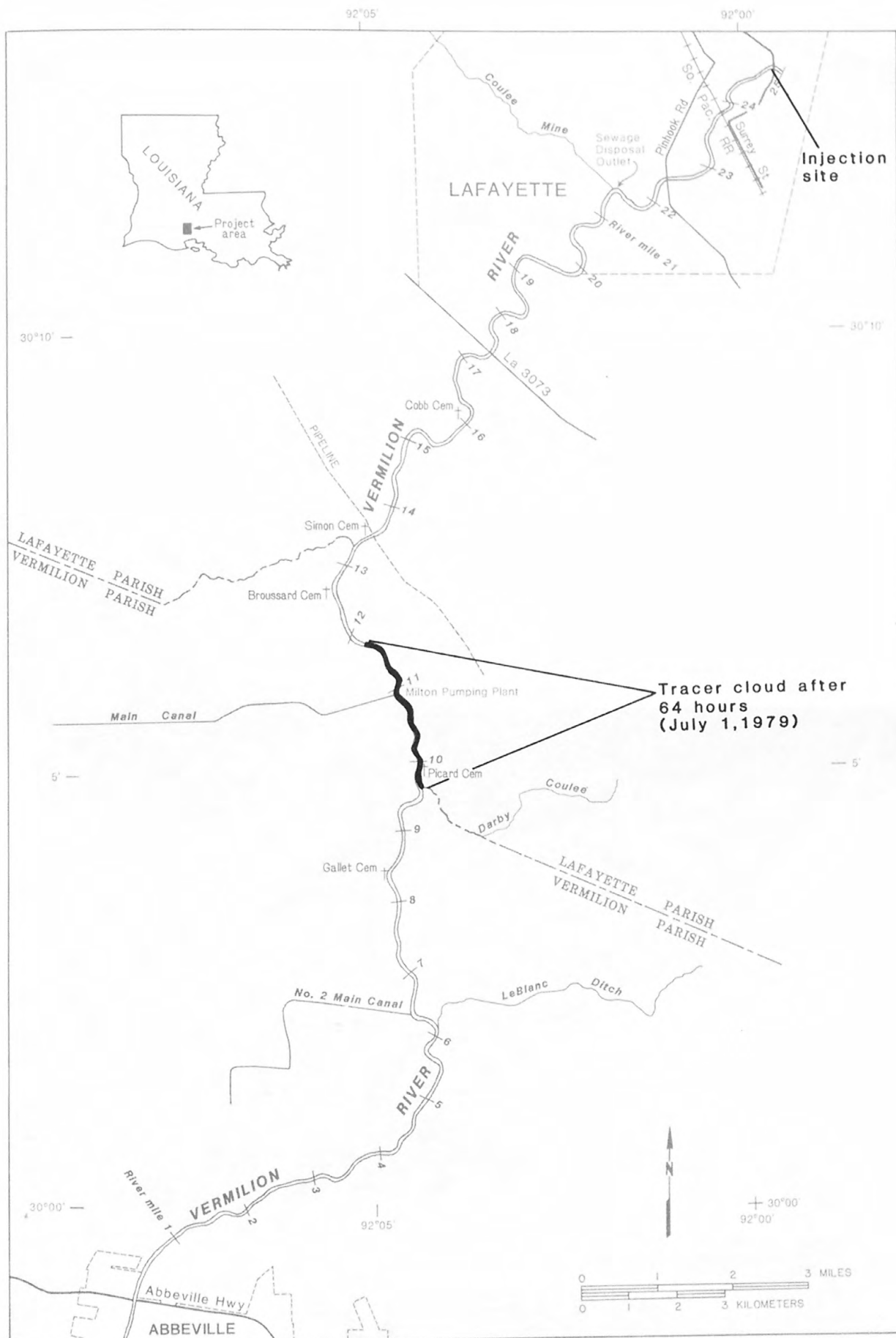
Base from U.S. Geological Survey (modified)
Lafayette, 1955 (revised 1971), and St. Martinville, 1970

Figure 10.--Location of tracer cloud after 18 hours.



Base from U.S. Geological Survey (modified)
Lafayette, 1955 (revised 1971), and St. Martinville, 1970

Figure 11.--Location of tracer cloud after 42 hours.



Base from U.S. Geological Survey (modified)
Lafayette, 1955 (revised 1971), and St. Martinville, 1970

Figure 12.--Location of tracer cloud after 64 hours.



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