UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH THE NORTH CENTRAL TEXAS COUNCIL OF GOVERNMENTS, THE TRINITY RIVER AUTHORITY OF TEXAS, AND THE TEXAS WATER DEVELOPMENT BOARD

OPEN-FILE REPORT 76-683
(SHEET 1 OF 3)

TIME OF TRAVEL OF SOLUTES IN THE EAST FORK TRINITY RIVER, NOVEMBER 1975; AND ELM FORK TRINITY RIVER, DECEMBER 1975; TRINITY RIVER BASIN, TEXAS

The U.S. Geological Survey, in cooperation with the North Central Texas Council of Governments, the Trinity River Authority of Texas, and the Texas Water Development Board, conducted two time-of-travel studies in the Trinity River basin in November and December, 1975. Field data were collected on the East Fork Trinity River during November 18-22, 1975, and on the Elm Fork Trinity River during December 8-13, 1975. The purpose of these two studies was to provide data that could be used by the Trinity River Authority and the Texas Water Quality Board in the development of a mathematical water-quality model of the two streams. The model is to be used in a comprehensive water-quality management plan for the Trinity River basin. Previous time-of-travel data were obtained in the Trinity River basin in July and August, 1972 (Ollman, 1973) and in September 1973 and July-August, 1974 (Ollman, 1975).

The time of travel of solutes in the East Fork Trinity River and the Elm Fork Trinity River was determined by injecting a fluorescent dye (Rhodamine WT, 20-percent solution) that could be detected by fluorometric analysis of water samples collected at selected downstream sites. Plots of dye concentration versus time were made for each injection and sampling site. The graphs were then used to determine arrival times of the leading edge, the peak, and the trailing edge of the dye cloud. The trailing edge was defined as the concentration value equal to 10 percent of the peak concentration.

Measurements of the concentration and dispersion of the dye also provide information on the probable behavior of soluble contaminants or pollutants that might be introduced in the reaches studied. The methods and equipment used in the two studies were similar to those described by Wilson (1968).

The study in November 1975 was conducted on the East Fork Trinity River from just below the Rockwall-Forney Dam at Lake Ray Hubbard to the confluence with the Trinity River, a distance of 27.0 miles (43.4 km). The study section was divided into two reaches to reduce the time required to complete the study and to produce more meaningful time-concentration curves. Dye concentrations were measured at three to four sites in each reach.

The discharge during the study period has been equaled or exceeded at the gaging station East Fork Trinity River near Crandall about 60 percent of the time during the 22-year period (1954-75) since completion of Lavon Lake and about 80 percent of the time during the 5-year period (1971-75) since completion of Lake Ray Hubbard. A low-flow release of about 11 ft^3/s (0.31 m^3/s) was made from Lake Ray Hubbard during the study period. The remainder of the flow was effluent from the Duck Creek and South Mesquite Creek sewage-treatment plants. There was about 0.2 inch (5.1 mm) of rainfall on November 19, but no runoff was observed. However, small amounts of ground-water seepage into the channel were noticed near the confluence with the Trinity River. Discharge measurements were made at injection sites at the time of dye injection and at sampling sites as near the time of peak concentration as possible. Daily fluctuations in discharge occurred because of operations at the sewage-treatment plants.

The discharge measured upstream from South Mesquite Creek ranged from 28.2 ft^3/s (0.80 m^3/s) to 34.5 ft^3/s (0.98 m^3/s), while the discharge measured downstream from South Mesquite Creek ranged from 29.2 ft^3/s (0.83 m^3/s) to 50.5 ft^3/s (1.43 m^3/s). Because of the variation in discharge, the average discharge for the study period in the reach upstream from South Mesquite Creek was computed by using the gage-height record from the gaging station East Fork Trinity River near Forney. The average discharge downstream from South Mesquite Creek was computed by using the gage-height record from the gaging station East Fork Trinity River near Crandall.

Distances along the main channel were measured from U.S. Geological Survey topographic maps except for the lower 3.5 miles (5.6 km). Channel rectification had been completed on this portion of the river after the topographic maps were last revised. Therefore, distances along this portion of the channel were based on data furnished by the U.S. Army Corps of Engineers.

Figure 1 shows the location of the study area, the two stream reaches, the locations of gaging stations, and the graphs of dye concentration versus time for each injection and sampling site on the East Fork Trinity River. The data given in table 1 summarize the results of the study on the East Fork Trinity River.

The study in December 1975 was conducted on the Elm Fork Trinity River from just below the dam at Lewisville Lake to the Spur 482 crossing, a distance of 25.7 miles (41.4 km). The study section was divided into two reaches, and dye concentrations were sampled at three to five sites in each reach. Carrollton Dam, California Crossing Dam, and Frazier Dam, located at river miles 18.4, 8.5, and 3.5 (29.6, 13.7, and 5.6 km), respectively, form a series of pools within the study reaches that reduce stream velocities at low flows.

Figure 2 shows the location of the study area, the two stream reaches, the locations of gaging stations, and the graphs of dye concentration versus time for each injection and sampling site on the Elm Fork Trinity River. The data given in table 2 summarize the results of the study on the Elm Fork Trinity River.

The discharge during the study on Elm Fork Trinity River has been equaled or exceeded about 44 percent of the time at the gaging station Elm Fork Trinity River near Lewisville during the 26-year period (1950-75). The discharge at the gaging station Elm Fork Trinity River near Carrollton has been equaled or exceeded about 70 percent of the time during the 22-year period (1954-75).

The flow entering the study reaches on the Elm Fork Trinity River was derived mainly from releases of water from Lewisville Lake and Grapevine Lake. The release from Lewisville Lake was held constant at about 190 ft^3/s (5.4 m^3/s) during the study. About 20 ft^3/s (0.57 m^3/s) that was released from Grapevine Lake into Denton Creek entered the Elm Fork Trinity River at river mile 18.7 or 30.1 km (fig. 2). Other tributaries contributed small amounts of flow to the Elm Fork Trinity River, but the discharges of these tributaries were insignificant in relation to the releases from Lewisville Lake and Grapevine Lake.

Flow was diverted from the pool formed by Carrollton Dam at river mile 19.2 (30.9 km) by the Elm Fork water-treatment plant operated by the city of Dallas (fig. 2). During the study, the diversions at the Elm Fork plant ranged from 77 ft^3/s (2.18 m^3/s) to 140 ft^3/s (3.96 m^3/s). The city of Dallas also operates the Bachman water-treatment plant, which diverts water at river mile 3.8 (6.1 km) from the pool formed by Frazier Dam. The Bachman plant normally diverts the remaining low flow of the Elm Fork Trinity River. Diversion data for the two water-treatment plants were furnished by the city of Dallas.

Discharge measurements were made to supplement computations of average flow for the individual reaches for the period the dye cloud was in each reach. The average discharge for the upper three reaches given in table 2 was computed by using the gage-height record for the gaging station Elm Fork Trinity River near Lewisville. The average discharge for the reach Elm Fork intake to Sandy Lake Road was computed by using the gage-height record for the gaging station Elm Fork Trinity River near Carrollton, and the flows in the remaining four reaches were computed by using the record from the gaging station near Carrollton together with a discharge measurement made just downstream from Sandy Lake Road.

METRIC CONVERSIONS

The English units used in this report may be converted to metric units by the following factors:

From		Multiply by	To obtain	
Unit	Abbreviation		Unit	Abbreviation
cubic feet per second	ft^3/s	0.02832	cubic meters per second	m^3/s
feet per second	ft/s	30.48	centimeters per second	cm/s
inches	--	25.4	millimeters	mm
miles	--	1.609	kilometers	km

REFERENCES CITED

Ollman, R. H., 1973, Time-of-travel of solutes, field observations of water quality, and suspended-sediment data for stream reaches in the Trinity River basin, Texas, July 31 to August 14, 1972: U.S. Geol. Survey open-file rept., 2 p.

1975, Time-of-travel of solutes in the Trinity River basin, Texas, September 1973 and July-August 1974: U.S. Geol. Survey open-file rept., 3 p.

Trinity River Authority of Texas, 1974, Basic information, Trinity River basin, Texas: Trinity River basin Water Quality Management Plan.

Wilson, J. F., Jr., 1968, Fluorometric procedures for dye tracing: U.S. Geol. Survey Technique Water-Resources Inv., book 3, chap. A-12, 31 p.

TABLE 1.-SUMMARY OF EAST FORK TRINITY RIVER STUDY, NOVEMBER 18-22, 1975

Reach			Subreach				Dye cloud: Leading edge		Dye cloud: Peak		Dye cloud: Trailing edge		Remarks
No. a/	Description	Distance (river miles) b/	From	To	Distance (river miles) b/	Discharge (ft^3/s) c/	Travel time from upstream site (hours)	Average velocity (ft/s)	Travel time from upstream site (hours)	Average velocity (ft/s)	Travel time from upstream site (hours)	Average velocity (ft/s)	
1	U.S. 80 to U.S. 175	14.83	U.S. 80	Scyene Road	2.52	33.3	9.40	0.39	11.38	0.32	13.75	0.27	Injection at 0700 hours, peak at 1830 hours, 11/18/75.
			Scyene Road	South Mesquite Creek	4.98	33.3	26.50	.28	30.00	.24	32.50	.22	Peak at 0030 hours, 11/20/75.
			South Mesquite Creek	Malloy Bridge	3.33	39.8	13.50 d/	.36	12.67	.39	13.50	.36	Peak at 1310 hours, 11/20/75.
			Malloy Bridge	U.S. 175	4.00	39.8	18.50	.32	19.67	.30	19.00	.31	Peak at 0850 hours, 11/21/75.
2	U.S. 175 to confluence	12.14	U.S. 175	F.M. 3039	3.09	39.8	22.40	.20	24.69	.18	47.27	.10	Injection at 1200 hours, 11/18/75. Peak at 1250 hours, 11/19/75.
			F.M. 3039	F.M. 1389	3.02	39.8	20.00	.22	22.83	.19	21.00	.21	Peak at 1140 hours, 11/20/75.
			F.M. 1389	confluence	6.03	39.8	18.50 d/	.48	18.67	.47	17.50	.51	Peak at 0620 hours, 11/21/75.

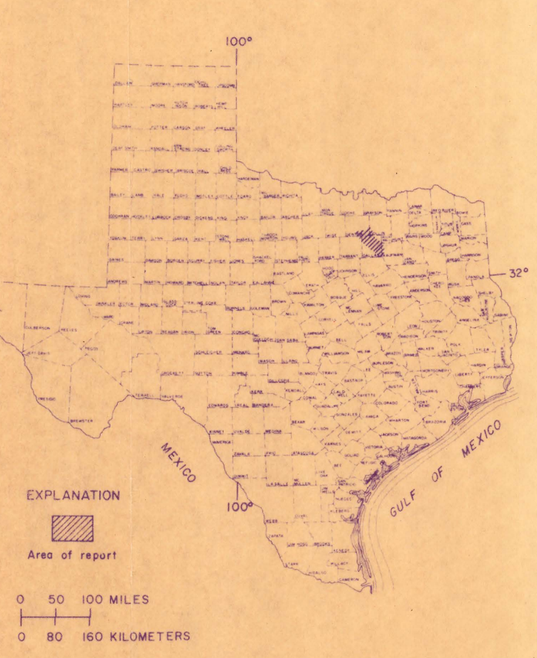
a/ Number of reach corresponds to the reach number on figure 1.
b/ Distances based on channel conditions at time of study as determined from data from Corps of Engineers and U.S. Geological Survey topographic maps.
c/ Average flow for period dye cloud was in subreach as computed from record at continuous-record gaging station.
d/ Estimated.

TABLE 2.-SUMMARY OF ELM FORK TRINITY RIVER STUDY, DECEMBER 8-13, 1975

Reach			Subreach				Dye cloud: Leading edge		Dye cloud: Peak		Dye cloud: Trailing edge		Remarks
No. a/	Description	Distance (river miles) b/	From	To	Distance (river miles) b/	Discharge (ft^3/s) c/	Travel time from upstream site (hours)	Average velocity (ft/s)	Travel time from upstream site (hours)	Average velocity (ft/s)	Travel time from upstream site (hours)	Average velocity (ft/s)	
1	0.1 mile downstream from Lewisville Dam to 0.6 mile downstream from Valley View Lane	17.1	0.1 mile downstream from Lewisville Dam	2.5 miles downstream from State Highway 121	4.3	194	6.00	1.05	7.67	0.82	9.17	0.69	Injection at 0720 hours, peak at 1500 hours, 12/9/75.
			2.5 miles downstream from State Highway 121	I.H. 35E	4.2	194	4.67	1.32	5.50	1.12	9.50 d/	.65	Peak at 2030 hours, 12/9/75.
			I.H. 35E	Elm Fork Intake	2.3	194	19.00	.18	21.00	.16	20.50	.16	Peak at 1730 hours, 12/10/75.
			Elm Fork Intake	Sandy Lake Road	.8	92	11.00	.11	14.67	.08	20.67	.06	Peak at 0810 hours, 12/11/75.
			Sandy Lake Road	0.6 mile downstream from Valley View Lane	5.5	100	18.00	.45	19.33	.42	20.83	.39	Peak at 0330 hours, 12/12/75.
2	0.6 mile downstream from Valley View Lane to Spur 482	8.6	0.6 mile downstream from Valley View Lane	Spur 348	3.6	100	25.00	.21	31.33	.17	38.50	.14	Injection at 1430 hours, 12/8/75. Peak at 2150 hours, 12/9/75.
			Spur 348	Wildwood Drive	2.8	100	25.50 d/	.16	30.17	.14	34.00	.12	Peak at 0400 hours, 12/11/75.
			Wildwood Drive	Spur 482	2.2	100	29.00	.11	32.67	.10	39.17	.08	Peak at 1240 hours, 12/12/75.

a/ Number of reach corresponds to the reach number on figure 2.
b/ Distances from Trinity River Authority of Texas, 1974.
c/ Average flow for period dye cloud was in subreach as computed from record at continuous-record gaging station.
d/ Estimated.

LOCATION MAP



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