FREMONT LAKE, WYOMING--

SOME ASPECTS OF THE INFLOW OF WATER AND SEDIMENT

By William W. Emmett and Robert C. Averett

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CONVERSION FACTORS AND VERTICAL DATUM

For use of readers who prefer to use inch-pound units, rather than the metric (International System) units used in this report, the following conversion factors may be used:

Multiply metric unit	By	To obtain inch-pound unit
millimeter (mm)	0.03937	inch
millimeter per year (mm/yr)	.03937	inch per year
meter (m)	3.281	foot
kilometer (km)	.6214	mile
square kilometer (km^2)	.3861	square mile
cubic meter (m^3)	264.2	gallon
	35.31	cubic foot
cubic kilometer (km^3)	.2399	cubic mile
kilogram (kg)	2.205	pound
kilogram per cubic meter (kg/m^3)	.06243	pound per cubic foot
ton	1.102	ton
ton per day (ton/d)	1.102	ton per day
ton per year (ton/yr)	1.102	ton per year

National Geodetic Vertical Datum of 1929 (NGVD of 1929): A geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called "Mean Sea Level of 1929."

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ABSTRACT

Fremont Lake is a large (20.6 square kilometers), deep lake (185 meters) in western Wyoming. Average annual inflow of water is about 5.1 cubic meters per second, and this discharge is equaled or exceeded about 23 percent of the time. Annual instantaneous peak flows of Pine Creek usually exceed 30 cubic meters per second and the 100-year flood is about 80 cubic meters per second. About 800 tons of sediment are delivered to the lake annually; annual deposition of sediment in the northern lake area throughout the last 10,000 years about equals contemporary values of sediment inflow. Only small quantities of fine-grained sediment are transported beyond the delta at the northern end of the lake. Current rates of deposition in the delta are about 1 to 3 millimeters per year. Sediment in the delta generally is sand size; elsewhere in the lake, sediment generally is clay and silt size.

INTRODUCTION

Fremont Lake is situated in a glaciated basin on the west flank of the Wind River Range in western Wyoming. The center of the lake is just east of longitude 110° W. and south of latitude 43° N., or about 10 km north of the town of Pinedale (fig. 1). Fremont Lake is one of hundreds of glacially formed lakes in the area and is the largest and deepest of these lakes in the northeastern part of the Green River basin.

The geologic setting, or glacial history, of the area has been described previously (for example, Richmond, 1965). Briefly, the history of Fremont Lake was marked by two main glaciations, the Bull Lake and the Pinedale. Each glaciation had several stages or successions of advance and retreat that left, in the lower areas, a hummocky landscape of glacial till ranging in age from about 10,000 to 70,000 years. In the southern two-thirds of the lake basin, little bedrock is apparent; in contrast, little till is apparent in the northern one-third of the lake basin where scoured rock surfaces are dominant. Most observers estimate the last recession of Pinedale ice from the basin occurred about 9,000 years ago--indicating, at least for purposes of this paper, a contemporary lake existence of about 10,000 years.

A sign erected by the local historical board (fig. 2) provides a brief history of the naming of the lake during the mountain-men era of the mid-1800's. This sign is located on the hummocky till of the terminal moraine near the lake outlet. The natural beauty of the lake area is shown in figure 3, a view looking downlake from near the lake inlet. An extensive lateral moraine is shown along the right (west) side of the lake; the foreground and the landmass jutting into the lake consist of bedrock mantled by a thin layer of glacial deposits.

Some bathymetry and preliminary physical and chemical characteristics of Fremont Lake have been described by Rickert and Leopold (1972) and Leopold (1980). The bathymetric map in figure 4 is from data collected during 1970 and shows a maximum width of about 2 km and a maximum length of about 15 km. The actual area of the lake surface is about 20.6 km^2; the shoreline is about 40 km. Maximum depth is slightly more than 185 m making Fremont Lake the tenth deepest lake wholly within the United States. The nominal water surface is at an elevation of about 2,261 m above the National Geodetic Vertical Datum (NGVD) of 1929; the mean depth is about 82.5 m. The resulting volume of water, about 1.7 km^3, is chemically dilute; Rickert and Leopold (1972) reported a mean dissolved-solids concentration of about 13 mg/L (milligrams per liter), which places Fremont Lake among the several most chemically dilute lakes in the United States.

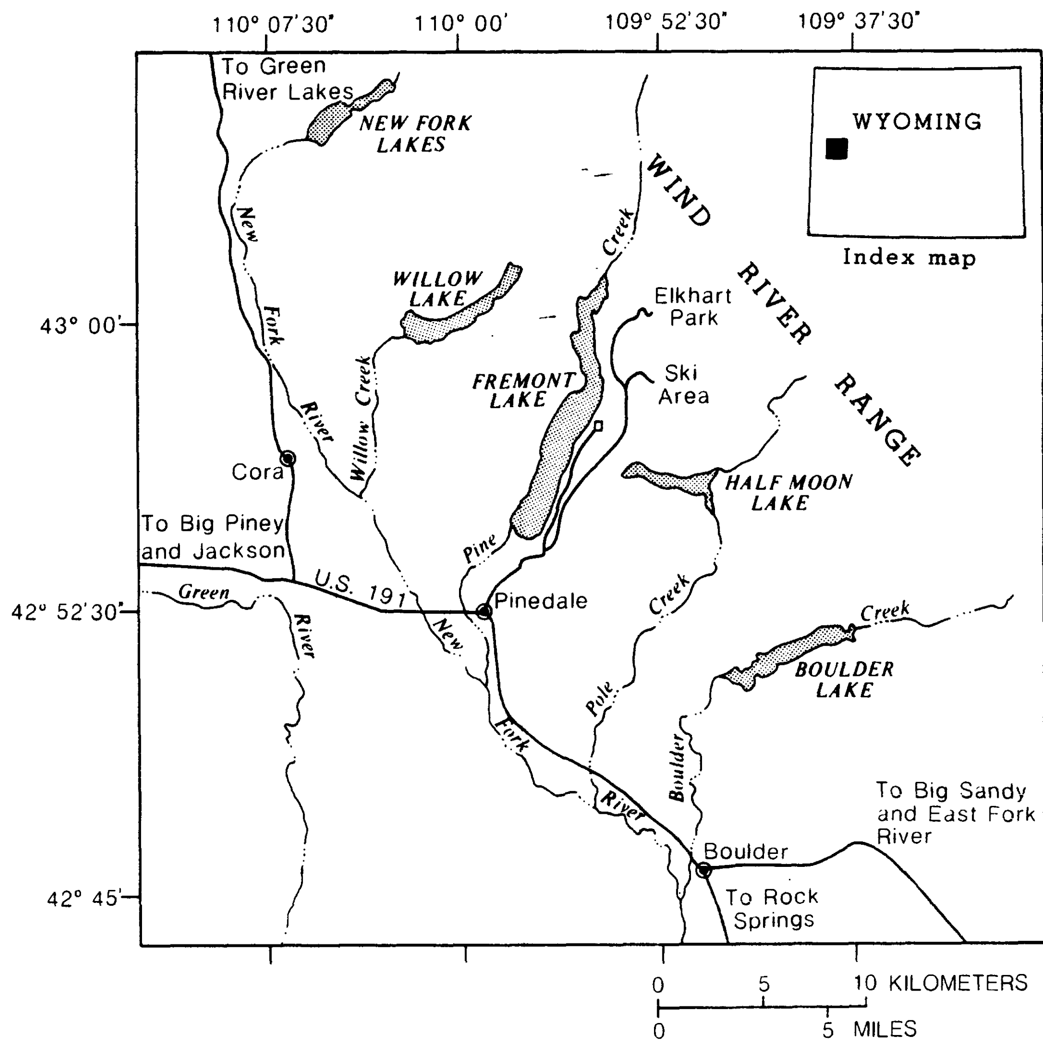

Figure 1.--Location of Fremont Lake and nearby natural and cultural features.

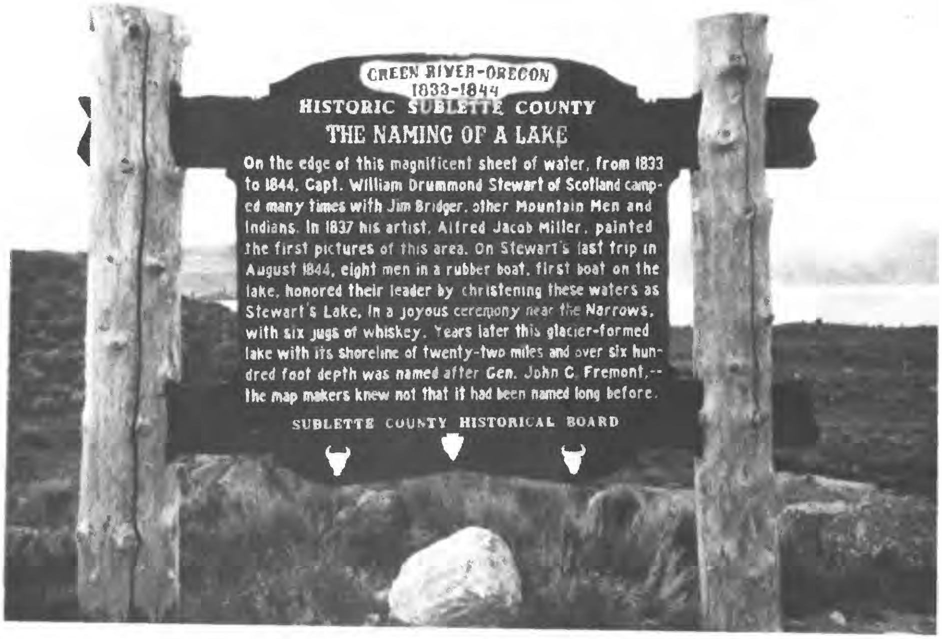

Figure 2.--Historical sign located near outlet of Fremont Lake.

Figure 3.--Scenic view of lake area from near inlet to Fremont Lake.

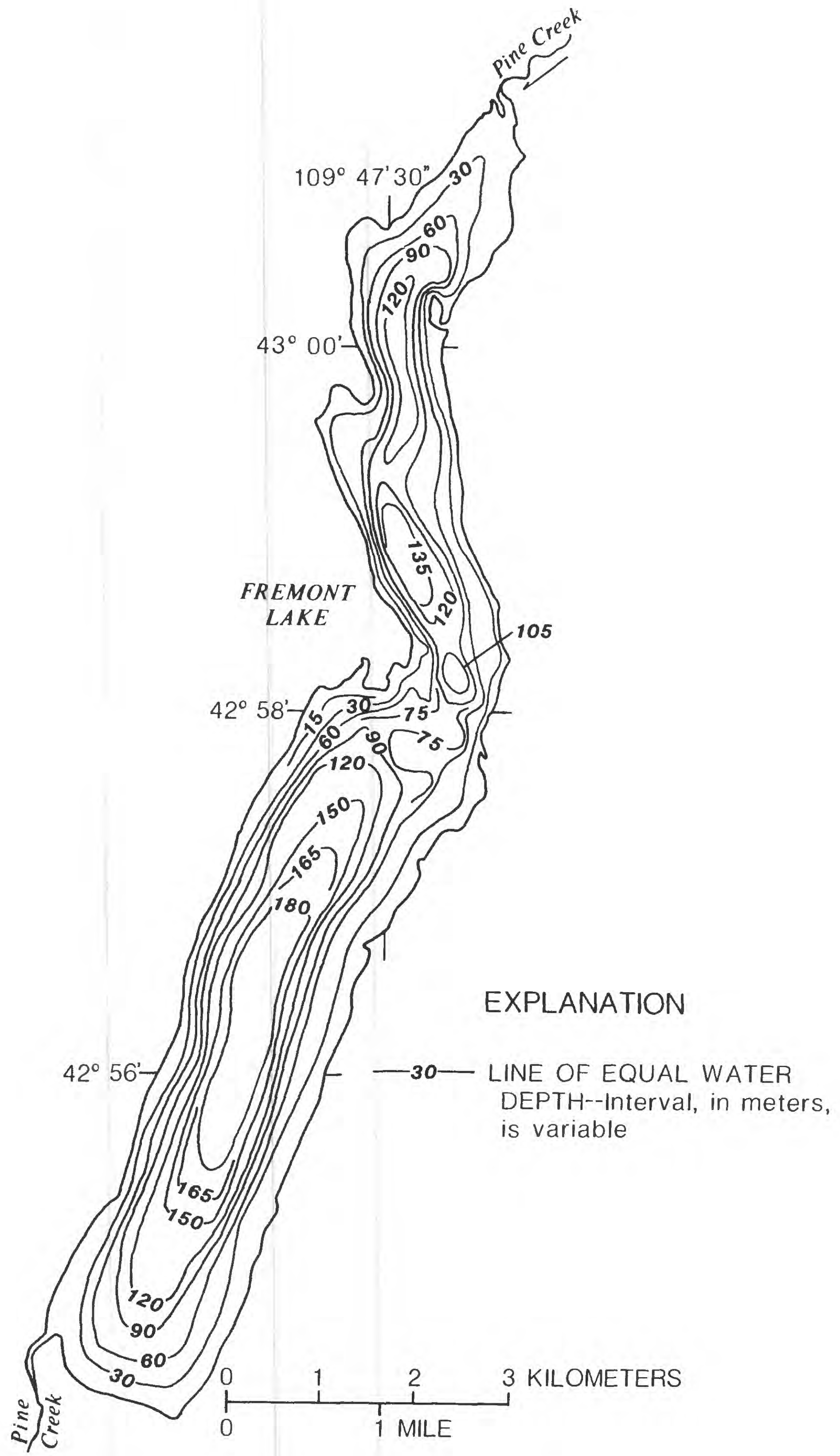

Figure 4.--Bathymetric map (prepared by the authors from data collected during 1970 by L.B. Leopold, University of California at Berkeley).

Purpose and Scope

The purpose of this report is to provide some information pertaining to: (1) The inflow of water and sediment to Fremont Lake, (2) the disposition of sediment in the lake, and (3) the relation of these data to previous work.

Several studies since Blackwelder's (1915) work on glacial history have contributed valuable information pertaining to the geology, hydrology, and other aspects of Fremont Lake and the surrounding area, which is essential to understanding landscape morphology (for example, source area, erosion, transport, and deposition of sediment). However, because these reports of earlier studies do not include sediment-transport data, they are not included in the references cited.

Acknowledgments

The authors would like to thank Robert M. Myrick, now retired from the U.S. Geological Survey, for assistance in the collection and compilation of much of the present data. Luna B. Leopold, University of California at Berkeley, who initiated sediment studies in central Wyoming, provided advice and assistance during this study. Radiocarbon dating was done by The University of Arizona.

STREAMFLOW

Values of streamflow are necessary for determination of sediment loads transported by the stream. Pine Creek (sometimes called Fremont River) enters the north end of Fremont Lake and is the only stream contributing substantial inflow to the lake. At 0.43 river km upstream from the lake, a U.S. Geological Survey gaging station (Pine Creek above Fremont Lake, Wyoming, station 09196500) provides inflow documentation. The station was established in 1954, and complete yearly records exist for water years (October through September) 1955 to present (1987). In this report, data from water years 1955 through 1983 are used unless otherwise noted. At this gaging station, the drainage area is 196.3 km^2. The total drainage area of Fremont Lake is 244 km^2; excluding the surface area of the lake, however, only about 27 km^2 of lakeside slopes are ungaged, so an adequate record of total inflow is provided by the single gaging station.

Pine Creek is the only stream draining the lake. At the lake outlet, a low (1.7 m) dam built in 1934 partially has regulated outlet flows, primarily for benefit of downstream irrigators. Prior to 1918, two gaging stations were operated briefly along Pine Creek between the lake and Pinedale. Since April 1985, flow in Pine Creek downstream from the dam has been monitored by a new gaging station. Because the periods of operation of the upstream and downstream gaging stations do not overlap sufficiently, water records for those downstream gaging stations are not included in this report; however, some suspended-sediment data collected at the downstream gaging stations later are used to illustrate near-zero quantities of sediment leaving the lake.

Quantity

Mean daily flows at Pine Creek above Fremont Lake are listed in table 1. These discharges were determined by averaging the daily mean discharges for each calendar date for the period of record. Accordingly, values in table 1 represent the average-year daily discharges.

Pine Creek upstream from Fremont Lake has no diversion or regulation structures although several small natural lakes may slightly attenuate flow. Thus, the gaging station provides an adequate measure of runoff for the area. Volume of runoff primarily is dependent on the quantity of winter precipitation falling as snow; the timing of runoff is related to spring warming trends. Data in table 1 indicate that spring runoff begins about the first of May, increases consistently and rapidly, and, historically, peaks on June 23. After the peak, runoff decreases consistently but less rapidly; flows larger than those that occur in early May do not occur after late August. On the average, about 40 percent of total flow occurs during June.

Discharges also are tabulated as monthly and annual flows in table 2. Monthly mean discharges were determined by averaging discharges for all days for each month during the period of record. Thus, it is easy to detect extreme months. For example, the 3 months of largest discharge were June of 1971, 1972, and 1974; months of smallest discharge were the winter months of 1977.

Table 1.--Mean daily flow, in cubic meters per second, Pine Creek above Fremont Lake, water years 1955-83

Day of month	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1	2.15	1.01	0.738	0.594	0.568	0.466	0.531	2.02	15.8	24.2	7.93	3.12
2	2.07	1.02	.764	.590	.566	.464	.535	2.23	17.2	24.1	7.65	3.05
3	2.01	.997	.749	.584	.567	.454	.536	2.42	18.9	22.9	7.14	2.96
4	1.94	.989	.752	.591	.549	.475	.539	2.62	20.9	22.4	6.58	2.87
5	1.91	.970	.753	.591	.539	.470	.553	2.86	21.8	21.8	6.11	2.79
6	1.86	.953	.748	.594	.526	.470	.568	3.14	23.1	21.2	5.75	2.72
7	1.85	.948	.737	.587	.521	.467	.594	3.49	24.0	21.3	5.45	2.61
8	1.67	.932	.728	.575	.515	.467	.609	3.84	24.7	20.7	5.27	2.56
9	1.63	.920	.728	.575	.510	.467	.634	4.30	25.3	20.2	5.13	2.60
10	1.61	.906	.716	.578	.504	.464	.666	4.81	25.1	20.6	5.10	2.66
11	1.60	.892	.697	.589	.493	.456	.683	4.79	24.0	19.7	5.10	2.72
12	1.57	.872	.688	.589	.490	.459	.688	4.70	23.5	19.3	4.87	2.67
13	1.55	.861	.680	.586	.487	.459	.697	4.76	24.1	18.5	4.70	2.62
14	1.52	.852	.674	.589	.479	.462	.714	4.93	24.9	17.5	4.64	2.49
15	1.51	.844	.666	.581	.479	.459	.742	5.18	25.4	16.7	4.39	2.42
16	1.52	.841	.660	.578	.481	.456	.773	5.30	25.0	15.8	4.16	2.42
17	1.50	.827	.657	.569	.484	.456	.818	5.66	24.4	14.6	3.99	2.48
18	1.47	.827	.646	.564	.487	.462	.861	6.32	24.3	13.7	3.96	2.64
19	1.44	.816	.640	.561	.481	.464	.915	7.08	24.6	13.3	4.08	2.92
20	1.41	.796	.632	.566	.481	.464	.994	8.21	25.9	12.9	4.36	2.74
21	1.38	.782	.617	.558	.481	.464	1.06	9.43	26.9	12.6	4.59	2.55
22	1.35	.790	.615	.555	.473	.473	1.12	10.6	27.7	11.9	4.59	2.46
23	1.31	.782	.629	.555	.467	.473	1.21	11.7	28.7	11.0	4.53	2.35
24	1.29	.776	.626	.558	.464	.470	1.33	12.1	28.2	10.7	4.13	2.26
25	1.26	.773	.629	.555	.464	.467	1.42	12.6	27.6	10.5	3.82	2.19
26	1.23	.765	.629	.555	.467	.473	1.48	13.4	26.4	10.1	3.57	2.18
27	1.19	.762	.637	.555	.467	.464	1.49	14.8	25.5	9.57	3.40	2.26
28	1.16	.753	.623	.555	.464	.473	1.54	15.5	25.3	9.18	3.31	2.29
29	1.14	.748	.615	.564	.498	.479	1.66	16.1	24.8	8.78	3.17	2.32
30	1.11	.742	.606	.566	----	.490	1.82	16.0	24.1	8.30	3.17	2.27
31	1.08	----	.603	.572	----	.507	-----	15.4	----	8.18	3.34	-----
MEAN	1.53	.858	.674	.574	.499	.468	.926	7.63	24.3	15.9	4.77	2.57
STANDARD DEVIATION	.294	.087	.053	.014	.033	.011	.390	4.76	2.93	5.29	1.26	.255

Earlier it was stated that about 40 percent of the runoff occurs during June. From table 2, it can be determined that, on average, more than 75 percent of the runoff occurs during May through July and more than 90 percent during May through September.

Annual mean discharges also are tabulated in table 2. From table 2, the mean annual discharge (5.06 m^3/s) was exceeded by the annual mean discharges during 14 of the 29 years of record; from table 1, exceedance of the mean discharge by daily flows is normally from May 15 to August 11.

The tabulation of annual mean discharges in table 2 indicates the greatest volume of flow occurred during water year 1982, followed by water years 1965 and 1972. The smallest volume of flow occurred during water year 1977, followed by water years 1960 and 1961.

Frequency and Duration

Flow frequency is determined by arranging given flows in order of magnitude and assigning the greatest probability of recurrence to the median flow and the least probability of recurrence to the largest and smallest flows. A minimum of about 10 years of record is desirable for predictions of flow frequency. Generally, flow frequency may be reasonably extrapolated to a recurrence interval about twice the length of record. A flood-frequency series is obtained by arranging, in rank order, annual peak discharges, either instantaneous or daily mean (Dalrymple, 1960; U.S. Water Resources Council, 1981).

Table 2.--Monthly and annual mean flows, in cubic meters per second, Pine Creek above Fremont Lake, water years 1955-83

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Annual
1955	0.694	0.346	0.396	0.306	0.264	0.419	0.527	8.41	21.7	10.1	3.31	1.40	3.99
1956	.813	.852	.838	.725	.589	.649	1.87	11.8	33.0	15.4	4.62	1.49	6.06
1957	.615	.473	.450	.411	.411	.487	.595	5.04	26.6	22.7	5.61	3.26	5.58
1958	2.57	1.13	.634	.513	.493	.482	.646	16.4	17.7	4.81	3.12	2.00	4.22
1959	.850	.722	.702	.470	.598	.456	.810	3.94	30.1	12.1	4.93	1.84	4.76
1960	2.00	.935	.362	.334	.374	.467	1.25	5.47	20.3	6.60	2.89	2.19	3.60
1961	2.55	1.55	.813	.445	.348	.385	.479	8.78	18.4	4.39	1.94	3.62	3.65
1962	2.45	1.62	1.27	.807	.683	.583	2.79	7.22	27.2	18.1	5.24	1.53	5.81
1963	1.03	.544	.513	.513	.541	.498	.583	6.12	24.8	12.5	3.37	5.92	4.76
1964	1.83	.946	.649	.566	.484	.413	.589	6.68	18.2	23.7	4.45	1.02	4.98
1965	.419	.323	.745	1.00	.759	.575	.912	4.39	27.9	32.3	8.69	3.12	6.80
1966	2.15	.991	.688	.592	.430	.413	.816	12.5	15.4	7.39	3.12	2.01	3.91
1967	1.09	.606	.646	.646	.649	.464	.569	6.88	23.3	24.8	5.07	2.43	5.64
1968	2.30	1.12	.861	.626	.496	.572	.784	3.57	25.0	14.9	9.91	4.59	5.41
1969	2.61	1.38	.875	1.06	1.04	.544	1.95	16.4	20.4	14.7	4.33	1.57	5.61
1970	.688	.360	.196	.249	.419	.323	.340	7.00	27.5	10.5	3.00	2.16	4.39
1971	.671	.680	.960	.858	.581	.504	.725	7.28	33.4	21.7	6.88	3.31	6.46
1972	2.36	1.36	.796	.977	.719	.855	.835	6.54	36.3	18.4	5.95	2.83	6.49
1973	2.44	1.20	.532	.484	.439	.343	.411	8.35	23.1	11.0	4.11	3.94	4.70
1974	1.62	1.52	.835	.629	.552	.572	1.29	6.40	34.0	13.8	3.34	1.19	5.47
1975	.436	.312	.242	.297	.459	.340	.515	2.56	17.9	30.9	4.33	1.52	5.01
1976	.884	.830	.827	.566	.459	.530	.889	10.3	20.2	18.4	4.98	2.12	5.10
1977	1.21	.334	.191	.124	.129	.114	.705	4.25	15.1	3.99	3.12	3.62	2.74
1978	1.93	1.27	1.50	.821	.558	.623	1.41	5.18	27.4	24.1	6.06	3.00	6.17
1979	1.27	.530	.598	.518	.391	.354	.649	11.2	19.3	8.35	3.51	1.40	4.02
1980	.623	.430	.264	.243	.334	.362	1.44	10.8	23.4	13.6	2.50	1.56	4.62
1981	.714	.430	.439	.309	.262	.263	.889	6.71	23.5	7.90	2.50	1.27	3.77
1982	.929	.875	.864	.807	.552	.544	.855	7.00	25.6	30.6	9.20	4.39	6.88
1983	3.74	1.25	.818	.725	.442	.496	.725	3.88	27.2	22.9	8.38	4.33	6.26
MEAN	1.50	.859	.673	.573	.498	.468	.926	7.63	24.3	15.9	4.77	2.57	5.06
STANDARD DEVIATION	.871	.416	.300	.244	.175	.138	.538	3.51	5.65	8.16	2.11	1.24	1.07

Tabulation of peak-flow (flood) frequency is given in table 3 for Pine Creek at the gaging station; values listed are based on instantaneous peak discharges using the record from the gaging station.

The peak flow having a probability of 50 percent has an equal chance in any given year of being larger or smaller. The recurrence interval is the reciprocal of exceedance probability, or 2.0 years.

The 2-year peak flow at Pine Creek above Fremont Lake is about 50 m^3/s, or one-half the years for the period of record have a greater peak flow and one-half the years have a lesser peak flow. The instantaneous peak flow exceeds about 30 m^3/s every year, whereas only about once every 100 years, on the average, will the instantaneous peak flow be greater than about 80 m^3/s. The frequency distribution of high flows, when expressed as the ratio of a given flow to the 2-year flow, is similar among many rivers (for example, Leopold, Wolman, and Miller, 1964).

Flow duration is determined in much the same manner as flow frequency. The values of daily mean discharge are arranged in order of magnitude, and the number of days of occurrence for each magnitude of flow determines the percentage of time or duration of each flow (Searcy, 1959). The cumulative percentage of time each discharge value is equaled or exceeded is the flow-duration array. Data are available only from continuous-record gaging stations; records of at least several years tend to minimize variability because of years of abnormally high or low flow.

Table 3.--Flood-frequency data, Pine Creek above Fremont Lake

Annual exceedance probability	Recurrence interval (years)	Instantaneous peak discharge (cubic meters per second)
0.995	1.005	31.1
.990	1.01	32.3
.950	1.05	35.9
.900	1.11	38.2
.800	1.25	41.3
.500	2.00	48.4
.200	5.00	57.5
.100	10.0	63.4
.040	25.0	70.5
.020	50.0	75.8
.010	100	81.0
.005	200	86.2
.002	500	93.1

Flow-duration data are tabulated in the first two columns of table 4 (remaining columns of table 4 are used in a later discussion of sediment transport). For Pine Creek, the mean annual discharge of 5.06 m^3/s is equaled or exceeded about 23 percent of the time, a value also similar to that for many other streams (for example, Emmett, 1975). High flow occurs only a small percentage of the time; the 2-year peak flow of 48.4 m^3/s is equaled or exceeded by daily mean flows only about 0.35 percent of the time.

SUSPENDED SEDIMENT

Unlike dissolved solids, which tend to have the greatest values of concentration at low flow, suspended-sediment concentrations generally are larger during high flow than during low flow. Even when discharge is maximum, the increased competence of a stream to transport sediment is important only to the extent that sediment is available for transport. For discharges at given values of flow frequency or duration of flow, differences in values of suspended-sediment concentration between locations primarily are dependent on the rock and soil types and such factors as erodibility. Because of extremes of erodibility rates among soil types and human-induced effects on natural erosion rates, concentrations of suspended sediment for values of discharge at a given flow frequency are quite variable among locations.

Suspended-sediment measurements at Pine Creek above Fremont Lake were made on a few days of each of the years from 1975 through 1978. These measurements are published in reports summarizing water-resources data collected annually in Wyoming (U.S. Geological Survey, 1975-78). A few water samples collected by the authors during the 1980's confirm that the earlier data are still applicable. All published data for suspended-sediment measurements at Pine Creek above Fremont Lake are presented in table 5. Because suspended-sediment concentrations within the stream commonly are variable both laterally and vertically, the values of suspended-sediment concentration presented in table 5 actually are composite values obtained from several verticals at the measuring section. Thus, the composite values may be considered representative for the discharge. Because suspended-sediment concentrations also are extremely variable with discharge, the composite values need to be further considered to be instantaneous values and representative only of the respective discharge. For a given discharge, the suspended-sediment concentration can be substantially different depending on whether the water stage is rising or falling. Data of this report are too few to define a hysteresis for suspended-sediment concentrations; values of the concentration may be considered intermediate of any hysteresis effect.

Suspended-sediment samplers used were the DH-48 for wading measurements and the D-49 for cable measurements. Details of these samplers and sampling techniques have been described by Guy and Norman (1970).

Commonly, values of instantaneous suspended-sediment concentration are converted to instantaneous suspended-sediment transport rate (load) in terms of mass, in tons (megagrams) per day. These conversions also are included in table 5.

Table 4.--Daily mean flow duration and discharge, and related data for suspended-sediment transport rate; Pine Creek above Fremont Lake, water years 1955-83

Water		Suspended sediment			
Percentage of time discharge is equaled or exceeded	Discharge (cubic meters per second)	Instantaneous transport rate (tons per day)	Annual transport rate in discharge class (tons per year)	Cumulative transport rate (tons per year)	Percentage of annual transport rate
0.019	59.5	32.5	2.24	2.2	0.308
.378	48.1	25.4	33.3	35.6	4.881
1.407	39.6	20.3	76.3	111.8	15.537
2.521	34.0	17.0	69.1	180.9	24.841
4.560	27.5	13.3	98.8	279.7	38.406
6.779	22.7	10.6	86.0	365.7	50.209
9.026	18.4	8.34	68.4	434.1	59.606
10.932	15.3	6.73	46.6	480.7	66.006
12.925	12.5	5.30	38.8	519.5	71.330
15.021	10.2	4.20	32.2	551.6	75.748
17.211	8.50	3.40	27.2	578.9	79.485
19.165	7.08	2.75	19.7	598.5	82.184
21.828	5.66	2.13	10.7	619.2	85.023
23.707	4.81	1.76	22.1	631.3	86.682
26.718	3.96	1.41	15.5	646.7	88.806
31.005	3.11	1.06	16.6	663.4	91.091
34.866	2.61	.864	12.2	675.6	92.764
38.690	2.15	.692	9.67	685.2	94.092
42.117	1.76	.547	6.84	692.1	95.031
45.261	1.44	.436	5.01	697.1	95.719
48.905	1.19	.348	4.63	701.7	96.355
52.946	.991	.282	4.16	705.9	96.926
59.856	.793	.218	5.49	711.4	97.680
67.419	.651	.173	4.78	716.2	98.337
76.917	.538	.139	4.81	721.0	98.998
85.008	.453	.114	3.36	724.3	99.459
91.626	.368	.089	2.16	726.5	99.756
95.553	.312	.074	1.06	727.5	99.901
97.649	.249	.057	.435	728.0	99.960
98.489	.204	.045	.138	728.1	99.979
99.028	.167	.036	.070	728.2	99.989
99.254	.139	.029	.024	728.2	99.992
99.641	.113	.023	.032	728.2	99.997
100.000	.093	.018	.024	728.3	100.000
100.000	.000	------	-------	-----	-------

Table 5.--Water-discharge and instantaneous suspended-sediment data Pine Creek above Fremont Lake

Date	Discharge (cubic meters per second)	Suspended sediment Concentration (milligrams per liter)	Suspended sediment Transport rate (tons per day)
06-04-75	9.32	2	1.61
06-20-75	13.3	3	3.46
07-02-75	44.7	15	58.1
07-08-75	47.6	2	8.24
07-29-75	13.0	8	9.02
08-26-75	2.63	7	1.60
10-07-75	.736	0	.00
11-05-75	.963	2	.167
01-20-76	.566	7	.343
03-04-76	.708	2	.123
05-08-76	.623	7	.378
05-12-76	5.89	4	2.04
06-02-76	22.7	6	11.8
06-23-76	20.0	8	13.9
07-08-76	29.4	13	33.1
07-22-76	11.0	8	7.65
08-11-76	4.53	11	4.31
08-31-76	2.89	12	3.00
10-13-76	1.39	4	.481
11-09-76	.396	3	.103
12-14-76	.227	4	.079
01-25-77	.139	2	.024
03-09-77	.119	2	.021
04-21-77	.396	2	.069
05-10-77	5.32	10	4.61
05-30-77	3.40	2	.588
07-08-77	5.81	2	1.01
08-03-77	3.00	3	.780
09-01-77	5.81	6	3.02
10-05-77	2.24	2	.387
11-02-77	1.36	2	.235
12-01-77	1.42	2	.245
01-25-78	.623	2	.108
02-28-78	.566	3	.147
04-26-78	1.19	4	.412
05-23-78	8.07	5	3.49
06-14-78	34.0	2	5.88
06-28-78	33.4	4	11.6
07-20-78	17.5	5	7.58
08-03-78	10.7	8	7.39
09-06-78	2.66	2	.461

To obtain a sediment-rating curve, values of instantaneous suspended-sediment concentration or transport rate are plotted as functions of discharge. Although only two data points are required to develop either curve, the data usually are so variable that curves which are based on numerous data points provide more reliable results. A sediment-rating curve based on 41 data points was determined for Pine Creek above Fremont Lake. Systematic bias of data because of sample variability or analytical technique (for example, Ferguson, 1987) was considered minimal, and no bias correction was used. For Pine Creek, the curves of concentration and transport rate are shown in figure 5. The usual graph is that of transport rate and the difference in the two graphs is primarily the constant, 0.08658, converting milligrams per liter to tons per day.

A best-fit equation to describe the relation shown in the lower one-half of figure 5 can be developed by using log-transformed, least-squares regression techniques. The resulting equation is:

$$Q_s = 0.08658\ C_s\ Q_w$$

$$= 0.285\ Q_w\ 1.159,$$

where

Q_s = instantaneous suspended-sediment transport rate, in tons per day;

C_s = suspended-sediment concentration, in milligrams per liter; and

Q_w = instantaneous water discharge, in cubic meters per second.

This equation becomes a predictive relation for estimating the suspended-sediment transport rate at any discharge; however, reliability is greatest for discharges within the range of measured data.

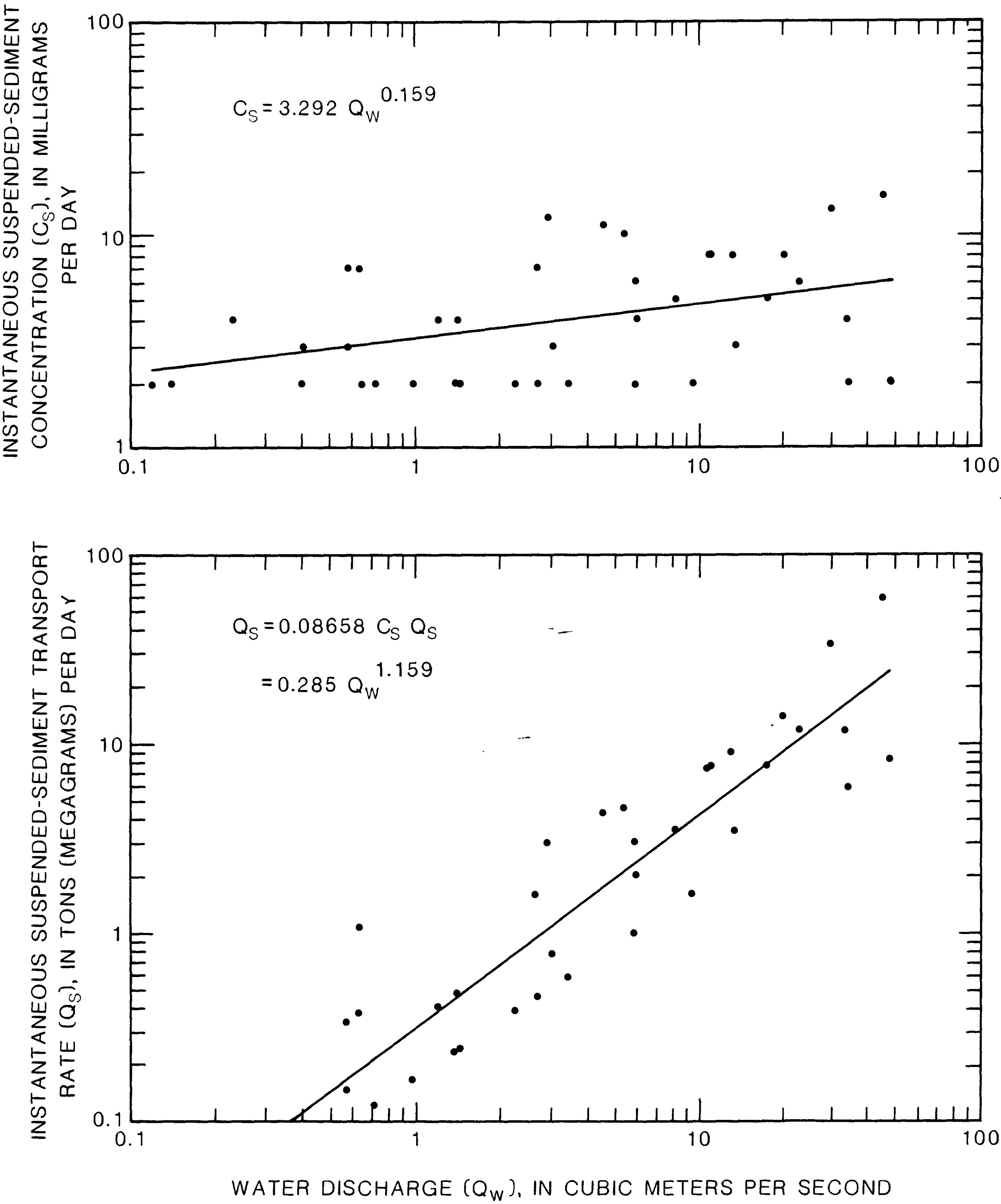

Figure 5.--Relations of instantaneous values of suspended-sediment concentration and transport rate to water discharge.

Annual Transport Rate

The relation of instantaneous suspended-sediment transport rate to discharge presented previously is sufficient to enable approximate computations of annual suspended-sediment transport rate. Flow-duration data and the instantaneous rating of suspended-sediment transport rate may be combined to provide the discharge of suspended sediment at each representative flow. These values are multiplied by the duration of each representative flow and totaled to obtain the annual suspended-sediment transport rate.

For Pine Creek above Fremont Lake, the complete computations are presented in table 4. In table 4, columns 1 and 2 are the flow-duration data based on the entire period of record. Column 3 is the suspended-sediment transport rate at the discharge indicated in column 2 and is based on the relation shown in figure 5. Column 4 is the average suspended-sediment transport rate during the time increment indicated in column 1, or the annual suspended-sediment transport rate in each discharge class. Column 5 is a cumulative summation of annual suspended-sediment transport rate and column 6 is the summation as a percentage of the annual transport rate.

Data in table 4 indicate that the cumulative suspended-sediment transport rate is about 728 tons/yr. The drainage area at the gaging station is 196.3 km^2 giving an average suspended-sediment yield of 3.7 $(tons/km^2)/yr$. On the basis of compacted soil weight (mass) of about 2,400 kg/m^3, about 300 m^3 of material is transported to Fremont Lake during an average year. Distributed over the drainage area upstream from the gaging station, this represents a lowering of the ground surface of about 0.15 mm per century. Thus, average erosion rates in the area are extremely slow.

The percentage of annual suspended-sediment transport rate is plotted as a function of percentage of time in figure 6. Slightly more than 60 percent of the suspended sediment is transported in 10 percent of the time and about 90 percent in 30 percent of the time. Therefore, most sediment is transported only during times of high flow.

Magnitude and Frequency

As discussed in the preceding section, large flows are responsible for transporting most suspended sediment. Using the concept of magnitude and frequency of forces first discussed by Wolman and Miller (1960), the effectiveness of each of the ranges of discharge (discharge classes) to transport suspended sediment can be evaluated. Wolman and Miller (1960) postulate that, because extremely large flows (though effective) occur so rarely, they are not the dominant discharges. Likewise, because small flows (though frequent) are so ineffective, they are not the dominant discharges. Wolman and Miller (1960) postulate that it is the more common large flows that are most effective. Emmett (1975) provided detail that bankfull discharge is a channel-forming, or dominant, discharge. Bankfull discharge has a recurrence of about 1.5 years for many streams and this value is assumed applicable to Pine Creek.

The suspended-sediment transport rate in each incremental discharge class from table 4 is plotted against discharge in figure 7; the dashed line shows the generalized trend. Maximum quantities of suspended sediment are transported in a discharge class that is about 30 m^3/s. Flows of this magnitude are about the annual instantaneous peak discharge (table 3).

Though bankfull discharge was not measured by field survey, the dominant or most effective discharge indicated in figure 7 approximates bankfull discharge.

DELTA OF FREMONT LAKE

The "Annual Transport Rate" section of this report indicates that about 728 tons of suspended sediment is transported to Fremont Lake from Pine Creek during the average year. Although bedload has not been measured, it is estimated to be about 10 percent of total load, based on measurements at nearby streams (for example, Emmett, Myrick, and Meade, 1980). Accordingly, the average annual total-sediment load is estimated to be about 800 tons from Pine Creek. At an unconsolidated or deltaic unit mass of about 1,600 kg/m^3, the annual volume of sediment entering the lake from Pine Creek is about 500 m^3. Because Fremont Lake has a glacial origin dating some 10,000 years ago, the total volume of sediment that has been transported into the lake area is about 5 million m^3.

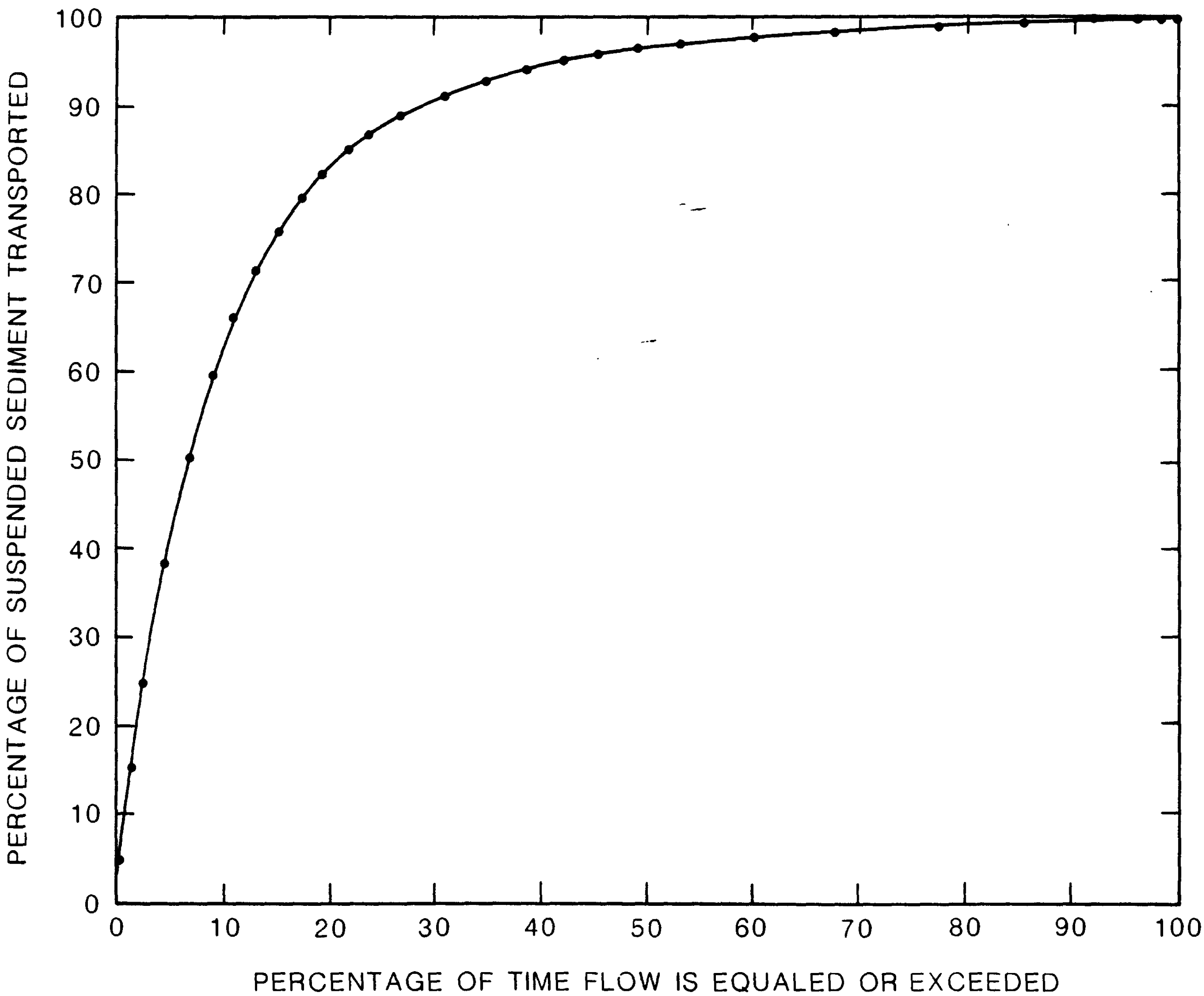

Figure 6.--Relation of percentage of suspended sediment transported to percentage of time flow is equaled or exceeded.

Rickert and Leopold (1972) reported that the volume of water stored in Fremont Lake divided by the annual volume of water inflow yielded a retention time in excess of 11 years, which indicates near-zero water velocities within the lake. Because sediment-trapping efficiency is great, nearly all sediment transported into the lake should be stored at the northern end of the lake near the inlet. Several suspended-sediment samples collected from the outlet during high flow in 1986 confirm that all or most of the sediment entering the lake remains in the lake (unpublished data collected by the Geological Survey).

An extensive submerged delta has formed at the northern end of Fremont Lake (for example, see fig. 4); depths in the lake generally are less than 2 m within 100 m of the point where Pine Creek flows into the lake. Just north of Fremont Lake, the flat along Pine Creek on which the gaging station is located appears to be an emerged delta. The elevation of this alluvial-deltaic deposit corresponds approximately to the elevation of the floodplain (that is, the deposit is flooded during almost all annual peak discharges of Pine Creek). Inflowing volumes of sediment are compared to stored volumes of sediment in the next section of this report.

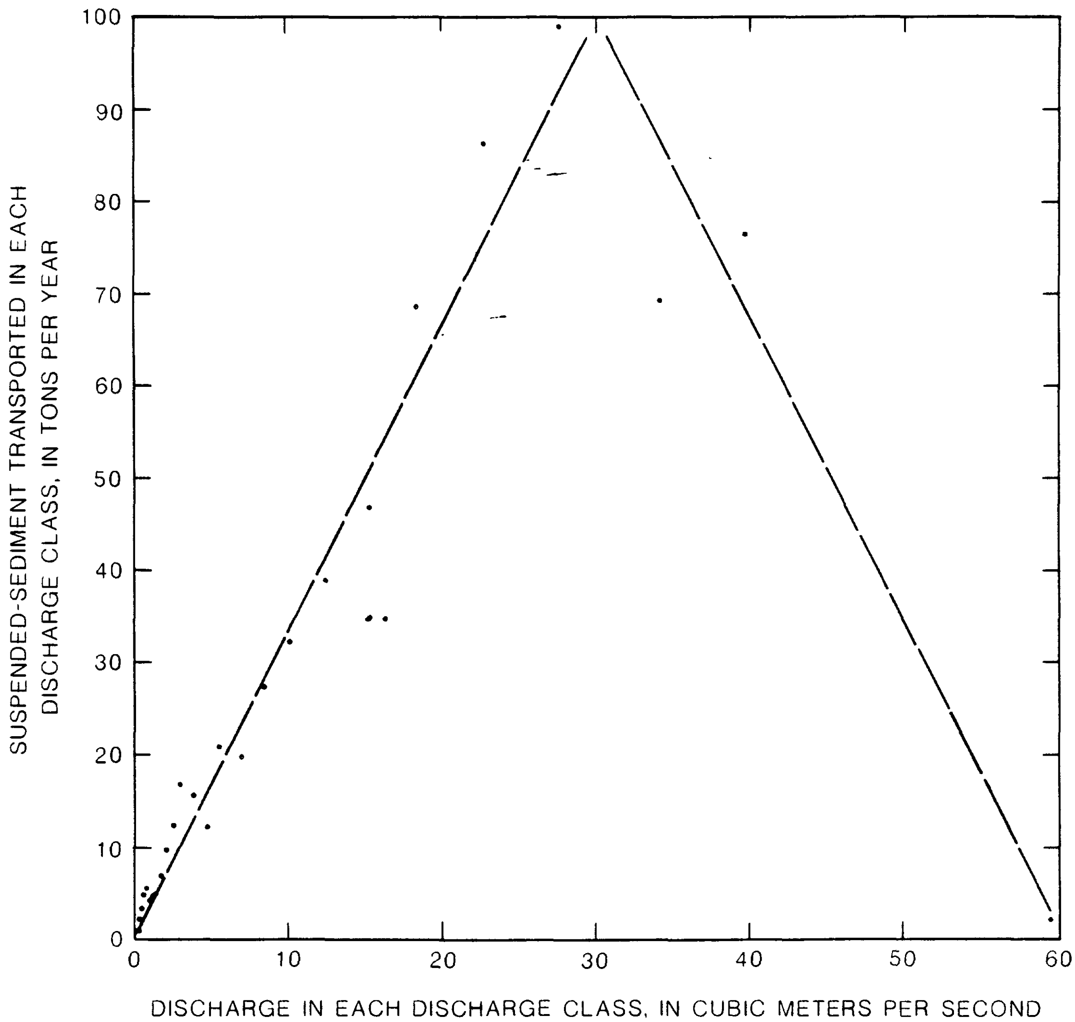

Figure 7.--Relation of suspended sediment transported to value of discharge in each discharge class.

Profiles and Bathymetry

In order to compare the accumulated sediment deposited near the northern shore of the lake with the average rate of measured sediment transport, it is necessary to compute the volume of the accumulated sediment; this was done using profiles and bathymetry. The accumulated sediment consists of alluvial deposits presently above the lake level and submerged deltaic deposits.

A combined profile of Pine Creek and the delta, and separate profiles of Pine Creek and the delta are shown in figure 8. The profile of the delta has the usual steep, avalanche-like front. It is assumed that the delta front terminates on bedrock or that only little unconsolidated sediment overlies the bedrock south of the delta front. Assuming that the bedrock surface has a smooth, slightly concave profile from the delta front to the bedrock valley floor about 1,000 m upstream from the creek mouth, a smooth curve connecting these two points has been drawn as the dashed line shown in profiles A and B of figure 8. The depth of the alluvial and deltaic deposits at different distances north and south of the shoreline were measured as the vertical distance between the surveyed profile and the estimated position of the bedrock surface.

Data used to construct the profiles in figure 8 are tabulated in table 6. Data in columns 1 and 2 were obtained from U.S. Geological Survey topographic maps. Data in columns 3 and 4 were derived from traverse 6 in figure 9. Water depth was measured in August 1984 by sonar as a function of distance southward from the mouth of Pine Creek. The elevation of the lake bottom was determined using several values from the original bathymetric study presented in figure 4; these values are listed in columns 5 and 6 of table 6.

Plotted profiles of the delta (for example, fig. 8, profile C) indicate that the maximum thickness of deltaic deposits is about 35 m and that the deltaic deposits are about 400 m wide and extend about 400 m into the lake. The measured surface area and thickness of deltaic deposits indicate that the volume of sediment in the delta is about 3 million m^3.

Alluvial deposits along the downstream reach of Pine Creek extend from the inlet to about 1,000 m upstream, have a maximum width of about 350 m at the shoreline, and have a maximum thickness of about 20 m. Because multiple traverses were not made along Pine Creek, the same accuracy as for estimating the volume of sediment in the delta is not applicable here. The volume was estimated using triangular shapes for the surface area and depositional wedge; the estimated volume of alluvial deposits in the floodplain along the downstream reach of Pine Creek is about 2 million m^3.

The volume of accumulated stored sediment in the northern lake area is about 5 million m^3. Annual sediment load has been determined to be about 500 m^3; 10,000 years (age of lake) times 500 m^3/yr is about 5 million m^3. Thus, there is general agreement between present rates of sediment transport and a 10,000-year accounting of sediment deposition in the northern lake area.

The profile data of the delta traverses were plotted on a planimetric map of Fremont Lake and the bathymetry of the delta area was determined; this map is shown in figure 10 and may be used to supplement the northern

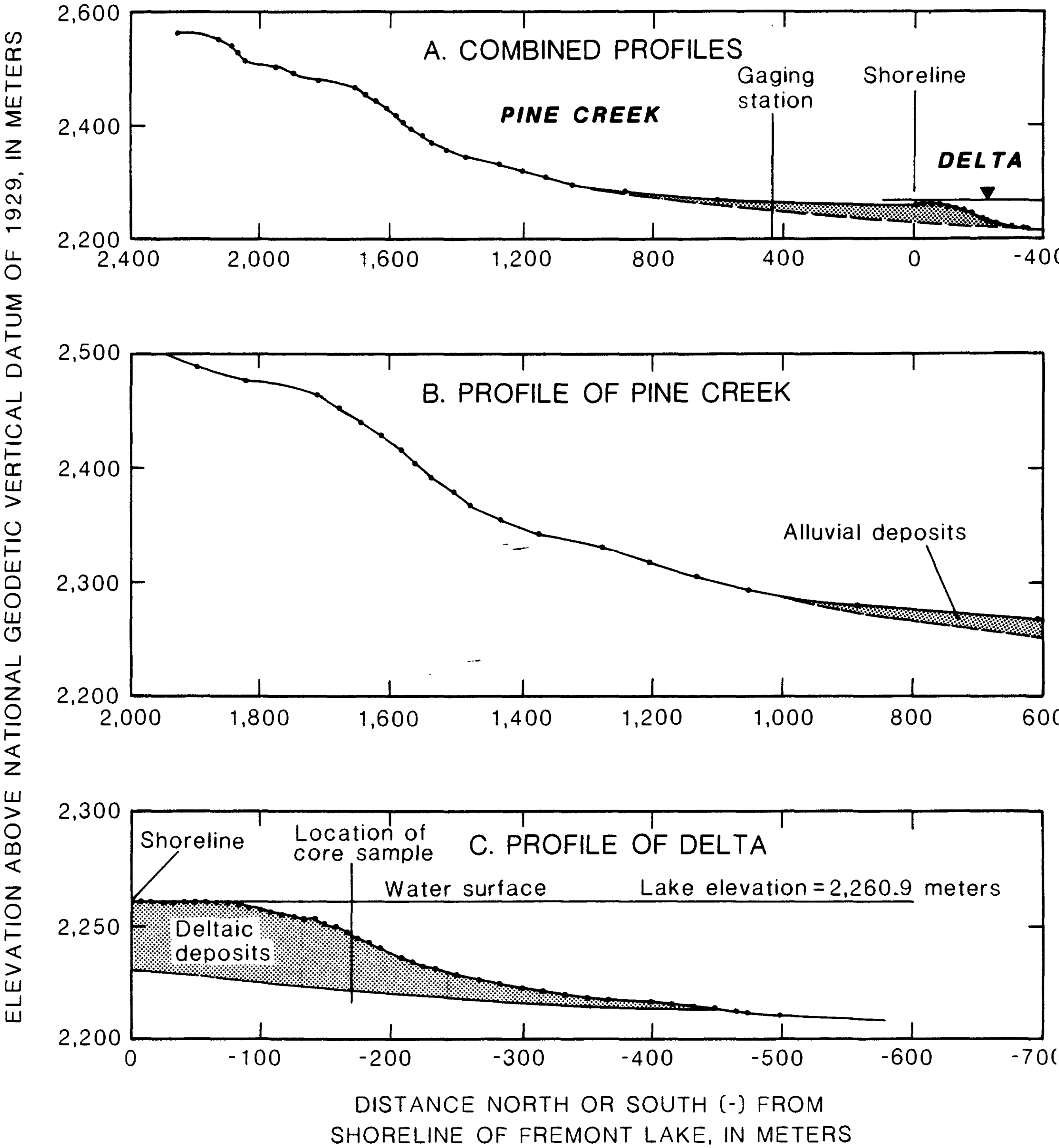

Figure 8.--Profiles along Pine Creek and the delta area, northern Fremont Lake.

end of existing bathymetric maps (for example, fig. 4). The traverses used to develop figure 10 generally radiated from the area marked as dock in figure 10, but several cross traverses also were used (fig. 9).

Deposition Rates

Evidence indicates that the 500 m^3/yr of sediment that is transported into the lake is deposited in the 400-m by 400-m expanse of delta. This results in an estimated average deposition rate on the delta of about 3 mm per year. Samples of deltaic deposits were collected by a gravity core sampler in order to confirm the estimated rate of deposition. Although the sampler weighed about 100 kg, penetration of the delta was less than 0.5 m primarily because occasional organic debris prevented deeper entry. A well-preserved but short core collected along traverse 6 (fig. 9; fig. 8, profile C) was chosen for further analysis. The location of the core site is shown on figure 8, profile C; the depth of the lake at the site is 17 m.

The core was divided into six equal samples, each 50 mm in length. One-half of each sample was used for size analysis and the other one-half for radiocarbon dating--carbon-14 age of inclusive organic debris.

The radiocarbon dating indicated ages of 80 to 310 years before present. The age of the top 0.15 m of the core averaged about 100 years before present; the bottom 0.15 m averaged about 300 years before present. The six ages are plotted in figure 11; the standard deviation of each age determination also is shown in the figure.

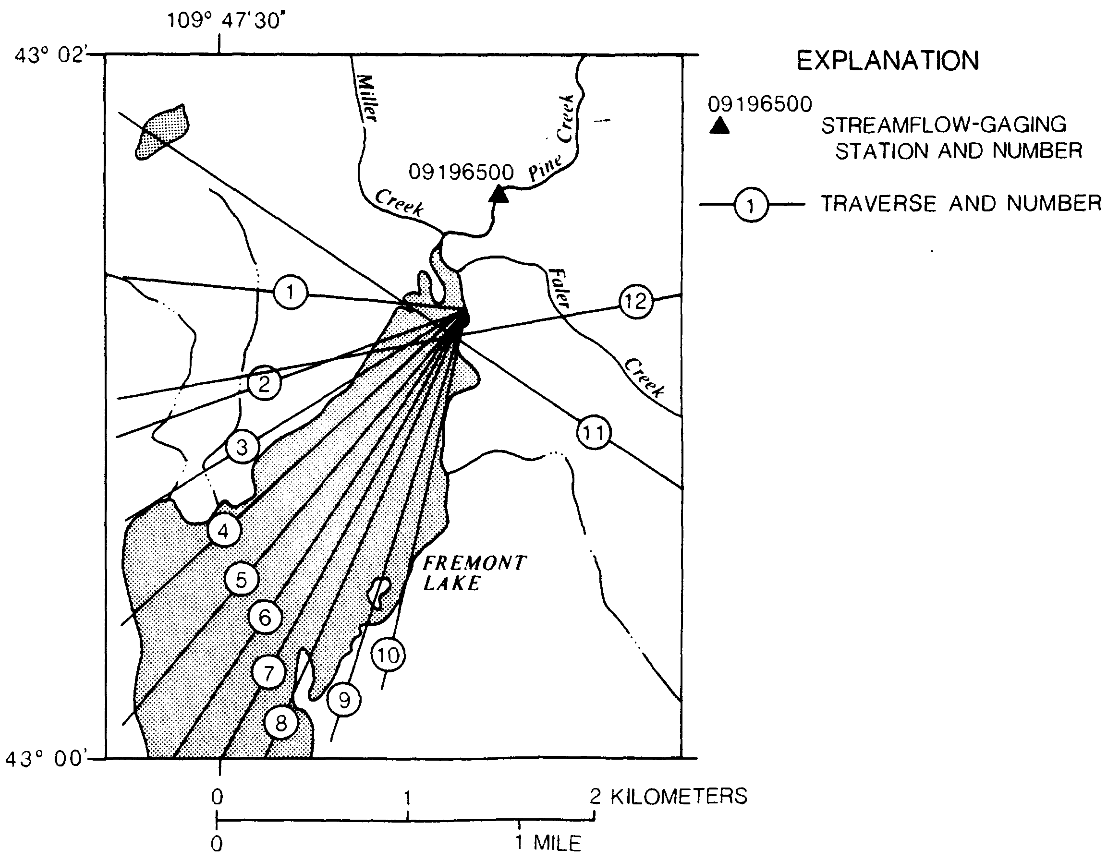

Figure 9.--Location of 12 traverses used for determining bathymetry of the delta (modified from Peterson and others, 1987).

Table 6.--Values of distance and land-surface elevation above National Geodetic Vertical Datum of 1929 used to construct profiles shown in figure 8

[Positive values indicate distance northward from shoreline; negative values indicate distance southward from shoreline]

Pine Creek upstream from Fremont Lake		Delta area of Fremont Lake (August, 1984)		Bathymetry data for Fremont Lake (1970)	
Distance (meters)	Elevation (meters)	Distance (meters)	Elevation (meters)	Distance (meters)	Elevation (meters)
2,255	2,560.20	0	2,259.52	-1189	2,199.94
2,127	2,548.00	-8	2,259.98	-1554	2,169.46
2,088	2,535.81	-16	2,259.98	-1966	2,138.98
2,069	2,523.62	-25	2,259.83	-----	--------
2,045	2,511.43	-33	2,259.68	-----	--------
1,951	2,499.24	-41	2,259.98	-----	--------
1,896	2,487.05	-50	2,259.98	-----	--------
1,823	2,474.86	-58	2,259.83	-----	--------
1,713	2,462.66	-66	2,259.68	-----	--------
1,679	2,450.47	-75	2,259.37	-----	--------
1,646	2,438.28	-83	2,258.61	-----	--------
1,615	2,426.09	-91	2,257.24	-----	--------
1,585	2,413.90	-100	2,256.32	-----	--------
1,564	2,401.71	-108	2,255.11	-----	--------
1,539	2,389.52	-116	2,254.19	-----	--------
1,506	2,377.32	-125	2,252.97	-----	--------
1,481	2,365.13	-133	2,252.06	-----	--------
1,436	2,352.94	-141	2,252.06	-----	--------
1,378	2,340.75	-149	2,249.92	-----	--------
1,280	2,328.56	-158	2,248.70	-----	--------
1,207	2,316.37	-166	2,246.27	-----	--------
1,134	2,304.18	-174	2,243.83	-----	--------
1,052	2,291.98	-183	2,241.39	-----	--------
890	2,279.79	-191	2,239.26	-----	--------
610	2,267.60	-199	2,237.43	-----	--------
427	Gaging station	-208	2,234.99	-----	--------
-----	---------	-216	2,233.16	-----	--------
-----	---------	-224	2,231.33	-----	--------
-----	---------	-233	2,230.11	-----	--------
-----	---------	-249	2,227.67	-----	--------
-----	---------	-266	2,225.54	-----	--------
-----	---------	-282	2,223.71	-----	--------
-----	---------	-299	2,221.88	-----	--------
-----	---------	-315	2,220.36	-----	--------
-----	---------	-332	2,218.84	-----	--------
-----	---------	-349	2,217.62	-----	--------
-----	---------	-365	2,216.70	-----	--------
-----	---------	-399	2,215.48	-----	--------
-----	---------	-415	2,214.26	-----	--------
-----	---------	-432	2,213.96	-----	--------
-----	---------	-448	2,213.04	-----	--------
-----	---------	-465	2,211.83	-----	--------
-----	---------	-473	2,210.91	-----	--------
-----	---------	-498	2,210.00	-----	--------

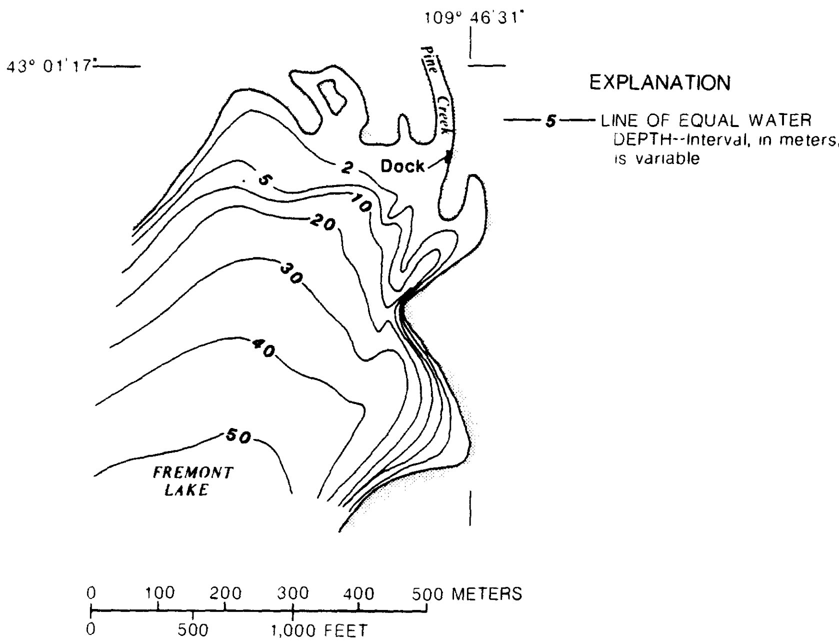

Figure 10.--Bathymetric map of delta (modified from Peterson and others, 1987).

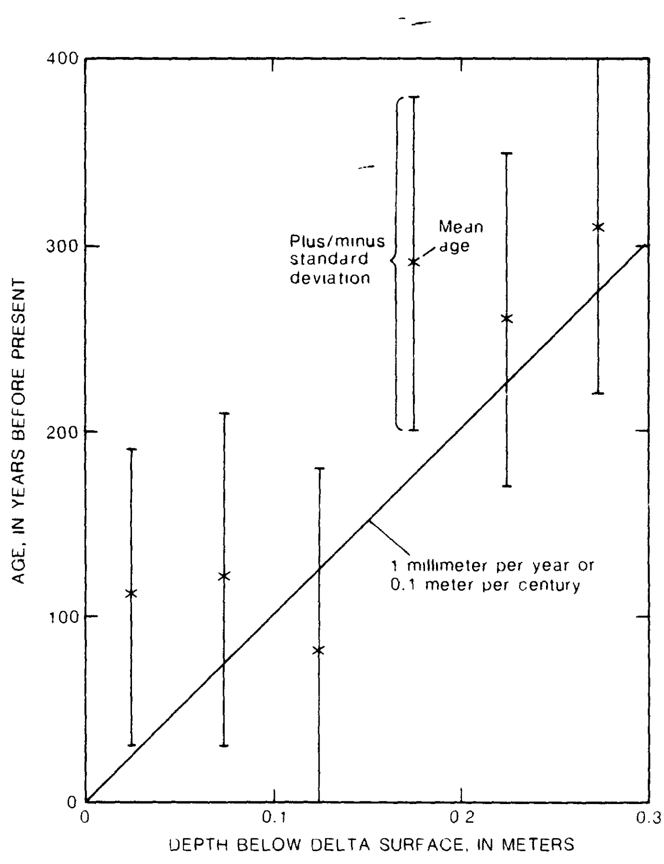

Figure 11.--Age of delta deposits determined from carbon-14 dating as a function of depth below delta surface.

A best-fit line can be drawn through the plotted data in several ways and the resulting deposition rates range from about 0 to 5 mm/yr. The relation shown in figure 11 has a slope of 1 mm/yr. Considering the factors affecting the two methods used for determining the deposition rate--sediment transport and carbon-14 dating, the results are not greatly dissimilar. The data indicate that all the coarse material, fine sand and larger, is deposited in the delta and little is transported farther into the lake. Therefore, the average deposition in the delta probably equals the average inflow of sediment from the watershed.

Particle Size of Bottom Sediments

Size analyses of the six samples of the core are listed in table 7. The methods of analysis were:

1. Sieve analysis for samples from depths greater than 0.05 m; particle sizes ranging from 4.0 to 0.062 mm.

2. Visual-accumulation tube for samples from depths less than 0.05 m; particle sizes ranging from 1.0 to 0.062 mm.

3. Sedigraph for all samples; particle sizes ranging from 0.031 to 0.002 mm.

There is little variation of particle size with depth throughout the 0.3-m length of the core; average values of median particle sizes are in the fine sand range.

A traverse of the entire length of the lake was made to obtain samples of deep-water sediment. Size analyses of the 41 collected samples are listed in table 8. Other than in the samples collected where the water is shallow at both ends of the lake, few sand-size or coarser particles are present. Median sizes generally are smaller than about 0.01 mm (silt), and appreciable quantities of clay are present.

Lake-bottom and deltaic-deposit sediments differ in size. This indicates that practically no sediment coarser than fine sand is transported to deep water. Data for four size classes listed in table 8 were studied to determine how they are distributed with lake depth; these data are plotted in figure 12. Considering particles larger than 0.062 mm, the size break between sand and silt, particles of this size comprise 50 percent of the bed sediment at depths less than 15 m. At depths less than 40 m, 80 percent of the bed sediment is finer than 0.062 mm. At depths greater than 100 m, 98 percent of the bed sediment is finer than 0.062 mm.

Table 7.--Size-distribution data for the core collected in the delta of Fremont Lake, August 1984

Sample depth below delta surface (meters)	Percentage finer than particle size (millimeters) indicated below											
	4.0	2.0	1.0	0.5	0.25	0.125	0.062	0.031	0.016	0.008	0.004	0.002
0 - 0.05	-----	----	100.0	99.4	90.3	56.0	35.3	29.5	20.3	13.9	10.1	7.2
0.05 - 0.1	100.0	99.4	97.1	90.7	73.7	37.5	10.0	7.6	4.9	3.3	2.2	1.6
0.1 - 0.15	100.0	99.3	96.7	89.5	68.3	33.6	9.1	6.2	3.7	2.4	1.7	1.2
0.15 - 0.2	100.0	99.5	96.2	87.5	64.4	24.8	6.2	4.8	3.1	2.2	1.5	1.1
0.2 - 0.25	100.0	99.9	98.4	93.9	78.6	40.1	10.5	7.9	5.1	3.5	2.4	1.7
0.25 - 0.3	100.0	99.9	99.2	98.0	87.0	47.0	11.9	9.1	5.7	3.9	2.8	1.9

Table 8.--Size-distribution data for lake-bottom sediments, Fremont Lake, 1984

[Size analysis type by numeral designation: 1, Sieve analysis, as necessary for all samples (16 mm (millimeters) to 2 mm); 2, VA tube, all samples (1 mm to 0.062 mm); 3, Sedigraph, all samples (0.031 mm to 0.002 mm); 4, Pipette, selected samples only (0.031 mm to 0.002 mm)]

Sample number and date (month and day)	Lake depth (meters)	Type of size analysis	Percentage finer than particle size (millimeters indicated below													
			16.0	8.0	4.0	2.0	1.0	0.5	0.25	0.125	0.062	0.03	0.016	0.008	0.004	0.002
1 (10-14)	5	1,2,3	-----	100.0	98.8	90.5	79.8	63.4	42.1	18.3	8.4	7.9	7.0	5.6	4.4	3.6
		4	-----	-----	-----	----	----	-----	-----	----	----	----	3.2	----	1.7	1.4
2 (10-14)	15	1,2,3	-----	100.0	99.3	95.2	88.8	68.6	42.1	16.4	3.6	3.3	3.1	2.9	2.6	2.3
		4	-----	-----	-----	----	----	-----	-----	----	----	----	1.2	----	.8	.6
3 (8-13)	15	1,2,3	-----	100.0	99.0	92.6	80.1	60.5	38.2	18.5	3.4	2.3	1.5	1.1	.8	.6
4 (10-14)	30	1,2,3	-----	-----	100.0	95.5	95.2	88.8	84.2	78.4	72.4	71.3	69.5	68.1	60.1	45.6
5 (8-13)	30	1,2,3	-----	100.0	97.3	92.6	92.3	86.0	84.4	83.4	81.9	79.7	76.2	74.3	64.0	49.2
		4	-----	-----	-----	----	----	-----	-----	----	----	81.5	79.9	77.4	70.0	55.3
6 (8-15)	34	1,2,3	100.0	98.1	91.9	84.8	82.1	69.8	63.2	61.0	57.5	56.9	56.3	55.5	50.0	39.1
7 (8-15)	39	1,2,3	100.0	98.4	96.3	95.3	95.2	93.7	90.6	87.9	84.3	83.5	80.1	78.0	72.1	58.2
8 (10-14)	45	1,2,3	-----	-----	-----	----	100.0	99.1	98.8	95.6	82.4	68.7	53.1	42.4	32.9	24.7
		4	-----	-----	-----	----	-----	-----	-----	----	----	59.4	50.0	37.7	28.1	21.5
9 (8-13)	45	1,2,3	-----	-----	100.0	96.1	93.3	80.9	68.9	60.6	50.0	37.5	30.5	26.5	21.3	15.5
10 (10-14)	60	2,3	-----	-----	-----	----	-----	100.0	99.7	99.4	97.7	94.8	87.9	77.2	62.5	49.8
11 (10-14)	75	2,3	-----	-----	-----	----	-----	100.0	99.2	98.4	90.4	77.8	54.3	42.8	35.0	27.7
		4	-----	-----	-----	----	-----	-----	-----	----	----	----	46.1	----	33.1	28.1
12 (8-13)	75	2,3	-----	-----	-----	----	-----	-----	100.0	99.8	98.3	95.8	89.4	81.1	66.8	54.1
13 (10-14)	90	2,3	-----	-----	-----	----	-----	100.0	99.9	99.2	98.2	96.2	89.3	80.0	65.3	51.5
14 (10-14)	105	2,3	-----	-----	-----	----	-----	100.0	99.7	99.6	98.4	94.4	84.1	73.8	60.0	46.7
		4	-----	-----	-----	----	-----	-----	-----	----	----	92.1	79.3	69.9	51.6	42.9
15 (8-13)	105	2,3	-----	-----	-----	----	100.0	99.8	99.8	99.7	98.0	92.1	80.4	70.6	56.4	42.6
16 (10-14)	120	2,3	-----	-----	-----	----	100.0	99.7	99.5	99.4	97.9	92.5	82.3	73.4	59.7	46.5
17 (8-13)	135	2,3	-----	-----	-----	----	-----	100.0	99.9	99.6	97.7	91.3	81.1	69.8	59.6	48.3
		4	-----	-----	-----	----	-----	-----	-----	----	----	----	75.9	----	52.1	41.4
18 (10-14)	150	2,3	-----	-----	-----	----	-----	100.0	99.6	99.4	97.8	90.7	79.3	67.9	54.3	41.8
19 (8-13)	165	2,3	-----	-----	-----	----	-----	-----	100.0	99.9	98.9	94.9	88.0	79.6	65.3	51.4
20 (10-15)	185	2,3	-----	-----	-----	----	-----	100.0	99.3	99.2	97.2	92.8	78.8	70.5	61.3	49.6
		4	-----	-----	-----	----	-----	-----	-----	----	----	----	72.2	----	56.8	45.8
21 (10-15)	150	2,3	-----	-----	-----	----	-----	100.0	99.9	99.8	98.8	95.9	87.5	78.1	67.2	55.3
22 (10-15)	120	2,3	-----	-----	-----	----	-----	100.0	99.7	99.6	98.2	94.3	83.5	71.2	60.9	50.6
23 (8-15)	105	2,3	-----	-----	-----	----	100.0	99.6	99.4	99.4	98.7	95.7	84.9	74.0	61.2	50.8
		4	-----	-----	-----	----	-----	-----	-----	----	----	91.5	81.5	73.1	57.9	47.9
24 (10-15)	145	2,3	-----	-----	-----	----	-----	-----	100.0	99.9	97.6	94.1	83.9	69.3	53.2	42.4
25 (8-15)	140	2,3	-----	-----	-----	----	100.0	99.9	99.7	99.7	98.6	90.7	72.0	51.3	38.0	28.1
26 (10-13)	120	2,3	-----	-----	-----	----	-----	100.0	96.6	86.0	78.8	69.0	51.2	39.0	30.3	24.8
		4	-----	-----	-----	----	-----	-----	-----	----	----	58.4	41.9	32.4	24.8	22.3
27 (8-15)	120	2,3	-----	-----	-----	----	-----	100.0	99.3	95.7	82.6	79.3	65.7	48.8	38.8	29.7
28 (10-15)	105	2,3	-----	-----	-----	----	-----	-----	100.0	98.0	87.5	77.0	58.2	46.0	36.8	30.2
29 (10-15)	90	2,3	-----	-----	-----	----	-----	-----	100.0	99.9	92.5	84.7	67.6	52.7	41.6	32.4
		4	-----	-----	-----	----	-----	-----	-----	----	----	76.9	59.9	46.7	40.1	34.9
30 (8-14)	90	2,3	-----	-----	-----	----	-----	-----	100.0	99.5	94.8	87.2	70.2	56.9	46.5	38.4
31 (10-15)	75	2,3	-----	-----	-----	----	-----	100.0	99.5	98.7	84.1	71.8	52.1	39.1	30.7	21.9
32 (10-15)	60	1,2,3	-----	-----	100.0	99.3	99.3	98.1	97.6	97.4	97.3	93.4	77.8	52.5	33.6	21.9
		4	-----	-----	-----	----	-----	-----	-----	----	----	91.7	75.9	45.6	25.8	17.5
33 (8-14)	60	1,2,3	-----	100.0	99.6	99.4	98.8	97.2	92.2	79.0	44.2	36.2	23.4	15.3	11.7	8.4
34 (10-15)	45	2,3	-----	-----	-----	----	-----	100.0	99.6	88.3	56.7	46.8	32.6	23.8	18.2	14.2
35 (8-14)	45	2,3	-----	-----	-----	----	-----	100.0	99.2	97.2	72.0	61.1	42.1	29.1	20.9	15.1
		4	-----	-----	-----	----	-----	-----	-----	----	----	51.2	36.1	26.7	20.8	16.6
36 (10-15)	30	2,3	-----	-----	-----	----	100.0	98.4	98.4	88.7	61.2	52.3	36.1	26.6	20.5	15.9
37 (8-14)	30	2,3	-----	-----	-----	----	100.0	99.0	98.8	97.8	75.1	63.5	44.3	32.7	25.2	19.9
38 (10-15)	15	2,3	-----	-----	-----	----	-----	100.0	96.1	67.1	35.5	32.8	26.1	18.2	14.6	10.9
		4	-----	-----	-----	----	-----	-----	-----	----	----	----	19.1	----	11.3	9.2
39 (8-14)	15	1,2,3	-----	100.0	97.9	89.9	86.4	40.4	10.9	4.9	3.1	3.1	2.7	2.1	1.7	1.3
40 (10-15)	5	1,2,3	-----	-----	100.0	98.1	91.9	53.6	32.2	15.2	9.0	5.6	2.9	1.9	1.4	1.2
41 (8-14)	5	1,2,3	100.0	87.9	76.0	61.3	58.1	30.5	24.1	19.6	16.0	14.9	10.8	8.3	6.8	5.6
		4	-----	-----	-----	----	-----	-----	-----	----	----	----	8.7	----	5.5	4.4

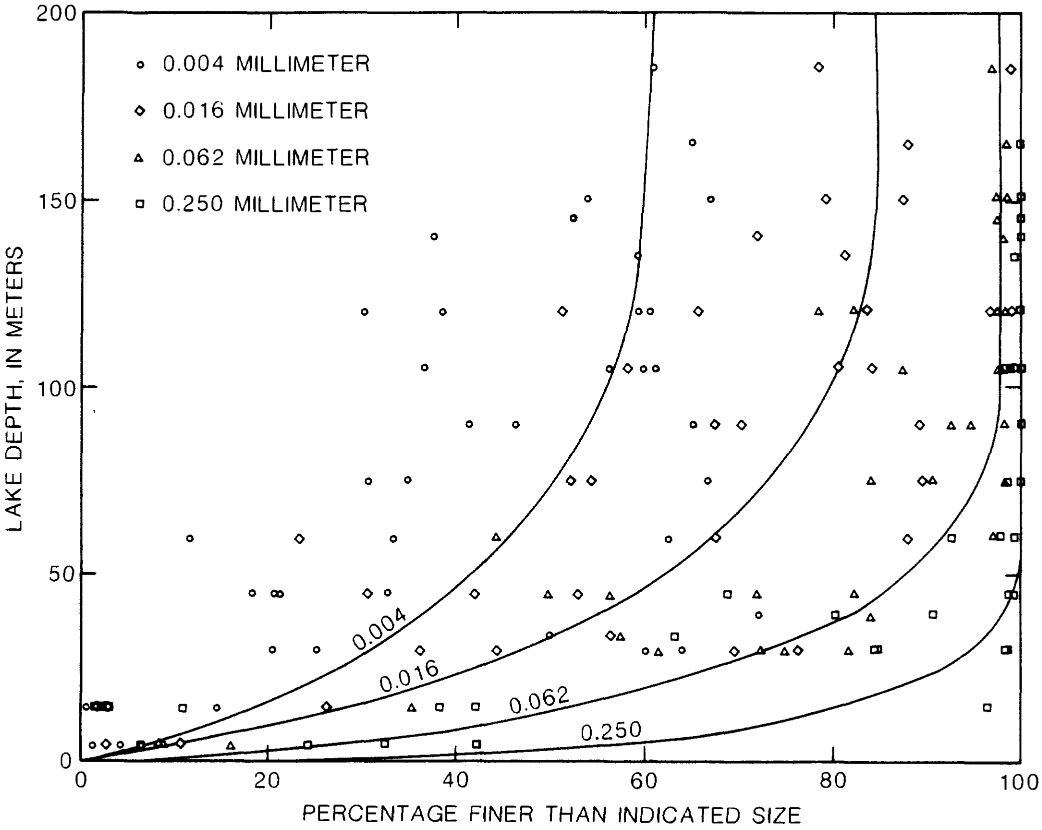

Figure 12.--Size distribution of bottom sediments.

SUMMARY

Fremont Lake is a glacially formed lake slightly more than 185 m deep and has a contemporary lake existence of about 10,000 years. The chemically dilute lake is located in the northeastern part of the Green River basin--a nearly pristine area in western Wyoming.

The mean annual inflow to the lake is about 5.1 m^3/s; this discharge is equaled or exceeded about 23 percent of the time. Annual peak flows generally exceed 30 m^3/s; bankfull discharge is estimated to be only slightly larger than this value. The 1.5-year flood has a magnitude of about 45 m^3/s.

The annual sediment transport to Fremont Lake is computed to be about 800 tons, providing about 500 m^3 of sediment to the delta in the northern end of the lake. Sediment stored in the floodplain along the downstream reach of Pine Creek and in the delta is about equal to 10,000 years of accumulation at the present rate of sediment transport. Most of the sediment is transported at discharges of about 30 m^3/s; accordingly, the dominant discharge for sediment transport is about equal to the bankfull discharge.

Present sediment-transport rates and radiocarbon dates indicate a deposition rate of about 1 to 3 mm/yr in the delta. Deltaic deposits are sandy, whereas deep-water lake deposits are silty and clayey. Little sediment is transported past the delta front into the deeper part of the lake. This is indicated by nearly sediment-free water samples (less than 2 mg/L suspended sediment) collected at the lake outlet.

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