UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
AUSTIN, TEXAS

DOUBLE MOUNTAIN FORK BRAZOS RIVER BETWEEN LUBBOCK AND BUFFALO LAKES, TEXAS

by

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Texas District Surface Water Branch
in cooperation with the
Texas State Board of Water Engineers

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DOUBLE MOUNTAIN FORK BRAZOS RIVER
BETWEEN LUBBOCK AND BUFFALO LAKES, TEXAS

PURPOSE

The purpose of this investigation was to study quantity, quality, and possible sources of the low flow and spring inflow of the Double Mountain Fork of the Brazos River between the Lubbock sewage disposal plant, 3 miles southeast of Lubbock, and a County Road crossing about 15 miles downstream and 4.2 miles northeast of Slaton, Lubbock County (fig. 1).

FIELD WORK

Field work was initiated by the U. S. Geological Survey in cooperation with the Texas State Board of Water Engineers on March 4, 1952 and completed March 18, 1954. Measurements of the flow of the river were made at eight designated points. (See fig. 1). Measurements were made at irregular intervals over the two year period. Chemical analyses of samples obtained were made by the Quality of Water Branch of the Geological Survey in Austin, Tex.

DATA

Results of all discharge measurements made at regular observation points are contained in table 1. Results of the special seepage investigation made March 4, 1953 are in table 2 and locations are shown on map figure 2. Chemical analyses and corresponding discharge measurements are contained in table 3. Chemical analyses of samples collected during the seepage investigation are in table 4.

The Geological Survey maintained a streamflow station from September 1939 to September 1949 on the Double Mountain Fork Brazos

River at the lower end of MacKenzie State Park and 2.5 miles upstream from the sewage disposal plant. The discharge record for this station is contained in table 5.

Precipitation records from the U. S. Weather Bureau and Texas Agricultural Experiment Station at Lubbock are given in table 6.

The Lubbock City-County Health Unit made a bacterial analysis of three sets of water samples taken from the river in the observed area during June and July 1953. A report of the Health Unit study is given on Page 13.

GENERAL

The elevation of the river bed at the upper end of the reach, site 1, is about 3,100 feet, and about 2,700 feet at the lower end, site 6. The river flows first through a relatively flat valley and into a narrow canyon at Buffalo Lakes. The canyon becomes deeper downstream from the plains and at the base of the escarpment below Buffalo Lakes rapidly changes to a wide valley with large overflow areas on each side of the river channel.

Seeps and springs occur in the river bed in the reach studied and the flow gradually increases from the upper end of the reach to Buffalo Lakes. Below site 4, (fig. 1) which is below the lower lake, the increase in flow becomes less and no springs are in evidence at the lower sites 5 and 6.

During the period of investigation the river was never dry at the upper end of the reach, site 1, but was frequently dry at the lower end, sites 5 and 6, especially during the summer months.

Local residents state that in earlier years, and as far back as 1936, Double Mountain Fork and Yellowhouse Creek, an upstream tributary, flowed continuously through what is now MacKenzie State Park in the city limits of Lubbock; however, basic data are not available for that early period. There was no flow in the Park area during the period of investigation except during and immediately after substantial rainfall. (See table 6).

The discharge record (table 5) for the former station in MacKenzie State Park shows that runoff at that point occurred only during periods of heavy rainfall. There was no flow during 98 of the 121 months the station was operated. The average discharge for the 10 year period of record was 1.67 cfs.

SEWAGE DISPOSAL PLANT

The sewage disposal plant of the City of Lubbock is situated on the right bank of the river near the upper end of the reach investigated. The effluent of the plant, about 6-mgd in 1954, is not discharged into the river. It is pumped from the disposal plant to three nearby earthen storage tanks and used for irrigation. The superintendent of the sewage disposal plant stated that during construction of the plant (1940-41) ground water seepage was so copious that it was necessary to install a 4-inch tile drain along the outside of the foundation of the effluent basin and pump house to intercept and carry off this abundant flow. This drain is still in place and still discharges into the river. Theoretically, no effluent reaches the river, but the discharge from this drain is contaminated as shown by the bacterial analyses made by the Lubbock City-County Health Unit. The laboratory of the Health Unit made bacterial analyses of three sets of water samples taken from the river in the vicinity of the sewage disposal plant and Buffalo Lakes during June and July 1953. (See report by E. L. Redford, Director of Laboratory, on page 13). However, this contamination is not serious as it practically disappears about 1 mile downstream from the disposal plant.

In case of failure of any of the effluent pumps, which supply the irrigation storage tanks, a by-pass canal, paralleling the river along the right bank, carries the sewage effluent from the plant to a point about 2,500 feet downstream where it is flumed over the river into an emergency lake formed by an ox-bow bend of the river which has been dammed at each end. The river by-passes this lake through a cut channel and there is no connection between them.

The effluent, with some exception, is used for irrigation all year. When not actually in use and not being stored in the three earthen storage tanks, the effluent is allowed to run into several wet weather lakes or into a series of terrace ditches on the left bank of the river. Undoubtedly, much of this water is absorbed by the porous alluvial soil and finds its way into the river as is evidenced by the numerous seeps and springs along the river channel.

EXISTING DAMS AND LAKES

The two Buffalo Lakes are privately owned and comprise a recreation area for fishing, boating, swimming and camping. The lakes are situated in the central part of the area investigated. The upper lake, No. 1, is the larger and has an uncontrolled spillway

63 feet long at the right end of the dam and a 6-inch outlet pipe with valve at the left end. The lower lake, No. 2, has an uncontrolled spillway 25 feet long at the right end of dam, an 18-inch corrugated iron culvert pipe with valve at the right end, and a 10-inch cast-iron pipe and valve at the left end of dam.

During November 1953 a new dam, No. 3, was constructed at measuring site No. 4 about ¼ mile downstream from the previous lower dam, No. 2. This new dam impounds water that passes Dam No. 2 and the inflow from seeps and springs on the left bank between the two dams. For controlled releases Dam No. 3 has 2½-inch cast-iron pipe and valve and a 12-inch corrugated iron pipe with valve. An uncontrolled service spillway 50 feet long has been excavated in rock on the right bank, and an uncontrolled emergency spillway 60 feet long has been excavated in earth on the left bank. During March 1954 a fourth dam was constructed about 800 feet downstream from Dam No. 3. It is a low channel dam and has four outlets, a 3-inch cast-iron pipe, a 12-inch cast-iron pipe, two 12-inch by 12-inch tile conduits, all open and at different elevations, and an uncontrolled spillway 20 feet long cut in earth on the right bank. An aerial photograph (fig. 7) shows the lakes as they now exist. The dotted lines show a proposed new development which will incorporate the three upper lakes into one large lake.

STREAMFLOW

Discharge measurements were made at eight designated points at irregular intervals during the period of this investigation. The results are listed in table 1 and are shown on graphs, figures

3-6. The flow at site C is from seeps along the river bed. Flow from the foundation drain at the sewage disposal plant, site C_2, is principally from underground sources and contributes a small but steady flow to the river. Seeps and springs, some from the Ogallala formation and some from nearby irrigation, add to the river flow and at site 2 results indicate an available supply of about 2 cfs. River flow passing this point is stored in the Buffalo Lakes. Discharge at site 3 is the result of flow over the spillway and release from the outlet conduit of the upper dam plus a small amount of seepage. The flow at site 4 is also from over the spillway or release from the outlet conduit of the lower dam plus inflow from the Ogallala formation along the left bank. Additional flow from the Ogallala formation along the left bank enters the river below site 4. This flow is largely consumed by evaporation, transpiration, and use in stock tanks upstream from site 5. No increase in flow was found between sites 5 and 6.

Results of the seepage investigation made March 4, 1953 indicate a gradual increase in flow from the initial site A to site 2 at the head of the upper Buffalo Lake. All flow passing site 2 goes into the Buffalo Lakes. Some of this flow spills and passes downstream at times. (See table 1).

RAINFALL AND EVAPORATION

According to U. S. Weather Bureau records, the average annual precipitation at Lubbock Agricultural Experiment Station for 43 years of record, 1912-1954, is about 18 inches. (See table 6). The major portion falls during the period April to October.

This is also the period of greatest evaporation. The temperatures during this period are usually high and strong winds frequently prevail. All these factors make water losses high and runoff low during the summer months except during periods of heavy rainfall.

Records of evaporation collected for the period 1951-54 at the Texas Agricultural Experiment Station at Lubbock, Texas were furnished by Dean Bloodgood, U. S. Department of Agriculture, Austin, Texas. Average monthly and annual evaporation for the period, as determined from a Bureau of Plant Industry type pan, converted to losses from a free water surface are given in table 7. Average annual gross evaporation for 1951-54 is given as 72.19 inches. Average annual rainfall for that period was 13.09 inches in comparison with the average for 1912-54 of 18.33 inches. (See table 6). Therefore, the average annual net evaporation for 1951-54 was 59.10 inches. Average monthly evaporation losses and equivalents in cfs for a water-surface area of 98 acres are also given in table 7.

The surface area of the two Buffalo Lakes at spillway elevation is about 98 acres. If it is assumed that the data on rainfall and evaporation collected at the Texas Agricultural Experiment Station at Lubbock is applicable to the Buffalo Lakes, the net average annual evaporation from the lakes for 1951-54 was 59.1 inches, or 483 acre-feet. This represents a rate of flow of 0.67 cfs. The maximum net average monthly evaporation for 1951-54 was 9.20 inches for June, or a rate of flow of 1.26 cfs. The only times the measured inflow to Buffalo Lakes, during the period of this investigation from March 1952 to March 1954, was less than 1.26 cfs was in September 1952 and in June and September 1953. It should be noted that the rainfall for September 1952 was 0.90 inches and for September 1953 was 0.08 in comparison with a 44-year average for September of 2.60 inches.

CONCLUSIONS

Measurements of inflow to the upper Buffalo Lake, site 2 (table 1) indicate a fairly dependable supply of about 2 cfs from the springs and seeps. The lakes store enough flood water to remain practically full most of the time. It appears that the inflow from the springs and seeps is sufficient to offset evaporation and transpiration losses under conditions existing at the time of this investigation.

QUALITY OF WATER

The following discussion on Quality of Water was prepared by Burdge Irelan, District Chemist, U. S. Geological Survey, Austin, Tex.:

Records of the discharge measurements and analyses of the water samples given in table 3 furnish the base data for the conclusions for this section of the report.

Typical analyses of samples collected from City of Lubbock and Reese Air Force Base wells obtained from the files of the Geological Survey are also tabulated in table 3 for purpose of comparison.

A large portion of the water supplied to the inhabitants of a city is discharged to the sewers. Some increase of mineral content because of addition of wastes and evaporation may be expected so that the effluent from a sewage disposal plant will be somewhat higher in dissolved solids than water furnished to the public. Decomposition of sewage tends to increase the nitrate content of effluent sewage waters so that high concentrations of nitrate in water in a stream may indicate inflow of sewage effluent.

The channels of both Double Mountain Fork and Yellowhouse Creek contain alluvial materials capable of absorbing and transmitting considerable quantities of water. Some of the water used for watering lawns, washing cars, washing streets and for other purposes is undoubtedly absorbed by this alluvial material in the City of Lubbock and may be the source of part of or all the small flows present in the Double Mountain Fork above the sewage disposal plant. This seepage water, no doubt, is somewhat polluted from various sources and the nitrate content should be greater than that of Lubbock city water but less than that of seepage water in the vicinity of the sewage disposal plant.

The analyses of water from wells supplying the City of Lubbock and Reese Air Force Base (table 3) are representative of the types of ground water near the river channel and of the waters which may waste into the streams or become part of the effluent from the sewage disposal plant.

It will be observed from table 3 that there is a considerable variation in the quantity of dissolved solids in ground waters used at Lubbock. However, as none of the sources listed contain more than 11 parts per million nitrate, the presence of quantities considerably in excess of that amount in the river samples probably indicated inflow of sewage effluent.

Results of the seepage investigation of March 4, 1953 are tabulated in table 4. Except for a smaller quantity of silica the water at site B is somewhat more mineralized than the water of the Lubbock City supply. Silica is utilized in cell wall construction by diatoms which commonly grow in flowing water. Hence, the silica content normally is lower in stream waters than in ground waters. The relatively high nitrate at site B may indicate pollution upstream from the sewage disposal plant. The water at this point is probably derived chiefly from upstream seepage. Analyses at sites B and C are nearly alike indicating no new source of water between sites B and C. Water at site D shows an increase in all constituents, indicating that there may have been some concentration by evaporation. The high nitrate strongly indicates seepage from the nearby sewage disposal plant. This is also indicated by the analysis of water from the 4-inch tile drain, site C_2 (table 3) which shows a nitrate concentration as high as 104 parts per million. The slight increase in dissolved solids at sites E and 1 indicate no important change in water source and, perhaps, additional evaporation. Changes from sites 1 to 3 indicate some precipitation of calcium carbonate because of aeration, and loss of silica and nitrate, probably because of vegetative growth. Probably most of the water entering the river between sites E and 3 is from the same source.

Water at site 4 is obviously more dilute than at site 3; hence, it must come principally from another source. The spring on the left bank just above site 4 (table 3) apparently comes from the Ogallala formation because it is not the same quality as the river water. It, or similarly derived and unmeasured springs, could account for the changes. Water at sites 5 and 6 is similar to, but more concentrated than that at site 4. Evaporation and growth of plants could account for the changes in this stretch of river.

Although the water at particular points changes somewhat in concentration from time to time certain general relations appear. The water at site C contains rather large amounts of silica and nitrate, indicating growing plants have not had much opportunity to remove them. Water from the tile drain at site C_2 is usually less concentrated than that at site C and contains more silica and generally more nitrate, indicating probable seepage from the sewage disposal plant. Site 1 is about 1 mile below the sewage disposal plant. Water at this point has the highest nitrate content of any of the regularly sampled points and a high silica content for stream water. Water at site 2 is generally less concentrated than that at site 1. This suggests some inflow from the Ogallala formation. The water here has a lower silica and nitrate content than at site 1. However, the concentrations of both silica and nitrate are higher during the winter months. It is probable that part of the change in concentration of these constituents is due to growth of diatoms during the warm months.

Water at site 3 is somewhat reduced in concentration from that at site 2. Silica concentrations are higher and nitrate concentrations are lower than that at site 2 on many sampling dates. There is some indication of precipitation of calcium carbonate but most of the decrease is probably due to ground-water inflow. Additional inflow is also indicated at site 4, as samples at this site are considerably lower in concentration than those at site 3. Concentrations observed at site 5 are generally slightly greater than that at site 4 but the analyses are very similar. The analyses suggest that generally there is very little inflow between these two sites.

During periods of substantial flow, such as April 30, 1952, the analyses of samples collected at sites 5 and 6 are nearly identical. During periods of low flow, water at site 6 is more concentrated than at site 5. This indicates no important ground-water inflow occurs between sites 5 and 6.

The chemical analyses support the following general conclusions:

1. Small flows occuring above the sewage disposal plant originate upstream, probably in considerable portion from waste water in the City of Lubbock.

2. Considerable increases occur below the sewage disposal plant probably because of seepage from nearby irrigation which uses effluent from the sewage disposal plant.

3. Some ground-water infiltration, not derived from sewage effluent, occurs between the sewage disposal plant and site 4.

4. There is no important ground-water inflow below site 5.

CONTAMINATION

Report of Lubbock City-County Health Unit Laboratory

by E. L. Redford, Director of Laboratory

In a brief study requested by J. O. Joerns, of the U. S. Geological Survey, to obtain data on the bacterial content of water in the creek seven water samples were collected above, at and below the sewage disposal plant of Lubbock, and an estimation of the coli-aerogenese group density or a "Most Probable Number" (MPN) test was done on each. One sample was collected above the sewage disposal plant, two from the effluent of the foundation drain at the sewage disposal plant, site C_2, two at State Highway 835, site 1, one from the upper part of upper Buffalo Lake, site 2, and one from the swimming area in the lower lake.

Using methods and tables from "Standard Methods of Water Analysis", 8th Edition, the following are the results of the seven samples examined:

Date	Point of collection	Site No.	Most Probable Number per Milliliter of Water
June 10, 1953	Foundation drain effluent	C_2	1600
June 10, 1953	State Highway 835	1	13
June 17, 1953	Above sewage disposal plant	C	13
June 17, 1953	Foundation drain effluent	C_2	1600
June 17, 1953	State Highway 835	1	35
July 1, 1953	Head of upper lake	2	0.78
July 1, 1953	Lower lake swimming area		2.2

We have been unable to find, in available publications, data for a comparable situation. However, some figures for comparison may be found in a study on natural bathing waters by (1) Stevenson, Albert H.; "Studies of Bathing Water Quality and Health" in which the bathing waters were found to have MPN's varying from 0.91 to 27.0 per milliliter. By using these figures it will be seen that only the effluent from the foundation drain shows higher bacterial numbers than natural swimming water. There are many reasons why the water from the foundation drain contains greater numbers of bacteria. Among these are: larger numbers to start, more organic material for food, near ideal growth temperatures, less natural enemies, and lack of sunlight. It will be seen also that when the water reaches State Highway 835, site 1, the Most Probable Number (MPN) has returned to approximately the same as found above the sewage disposal plant. By the time the water has reached the lake the bacterial count has dropped to less than 1 per milliliter which is better than the best natural bathing water in the above mentioned study.

No definite conclusions can be obtained from the small number of samples under so nearly the same conditions. For example, what would the MPN's be when the creek was out of banks after a heavy rain many miles upstream or after a heavy rain in downtown Lubbock and storm sewers were flowing? However, it is our opinion that the effluent from the foundation drain at the sewage disposal plant has so little effect on the bacterial flora of the creek and could be treated so easily that it needs no serious consideration.

(1) Stevenson, Albert H., "Studies of Bathing Water Quality and Health"; American Journal of Health, May 1953.

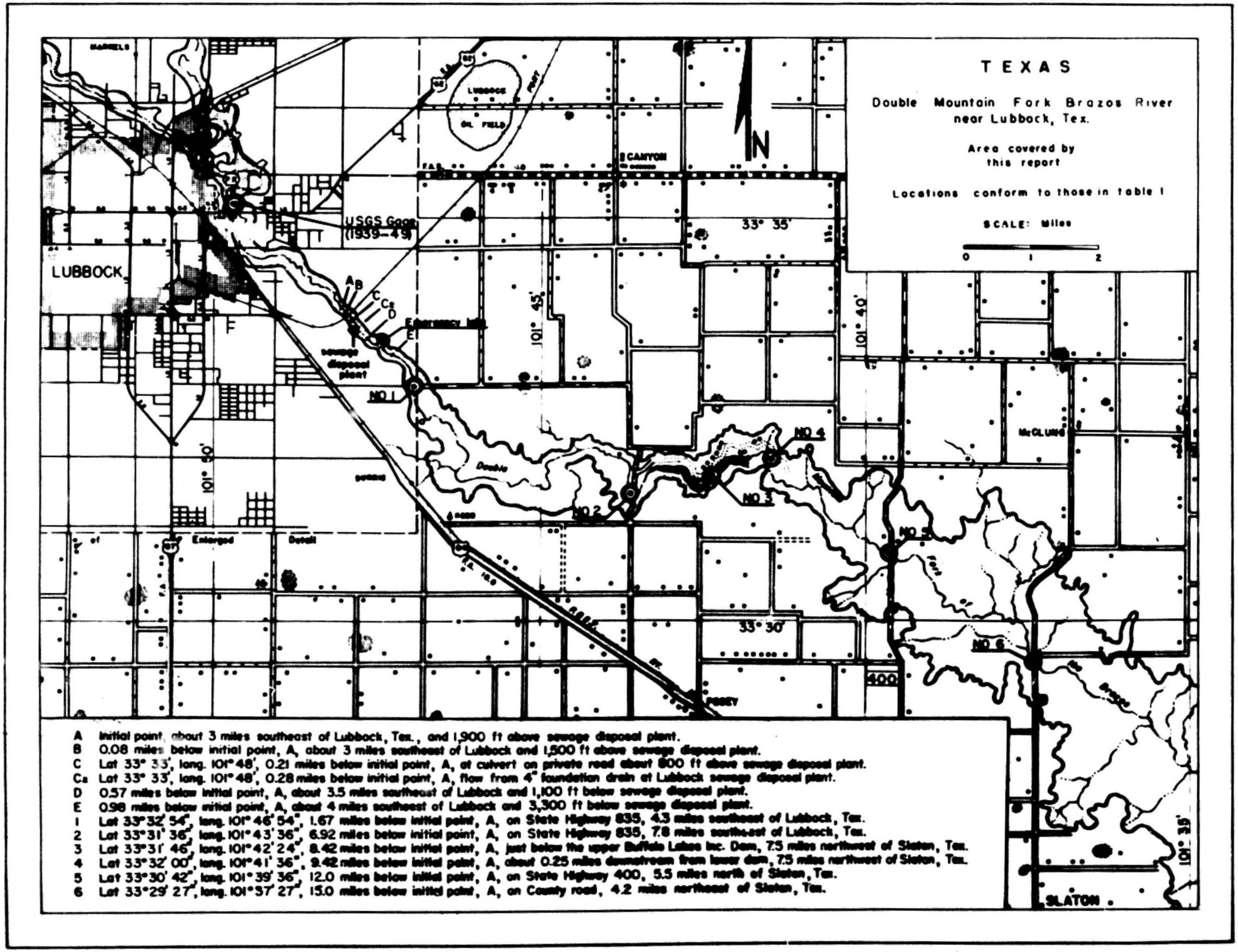
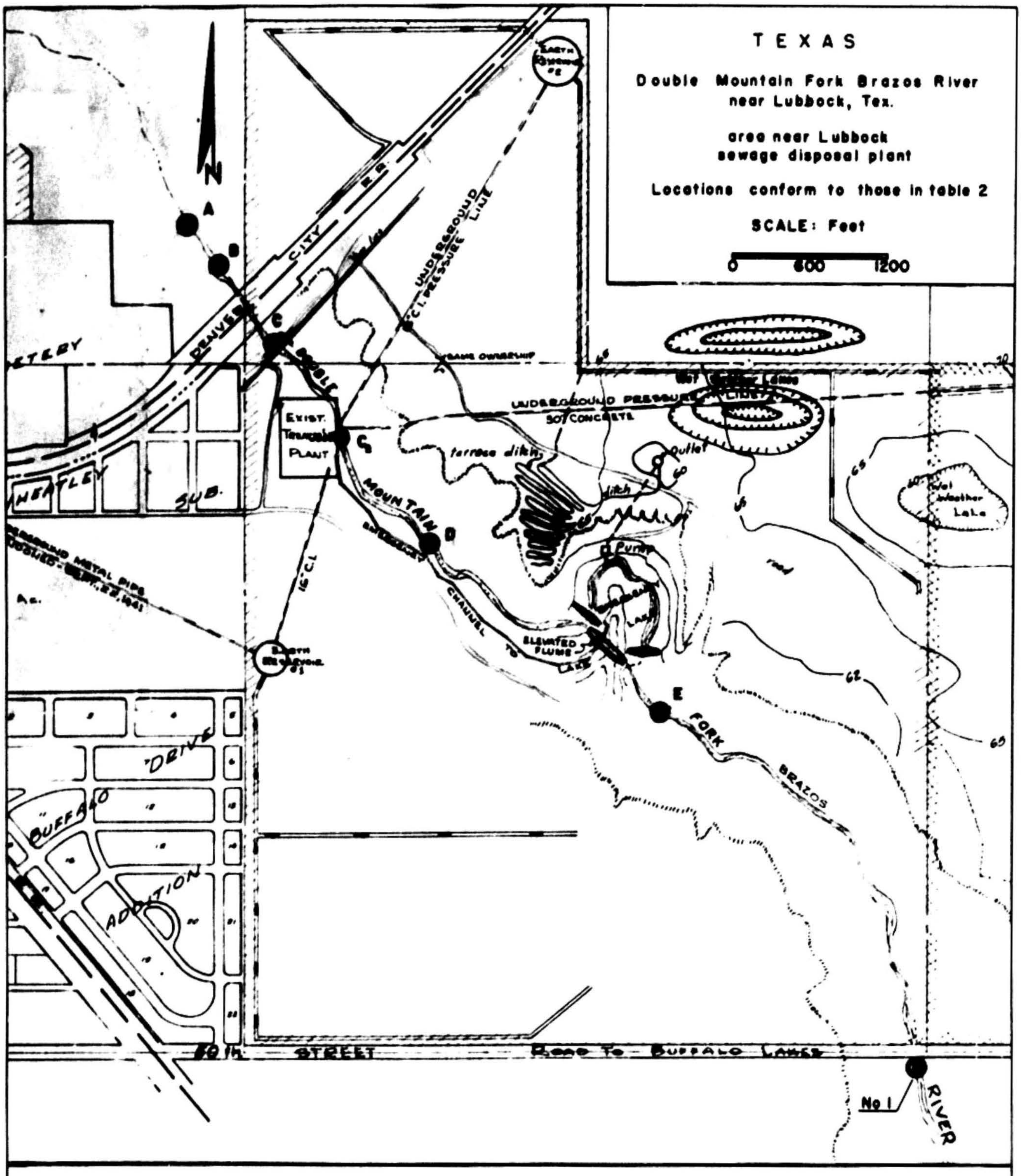


Figure 1. Map of area covered by this report.



A	Initial point, about 3 miles southeast of Lubbock, Tex., and 1,900 ft above sewage disposal plant.
B	0.08 miles below initial point, A, about 3 miles southeast of Lubbock and 1,500 ft above sewage disposal plant.
C	Lat 33° 33', long 101° 48', 0.21 miles below initial point, A, at culvert on private road about 800 ft above disposal plant.
C_0	Lat 33° 33', long 101° 48', 0.28 miles below initial point, A, flow from 4" foundation drain at sewage disposal plant.
D	0.57 miles below initial point, A, about 3.5 miles southeast of Lubbock and 1,100 ft below sewage disposal plant.
E	0.98 miles below initial point, A, about 4 miles southeast of Lubbock and 3,300 ft below sewage disposal plant.
I	Lat 33° 32' 54", long 101° 46' 54", 1.67 miles below initial point, A, on State Highway 835, 4.3 miles southeast of Lubbock, Tex.

Figure 2. Map of area near Lubbock sewage disposal plant.

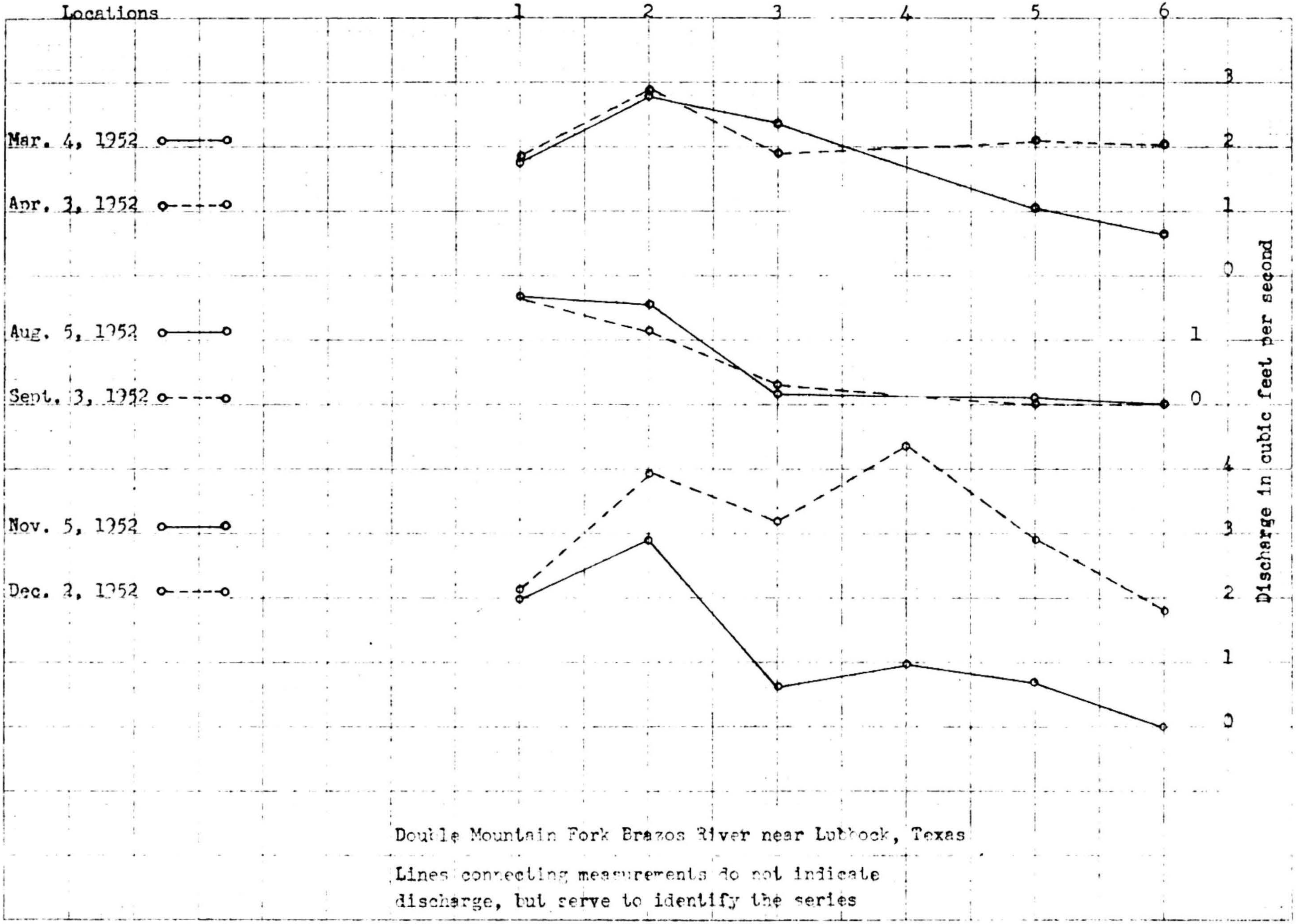


Figure 3. Graphs showing typical series of discharge measurements.

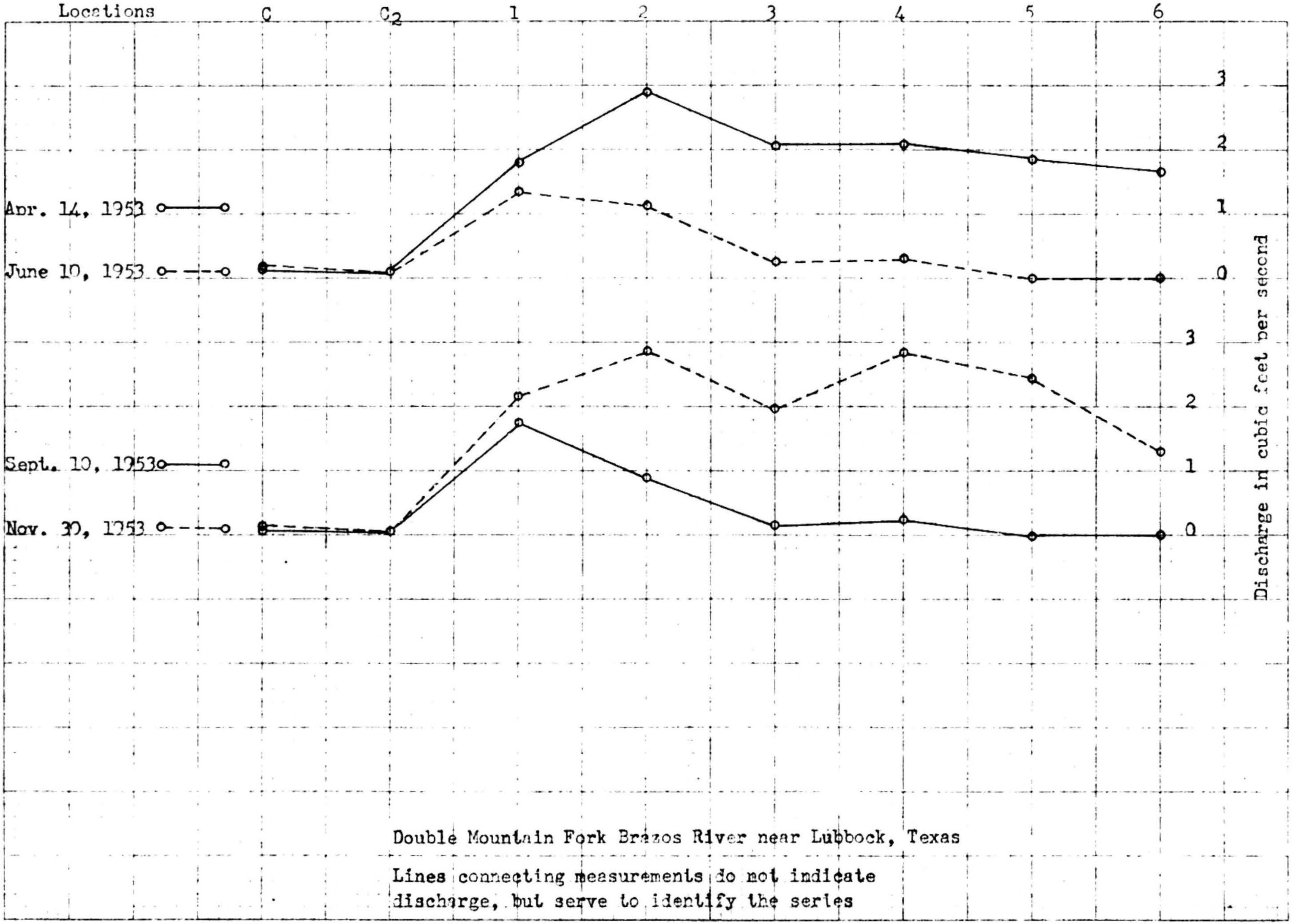


Figure 4. Graphs showing typical series of discharge measurements.

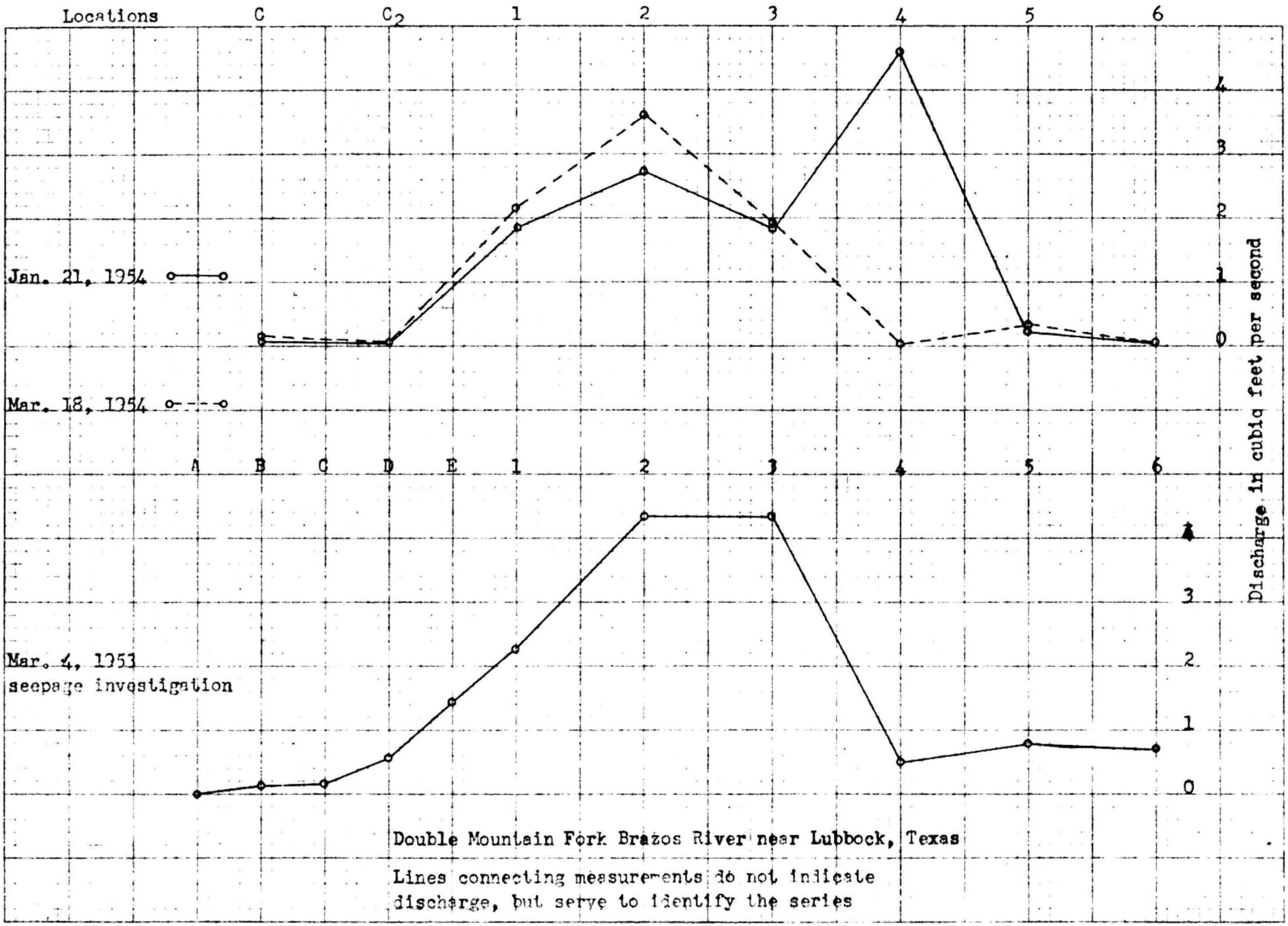


Figure 5. Graphs showing typical series of discharge measurements.

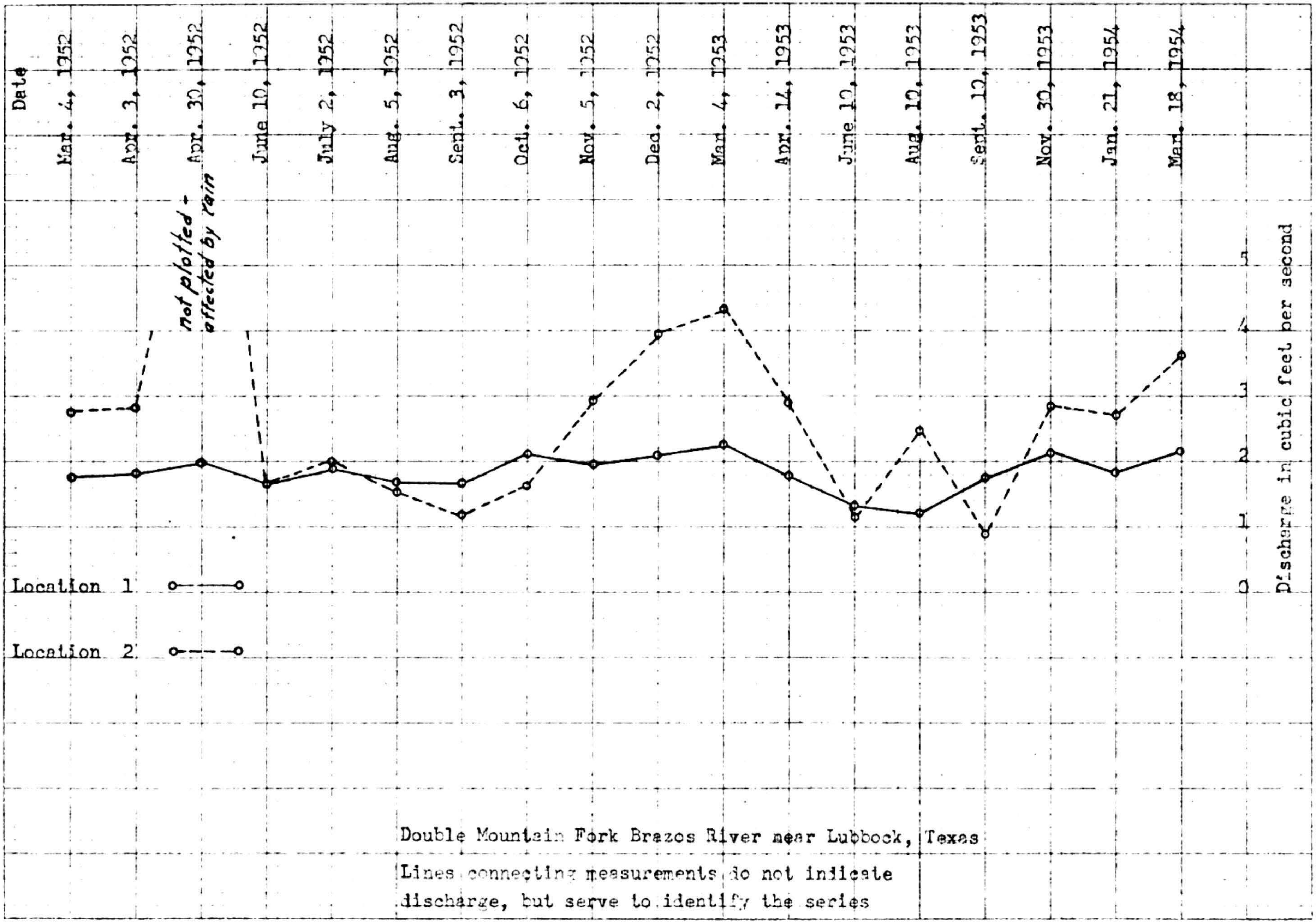


Figure 6. Graphs showing measured discharge at Locations 1 and 2 on dates indicated.

Figure 7. Aerial photograph of Buffalo Lakes near Lubbock, Texas
Courtesy Lubbock Chamber of Commerce

Table 1.—Discharge in cubic feet per second, Double Mountain Fork Brazos River at locations shown in footnotes to table. Initial point, A, about 3 miles SE of Lubbock, Tex.

Date	C	C_2	1	2	3	4	5	6
March 4, 1952			1.77	2.79	2.35b		1.04	0.64
April 3, 1952			1.85	2.84	1.88b		2.10	2.02
April 30, 1952			2.00	12.2a	22.5ab		39.2a	57.1a
June 10, 1952			1.69	1.64	.12		.36	.01
July 2, 1952			1.92	1.99	.22		0	0
August 5, 1952			1.68	1.57	.18		.10	0
September 3, 1952			1.64	1.15	.29		0	0
October 6, 1952			2.11	1.65	.50b		0	0
November 5, 1952			1.99	2.93	.61bc	0.98	.71	0
December 2, 1952			2.10	3.92	3.20bc	4.36c	2.91	1.80
March 4, 1953	0.17	—	2.26	4.32	4.37bc	.47	.80	.70
April 14, 1953	.11	.07	1.80	2.89	2.02b	2.06c	1.82	1.65
June 10, 1953	.18*	.06*	1.32	1.13	.25*	.28	0	0
August 3, 1953	.09	.04	1.21	2.47	.21	.09	0	0
September 10, 1953	.06	.04	1.74	.88	.13*	.22	0	0
November 30, 1953	.08	.03	2.17	2.84	1.96b	2.82bc	2.45	1.28
January 21, 1954	.05	.04	1.83	2.72	1.83b	4.60bc	.21	.03*
March 18, 1954	.11	.04	2.16	3.62	1.88b	.05*	.36	.03*

Table 1.—Continued

a Contains run-off from local rain.
b Water flowing over spillway
c Release through outlet conduit.
* Result of field estimate.

<u>Locations corresponding to above numbers</u>

C Lat 33°33', long. 101°48', 0.21 miles below initial point, A, at culvert on private road about 800 ft above Lubbock sewage disposal plant.

C_2 Lat 33°33', long. 101°48', 0.28 miles below initial point, A, flow from 4" foundation drain at Lubbock sewage disposal plant.

1 Lat 33°32'54", long. 101°46'54", 1.67 miles below initial point, A, on State Highway 835, 4.3 miles southeast of Lubbock, Tex.

2 Lat 33°31'36", long. 101°43'36", 6.92 miles below initial point, A, on State Highway 835, 7.8 miles southeast of Lubbock, Tex.

3 Lat 33°31'46", long. 101°42'24", 8.42 miles below initial point, A, just below the upper Buffalo Lakes Inc. Dam, 7.5 miles northwest of Slaton, Tex.

4 Lat 33°32'00", long. 101°41'36", 9.42 miles below initial point, A, about ¼ mile downstream from lower dam, 7.5 miles northwest of Slaton, Tex.

5 Lat 33°30'42", long. 101°39'36", 12.0 miles below initial point, A, on State Highway 400, 5.5 miles north of Slaton, Tex.

6 Lat 33°29'27", long. 101°37'27", 15.0 miles below initial point, A, on County road, 4.2 miles northeast of Slaton, Tex.

Table 2.—Discharge measurements to determine seepage, on Double Mountain Fork Brazos River from .3 miles below 19th St, Lubbock, Tex. to 4.2 miles north of Slaton, Tex., a distance of 15.0 miles.

Date	Stream	Number	Location	Approximate dist. (miles) below initial point	Discharge in second-feet: Main stream	Discharge in second-feet: Gain or loss in section	Discharge in second-feet: Total Gain or Loss
1953 March 4	Double Mountain Fork Brazos River	A	About 3 miles SE of Lubbock, Tex., and 1,300 ft above sewage disposal plant.	0	0	0	0
4	do	B	About 3 miles SE of Lubbock, and 1,500 ft above sewage disposal plant.	0.08	0.10	+0.10	+0.10
4	do	C	About 3 miles SE of Lubbock and 800 ft above sewage disposal plant.	.21	.17	+ .07	+ .17
4	do	D	About 3½ miles SE of Lubbock and 1,100 ft below sewage disposal plant.	.57	.54	+ .37	+ .54
4	do	E	About 4 miles SE of Lubbock and 3,300 ft below sewage disposal plant and 700 ft below emergency lake.	.98	1.42	+ .88	+1.42
4	do	1	4.3 miles SE of Lubbock at 50th St Crossing: (State Highway 835).	1.67	2.26	+ .84	+2.26
4	do	2	7.8 miles SE of Lubbock on State Highway 835.	6.92	4.32	+2.06	+4.32
4	do	3	7.5 miles NW of Slaton, Tex., just below Upper dam.	8.42	4.37	+ .05	+4.37
			The above water is stored in Buffalo Lakes.				
4	do	4	7.5 miles NW of Slaton, about ¼ mile below lower dam.	9.42	.47	+ .47	+ .47
4	do	5	5.5 miles N of Slaton on State Road 400.	12.0	.80	+ .33	+ .80
4	do	6	4.2 miles N of Slaton on County Road	15.0	.70	+ .10	+ .70

Table 3.—Chemical analyses, temperatures and corresponding discharges.

LOCATION.—Site C, lat 33°33', long. 101°48', 0.21 miles below initial point, A, at culvert on private road about 800 ft above Lubbock sewage disposal plant.

RECORDS AVAILABLE.—March 4, 1953 to March 18, 1954.

Temperature, discharge and chemical analyses in parts per million

Date of collection	Temperature (° F)	Measured discharge (cfs)	pH	Specific conductance (micromhos at 25° C)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Hardness as $CaCO_3$ Total	Hardness as $CaCO_3$ Noncarbonate	Percent sodium
Mar. 4, 1953	42	0.17	8.5	1,800	30	60	100	156	14	278	277	238		29	1,040	560	309	38
Apr. 14, 1953	66	.11																
June 10, 1953		.18																
Aug. 3, 1953	84	.09	8.4	1,570	36	60	187	152	12	274	272	202	3.6	18	1,030	507	262	39
Sept. 10, 1953	60	.06	8.4	2,180	48	52	135	232	12	354	402	302	4.0	29	1,300	684	374	42
Nov. 30, 1953	57	.08		2,960	49						563	440		28				
Jan. 21, 1954	33	.05	8.4	2,960	33	75	180	303	16	418	556	430		38	1,840	927	558	42
Mar. 18, 1954	46	.11	8.5	2,960	36	82	187	303	21	453	561	440		28	1,880	974	568	40

Table 3.—Continued

LOCATION.—Site C_2, lat 33°33', long. 101°48', 0.28 miles below initial point, A, flow from 4" foundation drain at Lubbock sewage disposal plant.
RECORDS AVAILABLE.—November 6, 1952 to March 18, 1954.

Temperature, discharge and chemical analyses in parts per million

Date of collection	Temperature (° F)	Measured discharge (cfs)	pH	Specific conductance (micromhos at 25° C)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na + K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Hardness as $CaCO_3$: Total	Hardness as $CaCO_3$: Noncarbonate	Percent sodium
Nov. 6, 1952			8.2	1,890	60	66	71	219	0	307	245	242		104	1,160	456	205	51
Apr. 14, 1953	68	.07																
June 10, 1953		.06																
Aug. 3, 1953	73	.04	8.5	1,830	75	56	82	229	20	344	274	240	4.4	30	1,180	476	161	51
Sept. 10, 1953	73	.04	8.2	1,830	78	58	84	223	0	386	285	232	4.4	29	1,180	490	174	50
Nov. 30, 1953	66	.03		2,030	60						346	248		21				
Jan. 21, 1954	42	.04	8.5	2,070	44	51	126	202	17	334	351	275		35	1,260	645	343	40
Mar. 18, 1954	62	.04	8.6	2,160	56	50	134	207	20	332	376	285		32	1,320	676	370	40

Table 3.—Continued

LOCATION.—Site 1, lat 33°32'54", long. 101°46'54", 1.67 miles below initial point, A, on State Highway 835, 4.3 miles southeast of Lubbock, Tex.

RECORDS AVAILABLE.—March 4, 1952 to March 18, 1954

Temperature, discharge and chemical analyses in parts per million

Date of collection	Temperature (° F)	Measured discharge (cfs)	pH	Specific conductance (micromhos at 25° C)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na + K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Hardness as $CaCO_3$: Total	Hardness as $CaCO_3$: Noncarbonate	Percent sodium
Mar. 4, 1952	43	1.77	7.6	2,910	45	92	172	290	0	452	523	425	5.6	48	1,820	936	566	40
Apr. 3, 1952	55	1.85	8.1	2,860	52	90	173	301	0	479	549	422		38	1,860	936	544	41
Apr. 30, 1952	68	2.00	8.6	2,430	49	82	138	251	24	343	453	342		54	1,560	772	451	41
June 10, 1952	80	1.69																
July 2, 1952	73	1.92																
Aug. 5, 1952	81	1.68	8.5	3,100	58	63	168	305	22	334	542	422		52	1,800	848	538	44
Sept. 3, 1952	74	1.64																
Oct. 6, 1952		2.11																
Nov. 5, 1952	60	1.99	8.3	2,960	60	91	175	302	13	439	565	425		44	1,890	946	566	41
Dec. 2, 1952	54	2.10	8.5	2,950	62	90	172	310	24	420	553	428		52	1,900	932	548	42
Mar. 4, 1953	48	2.26	8.5	2,800	52	88	164	288	24	394	527	398		58	1,790	894	531	41
Apr. 14, 1953	66	1.80	8.4	2,780	54	99	145	307	19	341	549	410		62	1,810	843	532	44
June 10, 1953	78	1.32	8.4	2,860	50	99	160	303	19	441	537	405		50	1,840	905	512	42
Aug. 3, 1953	80	1.21	8.5	2,570	60	58	154	290	18	333	503	380		56	1,680	778	474	45
Sept. 10, 1953	64	1.74	8.5	2,830	71	90	168	318	32	433	538	412	4.8	55	1,900	916	507	43
Nov. 30, 1953	58	2.17		3,060	59						563	450		59				
Jan. 21, 1954	40	1.83	8.4	2,970	42	89	160	333	16	448	545	422		58	1,880	880	486	45
Mar. 18, 1954	49	2.16	8.5	2,980	52	82	173	319	16	446	535	440		50	1,890	916	524	43

Table 3.—Continued

LOCATION.—Site 2, lat 33°31'36", long. 101°43'36", 6.92 miles below initial point, A, on State Highway 835, 7.8 miles southeast of Lubbock, Tex.
RECORDS AVAILABLE.—March 4, 1952 to March 18, 1954.

Temperature, discharge and chemical analyses in parts per million

Date of collection	Temperature (° F)	Measured discharge (cfs)	pH	Specific conductance (micromhos at 25° C)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na + K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Hardness as $CaCO_3$ Total	Hardness as $CaCO_3$ Noncarbonate	Percent sodium
Mar. 4, 1952	43	2.79	8.0	2,500	19	58	154	269	0	417	479	355	6.0	8.2	1,550	778	436	43
Apr. 3, 1952	56	2.84	8.6	2,540	21	42	159	278	23	343	506	362		8.7	1,570	759	440	44
Apr. 30, 1952	61	12.2	8.5	815	15	35	34	80	6	145	134	92		5.1	505	228	98	43
June 10, 1952	83	1.64																
July 2, 1952	76	1.99																
Aug. 5, 1952	85	1.57	8.5	2,110	14	52	118	227	20	301	389	298		3.8	1,270	614	334	45
Sept. 3, 1952	76	1.15	8.3	2,370	15	59	139	261	11	376	454	342		5.6	1,470	718	392	44
Oct. 6, 1952	63	1.65	8.4	2,510	13	56	147	280	9	370	491	368		7.0	1,550	744	426	45
Nov. 5, 1952	54	2.93	8.4	2,600	18	60	157	288	11	425	505	370		9.5	1,630	795	428	44
Dec. 2, 1952	42	3.92	8.5	2,700	33	57	160	285	16	388	513	372		19	1,650	800	456	44
Mar. 4, 1953	50	4.32	8.5	2,550	20	48	158	283	18	360	516	362		16	1,600	770	444	44
Apr. 14, 1953	63	2.89																
June 10, 1953	79	1.13	8.4	2,320	16	50	132	255	9	367	443	312		6.9	1,400	668	352	45
Aug. 3, 1953	81	2.47	8.4	2,100	26	52	114	247	9	293	426	300	4.0	5.0	1,330	598	343	47
Sept. 10, 1953	67	.88	8.4	2,420	22	50	135	288	13	332	473	358	4.4	3.5	1,510	680	386	48
Nov. 30, 1953	49	2.84	8.4	2,690	24	54	158	288	15	396	509	372		8.2	1,760	784	434	44
Jan. 21, 1954	36	2.72	8.4	2,670	26	54	160	284	15	405	501	368		16	1,620	796	436	44
Mar. 18, 1954	47	3.62	8.5	2,880	36	77	168	321	26	478	539	400		26	1,830	883	448	44

Table 3.—Continued

LOCATION.—Site 3, lat 33°31'46", long. 101°42'24", 8.42 miles below initial point, A, just below the upper Buffalo Lakes Inc. Dam, 7.5 miles northwest of Slaton, Tex.
RECORDS AVAILABLE.—March 4, 1952 to March 18, 1954.

Temperature, discharge and chemical analyses in parts per million

Date of collection	Temperature (° F)	Measured discharge (cfs)	pH	Specific conductance (micromhos at 25° C)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na^+K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Hardness as $CaCO_3$ Total	Hardness as $CaCO_3$ Noncarbonate	Percent sodium
Mar. 4, 1952	46	2.35	8.2	2,320	2.6	63	132	250	0	390	421	335	5.0	2.0	1,400	700	380	44
Apr. 3, 1952	58	1.83	8.5	2,940	10	84	142	321	14	363	503	458		1.0	1,710	794	472	47
Apr. 30, 1952	69	22.5	8.6	2,230	7.4	40	131	248	17	307	430	318		2.0	1,340	638	358	46
June 10, 1952	81	.12																
July 2, 1952	73	.22																
Aug. 5, 1952	83	.18	8.5	2,220	43	40	124	247	17	324	371	328		4.8	1,330	610	316	47
Sept. 3, 1952	75	.29	8.4	2,170	38	42	123	245	13	367	352	320		5.8	1,320	611	289	47
Oct. 6, 1952	64	.50	8.4	2,240	29	62	127	248	14	423	375	320		5.6	1,390	676	306	44
Nov. 5, 1952	58	.61	8.4	2,230	30	62	128	247	16	426	373	318		5.8	1,390	681	306	47
Dec. 2, 1952	47	3.20	8.5	2,400	12	42	144	282	18	344	475	355		4.8	1,500	697	385	47
Mar. 4, 1953	50	4.37	8.6	2,560	6.0	48	153	290	22	367	494	370		9.0	1,570	749	412	46
Apr. 14, 1953	60	2.02	8.5	2,620	7.7	50	158	296	22	375	516	375		11	1,620	774	430	45
June 10, 1953		.25	8.4	2,570			129	266	17	473	430	372		4.5	1,590	812	396	42
Aug. 3, 1953	88	.21	8.5	3,040	19	52	189	371	24	406	645	460	6.4	5.8	1,970	906	534	47
Sept. 10, 1953	64	.13	8.4	2,490	36	58	147	287	18	471	371	388	5.2	12	1,550	749	333	45
Nov. 30, 1953	52	1.96		1,850	14						324	238		1.5				
Jan. 21, 1954	38	1.83	8.4	2,050	8.6	47	114	227	14	327	372	282		4.8	1,230	586	294	46
Mar. 18, 1954	47	1.88	8.5	2,350	6.8	49	138	279	17	371	483	325		3.5	1,460	690	358	47

Table 3.—Continued

LOCATION.—Site 4, lat 33°32'00", long. 101°41'36", 9.42 miles below initial point, A, about ¼ mile downstream from lower dam, 7.5 miles northwest of Slaton, Tex.
RECORDS AVAILABLE.—November 5, 1952 to March 18, 1954.

Temperature, discharge and chemical analyses in parts per million

Date of collection	Temperature (° F)	Measured discharge (cfs)	pH	Specific conductance (micromhos at 25° C)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na + K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Hardness as $CaCO_3$: Total	Hardness as $CaCO_3$: Noncarbonate	Percent sodium
Nov. 5, 1952	57	0.98	8.6	1,990	38	58	113	217	23	435	303	260		4.2	1,230	609	214	44
Dec. 2, 1952	45	4.36	8.6	2,100	30	56	122	235	24	400	359	288		5.2	1,320	641	273	44
Mar. 4, 1953	50	.47	8.6	1,710	52	66	93	170	31	448	209	195		7.7	1,040	547	128	40
Apr. 14, 1953	64	2.06	8.6	2,420	20	59	138	254	30	396	416	318		13	1,440	714	340	44
June 10, 1953		.28	8.4	1,410	60	66	78	121	15	475	132	138		3.5	846	485	71	35
Aug. 3, 1953	77	.09	8.4	1,470	77	46	85	153	12	424	157	180	4.8	0.5	923	464	97	42
Sept. 10, 1953	62	.22	8.5	1,460	60	26	88	121	18	350	82	195	4.8	0.5	767	427	110	38
Nov. 30, 1953	52	2.82	8.2	1,710	18	47	88	168	0	304	281	215		1.2	967	480	230	43
Jan. 21, 1954	36	4.60	8.4	1,940	19	60	103	203	13	380	314	250		3.0	1,150	573	240	44
Mar. 18, 1954	47	.05	8.5	2,200	32	78	130	222	26	516	349	270		1.5	1,360	729	262	40
LOCATION.—Spring flow from left bank about 300 ft upstream from above location.																		
Mar. 18, 1954	50	.11	8.7	779	59	38	47	43	18	315	14	55		4.0	967	288	0	25

Table 3.—Continued

LOCATION.—Site 5, lat 33°30'42", long. 101°39'36", 12.0 miles below initial point, A, on State Highway 400, 5.5 miles north of Slaton, Tex.
RECORDS AVAILABLE.—March 4, 1952 to March 18, 1954.

Temperature, discharge and chemical analyses in parts per million

Date of collection	Temperature (° F)	Measured discharge (cfs)	pH	Specific conductance (micromhos at 25° C)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na + K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Hardness as $CaCO_3$ Total	Hardness as $CaCO_3$ Noncarbonate	Percent sodium
Mar. 4, 1952	47	1.04	8.1	2,090	9.6	64	116	225	0	504	316	260	6.0	0.5	1,250	636	224	43
Apr. 3, 1952	61	2.10																
Apr. 30, 1952	68	39.2	8.7	2,250	11	42	129	254	25	322	420	315		1.5	1,360	636	330	46
June 10, 1952	88	.36																
July 2, 1952		0																
Aug. 5, 1952	95	.10	8.5	2,180	26	28	125	259	27	353	358	310		2.2	1,310	584	250	49
Sept. 3, 1952		0																
Oct. 6, 1952		0																
Nov. 5, 1952	56	.71	8.5	2,080	33	51	119	226	19	440	317	272		3.8	1,260	616	224	44
Dec. 2, 1952	37	2.01	8.6	2,140	26	56	124	246	27	416	363	295		5.0	1,350	650	264	45
Mar. 4, 1953	53	.80	8.6	2,350	14	60	136	258	29	450	388	312		9.3	1,430	708	292	44
Apr. 14, 1953	62	1.82	8.6	2,400	18	50	142	267	30	426	414	322		7.5	1,460	709	310	45
June 10, 1953		0																
Aug. 3, 1953		0																
Sept. 10, 1953		0																
Nov. 30, 1953	55	2.45		1,840	24						279	228		0.5				
Jan. 21, 1954	35	.21	8.6	1,990	18	62	108	212	30	405	307	252		1.8	1,190	598	216	44
Mar. 18, 1954	48	.36	8.5	2,350	26	42	136	267	26	475	365	305		2.0	1,400	664	232	47

Table 3.—Continued

LOCATION.—Site 6, lat 33°29'27", long. 101°37'27", 15.0 miles below initial point, A, on County road, 4.2 miles northeast of Slaton, Tex.
RECORDS AVAILABLE.—March 4, 1952 to March 18, 1954.

Temperature, discharge and chemical analyses in parts per million

Date of collection	Temperature (° F)	Measured discharge (cfs)	pH	Specific conductance (micromhos at 25° C)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na + K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Hardness as $CaCO_3$ Total	Hardness as $CaCO_3$ Noncarbonate	Percent sodium
Mar. 4, 1952	47	0.64	8.0	2,780	12	68	138	345	0	599	488	335		0.0	1,690	737	246	50
Apr. 3, 1952	60	2.02																
Apr. 30, 1952	67	57.1	8.7	2,250	17	44	123	260	24	314	422	315		1.0	1,360	616	318	48
June 10, 1952	90	.01																
July 2, 1952		0																
Aug. 5, 1952		0																
Sept. 3, 1952		0																
Oct. 6, 1952		0																
Nov. 5, 1952		0																
Dec. 2, 1952	37	1.80	8.6	2,250	28	58	127	262	31	407	394	310		5.1	1,420	667	282	46
Mar. 4, 1953	48	.70	8.6	2,790	9.6	61	155	349	36	508	520	372		6.6	1,760	790	313	49
Apr. 14, 1953	62	1.65	8.7	2,590	15	46	144	309	36	406	465	350		11	1,580	707	314	49
June 10, 1953		0																
Aug. 3, 1953		0																
Sept. 10, 1953		0																
Nov. 30, 1953	46	1.28		1,950	22						305	238		0.5				
Jan. 21, 1954	42	.03	8.5	2,340	20	62	119	287	27	453	417	295		3.0	1,450	64[illegible]	[illegible]	[illegible]
Mar. 18, 1954	48	.03	8.6	5,460	24	48	226	976	44	680	1,490	700		2.5	3,840	1,0[illegible]	[illegible]	[illegible]

Table 3.—Continued

Wells Used For Municipal Water Supply, City of Lubbock and Reese Air Force Base

Chemical analyses in parts per million

Date of collection	Well Number	Measured discharge (cfs)	pH	Specific conductance (micromhos at 25° C)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na + K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Hardness as $CaCO_3$ Total	Hardness as $CaCO_3$ Noncarbonate	Percent sodium
Sept. 22, 1944	1					78	96	160	0	423	379	126	3.2	11	1,200	589	242	37
Sept. 22, 1944	3					63	63	76	0	316	165	98	3.4	4.1	738	416	157	28
Sept. 22, 1944	13					76	94	166	0	345	44	146	3.2	1.5	1,200	576	294	38
Sept. 25, 1944	16					45	58	59	0	249	120	78	3.5	2.8	619	351	147	27
Oct. 2, 1944	4					48	57	69	0	331	139	62		0.8	628	354	83	30
Feb. 15, 1944	2		8.1	1,130	52	57	65	93	0	318	169	110	5.4	7.5	746	410	150	28
Feb. 15, 1945	19		7.5	1,580	64	69	80	150	0	317	272	190	4.1	5.1	1,030	501	241	39
Nov. 10, 1951	15		7.5	1,180	55	59	57	121	0	368	227	68	2.8	2.5	780	382	80	[illegible]
Nov. 10, 1951	31		8.3	766	49	49	40	57	0	304	85	43	2.0	4.5	494	287	36	28
Reese Air Force Base																		
Nov. 14, 1952	4		7.7	900	48	23	32	135	0	432	70	30	4.4	2.2	557	189	0	61
Nov. 24, 1953	1		7.5	965	50	33	42	121	0	386	119	44	4.4	4.5	608	255	0	51
Nov. 24, 1953	2		7.6	1,050	46	29	40	150	0	406	123	60	6.0	3.0	657	237	0	58
Nov. 24, 1953	5		7.8	932	45	28	37	129	0	396	102	40	5.2	4.0	585	212	0	56
Nov. 24, 1953	6		7.7	1,010	48	27	37	149	0	403	123	47	6.0	3.0	638	220	0	60

Table 4.—SEEPAGE RUN—March 4, 1953. Double Mountain Fork Brazos River from site A, about 3 miles southeast of Lubbock, 1,900 ft above sewage disposal plant to site 6, 15.0 miles downstream, 4.2 miles northeast of Slaton on County Road.

Temperature, discharge, and chemical analyses in parts per million

Location	Miles from initial point, A	Temperature (° F)	Measured discharge (cfs)	pH	Specific conductance (micromhos at 25° C)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na + K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Hardness as $CaCO_3$ Total	Noncarbonate	Percent sodium
A	0		0																
B	0.08		0.10	8.5	1,670	28	56	92	157	10	266	288	215		28	1,000	518	284	40
C	.21	42	.17	8.5	1,800	30	60	100	156	14	278	277	238		29	1,040	560	309	38
D	.57	47	.54	8.5	2,500	45	78	149	256	21	342	494	340		68	1,620	807	492	41
E	.98		1.42	8.4	2,830	51	82	164	300	18	418	527	398		62	1,810	879	506	43
1	1.67	48	2.26	8.5	2,800	52	88	164	288	24	394	527	398		58	1,790	894	531	41
2	6.92	50	4.32	8.5	2,550	20	48	158	283	18	360	516	362		16	1,600	770	444	44
3	8.42	50	4.37	8.6	2,560	6.0	48	153	290	22	367	494	370		9	1,570	749	412	46
4	9.42	50	.47	8.6	1,710	52	66	93	170	31	448	209	195		7.7	1,040	547	128	40
5	12.0	53	.80	8.6	2,350	14	60	136	258	29	450	388	312		9.3	1,430	708	292	44
6	15.0	48	.70	8.6	2,790	9.6	61	135	349	36	508	520	372		6.6	1,760	790	313	49

The above locations correspond to those shown on Table 2.

Table 5.—U.S.G.S. gaging station on Double Mountain Fork Brazos River in MacKenzie State Park, Lubbock, Tex.

Runoff in acre-feet 1/

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1939	—	—	—	—	—	—	—	—	0	0	0	0	0 2/
1940	0	0	0	0	0	0	0	0	0	0	0	0	0
1941	0	0	8.7	0	3,730	2,170	302	.4	.6	477	39	.2	6,728
1942	0	0	0	14	0	803	6.3	0	1,040	112	0	34	2,009
1943	0	0	0	0	0	0	0	0	0	0	0	0	0
1944	0	0	0	0	210	68	15	0	0	0	0	0	293
1945	0	0	0	0	0	0	0	0	0	0	0	0	0
1946	0	0	0	0	0	0	0	0	0	6.7	0	0	7
1947	0	0	0	0	4.6	0	0	0	0	0	0	0	5
1948	0	0	0	0	0	0	0	0	0	0	0	0	0
1949	0	0	0	0	2,990	65	.2	0	0	—	—	—	3,055 2/

Average discharge.— 10 years, 1.67 cfs.

Total 1940-1949 12,097

Annual average (10 years) 1,210

1/ An acre-foot is the quantity of water required to cover 1 acre to the depth of 1 foot or 325,830 gallons.

2/ Incomplete year.

Table 6.—Monthly and annual precipitation, in inches, and departure from the long-term average. Records from Texas Agricultural Experiment Station at Lubbock, Tex.

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual	Departure from average
1911	—	—	—	2.36	0.72	0.28	6.75	0.21	1.33	1.08	0.22	1.55	14.50 1/	—
12	.02	1.28	.61	.50	1.58	.96	3.35	2.37	.73	2.81	.01	.38	14.60	- 3.73
13	.04	.20	1.18	1.82	.24	5.88	.40	.32	4.19	1.53	1.54	2.12	19.46	+ 1.13
14	.15	.10	.31	1.46	4.04	3.86	6.17	5.95	.46	7.12	.35	1.47	31.44	+13.11
1915	.09	3.00	2.52	6.18	1.52	4.01	1.42	2.96	7.86	1.52	.04	.76	31.88	+13.55
16	.17	T	1.15	2.63	.39	1.52	.36	2.45	2.79	2.91	.55	.11	15.03	- 3.30
17	.35	.05	.21	.58	1.07	.64	1.42	1.16	3.03	.14	.08	T	8.73	- 9.60
18	.84	.58	.05	.72	1.67	2.95	.53	.79	.79	.51	.69	2.33	12.45	- 5.88
19	.12	.25	3.39	3.53	2.10	3.52	2.28	2.83	5.70	7.34	.36	.19	31.61	+13.28
1920	1.27	.11	.24	.15	2.91	3.66	2.19	2.64	1.63	1.43	2.22	.09	18.54	+ .21
21	.22	.45	1.47	.24	.43	7.71	.84	.92	4.50	.02	T	T	16.80	- 1.53
22	.34	.20	.55	3.59	3.50	2.43	1.36	.28	.17	.56	1.50	.07	14.55	- 3.78
23	.24	.86	1.04	3.18	2.77	3.98	1.65	1.59	2.67	6.80	.85	.64	26.27	+ 7.94
24	T	.17	.96	.86	.90	1.79	1.20	1.76	1.25	.47	.03	.15	9.54	- 8.79
1925	.65	.02	T	1.12	2.31	.86	3.38	3.32	9.44	1.33	.11	.21	22.75	+ 4.42
26	.56	.04	1.64	1.81	5.14	1.10	1.03	2.75	4.15	8.40	.67	1.63	28.92	+10.59
27	.79	.37	T	.40	T	2.91	2.16	.59	1.16	.40	T	.81	9.59	- 8.74
28	.31	1.18	T	.15	3.08	1.06	6.78	4.04	.08	2.10	.74	.28	19.80	+ 1.47
29	.43	.34	2.03	.15	6.91	.90	.20	1.68	1.36	3.56	1.00	.07	18.63	+ .30
1930	.61	.03	.45	1.04	1.71	1.70	.12	1.34	.11	3.91	.94	1.44	13.40	- 4.93
31	.32	1.98	1.34	1.82	1.32	.95	2.17	2.44	.72	3.47	1.39	1.44	19.36	+ 1.03
32	.93	1.09	.04	1.84	2.37	5.66	1.90	3.15	3.41	1.29	T	2.48	24.16	+ 5.83
33	.37	.95	.02	.06	2.77	.61	1.36	2.19	.71	.42	.79	.06	10.31	- 8.02
34	.06	.06	1.98	1.08	1.26	.28	.65	1.66	1.86	.28	.55	T	9.72	- 8.61
1935	.15	.60	.89	.04	3.49	2.57	1.25	1.69	3.02	1.22	2.04	.33	17.29	- 1.04

Table 6.—Continued

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual	Departure from average
1936	1.08	0.02	0.59	0.92	5.86	0.92	1.05	0.13	13.93	1.52	0.74	0.21	26.97	+ 8.64
37	.26	.01	1.81	2.01	4.00	3.12	1.32	2.06	3.85	3.22	.07	.52	22.25	+ 3.92
38	.91	1.18	.49	.14	1.99	5.89	4.01	.47	.63	.51	.27	.03	16.52	- 1.81
39	2.45	.19	.09	.28	1.82	.67	1.73	2.75	.01	.94	.18	.60	11.71	- 6.62
1940	.23	1.77	T	1.84	1.74	2.06	T	1.57	.73	1.07	2.35	.20	13.76	- 4.57
41	.55	.61	3.56	2.23	12.69	4.13	3.68	1.85	4.47	5.89	.17	.72	40.55	+22.22
42	.04	.18	.51	3.25	.35	1.74	2.58	4.97	7.61	3.39	.01	2.80	27.43	+ 9.10
43	.04	.02	.25	.53	2.71	2.37	3.17	T	1.16	.10	.62	1.87	12.84	- 5.49
44	1.28	1.36	1.09	.84	3.03	1.75	2.93	2.37	3.73	.80	1.72	1.64	22.54	+ 4.21
1945	.69	.39	.10	.46	.46	.36	3.08	2.17	2.22	2.26	.27	.32	12.78	- 5.55
46	1.18	.15	.76	.97	1.49	2.72	.58	3.55	3.59	4.67	.44	1.04	20.24	+ 1.91
47	.73	.02	.69	1.06	6.35	1.56	1.06	.06	.08	.37	1.43	.52	13.93	- 4.40
48	.11	1.59	.22	.48	1.91	1.36	1.22	.31	1.08	1.09	.02	.10	9.49	- 8.84
49	3.85	.29*	.80*	1.78	6.95	4.62	2.47	2.36	4.53	1.02	0.00	.39	29.06	+10.73
1950	.23	.07	0.00	.68	2.51	.77	2.67	1.40	2.24	.29	.03	.02	10.91	- 7.42
51	.21	.72	.61	.55	2.61	1.91	1.92	3.03	.50	.64	.13	T	13.73	- 4.60
52	1.16	.14	.02	3.39	1.73	1.76	3.31	1.17	.90	0.00	.74	.22	14.54	- 3.79
53	.35	.09	.07	.48	.35	.45	1.26	2.21	.08	4.02	.12	T	10.88	- 7.45
54	T	T	.02	2.01	3.63	.39	.36	2.92*	T	3.08	T	.80	13.21	- 5.12
Average	.57	.53	.81	1.37	2.66	2.27	2.03	1.98	2.60	2.17	.60	.70	18.33	

1/ Incomplete. year.

* Weather Bureau at Airport.

Table 7.--Evaporation losses (converted to free water surface) at Texas Agricultural Experiment Station, Lubbock, Tex.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Evaporation in inches 1951-54	3.09	3.43	5.75	7.01	7.57	10.33	8.93	8.15	6.42	5.27	3.41	2.83	72.19
Average rainfall in inches at Lubbock, Tex. 1951-54	.43	.24	.40	1.61	2.20	1.13	1.71	2.56	.37	1.94	.25	.26	13.09
Average net evaporation in inches 1951-54	2.66	3.19	5.35	5.40	5.37	9.20	7.22	5.59	6.05	3.33	3.16	2.57	59.10
Average net evaporation in acre-feet for a water surface area of 98 acres 1951-54	21.7	26.1	43.7	44.1	43.9	75.1	59.0	45.7	49.4	27.2	25.8	21.0	483
Equivalent cfs	0.35	.47	.71	.74	.71	1.26	.96	.74	.83	.44	.43	.34	0.67