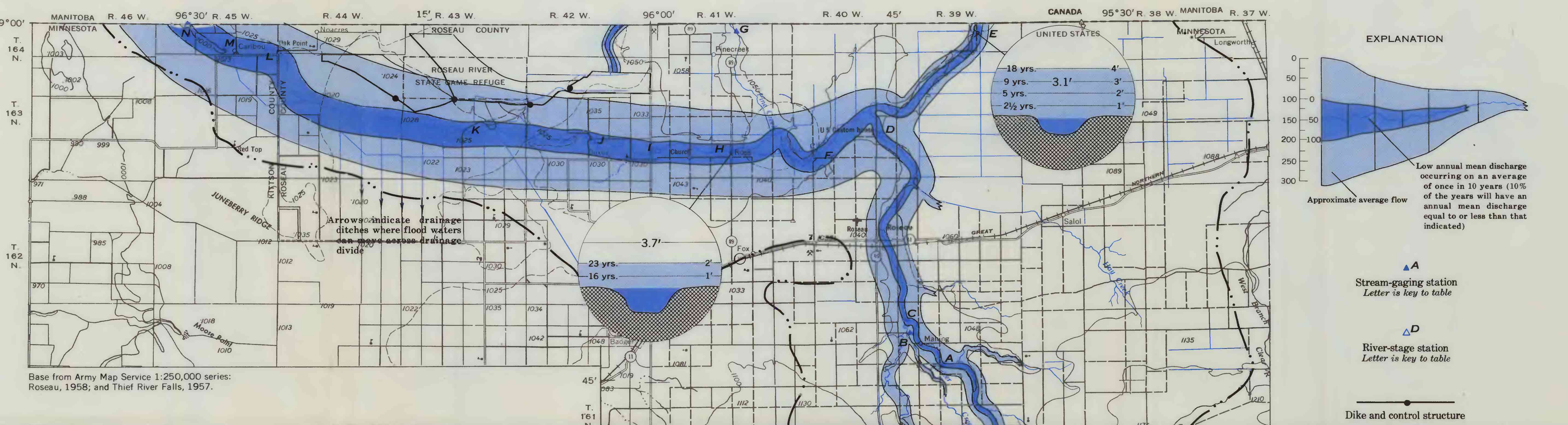
PREPARED IN COOPERATION WITH
THE MINNESOTA DEPARTMENT OF CONSERVATION
DIVISION OF WATERS

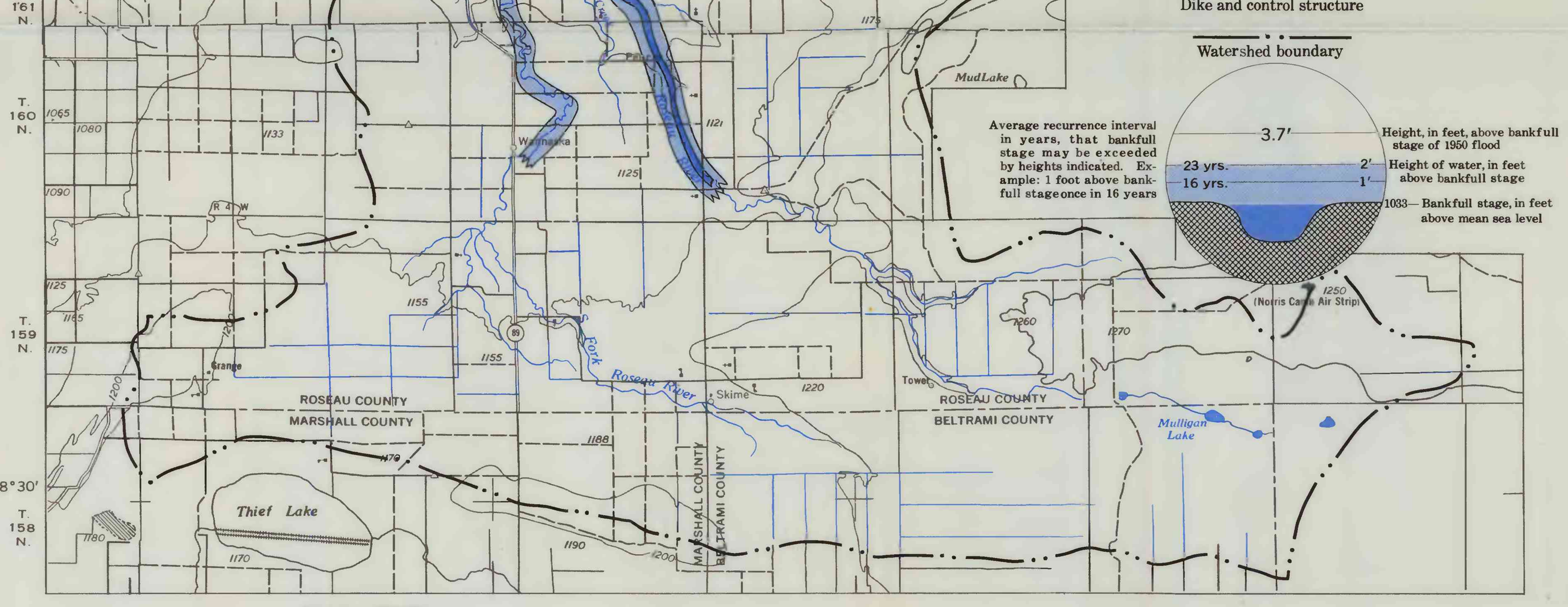
SURFACE WATER



Base from Army Map Service 1:250,000 series:
Roseau, 1958; and Thief River Falls, 1957.

Letter key	Stream-gaging and river-stage stations	Drainage area square mi.	Records available	Maximum discharge for period of record: cfs	cfs per square mile	Ten year high annual mean discharge*
A	Roseau River near Malung	252	1928–46	1780	7.1	110
B	South Fork Roseau River nr. Malung	312	1911–14 1928–46	1890	6.1	90
C	Roseau River below South Fork nr. Malung	573	1946–65	3650	6.4	200
D	Roseau River nr. Roseau (stage only)	----	1930–60	----	-----	----
E	Sprague Creek nr. Sprague, Manitoba	169	1928–65	2070	12.2	100
F	Roseau River at Roseau Lake (stage only)	----	1939–65	----	-----	----
G	Pine Creek nr. Pinecreek	74.6	1928–53	706	9.5	42
H	Roseau River at Ross	1220	1928–65	6560	5.4	470
I	Roseau River nr. Badger (stage only)	----	1928–65	----	-----	----
J	Roseau River nr. Duxby (stage only)	----	1929–56	----	-----	----
K	Roseau River nr. Haug (stage only)	----	1932–65	----	-----	----
L	Roseau River at Oak Point (stage only)	----	1933–39 1941–60	----	-----	----
M	Roseau River below State ditch 51 nr. Caribou	1570	1917 1920–65	4080	2.6	520
N	Roseau River at International Boundary nr. Caribou	1590	1933–65	----	-----	----

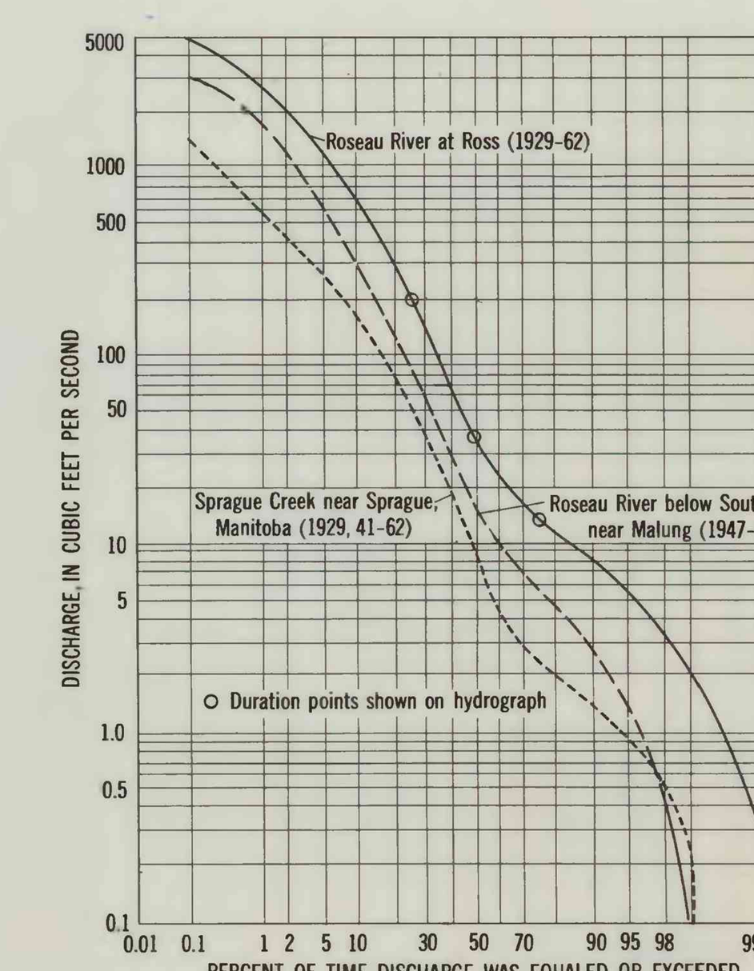
*10% of the years will have an annual mean discharge greater than that indicated



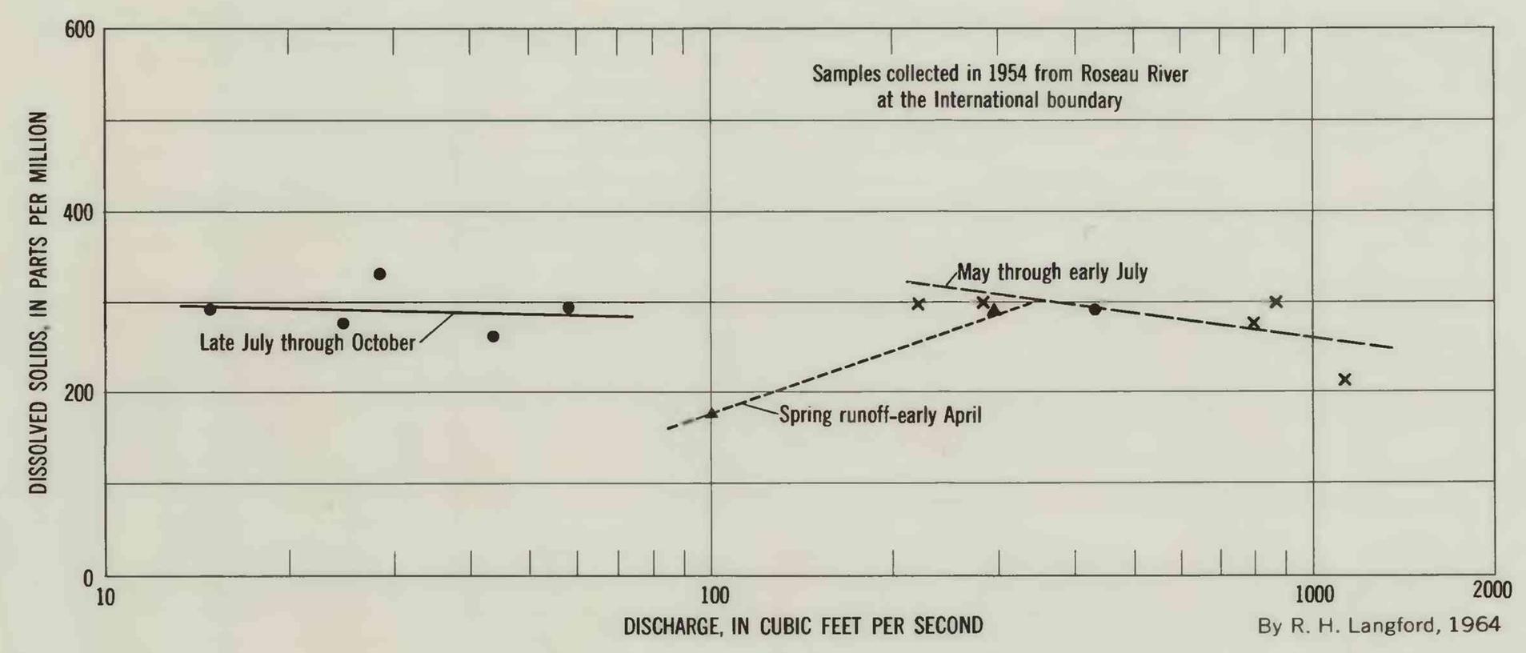
SCALE 1:250 000
CONTOUR INTERVAL 50 FEET
DATUM IS MEAN SEA LEVEL

ANNUAL MEAN DISCHARGE FROM A DRAINAGE AREA OF 1,150 SQUARE MILES WITHIN THE UNITED STATES CONTRIBUTES SLIGHTLY MORE THAN HALF OF THE FLOW OF THE ROSEAU RIVER AT THE INTERNATIONAL BORDER

The remainder of the annual mean discharge is from a drainage area of 440 square miles in Canada. Slightly more than half of the 10 year low annual mean discharge at the international border is runoff from the Canadian drainage area. Stage-frequency diagrams indicate that the channel capacity of the Roseau River is generally sufficient for containing high flows in the till areas (see surficial-geology map on low flow figure). Overbank flooding occurs almost every year, however, where the Roseau River crosses Big Swamp or where tributary streams cross swamps



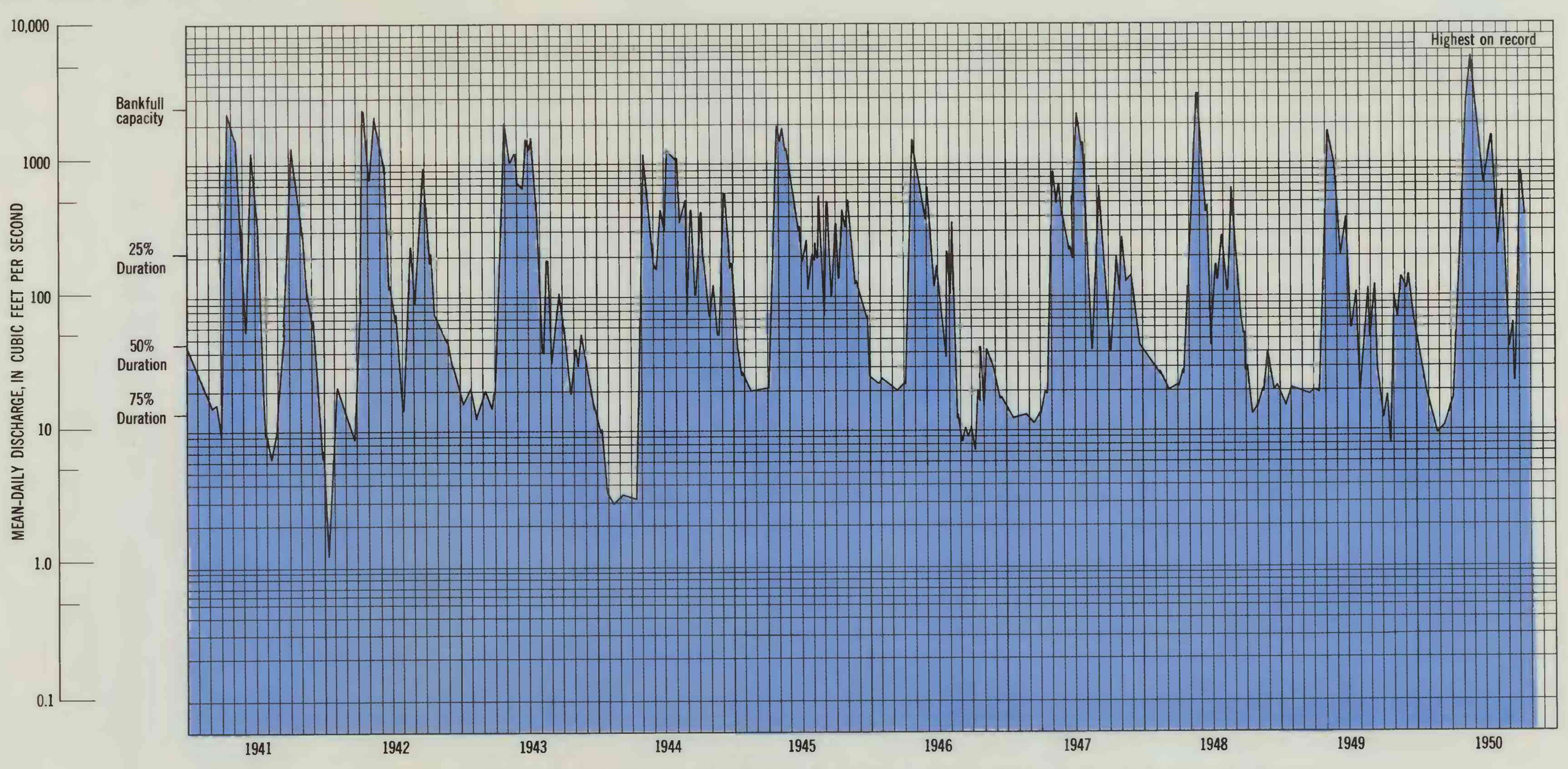
FLATTENING OF LOWER AND MIDDLE PART OF FLOW-DURATION CURVES INDICATE THAT WATER IS BEING RELEASED SLOWLY FROM STORAGE



By R. H. Langford, 1964

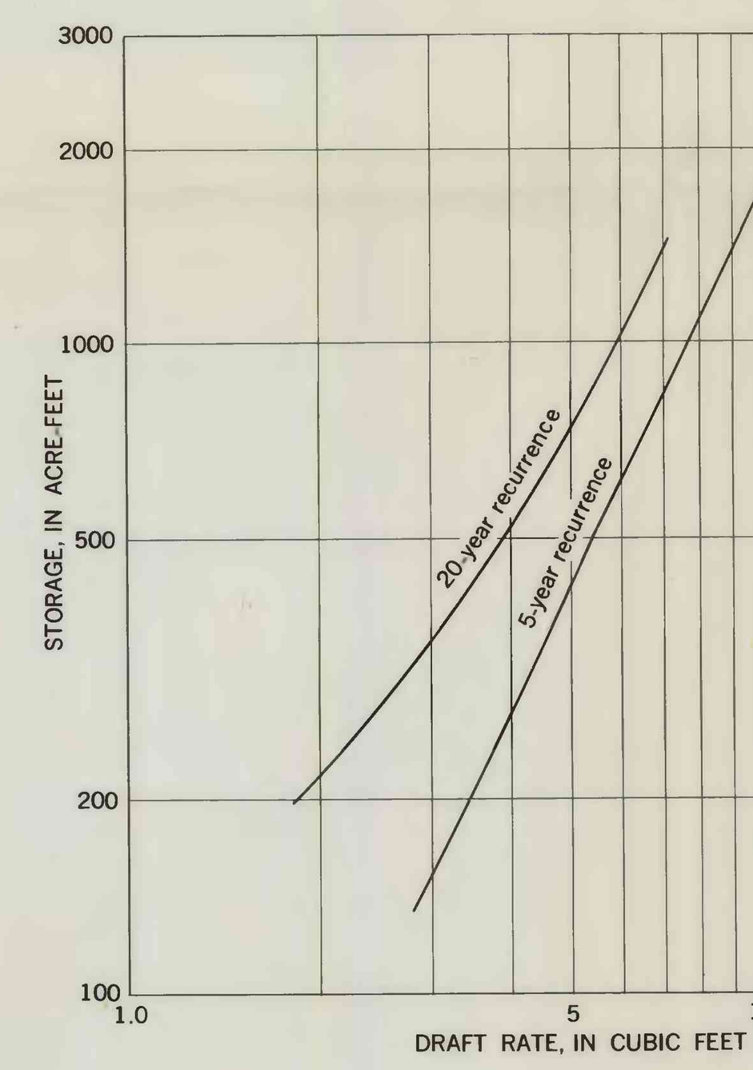
SURFACE WATER QUALITY IS NEARLY UNIFORM DESPITE THE WIDE RANGE IN DISCHARGE

Total dissolved solids of 300 ppm (parts per million) is rarely exceeded. The minimum dissolved-solids content was 179 ppm, and the maximum was only 328 ppm. The range in concentration of the individual dissolved constituents was correspondingly narrow. The water is highly colored by dissolved organic constituents



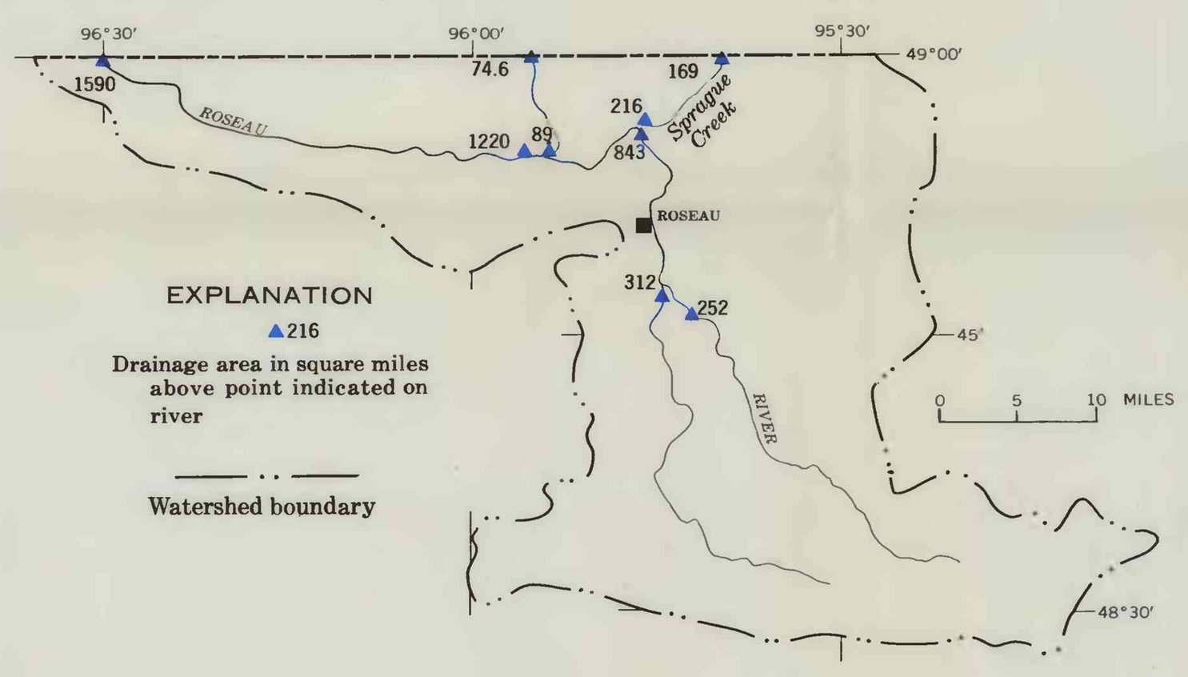
DISCHARGE OF ROSEAU RIVER AT ROSS IS SELDOM LESS THAN 5 CUBIC FEET PER SECOND

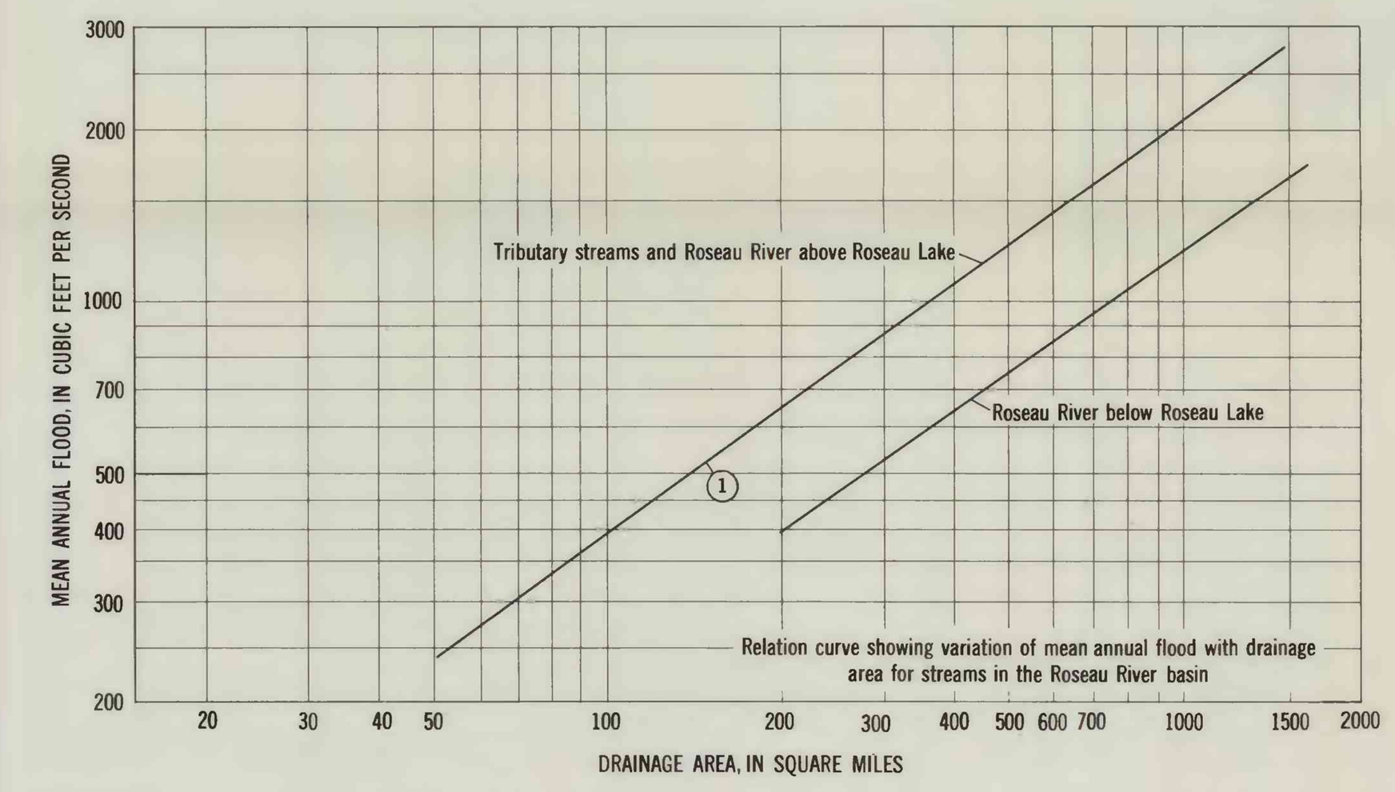
Peak discharge is more than 1,000 cfs annually and a record high stage in 1950 exceeded 6,000 cfs. The percent of time indicated discharge was equaled or exceeded is shown by duration points and may be compared with flow-duration curves above

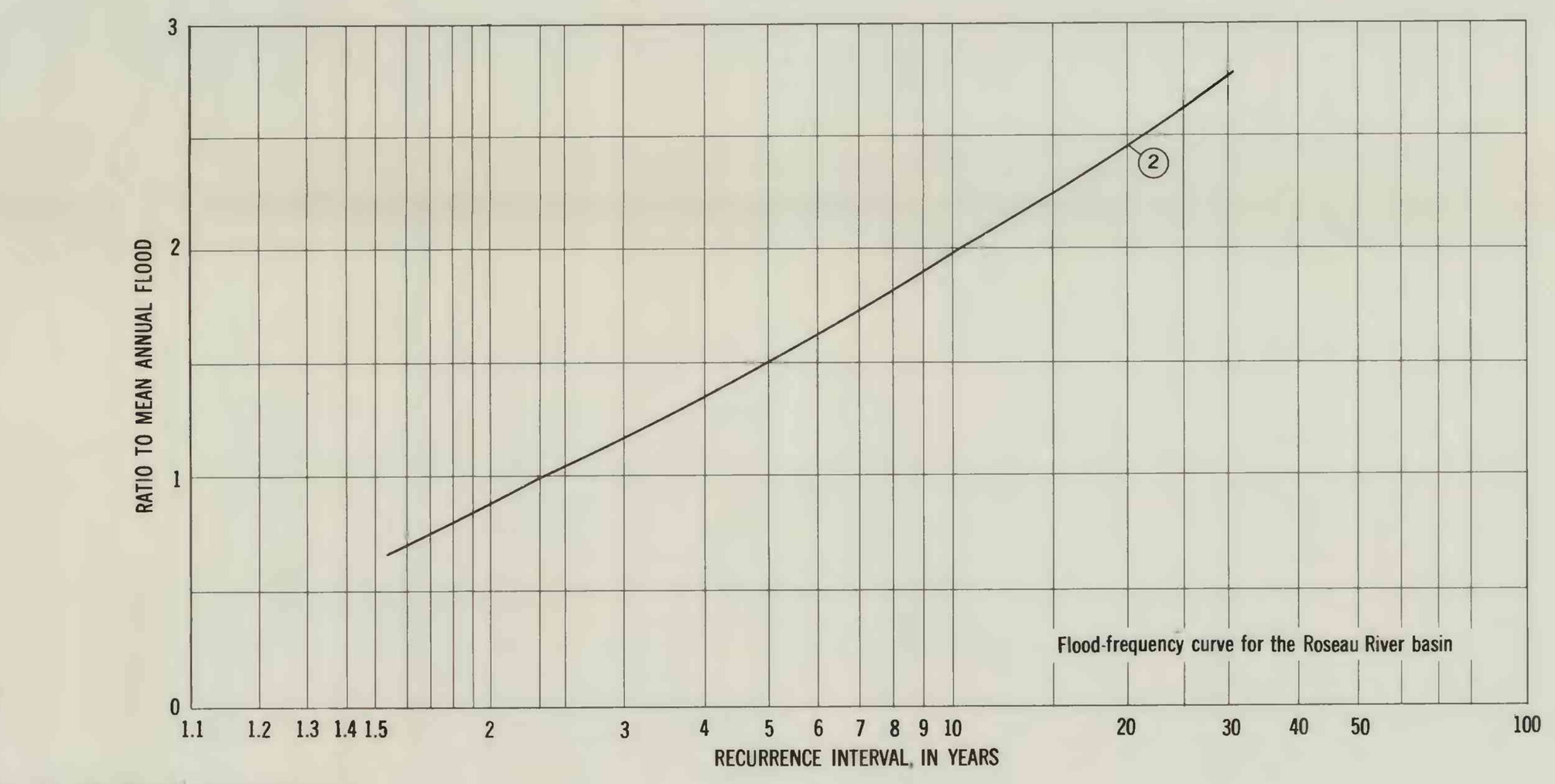


STORAGE-DRAFT-FREQUENCY RELATIONS FOR ROSEAU RIVER BELOW SOUTH FORK NEAR MALUNG, SHOW THAT ONLY SMALL SURFACE-WATER SUPPLIES MAY BE DEVELOPED BY STORAGE IN RESERVOIRS IN THIS AREA. *The curves indicate the amount of storage needed for various draft rates neglecting evaporation and seepage losses. Evaporation losses from open water may be expected to average about 25 inches per year in the watershed. The curves were developed on the basis of 19 years of available streamflow record*

Example: Determine the amount of storage required to maintain a constant draft rate of 4 cfs (2,584,000 gallons per day, each day of the year). If a relatively dependable supply is needed, where storage would be insufficient on the average of about once in 20 years, the curve indicates that a storage capacity of 500 acre-feet is required. Additional storage capacity would be required to compensate for evaporation and seepage loss



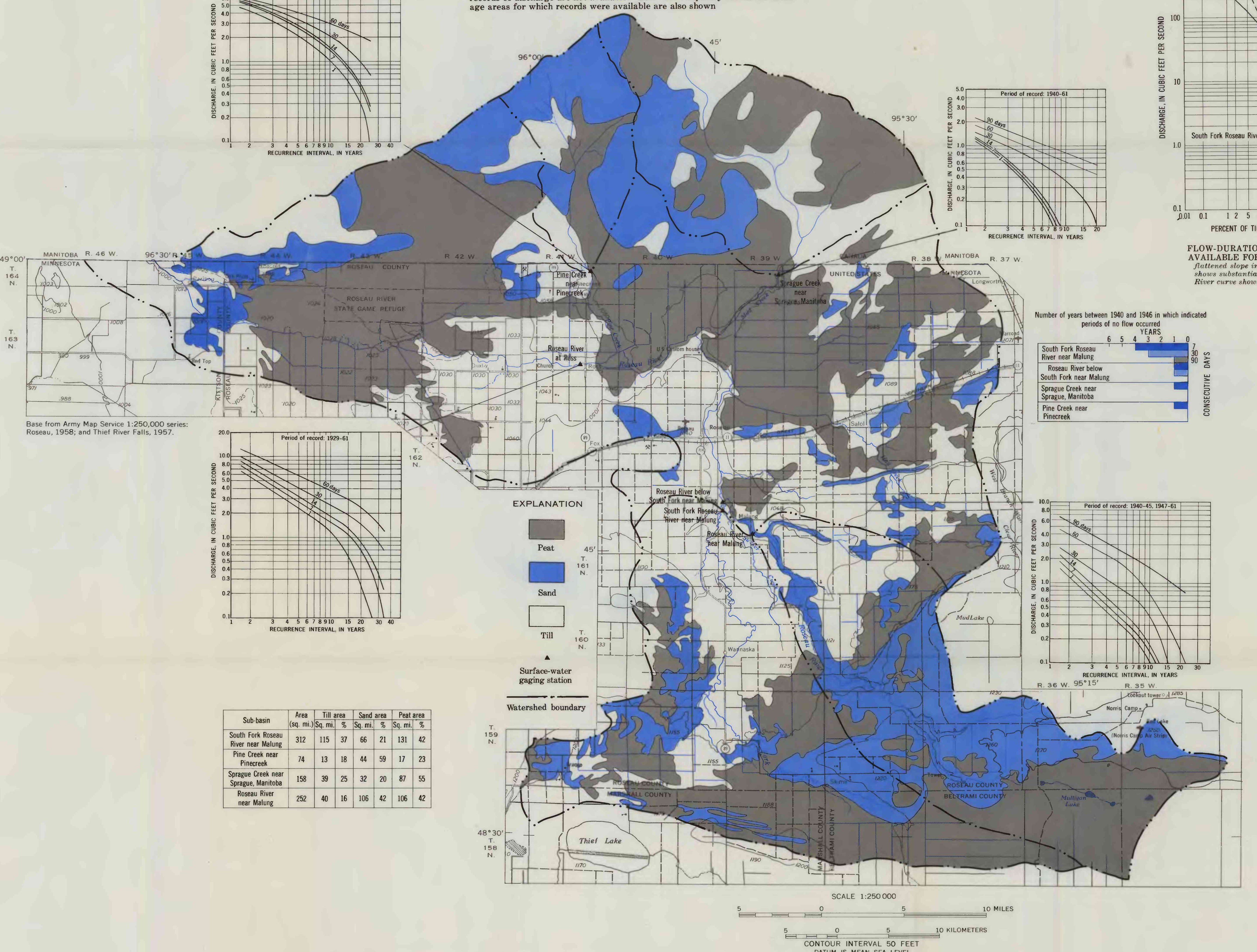




FLOOD FREQUENCY AND RELATION CURVES ARE USED TO DETERMINE THE MAGNITUDE OF A FLOOD OF A SELECTED FREQUENCY FOR ANY STREAM IN THE WATERSHED UNIT (PRIOR AND HESS, 1961)

Drainage areas in square miles above selected points on the rivers in the watershed are shown on the map. Example: Find the magnitude of a 20-year flood on a tributary stream where the drainage area above the site is about 150 square miles. Step 1. Relation curve at point (1) shows that for a drainage area of 150 square miles the mean annual flood is 510 cfs (cubic feet per second). Step 2. Flood-frequency curve at point (2) shows that for a recurrence interval of 20 years the ratio to the mean annual flood is 2.45. Step 3. Multiply the mean annual flood of 510 cfs (step 1) by the ratio of 2.45 (step 2) to obtain 1250 cfs; which is the magnitude of a 20-year flood. The height above bankfull stage for various recurrence intervals is shown for two sites on flow diagram above

Knowledge of low-flow characteristics of streams is essential to management of water resources. The following comparison of Pine Creek and South Fork Roseau River was made to determine the effect of surficial geology on the low flow of the streams. This type of information is useful in predicting the flow of streams during periods of drought and in estimating flow of streams where records of discharge are not available. Low-flow frequency curves for drainage areas for which records were available are also shown



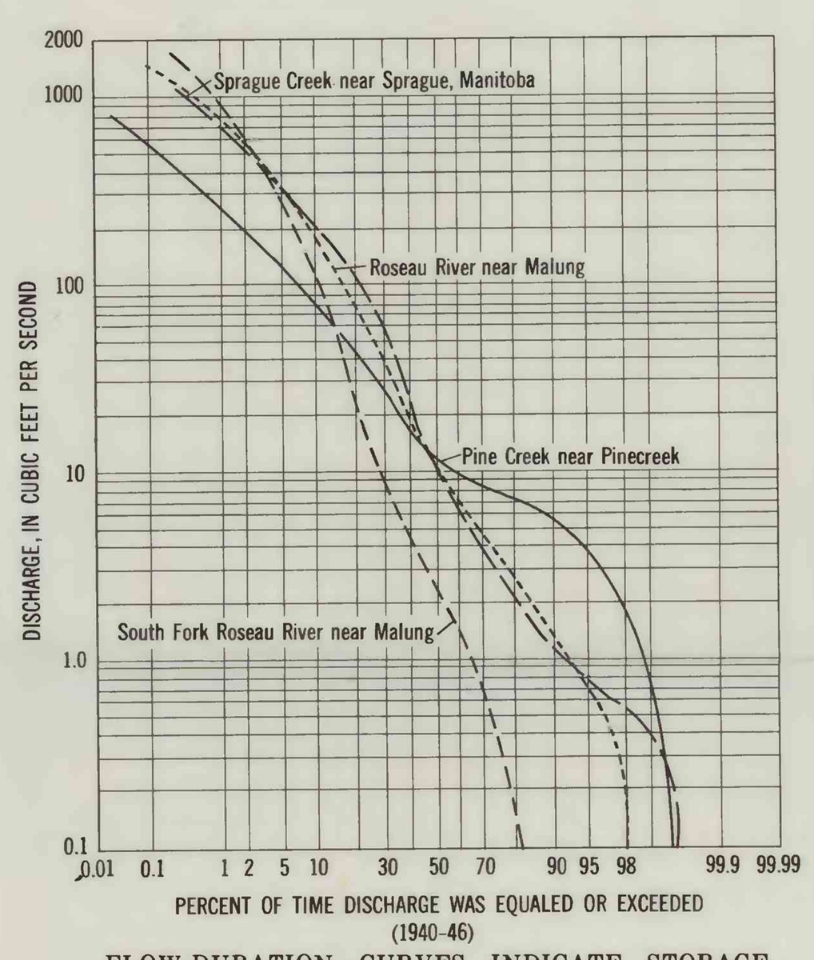
Sub-basin	Area (sq. mi)	Till area Sq. mi	Till area %	Sand area Sq. mi	Sand area %	Peat area Sq. mi	Peat area %
South Fork Roseau River near Malung	312	115	37	66	21	131	42
Pine Creek near Pinecreek	74	13	18	44	59	17	23
Sprague Creek near Sprague, Manitoba	158	39	25	32	20	87	55
Roseau River near Malung	252	40	16	106	42	106	42

Base from Army Map Service 1:250,000 series:
Roseau, 1958; and Thief River Falls, 1957.

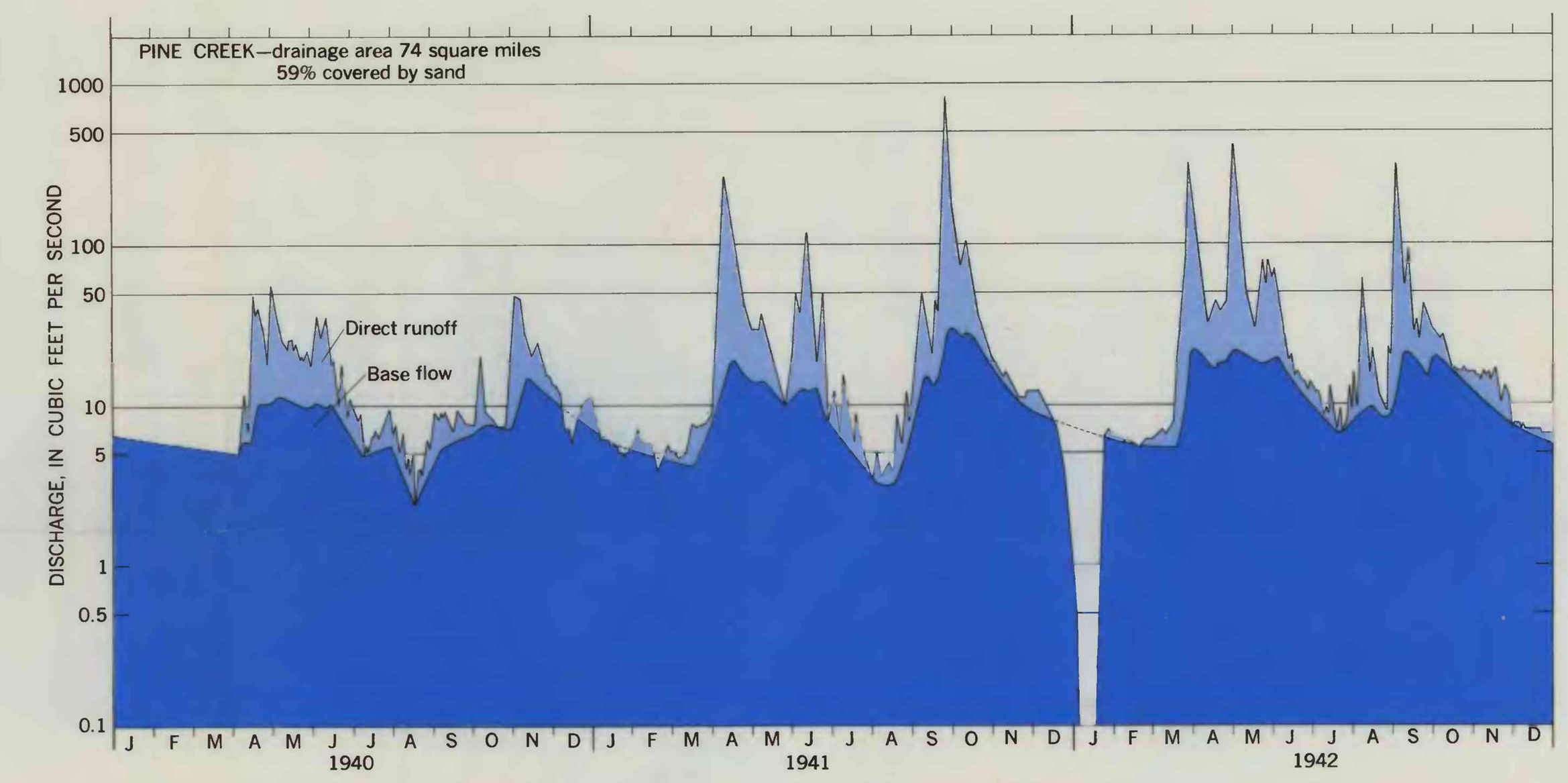
SCALE 1:250 000
CONTOUR INTERVAL 50 FEET
DATUM IS MEAN SEA LEVEL

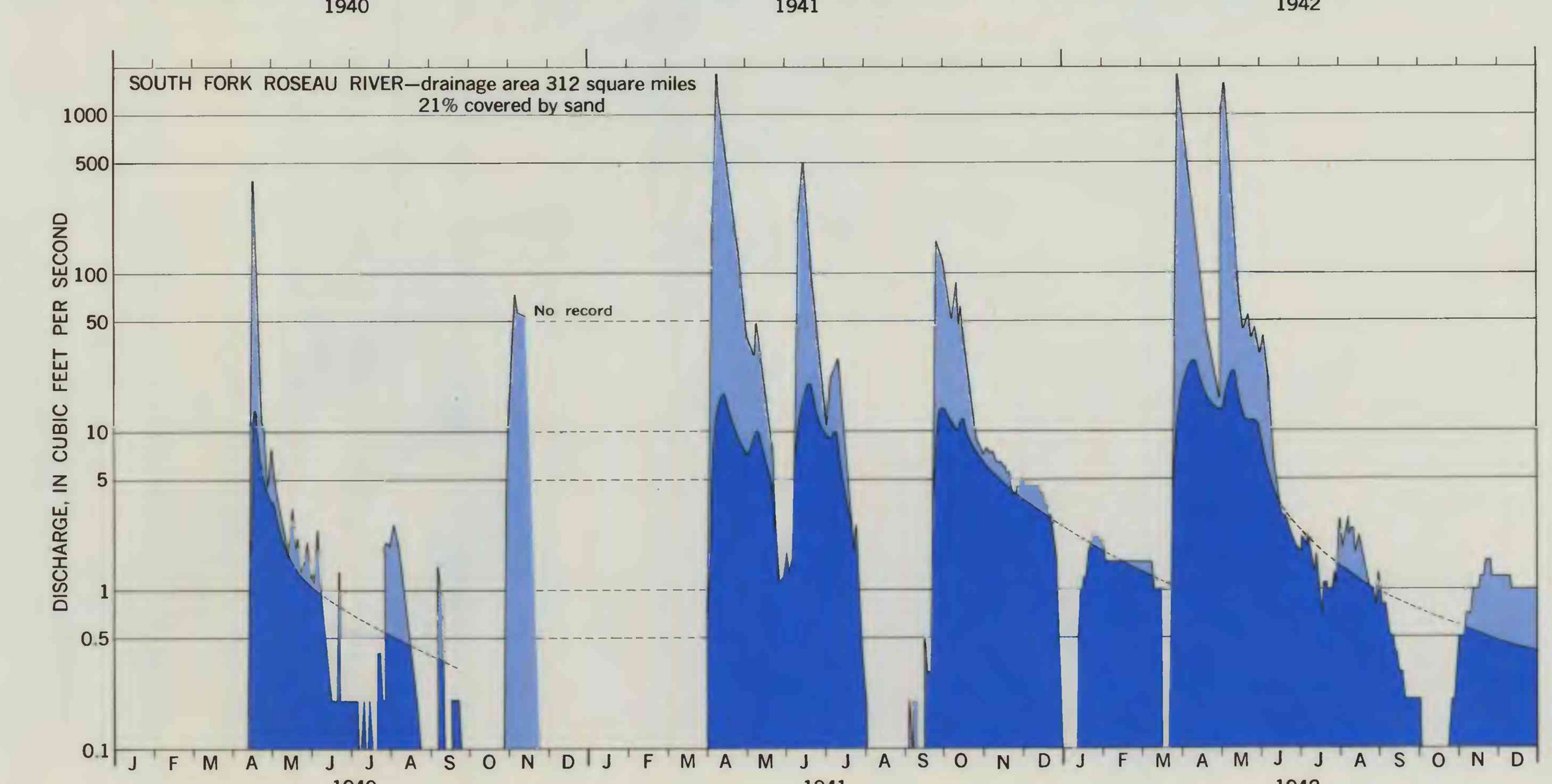
BASINS SELECTED FOR QUALITATIVE COMPARSION OF LOW FLOWS ARE RELATIVELY FLAT AND POORLY DRAINED

Relief in the basins is about 25 to 40 feet per mile in the interstream areas and generally less than 15 feet per mile near the streams. Stream slope along the Roseau River upstream from the village of Roseau is about 17 feet per mile, but downstream from the village to Big Swamp the slope is about 0.2 foot per mile. Of the tributary streams, Pine Creek has the steepest slope ranging from about 90 feet per mile in the uppermost reach to about 3 feet per mile near the mouth. Slope of Sprague Creek ranges from 17 to 2 feet per mile. Sand areas are generally higher and better drained than the till and peat areas. Peat is generally less than 4 feet thick, but locally is as much as 8 feet thick. In peat areas water is released from storage very slowly and is not a significant source of low streamflow. In general peat lands are areas where surface water is discharged mostly by evapotranspiration



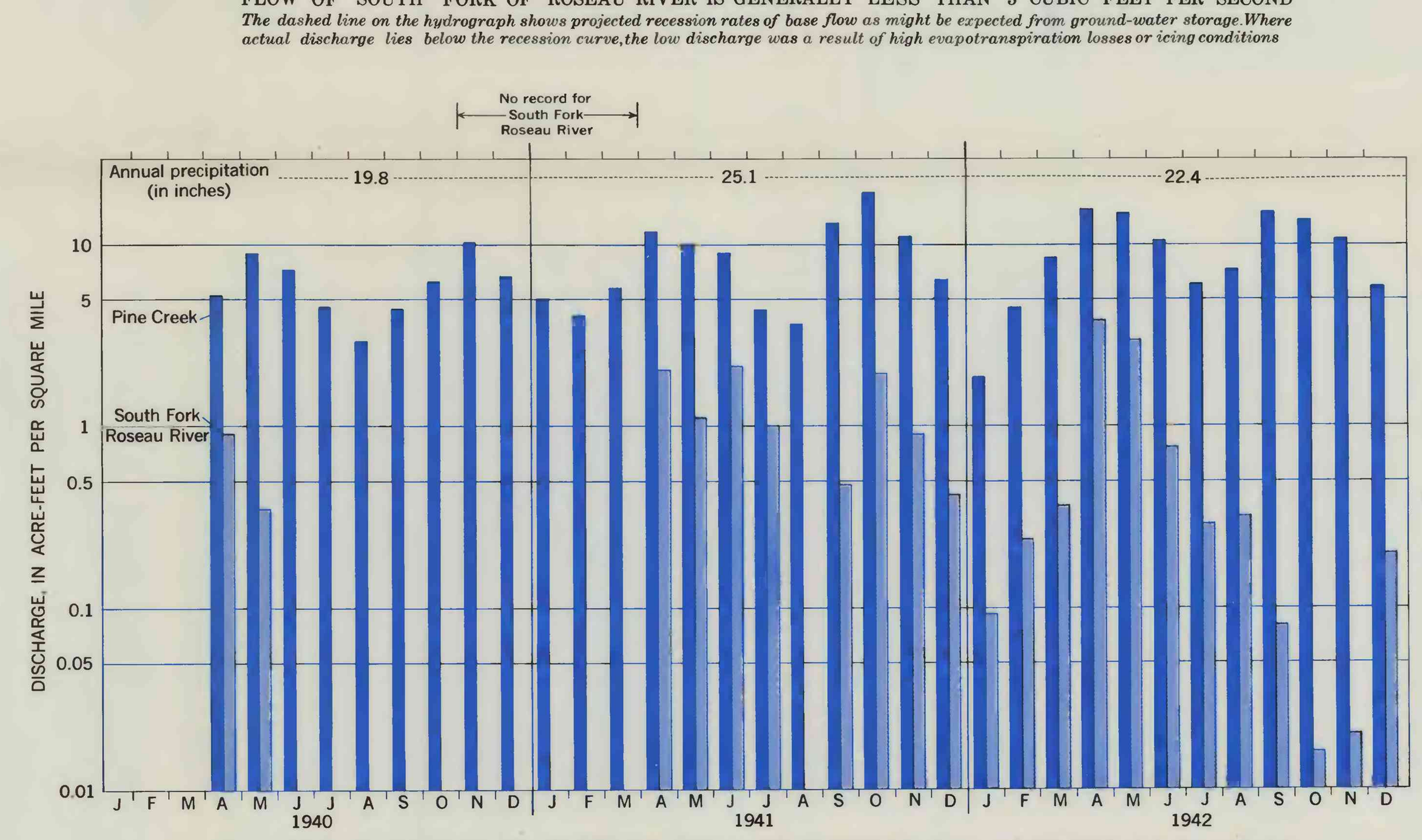
FLOW-DURATION CURVES INDICATE STORAGE AVAILABLE FOR MAINTAINING LOW FLOWS.— *The flattened slope in the middle part of the Pine Creek curve shows substantial storage, whereas, the South Fork Roseau River curve shows little storage*





BASE FLOW OF PINE CREEK IS GENERALLY MORE THAN 5 CUBIC FEET PER SECOND, WHEREAS BASE FLOW OF SOUTH FORK OF ROSEAU RIVER IS GENERALLY LESS THAN 5 CUBIC FEET PER SECOND

The dashed line on the hydrograph shows projected recession rates of base flow as might be expected from ground-water storage. Where actual discharge lies below the recession curve, the low discharge was a result of high evapotranspiration losses or icing conditions



QUANTITATIVE COMPARISON OF BASE FLOWS WAS MADE ON THE BASIS OF ACRE-FEET PER SQUARE MILE

Monthly base flow of Pine Creek ranged from about 2 acre-feet per square mile to about 20 acre-feet per square mile and monthly discharge for South Fork ranged from less than 0.01 acre-foot to about 4 acre-feet. Base flow of South Fork was exceptionally low during 1940 because ground-water storage was depleted during the 2 previous dry years, consequently, little water was available for discharge to the river during 1940. Base flow of Pine Creek during 1940 was near normal. Because of relatively high infiltration capacity of sand, ground-water runoff to streams from sandy areas may be appreciable even during years of low precipitation

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D.C.—1967—W66420

WATER RESOURCES OF THE ROSEAU RIVER WATERSHED, NORTHWESTERN MINNESOTA

By
T. C. Winter, R. W. Maclay, and G. M. Pike

1967