REPORT OF INVESTIGATION 57

STATE OF ILLINOIS

DEPARTMENT OF REGISTRATION AND EDUCATION

Lake Evaporation in Illinois

by WYNDHAM J. ROBERTS and JOHN B. STALL

ILLINOIS STATE WATER SURVEY

URBANA

1967

REPORT OF INVESTIGATION 57

Lake Evaporation in Illinois

by WYNDHAM J. ROBERTS and JOHN B. STALL

Printed by authority of the State of Illinois—Ch. 127, IRS, Par. 58.29

STATE OF ILLINOIS
HON. OTTO KERNER, Governor

DEPARTMENT OF REGISTRATION AND EDUCATION
JOHN C. WATSON, Director

STATE WATER SURVEY DIVISION
WILLIAM C. ACKERMANN, Chief

URBANA
1967

CONTENTS

Lake Evaporation in Illinois

by Wyndham J. Roberts and John B. Stall

SUMMARY

This report furnishes information regarding the magnitude and variability of evaporation losses from lakes in Illinois, processed in a readily usable and meaningful format. This knowledge is greatly needed to allow efficient development and use of surface water resources. Of the annual rainfall in Illinois, 44 percent is returned directly to the atmosphere by evaporation from both land and water surfaces. Annual lake evaporation varies from 30 to 38 inches.

The physical processes of evaporation are described to aid in understanding the complexities of determining lake evaporation. As liquid water is heated, thermal agitation weakens hydrogen bonds holding water molecules together so that some molecules escape to the air. The rate at which evaporation occurs depends primarily on the water and air temperatures and the amount of moisture already in the air.

The water budget, mass transfer, and energy budget procedures for determining lake evaporation are the three principal methods available. In selecting the method to use in computing lake evaporation in Illinois, the authors made a thorough study of the 1950-1951 Lake Hefner project and the ensuing methodology published by the U. S. Weather Bureau. Use was then made of these Weather Bureau computational procedures which allow pan and lake evaporation to be computed from the four climatic elements of air and dew point temperature, solar radiation, and wind movement.

Data on observed pan evaporation for 17 stations in and near Illinois were compiled for the May–October season for a 16-year period, from which monthly and annual maps were drawn. Records of needed climatic data for seven stations were ferreted out for a selected 52-year period and shorter records for three stations were compiled, from which computations were made by electronic computer of monthly pan and lake evaporation.

The computation procedures were checked prior to their extensive use by comparing computed and observed pan evaporation at the six stations where concurrent data were available. Computed values were equal to or higher than observed values. Thus, where adjustments were indicated, computations of both lake and pan evaporation were adjusted downward by amounts of 5 to 15 percent. For three stations, less than the full adjustment was used, since considered judgment suggested that the observed values were too low and the computed values more nearly correct.

Tables showing the monthly lake evaporation in inches at 10 stations in and near Illinois are the primary results of this report and furnish adequate time and place sampling of lake evaporation in Illinois. Maps of monthly and average annual evaporation also are presented, and the variability is indicated by duration curves. Additional tables show the maximum net lake evaporation (total lake evaporation minus expected rainfall) for the 10 stations for periods up to 60 months and recurrence intervals from 2 to 50 years. Applications of these data for computing actual evaporative loss and net yield of a reservoir are illustrated.

The results in this report are believed to be a rational evaluation of the general magnitudes and variability of lake evaporation in Illinois. Evaporation from a specific lake can vary from the general picture because of exposure, shape, depth, and other factors. However, the results given are believed to be generally valid, useful, and applicable to a wide range of Illinois conditions.

INTRODUCTION

The increasing efficiency of modern water use requires progressively greater accuracy in accounting for water losses. In the field of municipal and industrial water supply, knowledge of evaporative losses from impoundments is vital to efficient water systems operation. At the turn of the century, some Illinois reservoirs were designed and built using evaporation and accompanying hydrologic data gathered primarily in the eastern United States. These data deficiencies in Illinois have been largely overcome. It is the purpose of this report to summarize all evaporation data collected in Illinois and to show how such data increase the reliability of reservoir design and operation.

The Illinois State Water Survey operated standard evaporation pans for about 16 years at three locations in Illinois—Rockford, Urbana, and Carbondale. In attempting to utilize these pan observations to make rational evaluations of lake evaporation, four principal limitations were noted: 1) the observations were made on pans, and many technical questions are unanswered regarding proper pan-to-lake coefficients; 2) the observations covered only the warm season, May to October; 3) the 16-year period of observations seemed to fall far short of an adequate sampling of the time variability of evaporation ; and 4) the three stations seemed to be an inadequate place-sampling of evaporation throughout the state.

This study was carried out to overcome these limitations as much as possible, and to furnish processed results on lake evaporation magnitudes and variability in a readily usable and meaningful format. A method for obtaining evaporation directly from climatological data was used to expand the length of evaporation records.

Background

The instrument used by the Illinois Water Survey for measuring evaporation is the U. S. Weather Bureau class A pan. This is a circular pan 4 feet in diameter and 10 inches deep, supported on a grill of 2- by 4-inch lumber to allow free circulation of air around it. The top edge of the pan is 14 inches above the ground and approximately 2 inches above the water surface. A bronze stilling basin permits measuring pan water levels with a hook gage. A nonrecording 8-inch raingage is installed adjacent to the pan. A totalizing anemometer is mounted on the pan base, with the plane of the cups 6 inches above the rim of the pan. Total wind movement in statute miles for 24-hour periods is recorded at times of observation, generally 7 a.m. There are approximately 390 such stations in the 50 states.

The first Illinois station was installed by the Weather Bureau at Springfield in 1941. The Water Survey installed similar stations at Urbana and Carbondale in 1947 and near Rockford in 1950, which were operated during each growing season until the fall of 1962 when data gathering was discontinued. Illinois evaporation data were summarized graphically for the 6-year period from 1947 through 1952 by Roberts (1953). A more recent summary (Illinois State Water Survey, 1960) adjusts the values by coefficients to represent lake evaporation.

Daily records of pan evaporation observations at Weather Bureau installations are published for each state in monthly issues of *Climatological Data,* and monthly totals are printed in the annual summaries. While more than 4000 station-years of record have been accumulated at class A pan evaporation stations in the United States, the validity of 'pan coefficients' has been open to question.

A pioneering and comprehensive research project centered on techniques for determining evaporation was carried out at Lake Hefner, Oklahoma, in 1950–1951 by a group of five cooperating federal agencies. Growing out of that project were the U. S. Weather Bureau nomograph for computing evaporation (Kohler et al., 1959) and a subsequent formula for mathematical solution of the nomograph adapted for computer use (Lamoreux, 1962), which have opened a new avenue of evaporation research based on climatological records. These procedures allow pan and lake evaporation to be computed from four items of climatic data—air temperature, dew point temperature, wind movement, and solar radiation. Since long-term climate records are widely available, these techniques permit extended and refined evaporation information.

In planning this evaporation research in Illinois, the authors studied in detail the results of the Lake Hefner project, the ensuing methodology, and its verification. The thorough testing and highly satisfactory results indicated the desirability of using the Weather Bureau computational procedures for the Illinois study.

Plan of Report

The material in this report is presented in three main sections. First, the physical processes of evaporation and principal methods for computing lake evaporation are described. Also, procedures and formulas used in the study are presented and briefly discussed. Second, available data for Illinois on both evaporation and climate factors are delineated, and data analyses and adjustments during the computations are described.

In the final section, the resulting information on the magnitude and variability of lake evaporation in Illinois is presented, and its application in determining net reservoir yield is shown. Tables of data for 10 stations on monthly lake evaporation computed for 52 years and maximum net evaporation from a lake surface for various durations and recurrence intervals are provided in the appendix.

Acknowledgments

The general leadership and direction of this project has been carried out jointly by the two authors. Wyndham J. Roberts directed the Illinois State Water Survey's evaporation research program, which included supervising the installation and operation of class A pans at Carbondale, Rockford, and Urbana during 16 years. John B. Stall searched out the necessary older records of climatic data and supervised the use of those data to compute evaporation.

This study was conducted by the authors under the general supervision of H. F. Smith, Head of the Hydrology Section, and William C. Ackermann, Chief, Illinois State Water Survey. Many other Water Survey personnel contributed. Robert Sinclair, Statistical Assistant, wrote the principal computer program used to compute evaporation and several smaller programs used in averaging, adjusting, and sorting the output data. Dr. Ramamand Prasad, Engineering Assistant, aided immeasurably in the data handling and wrote computer programs for various comparisons, adjustments, and ranking of data. Dr. Walter F. Claussen, Principal Chemist, contributed important comments to the section on evaporation processes. Stanley A. Changnon, Jr., Climatologist, contributed greatly to this project by furnishing climatic data from stations at Chicago, Moline, Peoria, and Urbana, many of which were taken directly from IBM punch cards compiled under his continuing program of climatological data collection for Illinois. Marvin C. Clevenger, Machine Supervisor, aided in processing these data cards and in punching the input data on cards. Douglas M. A. Jones, Associate Meteorologist, consulted with the authors regarding some of the general results. James Gibb, Assistant Hydrologist, checked details on the manuscript; Mrs. J. Loreena Ivens, Technical Editor, edited the final report; and John Brother, Jr., Chief Draftsman, prepared the illustrations.

Extensive cooperation was extended to the authors by many U. S. Weather Bureau scientists. The aid of Tor J. Nordenson, Don R. Baker, and Wallace W. Lamoreux, of the Hydrologic Services Division, Washington, D. C., is gratefully acknowledged. Personnel from various Weather Bureau offices compiled and furnished many data for this study: G. N. Brancato, St. Louis data; Escal Bennett, Indianapolis data; Lawrence Schaal, Indiana State Climatologist, solar radiation data summary for Indianapolis; S. W. Rampy, Evansville data; and Morton H. Bailey, Tennessee State Climatologist, evaporation data for Tennessee. William L. Denmark, Illinois State Climatologist, aided in locating some of the needed older records in Illinois.

Climatic data, particularly solar radiation observations at the Argonne National Laboratory, Lemont, Illinois, were obtained through the courtesy of Dr. Harry Moses and Dr. James Carson.

All of the computations of evaporation were carried out at the University of Illinois computer facilities on the IBM 7094 system.

EVAPORATION

The waters of the world are found in five forms; the salt water of the oceans, the frozen water of the ice fields, the water in the ground, the water in lakes and rivers, and atmospheric vapor. Slightly more than 97 percent of all water is in the oceans; 0.6 percent is buried as ground water; and the ice masses hold 2.15 percent. The remaining fraction of a percent is either vapor in the atmosphere or water in lakes and rivers (Leopold, 1966). This water forms the hydrologic cycle, and it is estimated that on the order of 95,000 cubic miles per year is precipitated and evaporated.

In Illinois, it is estimated that during an average day 2000 billion gallons of moisture flows over the state. Only about 5 percent, or 100 billion gallons per day, precipitates on the ground. About 44 billion gallons of this precipitation is evaporated directly to the atmosphere from land and water. Land evaporation cannot be measured accurately, but it can be estimated when rainfall and streamflow are known.

Precipitation in Illinois varies annually from 46 inches in the extreme south to 32 inches on the northern border, as shown in figure 1. Direct runoff accounts for about one-third of this precipitation in southern Illinois and about one-fourth in northern Illinois. Thus the annual water loss directly to the atmosphere is equivalent to a column of water varying from 24 to 30 inches in height.

Evaporation Processes

Evaporation transforms water in its liquid or solid state into a water vapor which mixes with the atmosphere. It includes the sublimation of snow and ice in which the water molecules in a solid state pass directly to a vapor. It is considered separate from evapotranspiration, which is the exhaling of water vapor from the surface of green tissues in plants and the evaporation of moisture from soil.

Evaporation of water from a lake surface utilizes energy furnished by the sun which heats the water. The rate at which evaporation occurs is controlled primarily by the temperature of the water, the temperature of the air, and the degree to which the air is saturated with moisture. Knowledge of evaporative processes is important in understanding how water losses to evaporation from a lake or reservoir are determined.

The water molecule is composed of one oxygen atom with an atomic weight of 16, and two hydrogen atoms each having an atomic weight of 1. The molecular weight of the water molecule H_2O is thus 18. This water molecule can be roughly considered to have a radius of 1 angstrom (Davis and Day, 1961, p. 85), which is one hundred millionth of a centimeter. Within each atom, the electrons revolve around the nuclei at extremely

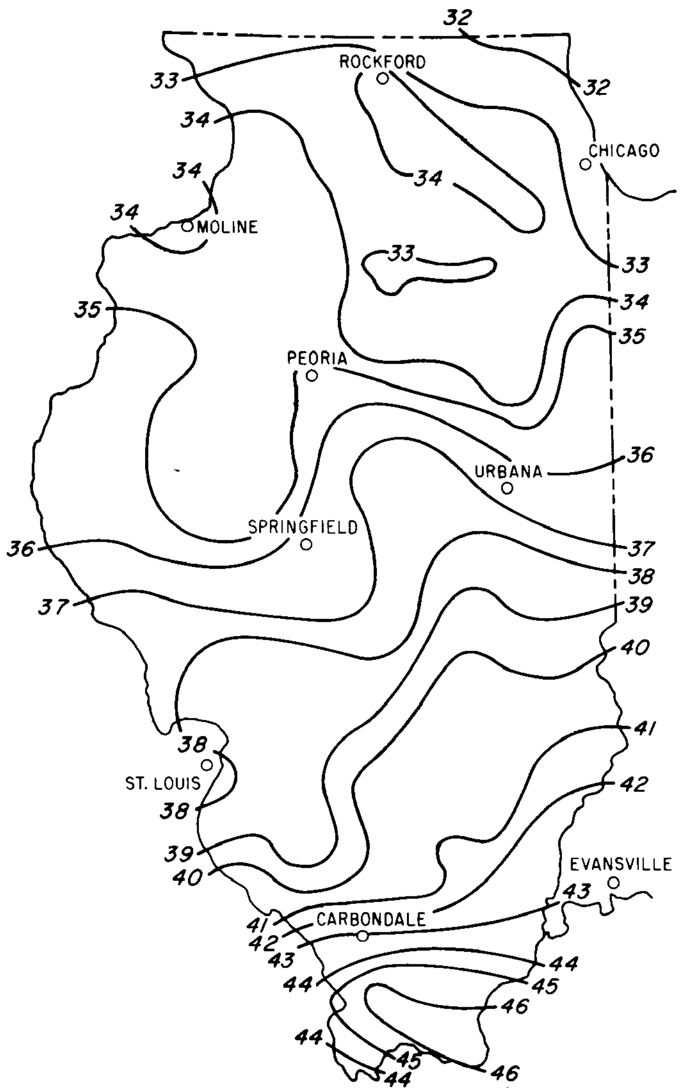


Figure I. Average annual precipitation in inches

rapid rates and in a random fashion, darting in and out, over and around, rather than following a fixed orbit. Because of their tremendous speed of movement, these orbiting electrons effectively 'occupy' a globular space.

Within the molecule the motions of the oxygen and hydrogen atoms are vibrations and rotations which stretch and bend the primary covalent bonds between these atoms. Between water molecules, translational and rotational motions stretch and bend the weaker hydrogen bonds between the molecules; it is this type of motion that is important as a causative factor in the evaporative process.

As the fluid water is heated, the molecules are increasingly energized and agitated, which results in increasing distances between the liquid molecules and decreasing strengths of forces between them. This causes some of the water molecules to 'escape' the liquid surface and be absorbed in the air, which is the evaporation process. Higher temperatures permit more rapid rates of escape.

During this continuous flight of molecules from the water surface into the air, molecules of water vapor are returning to the surface at a rate depending on the concentration of the vapor (Daniels, 1954, p. 169). When equilibrium is established, the rate of escape of molecules is equal to the rate of concentration of vapor, and the vapor is said to be saturated.

The pressure exerted by water vapor that is in equilibrium with liquid water is called vapor pressure. The amount of water vapor contained in the air is measured as vapor pressure in inches of mercury. This is the same unit of measure used to signify atmospheric pressure itself, which at sea-level elevation is about 29 to 30 inches of mercury. At an air temperature of 70 F, if the air were completely saturated with waper vapor, the vapor pressure would be 0.732 inch of mercury.

The equilibrium rate of molecular escape and condensation is dependent on temperature. At a given temperature there is a specific saturation vapor pressure which represents this equilibrium. At this temperature and vapor pressure the air is completely loaded with water vapor molecules and can absorb no more, and the relative humidity is said to be 100 percent.

If the air at a particular temperature is not completely saturated with water molecules, then its vapor pressure is less than the saturation vapor pressure, and it has a relative humidity of less than 100 percent. Relative humidity is the weight of the water vapor in the air expressed as a percent of the total amount of water vapor which it could hold if it were saturated. If air at a given temperature is holding less water vapor than it could at saturation, then this air could be cooled to a lower temperature, called the dew point temperature, at which saturation would be reached and condensation would begin.

The evaporation process is illustrated schematically in figure 2. Liquid water at 78 F is represented in the lower portion of this illustration. Here the water molecules have an average spacing of about 3 angstroms, and are held together by strong hydrogen bonds which are unusually strong at the surface and cause surface tension. As previously explained, thermal agitation of the molecules provides the energy by which some molecules escape. Air at 78 F and 67 percent relative humidity is illustrated in the upper portion of figure 2. Here the average distance between water molecules is 131 angstroms, the molecules have virtually no attraction toward each other, and the vapor in the air is invisible. If the air at 78 F were to become saturated, this average distance would be lowered to 109 angstroms, and still no significant attraction would occur.

Figure 2 also illustrates the enormous expansion that takes place as water changes from the liquid to the vapor state. The average spacing between water molecules increases about 44-fold as water changes from the liquid to the vapor state. The volume occupied by 1 gram of water vapor varies with temperature. For example, liquid water regardless of temperature weighs about

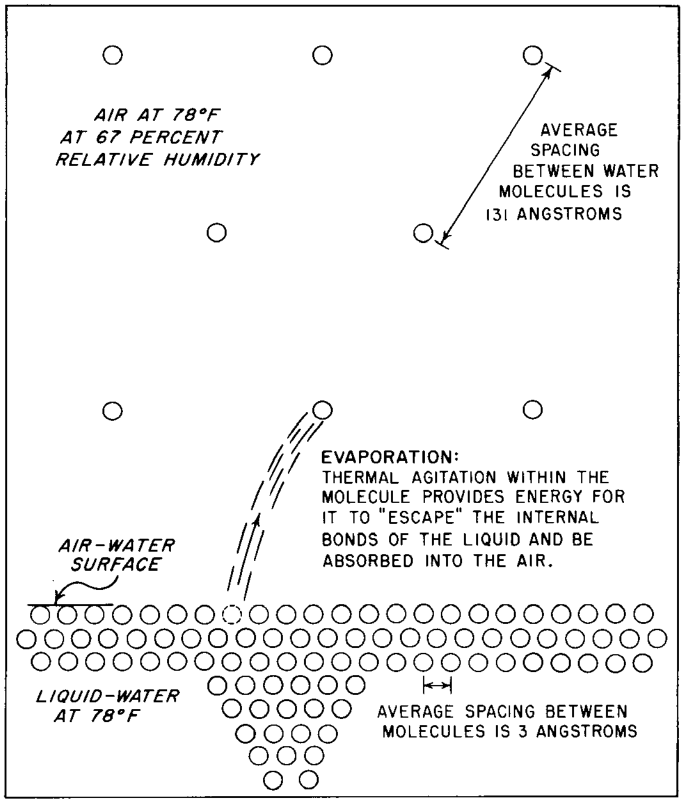


Figure 2. The evaporation process

1 gram per milliliter, but 1 gram of saturated water vapor at 78 F occupies about 42,300 milliliters. This change in state from liquid to vapor represents an expansion of about 42,000 times in volume.

Methods for Determining Evaporation

Historically, the magnitude and variability of evaporation from a lake surface have been measured and computed in three primary ways: the water budget method, the mass transfer method, and the energy budget method.

In selecting the method to use in computing lake evaporation in Illinois, results of the comprehensive Lake Hefner evaporation research project in 1950–1951 were studied (U.S. Geological Survey, 1954). Lake Hefner, in Oklahoma, is a water-supply reservoir with an area of 2587 acres. It was carefully chosen for their project because the physical setting allowed a precise accounting of the water budget. Elaborate instrumentation, operated for 16 months, allowed evaporation to be computed by the mass transfer and energy budget methods. These results were checked against the actual evaporation determined by the water budget. Extensive measurements of evaporation were also made by evaporation pan installations, on both the lake and the shore.

Water Budget Method. Lake evaporation as determined by this method is the sum of the inflow minus outflow, minus change in storage. That is, $E = I - O - \Delta S$, in which E is evaporation, I is inflow, O is outflow, and ΔS is change in reservoir contents.

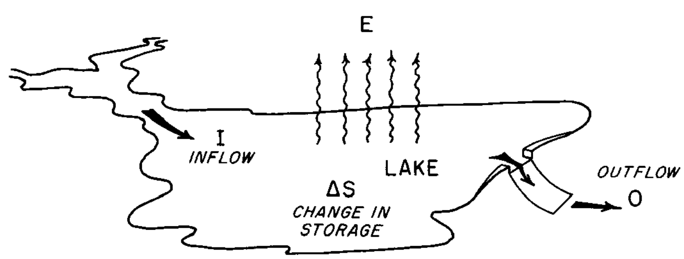
A schematic diagram is shown in figure 3. Generally the use of this method is impractical because measurement errors greatly affect the residual which is the evaporation.

Mass Transfer Method. The mass transfer theory considers air flowing with constant velocity past a fixed solid boundary. Evaporation is a boundary-layer phenomenon resulting from tangential stresses which retard the air flow and build up the thickness of the boundary layer into a vapor blanket of the form illustrated in figure 4.

Attempts to formulate evaporation equations based on models of the mass transfer method have proven unsatisfactory. The Lake Hefner studies developed the empirical equation $E = 0.06\ u\ (e_o - e_a)$, in which E is daily evaporation in inches, u is the average wind velocity in miles per hour, e_o is the vapor pressure of saturated air at the temperature of the water surface in inches of mercury, and e_a is the vapor pressure of the air in inches of mercury.

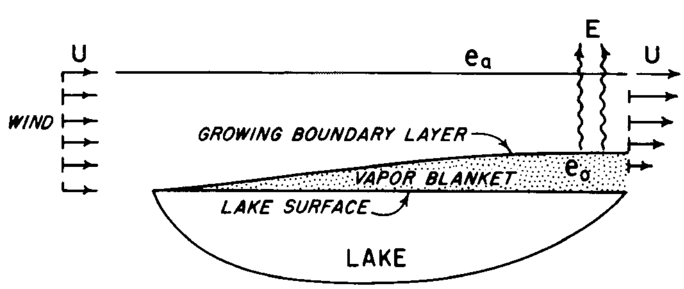
This equation, developed from water-budget data, embodies the principle of mass transfer theory. It is now believed possible, despite gaps in knowledge of mass transfer theory, to compute daily evaporation from a water surface with reasonable accuracy with this equation, but it is not generally as useful as the energy budget method.

Energy Budget Method. The principal elements in the energy budget of a lake that affect evaporation are shown in figure 5. The law of conservation of energy



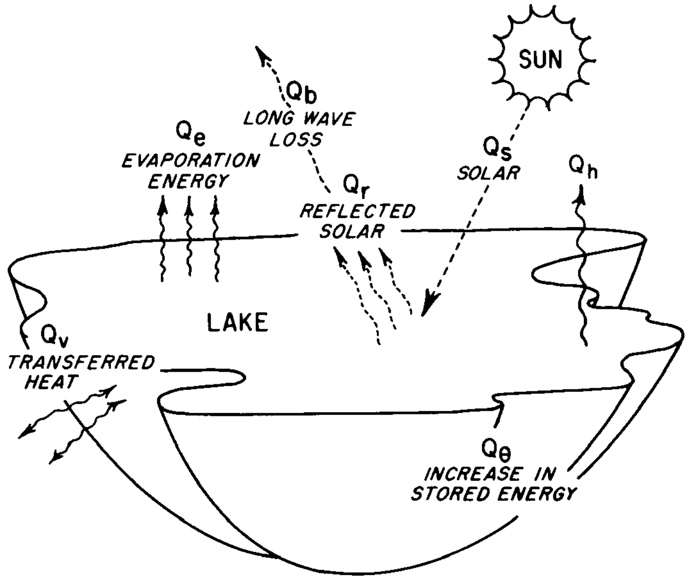
$$E = I - O - \Delta S$$

Figure 3. Water budget method for determining lake evaporation



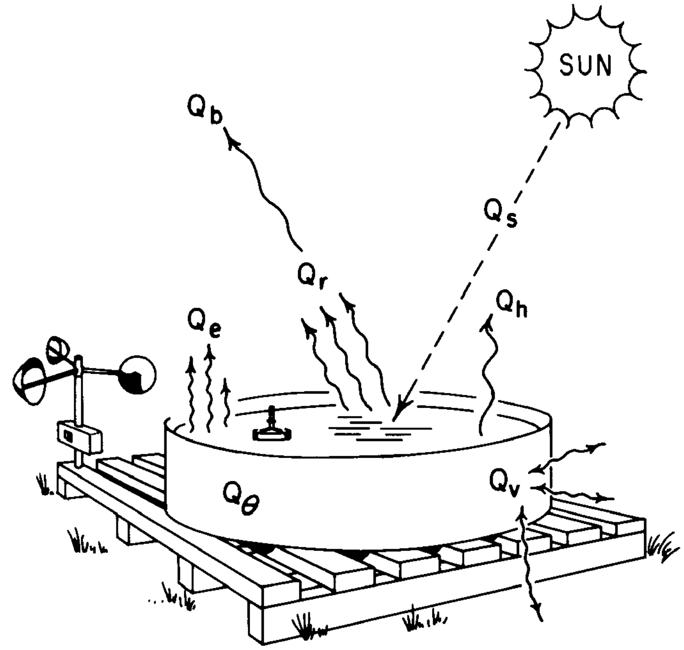
$$E = 0.06\ U\,(e_o - e_a)\ \text{inches per day}$$

Figure 4. Mass transfer method for determining evaporation



$$Q_e = Q_s - Q_r - Q_b - Q_h - Q_\theta \pm Q_v$$

Figure 5. Elements of the energy budget method for determining evaporation



$$Q_e = Q_s - Q_r - Q_b - Q_h - Q_\theta \pm Q_v$$

Figure 6. Energy budget method applied to class A pan

indicates that the total energy reaching the lake must be equal to the total energy leaving the lake plus the increase in internal energy of the lake.

In the formula in figure 5 (U.S. Geological Survey, 1954), Q_e is the energy available for evaporation, Q_s is the solar radiation energy, Q_r is the reflected solar radiation, Q_b is the net long-wave radiation, Q_h is the energy transferred from the lake back to the atmosphere, Q_θ is the increase in energy stored in the lake, and Q_v is the energy transferred into or from the lake bed.

Considerable information is known about many of the individual energy elements in this budget; this knowledge stems from the basic laws of physics and the physical properties of water and air. Some of the energy elements and physical properties can be measured accurately. At the Lake Hefner study, the extensive instrumentation recorded successfully a wealth of data on these physical factors, as well as other climatic data.

Understanding Pan Evaporation

The energy budget as shown in figure 5 can be applied to evaporation from a pan, as illustrated in figure 6. The pan budget contains the same elements as the lake budget in figure 5 except that heat is lost through the side and bottom of the pan.

One major approach in their evaluation of results during the Lake Hefner study was to apply the energy budget to data from a Weather Bureau class A evaporation pan (U.S. Geological Survey, 1954, p. 71–119). By using the abundance of physical measurements made there, a conceptual model was formulated to represent and accommodate all of the energy elements in the budget. Having formulated this conceptual model to represent the workings of the great complex of factors involved, the researchers undertook to ‘calibrate’ the model. The model could then be given the internal coefficients necessary to enable it to reproduce, in this case, the actual values of pan evaporation measured from an input of climatic data.

This calibration of the model was carried out by a graphical-coaxial fitting technique described by Linsley et al. (1949). The results agreed closely with the Lake Hefner class A pan data. In a comprehensive follow-up study, the same model and approach were used to reproduce pan evaporation at eight stations located throughout the country. Again the model provided excellent results, and the internal coefficients furnished by this nationwide calibration of the model varied only slightly and reasonably from the Lake Hefner results. Further and more extensive nationwide testing of this model developed and refined the relationships involved (Kohler et al., 1955; Harbeck et al., 1958). These have now come into general use in the form of a four-quadrant diagram (Kohler et al., 1959) which is similar to that shown in figure 7 for lake evaporation.

Understanding Lake Evaporation

In attempting to derive an expression from the energy budget which would compute lake evaporation adequately, the Lake Hefner group used an approach identical to that used for pan evaporation. This general approach is clearly indicated by the similarity of figures

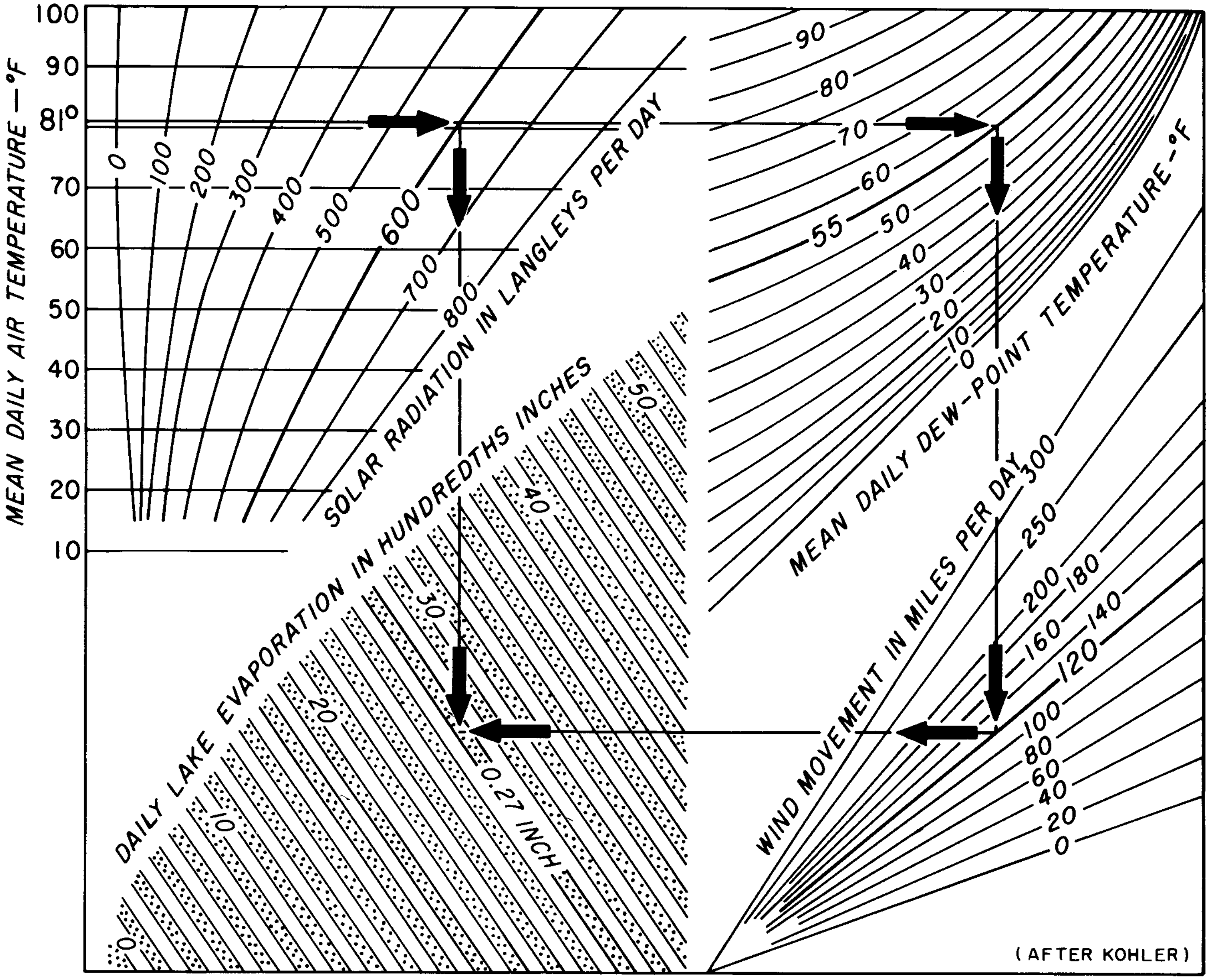


Figure 7. Lake evaporation nomograph

5 and 6. The energy budgets for the pan and for the lake contain all the same elements, and the principal differences are identified readily: 1) the lake, a much larger and deeper body of water, has far greater capacity for storing the internal heat energy Q_θ ; and 2) great quantities of heat Q_v are transferred through the sides and bottom of the pan, as illustrated in figure 6.

While considering these differences, researchers at Lake Hefner used the same basic conceptual model derived for pan evaporation to represent lake evaporation. The physical differences between the lake and pan were accounted for in the model by altering slightly its internal coefficients. This conceptual model for lake evaporation was 'calibrated' by use of the Lake Hefner climatic data and the actual measured lake evaporation. This worked very effectively. Again the climatic data were fitted empirically by the graphical-coaxial technique (Linsley et al., 1949) to provide the necessary internal coefficients so that the model would reproduce the observed lake evaporation.

This provided a four-quadrant diagram (figure 7) by which lake evaporation can be compared from four climatic elements: air temperature, dew point temperature, wind movement, and solar radiation. The graph in figure 7 is structurally identical to that published by the Weather Bureau researchers who developed it (Kohler et al., 1959). Although this nomograph was developed for use with daily values, it is also usable with monthly average values and gives reasonably reliable results with annual average values.

How the four-quadrant diagram may be used to compute a value of monthly lake evaporation is illustrated in figure 7. The climatic data for the example are: average daily air temperature for the month, 81 F; average solar radiation, 600 langleys per day; dew point, 55 F; and average daily wind movement, 120 miles. At the upper left quadrant of figure 7, a horizontal line pases from the 81-F mark to the first intersection at the 600-langley curve, and projects toward the right to the intersection of the 55-F dew point curve. At this stop a vertical line runs downward to the curve of the 120-mile wind movement, from where a horizontal line projects toward the left to intersect a vertical line from the first intersection. The average daily lake evaporation, 0.27 inch, is read at this point.

Computation by Digital Computer

The procedures just described for determining pan and lake evaporation from observed climatic data were the result of several years of combined effort. They were used extensively by the Weather Bureau to compile a nationwide picture of evaporation, based on observed data from 297 pans and climatic data at 255 first-order weather stations for the 10-year period 1946–1955 (Kohler et al., 1959). The results contributed greatly to general knowledge of evaporation in the United States.

These computational procedures also were adapted for use on a digital computer by Lamoreux (1962), so that large quantities of historical records can be practicably processed. The complete computations for pan and lake evaporation can be accomplished by his equations which follow.

For pan evaporation, the expression is:

$$E_p = \{\exp [(T_a - 212)\ (0.1024 - 0.01066 \ln R)] - 0.0001 + 0.025\ (e_s - e_a)^{0.88}\ (0.37 + 0.0041\ U_p)\} \times \{0.025 + (T_a + 398.36)^{-2}\ 4.7988 \times 10^{10} \exp [-7482.6/(T_a + 398.36)]\}^{-1} \quad (1)$$

For lake evaporation, the expression is:

$$E_L = \{\exp [(T_a - 212)\ (0.1024 - 0.01066 \ln R)] - 0.0001 + 0.0105\ (e_s - e_a)^{0.88}\ (0.37 + 0.0041\ U_p)\} \times (0.015 + (T_a + 398.36)^{-2}\ 6.8554 \times 10^{10} \exp [-7482.6/(T_a + 398.36)]\}^{-1} \quad (2)$$

The terms in these expressions are:

E_p = pan evaporation, inches
E_L = lake evaporation, inches
T_a = air temperature, degrees Fahrenheit
e_a = vapor pressure, inches of mercury at temperature T_a
e_s = vapor pressure, inches of mercury at temperature T_d
T_d = dew point temperature, degrees Fahrenheit
R = solar radiation, langleys per day
U_p = wind movement, miles per day

Equations 1 and 2 were used for this Illinois study of evaporation. Thorough review of the development, testing, and use of these Weather Bureau procedures indicated their value for extending and refining evaporation data in the state.

DATA AND ANALYSES FOR ILLINOIS

Observed Pan Data Available

At the beginning of this study, all records of pan evaporation in and near Illinois were searched out and compiled, primarily from U. S. Weather Bureau *Climatological Data.* Twenty-six records of varying length were located, 20 in adjoining states and 6 in Illinois. Three of the Illinois records were from the pans operated by the Water Survey at Rockford, Urbana, and Carbondale; two were from Weather Bureau stations at Springfield and Dixon Springs; and one was from a privately operated station at Ficklin. Class A pan observations starting with August 1962 were also available at Hennepin and Carlyle, but the records were too short for use in this study.

The solid dots on figure 8 mark the stations having observed pan records, and the histogram in figure 9 shows the periods of records.

To use these data efficiently, a standard period of record was selected, which was the 16 years 1947 through 1962. For this period, 17 stations had complete or almost complete records for the May through October season. These data are tabulated in table 1 and were used to form the map of pan evaporation in Illinois, figure 10. This map represents the basic pattern of summer-season evaporation for the state.

Individual monthly maps also were drawn to show the variation in evaporation during the season, and these were used later in the study as an aid in preparing the monthly and seasonal maps of computed lake evaporation.

Climatic Data Available

Since the computation of evaporation by equations 1 and 2 required four elements of climatic data (air temperature, dew point, solar radiation, and wind movement), a search was made for records of observations of these elements in and near Illinois. The open circles on figure 8 mark the 30 stations where part or all of these elements had been observed for some period.

The searching of old records to find concurrent observations of all four data elements became one of the most time-consuming phases of the study. After considerable correspondence and cooperation from Weather Bureau

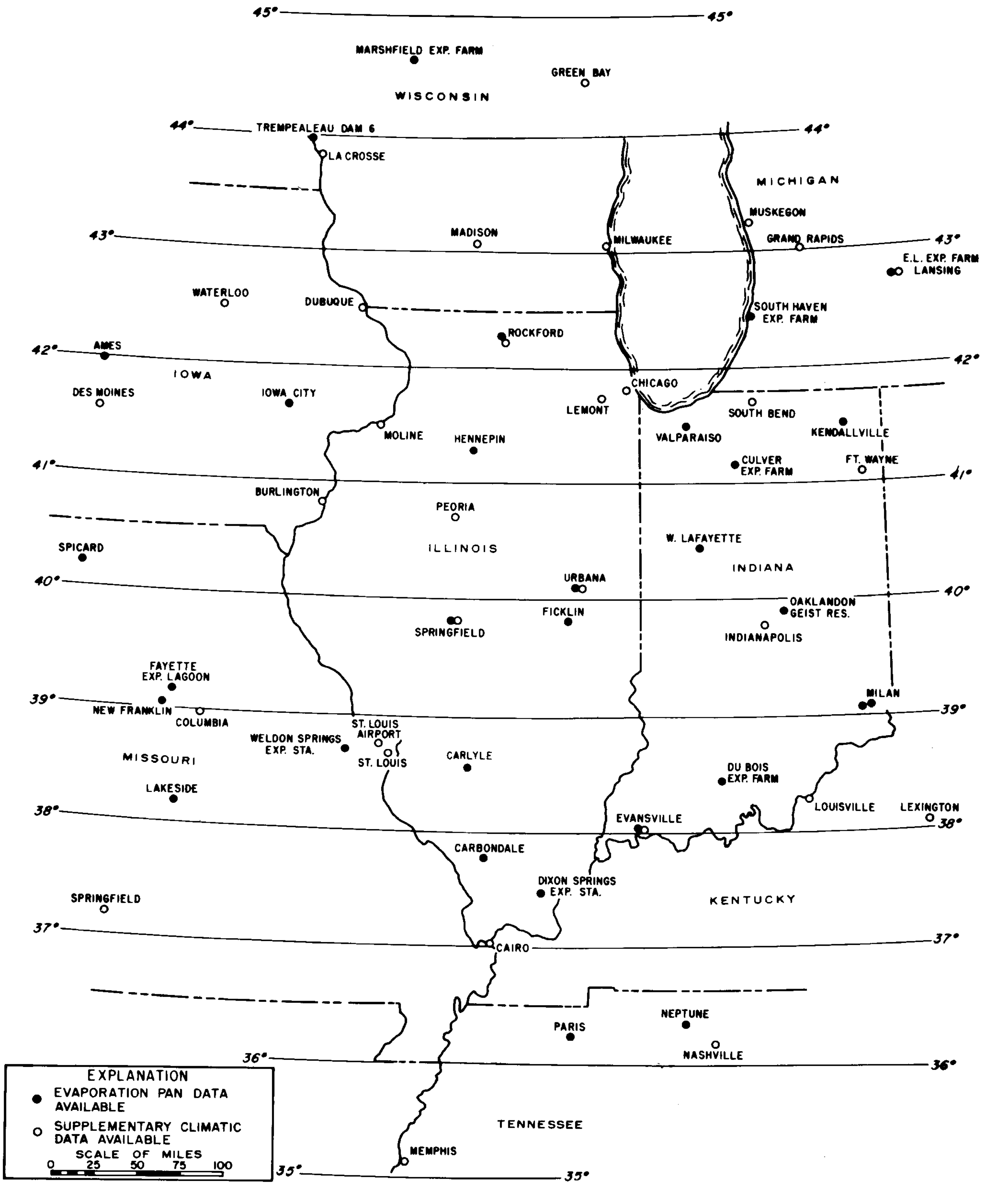


Figure 8. Location of data stations in and near Illinois

officials, the historical picture was fitted together for the 30 stations. However, initial experience in searching these data, computing the desired monthly means, and determining the observers' practices in early years revealed the practical burdens of compiling the needed data from the many historical observations. For this reason, these compilations were limited to seven stations with long-term records, and three other stations having differing records were also used for the computations of evaporation.

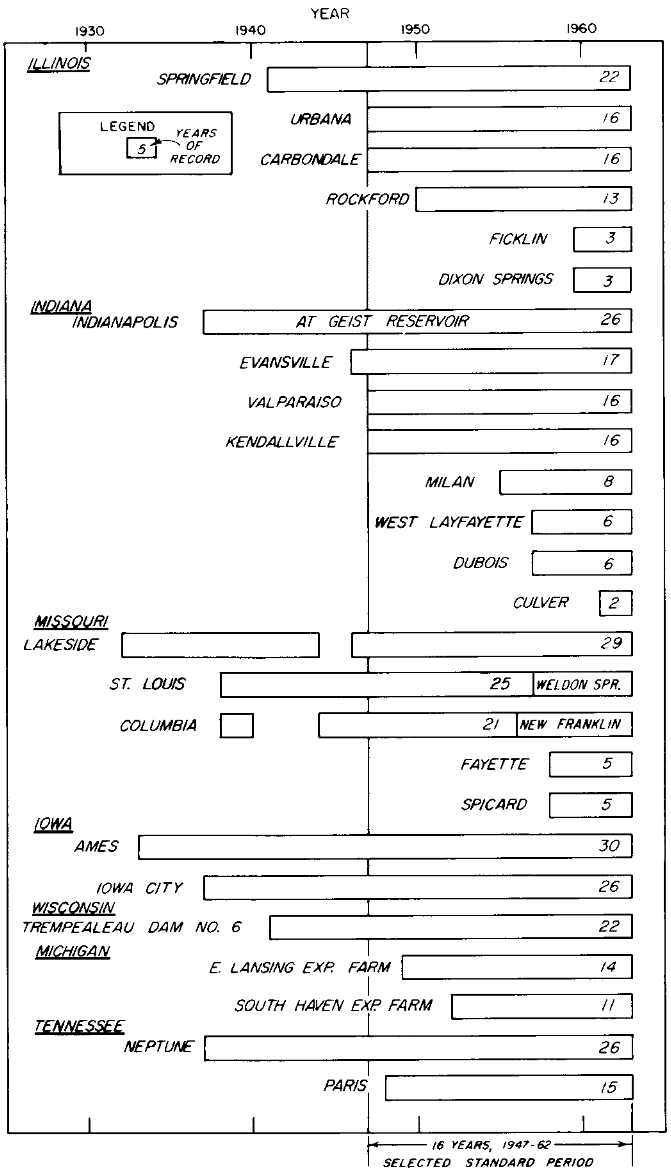


Figure 9. Length of records of observed pan evaporation in and near Illinois

The 10 stations selected were Springfield, Chicago, Moline, Peoria, Urbana, Rockford, St. Louis, Indianapolis, Evansville, and Carbondale. The histogram in figure 11 shows the length of the climatic data records at these stations and indicates the 52-year standard period, 1911–1962, that was selected for the computations. Figure 11 also shows the records of observed pan evaporation that were available at some of these stations.

Urbana, Rockford, and Carbondale were included in order to use their observed pan evaporation data. The 33-year climatic record at Urbana was considered a reasonable sampling of the 52-year period and thus was used without modification for the Urbana computations. Carbondale and Rockford data were treated in a different manner, since climatic data were not available. Lake evaporation at Carbondale was synthesized by using the relation between the observed pan evaporation at Carbondale and Evansville. Rockford evaporation data were similarly synthesized by using computed Moline values. The shorter climate records at Lemont (figure 11) were also useful in the study.

Table 1. Average Observed Class A Pan Evaporation (May-October) for the 16-Year Period 1947- 1962

Station	Pan evaporation *(inches)*
Illinois	
Springfield	40.65
Urbana	32.40
Carbondale	34.36
Rockford (1950—1962)	28.18
Indiana	
Indianapolis, Geist Reservoir	27.33
Evansville	38.91
Valparaiso	29.40
Kendallville	28.54
Missouri	
Lakeside	35.34
St. Louis	30.02
Columbia	34.89
Iowa	
Ames	39.90
Iowa City	36.64
Wisconsin	
Trempealeau Dam 6	32.99
Michigan	
East Lansing Experiment Farm (1949–1962)	35.46
Tennessee	
Neptune	31.18
Paris (1948–1962)	33.02

Of the four required climatic elements, air temperature T_a in degrees Fahrenheit was the most readily available data for most weather stations. Usually both daily observations and monthly means were found in readily usable form.

Data on dew point temperature T_d in degrees Fahrenheit were available at many stations, even for early years. At other stations, relative humidity observations furnished the needed information. For most years it was necessary to compute a dew point temperature to represent the monthly mean. For many older records, this was the average of the daily recorded dew points, which were usually an average of early morning and early afternoon readings. For more recent years, the published mean monthly values for average relative humidities at midnight, 6 a.m., noon, and 6 p.m. were used.

Few direct observations of solar radiation R in langleys had been made. Records were available at Columbia (Missouri) for several years and at Lemont for seven years, but Indianapolis was the only one of the selected stations having a local record of solar radiation for a long period, 1950–1962. Solar radiation at the other stations was computed by use of observations of sunshine, as a percent of possible sunshine.

For these computations, use was made of the equation developed by Hamon et al. (1954) which relates solar

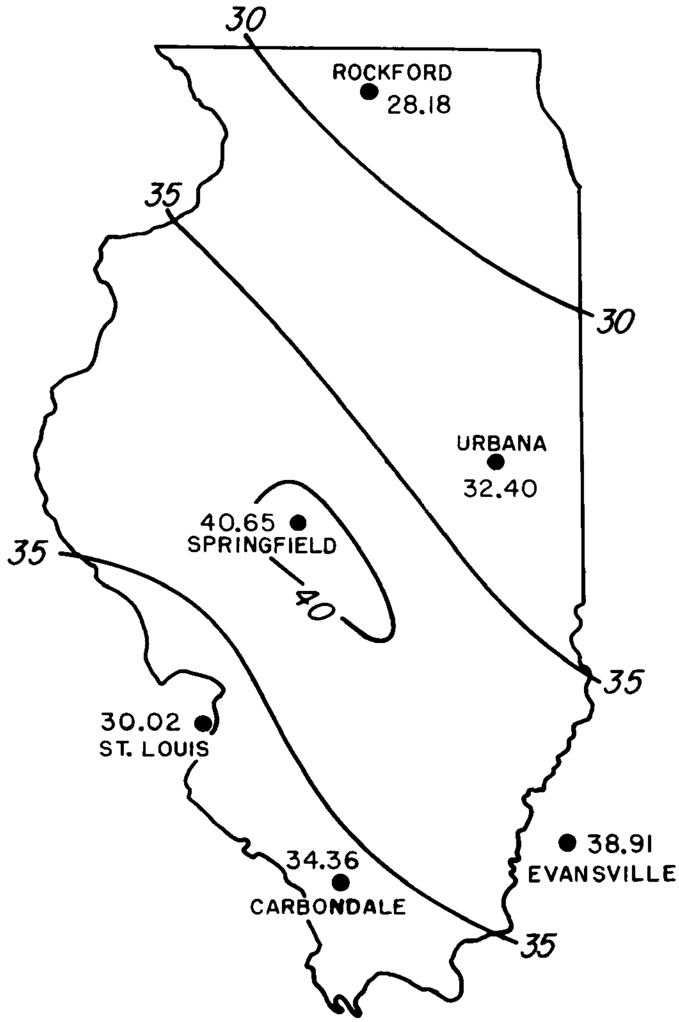


Figure 10. Pan evaporation in inches for May-October for 16 years

radiation to latitude, time of year, and percent of possible sunshine. This equation had been used also by Kohler et al. (1955) and Nordenson (1962) in developing the methodology for computing evaporation. To convert sunshine data to solar radiation, monthly conversion curves, developed directly from the graph given by Hamon, were drawn for each degree of latitude. An example is shown in figure 12 for 40° north latitude, approximately the latitude (see figure 8) of Springfield and Urbana. Each curve represents the relation for about the 15th day of the month.

The conversion procedure for computing solar radiation was checked by using the observations of solar radiation at Lemont for the seven years, 1951–1952 and 1955–1959, and the values for nearby Chicago that were computed with data for percent sunshine and conversion curves for 42° north latitude. The results are shown in figure 13. The plotted points, which are the monthly mean values for the seven years, cluster nicely about the 45-degree line of equality, indicating that this conversion procedure seems to work very well.

Data on wind movement U in miles per hour were available at nearly all of the weather stations for most years. However, the station anemometers were usually 50 to 100 feet above the ground surface, whereas wind movement at 2 feet above the ground surface was desired for computing evaporation by equations 1 or 2.

Thus, observed wind movement was adjusted to pan height, 2 feet, by use of the power law as described by Nordenson (1962). The basic equation used was $U_1/U_2 = (Z_1/Z_2)^{0.30}$ in which U_1 is the wind movement at pan height, U_2 the wind movement at the weather anemometer, Z_1 the height of the pan anemometer (2 feet), and Z_2 the height of the weather station anemometer.

It was possible to check this procedure by use of data from those stations where wind movement had been measured at both a weather station and a nearby class A evaporation pan. At Springfield, for example, observations of wind movement for April–October at the class A evaporation pan and at the weather station anemometer (height of 49 feet) were available for a 13-year period, 1950–1962. Wind data from the anemometer at 49 feet were adjusted to produce a computed wind movement at the pan, and this computed result was checked with the observed wind data at the pan. As the results in

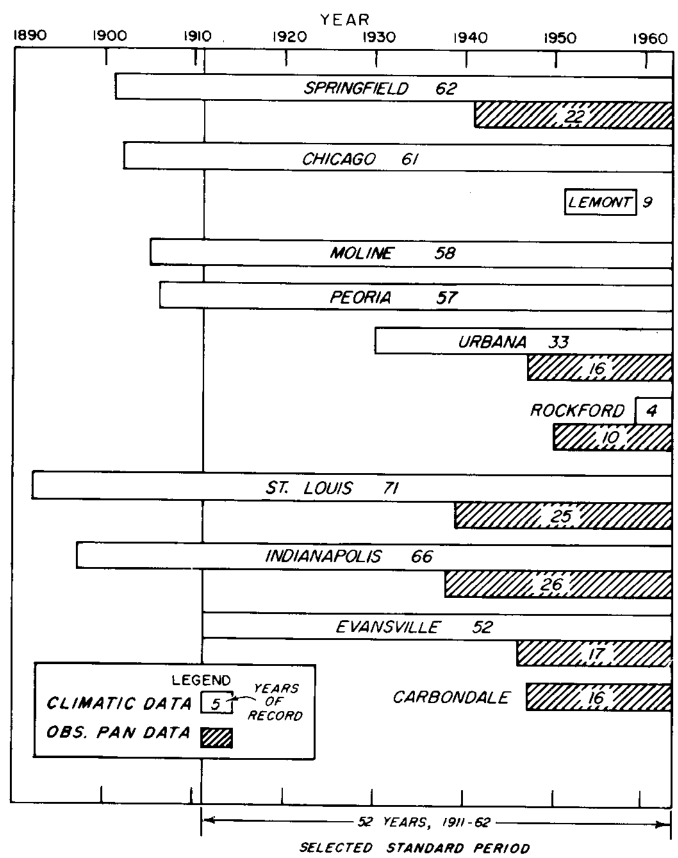


Figure 11. Length of climatic data records and observed pan data for selected stations

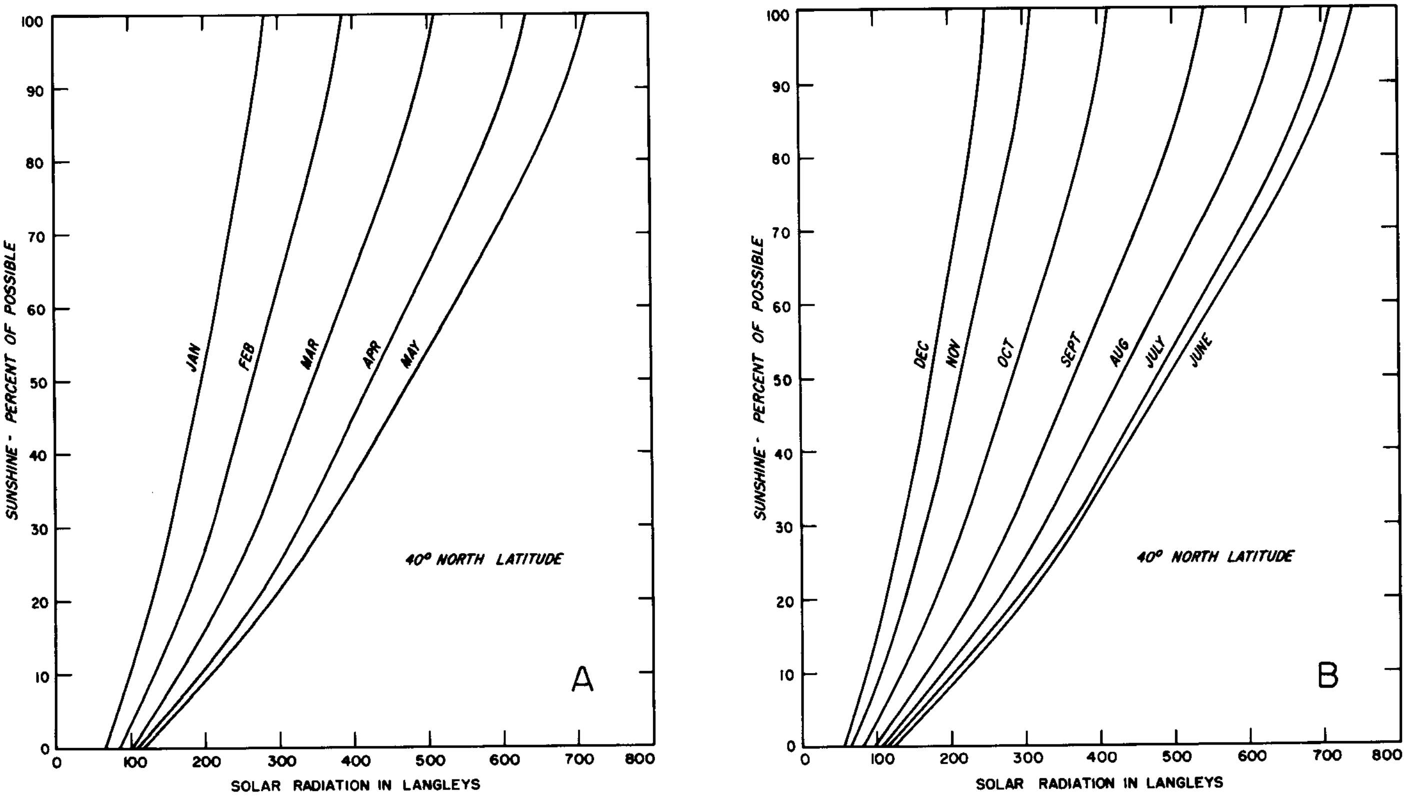


Figure 12. Curves relating solar radiation to percent possible sunshine for 40° north latitude for January-May (A) and June-December (B)

figure 14 show, the points seem to follow the 45-degree line of equality very well. In some cases the exponent 0.30 in the equation had to be changed to provide a good fit to the observed wind movement at the pan. For the stations checked, this exponent was usually near 0.30 but did vary from 0.29 to 0.61.

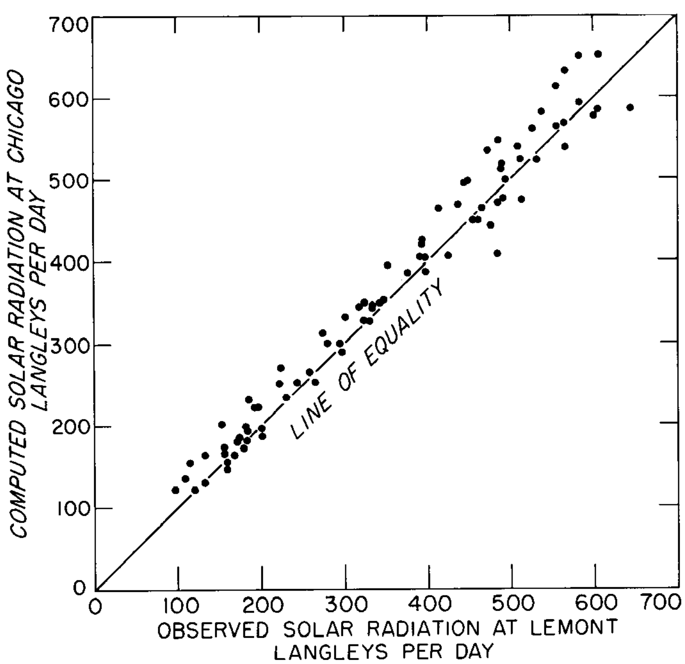


Figure 13. Monthly solar radiation, observed values at Lemont versus computed values at Chicago, for seven years

Adjustment of Data

Pan evaporation was computed and a direct check was made against the observed pan evaporation data for the period of concurrent record (figure 11) for six stations: Rockford, Evansville, Springfield, Indianapolis, Urbana,

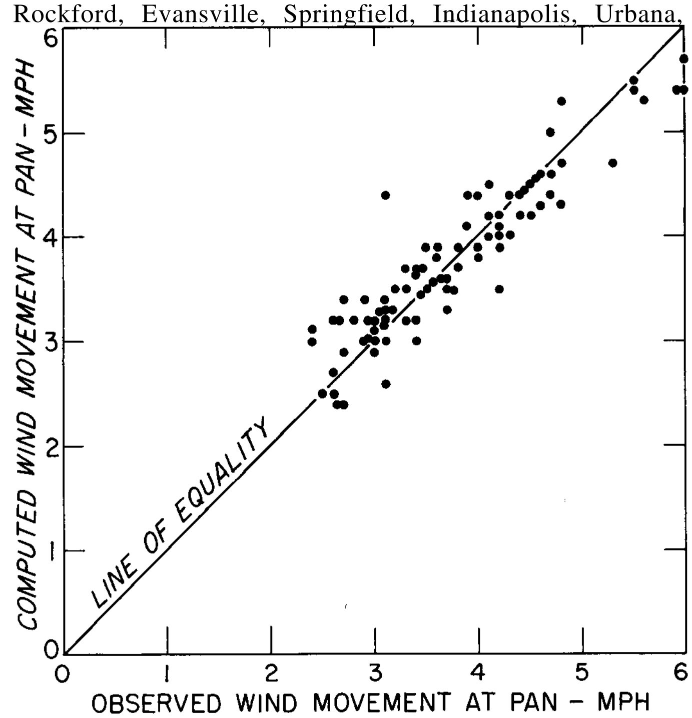


Figure 14. Wind movement, observed data at pan height versus that computed from weather station anemometer at Springfield for April-October for 13 years

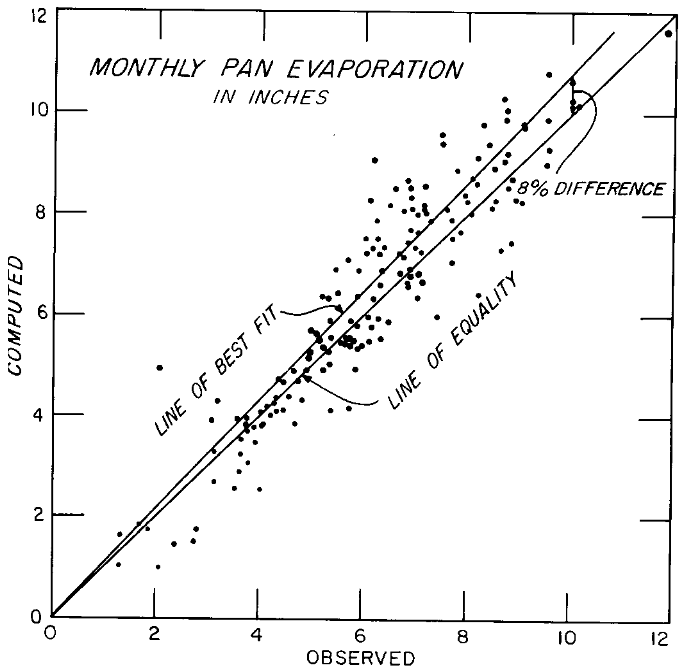


Figure 15. Observed and computed monthly pan evaporation at Springfield for 22-year period, April-October

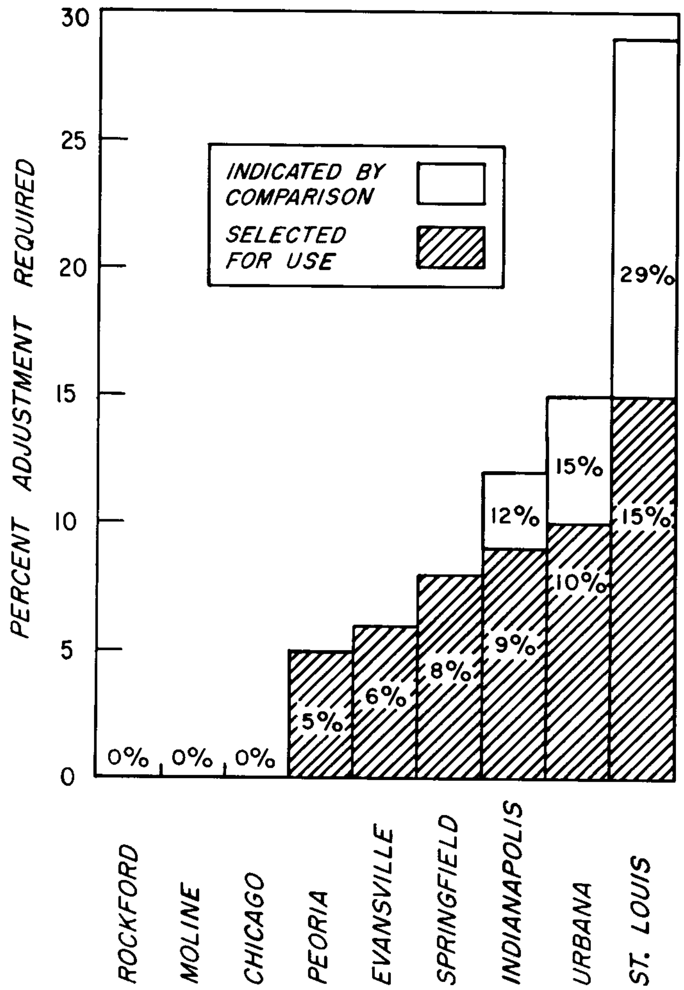


Figure 16. Adjustments required on computed evaporation to match observed evaporation

and St. Louis. The differences were adjusted on the basis of overall considerations of the accuracy and variability of both the pan observations and the observations of climatic data.

At Rockford the two sets of data were equal, but at the other five stations the evaporation computed by use of climatic data was greater than that observed in the class A pan. The Springfield example in figure 15, for the 22-year period 1941–1962, indicates that the computed values were 8 percent greater than the observed values at that station.

For the first adjustment, the five computed values were considered to be too high and were adjusted downward to coincide with the observed values. Figure 16 shows the magnitudes of these differences and the downward adjustments required on the computed evaporation to make it equal to the observed evaporation. The adjustments required were: Rockford, none; Evansville, 6 percent; Springfield, 8 percent; Indianapolis, 12 percent; Urbana, 15 percent; and St. Louis, 29 percent.

After these adjustments had been made, the evaporation for the 52-year period 1911–1962 for the May–October season was drawn as a map and compared with the pan evaporation map in figure 10. On the basis of the differences shown and the judgment of the authors, it was decided that the computed values were more reliable than the three high adjustments would indicate and that the observed values in these cases might be too low. Revised adjustments selected for these three stations were: Indianapolis, 9 percent; Urbana, 10 percent; and St. Louis, 15 percent.

Adjustments of computed pan evaporation for the other three stations, which lacked observed pan data for a direct check, were then selected on the basis of the first six and the relative geographic locations of the towns. These adjustments were: Moline, none; Chicago, none; and Peoria, 5 percent. All adjustments selected for use are shown in figure 16, and were made prior to the further processing and mapping of data.

Magnitude and Variability of Lake Evaporation

The general pattern of average annual lake evaporation in Illinois, based on computations for the standard 52-year period, is shown in figure 17. The arrangement of isoevaporation lines is significant in that it exhibits variations not compatible with latitude or geography. The most prominent feature is a ridge of high evaporation extending from Evansville (Indiana) northwestward to eastern Iowa. Both Peoria and Springfield have slightly higher annual values than St. Louis, but Evansville has a substantially higher value. Stations east and north of Peoria have lower values, although the amount is somewhat higher at Chicago than at Urbana or Rockford.

Figures 18, 19, and 20 show monthly maps of lake evaporation in Illinois. During the first four months of the year, the areal difference in evaporation is largely latitudinal, decreasing from south to north as shown in figure 18. By May, the ridge of high evaporation is noticeable (figure 19). It is most clearly defined on the June and July maps, but persists on the monthly maps through October, as shown in figure 20. In November and December the ridge disappears and the isolines again become roughly latitudinal.

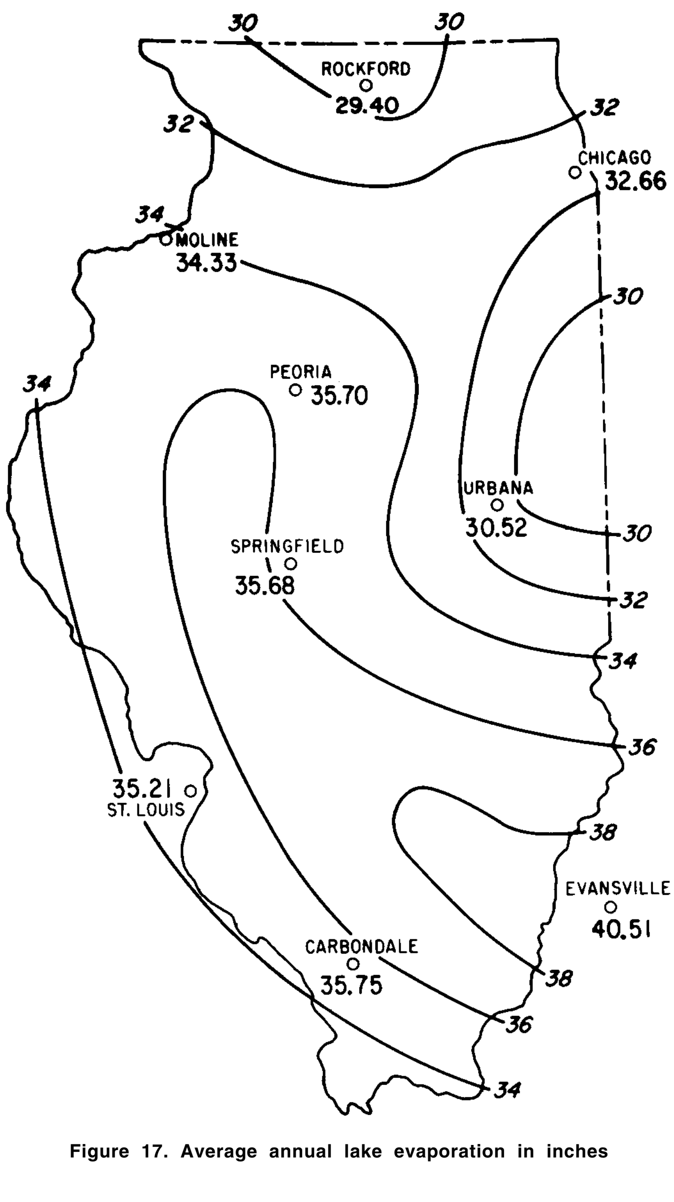


Figure 17. Average annual lake evaporation in inches

Figures 21, 22, and 23 show duration curves of monthly evaporation at Rockford, Springfield, and Carbondale. An explanation of the duration curves is shown by the April examples in table 2. The April lake evaporation at Rockford can be expected to exceed 1.8 inches over 98 percent of the time and to exceed 3.9 inches only 2 percent of the time. For 50 percent of the Aprils, more than 3.1 inches of lake evaporation can be expected at Springfield and 3.4 inches at Carbondale.

Table 2. April Lake Evaporation Expected at Various Frequencies

Station	April evaporation (*inches*) for given percent of time		
	98%	50%	2%
Rockford	1.8	2.9	3.9
Springfield	2.0	3.1	4.4
Carbondale	2.6	3.4	5.1

Variability of annual lake evaporation is tabulated in table 3. As one example, the annual lake evaporation at Rockford would be 22.1 inches during 98 percent of the years and 35.5 inches for 2 percent of the years. For 50 percent of the years, the evaporation at Chicago would be 32.7 inches while at Carbondale it would be 35.9 inches. Graphical representation of annual lake evaporation is presented in figure 24. Duration curves are shown for the 10 selected stations in and near Illinois.

Table 3. Variability of Annual Lake Evaporation

Station	Annual lake evaporation (*inches*) for given percent of years							
	98%	90%	70%	50%	30%	10%	2%	Mean
Rockford	22.1	25.0	28.5	29.7	30.8	32.9	35.5	29.4
Chicago	24.9	28.6	31.2	32.7	33.9	36.3	41.4	32.7
Moline	27.9	30.7	32.5	34.9	35.7	37.8	40.8	34.3
Peoria	27.2	30.2	33.4	35.8	36.9	42.4	45.6	35.7
Urbana	21.6	24.0	28.2	31.2	33.0	36.3	37.7	30.5
Indianapolis	24.5	26.9	28.5	30.0	31.9	33.4	35.1	30.1
Springfield	30.5	31.7	34.2	35.5	36.9	40.1	43.2	35.7
St. Louis	29.3	31.0	33.6	35.2	36.5	39.4	44.6	35.2
Carbondale	29.6	32.8	34.7	35.9	36.8	38.8	40.7	35.8
Evansville	34.6	37.7	39.5	40.3	41.4	43.5	47.7	40.5

Tabulations of computed monthly lake evaporation in inches at Rockford, Chicago, Moline, Peoria, Urbana, Indianapolis, Springfield, St. Louis, Carbondale, and Evansville are presented in tables 9—18 in the appendix.

Monthly lake evaporation was compared with monthly pan evaporation for these locations to obtain average

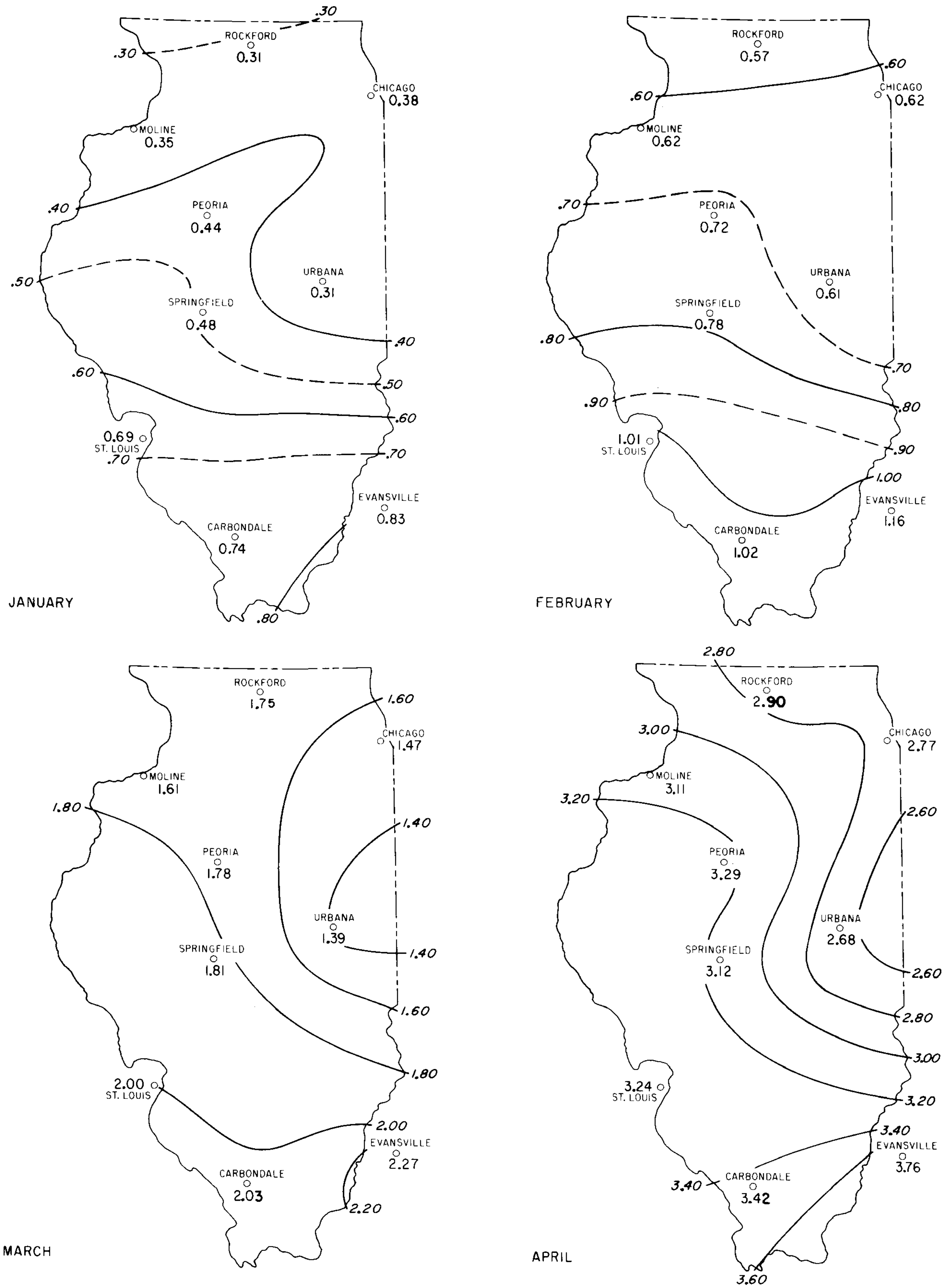


Figure 18. Average monthly lake evaporation in inches, January-April

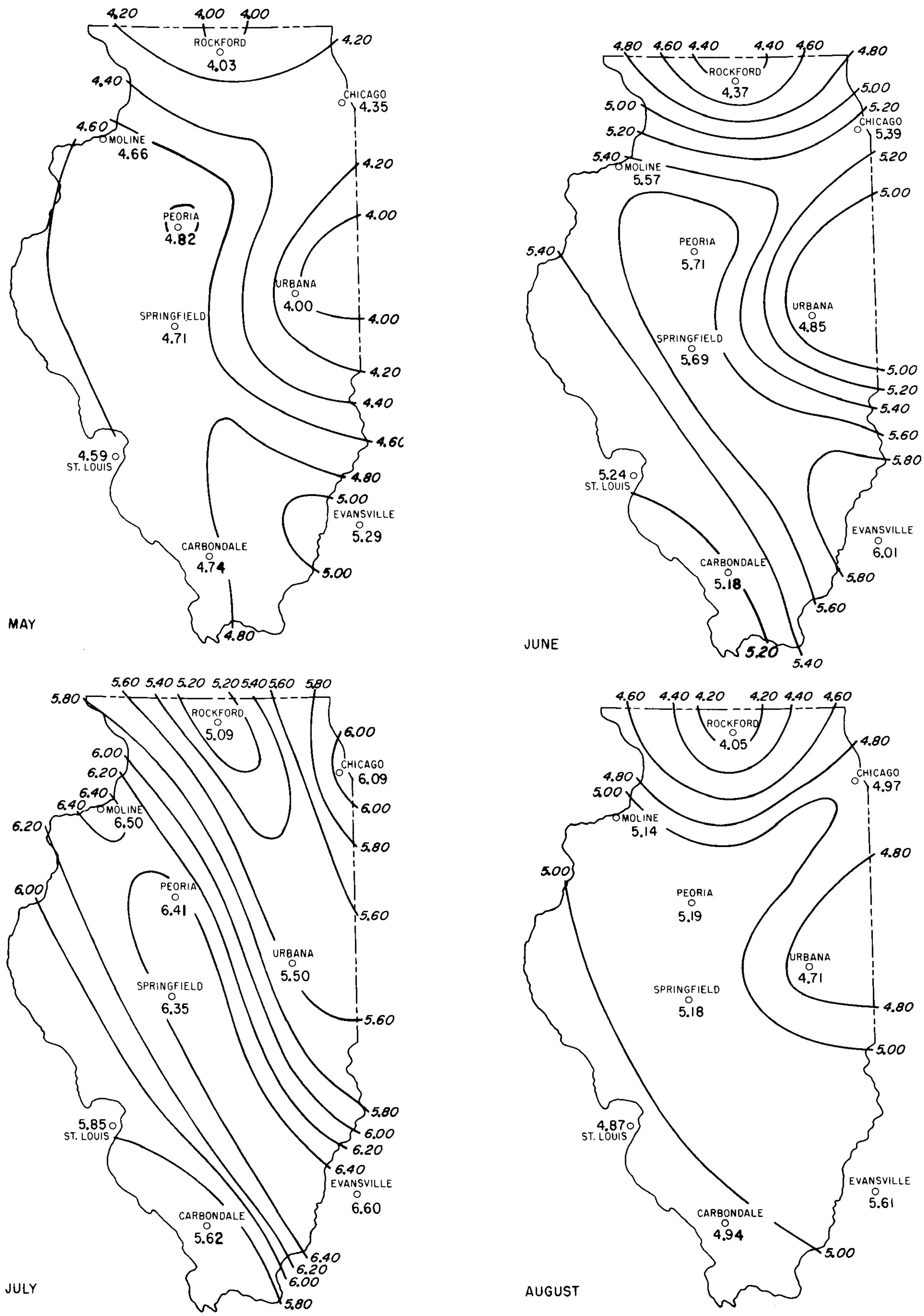


Figure 19. Average monthly lake evaporation in inches, May-August

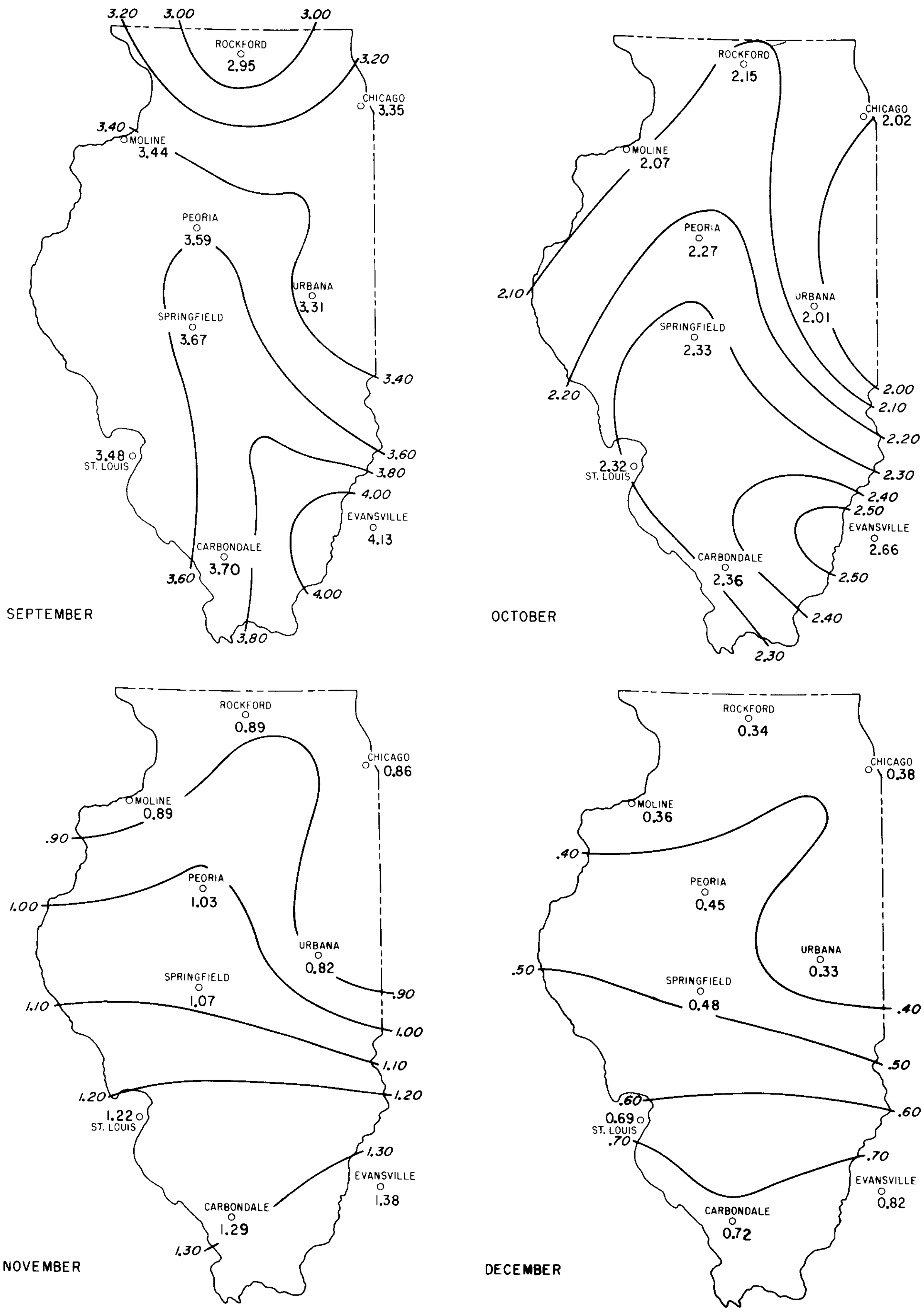


Figure 20. Average monthly lake evaporation in inches, September-December

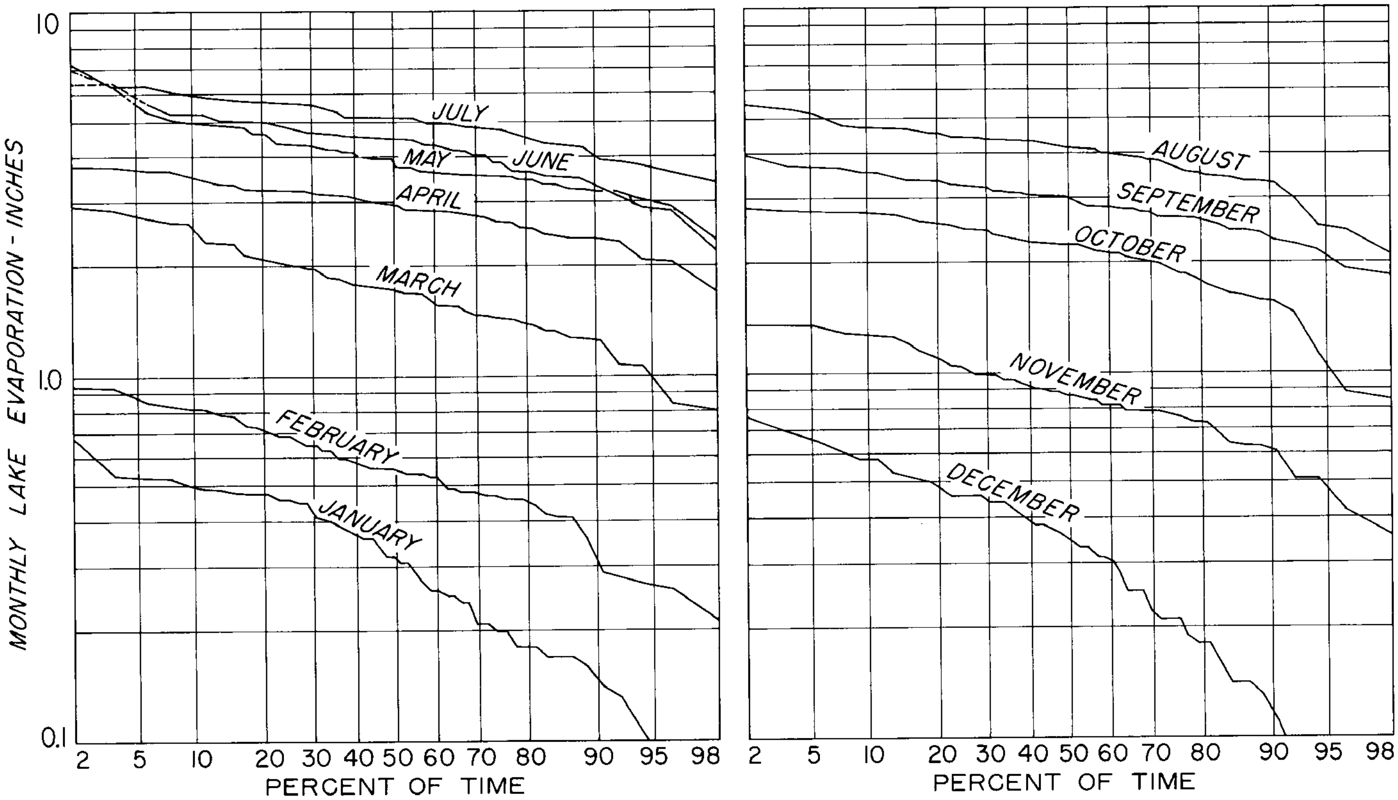


Figure 21. Duration curves of monthly evaporation at Rockford

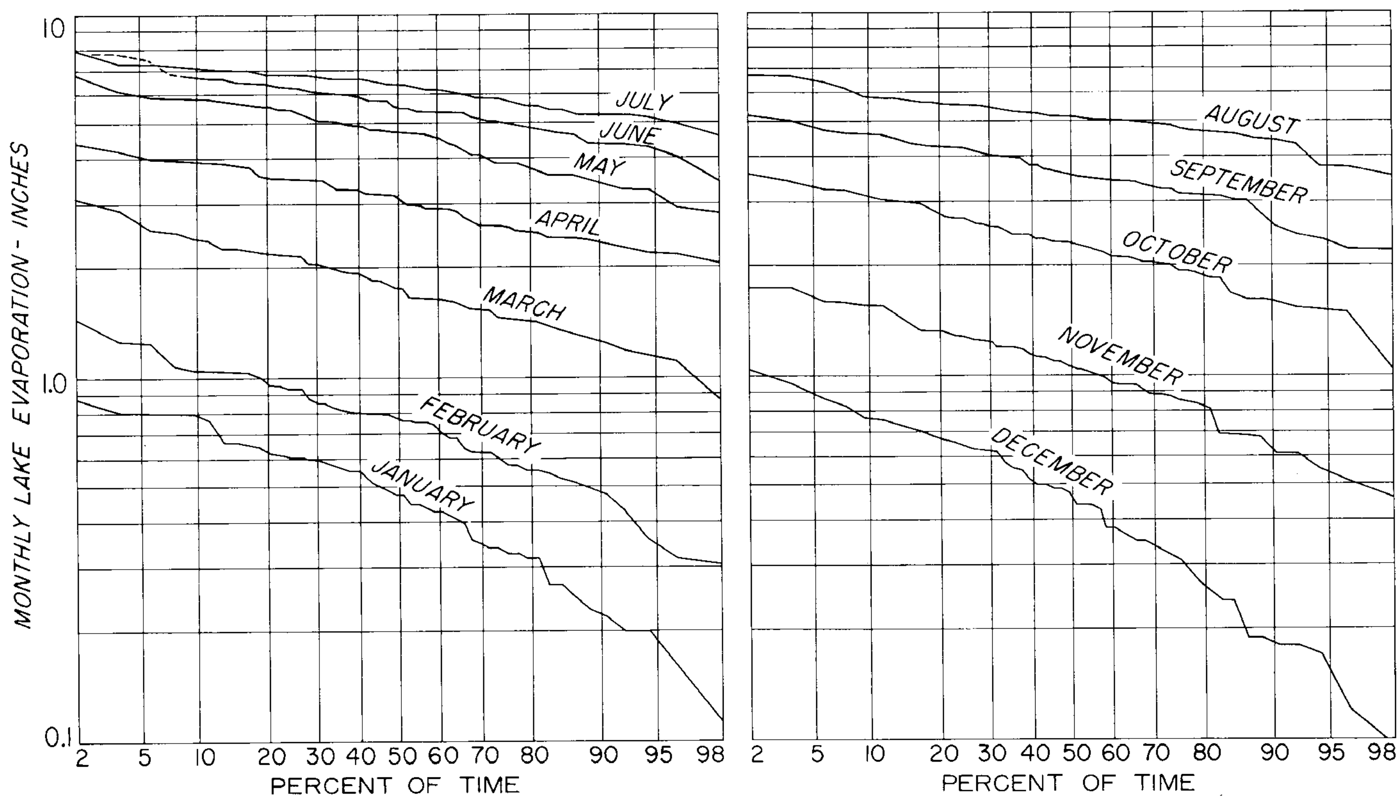


Figure 22. Duration curves of monthly evaporation at Springfield

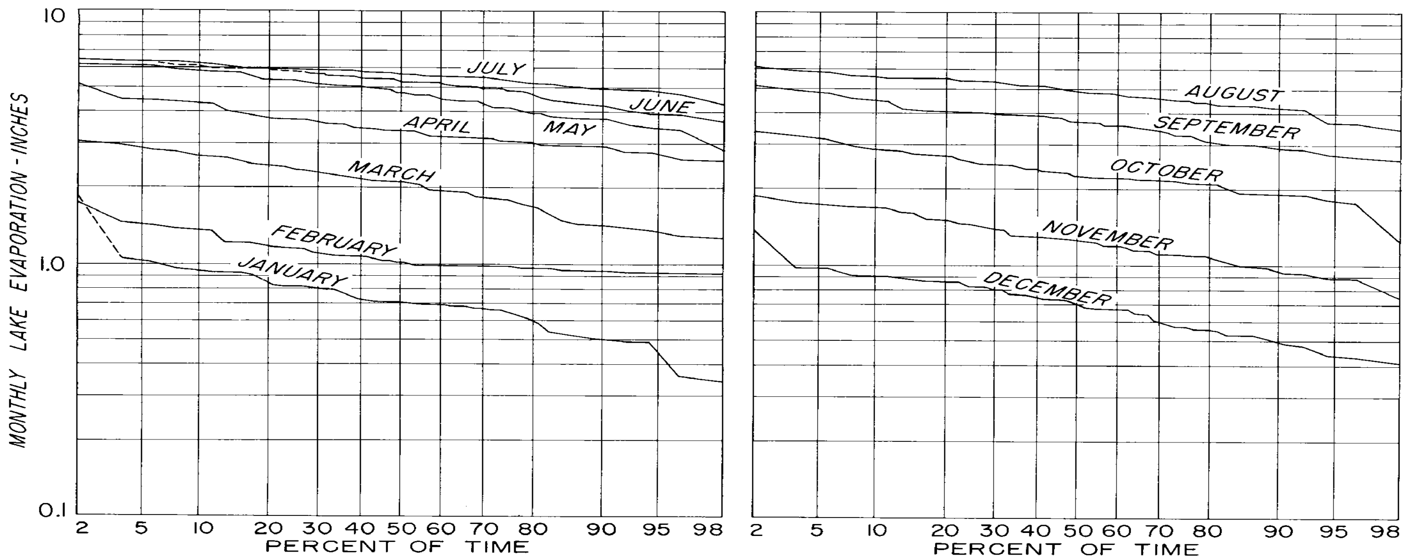


Figure 23. Duration curves of monthly evaporation at Carbondale

monthly pan-to-lake coefficients. In this study, pan-to-lake coefficients have not been used as an important procedure; however, for the information of the reader, the indicated monthly and annual pan-to-lake coefficients are given in table 4.

The data presented in this report are intended to show the general lake evaporation situation in Illinois. It is recognized that evaporation from a specific lake can vary from the general picture because of exposure, shape, depth, and other factors. Generally, the data are applicable to a wide range of Illinois water bodies. The monthly maps of lake evaporation together with the duration curves of evaporation could be useful in formulating and managing water conservation programs.

Table 4. Average Monthly and Annual Pan-to-Lake Coefficients

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Rockford	.56	.68	.83	.80	.81	.79	.79	.77	.74	.72	.62	.54	.77
Chicago	.61	.75	.80	.81	.81	.79	.78	.76	.73	.68	.61	.56	.77
Moline	.64	.75	.78	.77	.77	.76	.75	.75	.72	.70	.62	.56	.74
Peoria	.63	.72	.74	.74	.75	.75	.73	.72	.70	.65	.61	.58	.73
Urbana	.66	.78	.82	.81	.81	.81	.79	.79	.76	.71	.67	.60	.78
Indianapolis	.62	.72	.79	.81	.81	.80	.78	.78	.76	.71	.63	.58	.77
Springfield	.63	.73	.74	.75	.75	.74	.73	.73	.70	.66	.62	.60	.72
St. Louis	.62	.70	.74	.76	.77	.75	.74	.73	.70	.67	.62	.59	.72
Carbondale	.61	.68	.73	.74	.77	.76	.75	.74	.72	.67	.63	.59	.73
Evansville	.62	.69	.73	.75	.77	.75	.75	.74	.72	.68	.62	.61	.73
Average of all 10 stations	.62	.72	.77	.77	.78	.77	.76	.75	.73	.69	.63	.58	.75

Application to Net Reservoir Yield

Analytical methods available for determining the probable yield of a proposed impoundment invariably furnish information on the gross yield. The traditional Rippl mass curve analysis furnishes this type of information. Similar information is given by a new method described by Stall (1964), whose technique furnishes an array of results showing gross yield from the proposed reservoir for various recurrence intervals and the critical drawdown period in each case.

Evaporation loss is of major importance in the operation of a surface water impounding reservoir. The purpose of this section is to show a means by which the evaporative loss can be evaluated so that the gross yield of a reservoir can be reduced to the net yield. Separate consideration must be given to seepage losses (Harr, 1962).

The net evaporation loss from a lake was determined by Stall (1964) as being the difference between a'maximum expected gross lake evaporation minus the minimum expected precipitation on the lake surface for various recurrence intervals and for critical periods having various durations. This approach assumed maximum evaporation and minimum precipitation would occur

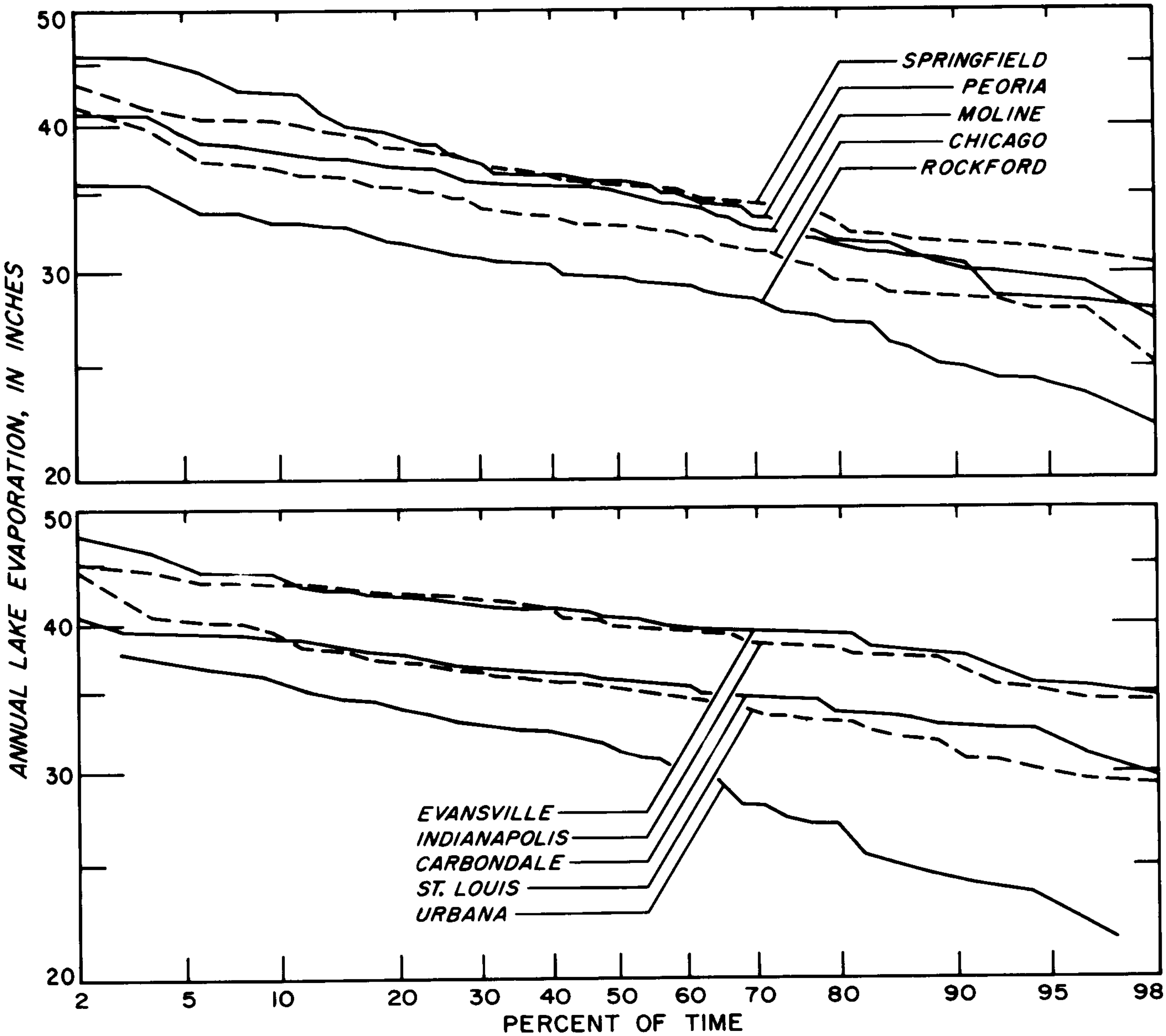


Figure 24. Duration curves of annual lake evaporation for 10 stations

simultaneously. More recent studies of lake evaporation and rainfall suggest that maximum evaporation and minimum rainfall for the same recurrence intervals seldom occur during the same calendar months, and often are 6 months out of phase.

The method described here results in slightly lower evaporation losses than reported by Stall (1964). The method is illustrated with Springfield data.

The monthly lake evaporation data computed for Springfield (appendix table 15) furnished a continuous record of lake evaporation in inches for 52 years, extending from January 1911 through December 1962. The monthly precipitation in inches for the same 52-year period is shown in table 5, as published in U. S. Weather Bureau *Climatological Data.* For every month of the 52-year period for which lake evaporation and precipitation were available, the precipitation was subtracted from the evaporation to obtain the net evaporation. Table 6 shows the values of net lake evaporation computed for Springfield.

This computation was made on the assumption that the lake evaporation in inches in a particular month is the positive amount as shown in table 15, while the actual inches of rainfall from table 5, which would fall directly on the lake surface during the same month, would 'counteract' evaporation in the amount of the rainfall. In this sense, the precipitation can be considered as negative evaporation. In table 6, no net evaporation is shown for many months; this means that the precipitation for these months was greater than the lake evaporation, so resulting net lake evaporation was zero.

A continuous monthly record of net lake evaporation

Table 5. Monthly Precipitation at Springfield in Inches, 1911 - 1962

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1911	2.34	1.73	1.86	4.40	1.18	3.44	4.87	3.37	10.68	2.00	3.10	1.86
1912	1.08	1.56	4.21	5.39	4.40	3.13	4.47	2.87	1.42	3.49	1.48	0.31
1913	3.55	1.35	5.55	3.55	0.96	1.84	1.66	2.88	3.41	3.61	4.49	0.77
1914	2.13	2.53	1.01	2.99	1.11	1.69	1.39	3.32	1.82	2.08	0.49	2.20
1915	2.11	2.28	0.80	2.04	9.86	3.22	5.72	6.21	3.31	0.73	1.60	2.91
1916	4.77	1.00	1.89	1.43	4.21	3.14	0.31	4.34	3.35	1.97	2.26	1.22
1917	1.69	0.47	5.17	3.77	3.93	10.77	3.86	2.35	1.61	0.81	0.25	0.75
1918	1.88	1.71	0.63	5.19	5.16	3.81	3.00	3.46	4.71	2.79	2.29	2.45
1919	0.09	2.15	2.26	1.26	3.87	5.46	1.25	1.85	2.74	5.63	3.10	0.30
1920	0.79	0.58	6.34	5.42	6.89	3.89	0.92	4.60	3.08	1.49	0.79	2.99
1921	1.68	0.71	5.09	4.75	1.17	5.41	1.67	5.18	4.33	1.61	3.25	2.71
1922	1.83	0.86	6.81	5.20	4.64	1.19	2.56	0.55	1.00	1.95	2.53	1.59
1923	1.06	0.79	5.23	1.72	3.46	2.74	1.31	5.35	5.66	4.53	1.44	3.40
1924	1.23	1.96	2.79	2.18	3.83	5.47	1.71	3.10	2.02	3.02	1.74	4.72
1925	0.42	1.65	2.94	2.59	1.10	3.74	3.51	4.42	4.45	2.23	2.33	1.32
1926	1.64	2.43	3.57	5.05	4.54	5.01	2.40	4.39	15.16	4.87	4.52	0.90
1927	1.75	1.03	6.59	5.45	7.01	3.50	3.17	3.37	7.46	2.16	4.96	2.68
1928	1.02	2.42	1.14	2.88	4.61	5.06	3.09	0.73	3.35	3.72	1.79	1.94
1929	2.58	0.65	2.96	3.56	6.32	3.41	4.66	2.08	1.65	3.33	1.17	1.31
1930	3.80	2.76	1.17	1.55	1.65	2.40	1.33	2.68	2.71	1.44	2.51	0.32
1931	0.27	1.57	2.79	1.88	4.87	3.94	2.78	3.58	3.15	3.51	5.07	2.80
1932	2.16	0.98	1.59	1.49	2.78	6.39	2.30	5.42	1.13	3.70	1.32	2.79
1933	2.85	1.19	6.50	2.57	8.69	3.29	0.42	2.34	5.05	2.38	0.28	0.91
1934	1.33	0.90	3.50	1.21	0.32	4.55	6.11	3.62	5.24	1.64	5.38	1.88
1935	2.10	1.57	2.90	3.39	7.91	5.69	5.43	1.23	3.22	2.13	4.59	1.06
1936	1.77	1.74	3.61	2.20	1.88	1.14	1.36	1.61	6.06	2.54	2.30	2.71
1937	4.95	1.67	0.69	3.64	2.42	4.72	6.70	0.94	2.16	2.81	1.62	2.31
1938	1.53	2.12	4.45	3.32	7.34	4.23	2.83	2.49	1.98	3.36	1.48	1.85
1939	2.89	3.21	4.56	5.37	1.62	3.90	1.07	5.75	0.14	1.99	1.46	1.09
1940	1.21	0.80	2.80	3.68	3.37	1.53	1.31	2.47	0.38	1.14	2.46	1.73
1941	2.67	0.58	1.34	5.37	3.03	2.25	2.23	2.05	6.97	13.39	3.37	1.47
1942	1.59	4.82	1.82	2.34	3.43	5.44	7.06	0.91	4.45	3.07	5.82	2.61
1943	1.01	0.72	2.37	3.44	10.60	2.78	3.03	0.10	2.45	2.76	1.28	1.82
1944	0.38	2.76	3.72	8.52	4.26	0.58	0.81	4.11	3.84	1.22	1.37	1.71
1945	1.06	1.32	4.77	4.62	4.20	7.34	1.00	3.36	8.38	1.95	3.18	2.22
1946	1.22	1.80	2.58	2.54	5.59	5.27	4.15	3.17	3.06	3.65	5.33	1.55
1947	1.93	0.36	2.54	5.18	5.11	6.86	1.26	1.85	5.03	2.64	1.03	2.69
1948	0.56	1.53	4.86	1.29	2.52	7.65	4.42	2.03	0.90	1.27	1.93	1.90
1949	5.67	2.65	2.01	1.95	2.52	3.10	3.43	4.21	2.21	4.60	0.43	4.74
1950	5.22	2.25	1.71	2.81	1.75	4.25	5.63	2.81	1.35	0.97	2.48	0.78
1951	1.77	4.43	3.86	5.09	2.49	8.80	1.66	1.96	2.76	2.89	2.25	1.55
1952	1.65	2.20	2.81	5.19	3.08	4.20	4.01	0.94	0.62	1.14	2.75	1.80
1953	1.30	1.34	5.08	1.85	1.33	3.30	3.88	0.65	1.92	1.18	0.78	1.37
1954	0.85	1.15	1.54	3.59	1.95	3.95	2.25	4.54	0.91	3.25	0.82	1.87
1955	2.32	2.76	1.43	3.37	5.11	2.50	4.01	3.06	2.60	6.15	0.69	0.15
1956	0.57	1.73	0.63	3.22	3.56	3.09	6.88	5.20	0.81	0.45	2.44	2.63
1957	1.59	1.76	2.00	8.86	4.61	5.65	4.60	3.07	1.31	2.85	2.25	3.42
1958	1.23	0.51	1.08	3.07	2.95	8.14	6.85	0.67	1.73	0.64	3.26	0.43
1959	1.83	2.04	2.91	2.23	3.15	0.23	3.64	5.39	6.47	5.41	1.25	1.33
1960	1.31	2.15	4.09	4.43	4.07	8.87	3.73	2.55	1.64	2.55	2.13	1.40
1961	0.35	1.79	3.47	3.95	4.22	2.43	6.38	3.07	6.35	2.10	2.60	1.28
1962	3.04	1.48	3.54	1.31	3.16	3.62	3.82	1.11	1.42	5.68	1.91	0.53

for the 52-year period at Springfield is thus provided by table 6. In order that these data may furnish the most meaningful information, a partial series of maximum net evaporation magnitudes was developed for a number of durations varying from 1 month to 60 months. For each of the maximum evaporation events in the partial series, a recurrence interval was assigned by the equation $R = n/m$, in which R is the recurrence interval in years, n the period of record in years, and m the rank of the event. This development of the series and assignment of recurrence intervals followed methodology for low flows in Illinois developed by Stall (1964).

This process furnished a number of maximum net evaporation magnitudes for various lengths of time based upon the basic data. The magnitudes of the net evaporation for various durations were associated with the recurrence intervals provided by the equation. These data were interpolated to provide values for the more convenient recurrence intervals shown in appendix table 25 for Springfield.

Maximum net evaporation data were obtained by the method just described for the 10 selected locations in and near Illinois and are given in tables 19-28 in the appendix. These data are in a form most helpful for

Table 6. Net Lake Evaporation at Springfield in Inches, 1911-1962

(Lake evaporation minus precipitation)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1911			.32		5.01	2.97	1.55	1.37				
1912					.69	2.27	1.07	1.76	2.02			.56
1913					3.75	4.85	5.14	2.99				
1914			.38		4.58	4.61	5.40	1.76	1.42		.98	
1915			.54	2.41		1.93				1.97		
1916				1.18	.18	2.06	6.89	.73	.09			
1917		.28			.07		2.70	2.34	1.99	.85	.77	
1918			2.27		.23	2.10	3.25	1.65				
1919	.72			1.67	.65	6.06	3.73	1.55				
1920		.22				2.44	5.74		.89	.95	.10	
1921		.09			4.33	.78	5.24			.97		
1922		.20			.31	5.68	3.58	5.03	3.29	.67		
1923				1.53	1.32	3.12	5.36					
1924				1.38			3.60	2.07	1.09	.01		
1925				1.40	4.01	2.30	2.40	.74				
1926					.70	.45	4.06	.17				
1927						1.63	3.10	.95		.41		
1928			.82	.02	.99		3.26	4.55	.16			
1929						1.44	1.26	2.93	1.54			
1930			.85	2.02	3.49	3.44	5.79	3.14	1.02	.50		.18
1931	.40			1.66		2.19	4.10	1.38	.91			
1932		.06		1.71	3.00		4.43	.13	2.90			
1933				.37		4.55	6.97	3.09			1.03	
1934				2.88	6.51	2.89	.99	1.10		1.41		
1935							1.45	4.56	.76	.06		
1936				.84	4.07	5.52	6.72	5.10				
1937			1.16		2.40	.71		4.63	2.12			
1938				.25		1.40	3.86	3.13	2.19	.25	.09	
1939					4.11	1.04	4.59		5.11	1.01		
1940					.36	4.04	5.75	2.16	4.27	2.01		
1941		.07	.41		2.81	3.23	4.44	3.26				
1942				1.58	.41			4.18				
1943		.52				1.99	2.94	5.39	1.12			
1944	.21					5.51	6.25	1.06		1.48		
1945							5.19	2.20		.49		
1946			.53	1.33		.72	2.16	.60	1.26			
1947		.46					5.55	4.84				
1948				2.63	2.47		.89	3.46	2.64	.85		
1949				1.35	3.10	3.04	2.59	.88	1.21		1.13	
1950					3.06	1.23		.95	1.45	1.90		
1951					2.30		4.20	3.04	.40			
1952					1.09	2.56	2.46	4.26	3.90	2.10		
1953				1.34	3.13	4.61	2.93	5.52	3.15	2.08	.95	
1954		.32	.52	.39	3.23	2.52	5.14	.38	3.84		.24	
1955			.76	.86		2.92	2.59	3.38	2.06		.58	.59
1956			1.94	.28	2.34	3.37			3.79	2.98		
1957			.06				1.67	2.75	2.38			
1958		.57	.35	.49	2.55			4.97	2.08	2.34		.28
1959				1.31	1.57	6.31	2.49					
1960							2.02	2.78	2.60			
1961	.54				.55	3.14		1.72		.24		
1962				2.32	2.78	2.25	1.45	4.19	2.08			.23

further use in determining the net yield of a reservoir, as will be illustrated by an example.

To illustrate the computation of net reservoir yield, calculations are shown for a theoretically proposed reservoir on Hamilton Creek near Mt. Sterling, in central Illinois. This reservoir is described physically in table 7 as reported by Dawes and Terstriep (1966). Since Mt. Sterling is only 60 miles west of Springfield, it is reasonable to assume that the Springfield evaporation data apply. The evaporation computations are carried out for a recurrence interval of 40 years (see figure 25).

The first three columns in table 7 show gross yield results obtained from a low-flow analysis by the Stall (1964) method. For a 40-year recurrence interval, the gross draft rate which this reservoir will yield is 1.8 million gallons per day (mgd) and the critical drawdown period is 16 months or 486 days. The fourth column in table 7 shows the net evaporation loss from the proposed reservoir in inches, which are values read directly from appendix table 25. For the 40-year recurrence interval, the 16-month net evaporation loss will be 31 inches or 2.58 feet.

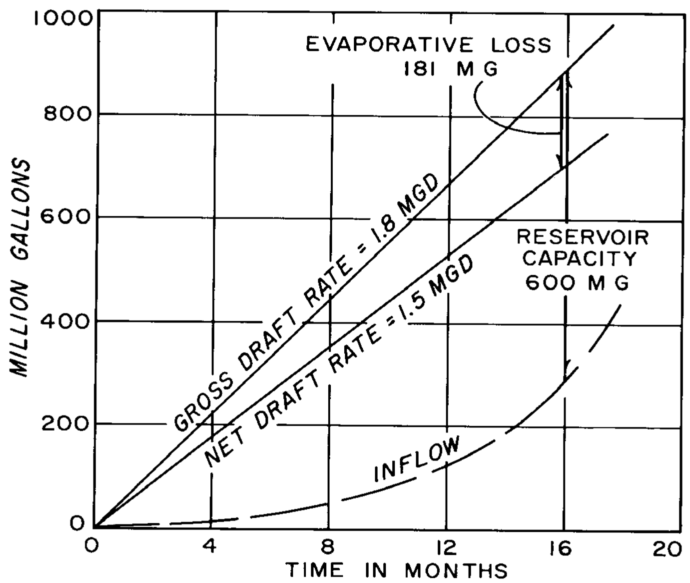


Figure 25. Computations of evaporative loss and net draft rate for proposed reservoir on Hamilton Creek

The reservoir would be full at the beginning of a critical drawdown period, in this case 16 months, and empty at the end of it; however, during this period the lake level would fluctuate, and the surface area exposed to evaporation would vary from 333 acres to zero. Hudson and Roberts (1955) recommend that the effective evaporative surface for the critical drawdown period be 65 percent of the lake surface area when full, and this relation was used here.

The net yield or net draft rate for the 40-year recurrence interval is computed as shown in table 8. Similar calculations using the appropriate recurrence intervals result in the corresponding gnet draft rates shown in table 7. In each case the net draft rates are less than the gross draft rates in column 2 of the table. The differences are considered to be a rational evaluation of the probable evaporative loss.

Figure 26 shows a graph of gross reservoir yield versus the net reservoir yield for the proposed reservoir on Hamilton Creek near Mt. Sterling.

Thus, both the annual evaporation data and the maximum net evaporation data for certain recurrences and durations are directly applicable to reservoir design. Although these data have been presented for selected locations, their distribution is such as to represent adequately any area in the state.

Table 7. Analysis of Evaporation Loss for Proposed Reservoir on Hamilton Creek near Mt. Sterling

Physical Data

Reservoir capacity = 2.03 equivalent inches on drainage area
= 1700 acre-feet
= 600 million gallons

Reservoir surface area = 333 acres

Drainage area = 15.7 square miles

(Located about 60 miles west of Springfield so that the Springfield evaporation data are assumed to apply)

Data available from gross yield analysis				
Drouth recurrence interval	Gross draft rate *(mgd)*	Duration of critical drawdown period *(months)*	Net evaporation loss, from table 25 *(inches)*	Net draft rate *(mgd)*
(mean)	5.6	—	—	—
2	4.5	7	9	4.3
5	3.4	9	13	3.2
10	2.5	12	15	2.3
20	2.0	18	27	1.7
30	1.9	16	27	1.6
40	1.8	16	31	1.5

Table 8. Computation of Net Reservoir Yield for Proposed Reservoir on Hamilton Creek near Mt. Sterling

(All computations apply to the 16-month critical drawdown period shown in figure 25)

The total gross draft is

1.83 *mgd* × 486 *days* = 889 *million gallons* (*m g*)

The inflow to the reservoir is total gross draft minus total reservoir capacity, or

889 *mg* — 600 *mg* = 289 *m g*

The effective evaporative surface area of the lake is

333 *acres* × 0.65 = 216 *acres*

The evaporative loss is

2.58 *feet* × 216 *acres* = 557 *acre-feet,* or 181 *m g*

The net usable reservoir capacity is the total reservoir capacity minus the evaporative loss, or

600 *mg* — 181 *mg* = 419 *mg*

The total net draft which the reservoir can furnish is the net usable reservoir capacity plus the inflow, or

419 *mg* + 289 *m g* = 708 *m g*

The net draft rate, or the net yield, which the reservoir can furnish is the total net draft divided by total days in the critical period, or

708 *m g* ÷ 486 *days* = 1.5 *mgd*

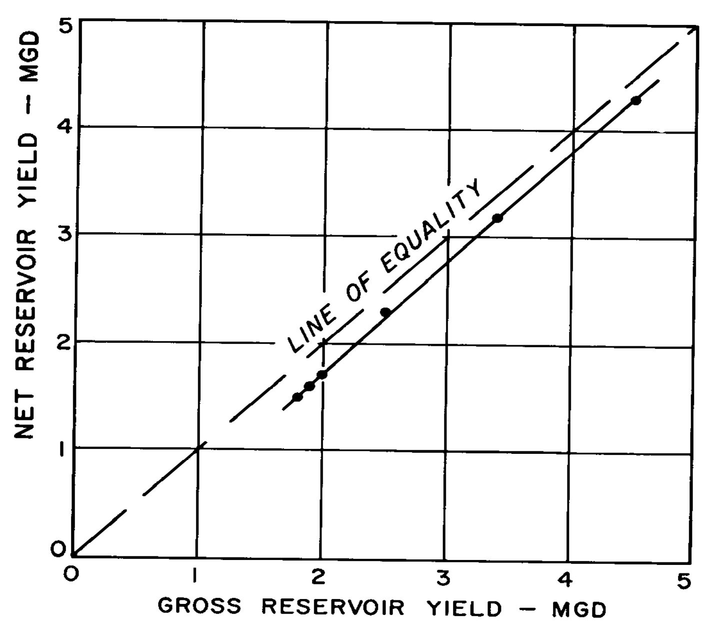


Figure 26. Reservoir gross yield versus net yield for proposed reservoir on Hamilton Creek

REFERENCES

Daniels, Farrington. 1954. Outlines of physical chemistry. Ninth printing, John Wiley and Sons, New York.

Davis, Kenneth S., and John Arthur Day. 1961. Water the mirror of science. Anchor Books, Doubleday and Co., Garden City, N. Y.

Dawes, Julius H., and Michael L. Terstriep. 1966. Potential surface water reservoirs of north-central Illinois. Illinois State Water Survey Report of Investigation 56.

Hamon, R. W., L. L. Weiss, and W. T. Wilson. 1954. Insolation as an empirical function of daily sunshine duration. Monthly Weather Review v. 82(6).

Harbeck, G. E., Jr., M. A. Kohler, G. E. Koberg, and others. 1958. Water loss investigations: Lake Mead studies. U. S. Geological Survey Professional Paper 298.

Harr, Milton E. 1962. Ground water and seepage. McGraw-Hill Book Co., New York.

Hudson, H. E., Jr., and W. J. Roberts. 1955. 1952–55 Illinois drought with special reference to impounding reservoir design. Illinois State Water Survey Bulletin 43.

Illinois State Water Survey. 1960. Lake evaporation in Illinois. Technical Letter 5.

Kohler, M. A., T. J. Nordenson, and D. R. Baker. 1959. Evaporation maps for the United States. U. S. Weather Bureau Technical Paper 37. (The four separate Pan and Lake Evaporation Maps are available for 10 cents from the Superintendent of Documents, Washington, D. C.)

Kohler, M. A., T. J. Nordenson, and W. E. Fox. 1955. Evaporation from pans and lakes. U. S. Weather Bureau Research Paper 38.

Lamoreux, Wallace M. 1962. Modern evaporation formulae adapted to computer use. Monthly Weather Review, January.

Leopold, Luna B. 1966. The water resource. International Science and Technology No. 55: 24–34.

Linsley, R. K., M. A. Kohler, and J. L. H. Paulhus. 1949. Applied hydrology. McGraw-Hill Book Co., New York.

Nordenson, Tor J. 1962. Evaporation rates. *In* Evaporation from the 17 Western States, by J. Stuart Meyers. U. S. Geological Survey Professional Paper 272-D.

Roberts, W. J. 1953. Evaporation records in Illinois. Illinois State Water Survey Circular 43.

Stall, John B. 1964. Low flows of Illinois streams for impounding reservoir design. Illinois State Water Survey Bulletin 51.

U. S. Geological Survey. 1954. Water loss investigations: Lake Hefner studies, technical report. Professional Paper 269.

APPENDIX

Table 9. Monthly Lake Evaporation in Inches at Rockford

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1911	.08	.53	2.33	2.65	4.96	5.24	5.63	3.99	2.18	.89	.35	.21	29.04
1912	.03	.21	.84	2.07	4.14	4.54	4.96	3.52	2.66	2.60	.99	.46	27.02
1913	.21	.47	1.31	3.22	3.64	4.90	5.81	3.90	2.82	1.44	.64	.13	28.49
1914	.21	.27	1.39	2.88	4.62	4.48	5.50	4.72	2.85	1.57	1.14	.05	29.68
1915	.07	.36	1.26	3.77	3.26	3.88	3.82	3.36	2.42	2.08	.78	.08	25.14
1916	.24	.42	1.56	2.98	3.75	4.17	6.26	4.72	3.05	2.32	.93	.35	30.75
1917	.26	.41	1.91	2.46	3.51	3.53	5.14	4.37	2.85	1.63	.84	.14	27.05
1918	.13	.59	2.71	2.72	4.28	4.20	4.83	4.22	2.64	1.99	.75	.28	29.34
1919	.36	.54	1.75	2.41	3.26	4.31	5.97	4.14	3.22	1.69	.82	.04	28.51
1920	.18	.46	2.02	2.08	3.99	5.06	5.15	4.33	3.26	2.35	.61	.25	29.74
1921	.48	.59	1.78	3.17	4.39	4.74	5.72	3.44	3.16	2.49	.51	.38	30.85
1922	.54	.79	1.45	2.53	3.69	5.02	4.67	4.39	3.35	2.74	.78	.44	30.39
1923	.25	.49	1.47	2.94	3.73	4.47	5.14	3.54	2.53	2.11	.90	.44	28.01
1924	.17	.29	.61	2.78	3.19	3.10	4.27	3.82	2.75	2.77	.96	.22	24.93
1925	.20	.46	1.73	2.82	3.99	4.36	4.77	4.42	2.66	.84	.73	.11	27.09
1926	.29	.49	1.08	2.77	4.31	4.31	4.32	3.33	1.81	1.11	.42	.18	24.42
1927	.16	.72	1.25	1.69	2.31	3.50	4.76	3.80	3.06	2.22	.63	.25	24.35
1928	.36	.58	2.16	2.86	4.82	3.52	4.80	4.20	3.11	2.11	.78	.36	29.66
1929	.07	.26	1.96	3.10	3.69	5.01	4.98	4.41	3.05	2.15	.82	.25	29.75
1930	.14	.84	2.66	3.44	4.20	4.59	5.60	4.14	3.70	2.00	1.28	.31	32.90
1931	.48	.95	1.55	3.17	3.64	5.27	6.26	4.70	3.36	2.14	.96	.42	32.90
1932	.45	.86	2.92	1.27	4.63	4.57	5.62	3.71	3.44	1.81	.89	.41	30.58
1933	.70	.82	1.56	2.86	3.33	6.34	5.56	4.26	3.53	2.22	1.09	.33	32.60
1934	.48	.78	1.86	3.54	6.33	6.32	5.55	4.16	2.45	2.74	1.04	.14	35.39
1935	.26	.48	1.83	2.80	3.01	3.62	5.74	4.77	3.11	2.28	.51	.21	28.62
1936	.17	.28	2.32	3.06	5.10	5.29	7.35	5.49	2.94	2.03	.95	.53	35.51
1937	.24	.56	1.68	2.38	4.01	4.66	5.88	4.69	3.68	1.86	1.10	.16	30.90
1938	.18	.56	2.63	3.36	3.57	4.52	5.17	4.41	3.05	2.84	1.34	.46	32.09
1939	.32	.73	2.35	2.86	5.00	4.55	5.14	3.89	4.00	2.70	1.27	.77	33.58
1940	.17	.44	1.46	3.00	3.74	5.02	6.08	3.43	3.55	2.66	.78	.21	30.54
1941	.20	.47	1.76	2.97	4.89	4.16	5.14	4.39	3.36	1.71	.86	.38	30.29
1942	.27	.41	1.72	3.76	3.55	3.87	4.98	3.92	2.80	2.48	.89	.06	28.71
1943	.10	.63	1.68	3.18	3.12	3.65	5.17	3.60	2.81	2.38	.77	.51	27.60
1944	.53	.48	1.07	2.36	3.55	4.27	5.14	4.31	2.74	2.51	.63	.18	27.77
1945	.18	.48	2.86	3.22	3.32	3.69	5.14	4.33	2.66	2.25	.87	.19	29.19
1946	.39	.82	2.11	3.65	3.47	4.64	5.31	3.90	3.35	2.48	1.03	.58	31.73
1947	.45	.53	1.49	2.34	3.44	3.49	5.18	5.30	3.63	2.59	.68	.33	29.45
1948	.38	.56	1.69	3.64	3.60	4.01	4.81	4.53	3.20	2.23	.74	.46	29.85
1949	.25	.65	1.78	3.23	4.17	4.54	5.03	4.00	2.66	2.30	1.27	.58	30.46
1950	.53	.56	1.41	2.38	4.03	4.58	4.31	3.42	2.60	2.71	.87	.34	27.74
1951	.32	.46	1.37	2.55	3.59	2.84	3.16	2.43	2.30	1.87	.73	.44	22.06
1952	.48	.65	1.32	3.24	2.90	3.39	3.61	2.09	1.90	2.66	1.34	.30	23.68
1953	.31	.74	1.54	2.74	3.56	4.81	4.45	3.30	3.17	2.55	1.20	.50	28.87
1954	.49	.94	1.64	3.22	3.60	4.62	3.78	2.52	2.26	1.61	.85	.39	25.90
1955	.40	.57	2.01	3.37	4.30	2.90	4.87	4.31	2.90	2.23	.99	.52	29.37
1956	.46	.55	2.09	3.22	4.21	2.16	3.90	2.99	2.46	2.79	.99	.31	26.13
1957	.37	.69	2.06	2.62	4.27	4.52	5.72	4.54	2.86	1.94	.82	.65	31.06
1958	.31	.54	1.70	3.00	7.09	4.08	4.23	4.64	3.07	2.20	1.33	.48	32.67
1959	.41	.67	1.88	3.12	5.35	5.07	5.44	4.11	2.86	1.54	.78	.46	31.69
1960	.46	.54	.81	3.14	3.96	4.70	4.94	4.09	3.08	2.27	1.23	.60	29.82
1961	.50	.69	1.97	2.83	4.92	5.63	5.72	4.44	3.28	2.26	.91	.37	33.52
1962	.49	.63	1.42	3.26	4.34	4.66	4.46	5.12	3.27	2.01	1.00	.69	31.35
AVERAGE	.31	.57	1.75	2.90	4.03	4.37	5.09	4.05	2.95	2.15	.89	.34	29.40

Table 10. Monthly Lake Evaporation in Inches at Chicago

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1911	.22	.48	1.57	2.24	5.68	6.06	6.33	4.96	2.48	1.18	.46	.35	32.01
1912	.12	.38	.99	2.92	4.48	5.62	4.91	3.52	3.09	1.96	.96	.52	29.47
1913	.33	.67	1.36	3.13	4.04	6.18	5.95	4.50	2.80	1.29	.69	.37	31.31
1914	.29	.51	1.34	2.42	5.08	5.53	6.15	4.89	3.60	1.74	1.14	.21	32.90
1915	.20	.50	1.25	3.78	2.60	4.13	3.81	3.13	2.48	1.91	.89	.24	24.92
1916	.37	.54	1.14	2.32	3.85	4.50	7.35	6.04	3.30	2.02	1.01	.36	32.80
1917	.41	.51	1.57	2.22	3.73	4.21	5.40	4.68	3.10	1.06	.79	.24	27.92
1918	.19	.54	2.18	2.10	4.74	5.41	5.57	4.63	2.52	1.60	.87	.38	30.73
1919	.54	.59	1.55	1.95	3.84	5.38	7.03	5.87	3.49	1.54	.78	.13	32.69
1920	.17	.46	1.77	2.03	4.72	5.75	6.04	4.74	3.70	2.32	.87	.33	32.70
1921	.56	.50	1.36	3.24	4.87	5.44	7.50	4.93	3.50	1.92	.47	.28	34.57
1922	.49	.67	1.28	2.51	4.49	6.26	5.96	5.20	3.54	2.25	.61	.38	33.64
1923	.40	.48	1.24	2.67	4.24	5.67	6.02	4.16	2.61	1.49	.72	.48	30.18
1924	.41	.45	.71	2.66	3.92	4.78	5.88	4.11	2.68	2.59	.97	.26	29.42
1925	.30	.63	1.93	3.09	4.44	5.75	5.51	5.16	2.87	.92	.72	.30	31.62
1926	.33	.39	.94	2.47	4.83	5.37	5.66	3.97	1.81	1.40	.53	.29	27.99
1927	.26	.86	1.44	2.38	2.93	5.11	5.71	3.91	3.18	2.07	.60	.34	28.79
1928	.42	.60	1.61	2.44	4.77	3.86	5.12	4.57	3.44	1.79	.64	.30	29.56
1929	.21	.42	1.61	2.55	3.65	4.17	5.56	4.47	3.06	1.59	.73	.11	28.73
1930	.22	.77	1.55	2.85	4.62	5.63	6.40	4.73	3.10	1.66	.88	.31	33.32
1931	.44	.76	.85	3.19	3.71	5.27	6.43	5.47	3.43	1.96	.90	.45	32.86
1932	.29	.82	1.09	2.99	4.26	5.08	6.17	4.89	3.40	1.27	.65	.32	31.23
1933	.61	.81	1.08	2.06	2.95	6.69	6.70	5.37	3.14	1.97	.72	.34	32.44
1934	.53	.59	1.30	2.87	6.59	5.88	6.24	5.29	2.31	2.23	.85	.18	34.86
1935	.33	.36	1.65	2.18	2.99	4.15	5.90	4.72	3.58	1.95	.47	.23	28.51
1936	.19	.36	1.83	2.35	5.49	5.28	7.05	5.18	3.05	1.13	.86	.50	33.87
1937	.26	.65	1.27	2.03	4.50	4.79	6.57	5.55	3.66	1.59	.99	.19	32.05
1938	.26	.43	1.89	3.08	3.75	4.97	5.46	5.43	2.78	2.63	1.25	.37	32.30
1939	.25	.65	1.80	2.39	3.57	5.22	6.06	5.41	4.18	2.32	1.01	.59	33.45
1940	.18	.39	.96	2.49	2.87	5.04	6.47	3.48	3.52	2.11	.76	.23	28.50
1941	.22	.51	1.12	2.80	5.13	4.78	6.17	5.29	3.71	1.60	.81	.32	32.46
1942	.43	.41	1.27	4.00	3.83	3.64	5.67	4.31	2.63	1.88	.69	.04	28.80
1943	.24	.89	1.57	3.31	3.44	6.14	6.26	4.91	3.19	2.24	.76	.58	33.53
1944	.49	.57	.91	2.25	4.08	5.82	7.00	5.30	3.48	2.34	.66	.18	33.08
1945	.11	.52	2.40	2.96	3.36	4.36	5.88	5.13	2.58	2.22	.73	.19	30.44
1946	.31	.57	1.83	3.80	3.70	5.02	6.70	5.38	4.10	2.45	.93	.47	35.26
1947	.40	.46	1.24	1.91	3.32	4.58	6.33	6.13	3.65	2.48	.60	.26	31.36
1948	.38	.77	1.43	3.30	4.29	4.85	6.29	5.91	4.00	2.22	.92	.62	34.98
1949	.57	.68	1.81	3.77	5.16	6.18	5.66	5.45	3.56	2.53	1.09	.60	37.06
1950	.63	.68	1.31	1.97	5.67	6.35	6.49	5.28	3.18	2.71	.91	.33	35.51
1951	.48	.60	1.59	2.17	4.99	4.68	5.67	4.05	3.43	2.09	.85	.49	31.09
1952	.52	.90	1.45	3.48	3.30	5.95	6.44	4.72	3.98	2.67	1.40	.46	35.27
1953	.45	1.00	1.52	2.24	4.51	6.83	6.65	6.28	4.82	3.06	1.49	.78	39.63
1954	.62	1.26	1.77	2.96	4.73	6.42	6.48	4.63	4.43	1.91	1.11	.58	36.90
1955	.67	.75	2.18	4.21	5.53	5.76	7.41	6.48	4.48	2.36	.95	.58	41.36
1956	.62	.76	1.65	2.90	4.55	6.89	5.49	5.11	4.20	3.09	1.03	.42	36.71
1957	.40	.84	1.83	2.43	3.81	5.85	6.57	5.18	3.40	1.78	.97	.76	33.82
1958	.54	.72	1.51	3.50	6.44	4.66	4.92	5.67	3.58	2.92	1.23	.47	36.16
1959	.42	.71	1.75	2.95	4.82	6.09	5.72	4.99	3.76	1.78	.94	.65	34.58
1960	.50	.59	1.25	3.90	4.29	4.74	5.62	4.43	3.26	2.24	1.19	.67	32.68
1961	.59	.73	1.56	2.27	4.78	6.85	6.25	5.57	3.72	2.38	.98	.44	36.12
1962	.30	.42	1.23	3.52	6.24	6.26	5.88	5.32	3.31	2.03	.95	.52	35.98
AVERAGE	.38	.62	1.47	2.77	4.35	5.39	6.09	4.97	3.35	2.02	.86	.38	32.66

Table 11. Monthly Lake Evaporation in Inches at Moline

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1911	.08	.63	2.28	2.86	6.27	6.64	7.08	5.22	2.38	.98	.38	.26	35.06
1912	.01	.26	.95	2.55	5.20	5.96	6.47	4.69	2.98	2.64	1.09	.57	33.37
1913	.29	.61	1.49	3.80	4.80	6.45	7.58	4.99	3.25	1.50	.71	.18	35.65
1914	.24	.38	1.45	3.18	5.95	5.82	7.15	6.00	3.47	1.71	1.21	.03	36.59
1915	.08	.45	1.43	4.64	3.85	5.24	4.99	4.40	2.79	2.09	.79	.07	30.82
1916	.27	.54	1.54	3.26	4.75	5.51	7.92	5.81	3.46	2.24	1.00	.38	36.68
1917	.32	.48	1.74	2.44	4.16	4.28	6.62	5.41	3.11	1.45	.83	.11	30.95
1918	.14	.72	2.59	2.78	5.49	5.43	6.21	5.27	2.76	1.78	.80	.30	34.27
1919	.47	.60	1.66	2.35	3.66	5.46	7.62	5.17	3.72	1.64	.85	.02	33.22
1920	.22	.51	1.92	1.99	4.81	6.62	6.85	5.43	3.81	2.24	.63	.27	35.30
1921	.55	.65	1.67	3.52	5.54	6.12	7.50	4.73	3.72	2.44	.51	.41	37.36
1922	.65	.89	1.33	2.44	4.38	6.56	5.77	5.46	4.03	2.74	.81	.46	35.52
1923	.27	.56	1.45	3.05	4.37	5.65	6.42	4.25	2.53	2.04	.91	.49	31.99
1924	.19	.37	.59	2.97	3.45	3.68	5.34	4.92	3.00	2.94	.99	.21	28.65
1925	.22	.50	1.83	3.02	5.07	5.43	6.04	5.64	2.77	.84	.77	.09	32.22
1926	.31	.53	1.08	3.04	5.12	5.39	5.07	3.94	1.83	1.03	.40	.17	27.91
1927	.18	.80	1.21	1.79	2.39	4.96	5.85	4.72	3.55	2.16	.59	.26	28.46
1928	.44	.67	2.09	3.16	6.00	4.33	6.33	5.52	3.69	2.00	.80	.41	35.44
1929	.07	.36	1.93	3.55	4.75	6.16	6.37	5.67	3.51	2.00	.84	.27	35.48
1930	.17	.87	2.34	3.86	4.96	5.76	7.03	4.74	4.35	1.82	1.29	.33	37.52
1931	.55	.98	1.37	3.46	4.35	6.65	7.74	5.64	3.89	1.95	.93	.45	37.96
1932	.45	.86	1.19	2.96	5.54	5.66	7.18	4.51	4.15	1.61	.90	.46	35.47
1933	.75	.91	1.35	2.86	3.59	7.87	6.98	5.05	3.98	2.04	1.06	.32	36.76
1934	.53	.83	1.74	4.04	7.56	7.76	6.73	5.10	2.52	2.80	1.05	.12	40.78
1935	.29	.50	1.68	2.63	3.08	4.37	7.29	5.89	3.48	2.05	.50	.19	31.95
1936	.18	.30	2.07	3.32	6.13	6.50	8.68	6.76	3.22	1.92	.97	.59	40.64
1937	.26	.61	1.58	2.22	4.93	5.94	7.36	5.70	4.32	1.63	1.14	.16	35.85
1938	.21	.56	2.32	3.72	4.19	5.72	6.53	5.38	3.31	2.92	1.33	.48	36.67
1939	.35	.76	2.27	2.94	6.10	5.72	6.46	4.71	4.75	2.59	1.23	.81	38.69
1940	.18	.46	1.26	3.13	4.27	6.13	7.51	3.93	4.24	2.55	.80	.22	34.68
1941	.21	.57	1.77	3.25	6.18	5.11	6.53	5.11	3.88	1.61	.88	.38	35.48
1942	.33	.43	1.40	4.31	4.07	4.71	6.30	4.87	2.89	2.31	.86	.05	32.53
1943	.11	.78	1.64	3.48	3.39	4.44	6.65	4.29	2.84	2.17	.76	.56	31.11
1944	.61	.54	.99	2.27	4.11	5.24	6.47	5.43	2.75	2.47	.56	.16	31.60
1945	.19	.52	2.69	3.42	3.66	4.44	6.67	5.34	2.76	2.07	.85	.20	32.81
1946	.45	.87	1.95	4.28	4.04	5.83	6.94	4.90	4.15	2.31	.98	.62	37.32
1947	.52	.53	1.34	2.20	4.01	4.24	6.81	6.73	4.18	2.48	.63	.35	34.02
1948	.43	.59	1.67	4.14	4.42	4.83	6.12	5.75	3.85	2.12	.71	.51	35.14
1949	.26	.68	1.58	3.76	5.05	5.82	6.63	5.32	2.95	2.19	1.21	.62	36.07
1950	.54	.60	1.20	2.27	4.80	5.78	5.58	3.92	2.62	2.57	.84	.34	31.06
1951	.34	.47	1.26	2.39	4.92	3.56	5.40	4.27	3.03	1.75	.76	.45	28.60
1952	.49	.66	1.23	3.54	4.04	6.53	6.53	4.67	3.87	2.42	1.31	.30	35.59
1953	.30	.76	1.37	2.09	4.16	6.10	6.51	5.75	4.32	2.58	1.22	.52	35.68
1954	.52	.94	1.52	2.91	4.11	5.89	6.06	4.14	3.47	1.57	.84	.40	32.37
1955	.43	.63	1.87	3.99	5.01	4.44	7.40	6.32	4.46	2.06	1.03	.58	38.22
1956	.51	.61	1.90	3.40	4.97	6.47	5.67	5.30	4.01	2.91	.95	.30	37.00
1957	.39	.71	1.88	2.44	3.58	4.93	5.70	4.49	3.03	1.86	.79	.69	30.49
1958	.34	.66	1.52	3.18	5.46	4.64	4.87	5.37	3.43	2.78	1.30	.52	34.07
1959	.45	.72	1.72	3.29	4.50	5.87	5.97	5.25	3.44	1.41	.79	.46	33.87
1960	.53	.53	.85	3.30	3.32	4.25	6.40	4.95	3.56	1.94	1.22	.69	31.54
1961	.57	.71	1.68	2.42	4.93	6.54	5.77	5.25	3.46	2.15	.91	.39	34.78
1962	.54	.59	1.35	3.63	5.07	6.11	4.59	5.19	3.37	1.83	.96	.73	33.96
AVERAGE	.35	.62	1.61	3.11	4.66	5.57	6.50	5.14	3.44	2.07	.89	.36	34.33

Table 12. Monthly Lake Evaporation in Inches at Peoria

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1911	.14	.60	2.07	2.34	6.30	6.50	6.99	5.07	2.55	1.13	.55	.23	34.41
1912	.23	.34	.91	3.40	4.90	5.62	5.59	3.99	2.64	1.75	1.06	.61	31.04
1913	.16	.44	1.11	3.02	3.97	5.85	6.58	4.85	2.63	1.05	.73	.17	30.56
1914	.06	.32	1.23	3.18	5.74	5.92	6.53	4.75	2.74	1.58	1.20	.04	33.29
1915	.04	.49	1.22	4.23	3.55	4.45	4.23	3.16	2.63	2.09	.99	.15	27.23
1916	.07	.31	1.37	3.00	3.57	5.14	7.48	5.42	2.88	1.86	.99	.35	32.44
1917	.54	.71	2.32	2.68	4.35	5.45	6.74	5.36	3.39	1.35	.85	.23	33.97
1918	.11	.72	2.85	2.53	5.39	5.79	5.96	4.85	2.75	1.90	.84	.42	34.11
1919	.49	.53	1.73	2.51	3.63	5.77	7.35	5.58	3.91	1.66	.90	.06	34.12
1920	.20	.65	2.17	2.04	4.45	5.85	6.30	4.65	3.69	2.36	.68	.33	33.37
1921	.50	.65	1.97	3.48	5.44	5.71	7.15	4.59	3.33	2.34	.43	.24	35.83
1922	.35	.84	1.18	2.82	4.63	6.51	6.41	5.62	4.10	2.40	.67	.38	35.91
1923	.40	.44	1.41	2.82	4.41	5.40	6.84	4.72	2.20	1.89	.84	.44	31.81
1924	.28	.39	.58	3.45	3.46	4.44	5.61	4.68	2.84	2.78	1.06	.18	29.75
1925	.30	1.11	2.35	4.16	5.38	6.00	6.28	5.36	3.17	.91	.85	.30	36.18
1926	.34	.60	1.15	2.77	5.72	5.89	6.47	4.39	2.05	1.56	.58	.23	31.75
1927	.30	.99	1.82	2.54	3.48	5.63	6.16	5.00	3.33	2.32	.70	.32	32.59
1928	.44	.78	2.27	3.56	6.02	4.62	6.45	5.42	3.47	1.98	.73	.38	36.12
1929	.17	.49	2.24	3.04	4.04	5.54	5.85	4.48	3.16	1.82	.78	.12	31.73
1930	.17	1.06	2.27	4.08	5.06	6.21	7.39	5.56	4.24	2.06	.90	.36	39.36
1931	.58	.81	1.18	3.59	4.11	6.20	6.87	5.38	3.98	2.12	1.09	.48	36.39
1932	.46	1.08	1.38	3.30	5.65	5.96	6.63	5.07	3.93	1.99	.99	.47	36.91
1933	.91	.94	1.53	3.03	3.42	7.56	7.32	5.19	3.80	2.10	1.29	.45	37.54
1934	.57	.87	1.64	3.97	6.96	7.14	6.75	5.01	2.50	2.79	1.14	.16	39.50
1935	.36	.49	1.57	2.45	2.55	4.25	6.73	5.29	3.55	2.00	.53	.23	30.00
1936	.24	.42	2.27	3.37	5.96	6.63	8.35	6.59	3.31	1.87	1.07	.57	40.65
1937	.23	.68	1.50	2.30	5.20	5.55	7.01	5.94	4.27	1.96	1.06	.09	35.79
1938	.36	.51	2.18	3.86	3.71	5.28	6.14	5.55	3.53	3.09	1.30	.44	35.95
1939	.35	.58	2.15	2.63	6.15	5.50	5.80	5.03	4.80	2.69	1.06	.67	37.41
1940	.16	.44	1.54	3.04	3.74	5.96	7.02	4.01	4.13	2.76	.94	.24	33.98
1941	.25	.69	1.59	3.10	5.87	5.40	6.69	5.54	3.43	1.42	.93	.44	35.35
1942	.43	.38	1.45	3.95	4.37	4.44	5.90	5.18	2.89	1.95	.66	.06	31.66
1943	.13	.88	1.47	2.99	2.92	4.61	5.97	4.10	3.25	2.32	.87	.52	30.03
1944	.73	.61	1.07	2.12	4.23	6.31	6.48	4.30	3.40	2.55	.50	.18	32.48
1945	.16	.43	2.27	3.05	3.13	3.30	5.59	5.24	2.76	2.38	.88	.28	29.47
1946	.53	.99	2.27	3.86	3.27	5.15	6.40	3.87	4.33	2.66	1.05	.59	34.97
1947	.58	.84	1.74	2.61	4.17	4.19	6.86	6.57	4.28	2.57	.65	.38	35.44
1948	.48	.71	1.53	4.19	4.98	5.22	5.44	5.76	4.05	2.41	.88	.74	36.39
1949	.69	.79	2.51	4.25	5.98	6.05	6.37	6.19	4.04	2.75	1.94	1.01	42.57
1950	.81	.85	1.75	3.13	5.89	6.72	6.59	4.76	3.25	3.28	1.21	.60	38.84
1951	.70	.76	1.76	3.10	6.13	4.41	6.06	4.94	3.60	2.48	1.14	.76	35.84
1952	.76	1.01	1.78	4.16	4.76	7.17	6.79	5.17	4.67	3.40	2.03	.69	42.39
1953	.53	1.33	2.02	3.35	7.49	7.31	5.10	6.60	5.42	3.55	1.81	1.02	45.59
1954	.84	1.18	2.16	4.30	5.29	6.90	7.39	4.95	4.88	2.51	1.33	.65	42.38
1955	.66	.93	2.39	4.86	5.69	5.88	7.77	7.22	4.70	2.90	1.49	.93	45.42
1956	.80	.64	2.83	4.01	6.10	6.83	5.60	6.06	5.02	3.97	1.50	.61	44.03
1957	.50	1.02	2.31	2.78	4.48	5.86	6.73	5.85	3.99	2.53	1.31	1.01	38.43
1958	.70	.98	1.79	3.76	6.28	5.18	4.55	5.44	3.89	3.52	1.65	.70	38.44
1959	.83	.95	2.22	3.71	5.09	6.52	6.85	5.43	4.35	1.92	1.06	.79	39.72
1960	.73	.73	1.19	3.88	3.51	4.77	6.19	5.40	3.73	2.53	1.50	.80	34.96
1961	.90	.91	1.93	3.00	4.90	6.30	5.68	5.20	3.60	2.27	1.15	.44	36.28
1962	.60	.61	1.23	3.86	5.21	6.02	5.09	5.81	3.69	2.08	1.26	.64	36.10
AVERAGE	.44	.72	1.78	3.29	4.82	5.71	6.41	5.19	3.59	2.27	1.03	.45	35.70

Table 13. Monthly Lake Evaporation in Inches at Urbana

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1930	.12	.59	1.71	3.28	4.45	5.13	4.94	4.10	3.15	1.37	.64	.14	29.62
1931	.17	.44	.85	2.96	3.10	3.72	5.56	5.21	3.47	1.69	.87	.17	28.21
1932	.34	.71	.99	3.17	4.69	5.27	5.98	4.57	3.15	1.66	.31	.10	30.94
1933	.47	.74	1.16	2.43	3.06	6.78	6.45	4.85	3.55	1.95	.95	.15	32.54
1934	.37	.23	1.42	3.12	5.88	6.58	6.24	4.79	1.88	2.39	.89	.08	33.87
1935	.38	.41	1.35	1.79	2.05	3.73	5.38	4.79	3.32	1.62	.19	.56	25.57
1936	.13	.24	1.52	2.16	4.50	6.27	6.98	5.57	3.01	1.64	.89	.20	33.11
1937	.13	.60	1.01	1.74	3.85	4.33	4.65	4.59	3.81	1.59	.66	.09	27.05
1938	.19	.32	1.63	3.18	3.44	4.81	5.05	4.28	3.34	2.71	.87	.15	29.97
1939	.20	.60	1.62	2.23	5.23	4.50	5.03	4.61	4.32	2.24	.92	.30	31.80
1940	.09	.31	1.23	2.16	3.30	5.56	6.46	4.52	3.75	2.54	.68	.24	30.84
1941	.15	.25	.95	2.92	4.08	4.44	5.18	5.43	2.95	1.11	.60	.15	28.21
1942	.25	.16	1.16	3.16	2.80	2.52	3.99	3.37	1.92	1.58	.53	.18	21.62
1943	.13	.95	1.46	2.54	1.97	3.81	5.13	3.57	2.21	1.93	.65	.27	24.62
1944	.53	.38	.82	1.89	2.61	5.36	6.04	4.25	2.43	2.20	.85	.05	27.41
1945	.09	.35	1.60	2.43	3.91	2.32	5.14	4.58	1.79	2.00	.67	.15	25.03
1946	.21	.48	1.31	1.86	2.55	3.21	5.33	3.06	3.12	1.62	.78	.47	24.00
1947	.30	.60	1.25	1.95	4.10	3.93	5.86	5.59	3.53	1.98	.35	.15	29.59
1948	.14	.46	.93	3.18	4.82	5.16	5.19	5.45	3.45	2.02	.71	.69	32.20
1949	.45	.98	1.99	3.27	4.93	5.52	5.61	4.90	3.26	1.96	1.17	.53	34.57
1950	.41	.45	1.08	1.90	4.15	4.76	5.01	3.62	2.34	2.32	.95	.12	27.11
1951	.34	.39	1.18	1.30	3.96	3.44	4.91	3.95	2.17	1.39	.35	.34	23.72
1952	.42	.90	1.43	2.91	3.25	5.85	5.72	4.28	3.94	2.59	1.15	.25	32.69
1953	.30	1.06	1.40	2.71	3.81	6.17	5.90	5.54	4.64	2.83	1.21	.68	36.25
1954	.57	1.21	1.75	3.55	4.74	5.76	6.54	4.35	4.47	1.82	1.25	.77	36.78
1955	.16	1.01	1.78	4.25	4.45	4.54	5.80	5.72	4.05	2.05	.79	.55	35.15
1956	.67	.82	2.32	3.02	5.54	6.43	5.19	4.98	4.19	3.05	1.12	.38	37.71
1957	.31	.74	1.76	2.15	4.18	4.75	6.00	5.52	3.47	2.15	1.05	.63	32.71
1958	.48	.94	1.21	3.20	5.05	4.53	4.33	5.55	3.55	2.90	1.33	.53	33.60
1959	.50	.76	1.91	3.07	4.38	5.97	5.92	5.02	3.89	1.69	.85	.51	34.47
1960	.48	.61	1.02	3.25	3.26	4.14	5.65	4.95	3.92	2.22	1.18	.52	31.20
1961	.66	.72	1.56	2.35	4.31	5.12	5.11	5.04	3.79	1.93	.88	.49	31.96
1962	.11	.67	1.49	3.41	5.52	5.69	5.14	4.89	3.24	1.74	.73	.33	32.96
AVERAGE	.31	.61	1.39	2.68	4.00	4.85	5.50	4.71	3.31	2.01	.82	.33	30.52

Table 14. Monthly Lake Evaporation in Inches at Indianapolis

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1911	.37	.63	1.67	2.43	5.72	6.10	6.18	4.77	3.13	2.15	.67	.46	34.28
1912	.30	.57	1.07	2.91	4.69	4.98	4.04	3.64	3.66	2.01	1.04	.63	29.54
1913	.39	.65	1.52	2.79	4.31	5.87	5.71	4.90	2.63	1.61	.82	.41	31.61
1914	.39	.49	1.30	2.39	5.17	5.24	5.81	4.29	3.30	1.52	1.17	.17	31.24
1915	.36	.78	1.28	3.62	3.50	4.95	4.80	2.80	2.91	2.12	1.05	.30	28.47
1916	.44	.51	1.41	2.34	4.01	4.06	6.55	4.93	3.51	2.09	1.21	.41	31.47
1917	.46	.52	1.55	2.20	3.48	5.05	5.54	4.21	3.32	1.25	.85	.28	28.71
1918	.21	.75	2.20	2.21	5.24	5.54	5.50	4.50	2.61	3.14	.78	.39	33.07
1919	.64	.61	1.76	2.53	3.22	5.40	6.52	4.83	3.67	1.63	.74	.30	31.85
1920	.25	.50	1.80	1.83	4.23	5.28	5.45	4.01	3.36	2.52	.73	.34	30.30
1921	.50	.60	1.61	2.95	5.09	5.31	6.58	4.36	2.63	1.93	.65	.39	32.60
1922	.47	.68	1.23	2.66	4.43	5.08	5.81	5.36	4.15	2.32	.90	.42	33.51
1923	.44	.24	1.54	2.75	3.89	5.23	5.58	4.21	2.63	1.83	.86	.48	29.68
1924	.38	.49	.74	2.96	3.38	4.60	5.47	4.66	2.61	2.66	.94	.29	29.18
1925	.45	.85	1.97	3.32	4.65	5.50	5.50	4.88	3.46	.85	.76	.36	32.55
1926	.40	.58	.97	2.19	4.93	4.70	5.43	3.82	2.24	1.54	.64	.28	27.72
1927	.32	.80	1.51	2.22	3.22	4.67	5.52	3.95	3.81	2.44	.76	.43	29.65
1928	.46	.61	1.48	2.68	4.55	3.13	5.56	5.05	3.65	2.06	.77	.51	30.51
1929	.43	.58	1.94	3.13	3.75	5.61	5.72	4.93	3.14	1.70	.73	.33	31.99
1930	.26	1.06	1.64	3.16	4.66	5.47	6.44	4.30	3.22	1.98	.83	.37	33.39
1931	.52	.86	.87	3.17	3.68	5.19	6.54	4.50	3.48	1.76	.89	.48	31.94
1932	.55	.90	1.06	2.79	4.73	5.55	6.06	4.86	3.22	1.70	.68	.40	32.50
1933	.68	.83	1.26	2.56	3.60	6.93	5.94	4.89	3.17	1.83	.72	.44	32.85
1934	.51	.54	1.49	3.17	5.56	5.95	5.98	3.94	2.55	2.44	.97	.31	33.41
1935	.53	.58	1.71	2.16	2.94	4.15	5.29	4.03	3.56	1.72	.50	.24	27.41
1936	.29	.39	1.96	2.42	5.39	6.06	6.57	5.85	3.18	1.71	.78	.51	35.11
1937	.29	.59	1.40	2.20	4.23	4.69	5.81	5.21	3.43	1.49	.74	.21	30.29
1938	.39	.53	1.67	3.26	3.85	5.06	5.57	4.98	3.28	2.45	.98	.39	32.41
1939	.38	.68	1.84	2.71	5.32	4.93	5.36	4.91	4.07	2.15	.74	.39	33.48
1940	.12	.38	1.08	1.99	3.03	5.17	6.24	4.65	3.50	2.35	.53	.22	29.26
1941	.26	.43	1.35	3.26	4.97	4.72	6.02	5.09	3.60	1.41	.78	.33	32.22
1942	.43	.41	1.06	3.33	3.49	4.24	5.37	3.95	2.82	1.76	.71	.13	27.70
1943	.26	.81	1.41	2.35	3.05	5.29	5.34	4.48	2.48	1.76	.71	.49	28.43
1944	.59	.61	1.27	2.40	4.29	5.83	6.24	4.75	3.12	2.06	.56	.18	31.90
1945	.27	.60	2.15	2.58	3.33	3.90	5.45	4.75	2.59	1.81	.70	.20	28.33
1946	.43	.72	1.95	3.04	3.69	5.21	6.04	4.15	3.42	2.24	.87	.55	32.31
1947	.42	.54	1.28	2.43	3.90	4.33	5.19	5.26	3.39	2.37	.61	.44	30.16
1948	.28	.61	1.28	2.59	4.02	5.29	5.04	5.00	2.97	1.49	.69	.45	29.71
1949	.36	.72	1.36	2.63	4.49	4.90	4.84	4.16	2.95	1.97	.93	.68	29.99
1950	.43	.36	1.15	2.01	3.99	4.56	4.87	3.95	2.37	1.95	.55	.28	26.47
1951	.37	.22	1.12	1.96	4.80	3.69	4.43	3.86	2.35	1.66	.50	.28	25.24
1952	.30	.60	1.14	2.30	3.19	5.19	5.34	3.94	3.28	1.88	.77	.29	28.22
1953	.30	.82	1.23	1.73	3.44	5.31	5.30	4.50	3.53	2.09	.96	.55	29.76
1954	.40	.88	1.36	2.87	3.64	5.17	5.90	3.73	3.13	1.21	.58	.30	29.17
1955	.35	.57	1.57	2.68	3.81	3.66	4.67	4.51	3.09	1.60	.70	.44	27.65
1956	.40	.56	1.67	2.15	4.09	4.85	4.10	4.10	3.25	2.13	.83	.39	28.52
1957	.25	.52	1.39	1.90	3.75	4.45	5.18	5.48	2.49	1.58	.78	.51	28.28
1958	.39	.72	.72	2.26	3.70	3.55	3.48	4.12	2.46	2.06	.77	.38	24.61
1959	.39	.64	1.33	2.44	3.37	4.92	4.96	4.00	3.07	1.44	.65	.34	27.55
1960	.48	.46	1.19	2.82	2.79	4.00	4.58	3.93	2.69	1.57	.81	.35	25.67
1961	.45	.62	1.08	1.71	3.42	4.28	4.01	3.47	3.02	1.62	.52	.27	24.47
1962	.30	.47	.96	2.66	4.20	4.95	4.39	3.98	2.56	2.60	1.55	.96	29.58
AVERAGE	.39	.61	1.41	2.57	4.07	4.96	5.46	4.45	3.11	1.91	.79	.38	30.11

Table 15. Monthly Lake Evaporation in Inches at Springfield

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1911	.33	.78	2.18	2.51	6.19	6.41	6.42	4.74	2.23	1.49	.68	.32	34.28
1912	.23	.52	1.01	3.30	5.09	5.40	5.54	4.63	3.44	2.37	1.32	.87	33.72
1913	.32	.56	1.53	3.21	4.71	6.69	6.80	5.87	3.31	1.53	.88	.27	35.68
1914	.40	.43	1039	2.70	5.69	6.30	6.79	5.08	3.24	1.84	1.47	.09	35.42
1915	.16	.69	1.34	4.45	3.97	5.15	5.09	3.54	3.06	2.70	1.33	.34	31.82
1916	.36	.50	1.62	2.61	4.39	5.20	7.20	5.07	3.44	1.94	1.24	.48	34.05
1917	.62	.75	2.39	2.95	4.00	5.48	6.56	4.69	3.60	1.66	1.02	.36	34.08
1918	.25	.86	2.90	2.08	5.39	5.91	6.25	5.11	3.06	1.91	.99	.44	35.15
1919	.81	.77	1.86	2.93	3.63	6.11	7.31	5.58	4.29	1.66	.95	.24	36.14
1920	.35	.80	2.28	2.30	4.60	6.33	6.66	4.49	3.97	2.44	.89	.38	35.49
1921	.60	.80	2.25	3.34	5.50	6.19	6.91	4.44	3.23	2.58	.69	.38	36.91
1922	.63	1.06	1.48	3.00	4.95	6.87	6.14	5.58	4.29	2.62	.92	.49	38.03
1923	.52	.53	1.66	3.25	4.78	5.86	6.67	4.90	2.37	2.01	.95	.43	33.98
1924	.32	.53	.86	3.56	3.42	4.42	5.31	5.17	3.11	3.03	1.08	.24	31.05
1925	.42	.80	2.41	3.99	5.11	6.04	5.91	5.16	3.47	1.02	.89	.31	35.53
1926	.33	.61	1.19	2.65	5.24	5.46	6.46	4.56	2.22	1.64	.69	.35	31.40
1927	.34	1.02	1.67	2.56	3.53	5.13	6.27	4.32	3.18	2.57	.81	.29	31.69
1928	.43	.58	1.96	2.90	5.60	4.47	6.35	5.28	3.51	2.06	.61	.52	34.27
1929	.27	.48	2.16	3.26	3.94	4.85	5.92	5.01	3.19	1.85	.61	.17	31.71
1930	.20	1.05	2.02	3.57	5.14	5.84	7.12	5.82	3.73	1.94	1.19	.50	38.12
1931	.67	.94	1.28	3.54	3.95	6.13	6.88	4.96	4.06	2.20	1.19	.50	36.30
1932	.45	1.04	1.47	3.20	5.73	6.25	6.73	5.55	4.03	2.14	.86	.49	37.99
1933	.81	1.06	1.60	2.94	3.64	7.84	7.39	5.43	4.11	2.28	1.31	.44	38.85
1934	.56	.83	1.67	4.09	6.83	7.44	7.10	4.72	2.46	3.05	1.28	.19	40.22
1935	.44	.56	1.65	2.44	2.86	4.81	6.88	5.79	3.98	2.19	.46	.18	32.24
1936	.11	.31	2.04	3.04	5.95	6.66	8.08	6.71	3.35	2.06	1.25	.64	40.20
1937	.34	.81	1.85	2.45	4.82	5.43	6.66	5.57	4.28	2.09	1.11	.19	35.60
1938	.41	.63	2.21	3.57	4.28	5.63	6.69	5.62	4.17	3.61	1.57	.62	39.01
1939	.49	.63	2.51	2.64	5.73	4.94	5.66	5.14	5.25	3.00	1.04	.68	37.71
1940	.61	.32	1.31	2.36	3.73	5.57	7.06	4.63	4.65	3.15	.95	.37	34.71
1941	.22	.65	1.75	2.94	5.84	5.48	6.67	5.31	3.62	1.51	1.03	.55	35.57
1942	.57	.36	1.77	3.92	3.84	4.10	5.69	5.09	3.14	2.33	.85	.12	31.78
1943	.27	1.24	1.90	3.00	2.95	4.77	5.97	5.49	3.57	2.43	1.09	.35	33.03
1944	.59	.81	1.26	2.20	4.17	6.09	7.06	5.17	3.44	2.70	.51	.18	34.18
1945	.20	.55	2.28	2.80	3.34	3.42	6.19	5.56	2.59	2.44	.84	.25	30.46
1946	.60	1.04	3.11	3.87	3.33	5.99	6.31	3.77	4.32	2.74	.96	.63	36.67
1947	.50	.82	1.51	2.24	4.70	4.69	6.81	6.69	4.37	2.61	.55	.33	35.82
1948	.48	.63	1.41	3.92	4.99	5.29	5.31	5.49	3.54	2.12	.69	.67	34.54
1949	.81	.88	1.95	3.30	5.62	6.14	6.02	5.09	3.42	2.05	1.56	.83	37.67
1950	.67	.69	1.57	2.55	4.81	5.48	5.35	3.76	2.80	2.87	1.12	.58	32.25
1951	.61	.77	1.44	2.45	4.79	4.34	5.86	5.00	3.16	2.11	1.00	.63	32.16
1952	.66	.97	1.67	3.30	4.17	6.76	6.47	5.20	4.52	3.24	1.73	.62	39.31
1953	.45	1.26	1.82	3.19	4.46	7.91	6.81	6.17	5.07	3.26	1.73	1.06	43.19
1954	.82	1.47	2.06	3.98	5.18	6.47	7.39	4.92	4.75	2.34	1.06	.56	41.00
1955	.48	.94	2.19	4.23	5.00	5.42	6.60	6.44	4.66	2.38	1.27	.74	40.35
1956	.54	.76	2.57	3.50	5.90	6.46	5.31	5.06	4.60	3.43	1.38	.44	39.95
1957	.43	.96	2.06	2.42	4.60	5.07	6.27	5.82	3.69	2.30	1.22	.96	35.80
1958	.77	1.08	1.43	3.56	5.50	4.99	4.65	5.64	3.81	2.98	1.55	.71	36.67
1959	.58	.84	2.21	3.54	4.72	6.54	6.13	5.07	4.07	1.68	1.19	.66	37.23
1960	.65	.71	1.06	3.82	3.65	4.43	5.75	5.33	4.24	2.53	1.59	.77	34.53
1961	.89	.86	1.98	2.64	4.77	5.57	5.54	4.79	3.81	2.34	1.14	.72	35.05
1962	.56	.76	1.54	3.63	5.94	5.87	5.27	5.30	3.50	2.25	1.17	.76	36.55
AVERAGE	.48	.78	1.81	3.12	4.71	5.69	6.35	5.18	3.67	2.33	1.07	.48	35.68

Table 16. Monthly Lake Evaporation in Inches at St. Louis

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1911	.63	1.03	2.43	2.83	6.19	5.95	6.23	4.50	3.14	1.57	.91	.54	35.95
1912	.41	.59	1.23	3.26	5.50	4.85	5.61	4.74	3.55	2.44	1.50	1.02	34.70
1913	.62	.88	1.81	3.40	4.64	5.98	5.76	5.87	3.33	1.89	1.28	.62	36.08
1914	.91	.77	1.91	2.88	5.79	6.75	5.95	4.46	3.02	1.70	1.54	.31	35.99
1915	.55	.94	1.37	4.57	4.10	4.56	5.09	3.50	3.57	2.99	1.67	.60	33.51
1916	.65	.88	2.08	2.72	4.99	4.97	6.93	4.99	3.59	2.33	1.63	.73	36.49
1917	.87	.84	2.28	3.09	4.49	5.95	6.11	5.13	3.44	1.85	1.19	.42	35.66
1918	.34	1.06	2.95	2.28	5.09	4.97	5.61	5.12	3.04	2.21	1.14	.85	34.66
1919	1.10	1.15	2.30	3.22	2.86	5.17	6.72	5.38	4.09	1.57	1.20	.49	35.25
1920	.61	.83	2.43	2.43	3.76	5.53	6.11	4.37	3.67	2.82	1.11	.79	34.46
1921	.96	1.26	2.58	3.57	5.36	5.70	6.72	4.70	2.87	2.80	1.06	.75	38.33
1922	.68	1.06	1.60	3.33	5.13	5.52	5.40	5.12	4.20	2.60	1.30	.74	36.68
1923	.88	.83	2.04	3.59	4.14	5.23	5.62	4.30	2.46	1.95	1.25	.83	33.12
1924	.59	.98	1.19	3.40	3.04	3.48	4.56	5.12	2.66	2.74	1.37	.55	29.68
1925	.70	1.10	2.70	3.94	4.70	5.44	5.67	5.31	3.24	.98	1.07	.61	35.46
1926	.73	1.04	1.46	3.03	5.41	5.04	5.95	4.69	2.52	1.77	.87	.49	33.00
1927	.54	1.12	1.70	2.23	3.42	4.41	5.57	3.72	3.73	2.70	.97	.61	30.72
1928	.83	.98	1.90	2.63	4.88	3.73	5.55	4.23	3.59	2.33	1.01	.78	32.44
1929	.51	.67	2.06	2.98	3.34	4.73	4.75	4.65	2.95	1.97	.90	.63	30.14
1930	.43	1.32	2.52	4.03	4.76	5.65	7.08	4.85	3.24	2.16	1.31	.69	38.04
1931	.85	1.12	1.50	3.57	4.17	6.13	5.86	4.72	4.02	2.15	1.29	.74	36.12
1932	.77	1.34	1.79	3.70	5.62	5.23	6.25	4.82	3.41	2.30	1.03	.63	36.89
1933	1.10	1.13	1.80	2.70	3.56	6.97	5.86	4.80	3.70	2.15	1.24	.76	35.77
1934	.82	.98	1.68	3.52	6.16	6.20	6.63	4.25	2.19	2.79	1.39	.50	37.11
1935	.66	.89	1.83	2.37	2.42	4.06	5.66	4.66	3.76	1.77	.73	.48	29.29
1936	.43	.61	2.81	3.05	5.64	6.57	7.58	6.43	3.00	1.88	1.37	.76	40.13
1937	.40	.92	1.63	2.97	4.64	4.67	5.61	5.10	3.51	2.10	1.27	.39	33.21
1938	.72	.88	2.24	3.54	3.89	4.39	5.71	5.43	3.76	3.17	1.43	.67	35.83
1939	.72	.78	2.28	2.69	4.87	4.22	5.04	4.65	4.71	2.84	.95	.66	34.41
1940	.22	.50	1.70	2.67	4.41	5.16	6.58	4.42	3.90	2.83	1.03	.56	33.98
1941	.54	.59	1.90	3.51	5.76	5.16	6.23	5.23	3.40	1.57	.72	.66	35.27
1942	.90	.75	2.04	4.08	4.81	4.40	6.38	5.25	3.77	2.52	1.23	.52	36.65
1943	.72	1.63	1.67	3.10	2.91	5.02	6.10	5.15	3.14	2.24	1.22	.62	33.52
1944	.71	1.07	1.60	2.56	4.60	6.48	6.39	4.86	3.40	2.84	.87	.42	35.80
1945	.47	.88	2.43	2.96	3.44	3.50	6.09	4.85	2.52	2.01	1.14	.43	30.72
1946	.63	1.22	2.33	3.50	3.40	5.95	6.13	3.48	3.83	2.57	1.12	.73	34.89
1947	.65	.77	1.43	2.55	4.50	4.07	5.86	5.92	3.73	2.68	.71	.71	33.58
1948	.50	.79	1.69	3.95	3.85	5.08	5.44	5.39	3.71	2.31	1.22	.81	34.74
1949	.44	.98	1.63	3.34	5.27	4.61	3.45	4.66	3.17	1.89	1.68	.94	32.06
1950	.81	.98	2.05	2.93	4.12	5.15	5.54	3.66	2.52	2.63	.84	.52	31.75
1951	.83	.86	1.75	3.03	6.06	4.71	5.24	4.73	3.20	2.19	1.10	.68	34.38
1952	.91	1.14	2.17	3.29	4.88	6.77	6.50	4.25	4.17	3.11	1.57	.73	39.49
1953	.68	1.50	2.39	3.45	5.45	7.23	6.94	5.92	4.84	3.07	1.87	1.20	44.54
1954	.87	1.75	2.35	4.38	4.49	6.39	7.37	4.52	4.28	2.13	1.22	.83	40.58
1955	.87	1.18	2.48	3.82	4.37	4.47	5.67	5.38	4.42	2.42	1.43	.97	37.48
1956	.77	.90	2.68	3.63	5.05	5.96	5.21	5.82	4.73	3.25	1.48	.70	40.18
1957	.54	1.03	1.77	2.61	4.12	4.23	5.85	5.11	3.18	2.33	1.17	1.13	33.07
1958	.82	1.40	1.50	3.43	5.23	4.66	3.75	4.14	2.23	2.57	1.59	.66	31.98
1959	.64	1.35	2.96	4.10	5.19	5.63	5.51	4.87	3.80	1.97	1.21	.70	37.93
1960	.74	.92	1.37	4.15	4.21	5.46	5.91	5.42	4.07	2.14	1.57	1.06	37.02
1961	.94	1.03	2.19	3.28	4.30	5.27	5.63	5.06	4.33	2.86	1.37	.91	37.17
1962	.84	1.30	1.72	2.69	5.54	4.93	5.43	5.41	2.71	2.11	1.32	.89	34.89
AVERAGE	.69	1.01	2.00	3.24	4.59	5.24	5.85	4.87	3.48	2.32	1.22	.69	35.21

Table 17. Monthly Lake Evaporation in Inches at Carbondale

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1911	.69	1.10	2.33	2.90	5.84	5.87	5.83	4.65	3.43	1.83	.93	.67	36.07
1912	.50	.67	1.26	3.16	5.16	5.24	5.54	4.94	3.99	2.51	1.52	.98	35.47
1913	.79	.97	2.07	3.29	5.71	6.05	6.05	5.88	3.08	1.75	1.18	.57	37.39
1914	.82	.61	1.47	2.92	5.67	6.07	6.29	5.14	3.59	2.12	1.69	.41	36.80
1915	.54	1.20	1.40	4.26	3.93	4.48	5.52	3.70	3.75	2.49	1.68	.64	33.59
1916	.73	.85	2.04	3.12	5.10	4.75	5.90	4.73	4.02	2.72	1.72	.80	36.48
1917	.69	1.01	2.42	3.59	4.68	5.64	5.59	5.15	4.08	2.18	1.25	.44	36.72
1918	.36	.98	2.93	2.77	5.71	5.69	5.51	5.51	2.95	2.21	1.44	.88	36.94
1919	.93	1.09	2.30	3.34	3.48	5.15	6.19	5.39	4.77	1.92	1.19	.53	36.28
1920	.96	.83	2.40	2.77	4.47	5.45	5.51	4.50	3.72	2.93	1.27	.86	35.67
1921	.94	.99	3.04	4.00	5.36	5.55	6.27	4.97	3.46	2.69	1.30	.91	39.48
1922	.74	1.07	1.94	3.59	5.13	5.44	5.57	5.48	4.58	2.88	1.50	.80	38.72
1923	.91	.92	2.17	3.38	4.15	5.06	5.84	4.19	3.37	2.55	1.36	.87	34.77
1924	.71	.99	1.42	3.81	3.77	5.03	5.51	5.49	3.71	3.38	1.45	.67	35.94
1925	.83	1.35	2.76	4.40	5.03	5.96	5.85	5.82	4.12	1.20	1.19	.74	39.25
1926	.71	1.07	1.79	3.20	6.04	5.92	6.11	4.30	3.95	1.92	1.00	.49	36.50
1927	.58	1.19	1.93	3.02	3.76	4.57	5.66	4.30	3.90	2.74	1.23	.77	33.65
1928	.82	.90	1.80	3.06	5.18	3.91	5.88	4.80	3.98	2.37	1.13	.87	34.70
1929	.68	.74	2.48	3.42	3.77	5.23	5.35	5.16	3.02	2.12	.89	.56	33.42
1930	.52	1.33	2.28	3.87	4.87	5.81	6.25	5.51	3.28	2.16	1.22	.64	37.74
1931	.79	1.17	1.38	3.03	3.82	4.28	5.98	4.23	4.05	2.49	1.37	.60	33.19
1932	.93	1.40	1.69	3.40	5.33	5.52	5.95	4.64	3.28	2.10	1.06	.68	35.98
1933	1.04	1.16	1.82	3.15	4.03	6.29	5.88	4.90	4.00	2.45	1.43	.87	37.02
1934	.93	.93	1.82	3.58	5.81	5.74	5.73	5.00	2.88	2.85	1.63	.74	37.64
1935	.87	1.12	2.20	2.60	3.40	3.94	5.63	4.69	4.42	2.39	.94	.57	32.77
1936	.61	.76	2.80	3.18	6.07	6.37	6.38	6.12	4.13	2.20	1.29	.82	40.73
1937	.53	1.07	1.91	3.06	5.07	5.49	5.71	5.37	3.93	2.18	1.27	.53	36.12
1938	.81	1.15	2.26	3.91	4.97	4.94	5.19	5.15	3.92	3.24	1.76	.83	38.13
1939	1.01	.95	2.53	2.96	5.32	5.10	5.96	5.20	5.11	3.12	1.24	.89	39.39
1940	.34	.66	1.81	2.92	4.40	5.26	5.87	5.11	3.84	2.68	1.10	.65	34.64
1941	.69	1.01	2.10	3.72	5.54	5.52	5.50	5.40	4.51	1.92	1.08	1.42	38.41
1942	.70	.83	2.12	3.64	4.40	4.93	5.73	4.63	3.59	2.23	1.28	.43	34.51
1943	.68	1.37	1.28	3.44	4.44	5.40	5.75	5.58	2.91	2.27	1.28	.58	34.98
1944	.67	1.09	1.93	3.16	4.74	5.90	5.90	5.37	3.51	2.59	1.12	.48	36.46
1945	.51	.72	2.28	3.19	3.57	4.33	5.34	4.82	2.75	2.00	.99	.51	31.01
1946	.64	1.20	.92	2.61	3.47	2.78	5.97	5.20	3.49	3.02	2.20	1.10	32.60
1947	.83	.70	1.65	3.77	5.27	4.83	5.64	4.28	3.86	2.49	.74	.67	34.73
1948	.49	.67	1.95	5.19	4.66	5.56	5.29	4.43	3.56	1.90	1.08	.73	35.51
1949	.66	.93	2.12	3.34	5.31	5.74	4.98	5.35	3.42	2.32	1.58	.92	36.67
1950	1.90	.95	2.64	2.97	4.77	5.24	5.57	4.31	2.62	1.90	1.10	.55	34.52
1951	.68	.72	1.54	2.57	5.09	4.08	4.28	3.68	3.01	2.19	1.03	.75	29.62
1952	.66	1.07	2.15	3.37	4.13	5.81	5.09	4.54	3.68	2.82	1.48	.77	35.57
1953	.72	1.44	2.26	2.58	4.15	6.33	5.86	5.62	4.90	2.12	1.68	.91	38.97
1954	.71	1.75	2.34	4.48	3.95	5.48	5.90	5.51	3.93	2.16	1.08	.69	37.98
1955	.69	.99	2.12	3.69	3.80	3.66	5.10	5.21	4.07	2.35	1.28	.67	33.63
1956	.67	1.02	2.45	3.76	4.98	4.36	4.94	4.45	4.03	2.50	1.40	.74	35.30
1957	.63	1.07	1.92	3.17	4.35	4.21	4.87	4.84	3.12	2.26	1.17	.98	32.59
1958	.80	.98	1.43	3.17	4.40	4.86	4.90	4.23	3.24	2.24	1.88	.67	32.80
1959	.82	1.13	2.66	4.45	4.91	4.97	5.19	4.51	4.09	2.19	1.13	.70	36.75
1960	.71	.86	1.35	4.37	4.66	5.24	4.71	4.84	3.59	2.23	1.26	.76	34.58
1961	.77	1.04	2.11	3.34	4.50	5.43	5.49	4.59	3.69	2.35	.98	.56	34.85
1962	.49	1.02	1.71	3.77	6.11	5.02	5.81	5.61	2.67	2.31	.89	.53	35.84
AVERAGE	.74	1.02	2.03	3.42	4.74	5.18	5.62	4.94	3.70	2.36	1.29	.72	35.75

Table 18. Monthly Lake Evaporation in Inches at Evansville

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1911	.81	1.29	2.67	3.39	6.81	6.75	6.83	5.17	3.92	2.07	.99	.74	41.44
1912	.60	.80	1.49	3.68	5.82	5.92	6.55	5.85	4.68	3.00	1.71	1.16	41.26
1913	.93	1.28	2.39	3.83	6.58	7.07	7.25	6.20	3.32	1.91	1.26	.65	42.67
1914	.90	.75	1.65	3.32	6.43	7.13	7.75	5.69	4.12	2.55	1.95	.46	42.70
1915	.66	1.31	1.68	4.95	4.41	5.24	6.54	4.34	4.31	2.96	1.89	.75	39.04
1916	.85	1.10	2.38	3.59	5.52	5.32	7.07	5.37	4.49	3.04	1.93	.94	41.60
1917	.83	1.18	2.70	4.05	5.25	6.42	6.35	5.67	4.57	2.46	1.38	.54	41.40
1918	.44	1.15	3.17	3.14	6.38	6.38	6.17	5.98	3.25	2.37	1.59	.96	40.98
1919	1.08	1.25	2.64	3.79	3.85	5.67	7.57	5.93	5.02	2.12	1.37	.64	40.93
1920	1.04	.93	2.57	3.02	4.83	6.07	6.11	5.03	4.12	3.20	1.40	.94	39.26
1921	1.03	1.10	3.26	4.51	5.86	5.95	7.68	5.56	3.74	3.05	1.39	1.00	44.13
1922	.85	1.17	1.98	3.91	5.54	5.92	6.26	6.10	4.99	3.16	1.72	.88	42.48
1923	.96	1.04	2.44	3.80	4.41	5.54	6.74	5.63	3.68	2.80	1.50	.94	39.38
1924	.84	1.10	1.57	4.25	4.17	5.56	6.32	6.21	4.15	3.75	1.56	.75	40.23
1925	.95	1.54	3.08	4.80	5.58	6.74	6.74	6.75	4.30	1.34	1.35	.87	44.04
1926	.84	1.17	1.99	3.67	6.90	6.74	7.42	4.96	4.62	2.21	1.07	.53	42.12
1927	.70	1.37	2.22	3.42	4.17	5.21	6.52	4.88	4.26	3.17	1.26	.90	38.08
1928	.96	1.04	2.01	3.39	5.71	4.47	7.18	5.40	4.50	2.62	1.20	1.03	39.51
1929	.77	.91	2.83	3.92	4.32	5.88	5.88	5.92	3.51	2.35	1.00	.62	37.91
1930	.62	1.49	2.69	4.33	5.19	6.53	7.40	5.91	3.46	2.48	1.35	.72	42.17
1931	.93	1.35	1.49	3.56	4.25	6.74	6.96	4.66	4.45	2.76	1.48	.65	39.28
1932	1.01	1.57	2.02	3.73	5.92	6.07	6.84	4.99	3.53	2.42	1.17	.75	40.02
1933	1.19	1.35	1.94	3.55	4.32	7.53	6.72	5.31	4.26	2.71	1.53	.92	41.33
1934	1.02	1.11	1.98	3.85	6.48	6.35	6.46	4.87	3.19	3.25	1.75	.81	41.12
1935	1.01	1.27	2.27	2.81	3.60	4.25	6.30	5.01	4.70	2.58	.96	.66	35.42
1936	.73	.94	3.14	3.70	7.13	7.68	7.83	7.20	4.43	2.46	1.51	.93	47.66
1937	.55	1.18	2.08	3.33	5.63	5.99	6.50	5.85	4.28	2.39	1.36	.56	39.70
1938	.94	1.23	2.31	4.39	5.40	5.36	5.76	5.76	4.31	3.64	1.90	.93	41.93
1939	1.08	1.08	2.80	3.28	5.77	5.61	6.37	5.84	5.44	3.39	1.34	1.03	43.03
1940	.42	.73	1.91	3.16	4.76	5.62	6.82	5.40	4.45	3.11	1.22	.69	38.29
1941	.78	1.18	2.42	4.31	6.25	6.25	6.37	6.11	4.83	2.09	1.25	2.41	44.25
1942	.86	.97	2.32	4.18	4.96	5.66	6.88	5.39	4.06	2.42	1.36	.46	39.52
1943	.75	1.62	1.73	3.94	4.89	6.25	6.90	6.37	3.44	2.56	1.45	.67	40.57
1944	.66	1.22	2.09	3.48	5.49	6.81	6.84	6.00	4.07	2.99	1.17	.54	41.36
1945	.59	.82	2.50	3.63	4.15	4.92	6.31	5.65	3.17	2.35	.90	.57	35.56
1946	.74	1.36	2.76	3.84	3.26	6.34	5.92	4.14	3.55	2.53	1.23	.94	36.61
1947	.77	1.10	2.01	3.35	5.31	5.31	6.35	6.27	4.37	2.96	.83	.81	39.44
1948	.56	.81	2.14	4.02	5.19	6.32	6.06	5.89	4.00	2.28	1.21	.79	39.27
1949	.67	1.08	2.15	3.11	5.72	5.13	6.08	4.87	3.64	2.23	1.81	1.03	37.52
1950	1.83	1.09	2.36	3.54	6.41	6.02	6.03	4.81	3.22	3.02	1.18	.64	40.15
1951	.76	.81	1.71	3.37	6.06	4.90	6.26	5.73	3.89	2.53	1.10	.79	37.91
1952	.71	1.18	2.34	3.39	4.85	7.14	6.71	5.62	4.39	3.19	1.55	.81	41.88
1953	.75	1.61	2.51	3.51	5.12	7.64	7.37	6.57	5.08	3.18	1.86	1.03	46.23
1954	.80	1.80	2.57	4.23	4.71	6.88	7.25	5.28	4.54	2.18	1.23	.74	42.21
1955	.75	1.06	2.31	4.07	4.79	4.86	6.37	6.46	4.46	2.34	1.39	.77	39.63
1956	.75	1.11	2.68	3.75	5.55	5.94	5.77	5.24	4.32	3.00	1.53	.76	40.40
1957	.69	1.14	1.99	3.43	4.25	4.20	5.54	5.70	3.05	2.26	1.30	1.08	34.63
1958	.90	1.18	1.57	3.49	5.47	5.81	6.04	5.97	3.90	2.89	1.65	.79	39.66
1959	.93	1.25	2.99	4.16	5.24	6.38	6.24	5.42	4.47	2.30	1.22	.74	41.34
1960	.78	.92	1.71	4.84	4.63	5.89	6.23	5.75	4.42	2.42	1.46	.87	39.92
1961	.95	1.15	2.08	3.60	4.98	6.21	6.22	5.42	4.58	2.67	1.09	.61	39.56
1962	.58	1.16	1.85	4.22	6.66	5.82	6.58	5.83	3.12	2.37	1.03	.63	39.90
AVERAGE	.83	1.16	2.27	3.76	5.29	6.01	6.60	5.61	4.13	2.66	1.38	.82	40.51

Table 19. Maximum Net Evaporation from a Lake Surface at Rockford, in Inches

Duration in Months	Recurrence Interval in Years												
	2	3	4	5	6	8	10	15	20	25	30	40	50
1	3.30	3.89	4.04	4.41	4.69	4.75	4.96	5.71	5.80	5.83	6.00	6.35	6.64
2	4.6	5.6	6.0	6.5	6.9	7.3	7.6	8.0	8.3	8.5	8.7	9.1	9.4
3	5.0	6.2	7.1	7.5	8.1	8.7	9.3	9.5	10.3	11.4	11.8	12.0	12.2
4	6.7	6.6	8.0	8.2	8.7	9.2	9.9	12.1	12.9	13.4	13.5	13.6	13.6
5	5.6	6.8	7.8	8.7	9.8	10.1	11.9	13.6	14.2	15.0	15.2	15.3	15.4
6	4.4	6.4	7.8	9.0	9.9	11.5	12.1	13.0	14.0	14.4	14.8	15.5	16.1
7	3	6	8	9	10	12	12	12	13	14	15	16	16
8	3	5	8	9	9	11	12	13	13	13	14	15	16
9	2	5	7	8	8	9	10	12	13	13	13	15	16
10	1	4	6	6	7	9	10	12	12	13	13	15	16
11	0	3	5	5	7	8	9	11	12	12	13	15	17
12		1	4	6	7	8	9	10	11	11	12	15	19
14		2	5	6	7	8	11	13	14	15	16	19	22
16		0	2	5	7	10	12	14	15	16	18	20	22
18			1	5	7	11	11	13	14	14	14	16	18
20			0	5	7	10	11	11	12	12	13	15	17
22				2	5	7	8	9	10	11	12	15	17
24				0	4	5	5	7	9	12	13	14	15
26					0	4	7	10	12	14	15	16	18
28					1	5	9	12	13	13	15	18	21
30					0	4	9	13	14	15	17	19	21
32						3	7	11	13	14	15	18	20
34						0	3	11	12	14	15	17	19
36							0	9	11	12	12	13	13
38								12	13	13	13	14	15
40								12	14	14	15	16	17
42								14	14	15	15	16	16
44								13	15	15	16	16	17
46								11	14	14	15	16	17
48								8	12	14	15	16	16
50								9	12	15	18	19	20
52								7	11	16	18	20	22
54								5	9	14	17	20	23
56								4	8	13	15	19	22
58								0	6	10	12	16	20
60									7	11	13	16	19

Table 20. Maximum Net Evaporation from a Lake Surface at Chicago, in Inches

Duration in Months	Recurrence Interval in Years												
	2	3	4	5	6	8	10	15	20	25	30	40	50
1	4.17	4.74	5.07	5.15	5.21	5.53	5.78	6.01	6.12	6.14	6.28	6.56	6.79
2	6.5	7.5	8.0	8.2	8.3	9.0	9.4	9.8	10.2	10.2	10.4	10.7	11.0
3	8.1	9.5	10.0	10.6	11.0	11.3	11.8	13.0	13.9	14.4	14.7	15.0	15.3
4	9.4	10.7	11.4	12.1	12.8	13.0	13.1	13.7	14.3	15.2	15.8	16.5	17.2
5	9.4	11.3	12.1	12.4	13.3	14.8	15.1	15.3	15.8	16.4	17.0	17.9	18.7
6	9.7	10.8	11.6	12.1	14.8	15.6	16.0	17.0	17.5	18.0	18.2	18.6	18.9
7	9	10	12	13	14	15	16	17	18	18	18	19	19
8	8	10	11	12	13	14	15	16	17	18	18	18	19
9	7	9	10	11	12	14	14	15	17	18	18	18	18
10	4	8	9	10	11	12	13	15	16	17	17	18	18
11	3	7	9	10	11	12	12	15	16	16	16	16	16
12	2	7	9	10	10	11	12	13	14	15	16	17	18
14	0	7	11	12	13	14	14	15	16	16	18	21	24
16		6	11	14	15	17	18	19	20	21	22	23	25
18		5	10	14	15	16	17	20	22	23	23	24	25
20		2	10	12	12	14	15	19	20	22	23	26	28
22		1	7	10	11	12	13	16	18	20	22	24	26
24		0	3	9	10	12	13	15	16	17	20	22	24
26			3	12	12	13	16	19	20	20	21	22	23
28			6	12	14	15	17	21	21	21	21	21	22
30			5	11	14	14	15	18	19	21	22	22	23
32			2	10	10	11	13	17	18	19	20	21	22
34			0	7	8	9	11	16	17	18	18	19	19
36				2	6	10	13	14	15	16	17	18	18
38				6	8	11	13	17	20	22	22	23	24
40				0	9	13	16	17	19	22	23	25	27
42					8	13	15	18	19	19	21	26	30
44					4	11	12	17	17	17	20	25	29
46					2	9	10	13	15	15	17	22	27
48					0	8	10	14	15	16	18	22	26
50						0	12	17	20	21	22	25	28
52						8	12	18	23	25	27	30	33
54						8	12	18	22	24	27	31	35
56						0	10	19	21	23	25	31	36
58							7	18	19	20	23	28	34
60							0	16	18	18	20	26	32

Table 21. Maximum Net Evaporation from a Lake Surface at Moline, in Inches

Duration in Months	Recurrence Interval in Years												
	2	3	4	5	6	8	10	15	20	25	30	40	50
1	4.64	5.02	5.29	5.44	5.54	6.29	6.64	7.07	7.42	7.45	7.67	8.12	8.48
2	6.5	7.6	8.7	8.9	9.6	10.2	10.2	10.5	11.2	11.9	12.2	12.4	12.7
3	8.0	8.9	10.4	11.1	11.6	12.0	12.6	12.8	13.6	14.8	15.4	16.2	16.9
4	8.9	10.5	11.8	12.1	12.3	13.6	13.7	14.4	15.5	16.1	16.9	18.5	19.8
5	8.2	11.0	12.8	13.8	14.5	14.8	15.3	15.6	16.2	16.9	17.9	19.7	21.2
6	7.7	11.6	13.0	14.0	14.6	15.2	15.4	16.3	17.4	17.6	18.5	20.4	22.0
7	7	12	13	14	14	15	15	16	17	18	19	20	21
8	7	11	12	13	13	14	15	16	18	19	20	20	20
9	5	10	12	13	13	14	14	16	17	19	19	19	19
10	4	9	11	12	13	14	14	15	15	15	16	18	19
11	4	7	9	11	12	13	14	15	16	18	18	19	19
12	4	7	10	10	11	14	14	16	18	21	22	23	23
14	4	5	10	12	16	19	21	23	24	25	26	27	28
16	4	4	11	15	19	20	21	23	24	26	27	29	31
18	4	4	10	14	18	20	22	25	25	25	27	31	34
20	4	9	9	13	17	20	21	24	24	24	26	30	34
22	4	9	6	10	15	19	21	21	22	22	24	28	31
24	4	9	7	9	16	17	19	22	23	23	24	27	30
26	4	9	9	13	16	18	22	24	25	26	27	29	30
28	0	0	0	13	18	21	26	29	30	31	32	32	33
30				11	20	22	25	28	29	30	31	33	34
32				9	17	20	23	26	27	29	30	32	34
34				6	16	18	20	23	26	26	27	29	31
36				0	10	14	18	25	26	28	29	30	31
38					12	18	22	28	29	30	31	33	34
40					8	15	23	29	32	32	33	36	38
42					5	14	23	29	31	32	33	36	39
44					0	13	21	27	29	31	33	36	39
46						9	18	26	29	31	32	36	38
48						0	20	26	31	36	37	38	38
50							19	28	31	35	37	39	40
52							0	32	36	40	41	41	41
54								33	36	41	42	42	42
56								33	35	38	39	41	43
58								31	33	37	38	40	41
60								30	34	38	39	40	40

Table 22. Maximum Net Evaporation from a Lake Surface at Peoria, in Inches

Duration in Months	Recurrence Interval in Years												
	2	3	4	5	6	8	10	15	20	25	30	40	50
1	4.90	5.31	5.52	5.79	6.14	6.26	6.36	6.45	6.70	7.05	7.11	7.12	7.12
2	7.6	8.7	9.1	9.2	9.5	10.1	10.4	10.8	11.2	11.7	12.1	12.7	13.2
3	8.6	10.2	11.3	12.0	12.3	12.7	13.4	13.9	14.2	14.3	15.0	16.3	17.4
4	9.2	12.5	13.0	13.6	14.1	14.6	14.9	15.1	16.1	17.7	18.8	20.3	21.6
5	9.4	12.6	13.9	14.9	15.7	16.3	16.4	17.1	18.8	20.6	21.5	22.6	23.4
6	8.3	13.1	14.5	15.0	15.6	17.4	17.7	18.5	19.9	21.2	22.0	23.0	23.9
7	8	12	14	14	15	18	18	19	21	22	22	23	23
8	8	12	12	13	14	17	19	21	21	21	21	21	21
9	6	10	12	13	14	17	19	20	20	20	20	20	20
10	4	10	11	12	13	17	18	19	19	20	20	20	20
11	2	9	11	12	13	15	17	18	18	19	19	20	21
12	3	8	10	11	13	15	17	18	20	21	21	22	22
14	3	8	14	16	17	19	20	23	26	27	27	27	27
16	3	5	10	17	18	20	22	25	25	25	27	30	32
18	3	8	10	15	18	21	22	25	26	27	29	33	37
20	0	0	10	12	18	20	21	24	26	28	31	35	40
22			9	9	15	18	19	21	23	27	29	33	37
24			8	10	17	17	18	20	22	24	27	31	35
26			9	13	16	21	23	24	26	29	31	34	37
28			5	14	17	22	22	26	28	30	32	36	40
30			3	12	17	19	20	25	28	30	33	38	43
32			3	6	13	15	19	23	26	29	31	37	42
34			0	0	10	14	19	22	25	27	30	35	39
36					11	16	18	19	22	26	29	35	39
38					8	18	21	25	28	28	31	38	44
40					9	18	23	24	26	28	31	39	46
42					8	14	17	23	25	26	31	42	53
44					6	11	17	23	24	24	29	41	53
46					3	6	15	21	23	24	29	40	51
48					0	9	11	23	26	28	32	42	51
50						0	0	26	31	35	40	48	55
52								26	32	39	44	52	60
54								24	30	39	45	54	62
56								24	28	37	42	52	61
58								21	26	34	40	50	59
60								20	26	34	40	50	59

Table 23. Maximum Net Evaporation from a Lake Surface at Urbana, in Inches

Duration in Months	Recurrence Interval in Years										
	2	3	4	5	6	8	10	15	20	25	30
1	0	4.38	4.77	5.06	5.43	5.58	5.62	5.76	5.81	5.82	5.83
2		6.5	7.2	7.4	7.4	8.7	9.1	10.9	11.4	11.4	11.4
3		7.8	8.7	10.4	10.6	11.0	11.6	11.8	12.3	12.8	13.2
4		8.7	10.5	10.8	11.7	12.4	12.7	13.7	14.1	14.2	14.2
5		8.8	10.6	11.8	12.3	12.5	12.7	13.1	13.9	14.9	15.7
6		9.1	10.4	11.0	11.8	12.2	12.7	13.3	14.3	15.6	16.6
7		8	9	10	11	11	12	13	15	16	18
8		7	8	9	10	11	11	14	16	17	18
9		4	7	8	9	10	11	13	15	17	18
10		3	5	6	7	9	10	13	15	16	17
11		1	4	5	5	7	9	13	15	16	16
12		0	4	5	5	9	11	13	14	15	16
14			6	6	7	8	9	15	18	20	21
16			0	5	8	10	11	14	17	20	23
18				1	7	10	12	14	18	22	26
20				0	5	7	7	13	18	21	24
22					3	3	5	11	15	18	21
24					0	1	3	8	13	16	19
26						2	5	7	10	14	20
28						0	4	10	15	20	25
30							2	8	14	20	26
32							0	7	12	16	21
34								2	7	12	19
36								0	0	11	19
38									8	14	23
40								0	8	15	24
42									7	15	26
44									0	9	23
46										3	14
48										10	21
50										17	24
52										21	29
54										20	28
56										16	25
58										0	0
60											

Table 24. Maximum Net Evaporation from a Lake Surface at Indian apolis, in Inches

Duration in Months	Recurrence Interval in Years												
	2	3	4	5	6	8	10	15	20	25	30	40	50
1	3.42	3.81	4.08	4.68	4.78	4.92	5.12	5.37	5.52	5.74	5.87	6.05	6.19
2	4.8	6.2	6.8	7.0	7.2	7.4	7.9	8.3	8.5	8.6	8.7	8.9	9.1
3	5.5	7.3	8.5	9.3	9.7	10.0	10.1	11.1	12.0	12.0	12.0	12.0	12.1
4	5.1	7.3	8.9	10.2	10.4	10.9	11.8	13.1	14.4	14.8	15.0	15.3	15.5
5	5.6	7.0	9.4	10.2	11.6	12.2	12.8	13.7	13.9	14.0	14.0	14.2	14.4
6	4.4	6.2	9.2	9.2	10.3	12.4	12.8	13.2	13.8	14.3	14.4	14.5	14.5
7	3	5	7	9	10	11	11	12	13	13	14	14	14
8	0	4	6	8	9	9	9	10	11	13	13	13	14
9		1	5	6	7	8	8	9	11	12	12	13	13
10		0	3	5	5	5	6	8	9	9	10	11	12
11			2	3	3	3	4	5	6	8	9	10	11
12			0	1	1	3	4	5	7	10	11	11	11
14				2	4	6	7	9	12	14	15	15	15
16				1	4	5	6	8	11	15	17	19	20
18				0	1	3	4	7	11	14	15	15	16
20					0	0	2	4	7	11	12	13	13
22							0	0	4	6	8	9	11
24									0	0	4	7	10
26									1	3	5	9	14
28									4	5	7	11	17
30									3	4	5	10	15
32									0	0	2	5	11
34											0	0	0
36													
38											2	3	5
40											1	1	2
42											0	0	0
44													
46													
48													
50													
52													
54													
56													
58													
60													

Table 25. Maximum Net Evaporation from a Lake Surface at Springfield, in Inches

Duration in Months	Recurrence Interval in Years												
	2	3	4	5	6	8	10	15	20	25	30	40	50
1	5.01	5.38	5.52	5.72	5.76	6.15	6.30	6.61	6.78	6.87	6.91	6.94	6.97
2	7.2	8.3	8.8	9.2	9.5	9.9	10.0	10.9	11.6	11.7	11.9	12.1	12.2
3	8.7	10.1	10.9	11.8	12.4	12.9	13.6	14.4	14.6	14.6	15.1	16.2	17.2
4	9.7	11.2	12.0	13.2	13.7	16.0	16.2	16.5	17.0	17.5	18.3	19.9	21.2
5	9.9	11.2	13.6	14.3	15.2	17.2	17.9	18.2	18.6	19.2	19.9	21.1	22.1
6	10.0	11.9	13.8	15.2	15.8	16.9	18.3	18.7	19.5	20.5	20.8	21.1	21.4
7	9	12	13	14	15	16	17	19	19	20	20	22	23
8	9	11	12	13	14	16	16	18	19	20	21	22	24
9	8	10	11	13	13	15	16	18	19	19	20	22	23
10	6	9	10	11	13	15	15	16	17	19	20	22	23
11	5	7	9	12	13	14	14	16	17	19	20	22	23
12	4	8	8	11	13	14	15	18	20	21	22	23	24
14	0	8	11	13	14	18	19	22	23	25	26	28	31
16		8	13	14	16	20	23	23	24	25	27	31	35
18		6	11	14	16	20	20	25	27	29	31	35	39
20		5	9	12	14	18	21	25	26	26	28	34	38
22		0	8	10	11	15	18	21	22	24	26	31	35
24			4	11	13	15	17	21	24	26	29	34	38
26			5	15	16	18	19	22	25	30	33	38	43
28			4	13	15	17	18	24	29	34	38	43	48
30			4	10	12	16	19	26	29	31	34	41	48
32			0	6	11	15	19	24	27	28	31	39	46
34				4	8	13	15	21	25	27	29	36	43
36				0	8	13	14	22	24	27	30	38	44
38					10	15	20	24	28	33	37	44	50
40					13	18	20	26	30	32	36	45	54
42					10	16	18	24	29	30	34	44	53
44					7	12	15	23	27	28	32	42	53
46					0	0	12	21	26	27	32	42	52
48						7	11	20	28	28	32	44	55
50						0	16	23	32	34	39	49	59
52							15	25	35	37	41	51	60
54							16	26	38	39	44	54	64
56							0	25	37	38	42	52	61
58								23	33	34	38	49	59
60								23	34	34	39	49	58

Table 26. Maximum Net Evaporation from a Lake Surface at St. Louis, in Inches

Duration in Months	Recurrence Interval in Years												
	2	3	4	5	6	8	10	15	20	25	30	40	50
1	4.79	5.29	5.41	5.59	5.62	5.72	5.77	6.73	6.82	6.83	6.86	6.92	6.97
2	7.7	8.3	8.6	8.9	9.4	9.8	10.2	11.1	11.5	11.7	11.9	12.2	12.5
3	8.7	10.8	11.4	11.5	11.9	13.2	14.1	15.1	15.9	16.0	16.1	16.1	16.2
4	8.5	11.7	13.0	13.9	14.8	15.1	15.4	17.3	18.4	20.0	20.4	20.6	20.8
5	8.6	11.5	13.8	14.1	15.8	16.2	16.5	19.0	20.5	21.0	21.7	22.9	23.8
6	8.2	11.6	12.6	14.6	15.6	16.7	17.3	20.3	21.9	22.2	22.7	26.7	24.4
7	7	10	12	14	15	16	17	20	21	21	22	24	25
8	6	9	12	13	14	15	16	19	21	22	23	25	26
9	5	8	11	11	12	14	15	18	20	21	22	24	26
10	4	7	9	11	12	13	14	17	19	21	22	25	27
11	2	5	8	9	12	13	13	16	18	21	23	26	28
12	1	5	9	11	12	13	15	16	18	20	23	26	30
14	1	4	8	13	15	18	19	22	23	24	27	32	37
16	1	1	8	14	17	19	20	23	25	25	28	34	40
18	0	0	7	15	17	19	20	22	25	28	31	36	41
20			4	10	13	17	18	21	23	25	28	35	40
22			0	8	11	14	17	19	21	21	25	33	41
24				9	12	14	17	18	20	24	28	36	44
26				8	13	16	16	19	22	24	29	40	51
28				0	10	14	18	22	26	27	32	43	54
30					5	15	18	22	25	25	30	42	54
32					5	14	17	20	22	22	27	39	52
34					2	12	14	17	18	19	24	36	50
36					1	10	14	17	19	21	26	37	49
38					0	11	15	21	25	27	31	42	52
40						11	16	20	25	26	31	43	56
42						8	15	21	24	24	29	43	57
44						6	14	16	19	21	26	41	57
46						0	11	16	19	20	25	39	56
48							9	15	18	18	24	39	57
50							0	17	24	25	30	45	60
52								17	25	30	36	50	63
54								18	25	32	39	59	69
56								17	25	29	36	51	67
58								15	22	27	34	49	65
60								13	20	24	31	46	62

Table 27. Maximum Net Evaporation from a Lake Surface at Carbondale, in Inches

Duration in Months	Recurrence Interval in Years												
	2	3	4	5	6	8	10	15	20	25	30	40	50
1	4.22	4.47	4.82	4.87	4.93	5.12	5.20	5.54	5.74	5.77	5.83	5.95	6.04
2	6.4	7.2	7.8	8.6	8.8	9.3	9.4	9.8	9.9	9.9	9.9	10.0	10.0
3	7.2	9.4	10.4	10.6	11.2	12.0	12.9	13.8	14.0	14.1	14.1	14.1	14.1
4	7.4	9.7	11.2	12.3	13.0	14.2	15.2	16.7	17.1	17.3	17.6	18.1	18.5
5	6.3	9.3	11.9	13.5	14.5	14.8	16.0	17.6	18.4	19.1	19.3	19.4	19.5
6	6.0	9.3	12.4	14.0	14.6	16.2	16.6	18.2	18.8	19.4	19.5	19.6	19.6
7	5	8	11	13	13	15	16	17	18	18	18	18	18
8	3	7	10	12	12	13	16	17	17	18	18	18	18
9	1	6	8	9	10	12	15	16	16	16	17	17	17
10	0	3	6	7	8	10	12	13	14	15	15	15	15
11		2	4	4	7	9	10	13	14	14	14	15	15
12		0	2	5	6	10	12	14	15	15	15	15	15
14			4	6	7	11	12	18	19	21	21	21	22
16			2	7	8	12	14	16	18	20	21	24	26
18			1	5	7	10	11	16	18	18	19	22	24
20			0	1	5	6	9	14	16	17	17	19	20
22				0	0	2	3	10	12	12	13	15	17
24						0	0	11	12	13	15	18	21
26								10	13	16	18	23	28
28						1	3	9	12	18	21	26	31
30						0	2	8	12	17	20	24	28
32							0	6	10	15	17	20	22
34								0	5	10	13	15	18
36								2	4	8	11	15	19
38								0	7	10	12	16	21
40									8	13	15	18	21
42									5	12	15	19	23
44									0	0	14	17	19
46											12	13	15
48											8	10	11
50									5	9	11	13	15
52									6	9	11	13	14
54									6	11	12	13	13
56									0	0	10	12	13
58											4	5	5
60											0	2	4

Table 28. Maximum Net Evaporation from a Lake Surface at Evansville, in Inches

Duration in Months	Recurrence Interval in Years												
	2	3	4	5	6	8	10	15	20	25	30	40	50
1	5.35	5.81	5.99	6.24	6.26	6.31	6.46	6.65	6.85	7.10	7.14	7.15	7.15
2	8.4	9.2	9.7	10.3	10.7	11.1	11.3	11.8	12.1	12.2	12.6	13.2	13.7
3	10.0	11.3	12.0	12.9	13.7	14.7	15.0	17.1	17.7	18.1	18.6	19.4	20.2
4	11.0	12.8	13.7	14.3	15.4	17.1	18.8	20.3	21.4	21.8	22.6	24.2	25.6
5	12.3	14.0	15.3	15.8	17.3	19.0	19.5	22.5	22.7	22.9	24.0	26.0	27.8
6	12.3	14.0	15.3	16.8	17.8	19.7	21.2	22.5	23.4	23.8	24.8	26.8	28.5
7	12	14	16	17	18	19	20	22	24	24	25	26	27
8	11	13	16	17	17	18	18	21	24	24	25	26	27
9	8	12	14	16	16	16	17	20	23	24	25	25	26
10	7	10	12	14	14	15	16	18	22	23	24	24	25
11	3	8	9	11	12	13	15	20	21	23	23	24	24
12	1	6	8	10	11	15	17	20	22	23	23	24	24
14	0	6	9	11	16	20	23	26	28	30	31	31	32
16		7	12	14	19	25	28	31	32	32	32	33	34
18		7	11	17	19	23	27	29	30	31	32	33	35
20		5	10	15	16	20	24	27	29	32	32	33	33
22		0	7	10	13	17	20	23	25	27	28	30	31
24			4	7	9	15	20	24	26	27	28	29	29
26			6	8	10	18	21	29	31	32	34	36	38
28			0	8	11	21	25	31	34	34	35	38	41
30				8	12	21	24	33	34	34	36	39	42
32			3	7	10	21	23	28	31	33	35	39	42
34			0	2	6	18	20	24	27	29	31	35	39
36				0	0	17	20	23	26	27	28	31	33
38						17	23	27	31	33	34	35	35
40						19	24	33	33	33	35	38	41
42						21	24	31	34	36	38	40	42
44						18	21	27	31	33	34	36	38
46						14	17	23	27	30	34	35	37
48						12	16	22	26	26	27	30	33
50						13	15	27	30	30	32	35	39
52						0	0	29	33	35	37	40	43
54							24	30	34	37	39	43	47
56							0	0	30	34	37	42	46
58								23	27	30	33	37	41
60								0	24	29	32	35	39