EVAPORATION FROM DIFFERENT TYPES OF PANS

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SYNOPSIS

The rate of evaporation from different types of pans varies widely and before the evaporation data can be used in estimating the loss from large bodies of water, it is necessary to know the ratio between the evaporation from the type of pan used and that from a large water surface, or the relation between the evaporation from the pan and some pan for which the ratio of the evaporation to that from a large water surface is known.

A summary of the results of the available records, where a comparison has been made between the evaporation from different types of pans or between the evaporation from a pan and a large water surface under similar conditions, is given in this paper, together with recommendations as to the best types of pan to use under different conditions, and the procedure to be followed in taking the observations.

INTRODUCTION

Available records of evaporation from pans of different types, or from pans and large water surfaces under similar conditions, are either scattered through many publications or are buried among the unpublished records of various organizations. The writer has assembled such data and re-arranged them for presentation in tabular form. Credit is given in every instance to the publication or agency from which the record was obtained. The tables are published as an Appendix to the paper.

COMPARATIVE RESULTS

The records of the comparisons between the evaporation from many types of pans were taken (see Appendix), but particular attention was given to the pans most commonly used, such as the United States Weather Bureau Class *A* land pan and floating pan, the Colorado sunken pan, the United States Geological Survey floating pan, and the United States Bureau of Plant Industry sunken pan. Comparisons were also made, where records had been taken, between the evaporation from these pans and from large bodies of water. In addition to the record of the evaporation, all meteorological data pertaining to each tank were included. Where possible the data at the station were used, but when no records had been kept, the data were taken from the records of the nearest Weather Bureau Station.

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All the records have been summarized and only the mean data are included in this paper. In some cases merely the means for the entire period of the observations are given, but where sufficient records are available the monthly or the daily means are reported. The daily means are given only in those cases where intensive studies of evaporation were made for short periods, and where the observations were taken at frequent intervals during the day.

None of the records has been eliminated, nor have any observations been discarded, except where the original records indicate that the observations are in error. It was assumed that the observations were correct, except as noted, and that differences in the results were due to variations in the setting or the conditions under which the pans were exposed. Consideration was given, however, to the fact that the records from floating pans are less reliable than those from land pans on account of the difficulty in making accurate readings of the evaporation loss, and also because during wind storms water frequently splashes into the pan from the reservoir, or splashes out of the pan when there is a pronounced swell after a storm.

The comparisons of evaporation from pans and from large water surfaces are few and the results are uncertain because of the difficulty in segregating the evaporation from the other losses. Experiments on the evaporation from pans of different sizes, however, show that the size of the pan has a proportionately less effect on the evaporation as the size of pan increases. This fact is used as the basis for determining the relation between the evaporation from pans and from large water surfaces. The comparative data on the evaporation from reservoirs and from pans similarly exposed are presented to show how closely the facts are in accord with the theory, and also to give some idea as to the variation that may be expected in the results.

In reporting the data all the known details concerning the setting of the pans and the conditions under which they operated, are included. Unfortunately, many details are frequently lacking in the reported data. Under these circumstances, if there are discrepancies in the results the reasons for them can only be conjectured.

The tables giving these data are arranged according to the types of pans. All tables showing the comparison of one type of pan with various other types are grouped together. From the mean values taken from these tables, a summary of all the results in which a comparison with any of the standard pans was possible, was prepared. These mean ratios are not the means of the monthly ratios, but are the means of the ratios of the total evaporation losses from the pans.

The experiments[2] made by the late R. B. Sleight, Assoc. M. Am. Soc. C. E., at Denver, Colo., during 1915, 1916, and 1917, cover a wide range of conditions, and the results obtained are uniformly consistent. In using the ratios for the floating tanks, however, it should be kept in mind that the floating pans were not placed at the same point as the land pans and that results similar to those obtained elsewhere can not be expected. The obser-

[2] *Journal of Agricultural Research,* Vol. X, No. 5, July 30, 1917.

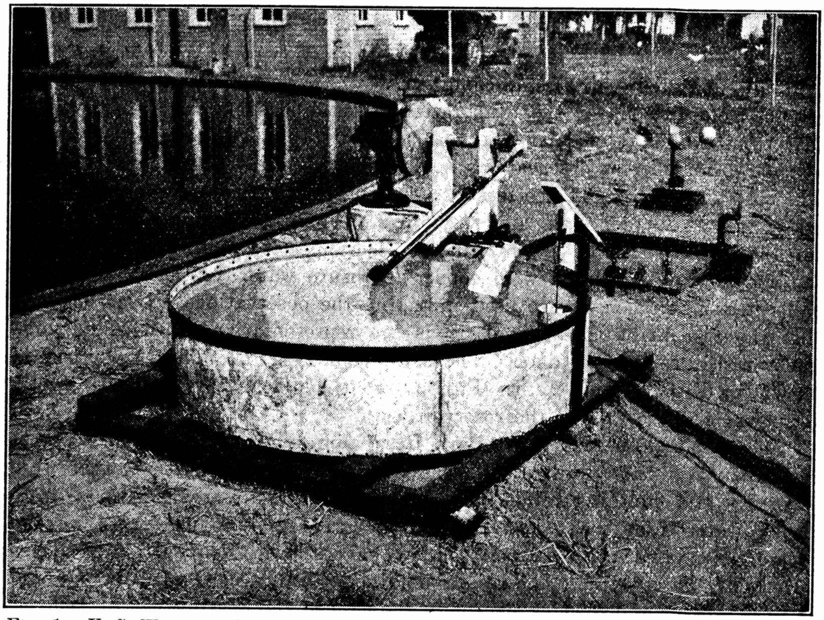

FIG. 1.—U. S. WEATHER BUREAU CLASS *A* LAND PAN, COLORADO SUNKEN PAN, AND 86-FOOT CIRCULAR RESERVOIR AND AUXILIARY EQUIPMENT AT FORT COLLINS, COLO.

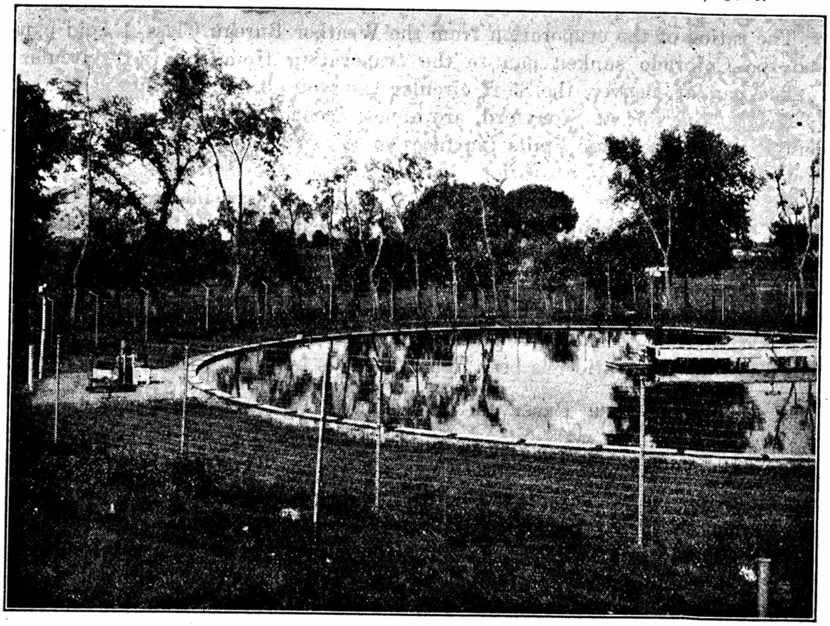

FIG. 2.—ARRANGEMENT OF EQUIPMENT FOR CONDUCTING EXPERIMENTS ON THE 85-FOOT CIRCULAR RESERVOIR AND VARIOUS STANDARD PANS AT FORT COLLINS, COLO.

vations of floating pans may be compared with each other, however, as they were all subjected to the same conditions.

The comparisons of the evaporation from different types of pans with that from the 85-ft circular reservoir at Fort Collins, Colo., are the results of a large number of observations made under carefully observed conditions. The observations cover three seasons. During the first two seasons, the readings were taken four times daily at 6-hr intervals, and during the last season they were taken three times daily. The 85-ft reservoir used in making the comparison was lined with copper to insure water-tightness. Carefully calibrated instruments were used in taking the observations. It is believed that the results of these comparisons are representative of the conditions under which they were taken. The equipment used in making the study is shown in Figs. 1 and 2. In Fig. 2, the Geological Survey floating pan is shown in the center of the reservoir.

The evaporation from East Park Reservoir and from the various evaporation pans at Stonyford, Calif., was compared under conditions that were favorable for obtaining reliable results. East Park Reservoir is in a practically water-tight basin, and during the period of the tests there was no precipitation and practically no inflow or outflow. Evaporation readings were taken twice daily. The results obtained are in accord with those found at Fort Collins and Denver, except in the case of the floating pan at Denver, and as previously stated, the land and floating pans at Denver were some distance apart. Figs. 3 and 4 show the evaporation pans at East Park Lake.

The ratios of the evaporation from the Weather Bureau Class *A* land pan and the Colorado sunken pan to the evaporation from the 12-ft circular sunken pan at Denver, the 85-ft circular reservoir at Fort Collins, and the 1 800-acre reservoir at Stonyford, are almost identical. Therefore, it is evident that between these limits (surfaces of 113 sq ft and 1 800 acres), there is no decrease in the evaporation per unit area as the size of the water surface increases. These conclusions are confirmed by experiments at Milford, Utah, on the evaporation from a Weather Bureau Class *A* land pan and a 12-ft circular sunken pan. In view of the fact that these observations were made at widely separated points, it may be assumed that these ratios are constant. If these conclusions are correct, it is possible to compute the evaporation from a lake or reservoir when the evaporation from any type of pan for which the ratio has been determined, is known.

Other Reservoir Evaporation Comparisons

A comparison of the evaporation from a buried pan and the total loss from Newell Reservoir, Alberta, Canada,[3] by the Department of Natural Resources of the Canadian Pacific Railroad for the period, 1919 to 1925, shows that on the average the total loss from the reservoir is 95% of that from the land pan. The season ratios, however, vary from a minimum of 77% to a maximum of 116 per cent. This large variation is probably due to the fact that the loss from the reservoir was determined from the seasonal inflow, outflow, precipitation, and change in elevation. Errors in any of

[3] *Transactions*, Am. Soc. C. E., Vol. 90 (1927), p. 350.

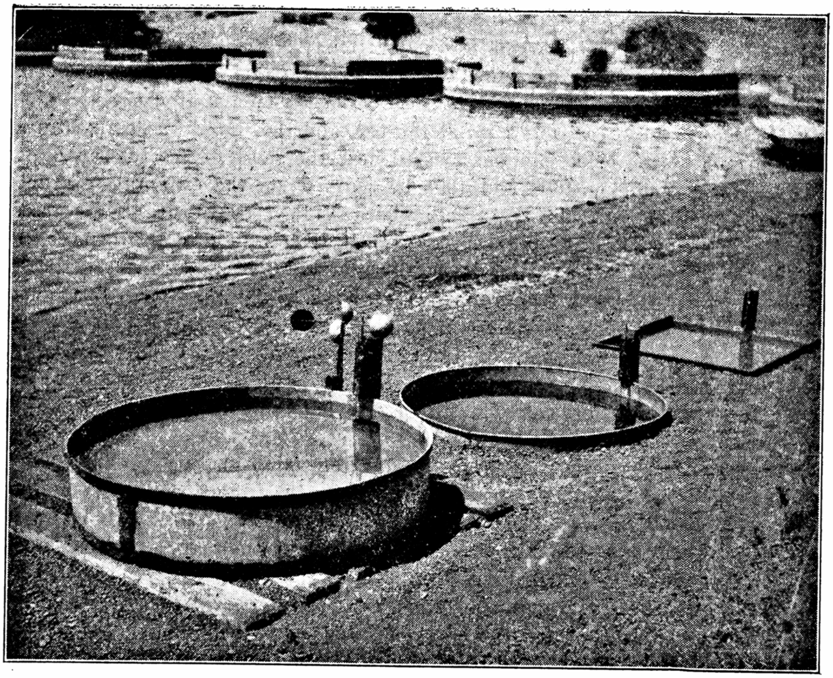

FIG. 3.—U. S. WEATHER BUREAU CLASS *A* LAND PAN, 4-FOOT CIRCULAR SUNKEN PAN, AND COLORADO PAN, AT EAST PARK RESERVOIR, STONYFORD, CALIF.

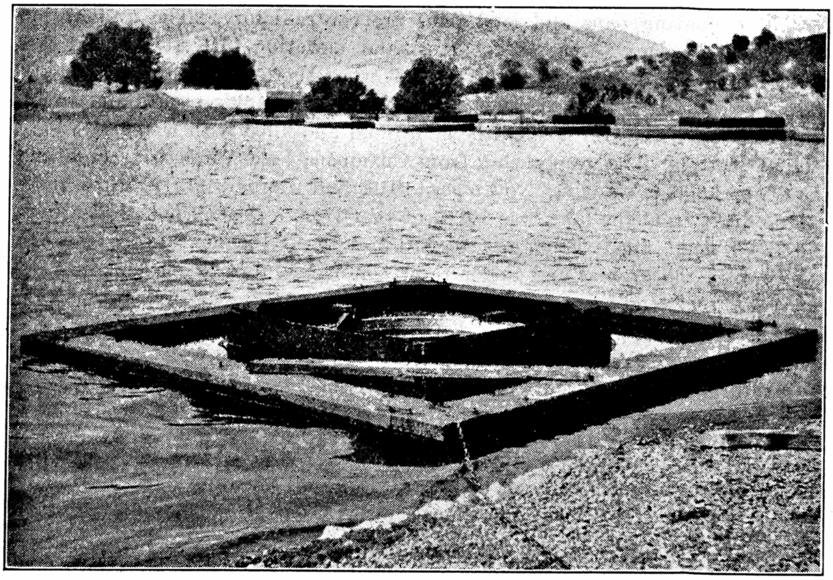

FIG. 4.—U. S. WEATHER BUREAU CLASS *A* LAND PAN USED AS A FLOATING PAN AT EAST PARK RESERVOIR, STONYFORD, CALIF.

these factors would be charged to evaporation. Newell Reservoir has an area of 16 430 acres at Elevation 2 485, and an available capacity of 189 000 acre-ft. The evaporation pan was 4 ft in diameter and 2 ft deep. It was sunk in the ground to within 2 in. of the top, and the water was maintained at the ground level. The pan was located near the shore of the reservoir.

Experiments during 1904 and 1905 by Duryea[4] on the evaporation from land and floating pans in the Santa Clara Valley, California, show that the average evaporation from the floating pans is 71% of that from the land pan. This value is based on the average results from six land pans and three floating pans divided into two groups. The values of the relation varied from a minimum of 55% to a maximum of 85 per cent. All pans were 3 ft square and 12 in. deep and the depth of water was approximately 10 in. The land pans were embedded in the ground and banked with earth nearly to their rims. The floating pans were floated on the Laguna Seca and, apparently, were freely exposed to the air.

Experiments were reported by S. T. Harding,[5] M. Am. Soc. C. E., on the evaporation from Lake Elsinore, in California, and from a pan 3 ft square floating in the lake for the period from May to September, 1916. The results show that the evaporation from the lake is 84% of that from the pan, but that the relation by months varies from a minimum of 63% to a maximum of 114 per cent. The evaporation from the lake was determined from the record of the inflow, outflow, precipitation, and change of stage. The high-water area of Lake Elsinore is 5 500 acres and the elevation, 1 261 ft.

Experiments reported[6] by J. B. Lippincott, M. Am. Soc. C. E., on the evaporation from Lake Hodges and Cuyamaca Lake, and the evaporation from floating pans and land pans are contradictory. The evaporation from Lake Hodges (area, 1 317 acres, and elevation, 315 ft), during six months from June, 1919, to October, 1921, when there was no draft from the lake, was 96% of the evaporation from a sunken pan 3 ft square and 18 in. deep, sunk with the rim flush with the ground and filled with water to within 4 in. of the top. The evaporation from Cuyamaca Lake (area, 978 acres, and elevation, 4 600 ft) during November, 1916, and January, 1919, when there was no draft from the lake, was 108% of that from a floating pan 3 ft square and 18 in. deep, filled with water to within 4 in. of the top. Later, the pan was sunk in the ground and under these conditions, during November, 1921, and June, 1922, the evaporation from the lake was 119% of the pan evaporation. Cuyamaca Lake is surrounded by a large swamp area, and the vegetation in this area may have increased the loss, due to the transpiration from the plants.

Choice of Type of Evaporation Pan

The type of pan chosen for evaporation observations will depend on the purpose of the experiment and on a knowledge of the information available for the different types of evaporation pans. Although a pan may be desir-

[4] *Engineering News,* Vol. 67, pp. 380–383.

[5] San Jacinto River Hydrographic Investigations, 1922, Div. of Water Rights, State of California, *Bulletin 9,* State Dept. of Eng.

[6] *Transactions,* Am. Soc. C. E., Vol. 90 (June, 1927), pp. 356–359.

able from several standpoints, it should not be chosen unless the relation of the evaporation from the pan to other types of pans and to large water surfaces is thoroughly established.

The types of pans most commonly used in the United States are: (1) The U. S. Weather Bureau Class *A* land pan shown in Figs. 2, 3, and 4; (2) the U. S. Bureau of Plant Industry sunken pan; (3) the Colorado sunken pan (see Figs. 2 and 3); (4) the U. S. Geological Survey[7] floating pan; and (5) the U. S. Weather Bureau floating pan. Each of these pans is built according to definite specifications and has certain advantages and disadvantages. For convenience, these types will be referred to by number in this paper.

Pan (1).—The Class A Land Pan of the United States Weather Bureau.—The Class *A* land pan is used more than any other type, and for general evaporation studies is probably the most satisfactory. This is the standard pan of the U. S. Weather Bureau and is the type used at all its evaporation stations. Other agencies also frequently install this type of pan and follow the Weather Bureau procedure in taking the observations. As shown in Fig. 5, this pan is 4 ft in diameter and 10 in. deep. It is made of 22-gauge galvanized iron and is supported on a grillage of timbers so that the bottom of the tank is 6 in. above the original ground surface. The pan is filled with water to within 2 in. of the top and is refilled as soon as the water has dropped 1 in. below this elevation. A special micrometer hook-gauge is used to measure the evaporation. This gauge is located in a stilling-well which acts as a support for the gauge. The auxiliary equipment consists of an anemometer, a rain gauge, "maximum-and-minimum" thermometers, and an instrument shelter. The readings are taken twice daily at approximately 7:00 A. M. and 7:00 P. M.

The pan is simple in design and easy to operate. Being above the ground, it does not blow full of water in wind storms. The water does not splash into it and the snow does not drift into it when rain or snow is falling. The water in the pan is fully exposed to the air, and follows the air temperatures quite closely. As a result, the evaporation from it changes more quickly with the changes in temperature than from other types of pan. In some experimental work, this is a desirable feature, but the rapid change in the temperature makes it difficult to obtain the true mean temperature of the water.

From the standpoint of making comparisons with known data on evaporation, this type of pan is probably best adapted to the study of evaporation from water surfaces, because a large number of these pans have been installed in the United States, and many observational data obtained under similar conditions with a uniform procedure, are available from them. It is to be regretted that relatively few of these pans have been installed in the eastern part of the United States, and, unfortunately, all the data necessary for making a comparison between evaporation records at different stations are

[7] In a letter dated December 11, 1929, N. C. Grover, M. Am. Soc. C. E., Chief Hydraulic Engineer of the U. S. Geological Survey, states that there is no official U. S. Geological Survey floating pan. The pan by that name was designed by E. F. Kriegsman, Assoc. M. Am. Soc. C. E.

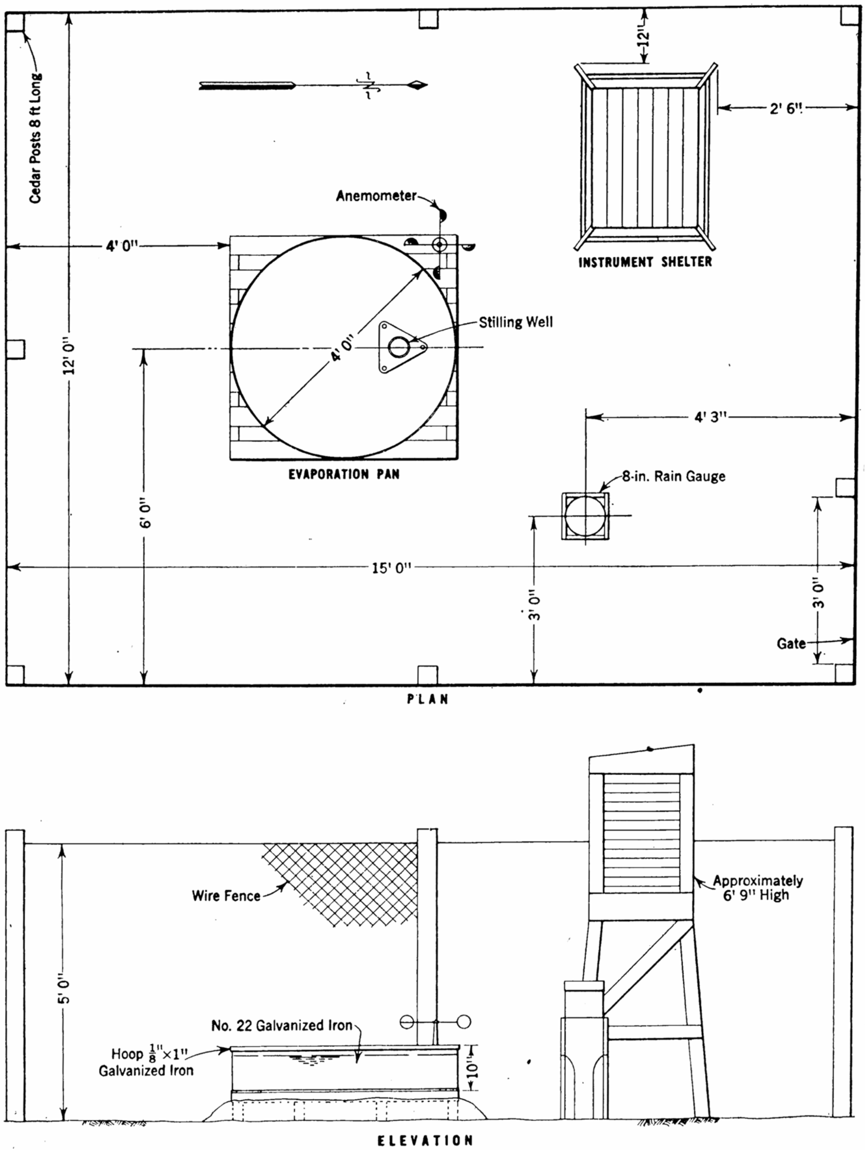

FIG. 5.—PLAN OF U. S. WEATHER BUREAU CLASS *A*, LAND PAN (TYPE (1)).

not observed by the Weather Bureau. The missing information, however, can usually be obtained from records of near-by Weather Bureau Stations.

Another criticism of this type is that the rate of evaporation is much higher than that from a large water surface under similar conditions, due to the fact that the pan is more fully exposed to the air than the reservoir. For this reason a large correction must be made in determining the reservoir evaporation from the pan record. This factor has been determined, however, under a wide variety of conditions, with very consistent results. Comparisons indicate that a factor of 0.69 or 0.70 should be used in converting the evaporation from the pan to that from the reservoir.

Pan (2).—United States Bureau of Plant Industry Sunken Pan.—The pan shown in Fig. 6 is also quite satisfactory. It is 6 ft in diameter and

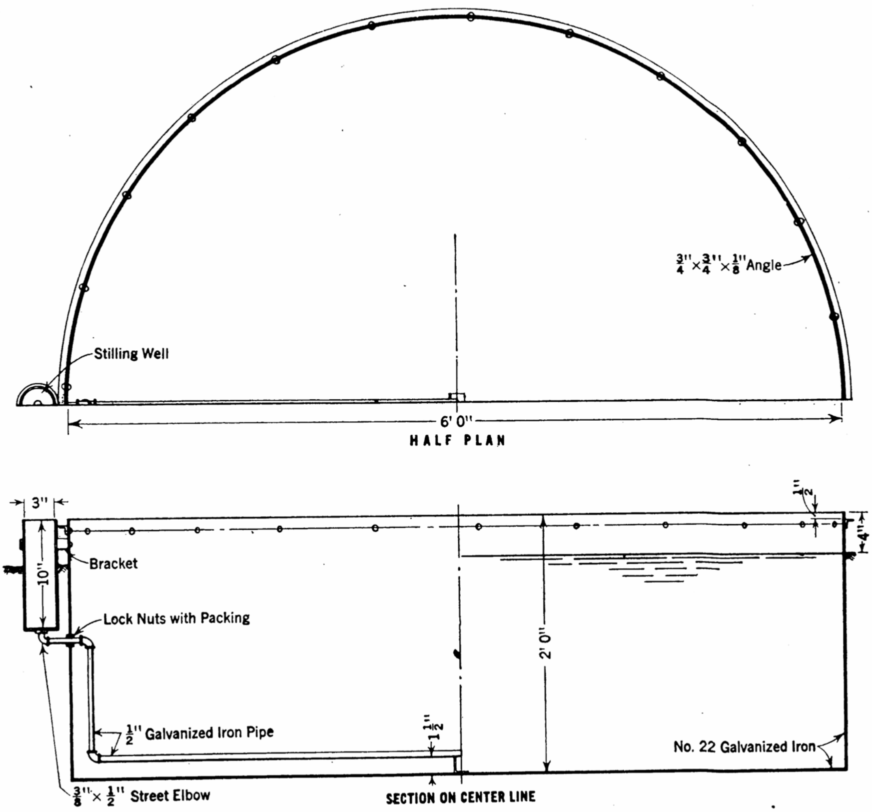

FIG. 6.—U. S. BUREAU OF PLANT INDUSTRY LAND PAN (TYPE (2)).

2 ft. deep, is made of 22-gauge galvanized iron, and is sunk in the ground so that 4 in. of the rim projects above the ground surface. The water surface is maintained at approximately the elevation of the surrounding ground, and whenever it deviates more than $\frac{1}{2}$ in. from the level, due to either evaporation or precipitation, it is brought back to the standard elevation by adding or removing water. The evaporation from the pan is measured by a special micrometer point-gauge, placed on the stilling-well, which is attached to the outside of the pan. A standard rain gauge, anemometer, and instrument shelter of the Weather Bureau type are a part of each station. Maximum-and-minimum thermometers and a psychrometer are provided for determining the temperature and the relative humidity. The readings are taken daily.

The Bureau of Plant Industry maintains an evaporation pan of this type at each of its dry land stations in the western half of the United States. Evaporation records, including complete meteorological data, are available at each of the stations up to and including 1916. After this date the water temperature records are lacking. The evaporation from this pan does not vary through as wide a range as that from Pan (1), nor does the temperature of the water follow the air temperature so closely. Since the variation in temperature is less, it is easier to determine the mean temperature. The evaporation is more nearly equal to that from a large water surface, and, consequently, a smaller correction is necessary to determine the evaporation from a large water surface. No direct comparisons are available between the evaporation from Pan (2) and from a large water surface, but comparisons have been made with pans for which this relation is known, and from this information it is possible to determine the factor to be used in computing the reservoir evaporation from the pan evaporation. This factor is given as 0.94 in Table 6, which is discussed subsequently.

Pan (2) is larger and more expensive to build and install than Pan (1) and data are not available from as many localities. Neither is the pan so well protected from splashing rain, drifting snow, and blowing dust and trash, as the Weather Bureau pan, but the fact that the rim is 4 in. above the ground minimizes the effect of these disturbing factors.

Pan (3).—The Colorado Sunken Pan.—The Colorado pan was developed at the Colorado Experiment Station. This pan, shown in Fig. 7, is usually made 3 ft deep, but will give satisfactory results if it is only 18 in. deep. It is made of 18-gauge galvanized iron and is sunk in the ground to within from 2 to 6 in. of the top, depending on conditions. Probably the most satisfactory depth is 4 in., because it tends to eliminate the difficulties due to splashing rain, drifting snow, and the accumulation of dust and trash to a considerable extent without introducing too great a rim effect due to the exposed metal. The water is maintained at the ground level and should not be permitted to deviate more than an inch each way from this level. A hook-gauge is used for measuring the evaporation and a stilling-well should be installed when accurate results are desired. A standard anemometer and rain gauge are provided for measuring the wind velocity and precipitation, and maximum-and-minimum thermometers for the temperature. A sling psychrometer is used to determine the humidity. Readings on the pan are taken twice daily.

The Colorado pan has not been used as extensively as Pans (1) and (2). It has advantages, however, which warrant a wider use of this type. It is cheap and easy to build and install. Due to the fact that the pan is sunk in the ground, the water temperature lags behind the air temperature. In this respect it resembles a large water surface more nearly than Type (1), and is similar to Pan (2). For this reason the mean temperature of the water is easy to determine. The evaporation from the Colorado pan is almost identical with that from a floating pan of the same size and shape, exposed under the same meteorological conditions, and is much easier to maintain.

The correction factor, 0.78 (in Table 6), for computing the equivalent evaporation from a reservoir is between that for Pans (1) and (2). It has been determined under a wide range of conditions with uniformly consistent results.

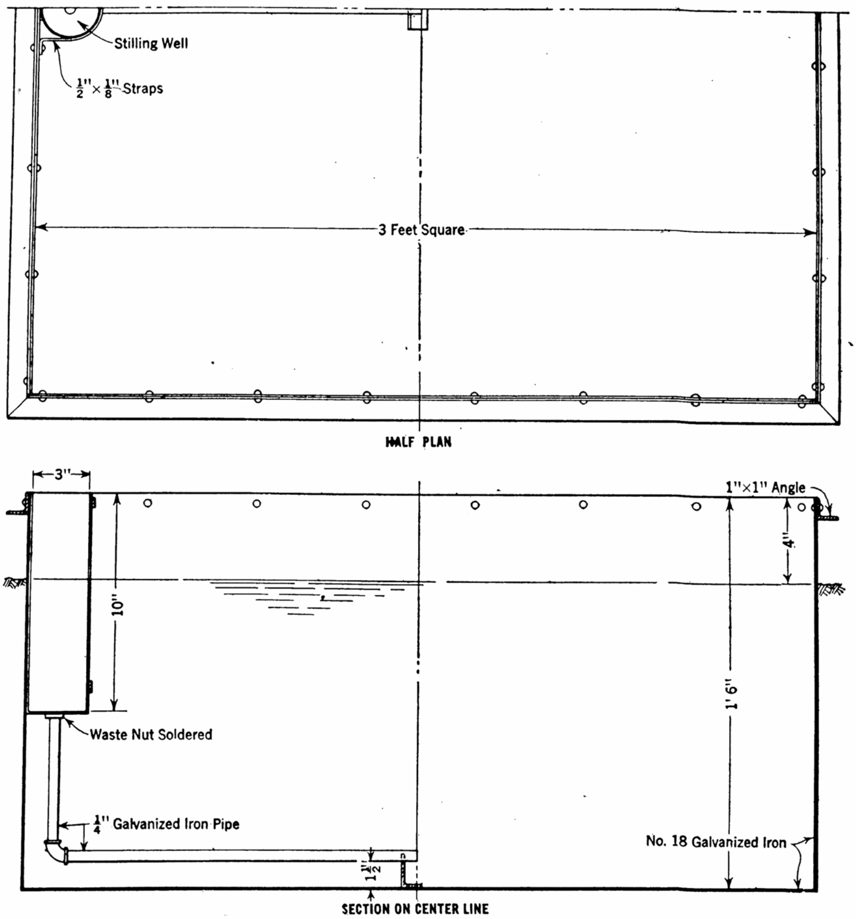

FIG. 7.—COLORADO LAND PAN (TYPE (3)).

Pan (4).—The United States Geological Survey Floating Pan.—The evaporation pan in Fig. 8, was designed for use in measuring the loss from lakes and reservoirs because it was thought that evaporation from a floating pan would be identical with that from a reservoir, but the experimental results have not substantiated this conclusion. This pan is made of 18-gauge galvanized iron and is supported by two cylindrical metal tubes, so that it floats in the water with 3 in. of the rim above the surface. The water inside the tank is kept at the same depth as that outside. Surging in the pan is reduced by two diagonal diaphragms beneath the water surface, which are perforated with 1-in. holes as shown. In order to protect it from the waves, the pan is surrounded by a raft supported by barrels to keep it from sinking when water-logged. Evaporation is determined by measuring the water required to bring the level to a fixed point which is attached to the intersection of the diaphragms. A special cup holding exactly enough water to raise

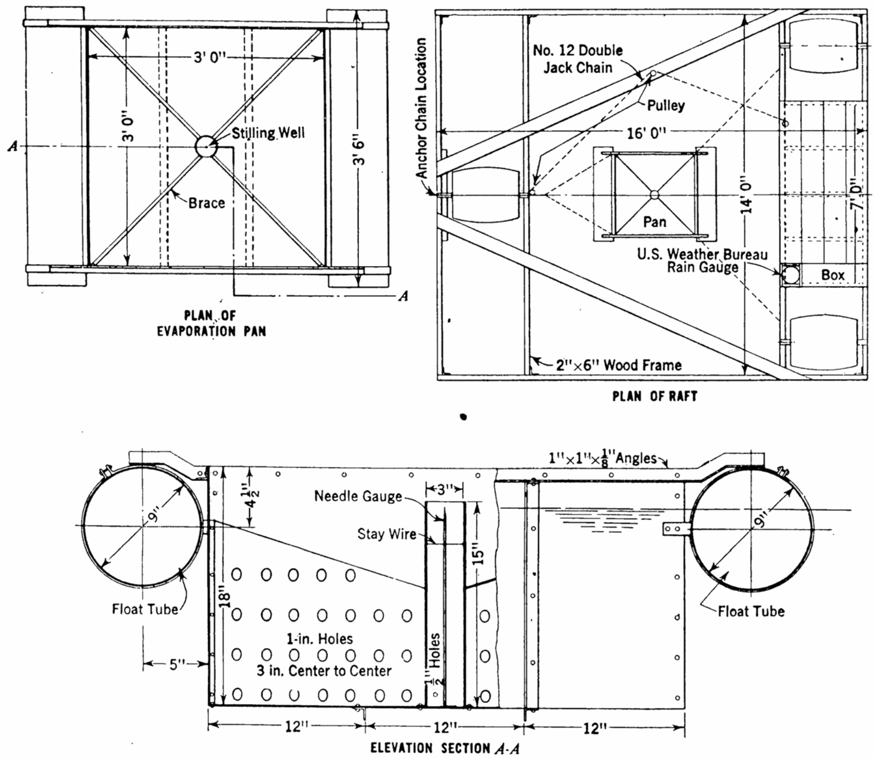

FIG. 8.—PLAN AND SECTION, U. S. GEOLOGICAL SURVEY FLOATING PAN (TYPE (4))

the level of the pan 0.01 in. is used in making the measurement. When complete meteorological records are desired, the same instruments should be used as are provided for Pan (2).

Being in the water, Pan (4) is protected from drifting snow and is not affected by the splashing of the rain, because as much splashes in as splashes out. Neither dust nor trash can blow into the pan. It is subject to the same conditions as those that occur in the lake or reservoir, and, consequently, the factor for computing the equivalent evaporation from the large water surface should be nearer unity than the factors for the land pans. The experimental results are inconsistent; however, the mean value of the factor is 0.77. The evaporation from the floating pan is almost identical with that from a similar sunken pan (see Table 3(*a*) and Table 6). Since, in comparison with the land pan (Type (1)), Pan (4) is more expensive to construct, more difficult to maintain, and is constantly subject to the danger of being splashed full of water from outside waves or being partly emptied by water splashing out of the tank, due to the rolling of the pan, this type is losing favor rapidly and is being replaced by some type of land pan.

Pan (5).—United States Weather Bureau Floating Pan.—Pans of the Weather Bureau type, as shown in Fig. 4, are sometimes used as floating pans. They have all the advantages and disadvantages of Pan (4), except that they roll more when there is a swell because of their greater size. This condition has been overcome to some extent by building cellular baffles in the pan below the water surface. Evaporation is almost identical with that from a buried pan of similar shape (see Table 1). The constant for converting the pan evaporation to reservoir evaporation has been established as 0.78 (Table 6). Equipment similar to that used at stations of the Bureau of Plant Industry is recommended.

From the foregoing discussion and from the experimental results, Pan (1) seems to be best adapted to the study of ordinary evaporation problems. For special problems, some of the other types of pans may give better results and, under these conditions, the merits of the different pans for the special problem should be investigated. The evaporation from Pan (2) probably approaches that from a large body of water more nearly than any of the other standard pans, but the factor for converting the pan evaporation to the reservoir evaporation is not known as definitely as for some of the other pans. Although this factor has been determined for the Colorado pan (Type (3)) under a wide range of conditions, this type has been used to only a limited extent in evaporation investigations, and, consequently, comparative evaporation records are available for only a few places. As previously mentioned, records observed from floating pans are unreliable, and since the evaporation from a sunken land pan is almost identical with that from a floating pan of the same size, there is no purpose in using a floating pan.

Procedure

The location of the evaporation pan should be given careful consideration; otherwise, comparable and reliable data can not be obtained. The land pans should be installed in level areas unobstructed by trees and buildings, and if the observations are for the purpose of determining the equivalent reservoir evaporation, the location chosen should be representative of conditions at the reservoir. Isolated places, where no satisfactory water supply is available, or where it is not possible to secure the services of an intelligent observer, should be avoided. The equipment should be protected by a close mesh-wire fence. Fig. 5 is a diagram of a completely equipped Class *A* Weather Bureau Station. Although floating pans are not recommended, if it is necessary to install one for any reason, the location chosen should be in an area protected, to some extent, from the full force of the waves. The exposure to the wind, however, should represent the average conditions for the reservoir. The approximate elevation of the area chosen should be known, because evaporation varies with altitude.

The evaporation from the different types of pans is dependent, to some extent, on the color of the pan, and for this reason it is recommended that no paint, tar, or other coating, be used. To reduce the growth of algæ and other plants in the water, the pans should be cleaned at least once a month, and oftener if necessary. Cleaning the tanks also reduces the concentration of salts in the water, which otherwise would occur due to the evaporation.

In order to obtain comparable evaporation data, complete meteorological records should be taken and a standardized procedure should be followed in taking the observations. The meteorological record should include the air and water temperature, the humidity, the wind movement, the precipitation, and the evaporation loss. The following instruments are required:

Two sets of "maximum-and-minimum" thermometers for determining the mean air and water temperature; or
Two ordinary thermometers where observations can be taken at 12-hr intervals, or oftener;
One psychrometer for determining the humidity of the air;
One anemometer for recording the wind movement;
One rain gauge for measuring the precipitation;
One gauge for measuring the evaporation; and
One instrument shelter for the air thermometers and the psychrometer.

The standard Weather Bureau practice should be followed in taking the observations. Complete instructions for the operation of Pan (1) are given in *Circular L* of the Instrument Division of the U. S. Weather Bureau, and observations on the other types of pans should follow the same procedure. The mean water temperature and the relative humidity of the air are not observed by the Weather Bureau at its Class *A* stations, but these observations should be taken. The mean temperature of the water may be determined either by readings of "maximum-and-minimum" thermometers floating in the water with their bulbs immersed $\frac{1}{4}$ in. beneath the surface of the water, or by readings on an ordinary thermometer similarly exposed. The "maximum-and-minimum" thermometers require only a single reading daily to obtain a fair average of the temperature, whereas the ordinary thermometer must be read twice daily at 12-hr intervals for similar accuracy. Maximum thermometers are easily broken, however, and for this reason are not as satisfactory when the readings are taken by amateur observers. Where possible, the sling or rotating psychrometer should be used for determining the humidity, but where the readings can not be taken at regular intervals, a hair hygrometer may be used to obtain approximate results.

The velocity of the wind varies with the elevation above the ground surface. For this reason, a standard anemometer setting should be adopted for each type of evaporation pan in order to obtain comparable results. The standard practice at Class *A* Weather Bureau stations is to mount the anemometers on the grillage of timbers which supports the pan so that the cups of the anemometer are 6 in. above the top of the pan (see Fig. 3). At stations of the Bureau of Plant Industry, the anemometer is placed so that the cups are 24 in. above the top of the pan. Although no standard has been adopted for installing the anemometers at stations where Pans (3) or (4) are used, it is suggested for uniformity that the anemometers be mounted so that their cups are 18 in. above the surface of the ground or the water. Either 3-cup or 4-cup anemometers, of the Weather Bureau pattern, may be used. The 3-cup anemometers are more accurate at high wind velocities, but near the ground the velocities are never so high that the 4-cup anemometer is not sufficiently accurate.

The rain gauge for evaporation stations should be of the Weather Bureau type and should be installed in accordance with the instructions in *Circular L* of the Weather Bureau. The evaporation gauges used in connection with the different pans are usually of special forms, but any gauge giving readings to within 0.001 ft should be satisfactory.

Observations should be taken at 7:00 A. M., according to the recommendations of the Weather Bureau, but where complete and accurate meteorological data require it, the readings should be taken oftener. Observations twice daily at 12-hr intervals (usually at 7:00 A. M. and 7:00 P. M.) give more accurate results, particularly as to the humidity. Where readings can not be taken at regular intervals, recording instruments should be used to obtain the records.

Conclusions

Records from floating pans are not as consistent or reliable as land-pan records; nor is the evaporation from a floating pan any nearer the evaporation from a large water surface than that from a sunken pan of the same size and shape.

Comparisons between the evaporation from Class *A* land pans of the Weather Bureau (Type (1)) and Colorado sunken pans (Type (3)) with the evaporation from large water surfaces, indicate that there is a definite relation between the pan and reservoir evaporation. For the Class *A* land pan, the factor for computing the reservoir evaporation from the pan evaporation is between 0.69 and 0.70, and for the Colorado pan, it is 0.78.

Comparison of the evaporation from different types of pans with that from large water surfaces of different sizes, shows that the size of the pan has a proportionately smaller effect on the evaporation as the size of the surface increases, and that when the diameter is greater than 12 ft, the size of the pan has practically no effect on the evaporation.

When all factors are considered, Pan (1) is probably better suited for evaporation investigations than the other evaporation pans. In order to obtain comparable evaporation results, standard equipment installed under representative conditions should be used, and a standard procedure should be followed in making the observations.

Acknowledgments

The author wishes to acknowledge the co-operation of those agencies and individuals who furnished evaporation data from their unpublished records, or who gave other information about the experiments.

APPENDIX

SUMMARY OF DATA ON EVAPORATION FROM WATER SURFACES

For convenience of reference in this Appendix the various pans used in evaporation studies are identified by numbers as defined in the paper. For example, Pan (1) is the Class *A* land pan of the U. S. Weather Bureau, shown in Figs. 1 and 5; Pan (2) is the sunken pan of the U. S. Bureau of Plant Industry, shown in Fig. 6; Pan (3) is the Colorado sunken pan shown in Figs. 1, 3, and 7; Pan (4) is the floating pan of the U. S. Geological Survey shown in Fig. 8; and Pan (5) is simply Pan (1) used as a floating pan, as shown in Fig. 4.

East Park Reservoir, Stonyford, Calif.—The data in Table 1 are from records of the Bureau of Agricultural Engineering, United States Department of Agriculture, for observations made in July, 1930.[8] Water was maintained at a level approximately 2 in. below the rim in Pans (1) and (3). In Pans (2) and (4), the level was 3 in. below the rim.

TABLE 1.—EVAPORATION FROM RESERVOIR COMPARED WITH THAT FROM PANS; EAST PARK RESERVOIR, STONYFORD, CALIF.

Item No.	Water surface	Dimensions: Area	Dimensions: Depth, in feet	Precipitation, in inches	Temperature, in Degrees, Fahrenheit: Air	Temperature, in Degrees, Fahrenheit: Water	Difference in vapor pressure, in inches	Velocity of wind, in miles per hour	Evaporation; total for the month, in inches	Ratio of evaporation, Item No. 1 to other items
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1	East Park Reservoir	1800 acres	......	0.0	82.12	80.72	0.6723	1.676	8.183	1.00
2	Pan (3)	3 ft. square	1.5	0.0	78.42	79.32	0.6395	1.940	9.498*	0.75
3	Pan (2)	Diameter, 4 ft.	3.0	0.0	78.42	79.77	0.6393	1.905	10.464	0.78
4	Pan (1)	Diameter, 4 ft.	0.83	0.0	78.42	73.83	0.4998	2.667	11.926	0.69
5	Pan (5)	Diameter, 4 ft.	0.83	0.0	78.53	77.91	0.5680	1.779	10.432	0.78

* Data for the period beginning July 19, 1930. The corresponding evaporation from the reservoir for the same period is 7.162.

Pans (2) and (3) were buried to within 3 in. and 1 in. of the top, respectively. Pan (1) was installed on a grillage of timbers, and Pan (5) was fixed in a raft. In Column (9), Table 1, all the anemometer readings have been reduced to surface velocities. East Park Reservoir is in a water-tight valley, geologically. Its elevation is 1 200 ft.

Comparison of Evaporation from Pan (1) and Various Other Types of Pans.—The data in Table 2 are largely self-explanatory. In Table 2(*a*) a comparison is afforded between evaporation from Pans (1) and (2) (see Columns (8) and (9)), a Class *A* land pan, and a sunken pan. This part of Table 2 was compiled from information presented[9] by Ivan E. Houk, M. Am. Soc. C. E., covering observations made during 1926, 1927, and 1928. Pan (1) was the standard type shown in Fig. 5, while Pan (2) was 4 ft in diameter

[8] *Technical Bulletin No. 271,* U. S. Dept. of Agriculture.

[9] *Transactions,* Am. Soc. C. E., Vol. 94 (1930), Table 9, p. 991.

TABLE 2.—COMPARISON BETWEEN EVAPORATION FROM PAN (1), AND VARIOUS OTHER TYPES OF PANS

Item No.	Month	Number of years of record	Precipitation, in inches	Temperature of air, in degrees Fahrenheit	Relative humidity (percentage)	Velocity of wind, in miles per hour	EVAPORATION: TOTAL FOR MONTH, IN INCHES		Ratio: Column (9) to Column (8)
							Pan (1)		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	(a) LOS GRIEGOS, NEW MEXICO, COLUMN (9), IS TYPE (2); 4 FEET IN DIAMETER AND 2 FEET DEEP								
	Pans						Type (1)	Type (2)	
1	Jan......	2	0.0	36.2	48	2.3	1.74	1.04	0.60
2	Feb......	2	0.33	41.1	50	3.6	3.06	2.12	0.69
3	March...	2	0.28	46.8	40	4.2	6.20	4.46	0.72
4	April.....	2	0.46	52.9	37	4.6	8.50	5.86	0.69
5	May.....	2	0.69	61.6	34	4.0	10.68	7.28	0.68
6	June.....	2	0.50	68.2	34	3.4	11.46	7.74	0.68
7	July.....	2	1.12	74.1	49	2.6	11.12	7.60	0.68
8	Aug.....	2	2.14	70.8	61	2.6	8.76	7.02	0.80
9	Sept.....	3	0.84	65.7	55	2.6	7.02	5.26	0.75
10	Oct......	2	0.61	56.0	56	2.3	5.27	3.82	0.72
11	Nov.....	2	0.02	45.4	52	3.0	3.70	2.72	0.74
12	Dec......	2	0.54	33.4	72	2.8	1.36	0.98	0.72
13	Totals...	......	7.53	....	....	....	78.87	55.90	....
14	Means...	......	....	54.3	49	3.2	....	....	0.71
	(b) GARNETT, COLORADO, COLUMN (9) IS TYPE (2); 4 FEET IN DIAMETER AND 2 FEET DEEP								
	Pans						Type (1)	Type (2)	
15	April.....	1	0.36	41.9*	....	4.2	....	....	0.79
16	May.....	2	1.14	48.4*	....	3.7	....	....	0.76
17	June.....	3	1.00	57.4*	....	3.4	....	....	0.78
18	July.....	3	2.16	61.6*	....	3.1	....	....	0.77
19	Aug.....	3	1.44	59.5*	....	1.8	....	....	0.76
20	Sept.....	3	1.00	53.5*	....	2.0	....	....	0.81
21	Oct......	3	0.45	43.8*	....	1.9	....	....	0.80
22	Totals...	......	7.55	....	....	....	....	....	....
23	Means...	......	....	52.3*	....	2.9	....	....	0.78
	(c) LINCOLN, NEBRASKA, COLUMN (9) IS BRIGGS PAN, TYPE (2); 7.5 FEET IN DIAMETER AND 2 FEET DEEP								
	Pans						Type (1)	Briggs Pan	
24	May.....	4	3.45	61	66	4.8	6.603	5.181†	0.78
25	June.....	4	4.38	72	65	3.6	8.789	6.386	0.73
26	July.....	4	1.73	78	60	3.0	10.250	7.094	0.69
27	Aug.....	4	3.14	74	65	2.7	8.592	5.921	0.69
28	Sept.....	4	2.61	66	66	3.5	6.612	4.612†	0.70
29	Oct......	4	2.51	54	67	4.1	4.588	3.160	0.69
30	Totals...	......	17.82	....	....	....	45.434	32.354	....
31	Means...	......	....	68	65	3.6	....	....	0.71
	(d) MILFORD, UTAH, COLUMN (9) IS TYPE (2); 12 FEET IN DIAMETER AND 3 FEET DEEP								
	Pans						Type (1)	Type (2)	
32	March...	1	0.90	41.3	54	4.4‡	3.98§	2.74§	0.69
33	April.....	2	0.64	49.3	53	4.3	8.42‖	5.54‖	0.66
34	May.....	2	0.82	57.7	39	4.9	11.19	7.74	0.69
35	June.....	2	0.02	65.2	38	4.8	14.71	9.92	0.67
36	July.....	2	0.66	73.3	39	4.2	14.02	9.40	0.67
37	Aug.....	3	0.23	70.0	45	4.6	13.39¶	9.02¶	0.67
38	Sept.....	3	0.21	60.0	41	4.9	10.75	7.23	0.67
39	Oct......	3	1.12	50.1	44	3.7	6.59	4.40	0.67
40	Totals...	......	4.60	....	....	....	83.05	55.99	....
41	Means...	......	....	58.4	44	4.5	....	....	0.67

* Temperature of water. † Three-year record. ‡ From *Water Supply Paper 617*, U. S. Geological Survey, p. 36. § Twelve days, March, 1926, estimated. ‖ Twenty-three days, April, 1927, estimated. ¶ Four days, August, 1925, estimated.

TABLE 2.—(*Continued*)

Item No. (1)	Month (2)	Number of years of record (3)	Precipitation, in inches (4)	Temperature of air, in degrees Fahrenheit (5)	Relative humidity (percentage) (6)	Velocity of wind, in miles per hour (7)	EVAPORATION: TOTAL FOR MONTH, IN INCHES Pan (1) (8)	(9)	Ratio: Column (9) to Column (8) (10)
(*e*) NELSON RESERVOIR, MONTANA, COLUMN (9) IS TYPE (5); 4 FEET IN DIAMETER AND 10 INCHES DEEP									
	Pans						Type (1)	Type (5)	
42	May.....	3	2.37	54.5	64	6.64	8.82	5.26	0.60
43	June.....	3	5.06	65.9	64	5.80	9.57	6.37	0.67
44	July.....	3	2.99	69.6	63	4.65	11.18	7.82	0.70
45	Aug.....	3	0.95	64.2	59	4.69	11.36	8.67	0.76
46	Sept.....	3	0.76	58.7	60	5.01	7.70	5.31	0.69
47	Oct......	3	0.09	47.9	66	5.32	4.26	2.78	0.65
48	Totals...	......	12.22	....	....	....	52.89	36.21	....
49	Means...	......	....	60.1	63	5.35	....	....	0.68
(*f*) OAKDALE, CALIFORNIA, COLUMN (9) IS TYPE (5); 4 FEET IN DIAMETER AND 10 INCHES DEEP									
	Pans						Type (1)	Type (5)	
50	June.....	1	0.00**	70.8	....	5.9	13.373	8.233	0.62
51	July.....	1	0.00	78.5	....	5.8	17.034	10.849	0.64
52	Aug......	1	0.00	73.6	....	5.5	14.651	9.303	0.63
53	Sept.....	1	0.06	68.8	....	4.6	10.351	6.839	0.66
54	Totals...	......	0.06	....	....	....	55.409	35.224	....
55	Means...	......	....	72.9	....	5.4	....	....	0.64
(*g*) FALL RIVER MILLS, CALIFORNIA, COLUMN (9) IS TYPE (5); 4 FEET IN DIAMETER AND 8 INCHES DEEP									
	Pans						Type (1)	Type (5)	
56	Jan......	5	2.30	33.1	....	1.5	....	1.085	....
57	Feb......	5	2.79	38.6	....	2.0	2.034††	1.755	0.86
58	March...	5	2.23	44.4	....	2.5	3.635‡‡	3.199	0.88
59	April.....	5	1.73	48.2	....	3.1	4.903	4.255	0.87
60	May.....	5	1.13	55.4	....	2.9	7.670	6.356	0.83
61	June.....	5	0.59	63.4	....	2.8	10.209	7.768	0.76
62	July.....	5	0.00**	69.3	....	2.8	13.032	9.226	0.71
63	Aug.....	5	0.06	66.1	....	2.8	11.445	7.732	0.68
64	Sept.....	5	0.57	57.5	....	2.4	7.235	5.349	0.74
65	Oct......	5	0.85	50.8	....	1.8	4.581	3.316	0.72
66	Nov.....	5	3.39	42.1	....	1.6	....	1.659	....
67	Dec......	5	1.72	34.1	....	1.5	....	1.368	....
68	Totals...	......	17.36	....	....	....	64.744	48.956	....
69	Means...	......	....	50.2	....	2.3	....	....	0.76

** Trace. †† Two-year record. ‡‡ Four-year record.

and 2 ft deep, with 3 in. of the tank above ground. Water in Pan (2) was maintained at ground level. The anemometer cups were fixed 24 in. above ground, and readings were taken generally at 5:00 P. M. Los Griegos, N. Mex., is at an elevation of 4 970 ft.

Table 2(*b*) is from unpublished data in the office of the State Engineer of Colorado, made available through the courtesy of R. J. Tipton, Assoc. M. Am. Soc. C. E. Observations were made in 1927, 1928, and 1930. Pans (1) and (2) were the same dimensions as given in Table 2(*a*), with the difference that Pan (2) was buried to within 2 in. above ground. Mariotte control apparatus[10] was used to maintain the level in the pans. A 3-cup anemometer was fixed at 18 in. above the ground. Garnett, Colo., is at Elevation 7 700.

[10] For description, see *Transactions*, Am. Soc. C. E., Vol. 94 (1930), p. 962.

Table 2(*c*)[11] is from data observed during the four years, 1917 to 1920, inclusive. The Briggs pan (Type (2)) was 7:5 ft in diameter and 2.0 ft deep, and was set with the rim flush with the ground. Water was maintained 4 in. below the rim in both pans, and the anemometer cups were 5 in. above Pan (1). The relative humidity readings in Column (6) were taken at Lincoln, Nebr. (3 miles from the pans) at 7:00 A. M. and 7:00 P. M. The pans, in this case, were at Elevation 1 150.

Table 2(*d*)[12] is from data observed during the three years, 1925, 1926, and 1927. Pan (2) was 12 ft in diameter, was set with the rim 3 in. above ground, and the water was maintained at ground level. The relative humidity in Column (6), Table 2(*d*), was taken from the record of Modena, Utah. Evaporation readings were taken at 8:00 A. M. The elevation of Milford, Utah, is 4 962.

Table 2(*e*) shows[13] some data and observations made during the three years, 1921, 1922, and 1923. Water in the floating pan, Type (5), was 6 in. deep, and the surface was maintained at the same elevation as the water in the reservoir. This pan was 350 ft from shore; the land pan, Type (5), was on a small knoll, 100 yd from shore. Anemometer readings were begun in 1922, with standard setting. Precipitation records (Column (4)) are those of Malta, Mont., and the relative humidity (Column (6)) readings are those at Havre, Mont. Nelson Reservoir is at Elevation 2 215.

The data pertaining to the floating pans in Tables 2(*f*) and 2(*g*) are from unpublished records furnished by the courtesy of the U. S. Weather Bureau. The land-pan records are from Climatological Data, California Section, U. S. Weather Bureau. The data in Table 2(*f*) were recorded during 1921. The land pan (Type (1)) was placed on a knoll and was filled with water to about 7 in., the anemometer cups being 6 in. above the rim. Observations were taken daily at 7:00 A. M. The floating pan (Type (5)) was exposed n a raft and filled to a depth of 6 to 7 in. of water. Oakdale, Calif., is at Elevation 215.

Data in Table 2(*g*) were recorded during the five years, 1925 to 1930. The land pan (Type (1)) was filled with water to a depth of about 7 in., anemometer cups being 11 in. above the rim. The floating pan (Type (5)) was submerged 4 in. and was filled with water to a depth of 6 in. Observations were taken daily at 7:30 A. M. Fall River Mills, Calif., is at Elevation 3 340, and the ground surrounding the station is flat.

Comparison Between Evaporation from Different Sizes of Pans.—Data compiled in Table 3(*a*) are from records of the U. S. Bureau of Agricultural Engineering, covering the years 1926, 1927, and 1928.[8] The wind velocity given is at the surface of the ground or water in each case. The wind velocities for Pans (3) and (4) are the same as for the reservoir. The elevation of Fort Collins, Colo., is 5 000 ft.

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[11] Comp. from *Monthly Weather Review*, Vol. 48, December, 1920, p. 715.

[12] Comp. from Climatological Data, Utah Section, U. S. Weather Bureau.

[13] Comp. from Climatological Data, Montana Section, and from the Annual Rept. of the Chief of the U. S. Weather Bureau; see *Transactions*, Am. Soc. C. E., Vol. 90 (1927), p. 275.

TABLE 3.—Comparison Between Evaporation from Different Sizes of Pans

			Pan *A*					Pan *B*				Pan *C*				Pan *D*					
			Temperature, in Degrees Fahrenheit																		
Item No.	Month	Number of years of record	Air	Water	Difference in vapor pressure, in inches	Wind velocity, in miles per hour	Total evaporation for the month, in inches	Temperature of water, in degrees Fahrenheit	Difference in vapor pressure, in inches	Total evaporation for the month, in inches	Ratio: Column (8) to Column (11)	Temperature of water, in degrees Fahrenheit	Difference in vapor pressure, in inches	Total evaporation for the month, in inches	Ratio: Column (8) to Column (15)	Temperature of water, in degrees Fahrenheit	Difference in vapor pressure, in inches	Wind velocity, in miles per hour	Total evaporation for the month, in inches	Ratio: Column (8) to Column (20)	Precipitation, in inches
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
(*a*) Fort Collins, Colorado																					
1	Pans		Reservoir: 85 Feet in Diameter and 6.75 Feet Deep					Pan (4): 3 Feet Square and 18 Inches Deep				Pan (3): 3 Feet Square and 18 Inches Deep				Pan (1): 4 Feet in Diameter and 10 Inches Deep					
2	April	2	45.6	50.8	0.1691	2.67	3.14	50.1	0.1677	4.08	0.77	49.6	0.1846	4.18	0.75	48.4	0.1857	3.71	5.21	0.60	1.408
3	May	2	58.3	62.5	0.2526	2.11	4.40	62.1	0.2530	5.80	0.76	61.6	0.2746	5.78	0.76	60.4	0.2752	2.91	6.94	0.63	2.176
4	June	2	62.3	68.5	0.2812	1.16	3.75	67.9	0.2800	4.94	0.76	66.6	0.2848	4.85	0.77	65.2	0.2699	1.70	5.42	0.69	2.565
5	July	2	70.5	75.8	0.3776	1.04	4.99	75.0	0.3709	6.59	0.76	74.1	0.3956	6.54	0.76	73.0	0.3842	1.58	7.21	0.69	1.229
6	Aug	2	67.2	72.3	0.3372	1.03	4.47	71.7	0.3313	5.82	0.77	70.3	0.3450	5.96	0.75	68.7	0.3203	1.56	6.26	0.71	1.128
7	Sept	3	57.4	64.7	0.3063	1.17	4.19	63.9	0.3014	5.22	0.80	60.9	0.2891	4.90	0.86	58.6	0.2607	1.76	5.10	0.82	0.522
8	Oct	3	48.8	54.4	0.1998	1.34	2.71	53.7	0.1974	3.59	0.76	51.4	0.1938	3.30	0.82	50.1	0.1876	2.05	3.77	0.72	0.792
9	Nov	3	37.9	41.1	0.0974	1.68	1.42	40.0	0.0898	1.74	0.82	37.1	0.0747	1.44	0.99	37.2	0.0782	2.60	1.84	0.77	0.474
10	Totals	......	......	......	......	......	29.07	......	......	37.78	......	......	......	36.95	......	......	......	......	41.75	......	10.291
11	Means	....	56.0	61.3	0.2526	1.52	......	60.6	0.2489	......	0.77	59.0	0.2553	......	0.79	57.7	0.2452	2.23	......	0.70	......
(*b*) Salt Creek Bridge, California (Circular, Floating, Type (5) Pan)																					
12	Pans		Pan (5): 12 Feet in Diameter and 10 Inches Deep					Pan (5): 6 Feet in Diameter and 10 Inches Deep				Pan (5): 4 Feet in Diameter and 10 Inches Deep				Pan (5): 2 Feet in Diameter and 10 Inches Deep					
13	May	5*	88.2	82.8	0.646	4.2	12.12	82.4	0.631	12.80	0.95	82.6	0.640	14.79	0.82	82.9	0.648	......	14.54	0.83	......
14	June	30*	86.0	82.6	0.628	5.0	10.89	82.0	0.604	11.61	0.94	82.0	0.609	13.29	0.82	81.9	0.601	......	13.83	0.79	......
15	July	6*	87.8	84.1	0.646	4.5	11.90	83.3	0.618	12.37	0.96	83.5	0.622	14.26	0.84	83.3	0.616	......	14.54	0.82	......
16	Totals	......	......	......	......	......	34.91	......	......	36.78	......	......	......	42.34	......	......	......	......	42.91	......	......
17	Means	......	86.53	82.84	0.633	4.83	......	82.24	0.609	......	0.95	82.29	0.615	......	0.82	82.23	0.609	......	......	0.81	......

* Days.

(c) Salton Sea, California (Circular Land Pan, Type (1))

18	Pans.......		Pan (1): 6 Feet in Diameter and 10 Inches Deep									Pan (1): 4 Feet in Diameter and 10 Inches Deep				Pan (1): 2 Feet in Diameter and 10 Inches Deep					
19	April.......	18*	75.9	75.5	0.589	4.93	11.58	.....	.....	.....	.....	76.1	0.616	11.52	1.01	76.1	0.610	.....	13.44	0.86	.....
20	May.......	31*	79.9	79.2	0.572	7.08	13.02	.....	.....	.....	.....	79.5	0.587	13.95	0.93	79.3	0.576	.....	16.86	0.77	.....
21	June.......	30*	83.8	83.7	0.710	7.03	13.62	.....	.....	.....	.....	83.3	0.694	15.48	0.88	82.9	0.681	.....	18.81	0.72	.....
22	July.......	30*	88.5	88.9	0.690	6.67	13.70	.....	.....	.....	.....	88.9	0.675	15.81	0.87	88.9	0.661	.....	19.62	0.70	.....
23	Totals.....	....	.....	.....	.....	.....	51.92	.....	.....	.....	.....	.....	.....	56.76	.....	.....	.....	.....	68.73	.....	.....
24	Means.....	....	82.68	82.50	0.6453	6.72	.....	.....	.....	.....	.....	82.57	0.6455	.....	0.92	82.40	0.6339	.....	.....	0.76	.....

(d) Brawley, California (Circular Land Pan, Type (1))

25	Pans.......		Pan (1): 6 Feet in Diameter and 10 Inches Deep									Pan (1): 2 Feet in Diameter and 10 Inches Deep									
26	March 5†...	4*	70.7	70.2	0.504	0.9	0.193‡	.....	.....	.....	.....	.....	.....	.....	.....	71.6	0.539	.....	0.283‡	0.68	.....
27	March 11†..	4*	68.4	67.3	0.476	1.0	0.228‡	.....	.....	.....	.....	.....	.....	.....	.....	67.6	0.488	.....	0.295‡	0.77	.....
28	March 17†..	3*	71.2	66.2	0.374	2.1	0.240‡	.....	.....	.....	.....	.....	.....	.....	.....	71.2	0.496	.....	0.315‡	0.76	.....
29	March 26†..	5*	64.4	65.1	0.362	4.5	0.283‡	.....	.....	.....	.....	.....	.....	.....	.....	66.0	0.382	.....	0.346‡	0.82	.....
30	April 2†....	5*	66.0	65.1	0.453	2.4	0.264‡	.....	.....	.....	.....	.....	.....	.....	.....	65.5	0.461	.....	0.362‡	0.73	.....
31	April 16‡...	5*	61.9	65.5	0.390	3.1	0.276‡	.....	.....	.....	.....	.....	.....	.....	.....	66.6	0.413	.....	0.354‡	0.78	.....
32	April 23‡...	5*	79.9	75.7	0.701	1.7	0.350‡	.....	.....	.....	.....	.....	.....	.....	.....	77.4	0.748	.....	0.453‡	0.77	.....
33	April 30‡...	5*	80.8	75.9	0.654	3.0	0.409‡	.....	.....	.....	.....	.....	.....	.....	.....	77.2	0.693	.....	0.532‡	0.77	.....
34	Means.....	....	70.4	68.9	0.489	2.3	0.280‡	.....	.....	.....	.....	.....	.....	.....	.....	70.4	0.528	.....	0.368‡	0.76	.....

(e) Mecca, California (Circular Land Pan, Type (1))

35	Pans.......		Pan (1): 6 Feet in Diameter and 10 Inches Deep									Pan (1): 2 Feet in Diameter and 10 Inches Deep									
36	March 5‡...	5	68.4	65.8	0.417	2.4	0.272‡	.....	.....	.....	.....	.....	.....	.....	.....	66.4	0.429	.....	0.362‡	0.75	.....
37	March 12‡..	5	67.5	64.0	0.413	2.3	0.244‡	.....	.....	.....	.....	.....	.....	.....	.....	64.4	0.421	.....	0.335‡	0.73	.....
38	March 17‡..	3	69.8	68.7	0.425	3.3	0.264‡	.....	.....	.....	.....	.....	.....	.....	.....	69.4	0.441	.....	0.398‡	0.66	.....
39	March 25‡..	4	64.4	65.3	0.362	3.7	0.276‡	.....	.....	.....	.....	.....	.....	.....	.....	64.8	0.350	.....	0.378‡	0.73	.....
40	April 2‡....	5	66.4	65.8	0.468	2.9	0.311‡	.....	.....	.....	.....	.....	.....	.....	.....	64.9	0.449	.....	0.449‡	0.69	.....
41	April 9‡....	3	74.8	71.2	0.465	4.0	0.346‡	.....	.....	.....	.....	.....	.....	.....	.....	72.3	0.492	.....	0.496‡	0.70	.....
42	April 16‡...	5	67.1	66.9	0.394	3.1	0.283‡	.....	.....	.....	.....	.....	.....	.....	.....	66.9	0.394	.....	0.382‡	0.74	.....
43	April 23‡...	5	82.6	73.2	0.669	3.2	0.449‡	.....	.....	.....	.....	.....	.....	.....	.....	73.8	0.685	.....	0.642‡	0.70	.....
44	April 29‡...	4	81.7	75.6	0.622	2.7	0.417‡	.....	.....	.....	.....	.....	.....	.....	.....	76.3	0.646	.....	0.559‡	0.75	.....
45	Means.....	....	71.4	68.5	0.471	3.1	0.318	.....	.....	.....	.....	.....	.....	.....	.....	68.8	0.479	.....	0.445‡	0.71	.....

* Days. † Period ending. ‡ Per 24 hours.

Tables 3(*b*) and 3(*c*) were compiled from unpublished data for 1910 furnished by the courtesy of the U. S. Weather Bureau. The pans in Table 3(*b*) were floated on a raft in an arm of the Salton Sea (approximate Elevation − 210), and were kept well immersed. The anemometer cups were approximately 8 in. higher than the rims of the pans.

The land pans in Table 3(*c*) were set on a platform 8 or 10 ft above the Salton Sea (approximate Elevation − 200), about ½ mile from the shore. Water was maintained in them at a depth of approximately 7 in. The anemometer cups were approximately 8 in. higher than the rims of the pans.

TABLE 4.—COMPARISON BETWEEN EVAPORATION FROM A 12-FOOT CIRCULAR SUNKEN PAN (TYPE (2)) AND VARIOUS OTHER TYPES

Item No.	Type of pan	Diameter, in feet	Depth, in feet	Depth of water in pan, in feet	Depth of setting, in feet	PERIOD OF OBSERVATION				EVAPORATION FOR THE PERIOD, IN INCHES		Ratio: Col. (11) to Col. (12)
						From	To	Except	Days of record	Item No. 1	Given pan	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
1	2	12.0	3.0	2.75	2.75	11/15/15	9/30/17	....	684	85.47	85.47	1.00
2	2	1.0	3.0	2.75	2.75	11/15/15	9/30/17	12/ 4/16 to 5/ 7/17	428	79.68	126.59	0.63
3	2	2.0	3.0	2.75	2.75	11/15/15	11/13/16	....	363	49.16	63.12	0.78
4	2	3.39	3.0	2.75	2.75	11/15/15	9/17/17	11/21/16 to 3/11/17	183	80.51	96.74	0.83
5	2	6.0	3.0	2.75	2.75	11/15/15	9/30/17	....	684	85.47	92.87	0.92
6	2	9.0	3.0	2.75	2.75	11/15/15	11/13/16	....	363	49.16	49.63	0.99
7	3	2.0†	3.0	2.75	2.75	4/17/16	9/24/17	11/13/16 to 5/29/17	328	68.18	89.49	0.76
8	3	3.0†	3.0	2.75	2.75	11/15/15	9/24/17	11/13/16 to 5/ 8/17	502	78.33	98.63	0.79
9	1	4.0	0.83	0.62	0.00‡	11/15/15	9/30/17	12/13/15 to 3/ 6/16 and 11/13/16 to 4/11/17	452	81 69	116.09	0.70
10	1	2.0	0.83	0.62	0.00‡	4/11/17	9/30/17	....	172	32.53	54.91	0.59
11	1	6.0	0.83	0.62	0.00‡	4/11/17	7/30/17	....	110	20.05	26.66	0.75
12	2	2.0	0.5	0.25	0.25	6/ 5/16	7/30/17	10/ 9/16 to 5/28/17	189	43.47	55.62	0.78
13	2	2.0	1.0	0.75	0.75	6/ 5/16	9/24/17	10/ 9/16 to 5/28/17	244	55.24	70.16	0.79
14	2	2.0	1.5	1.25	1.25	6/ 5/16	9/24/17	10/ 9/16 to 5/28/17	215	55.24	70.69	0.78
15	2	2.0	2.0	1.75	1.75	6/ 5/16	7/30/17	10/ 9/16 to 5/28/17	189	43.47	55.30	0.79
16	2	2.0	6.0	5.75	5.75	6/ 5/16	9/24/17	10/ 9/16 to 5/28/17	215	55.24	70.39	0.78
17	2	6.0	1.0	0.75	0.75	6/ 5/16	10/ 9/16	....	97	28.49	30.48	0.93
18	2	6.0	2.0	1.75	1.75	6/ 5/16	10/ 9/16	....	97	28.49	30.36	0.94
19	4	3.0†	1.5	1.25	1.25§	4/17/16	9/17/17	*	....	64.06	72.04	0.89
20	5	0.83	0.83	0.75	0.75	7/31/17	9/17/17	....	72	10.27	13.42	0.77
21	5	2.0	1.0	0.75	0.75	5/10/17	9/17/17	*	....	14.29	16.04	0.89
22	5	4.0	1.0	0.75	0.75	7/31/17	9/17/17	....	48	10.27	10.63	0.97
23	5	6.0	1.0	0.75	0.75	5/10/17	8/27/17	*	....	6.57	6.39	1.03

* Intermittent periods. † Square. ‡ Above ground. § Depth not given, but assumed to be standard.

Tables 3(*d*) and 3(*e*) are from unpublished records of 1910 furnished by the courtesy of the U. S. Weather Bureau. Water in the pans was maintained at an approximate depth of 8 in. In Table 3(*d*) anemometer cups were approximately 7 in., and in Table 3(*e*), 8.8 in., higher than the rim. The water surface was fully exposed. Brawley, Calif., is at Elevation − 110, and Mecca, Calif., is at Elevation − 189.

Comparison Between Evaporation from 12-Foot Circular Sunken Pan (Type (2)) and Various Other Types.—All the data in Table 4 were observed at Denver, Colo. (Elevation 5 346), during the years 1915, 1916, and 1917.[14]

[14] Comp. from *Journal of Agricultural Research,* Vol. X, No. 5, July 30, 1917, and from *Transactions,* Am. Soc. C. E., Vol. 90 (June, 1927), Table 15, p. 308.

General Comparisons: Land Pans and Floating Pans.—Table 5(*a*) has been compiled from three sources: *Bulletin 9* of the Department of Engineering, State of California; Climatological Data, California Section, U. S. Weather Bureau; and, *Transactions,* Am. Soc. C. E., Vol. 90 (June, 1927). Buena Vista Lake has an area of about 10 000 acres and is at Elevation 420. The observations were made in 1920, the temperature and precipitation records being taken at Bakersfield, Calif. The land pan—Type (3)—was sunk to within 3 in. of the top; the floating pan—Type (4)—was always submerged to within 6 in., of the top, or less. The depth of water was maintained at 3 in. below the top of both pans.

Table 5(*b*) is compiled from records in the *Water Supply Papers* of the U. S. Geological Survey, collected between 1916 and 1925. The Class *A* land pan (Type (1)) and the floating pan of the U. S. Geological Survey (Type (4)) were both of standard dimensions, as shown in Figs. 5 and 8, respectively. The floating pan was set in a lake 20 by 150 ft and from 8 to 10 ft lower than the land pan. Observations were taken at 7:00 A. M. Austin, Tex., is at Elevation 475.

Tables 5(*c*), 5(*d*), and 5(*e*) are from the set-up of identical pans at Morena Reservoir, Barrett Reservoir, and Lower Otay Reservoir, California, during 1928. The precipitation for all three was taken at the Barrett Dam and the temperature at Escondido, Calif. Some of the records were furnished by the courtesy of H. N. Savage, M. Am. Soc. C. E., and others were taken from Climatological Data, California Section, U. S. Weather Bureau. The elevations of the stations are as follows: Morena, 3 000 ft; Barrett, 1 600 ft; anod Lower Otay, 500 ft, above sea level.

Table 5(*f*) was compiled from data presented[15] by Charles H. Lee, M. Am. Soc. C. E., and from the Annual Reports of the Chief of the Weather Bureau. The floating pan (Type (4)), 3 ft square and 10 in. deep, was placed on a raft in Owens River. Water was kept approximately 2 in. below the rim. The deep land pan (Type (2)) was set with the top flush with the ground. In this pan water was never more than 4 in. below the rim. The shallow land pan (Type (3)) was set with the top 5 in. above ground and the water level was maintained approximately 2 in. below the rim. The anemometer cups were 42 ft above ground. Some of the evaporation records were partly estimated. Independence, Calif., is at Elevation 3 907; the period of record was from 1908 to 1911.

Table 5(*g*) was compiled from published and unpublished data recorded[16] by Mr. C. M. O'Neil, of the Canadian Pacific Railroad Company, during 1923 and 1924. The dimensions of land and floating pans were alike. The land pans were sunk in the ground to within 2 in. of their tops. Water was kept at ground level. In the floating pans, water was kept 4 in. below the rim or slightly above the level of submergence. The anemometer cups were 2 ft above ground. Temperature and wind velocity data were taken from plotted data. Brooks Reservoir, Alberta, Canada (Elevation 2 450), has an area of about 40 acres.

[15] *Transactions,* Am. Soc. C. E., Vol. LXXVIII (1915), pp. 177–178.
[16] *Loc. cit.,* Vol. 90 (June, 1927), pp. 343–351.

TABLE 5.—General Comparison of Evaporation Data from Land Pans and Floating Pans

Item No.	Month	Number of years of record	Precipitation, in Inches		Temperature, in Degrees Fahrenheit				Total Evaporation for the Month, in Inches			Ratio of Evaporation			Relative humidity (percentages)	Wind velocity, in miles per hour
					Air	Water						Column (11) to Column (10)	Column (12) to Column (11)	Column (12) to Column (10)		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
	(a) Bakersfield, California (Buena Vista Lake); Pans (3) and (4), 3 Feet Square and 2 Feet Deep															
1	Pan.........								Pan (3)	Pan (4)	Lake					
2	Jan.........	1	0.51		47.6	......	......	......	1.82	1.82	......	1.00	......	......	......	......
3	Feb.........	1	1.58		52.6	......	......	......	2.45	2.50†	......	1.02	......	......	......	......
4	March.......	1	2.28		53.4	......	......	......	2.83	2.89†	......	1.02	......	......	......	......
5	April........	1	0.14		59.0	......	......	......	5.99	6.78	......	1.13	......	......	......	......
6	May.........	1	0.00		68.3	......	......	......	9.05	10.58	......	1.17	......	......	......	......
7	June........	1	0.44		74.5	......	......	......	10.00	11.72	......	1.17	......	......	......	......
8	July.........	1	0.00		79.4	......	......	......	10.14	12.61	7.3	1.24	0.58	0.72	......	......
9	Aug.........	1	0.00*		81.2	......	......	......	9.62	11.27	7.0	1.17	0.62	0.73	......	......
10	Sept.........	1	0.00		71.7	......	......	......	7.21	8.46	7.1	1.17	0.84	0.98	......	......
11	Oct.........	1	0.63		60.4	......	......	......	4.88	5.42	4.6	1.11	0.85	0.94	......	......
12	Nov.........	1	0.16		55.6	......	......	......	2.29	2.44	2.0	1.06	0.82	0.87	......	......
13	Dec.........	1	0.76		49.0	......	......	......	1.56	1.50	......	0.96	......	......	......	......
14	Totals.......	......	6.50		......	......	......	......	67.84	77.99	28.0	......	......	......	......	......
15	Means.......	......	....		62.7	......	......	......	......	......	......	1.15	0.70	0.82	......	......
	(b) Austin, Texas (Pans (1) and (4), Standard Dimensions)															
16	Pans.........					Pan (1)	Pan (4)		Pan (1)	Pan (4)						
17	Jan.........	6	2.50		48.0	45.9	47.8	......	2.51	1.92	......	0.77	......	......	87.0	3.2
18	Feb.........	8	2.61		52.0	47.9	51.6	......	3.05	2.38	......	0.79	......	......	85.0	3.6
19	March.......	8	2.10		58.8	53.5	57.8	......	5.33	3.88	......	0.74	......	......	78.4	3.5
20	April........	9	4.41		66.2	60.6	65.4	......	6.03	4.92	......	0.83	......	......	81.8	2.5
21	May.........	9	4.47		73.4	69.0	72.6	......	6.91	5.46	......	0.79	......	......	83.3	1.7
22	June........	9	3.51		80.9	75.0	78.7	......	7.86	6.00	......	0.76	......	......	79.9	1.2
23	July.........	9	2.74		83.2	76.8	80.2	......	8.77	7.07	......	0.81	......	......	78.7	1.3
24	Aug.........	9	1.06		83.6	77.2	80.3	......	8.62	6.88	......	0.80	......	......	79.0	1.2
25	Sept.........	8	4.22		77.6	72.0	75.7	......	6.39	5.01	......	0.79	......	......	81.3	1.3
26	Oct.........	8	3.82		68.2	61.6	66.5	......	5.12	4.03‡	......	0.79	......	......	82.0	1.4
27	Nov.........	8	2.29		57.2	52.0	56.4	......	3.03	2.31	......	0.76	......	......	83.6	1.5
28	Dec.........	8	1.79		51.0	47.9	50.4	......	2.54	2.01	......	0.79	......	......	83.9	2.8
29	Totals.......	......	35.52		......	......	......	......	66.16	51.87	......	......	......	......	......	......
30	Means.......	......	....		66.7	61.6	65.3	......	......	......	......	0.78	......	......	82.0	2.1

* Trace. † Values estimated. ‡ Seven years of record.

(c) Morena Reservoir, California (Pans (3) and (4), 3 Feet Square and 1.5 Feet Deep

31	Pans........							Pan (3)	Pan (4)						
32	Jan..........	1	0.80	54.6	......	......	......	3.65	3.07	......	0.84	......	......	......	......
33	Feb..........	1	1.73	53.2	......	......	......	3.07	2.27	......	0.74	......	......	......	......
34	March.......	1	0.73	56.9	......	......	......	3.96	3.25	......	0.82	......	......	......	......
35	April........	1	0.17	57.2	......	......	......	6.72	6.37	......	0.95	......	......	......	......
36	May.........	1	0.31	64.3	......	......	......	8.86	7.48	......	0.84	......	......	......	......
37	June.........	1	0.00	66.3	......	......	......	9.44	8.60	......	0.91	......	......	......	......
38	July.........	1	0.00	69.9	......	......	......	11.14	10.03	......	0.90	......	......	......	......
39	Aug..........	1	0.00	70.0	......	......	......	11.23	9.93	......	0.88	......	......	......	......
40	Sept.........	1	0.00	69.5	......	......	......	9.71	8.82	......	0.91	......	......	......	......
41	Oct..........	1	0.32	61.8	......	......	......	7.00	5.97	......	0.85	......	......	......	......
42	Nov..........	1	1.09	56.8	......	......	......	4.23	3.65	......	0.86	......	......	......	......
43	Dec..........	1	2.90	53.0	......	......	......	2.76	......	......	......	......	......	......	......
44	Totals.......	......	8.05	......	......	......	......	81.77	69.44	......	......	......	......	......	......
45	Means.......	......	....	61.1	......	......	......	......	......	......	0.88	......	......	......	......

(d) Barrett Reservoir, California (Pans (3) and (4), 3 Feet Square and 1.5 Feet Deep

46	Pans........							Pan (3)	Pan (4)						
47	Jan..........	1	0.80	54.6	......	......	......	2.32	2.36	......	1.02	......	......	......	......
48	Feb..........	1	1.73	53.2	......	......	......	2.67	2.49	......	0.93	......	......	......	......
49	March.......	1	0.73	56.9	......	......	......	3.61	3.56	......	0.99	......	......	......	......
50	April........	1	0.17	57.2	......	......	......	6.06	6.06	......	1.00	......	......	......	......
51	May.........	1	0.31	64.3	......	......	......	7.53	§	......	§	......	......	......	......
52	June.........	1	0.00	66.3	......	......	......	9.49	§	......	§	......	......	......	......
53	July.........	1	0.00	69.9	......	......	......	10.65	§	......	§	......	......	......	......
54	Aug..........	1	0.00	70.0	......	......	......	10.30	§	......	§	......	......	......	......
55	Sept.........	1	0.00	69.5	......	......	......	9.49	§	......	§	......	......	......	......
56	Oct..........	1	0.32	61.8	......	......	......	5.75	5.30	......	0.92	......	......	......	......
57	Nov..........	1	1.09	56.8	......	......	......	3.79	3.16	......	0.83	......	......	......	......
58	Dec..........	1	2.90	53.0	......	......	......	2.41	2.01	......	0.83	......	......	......	......
59	Totals.......	......	8.05	......	......	......	......	74.07	24.94	......	......	......	......	......	......
60	Means.......	......	....	61.1	......	......	......	......	......	......	0.94	......	......	......	......

§ Records lost because pans were out of order.

TABLE 5.—(*Continued*)

Item No.	Month	Number of years of record	PRECIPITATION, IN INCHES		TEMPERATURE, IN DEGREES FAHRENHEIT: Air	Water			TOTAL EVAPORATION FOR THE MONTH, IN INCHES			RATIO OF EVAPORATION: Column (11) to Column (10)	Column (12) to Column (11)	Column (12) to Column (10)	Relative humidity (percentages)	Wind velocity, in miles per hour
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
(*e*) LOWER OTAY RESERVOIR, CALIFORNIA (PANS (3) AND (4), 3 FEET SQUARE AND 1.5 FEET DEEP)																
61	Pans........								Pan (3)	Pan (4)						
62	Jan..........	1	0.80		54.6	......	......	......	2.09	2.72	......	1.30	......	......	......	......
63	Feb..........	1	1.73		53.2	......	......	......	2.45	2.63	......	1.07	......	......	......	......
64	March.......	1	0.73		56.9	......	......	......	3.92	3.74	......	0.95	......	......	......	......
65	April.........	1	0.17		57.2	......	......	......	5.93	5.52	......	0.93	......	......	......	......
66	May..........	1	0.31		64.3	......	......	......	5.66	5.48	......	0.97	......	......	......	......
67	June.........	1	0.00		66.3	......	......	......	7.80	7.13	......	0.91	......	......	......	......
68	July..........	1	0.00		69.9	......	......	......	9.98	8.46	......	0.85	......	......	......	......
69	Aug..........	1	0.00		70.0	......	......	......	8.87	8.29	......	0.93	......	......	......	......
70	Sept..........	1	0.00		69.5	......	......	......	7.00	6.64	......	0.95	......	......	......	......
71	Oct...........	1	0.32		61.8	......	......	......	4.99	5.21	......	1.04	......	......	......	......
72	Nov..........	1	1.09		56.8	......	......	......	3.65	3.65	......	1.00	......	......	......	......
73	Dec..........	1	2.90		53.0	......	......	......	2.18	2.18	......	1.00	......	......	......	......
74	Totals........	......	8.05		......	......	......	......	64.52	61.65	......	......	......	......	......	......
75	Means.......	......	....		61.1	......	......	......	......	......	......	0.96	......	......	......	......
(*f*) INDEPENDENCE, CALIFORNIA (STANDARD, TYPE (4), FLOATING PAN, AND TYPE (3) LAND PAN, 3½ FEET IN DIAMETER AND 4 FEET DEEP; TYPE (3) LAND PAN, 3 FEET SQUARE AND 10 INCHES DEEP)																
76	Pans........								Pan (3)	Pan (3)	Pan (4)					
77	Jan..........	3	2.14		39.9	......	......	......	2.15‖	2.25¶	1.67	......	0.74	0.78	70	6.5
78	Feb..........	3	1.19		39.5	......	......	......	2.72‖	2.25¶	2.42	......	1.08	0.89	64	7.5
79	March.......	3	0.35		49.1	......	......	......	4.78	6.06‖	4.52	......	0.75	0.95	49	9.2
80	April.........	3	0.14		56.5	......	......	......	6.66	8.81‖	6.87	......	0.78	1.03	38	8.7
81	May..........	3	0.01		62.4	......	......	......	7.70‖	10.43‖	8.63	......	0.83	1.12	33	8.1
82	June.........	2	0.04		72.2	......	......	......	8.20	11.95¶	10.00	......	0.84	1.22	29	7.5
83	July..........	2	0.12		77.4	......	......	......	8.10	12.55¶	9.45	......	0.75	1.17	30	6.6
84	Aug..........	3	0.08		75.7	......	......	......	8.50‖	11.25‖	7.70	......	0.68	0.91	29	6.0
85	Sept..........	3	0.47		67.2	......	......	......	7.25‖	8.65‖	6.07	......	0.70	0.84	33	6.8
86	Oct...........	3	0.13		57.1	......	......	......	5.08‖	5.70‖	3.87	......	0.68	0.76	41	6.0
87	Nov..........	3	0.10		46.7	......	......	......	3.20‖	3.32‖	2.49	......	0.75	0.78	53	5.7
88	Dec..........	3	1.43		34.6	......	......	......	2.18‖	1.60‖	1.53	......	0.96	0.70	75	7.0
89	Totals........	......	6.21		......	......	......	......	66.52	84.82	65.22	......	......	......	......	......
90	Means.......	......	....		56.5	......	......	......	......	......	......	......	0.77	0.98	45	7.1

‖ Two-year record. ¶ One-year record.

	(*g*) BROOKS RESERVOIR AND LAKE NEWELL, ALBERTA, CANADA (PAN (2) AND PAN (5), 4 FEET IN DIAMETER AND 20 INCHES DEEP)															
						Brooks Reservoir			Lake Newell	Brooks Reservoir						
91	Pans.........		Brooks	Newell		Pan (2)	Pan (5)		Pan (2)	Pan (2)	Pan (5)		Brooks	Newell**		
92	May.........	2	0.83	0.98	......	......	......	......	5.53††	5.74††	......	......	......	0.96	......	3.2
93	June.........	2	2.93	2.74	59	61††	62††	......	5.65††	5.04††	5.86††	......	1.16	1.12	......	2.6
94	July.........	2	1.67	1.62	66	72††	69††	......	6.72	6.50	7.97	......	1.23	1.03	......	2.4
95	Aug.........	2	2.28	2.18	60	65††	64††	......	4.37	4.61	6.19	......	1.34	0.95	......	2.0
96	Sept.........	2	0.55	0.36	54	54††	54††	......	4.08	3.50	4.90	......	1.40	1.16	......	1.6
97	Totals.......	......	8.26	7.88	......	......	......	......	26.35	25.39	24.92	......	......	......	......	......
98	Means.......	......	......	......	59.8	63.0	62.2	......	......	......	......	......	1.27	1.14	......	2.4
	(*h*) CHESTNUT HILL RESERVOIR, BOSTON, MASS. (THREE TYPE (5) PANS)															
99	Pans:					Pan (5)	Pan (5)	Pan (5)	Pan (5)	Pan (5)	Pan (5)					
100	Diameter, in feet.....					1	1	10	1	1	10					
101	Depth, in feet.......					2	8	10	2	8	10					
102	June.........	18‡‡	......	......	......	72.5	72.9	73.3	5.29	5.13	4.58	......	0.89	0.87	......	......
103	July.........	31‡‡	......	......	......	77.2	77.7	77.2	7.99	8.04	7.14	......	0.89	0.89	......	......
104	Aug.........	31‡‡	......	......	......	74.4	75.0	74.4	6.93	7.05	7.41	......	1.05	1.07	......	......
105	Sept.........	30‡‡	......	......	......	65.7	66.6	66.0	5.64	5.81	5.13	......	0.88	0.91	......	......
106	Oct.........	28‡‡	......	......	......	57.0	57.7	56.6	3.39	3.47	2.79	......	0.80	0.82	......	......
107	Totals.......	......	......	......	......	......	......	......	29.24	29.50	27.05	......	......	......	......	......
108	Means.......	......	......	......	......	69.4	70.0	69.5	......	......	......	......	0.92	0.93	......	......
	(*i*) CHESTNUT HILL RESERVOIR, BOSTON, MASS. (THREE TYPE (5) PANS)															
109	Pans:					Pan (5)	Pan (5)	Pan (5)	Pan(5)§§	Pan(5)§§	Pan(5)§§					
110	Diameter, in feet.....					1	1	10	1	1	10					
111	Depth, in feet.......					2	8	10	2	8	10					
112	June 23–24...	24‖	......	......	64.5	69.4	70.0	69.0	0.490	0.500	0.420	......	0.84	0.86	50.0	11.9
113	June 24–25...	24‖	......	......	70.2	70.0	70.2	70.2	0.320	0.320	0.270	......	0.84	0.84	60.5	7.2
114	July 8–9......	24‖	......	......	77.8	79.6	80.2	79.6	0.320	0.320	0.242	......	0.76	0.76	74.4	6.2
115	July 9–10.....	24‖	......	......	74.4	77.7	78.2	77.8	0.310	0.320	0.255	......	0.80	0.82	76.2	8.0
116	July 10–11....	24‖	......	......	70.6	77.1	77.8	77.3	0.300	0.310	0.280	......	0.90	0.93	73.4	6.8
117	Aug. 7–8......	24‖	......	......	69.3	74.8	75.2	74.8	0.260	0.260	0.285	......	1.10	1.10	77.4	4.0
118	Sept. 11–12...	24‖	......	......	59.1	66.3	67.0	65.7	0.205	0.210	0.160	......	0.76	0.78	76.9	2.7
119	Oct. 14–15....	24‖	......	......	53.5	55.6	56.0	55.5	0.130	0.140	0.100	......	0.71	0.77	83.8	6.9
120	Totals.......	......	......	......	......	......	......	......	2.335	2.380	2.012	......	......	......	......	......
121	Means.......	......	......	......	67.4	71.3	71.8	71.2	......	......	......	......	0.85	0.86	71.6	6.7

** Pan (5) records for Lake Newell are not listed. †† Records are for 1924 only. ‡‡ Days. ‖ Hours. §§ Evaporation, in inches per 24 hours.

TABLE 6.—SUMMARY OF THE COMPARISON OF THE EVAPORATION FROM DIFFERENT TYPES OF PANS

Item No.	Type of pan	Location	Diameter, in feet	Depth of pan, in feet	Depth of water, in feet	Depth of setting, in feet	Elevation, in feet above sea level	Number of seasons of record	RATIO OF EVAPORATION FROM A GIVEN PAN OR RESERVOIR TO EVAPORATION FROM:						Observer
									Class *A* land pan, Type (1)	Sunken land pan, Type (2)	Colorado sunken land pan, Type (3)	Sunken circular land pan, Type (2)	U. S. Geological Survey floating pan, Type (4)	U. S. Weather Bureau floating pan Type (5)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
1	(2)	Denver, Colo..........	1.0	3.0	2.75	2.75	5 346	3	1.12	1.49	1.26	......	......	......	Sleight
2	(2)	Denver, Colo..........	2.0	3.0	2.75	2.75	5 346	2	0.90	1.21	1.02	......	......	......	"
3	(2)	Denver, Colo..........	3.39	3.0	2.75	2.75	5 346	3	0.85	1.13	0.96	......	......	......	"
4	(2)	Denver, Colo..........	6.0	3.0	2.75	2.75	5 346	3	0.77	1.02	0.87	......	......	......	"
5	(2)	Denver, Colo..........	9.0	3.0	2.75	2.75	5 346	2	0.71	0.95	0.80	......	......	......	"
6	(2)	Denver, Colo..........	12.0	3.0	2.75	2.75	5 346	3	0.70	0.94	0.80	......	......	......	"
7	(2)	Denver, Colo..........	2.0	0.5	0.25	0.25	5 346	2	0.90	1.20	1.02	......	......	......	"
8	(2)	Denver, Colo..........	2.0	1.0	0.75	0.75	5 346	2	0.89	1.19	1.01	......	......	......	"
9	(2)	Denver, Colo..........	2.0	1.5	1.25	1.25	5 346	2	0.90	1.20	1.02	......	......	......	"
10	(2)	Denver, Colo..........	2.0	2.0	1.75	1.75	5 346	2	0.90	1.20	1.02	......	......	......	"
11	(2)	Denver, Colo..........	2.0	6.0	5.75	5.75	5 346	2	0.90	1.19	1.01	......	......	......	"
12	(2)	Denver, Colo..........	6.0	1.0	0.75	0.75	5 346	1	0.75	1.00	0.85	......	......	......	"
13	(2)	Denver, Colo..........	6.0	2.0	1.75	1.75	5 346	1	0.75	1.00	0.85	......	......	......	"
14	(3)	Denver, Colo..........	2.0*	3.0	2.75	2.75	5 346	2	0.92	1.23	1.04	......	......	......	"
15	(3)	Denver, Colo..........	3.0*	3.0	2.75	2.75	5 346	3	0.88	1.18	1.00	......	......	......	"
16	(1)	Denver, Colo..........	2.0	0.83	0.62	0.00§	5 346	1	1.19	1.58	1.34	......	......	......	"
17	(1)	Denver, Colo..........	4.0	0.83	0.62	0.00§	5 346	3	1.00	1.33	1.13	......	......	......	"
18	(1)	Denver, Colo..........	6.0	0.83	0.62	0.00§	5 346	1	0.94	1.25	1.06	......	......	......	"
19	(5)	Salton Sea, Calif........	2.0	0.83	0.6	‖	—210	3¶	......	......	......	......	......	1.02	Bigelow
20	(5)	Salton Sea, Calif........	4.0	0.83	0.6	‖	—210	3¶	......	......	......	......	......	1.00	"
21	(5)	Salton Sea, Calif........	6.0	0.83	0.6	‖	—210	3¶	......	......	......	......	......	0.87	"
22	(5)	Salton Sea, Calif........	12.0	0.83	0.6	‖	—210	3¶	......	......	......	......	......	0.82	"
23	(1)	Salton Sea, Calif........	2.0	0.83	0.6	0.00§	—200	4¶	1.21	......	......	......	......	......	"
24	(1)	Salton Sea, Calif........	4.0	0.83	0.6	0.00§	—200	4¶	1.00	......	......	......	......	......	"
25	(1)	Salton Sea, Calif........	6.0	0.83	0.6	0.00§	—200	4¶	0.92	......	......	......	......	......	"
26	(4)	Independence, Calif......	3.0*	0.83	0.67	0.5	3 907	3	......	......	0.97**	......	......	......	Lee
27	(4)	Santa Clara Valley, Calif.	3.0*	1.0	0.83	......	......	2	......	......	0.71††	......	......	......	Duryea
28	(5)	Brooks Reservoir, Alberta, Canada..............	4.0	1.67	1.33	1.33	2 450	2	......	......	......	1.27	......	......	O'Neil
29	(5)	Brooks Reservoir, Alberta. Canada..............	4.0	1.67	1.33	1.33	2 450	2	......	......	......	1.14‡‡	......	......	"
30	(‡)	Newell Reservoir, Alberta, Canada..............	16.430†	......	......	......	2 485	7	......	......	......	0.95	0.70	......	"

* Square. † Acres. ‡ Lake or reservoir. § Exposed. ‖ Well immersed. ¶ Months. ** Sunken land pan, Column (12), 10 in. deep. †† Sunken land pan, Column (12), 12 in. deep; floating pan on raft in reservoir; ratio, average of six land pans to three floating pans. ‡‡ At Lake Newell, Alberta, Canada.

31	(‡)	Buena Vista Lake, Calif.	10 000†	......	......	......	420	1	......	......	0.82	......	0.81	......	Harding
32	(‡)	Lake Elsinore, Calif.	5 500†	......	......	......	1 261	1	......	......	......	......	......	......	"
33	(‡)	Lake Hodges, Calif.	1 317†	......	......	......	315	0.5	......	......	0.96	......	1.08	......	Lippincott
34	(‡)	Cuyamaca Lake, Calif.	978†	......	......	......	4 600	2¶	......	......	......	......	......	......	"
35	(‡)	Cuyamaca Lake, Calif.	978†	......	......	......	4 600	2¶	......	......	1.19	......	......	......	"
36	(2)	Stonyford, Calif.	4.0	3.0	2.75	2.75	1 200	1¶	0.88	......	0.96	1.00	......	1.01	Rohwer
37	(2)	Los Griegos, N. Mex.	4.0	2.0	1.75	1.75	4 970	2	0.71	......	......	......	......	......	Houk
38	(2)	Garnett, Colo.	4.0	2.0	......	1.83	7 700	3	0.78	......	......	......	......	......	Tipton
39	...	Means, Items No. 36, 37, and 38	......	......	......	......	......	......	0.79	......	0.96	1.00	......	1.01	....
40	(2)	Denver, Colo.	6.0	1.0	0.75	0.75	5 346	3	0.75	1.00	0.85	......	......	......	Sleight
41	(2)	Denver, Colo.	6.0	2.0	1.75	1.75	5 346	1	0.75	1.00	0.85	......	......	......	"
42	(2)	Denver, Colo.	6.0	3.0	2.75	2.75	5 346	1	0.77	1.02	0.87	......	......	......	"
43	...	Means, Items Nos. 40, 41, and 42	......	......	......	......	......	......	0.76	1.01	0.86	......	......	......	....
44	(2)	Lincoln, Nebr.	7.5	2.0	1.67	2.0	1 150	4	0.71	......	......	......	......	......	Loveland
45	(2)	Denver, Colo.	9.0	3.0	2.75	2.75	5 346	2	0.71	0.95	0.80	......	......	......	Sleight
46	(2)	Denver, Colo.	12.0	3.0	2.75	2.75	5 346	3	0.70	0.94	0.80	......	......	......	"
47	(2)	Milford Utah,	12.0	3.0	......	2.75	4 962	3	0.67	......	......	......	......	......	White
48	(2)	Fort Collins, Colo.	85.0	6.75	6.4	6.4	5 000	3	0.70	......	0.79	......	0.77	......	Rohwer
49	(‡)	East Park Reservoir, Stonyford, Calif.	1 800†	......	......	......	1 200	1¶	0.69	......	0.75	0.78	......	0.78	"
50	...	Means, Items Nos. 44 to 49	......	......	......	......	......	......	0.70	0.94	0.78	0.78	0.77	0.78	....
51	(3)	Stonyford, Calif.	3.0*	1.5	1.3	1.4	1 200	1¶	0.91	......	1.00	1.04	......	1.04	Rohwer
52	(3)	Fort Collins, Colo.	3.0*	1.5	1.33	1.33	5 000	3	0.89	......	1.00	......	0.98	......	"
53	(3)	Denver, Colo.	3.0*	3.0	2.75	2.75	5 346	3	0.88	1.18	1.00	......	......	......	Sleight
54	...	Means, Items Nos. 51, 52, and 53	......	......	......	......	......	......	0.89	1.18	1.00	1.04	0.98	1.04	....
55	(1)	Stonyford, Calif.	4.0	0.83	0.6	0.00§	1 200	1¶	1.00	......	1.10	1.14	......	1.14	Rohwer
56	(1)	Fort Collins, Colo.	4.0	0.83	0.62	0.00§	5 000	3	1.00	......	1.13	......	1.11	......	"
57	(1)	Denver, Colo.	4.0	0.83	0.62	0.00§	5 346	3	1.00	1.33	1.13	......	......	......	Sleight
58	...	Means, Nos. 55, 56, and 57	......	......	......	......	......	......	1.00	1.33	1.12	1.14	1.11	1.14	....

* Square. † Acres. § Exposed. ¶ Months.

TABLE 6.—(*Continued*)

Item No.	Type of pan	Location	Diameter, in feet	Depth of pan, in feet	Depth of water, in feet	Depth of setting, in feet	Elevation, in feet above sea level	Number of seasons of record	RATIO OF EVAPORATION FROM A GIVEN PAN OR RESERVOIR TO EVAPORATION FROM: Class *A* land pan, Type (1)	Sunken land pan, Type (2)	Colorado sunken land pan, Type (3)	Sunken circular land pan, Type (2)	U. S. Geological Survey floating pan, Type (4)	U. S. Weather Bureau floating pan, Type (5)	Observer
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
59	(4)	Buena Vista, Calif.	3.0*	2.0	1.75	1.5	420	1	......	......	1.15	......	1.00	......	Harding
60	(4)	Austin, Tex.	3.0*	1.5	......	......	475	9	0.78	......	......	......	1.00	......	Geological Survey.
61	(4)	Lower Otay Reservoir, Calif.	3.0*	1.5	1.25	......	500	1	......	......	0.96	......	1.00	......	Savage
62	(4)	Barrett Lake, Calif.	3.0*	1.5	1.25	......	1 600	1	......	......	0.94	......	1.00	......	"
63	(4)	Morena Lake, Calif.	3.0*	1.5	1.25	......	3 000	1	......	......	0.88	......	1.00	......	"
64	(4)	Fort Collins, Colo.	3.0*	1.5	1.25	1.25	5 000	3	0.91	......	1.02	......	1.00	......	Rohwer
65	(4)	Denver, Colo.	3.0*	1.5	1.25	1.25§§	5 346	2	......	......	......	......	1.00	1.09	Sleight
66	...	Means, Items Nos. 59 to 65.	......	......	......	......	......	......	0.84	......	0.99	......	1.00	1.09	....
67	(5)	Stonyford, Calif.	4.0	0.83	0.5	......	1 200	1¶	0.88	......	0.96	1.00	......	1.00	Rohwer
68	(5)	Nelson Reservoir, Mont.	4.0	0.83	0.5	0.5	2 215	4	0.68	......	......	......	......	1.00	Reclamation Bureau.
69	(5)	Fall River Mills, Calif.	4.0	0.67	0.5	0.33	3 340	5	0.76	......	......	......	......	1.00	Pac. Gas & Elec. Co.
70	(5)	Denver, Colo.	4.0	1.0	0.75	0.75	5 346	1	......	......	......	......	0.92	1.00	Sleight
71	...	Means, Items Nos. 67 to 70.	......	......	......	......	......	......	0.77	......	0.96	1.00	0.92	1.00	....
72	(5)	Salton Sea, Calif.	2.0	0.83	0.6	‖	—210	3¶	......	......	......	......	......	1.01	Bigelow
73	(5)	Denver, Colo.	2.0	1.0	0.75	0.75	5 346	1	......	......	......	......	1.00	1.08	Sleight
74	...	Means, Items Nos. 72 and 73.	......	......	......	......	......	......	......	......	......	......	1.00	1.04	....
75	(5)	Salton Sea, Calif.	6.0	0.83	0.6	‖	—210	......	......	......	......	......	......	0.87	Bigelow
76	(5)	Denver, Colo.	6.0	1.0	0.75	0.75	5 346	......	......	......	......	......	0.86	0.94	Sleight
77	...	Means, Items Nos. 75 and 76.	......	......	......	......	......	......	......	......	......	......	0.86	0.90	....

* Square. ‖ Well immersed. §§ Assumed to be standard depth. ¶ Months.

Tables 5(h) and 5(i) are from observations made[17] in 1885, on floating pans of the same type, but of different diameters and depths. All pans were floated in Chestnut Hill Reservoir, Boston, Mass. (Elevation 129), supported by a raft 20 ft wide and 40 ft long. They were filled with water to within 3 in. of their tops and submerged to within 6 in. of their tops (as scaled from photographs). Readings were taken daily for Table 5(h) and hourly for Table 5(i). The anemometer was 30.5 ft above the water surface.

Summary.—Table 6 is a summary tabulation of conclusions drawn from the preceding tables.

[17] *Transactions,* Am. Soc. C. E., Vol. XV (1886), p. 581.