# Comprehensive Monitoring of Meteorology, Hydraulics, and Thermal Regime of the San Diego Aqueduct, California

GEOLOGICAL SURVEY PROFESSIONAL PAPER 1137

# Comprehensive Monitoring of Meteorology, Hydraulics, and Thermal Regime of the San Diego Aqueduct, California

*By* HARVEY E. JOBSON *and* ALEX M. STURROCK, JR.

GEOLOGICAL SURVEY PROFESSIONAL PAPER 1137

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1979

**UNITED STATES DEPARTMENT OF THE INTERIOR**

**CECIL D. ANDRUS,** *Secretary*

**GEOLOGICAL SURVEY**

**H. William Menard,** *Director*

Library of Congress Cataloging in Publication Data

Jobson, Harvey E
Comprehensive monitoring of meteorology, hydraulics, and thermal regime of the San Diego Aqueduct, California.

(Geological Survey Professional Paper; 1137)
Includes bibliographical references.
Supt. of Docs. No.: I 19.16:1137
1. San Diego Aqueduct, Calif. 2. Meteorology--California, Southern--Observations. 3. Hydraulic me asurements--California, Southern. I. Sturrock, Alex M., joint author. II. Title. III. Series: United States. Geological Survey. Professional Paper; 1137.
TC764.J6 628.1'5 79-607792

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402

Stock number 024-001-03238-4

# CONTENTS



# ILLUSTRATIONS

# TABLES



# CONVERSION TABLE

[Factors for converting metric (SI) units to inch-pound units are shown to four significant figures]

| *Multiply metric unit* | *By* | *To obtain inch-pound unit* |
|---|---|---|
| meter (m) | 3.281 | foot (ft) |
| millimeter (mm) | 0.03937 | inch (in) |
| meter per second (m/s) | 35.31 | foot per second (ft/s) |
| cubic meter per second ($m^3$/s) | 0.02832 | cubic foot per second ($ft^3$/s) |
| pascal (Pa) | 10.00 | millibar (mb) |
| watt per square meter (W/$m^2$) | 2.065 | calorie per square centimeter per day [(Cal/$cm^2$)/d] |

# COMPREHENSIVE MONITORING OF METEOROLOGY, HYDRAULICS, AND THERMAL REGIME OF THE SAN DIEGO AQUEDUCT, CALIFORNIA

By HARVEY E. JOBSON and ALEX M. STURROCK, JR.

ABSTRACT

Water temperature, as well as meteorologic and hydraulic variables which influence the energy budget of the San Diego Aqueduct in southern California, were continuously monitored for a 1-year period beginning July 24, 1973. The incoming solar and atmospheric radiation, windspeed and direction, water temperature, and the wet- and dry-bulb air temperatures were recorded at 10-minute intervals at each end of the 26- kilometer concrete-lined canal, while the flow rates and stages were determined at hourly intervals for five locations. While only daily averaged values are presented in this report, a magnetic tape containing all the data can be obtained from the Automatic Data Processing Unit, U.S. Geological Survey, Water Resources Division, Reston, VA 22092. This report presents all information necessary for the use and interpretation of these data.

Windspeeds were typically low during the early morning hours and at maximum during the late afternoon; however, they were variable spatially. On the other hand, incoming radiation and absolute vapor pressure appeared to vary little from point to point. At a point where only the air temperature is known, the most accurate method to estimate vapor pressure is to compute it from the wet- and dry-bulb temperatures obtained at a remote site.

## INTRODUCTION

The ability to predict the effects of man-induced activity on various physical and biological water-quality factors is becoming increasingly important. Water temperature, while being an important water-quality characteristic in itself, affects nearly every physical property of water and influences the rate of nearly all chemical and biological reactions. A major obstacle to accurate temperature prediction in open channels is the estimation of the heat exchange due to evaporation.

In 1973 a comprehensive study of evaporation from open channels was initiated. The San Diego Aqueduct, owned and operated by the Metropolitan Water District of Southern California, was selected as the study site. The San Diego Aqueduct is a concrete-lined, open channel originating near Hemet, Calif. (about 120 km southwest of Los Angeles), and flowing generally south for about 26 km. The canal has a 3.66-m bottom width and side slopes of 1.5 to 1m. At full capacity it will deliver about 28 $m^3/s$, but it generally flows near half capacity. Since it carries water for municipal purposes, the flow rate is steady for long periods of time. Only three diversion points exist. Two of these are seldom used, and the third is insignificant in size.

Water temperature, as well as meteorologic and hydraulic variables which influenced the energy budget of the canal, were continuously recorded for a 1-year period beginning July 24, 1973. The incoming solar and incoming atmospheric radiation, windspeed and direction, water temperature, and wet- and dry-bulb temperatures were recorded at 10-minute intervals for each end of the canal, and the discharge and stage were recorded at hourly intervals for five locations.

The purpose of this report is three fold: (a) to present a description of the site, instrumentation, and procedures used in the study of the San Diego Aqueduct, (b) to present daily averaged values of the data obtained and provide the information necessary for the use of the complete data set, and (c) to present a general analysis of the temporal and spatial variability of the recorded data.

All data obtained during the study are available on magnetic tape and can be obtained from the Automatic Data Processing Unit, U.S. Geological Survey, Water Resources Division, Reston, VA 22092. The tape contains 10-minute values of all meteorologic and temperature data, hourly values of hydraulic data, and daily values of rainfall, pan evaporation, and supplementary windspeed measurements.

The spatial and temporal variations in windspeed and direction are analyzed in this report. The frequency of winds of various speeds and directions is also presented for each end of the canal. In addition to a presentation of the spatial and temporal variations in incoming atmospheric and solar radiation, the measurements are compared to computed clear-sky values, and the dependence of the measured diurnal variation in atmospheric radiation on sensor type is illustrated. Because the wet-bulb temperature is such a difficult parameter to measure, an analysis is presented which determines the most accurate method of predicting the vapor pressure using wet- and dry-bulb temperatures from a remote site. The variations in resistance to flow which occurred throughout the year are also presented.

## ACKNOWLEDGMENTS

The authors acknowledge the excellent cooperation extended by the Metropolitan Water District of Southern California. They granted the U.S. Geological Survey permission to install instrumentation on their premises, furnished copies of their operating records, and provided valuable assistance in the routine operation of the data-collection program. Especially helpful were Messrs. Paul Singer and Charles Voyles who were instrumental in granting the Survey permission to use the canal and to Mr. Kenneth Gandee who provided for the routine operations of the data collection.

## SITE DESCRIPTION

Evaporation was the process of major concern in the study and thus influenced the selection of a study site. Since the energy exchange due to evaporation is often small in comparison to radiation exchange and energy convected into and out of a stream-flow system, the most desirable site for study would be one where evaporation would be large and variations in the other elements of the energy budget small. Thackson and Parker (1971) presented monthly averaged meteorologic conditions for 88 locations in the United States. After a thorough study of these conditions, it was decided that the hot, dry climate found in southern California and southern Arizona provided the best general location for the study. Restricting attention to this general region of the country, a canal or other open-channel reach was sought which would have: (a) a traveltime of approximately 12 hours; (b) fairly constant and easily defined geometric and hydraulic characteristics; (c) reasonably steady flow rate; (d) very few tributary inflows of diversions; (e) a maximum depth of about 3 m; and (f) a fairly uniform wind exposure along the reach. After considerable reconnaissance, it was found that the San Diego Aqueduct most nearly met all the requirements. The San Diego Aqueduct carries water from the Casa Loma Canal to Lake Skinner (fig. 1).

Water for the San Diego Aqueduct is diverted from the Colorado River, below Parker Dam, and carried by the Colorado River Aqueduct to a point just west of the San Jacinto Mountains (fig. 1, northeast corner). At this point, the water can be diverted to the Casa Loma Canal or directly to the city of San Diego by underground pipe lines. Water for the San Diego Aqueduct is diverted from the Casa Loma Canal.

The general topography in the region consists of mountain massifs separated by the flat San Jacinto Valley floor. Areas with elevations above 610 m are shaded in figure 1. The elevation of the valley floor is approximately 450 m. The upper 40 percent of the canal traverses the approximate center of the valley, and the lower 60 percent of the canal runs along the extreme eastern edge of the San Jacinto valley; the land generally rises sharply to the east of the canal but is fairly flat to the west. A few short reaches in the lower part of the canal pass through cuts as deep as 18 m with steep side slopes. In general, the hilly areas of the region are used only for grazing, and the valley is grazed or used for the production of hay or other dryland crops. The National Atlas of the United States (U.S. Geological Survey, 1970) describes the natural vegetation as Coastal Sagebrush or Chaparral. Vegetation is of minor importance to the exposure of the water surface to either wind or radiation.

Thornthwaite (1931) described the climate as semiarid. The National Atlas (U.S. Geological Survey, 1970) shows the mean annual precipitation as ranging from 200 to 400 mm, with 30 days per year having more than 0.3 mm. The average annual runoff for the region is low, ranging from 10 to 30 mm; however, up to 130 mm of runoff may be expected in the mountains. Almost no precipitation occurs during the months of May–October. The average solar radiation is 121 W/m$^2$ in January and is 315 W/m$^2$ in July, and the mean temperature ranges from a low of 10°C in January to a high of 24°C in July. The mean dew point temperature is 2°C in January, whereas it is 10°C in July.

The San Diego Aqueduct is concrete lined, with a bottom slope of 0.00012. The cross section of the canal is trapezoidal, measuring 3.66 m for bottom width and 1.5 to 1 m for side slopes. The maximum design depth is 3.05 m, and it has a 0.305-m freeboard. Its capacity is about 28 m$^3$/s. The spoil dirt from the canal was piled along the sides so that the typical cross section appears as shown in figure 2. The spoil bank height varies along the length of the canal as shown in figure 3. The three very large bank height values represent places where the canal passes through deep cuts, but for the rest of the canal the bank height is more or less representative of the height of the spoil bank.

The 16 siphons which carry water under roads and drainageways for the San Diego Aqueduct are shown in figure 4. The longest, just south of Holland Road, is 197 m long, and the shortest, under Cottonwood Avenue, is 13 m long. The length, type, and location of all siphons are summarized in table 1. All siphons here have smooth transitions in the channel cross section upstream and downstream.

Three points are available for diverting water from

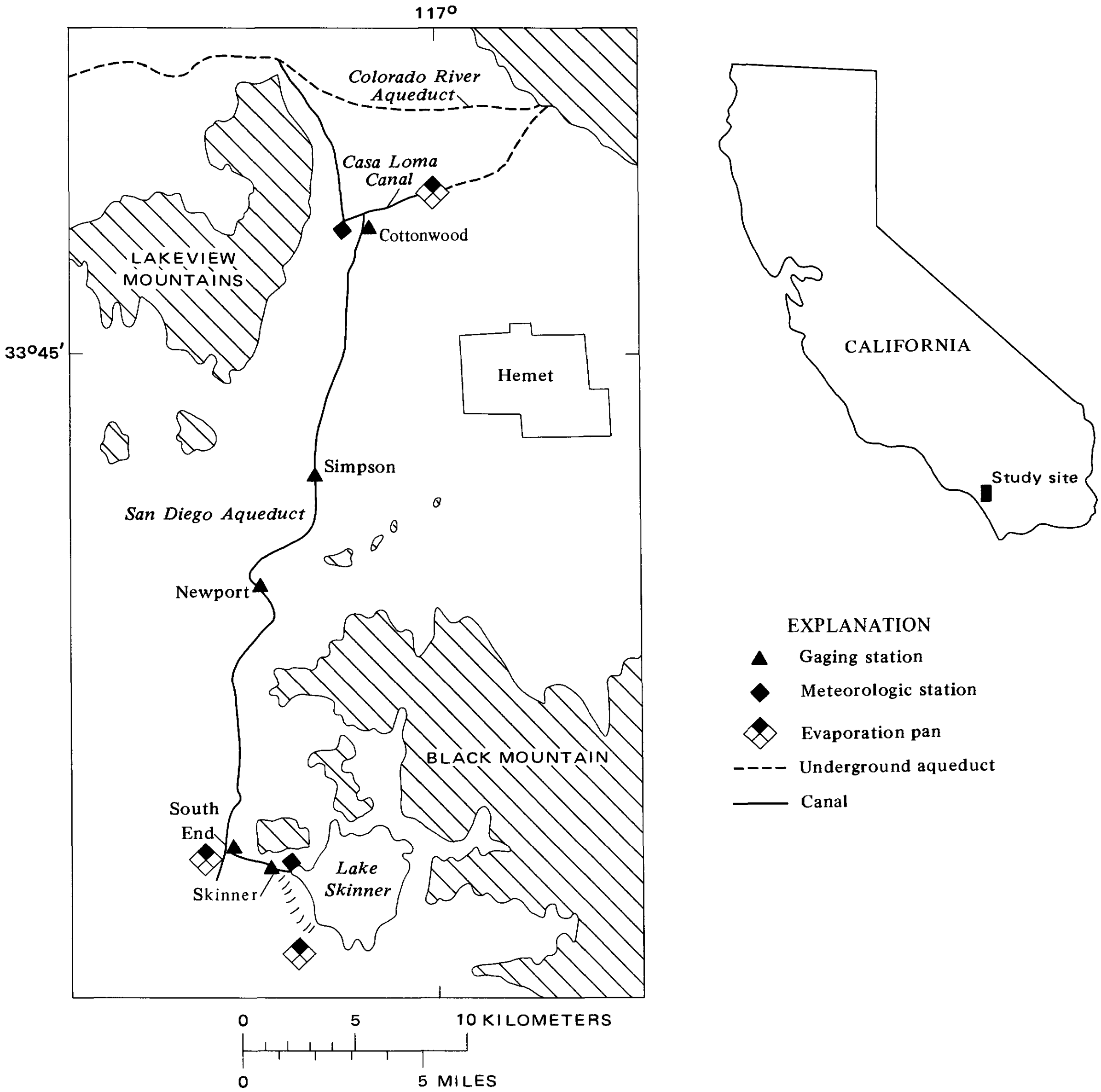


FIGURE 1.—San Diego Aqueduct and data-collection points. Shaded areas are above 610 m.

the canal. The first diversion structure, near Simpson Avenue, allows water to be diverted into the underground aqueduct shown in figure 1. This structure was in operation during 35 percent of the study and diverted a maximum of 3.02 $m^3/s$. The second diversion, known as EM–8, is insignificant in size. The maximum diverted flow was 0.15 $m^3/s$, but it generally diverted only about 0.03 $m^3/s$ for 1 or 2 hours during the day. This diversion structure is just below Holland Road and supplies water for a chicken farm. The third diversion structure, the So. End diversion, allows water to be diverted to San Diego without passing through Lake Skinner (fig. 1). The So. End diversion was not used except during the last 71 days (20 percent) of the study, when it was in continuous operation.

The diversion of water from the Casa Loma Canal at the entrance to the San Diego Aqueduct is shown in figure 5. The Casa Loma flows from east to west just behind the diversion structure. The outlet of the canal into Lake Skinner is shown in figure 6.

## INSTRUMENTATION

### RECORDING SYSTEM

Three types of recording systems were used for the study. Windspeed, wind direction, solar radiation, atmospheric radiation, wet- and dry-bulb temperatures, and water temperatures for each end of the canal were

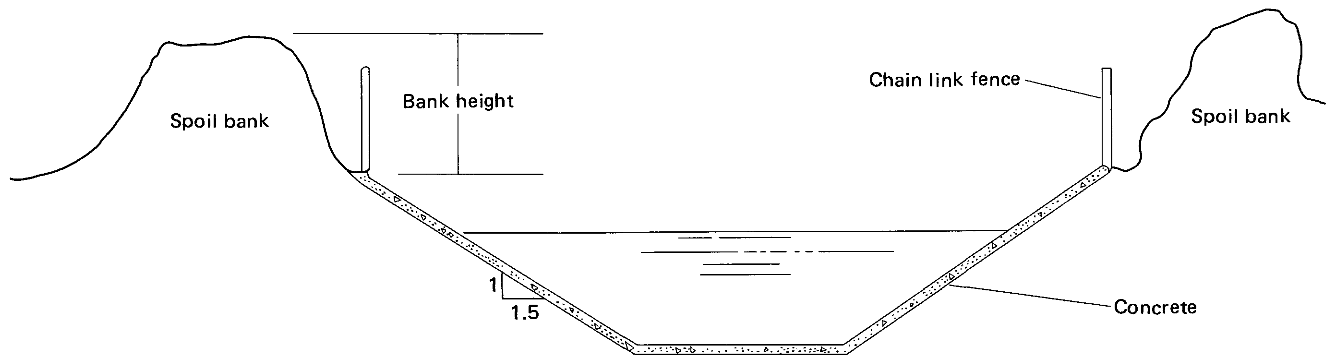


FIGURE 2.—Typical cross section of the canal.

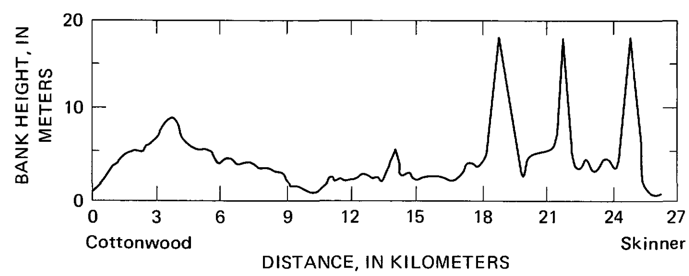


FIGURE 3.—Variation of bank height with distance along the canal.

recorded digitally at 10-minute intervals. Analog recorders were used to continuously record the stage at five points along the canal, the discharge of the EM-8 and Simpson road diversions, and after February 28, 1974, the discharge at the lower end of the canal. Analog records were digitized manually at hourly intervals. Rainfall, pan evaporation, pan windspeed, prevailing wind direction, and general weather conditions were observed daily.

The primary recording system to monitor radiation, wind, and temperatures consisted of Esterline Angus[1] D2020 recorders coupled with Pertec magnetic tape recorders. At 10-minute intervals the time, as well as the millivolt values of all 10 parameters, were recorded on magnetic tape. No averaging of the readings was possible, so recorded values were the millivolt readings at the instant they were sampled. A sampling of all 10 channels took only about 5 seconds. At approximately 1-hour intervals, the same information was printed in digital form on a paper tape. The paper tape allowed field monitoring of the system and served as a backup record on a few occasions when the magnetic tape system failed. At weekly intervals the magnetic and paper tapes were removed and mailed to NSTL Station, Miss., for processing. A total of 12 tapes was sufficient to allow them to be copied, cleaned, and returned to the field for reuse without a shortage occurring. The sys-

[1]The use of brand names in this report is for identification purposes only and does not imply endorsement by the U.S. Geological Survey.

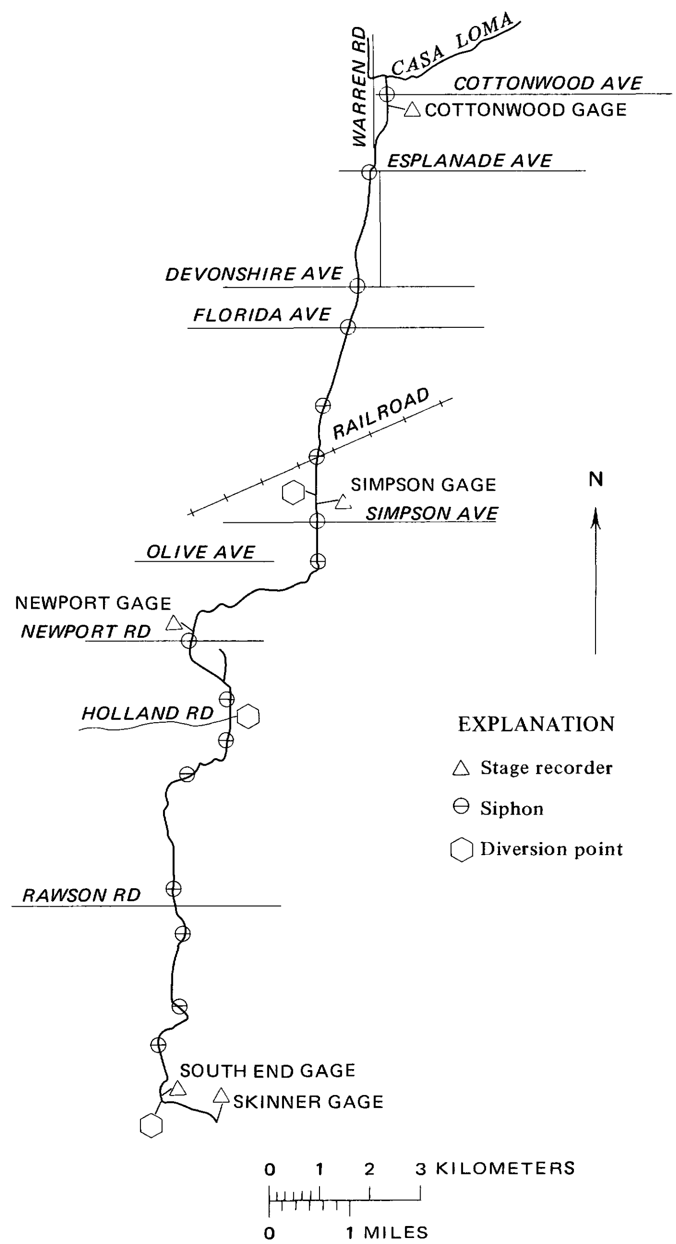


FIGURE 4.—San Diego Aqueduct, the diversion points, and locations of siphons and stage recorders.

TABLE 1.—*Locations of structures on San Diego Aqueduct*
[Information furnished by the Metropolitan Water District of Southern California]

| Name of structure | Distance from canal intake (m)[1] | Siphon characteristics Length (m) | Siphon characteristics Size |
|---|---|---|---|
| Cottonwood | 297.5 | 13.0 | pipe, 3.96 m I.D.[2] |
| Cottonwood stage | 593.7 | ---- | -------------- |
| Esplanade | 1,978.6 | 75.3 | box, 3.81×3.35 m |
| Devonshire | 4,453.4 | 40.3 | box, 3.81×3.35 m |
| Florida | 5,275.8 | 66.3 | box, 3.81×3.35 m |
| Stetson | 6,982.8 | 65.0 | box, 3.81×3.35 m |
| Railroad | 8,019.6 | 107.8 | box, 3.81×3.35 m |
| Simpson diversion | 8,793.8 | ---- | -------------- |
| Simpson stage | 9,134.2 | ---- | -------------- |
| Simpson | 9,410.9 | 61.1 | box, 3.81×3.35 m |
| Olive | 10,135.8 | 142.9 | pipe, 3.96 m I.D. |
| Newport stage | 13,460.3 | ---- | -------------- |
| Newport | 13,604.5 | 55.9 | box, 3.81×3.35m |
| Holland Road | 15,155.7 | 197.5 | pipe, 3.96 m I.D. |
| EM–8 diversion | 15,353.2 | ---- | -------------- |
| South Domanigoni | 15,932.6 | 133.8 | pipe, 3.96 m I.D. |
| Garbani Ranch | 17,042.0 | 158.5 | pipe, 3.96 m I.D. |
| French | 19,571.5 | 36.4 | box, 3.81×3.35 m |
| Rawson Road | 20,519.8 | 61.1 | box, 3.81×3.35 m |
| Bachelor Mountain | 22,525.7 | 158.5 | pipe, 3.96 m I.D. |
| South Bachelor Mountain | 23,852.1 | 36.4 | box, 3.81×3.35 m |
| So. End diversion | 24,978.4 | ---- | -------------- |
| So. End stage | 24,978.4 | ---- | -------------- |
| Skinner stage | 25,978.1 | ---- | -------------- |
| Skinner inlet | 25,982.7 | ---- | -------------- |

[1]Locations for siphons are determined by location of the siphon intake.
[2]Inside diameter.

FIGURE 5.—Diversion of water from the Casa Loma Canal at the entrance to the San Diego Aqueduct. Photograph taken from the east bank; view is to the north.

tem at the Cottonwood (north) end was housed in a plywood shelter (fig. 14). and at the Skinner (south) end it was housed in a concrete building (figs. 6 and 7).

The water stage was recorded on vertical-drum graphic recorders. These recorders had an unlimited range in stage because a stylus-reversing device was activated for each 0.3-m change in stage. A distance of 12.7 mm on the chart corresponds to a stage change of 0.305 m, and a distance of 4.6 mm corresponds to a time lapse of 24 hours. The stage records were collected as a part of the Metropolitan Water District's routine operating data. Charts were changed on a weekly basis, and copies of the charts were furnished to the Survey for analysis. These charts were read manually to determine the stage to the nearest 3 mm each hour.

FIGURE 6.—Skinner end of San Diego Aqueduct. Photograph taken from Lake Skinner dam; view is to the west.

FIGURE 7.—Recording system at downstream end of the canal.

The head on a Venturi meter at the Simpson road diversion was also determined from records of this type. The recorded head was converted to a discharge by use of a rating curve.

The diversion discharge to the chicken farm (EM–8) was recorded on a circular graphic chart which made one revolution per week. The chart was activitated by the head on a Venturi meter and was calibrated to read flow rate directly. The discharge could be easily read to the nearest 0.01 $m^3/s$. After February 28, 1974, the flow into Lake Skinner was recorded on a circular graphic chart which made one revolution per week. The flow rate could be easily read to the nearest 0.3 $m^3/s$. All circular charts were changed weekly; copies were sent to the Survey and digitized on an hourly basis. A supplementary windspeed was recorded on a weekly circular chart which contained a pip mark for the passage of each 16 km of wind. These charts were changed weekly, and the mean windspeed for each day was estimated.

## WIND

Propeller-type anemometers were used as the primary wind-sensing devices. The starting speed of the propeller is about 0.45 m/s, with complete tracking at about 1.40 m/s. The wind direction was measured by the movement of a wiper arm on a potentiometer housed in the main body of the anemometer.

The general exposure of the anemometer at Cottonwood is illustrated in figure 8. The sensor head was located approximately 2 m above the concrete platform, approximately 2.4 m above the elevation of the asphalt parking lot surrounding the concrete structure, and approximately 3.1 m above the surrounding ground level. The sensor was 3.8 m above the top of the canal. The valley floor is flat in this area, and no major obstructions occur within 1 km.

The wind exposure at the Skinner station was quite different from the Cottonwood station. The terrain rises steeply to the north as shown in figure 9, whereas it falls off rather rapidly to the south and west (fig. 10). The exposure of the primary anemometer at Skinner was adequate for south or west winds, poor for north winds, and only fair for east winds. The effective height probably varies with wind direction. The sensor was mounted 0.86 m above the roof of the building shown in figure 6. The railing (which was added after the study began) partly hides the sensor in the figure. The build-

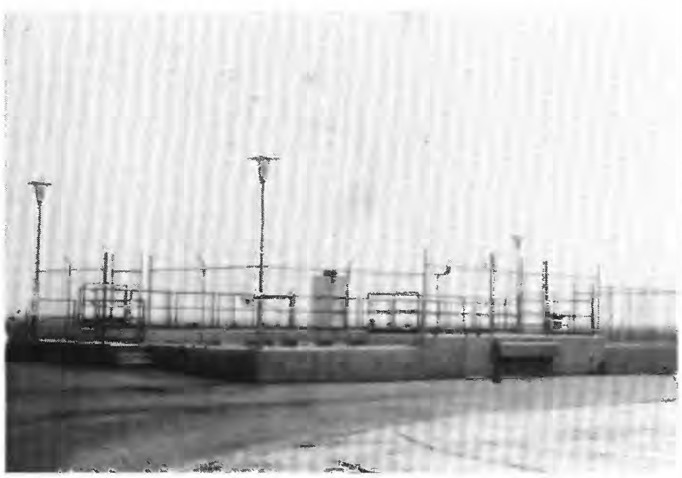

FIGURE 8.—Wind exposure at Cottonwood meteorologic station.

FIGURE 9.—Wind exposure at Skinner. Photograph taken from dam with view generally to the north.

FIGURE 10.—Wind exposure at Skinner. Photograph taken with view to the south.

FIGURE 11.—Psychrometer and supplementary anemometer at Cottonwood.

ing roof is 3.05 m above the level of the parking lot. The parking lot is generally lower than the surrounding terrain but about 0.3 m above the top of the canal.

Supplementary windspeed measurements were obtained over the water. At Cottonwood the supplementary anemometer was mounted on a swing-out arm which projected 3.0 m from the canal edge. The anemometer was 3.3 m above the top of the canal lining. The general location of the anemometer is illustrated in figure 11. Windspeed measurements were obtained by use of vertical axis cup anemometers equipped with totalizing dials. An electrical contact was closed upon the passage of each 16 km of wind, and the contact closure times were recorded on a circular chart. A closeup of the anemometer used at Cottonwood is shown in figure 12. At Skinner the supplementary anemometer was mounted on a short arm projecting to the west of the bridge over the canal shown in figures 6 and 13. The anemometer was 2.0 m above the top of the canal and was located near the center of the bridge.

Average daily windspeeds were obtained at the evaporation pans by reading a totalizing dial on the anemometers at approximately 0900 hours daily. The anemometers were mounted on the northwest corner of the evaporation-pan platform 0.15 to 0.20 m above the lip of the evaporation pan. The location of the evaporation pans is shown in figure 1.

### RADIATION

The total incoming solar radiation was determined by use of Eppley precision spectral pyranometers. These instruments are sensitive to radiation with a wavelength between 0.3 and 3 $\mu$m (micrometers). At Cottonwood the sensor was mounted on top of the plywood shelter housing the recording system (the instrument to the right in fig. 14). At Skinner it was mounted 1.14 m above the roof of the building (fig. 6).

Incoming atmospheric (longwave) radiation was determined by use of two types of instruments. From July 24, 1973, until November 27, 1973, atmospheric radiation was determined by use of Eppley (longwave) pyrgeometers which are sensitive to radiation in the range of 4 to 50 $\mu$m. These instruments were mounted beside the pyranometers (figs. 6 and 14). After November 27, 1974, a flat-plate radiometer of the Gier-Dunkle type was used to determine the incoming atmospheric component at Cottonwood. The flat-plate radiometer is sensitive to radiation of all wavelengths. Accordingly, the solar component, determined by use of the pyranometer, was subtracted from the total incom-

FIGURE 12.—Closeup of supplementary wind sensor and psychrometer at Cottonwood, view to the southeast.

FIGURE 13.—Closeup of supplementary wind sensor and psychrometer at Skinner, view to the south.

FIGURE 14.—Radiation instrumentation at Cottonwood, view to the south.

ing radiation to give the atmospheric component. The flat-plate radiometer was also mounted on top of the plywood shelter.

### TEMPERATURE

All temperatures were determined by use of platinum resistance temperature devices (RTD's). A 10-volt regulated d-c power supply furnished the required voltage to all the sensors. Capsule-style sensors with a sheath length of 63 mm and diameter of 3.2 mm were used for the dry- and wet-bulb temperatures. For measurement of water temperatures, a sensor with a sheath length of 127 mm and diameter of 6.3 mm was used.

Measurements of wet- and dry-bulb temperatures were made with a ventilated psychrometer as shown in figures 12 and 13. To insure proper wet-bulb depression, a vane axial fan with a constant output of 4.5 m/s was used to draw air through the tube. The total length of the tube was 203 mm, and the entire assembly was shielded from radiation by a curved aluminum sheet 380 mm long and curved in a semicircle with a 190-mm radius (fig. 15). The wet- and dry-bulb temperatures were measured by probes projecting across the tube mounted 139 mm and 51 mm behind the tube intake, respectively. The wet-bulb probe was covered by a wick which was continuously wetted by distilled water. The wick was a common white cotton shoelace which had been boiled in detergent to remove sizing and rinsed in distilled water. Water was supplied to the wick by gravity flow from a 1-gallon plastic bottle through a capillary tube. The rate of flow in the tube was controlled by a needle valve at the base of the bottle.

At Cottonwood the psychrometer was mounted under the swing-out arm as shown in figure 12. It was 2.7 m above the top of the canal. The general location of the psychrometer is illustrated in figure 11. At Skinner the psychrometer was mounted on a short arm which projected to the west of the bridge shown in figures 6 and 13. The psychrometer was 1.4 m above the top of the canal and near the center of the bridge.

Water-temperature probes were fastened to a wooden plank in such a manner that they would be 0.15, 0.61, 1.1, and 1.5 m above the bottom of the canal. At Cottonwood the plank was mounted to the west side of the canal so that it sloped downward with the canal side. The top of the plank can be seen in Figure 11. The temperature probes were held about 44 mm away from the concrete wall. Water temperatures were always found to be uniform, so on November 29, 1973, the bottom probe at Cottonwood was removed and not used during the remainder of the study. At Skinner a plank was mounted to the bridge so that it was held vertically near the center of the canal. The vertical locations of the probes at Skinner were the same as those used at Cottonwood.

### STAGE

The stage in the canal was recorded at the five locations shown in figure 4. In all cases, a float-stilling-well arrangement was used, and zero stage corresponds to zero depth in the canal. The Cottonwood gage was located on the right bank 0.593 km downstream of the canal entrance. The outlet of the Cottonwood Avenue siphon was 0.28 km upstream of the gage, and the entrance to Esplanade Avenue siphon was 1.38 km downstream. A gentle curve to the right begins 0.07 km below the gage. A photograph of the recorder and top of the stilling well is shown in figure 16, and the general canal conditions with a flow of about 2.8 $m^3/s$ is

FIGURE 15.—Closeup of the psychrometer.

FIGURE 16.—Recorder and stilling well at the Cottonwood gage, with view upstream.

shown in figure 17. Current meter measurements, made from the bridge shown in figure 17, were used to determine a stage-discharge relationship. The Cottonwood stage record was used to determine the discharge during times of unsteady flow.

The Simpson gage, located 9.13 km downstream from the canal entrance, is mounted over the center of the canal as shown in figure 18. It is 1.01 km downstream of the railroad siphon and 0.28 km upstream of the Simpson Road siphon. The Newport gage, located on the right bank 13.46 km downstream of the entrance, is shown in figure 19. The Newport gage is 3.18 km downstream of the Olive Avenue siphon and 0.14 km upstream of the entrance to the Newport Road siphon. The So. End gage, shown on the left side in figure 20, is located at the entrance to the So. End diversion (fig. 1). Before the construction of Skinner reservoir, the So. End diversion was the south end of the open part of the San Diego Aqueduct. The diversion is to the left in figure 20, and the flow into Lake Skinner continues toward the lower right. The Skinner gage was housed in the concrete building shown in figure 6 and is at the downstream end of the canal 25.98 km downstream of the canal entrance. The use of this gage was discontinued on February 20, 1974. The discharge at the time the photographs in figures 17, 18, 19, and 20 were taken was about 2.8 m³/s.

### FLOW RATE

Canal and diversion discharges were furnished by the Metropolitan Water District from their operating records during times of steady flow. The flow rate at Cottonwood was determined by the Metropolitan Water District from an analysis of gate openings which were periodically calibrated by current-meter meas-

FIGURE 17.—Canal at the Cottonwood gage, with view downstream.

FIGURE 18.—Simpson gage, view to the south.

FIGURE 19.—Newport gage.

FIGURE 20.—So. End gage and diversion, view to the west.

urements at the Cottonwood gage. The diversion discharge at Simpson road is determined by use of a calibrated weir. At the EM-8 diversion a Venturi meter was used. After February 28, 1974, the flow rate into Lake Skinner was continuously monitored by use of a sonic flow meter. The flow rate at the So. End diversion was not measured but can be obtained from continuity considerations.

### OTHER DATA

The Metropolitan Water District maintains two evaporation pans at the locations indicated in figure 1. The daily rainfall, pan evaporation, pan windspeed, general weather observations, and wind direction are recorded at about 0900 each day. On October 9, 1973, the observation station near the So. End diversion was moved to a point near the Lake Skinner outlet. Both locations are shown in figure 1.

## PROCEDURE

### DATA COLLECTION

All meteorologic instrumentation was designed to operate unattended for time periods of up to 1 week. However, on alternate days, the canal patrolman: (a) wiped dust from the radiometer bulbs; (b) checked the wick on the psychrometer (clean or change if necessary); (c) filled bottle with distilled water if necessary; (d) checked the printed output tapes for obvious malfunctions; (e) checked blower motors on the psychrometers; and (f) reported any malfunction to the Survey for correction. On a weekly basis, Water District personnel changed the magnetic and paper tapes as well as all weekly charts. The junior author visited the site on an approximately monthly basis to perform maintenance, check on the overall operation of the data-collection system, and carry out special measurements.

When the field magnetic tapes were received at the office, they were copied in compacted form on an inhouse tape. At the same time, a complete listing was produced as well as a time plot of the millivolt level for each channel. The computer listing and plots were compared with the output on the paper tape and instructions for further processing generated. At this point the major concern was to be sure the correct data were associated with each data block, the recorded times were correct, and that each day contained exactly 144 entries for each parameter. Corrections to the recorded times were frequently necessary because of short-term power outages, and so forth. Power outages were easily detected because the recorder clock would automatically start over at 0000 hours (midnight). All data were referenced to Pacific daylight time. Time checks written on the paper tape served as a reference for time corrections.

The hourly stage and discharge values were read from charts and keypunched. Likewise, the daily values of the supplementary windspeed, pan windspeed, pan evaporation, and daily rainfall were computed from recorded parameters and the values added to the data set. The declination of the sun was determined from a solar ephemeris.

### DATA PROCESSING

The next step in the processing of the data was to convert the millivolt values to engineering units and to delete all questionable values from the set. Converting to engineering units was simply a matter of applying the appropriate calibration factors to the millivolt readings, but detection of bad data in the set required considerable patience and systematic sorting.

Judgment as to the authenticity of the data was based primarily upon plots of the data as a function of time. Two types of plots were used: the original plots from the field data tapes where each 10-minute value was plotted as a function of time, and daily averaged plots where the entire year's data for a single parameter at each end of the canal could be displayed on one illustration. The recorder at Cottonwood developed a malfunction early in the study which caused the data to drift slowly off the true value. Comparison of the daily average plots from Cottonwood and Skinner on a channel-by-channel basis enabled the processor to determine the time at which a particular channel started drifting.

Considerable difficulty was experienced in keeping the wick on the psychrometer sufficiently wet. Time periods for which the wick was not sufficiently wet were obvious when a plot of the wet- and dry-bulb air temperature was inspected. In a like manner, times during which one of the water temperature probes was out of the water, owing to low stage, were also easily detected from a plot of the four water temperatures. Each channel of data was scanned several times, and data which were questionable were deleted. As a final check, after the data sets had been transferred to engineering units and questionable data deleted, a program was written which searched each channel of data for each station and printed the 20 largest values, 20 smallest values, and 20 largest changes to occur in 10 minutes, along with the date and time of occurrence of each event. The data on these listings were then rechecked for consistency and accuracy. As a final step the data were replotted on the 10-minute-interval basis and the plots scanned a final time.

Hydraulic data were processed in a similar fashion except that only hourly values and not 10-minute values were involved. The EM–8 diversion discharge was read directly from the circular chart, and no processing was necessary. An analog chart of the head on the weir at the Simpson Road diversion was furnished as well as the diversion discharge during times of steady flow. An analysis of the recorded head and discharge indicated that the flow could be computed from the formula

$$Qs = 1.62Y_w{}^{1.317} \qquad (1)$$

in which $Y_w$ is the head on the weir in meters, and $Qs$ is the Simpson Road diversion discharges in cubic meters per second. Equation 1 was used to determine the Simpson Road diversion discharge during time periods when the flow was changing.

For each day during which the flow was constant (209 out of 365), the Manning's roughness coefficient applicable to the Cottonwood stage was determined. The coefficients ranged from 0.0135 to 0.191 and could not be directly correlated with either stage or discharge. The variation appeared to result primarily from algal growth on the canal lining and therefore was more related to time of year than anything else.

Variable flow, extending over periods of 1–15 days, occurred on 27 occasions. During these time periods, the upstream flow was computed for each hour using the measured Cottonwood stage and Manning's equation. The roughness coefficients, obtained before and after the period of unsteady flow, were averaged for use in this computation.

Between February 28, 1974, and May 15, 1974, the discharge, as determined from the sonic flow meter at Skinner, was used to determine the flow in the canal. This value was read directly from an analog chart. The So. End diversion was in operation after May 15, 1974. Subsequent to that date the stage at Cottonwood was used to determine the flow into the upstream end of the canal. and the sonic flow meter was used to determine the flow at the downstream end. The flow at the So. End diversion could then be determined indirectly.

## CALIBRATION

Table 2 contains a summary of the calibration factors for instruments used in the study. All calibration equations were of the form

$$O = a + bE \qquad (2)$$

in which $O$ is output in the engineering units shown in table 2, $E$ is recorder output in millivolts, and $a$ and $b$ are constants shown in table 2.

TABLE 2.—*Calibration factors (for use in equation 3) of instrumentation used at the San Diego Aqueduct*

| Parameter | a | b | Units | Applicable dates |
|---|---|---|---|---|
| Cottonwood windspeed | 0.11 | 0.1984 | m/s | 07–25–73—07–23–74 |
| Skinner windspeed | .08 | .1997 | m/s | 07–25–73—07–23–74 |
| Cottonwood wind direction | 1.2 | 2.114 | degree | 07–25–73—07–23–74 |
| Skinner wind direction | −.7 | 2.089 | degree | 07–25–73—07–23–74 |
| Cottonwood solar | 0 | 110.0 | W/m² | 07–25–73—07–23–74 |
| Skinner solar | 0 | 103.1 | W/m² | 07–25–73—07–23–74 |
| All temperatures | −.03 | 4.995 | °C | 07–25–73—07–23–74 |
| Cottonwood atmospheric | 0 | 145.2 | W/m² | 07–25–73—08–28–73 |
| Cottonwood atmospheric | 0 | 145.6 | W/m² | 08–29–73—11–27–73 |
| Cottonwood total incoming | 0 | 562.4 | W/m² | 11–28–73—01–31–74 |
| Cottonwood total incoming | 0 | 355.0 | W/m² | 03–07–74—04–24–74 |
| Cottonwood total incoming | 0 | 474.2 | W/m² | 06–05–74—07–23–74 |
| Skinner atmospheric | 0 | 145.6 | W/m² | 07–25–73—08–29–73 |
| Skinner atmospheric | 0 | 145.2 | W/m² | 08–29–73—03–24–74 |
| Skinner atmospheric | 0 | 145.6 | W/m² | 04–24–74—05–28–74 |

After the study the anemometers were recalibrated, and their calibration constants had changed by less than 3 percent. Temperature probes were periodically checked against mercury thermometers and always found to be within ±0.1°C. The pyranometers were calibrated before and after use, and their calibration coefficients were found to have remained constant to within ±1 percent.

Considerable difficulty was experienced with the measurement of atmospheric radiation. Both pyrgeometers were calibrated before installation on July 25, 1973. By the end of August 1973, the measured atmospheric radiation at Cottonwood appeared to be drifting to the high side. To see if the difference between Cottonwood and Skinner readings was real or due to a drift in the calibration of pyrgeometers, on August 29, 1973, the sensors were interchanged. No shift in the daily average values at either end of the canal was observed after the sensors were interchanged, so it was assumed that the sensor calibrations were still valid. Although the recorder at Cottonwood malfunctioned three times between September 1, 1973, and November 28, 1973, the atmospheric radiation values measured at each end of the canal and the computed clear-sky values were all in general agreement.

On November 28, 1973, the pyrgeometer at Cottonwood was removed for a calibration check and replaced by a flat-plate radiometer of the Gier-Dunkle type. During December 1973, the measured atmospheric radiation at Skinner was 30 percent higher than that measured at Cottonwood. Unfortunately, it was impossible to determine whether one or both sensors were out of calibration. On January 31, 1974, the flat-plate radiometer failed, and it was replaced on March 7, 1974. This second flat-plate radiometer was operated until April 24, 1974, when it also failed. The first flat plate, which had been repaired and recalibrated, was reinstalled at Cottonwood on June 5, 1974. This radiometer operated continuously until the end of the study on July 23, 1974.

Meanwhile, difficulty was also being experienced at the other end of the canal. On March 24, 1974, the output of the pyrgeometer at Skinner started dropping sharply, falling essentially to zero by March 31, 1974. Unfortunately, the instrument could not be calibrated, so only the original calibration factor is available.

On April 24, 1974, the pyrgeometer removed from Cottonwood on November 20, 1973, was installed at Skinner. Although it had been recalibrated locally, the output using the new calibration factor appeared to be too large, so it was assumed that the original manufacturer's calibration factor was still valid. This instrument failed in a manner similar to the first pyrgeometer on May 28, 1974. After this date, no atmospheric radiation measurements were available at Skinner.

The hydraulic data were furnished by the Metropolitan Water District, and no extensive check on their accuracy was made by the Survey. However, the accuracy of the stage recorders at Cottonwood and Simpson Road were checked by measuring the centerline water depth from the bridge and comparing the results to the recorded stage. The centerline depth and stage always agreed to within ±6 mm. On January 15–16, 1974, the discharge was measured and the results compared with the value provided by the Metropolitan Water District. The results agreed to within 4 percent, which is considered to be about the accuracy of the flow measurements. Personnel of the California District of the Geological Survey made current-meter measurements which were used to calibrate the sonic flow meter at Skinner. The sonic flow meter was installed during the latter part of February 1974 and calibrated in early March.

It was realized that the five measured stages may not be representative of depths at all points along the canal. The word "depth" is used to mean the centerline (maximum) depth, which is also the stage (fig. 2) in all cases. An attempt was made to measure a longitudinal depth profile under several flow conditions to determine how to predict mean local depths from the recorded stages. These profiles were determined in the following manner. First an automobile odometer was used to place reference marks on the canal fence. No reference mark was placed closer than 160 m to either the intake or outlet of a siphon. Water depth was measured at each of these reference points for seven conditions which included flows ranging from 2.8 to 23 $m^3/s$.

It was impossible to measure the centerline depth (stage) directly except at a few points along the canal; however, it was fairly easy to measure the slope distance from the top of the canal lining to the water surface. The stage could then be computed from the known geometry of the canal. Comparisons of the stage, as determined from the slope measurements to the stage as measured directly, where possible, indicated that the slope measurements allowed the stage to be estimated within about ±9 mm.

The results of these measurements and calculations are summarized in table 3, which gives the centerline depth (stage) and the distance from the canal intake for each of seven runs. The flow variations during any run were very small, and the measured stages and discharges at the time of the runs will be presented later. Runs 1 and 7 were conducted on March 6 and April 24, 1974, respectively, when the hydraulic conditions were essentially constant. Unfortunately the flow was slightly unsteady during run 2 made on March 24,

TABLE 3.—*Profiles of centerline depth for the San Diego Aqueduct under nearly steady flow conditions*

[All values are in meters]

| Distance from intake | Stage run 1 | Distance from intake | Stage Run 2 | Run 3 | Run 4 | Run 5 | Run 6 | Run 7 |
|---|---|---|---|---|---|---|---|---|
| 593 | 2.98 | 148 | 1.02 | ------ | 1.01 | ------ | 1.81 | 2.47 |
| 1,398 | 2.86 | 477 | 1.17 | ------ | 1.17 | ------ | 1.98 | 2.65 |
| 2,444 | 2.84 | 811 | 1.12 | ------ | 1.10 | ------ | 1.89 | 2.58 |
| 3,249 | 2.80 | 1,145 | 1.03 | ------ | 1.03 | ------ | 1.82 | 2.48 |
| 4,054 | 2.79 | 1,477 | 1.03 | ------ | 1.02 | ------ | 1.81 | 2.45 |
| 4,897 | 2.77 | 1,811 | 1.03 | ------ | 1.03 | ------ | 1.82 | 2.46 |
| 6,147 | 2.77 | 2,294 | 1.06 | ------ | 1.05 | ------ | 1.84 | 2.46 |
| 7,450 | 2.76 | 2,614 | 1.04 | ------ | 1.02 | ------ | 1.81 | 2.44 |
| 8,529 | 2.78 | 2,935 | 1.03 | ------ | 1.02 | ------ | 1.80 | 2.43 |
| 9,135 | 2.79 | 3,254 | 1.01 | ------ | .99 | ------ | 1.77 | 2.40 |
| 9,794 | 2.78 | 3,574 | 1.03 | ------ | 1.01 | ------ | 1.80 | 2.42 |
| 11,083 | 2.77 | 3,893 | 1.02 | ------ | .99 | ------ | 1.77 | 2.40 |
| 11,888 | 2.70 | 4,214 | 1.01 | ------ | .98 | ------ | 1.75 | 2.36 |
| 12,692 | 2.65 | 4,835 | 1.02 | ------ | .98 | ------ | 1.75 | 2.36 |
| 13,497 | 2.60 | 5,080 | .98 | ------ | .96 | ------ | 1.71 | 2.33 |
| 14,143 | 2.64 | 5,611 | .99 | ------ | .96 | ------ | 1.73 | 2.33 |
| 15,594 | 2.62 | 5,927 | 1.01 | ------ | .98 | ------ | 1.74 | 2.33 |
| 16,871 | 2.70 | 6,266 | .98 | ------ | .95 | ------ | 1.70 | 2.30 |
| 17,602 | 2.76 | 6,580 | ------ | ------ | .91 | ------ | 1.75 | 2.25 |
| 18,407 | 2.75 | 6,715 | .95 | ------ | .92 | ------ | 1.68 | 2.25 |
| 19,212 | 2.72 | 7,223 | .96 | ------ | .94 | ------ | 1.70 | 2.26 |
| 20,011 | 2.72 | 7,541 | .95 | ------ | .92 | ------ | 1.69 | 2.26 |
| 20,333 | 2.71 | 7,780 | .98 | ------ | .94 | ------ | 1.71 | 2.27 |
| 21,385 | 2.56 | 8,355 | 1.01 | ------ | .96 | ------ | 1.73 | 2.23 |
| 22,190 | 2.61 | 8,679 | .98 | ------ | .95 | ------ | 1.71 | 2.16 |
| 23,489 | 2.51 | 9,004 | 1.01 | ------ | .96 | ------ | 1.74 | 2.16 |
| 24,532 | 2.45 | 9,654 | .95 | ------ | .92 | ------ | 1.69 | 2.17 |
| 25,015 | 2.39 | 9,955 | .91 | ------ | 89 | ------ | 1.67 | 2.15 |
| ------ | ------ | 10,439 | 1.06 | ------ | 1.05 | ------ | 1.81 | 2.25 |
| ------ | ------ | 10,778 | 1.06 | ------ | 1.03 | ------ | 1.78 | 2.23 |
| ------ | ------ | 11,078 | 1.03 | ------ | 1.02 | ------ | 1.77 | 2.23 |
| ------ | ------ | 11,399 | 1.02 | ------ | 1.01 | ------ | 1.75 | 2.18 |
| ------ | ------ | 11,718 | 1.01 | ------ | .98 | ------ | 1.74 | 2.19 |
| ------ | ------ | 12,038 | .98 | ------ | .94 | ------ | 1.68 | 2.05 |
| ------ | ------ | 12,357 | .96 | ------ | 94 | ------ | 1.68 | 2.13 |
| ------ | ------ | 12,705 | .92 | ------ | 91 | ------ | 1.64 | 2.13 |
| ------ | ------ | 12,996 | .87 | ------ | 85 | ------ | 1.58 | 2.11 |
| ------ | ------ | 13,317 | .84 | ------ | .80 | ------ | 1.54 | 2.11 |
| ------ | ------ | 13,944 | .92 | 0.91 | ------ | 1.66 | 1.61 | 2.17 |
| ------ | ------ | 14,258 | .88 | .87 | ------ | 1.60 | 1.55 | 2.13 |
| ------ | ------ | 14,574 | .84 | .82 | ------ | 1.57 | 1.53 | 2.13 |
| ------ | ------ | 14,888 | .77 | .75 | ------ | 1.53 | 1.46 | 2.13 |
| ------ | ------ | 15,540 | .84 | .82 | ------ | 1.68 | 1.57 | 2.16 |
| ------ | ------ | 15,775 | .80 | .77 | ------ | 1.67 | 1.55 | 2.16 |
| ------ | ------ | 16,314 | .92 | .89 | ------ | 1.84 | 1.68 | 2.25 |
| ------ | ------ | 16,644 | .92 | .89 | ------ | 1.87 | 1.69 | 2.26 |
| ------ | ------ | 17,441 | 1.09 | 1.05 | ------ | 2.05 | 1.85 | 2.24 |
| ------ | ------ | 17,760 | 1.09 | 1.05 | ------ | 2.05 | 1.84 | 2.41 |
| ------ | ------ | 18,081 | 1.09 | 1.05 | ------ | 2.05 | 1.82 | 2.43 |
| ------ | ------ | 18,402 | 1.12 | 1.08 | ------ | 2.11 | 1.85 | 2.40 |
| ------ | ------ | 18,723 | 1.17 | 1.13 | ------ | 2.19 | 1.89 | ------ |
| ------ | ------ | 19,043 | 1.20 | 1.17 | ------ | 2.22 | 1.92 | ------ |
| ------ | ------ | 19,364 | ------ | 1.12 | ------ | 2.19 | 1.87 | 2.44 |
| ------ | ------ | 19,864 | ------ | 1.19 | ------ | 2.25 | 1.89 | 2.48 |
| ------ | ------ | 20,183 | ------ | 1.20 | ------ | 2.26 | 1.89 | 2.50 |
| ------ | ------ | 20,976 | ------ | 1.22 | ------ | 2.30 | 1.88 | 2.48 |
| ------ | ------ | 21,293 | ------ | 1.20 | ------ | 2.29 | 1.84 | 2.46 |
| ------ | ------ | 21,608 | ------ | 1.26 | ------ | 2.37 | 1.88 | ------ |
| ------ | ------ | 21,925 | ------ | 1.33 | ------ | 2.43 | 1.92 | 2.58 |
| ------ | ------ | 22,241 | ------ | 1.37 | ------ | 2.47 | 1.95 | 2.60 |
| ------ | ------ | 22,892 | ------ | 1.57 | ------ | 2.67 | 2.11 | 2.58 |
| ------ | ------ | 23,212 | ------ | 1.58 | ------ | 2.70 | 2.09 | 2.74 |
| ------ | ------ | 23,532 | ------ | 1.61 | ------ | 2.71 | 2.11 | 2.75 |
| ------ | ------ | 24,017 | ------ | 1.68 | ------ | 2.78 | 2.15 | 2.78 |
| ------ | ------ | 24,338 | ------ | 1.71 | ------ | 2.82 | 2.16 | 2.80 |
| ------ | ------ | 24,657 | ------ | 1.77 | ------ | 2.87 | 2.27 | 2.85 |
| ------ | ------ | 25,139 | ------ | 1.81 | ------ | 2.91 | 2.32 | 2.85 |
| ------ | ------ | 25,459 | ------ | 1.84 | ------ | 2.94 | 2.34 | 2.87 |
| ------ | ------ | 25,780 | ------ | 1.87 | ------ | 2.98 | 2.37 | 2.91 |

1974, as well as during runs 3 and 4 made on March 25, 1974, and runs 5 and 6 made on March 26, 1974. The effect of the slight unsteadiness was accounted for by noting the time at which each measurement was obtained. All measurements were obtained by working in the downstream direction at a very nearly constant rate. The beginning times of runs 2, 3, 4, 5, and 6 were 1354, 0635, 1100, 0632, and 1012 hours, respectively, and the ending times were 1922, 0903, 1325, 0829, and 1705 hours, respectively.

## RESULTS

### GENERAL

All data obtained during this study are available on magnetic tape from the Automatic Data Processing Unit of the U.S. Geological Survey. The tape contains 10-minute values of all meteorologic and temperature data, hourly values of hydraulic data, and daily values of the supplementary data.

Table 4 contains daily averages of all meteorologic

TABLE 4.—*Daily averaged values of meteorologic and temperature data for San Diego Aqueduct (July 25, 1973–July 23, 1974)*

| Day of month | Wind-speed (m/s) | | Wind azimuth[3] (degree) | | Solar radiation (W/m²) | | Atmospheric radiation (W/m²) | | Air temperature (°C) | | Vapor pressure (kPa) | | Water temperature (°C) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | COT[1] | SKN[2] | COT | SKN | COT | SKN | COT | SKN | COT | SKN | COT | SKN | COT | SKN |
| **July 1973** | | | | | | | | | | | | | | |
| 25 | ------ | 1.31 | ------ | 211 | ------ | 332 | ------ | 394 | ------ | ------ | ------ | ------ | ------ | 25.4 |
| 26 | 1.74 | 1.23 | ------ | 192 | 326 | 331 | 390 | 385 | 26.2 | 27.1 | ------ | ------ | 25.7 | 25.5 |
| 27 | 1.43 | 1.27 | ------ | 222 | 320 | 326 | 386 | 378 | 24.5 | 25.5 | ------ | ------ | 25.8 | 25.7 |
| 28 | 1.22 | 1.14 | ------ | 203 | 310 | 319 | 391 | 382 | 24.3 | 25.2 | ------ | ------ | 25.8 | 25.7 |
| 29 | 1.66 | 1.18 | ------ | 204 | 304 | 319 | 396 | 381 | 24.4 | 24.7 | 1.45 | ------ | 26.1 | 25.8 |
| 30 | 1.66 | 1.33 | ------ | 215 | 306 | 310 | 398 | 385 | 24.8 | 25.1 | 1.28 | ------ | 26.2 | 25.9 |
| 31 | 1.26 | 1.26 | ------ | 199 | 310 | 309 | 410 | 401 | 25.9 | 25.8 | 1.22 | 1.38 | 26.0 | 26.0 |
| **August 1973** | | | | | | | | | | | | | | |
| 1 | 1.30 | 1.18 | ------ | 210 | 269 | 246 | 419 | 408 | 26.4 | 26.4 | ------ | 1.56 | 26.2 | 26.0 |
| 2 | 1.14 | 1.20 | ------ | 203 | 288 | 308 | 426 | 413 | 27.0 | 27.6 | 1.52 | 1.78 | 26.5 | 26.5 |
| 3 | 1.61 | 1.45 | ------ | 220 | 310 | 314 | 421 | 408 | 28.0 | 26.5 | ------ | ------ | 26.3 | 26.6 |
| 4 | 1.24 | 1.36 | ------ | 207 | 197 | 208 | 408 | 396 | 23.8 | 22.7 | ------ | ------ | 25.8 | 25.8 |
| 5 | 1.39 | 1.42 | ------ | 224 | 297 | 318 | 392 | 386 | 22.5 | 22.1 | ------ | ------ | 25.9 | 25.8 |
| 6 | 1.27 | 1.27 | ------ | 238 | 288 | 290 | 391 | 392 | 21.7 | 21.4 | ------ | 1.66 | 26.1 | 25.9 |
| 7 | 1.10 | 1.06 | ------ | 209 | 308 | 306 | 382 | 373 | 22.5 | 21.4 | ------ | ------ | 26.0 | 25.7 |
| 8 | ------ | 1.07 | ------ | 218 | ------ | 329 | ------ | 377 | ------ | 23.3 | ------ | ------ | ------ | 25.6 |
| 9 | 1.41 | 1.18 | ------ | 199 | 300 | 318 | 394 | 384 | 23.9 | 23.7 | ------ | ------ | 25.9 | 25.7 |
| 10 | 1.16 | 1.22 | ------ | 204 | 317 | 325 | 383 | 369 | 23.6 | 22.1 | ------ | ------ | 26.0 | 25.7 |
| 11 | 1.12 | 1.10 | ------ | 219 | 302 | 308 | 395 | 395 | 23.6 | 22.3 | ------ | 1.56 | 26.1 | 25.8 |
| 12 | 1.06 | 1.11 | ------ | 226 | 289 | 296 | 414 | 402 | 26.7 | 25.5 | ------ | 1.69 | 26.3 | 26.1 |
| 13 | 1.22 | 1.36 | ------ | 201 | 239 | 269 | 422 | 409 | 26.5 | 24.2 | ------ | ------ | 26.5 | 26.2 |
| 14 | 1.30 | 1.13 | ------ | 198 | 267 | 257 | 426 | 413 | 26.6 | 25.1 | ------ | 1.84 | 26.5 | 26.4 |
| 15 | 1.20 | 1.31 | ------ | 201 | 288 | 303 | 418 | 406 | 25.7 | 25.3 | 1.68 | 1.82 | 26.4 | 26.3 |
| 16 | .92 | 1.16 | ------ | 217 | 280 | 295 | 420 | 407 | 26.9 | 26.4 | ------ | 1.79 | 26.7 | 26.6 |
| 17 | 1.31 | 1.23 | ------ | 219 | 260 | 287 | 426 | 411 | 27.2 | 26.3 | 1.74 | 1.80 | 26.8 | 26.6 |
| 18 | 1.15 | 1.30 | ------ | 230 | 276 | 301 | 420 | 413 | 27.9 | 29.8 | 1.61 | ------ | 26.5 | 26.6 |
| 19 | 1.16 | 1.61 | ------ | 232 | 291 | 299 | 414 | 411 | 27.6 | 29.9 | ------ | ------ | 26.5 | 26.5 |
| 20 | 2.21 | ------ | ------ | 248 | 180 | 223 | 431 | 424 | 27.8 | 28.3 | ------ | 1.92 | 26.4 | 26.0 |
| 21 | ------ | 1.29 | ------ | 222 | ------ | 286 | ------ | 404 | ------ | 27.3 | ------ | 1.75 | ------ | 26.3 |
| 22 | 1.47 | 1.18 | ------ | 184 | 295 | 306 | 385 | 381 | 25.2 | 26.1 | 1.20 | 1.28 | 26.2 | 25.9 |
| 23 | 2.02 | 1.24 | ------ | 221 | 318 | 323 | 354 | 349 | 22.4 | 22.6 | ------ | ------ | 25.9 | 25.3 |
| 24 | 1.69 | 1.32 | ------ | 229 | 313 | 314 | 351 | 355 | 21.3 | 21.6 | ------ | ------ | 25.5 | 25.1 |
| 25 | 1.93 | 1.50 | ------ | 206 | 277 | 292 | 364 | 375 | 17.6 | 20.0 | 1.35 | 1.54 | 24.6 | 24.5 |
| 26 | 2.30 | 1.71 | ------ | 226 | 287 | 290 | 368 | 370 | 18.1 | 20.0 | ------ | 1.45 | ------ | 24.0 |
| 27 | 1.05 | 1.44 | ------ | 244 | 290 | 299 | 383 | 359 | 19.8 | 20.0 | ------ | ------ | ------ | 24.1 |
| 28 | 1.54 | 1.31 | ------ | 208 | 313 | 300 | 405 | 353 | 22.9 | 20.9 | 1.19 | 1.22 | ------ | 23.7 |
| 29 | .83 | 1.15 | ------ | 227 | 289 | 294 | ------ | 363 | 24.6 | 23.0 | ------ | 1.21 | ------ | 23.9 |
| 30 | 1.21 | .99 | 270 | 207 | 286 | 276 | 413 | 372 | 23.8 | 20.0 | ------ | 1.55 | ------ | 24.2 |
| 31 | 1.71 | 1.25 | 207 | 219 | 282 | 271 | 383 | 376 | 19.7 | 18.9 | ------ | 1.49 | ------ | 24.3 |
| **September 1973** | | | | | | | | | | | | | | |
| 1 | 1.36 | 1.06 | 225 | 200 | ------ | 262 | 406 | 360 | 21.3 | 18.4 | 1.36 | 1.39 | ------ | 24.2 |
| 2 | 1.05 | 1.31 | 205 | 218 | ------ | 278 | 427 | 366 | ------ | 19.2 | ------ | 1.43 | ------ | 24.1 |
| 3 | 1.40 | 1.46 | 220 | 231 | ------ | 272 | ------ | 378 | ------ | 19.6 | ------ | 1.57 | ------ | 24.0 |
| 4 | 1.31 | 1.09 | 240 | 209 | ------ | 165 | ------ | 379 | ------ | 17.8 | ------ | ------ | ------ | 23.7 |
| 5 | 1.04 | 1.22 | 29 | 249 | ------ | 257 | ------ | 378 | ------ | 19.5 | ------ | ------ | ------ | 24.2 |
| 6 | 1.27 | 1.00 | 66 | 252 | ------ | 283 | ------ | 366 | ------ | 22.4 | ------ | ------ | ------ | 24.5 |
| 7 | 1.58 | 1.08 | 211 | 202 | ------ | 285 | ------ | 370 | ------ | 22.5 | ------ | ------ | ------ | ------ |
| 8 | 1.62 | 1.35 | 185 | 219 | ------ | 247 | ------ | 384 | ------ | 18.9 | ------ | ------ | ------ | ------ |
| 9 | 1.98 | 1.28 | 191 | 211 | ------ | 231 | ------ | 388 | ------ | 18.5 | ------ | ------ | ------ | ------ |
| 10 | 1.72 | 1.24 | 221 | 254 | ------ | 140 | ------ | 394 | ------ | 18.0 | ------ | ------ | ------ | ------ |
| 11 | .93 | 1.32 | 52 | 252 | ------ | 252 | ------ | 385 | ------ | 20.3 | ------ | ------ | ------ | ------ |
| 12 | .86 | .99 | 261 | 192 | ------ | 240 | ------ | 374 | ------ | 19.7 | ------ | 1.64 | ------ | 24.4 |
| 13 | .93 | 1.15 | 259 | 216 | ------ | 220 | ------ | 389 | ------ | 18.7 | ------ | 1.68 | ------ | 24.4 |
| 14 | 1.23 | 1.11 | 197 | 230 | ------ | 245 | ------ | 379 | ------ | 19.7 | ------ | 1.64 | ------ | 24.8 |
| 15 | 1.25 | 1.02 | 196 | 194 | ------ | 232 | ------ | 368 | ------ | 18.1 | ------ | 1.48 | ------ | 24.5 |
| 16 | .99 | 1.31 | 199 | 206 | ------ | 248 | ------ | 356 | ------ | 17.7 | ------ | 1.38 | ------ | 24.2 |
| 17 | 1.55 | 1.17 | 206 | 226 | ------ | 265 | ------ | 352 | ------ | 18.0 | ------ | 1.25 | ------ | 23.8 |
| 18 | 1.39 | 1.23 | 202 | 208 | ------ | 271 | ------ | 339 | ------ | 18.3 | ------ | 1.04 | ------ | 23.7 |
| 19 | 1.11 | 1.09 | 210 | 209 | ------ | 255 | ------ | 348 | ------ | 19.5 | ------ | 1.15 | ------ | 23.7 |
| 20 | 1.18 | 1.19 | 235 | 188 | ------ | 243 | ------ | 359 | ------ | 18.1 | ------ | 1.41 | ------ | 23.8 |
| 21 | 1.43 | 1.08 | 190 | 207 | ------ | 253 | ------ | 354 | ------ | 19.2 | ------ | 1.47 | ------ | 23.8 |
| 22 | .88 | 1.09 | 57 | 202 | ------ | 110 | ------ | 381 | ------ | 16.7 | ------ | 1.64 | ------ | 23.4 |
| 23 | 3.05 | 1.54 | 216 | 203 | ------ | 195 | ------ | 366 | ------ | 17.5 | ------ | 1.48 | ------ | 23.5 |
| 24 | 1.60 | 1.08 | 257 | 218 | ------ | 248 | ------ | 354 | ------ | 17.6 | ------ | 1.37 | ------ | 23.4 |
| 25 | 1.66 | 1.68 | 245 | 41 | ------ | 249 | ------ | 367 | ------ | 20.9 | ------ | 1.15 | ------ | 22.8 |
| 26 | 3.33 | 1.73 | 45 | 231 | 284 | 259 | ------ | 353 | ------ | 24.6 | ------ | .54 | ------ | 22.4 |
| 27 | 1.24 | 1.28 | 70 | 24 | 267 | 256 | 397 | 360 | ------ | 25.8 | ------ | .52 | ------ | 22.3 |
| 28 | .91 | .87 | 74 | 212 | 252 | 250 | 371 | 362 | 24.4 | 25.2 | ------ | .59 | ------ | 22.1 |
| 29 | 1.02 | .85 | 219 | 197 | 243 | 242 | 376 | 358 | 23.0 | 23.7 | .67 | ------ | ------ | 22.2 |
| 30 | 1.62 | 1.06 | 204 | 197 | 249 | 243 | 366 | 344 | 20.6 | 20.8 | ------ | ------ | ------ | 22.4 |

See footnotes at end of table

TABLE 4.—*Daily averaged values of meteorologic and temperature data for San Diego Aqueduct (July 25, 1973–July 23, 1974)*—Continued

| Day of month | Wind-speed (m/s) | | Wind azimuth[3] (degree) | | Solar radiation (W/m²) | | Atmospheric radiation (W/m²) | | Air temperature (°C) | | Vapor pressure (kPa) | | Water temperature (°C) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | COT[1] | SKN[2] | COT | SKN | COT | SKN | COT | SKN | COT | SKN | COT | SKN | COT | SKN |
| **October 1973** | | | | | | | | | | | | | | |
| 1 | 1.60 | 1.39 | 207 | 208 | ------ | 230 | ------ | 358 | 16.9 | 16.4 | ------ | ------ | ------ | 22.5 |
| 2 | 1.20 | 1.33 | 213 | 243 | ------ | 189 | ------ | 355 | 16.4 | 15.5 | ------ | ------ | ------ | 22.5 |
| 3 | .81 | 1.04 | 44 | 192 | ------ | 218 | ------ | 356 | 17.2 | 16.9 | ------ | ------ | ------ | ------ |
| 4 | 1.15 | 1.18 | 199 | 90 | ------ | 232 | ------ | 341 | 22.2 | 21.6 | 0.98 | ------ | ------ | ------ |
| 5 | ------ | 1.19 | 206 | 202 | ------ | 233 | ------ | 343 | 19.4 | 19.2 | ------ | ------ | ------ | ------ |
| 6 | 1.57 | 1.17 | 207 | 197 | ------ | 72 | ------ | 360 | 14.4 | 15.5 | 1.27 | ------ | ------ | ------ |
| 7 | 2.58 | 1.31 | 218 | 206 | 203 | 199 | ------ | 357 | 16.2 | 16.5 | 1.16 | ------ | ------ | ------ |
| 8 | ------ | 1.24 | 219 | 217 | ------ | 118 | ------ | 364 | ------ | 15.2 | ------ | ------ | ------ | ------ |
| 9 | 1.73 | 1.40 | 217 | 184 | 176 | 186 | 363 | 345 | 15.1 | 15.4 | 1.11 | 1.22 | ------ | 21.3 |
| 10 | 1.00 | 1.55 | 83 | 44 | 224 | 227 | 332 | 316 | 14.2 | 15.6 | .75 | .85 | ------ | 20.9 |
| 11 | .95 | .96 | 68 | 221 | 242 | 218 | 346 | 325 | 16.2 | 16.6 | .60 | .72 | ------ | 20.1 |
| 12 | .87 | .96 | 64 | 62 | 219 | 212 | 348 | 339 | 17.6 | 19.0 | .65 | .76 | ------ | 20.3 |
| 13 | .81 | 1.05 | 225 | 30 | 218 | 217 | 365 | 355 | 21.2 | 22.7 | .61 | .72 | ------ | 20.8 |
| 14 | .91 | 1.04 | 205 | 226 | 220 | 220 | 362 | 353 | 21.5 | 23.6 | ------ | .70 | ------ | 20.9 |
| 15 | .98 | 1.01 | 241 | 239 | 217 | 214 | 376 | 358 | 21.8 | 23.3 | ------ | ------ | ------ | 21.0 |
| 16 | .95 | .91 | 246 | 239 | 199 | 183 | 395 | 365 | 23.3 | 24.2 | ------ | .90 | ------ | 21.1 |
| 17 | 1.16 | 1.30 | 52 | 39 | 211 | 197 | 395 | 367 | 24.1 | 25.3 | .89 | ------ | ------ | 21.3 |
| 18 | 1.11 | 1.10 | 48 | 29 | 213 | 205 | 396 | 378 | 23.8 | 24.8 | .81 | ------ | ------ | 21.4 |
| 19 | .88 | .94 | 269 | 197 | 207 | 203 | 383 | 368 | 22.6 | 23.8 | ------ | ------ | ------ | 21.4 |
| 20 | 1.53 | 1.06 | 214 | 200 | 211 | 204 | 362 | 347 | 19.0 | 20.1 | ------ | .96 | ------ | 21.2 |
| 21 | 1.08 | .84 | 224 | 219 | 198 | 203 | 343 | 337 | 16.0 | 16.9 | ------ | 1.14 | ------ | 21.1 |
| 22 | 1.28 | 1.06 | 213 | 213 | 191 | 194 | 374 | 340 | 14.8 | 14.9 | ------ | 1.31 | ------ | 21.0 |
| 23 | 1.47 | 1.28 | 53 | 252 | 151 | 168 | 357 | 350 | 15.6 | 16.1 | 1.22 | 1.31 | ------ | 20.8 |
| 24 | .93 | 1.38 | 36 | 36 | 198 | 193 | 352 | 333 | 16.7 | 17.1 | ------ | 1.12 | ------ | 20.7 |
| 25 | .90 | .88 | 221 | 193 | 191 | 193 | 341 | 333 | 16.6 | 18.1 | ------ | .97 | ------ | 20.1 |
| 26 | 1.24 | 1.33 | 74 | 27 | 161 | 178 | 342 | 335 | 17.3 | 18.8 | ------ | .71 | ------ | 19.8 |
| 27 | 1.41 | 1.55 | 37 | 42 | 204 | 201 | 335 | 329 | ------ | 21.5 | ------ | .48 | ------ | 19.8 |
| 28 | .94 | 1.05 | 251 | 191 | 200 | 198 | 338 | 333 | ------ | 21.8 | ------ | .36 | ------ | 19.5 |
| 29 | .98 | 1.38 | 10 | 27 | 191 | 191 | 335 | 329 | ------ | 20.4 | ------ | .40 | ------ | 19.3 |
| 30 | 1.63 | 1.69 | 26 | 20 | 197 | 193 | 331 | 327 | ------ | 20.2 | ------ | .28 | ------ | 19.2 |
| 31 | 1.40 | 1.16 | 195 | 182 | 191 | 188 | 348 | 340 | ------ | 20.3 | ------ | .42 | ------ | 18.7 |
| **November 1973** | | | | | | | | | | | | | | |
| 1 | 2.18 | 1.44 | 219 | 220 | 163 | 166 | 345 | 342 | ------ | 15.9 | ------ | 0.94 | ------ | 18.2 |
| 2 | 3.69 | 1.58 | 224 | 225 | 151 | 152 | 367 | 349 | ------ | 14.4 | ------ | 1.21 | ------ | 18.6 |
| 3 | 2.05 | 1.17 | 208 | 180 | 173 | 158 | 341 | 322 | ------ | 13.4 | ------ | 1.04 | ------ | 18.4 |
| 4 | .80 | .79 | 185 | 202 | 184 | 179 | 323 | 311 | ------ | 14.0 | ------ | .95 | ------ | 18.4 |
| 5 | ------ | .78 | ------ | 205 | ------ | 177 | ------ | 306 | ------ | 15.2 | ------ | .82 | ------ | 17.9 |
| 6 | ------ | .70 | ------ | 257 | ------ | 175 | ------ | 316 | ------ | 15.1 | ------ | .79 | ------ | 17.6 |
| 7 | ------ | .66 | ------ | 192 | ------ | 166 | ------ | 339 | ------ | 17.2 | ------ | .89 | ------ | 17.9 |
| 8 | ------ | .82 | ------ | 184 | ------ | 150 | ------ | 339 | ------ | 18.6 | ------ | 1.16 | ------ | 18.3 |
| 9 | ------ | 1.26 | ------ | 19 | ------ | 141 | ------ | 334 | ------ | 15.2 | ------ | 1.24 | ------ | 18.3 |
| 10 | ------ | 1.32 | ------ | 39 | ------ | 159 | ------ | 353 | ------ | 18.7 | ------ | ------ | ------ | 18.5 |
| 11 | ------ | 1.00 | ------ | 20 | ------ | 147 | ------ | 360 | ------ | 20.9 | ------ | ------ | ------ | 18.5 |
| 12 | ------ | 1.17 | ------ | 200 | ------ | 163 | ------ | 349 | ------ | 17.9 | ------ | ------ | ------ | 18.5 |
| 13 | ------ | 1.34 | ------ | 181 | ------ | 102 | ------ | 329 | ------ | 13.7 | ------ | ------ | ------ | 18.3 |
| 14 | ------ | .99 | ------ | 237 | ------ | 145 | ------ | 308 | ------ | 12.2 | ------ | 1.05 | ------ | 17.9 |
| 15 | ------ | 1.09 | ------ | 221 | ------ | 161 | ------ | 309 | ------ | 12.0 | ------ | .98 | ------ | 17.2 |
| 16 | ------ | .98 | ------ | 187 | ------ | 127 | ------ | 342 | ------ | 12.4 | ------ | 1.10 | ------ | 17.3 |
| 17 | ------ | 1.19 | ------ | 188 | ------ | 65 | ------ | 376 | ------ | 13.7 | ------ | 1.47 | ------ | 17.4 |
| 18 | ------ | 2.17 | ------ | 225 | ------ | 92 | ------ | 343 | ------ | 11.5 | ------ | 1.20 | ------ | 16.8 |
| 19 | ------ | 1.02 | ------ | 232 | ------ | 154 | ------ | 293 | ------ | 9.2 | ------ | .76 | ------ | 16.7 |
| 20 | ------ | .94 | ------ | 189 | ------ | 146 | ------ | 299 | ------ | 9.1 | ------ | ------ | ------ | 15.8 |
| 21 | ------ | 1.08 | ------ | 198 | ------ | 89 | ------ | 345 | ------ | 10.5 | ------ | .99 | ------ | 15.2 |
| 22 | ------ | 1.79 | ------ | 189 | ------ | 97 | ------ | 328 | ------ | 10.0 | ------ | .99 | ------ | 15.4 |
| 23 | ------ | 1.22 | ------ | 86 | ------ | 116 | ------ | 320 | ------ | 8.2 | ------ | ------ | ------ | 15.6 |
| 24 | ------ | 1.07 | ------ | 193 | ------ | 85 | ------ | 322 | ------ | 8.0 | ------ | ------ | ------ | 15.0 |
| 25 | ------ | 1.09 | ------ | 200 | ------ | 139 | ------ | 297 | ------ | 8.2 | ------ | .76 | ------ | 14.9 |
| 26 | ------ | 1.26 | ------ | 41 | ------ | 135 | ------ | 322 | ------ | 9.7 | ------ | .88 | ------ | 15.0 |
| 27 | ------ | 1.41 | ------ | 29 | ------ | 146 | ------ | ------ | ------ | 10.8 | ------ | .71 | ------ | 14.6 |
| 28 | ------ | 1.88 | ------ | 8 | ------ | 149 | ------ | ------ | ------ | 14.4 | ------ | .60 | ------ | 14.5 |
| 29 | .83 | 1.05 | 196 | 1 | 113 | 119 | 301 | ------ | 11.6 | 14.2 | 0.65 | .70 | 15.1 | 14.6 |
| 30 | 1.22 | 1.02 | 204 | 199 | 139 | 142 | 301 | 326 | 10.1 | 12.3 | .70 | .80 | 15.0 | 14.4 |
| **December 1973** | | | | | | | | | | | | | | |
| 1 | 1.44 | 1.05 | 213 | 226 | 49 | 41 | 372 | 326 | 7.3 | 9.2 | 0.84 | 0.91 | 15.0 | 13.9 |
| 2 | 1 16 | 1.07 | 201 | 2 | 139 | 142 | 403 | 312 | 6.9 | 8.5 | .63 | .66 | 14.9 | 14.2 |
| 3 | 56 | .84 | 200 | 43 | 126 | 148 | 289 | 310 | 7 3 | 9.5 | .52 | .53 | 14.0 | 13.8 |
| 4 | .62 | .57 | 202 | 39 | 88 | 84 | 283 | 320 | 7.5 | 9.6 | .67 | .64 | 13.6 | 12.8 |
| 5 | .88 | 1.01 | 3 | 10 | 136 | 140 | 314 | 320 | 9.4 | 11.3 | .55 | .61 | 13.7 | 13.2 |
| 6 | .92 | 1.54 | 13 | 49 | 140 | 144 | 299 | 325 | 10.6 | 13.9 | .45 | .49 | 13.8 | 13.4 |
| 7 | 1.14 | 1.15 | 21 | 4 | 134 | 126 | 317 | 332 | 12.8 | 14.4 | .42 | .51 | 13.7 | 13.3 |
| 8 | .62 | .98 | 205 | 6 | 137 | 142 | 310 | 339 | 12.3 | 15.3 | .53 | .57 | 13.6 | 13.3 |
| 9 | .94 | 1.55 | 203 | 4 | 141 | 146 | 299 | 331 | 12.3 | 15.5 | .50 | .52 | 13.5 | 13.2 |
| 10 | 1.08 | 1.18 | 5 | 21 | 140 | 144 | 299 | 332 | 12.6 | 15.2 | ------ | .56 | 13.5 | 13.1 |
| 11 | 1.09 | 1.00 | 204 | 232 | 107 | 115 | 274 | 325 | 10.7 | 12.7 | ------ | .71 | 13.5 | 13.1 |
| 12 | ------ | .82 | ------ | 200 | ------ | 125 | ------ | 317 | ------ | 10.4 | ------ | .91 | ------ | 13.1 |
| 13 | ------ | 1.05 | ------ | 27 | ------ | 104 | ------ | 325 | ------ | 8.6 | ------ | ------ | ------ | 13.1 |
| 14 | ------ | .84 | ------ | 264 | ------ | 84 | ------ | 339 | ------ | 10.9 | ------ | ------ | ------ | 13.3 |
| 15 | ------ | 1.64 | ------ | 17 | ------ | 132 | ------ | 326 | ------ | 14.1 | ------ | ------ | ------ | 13.2 |
| 16 | ------ | .65 | ------ | 230 | ------ | 127 | ------ | 334 | ------ | 14.4 | ------ | ------ | ------ | 13.2 |
| 17 | ------ | .76 | ------ | 207 | ------ | 134 | ------ | 327 | ------ | 13.4 | ------ | ------ | ------ | 13.0 |
| 18 | ------ | 1.69 | ------ | 33 | ------ | 137 | ------ | 309 | ------ | 11.9 | ------ | ------ | ------ | 12.8 |
| 19 | ------ | 1.55 | ------ | 80 | ------ | 130 | ------ | 309 | ------ | 12.8 | ------ | ------ | ------ | 14.0 |
| 20 | 1.18 | 2.11 | 3 | 64 | 137 | 141 | 278 | 305 | 9.1 | 12.8 | .37 | ------ | 12.6 | 12.3 |
| 21 | 1.00 | .85 | 191 | 241 | 98 | 98 | 277 | 311 | 8.1 | 10.6 | .43 | ------ | 12.4 | 12.0 |
| 22 | 1.47 | 1.01 | 244 | 237 | 104 | 90 | 312 | 325 | 8.4 | 9.6 | .78 | ------ | 12.4 | 12.2 |
| 23 | .93 | .93 | 199 | 7 | 119 | 121 | 302 | 308 | 6.4 | 8.4 | .68 | ------ | 12.4 | 12.1 |
| 24 | .98 | 1.70 | 37 | 16 | 125 | 132 | 276 | 300 | 7.4 | 10.1 | ------ | ------ | 12.2 | 12.0 |
| 25 | 1.22 | .78 | 204 | 188 | 121 | 119 | 283 | 307 | 6.9 | 9.5 | ------ | ------ | 11.8 | 11.5 |
| 26 | .55 | .66 | 229 | 194 | 128 | 129 | 299 | 313 | 7.6 | 9.5 | ------ | ------ | 11.6 | 11.4 |
| 27 | .88 | .82 | 215 | 233 | 45 | 38 | 317 | 334 | 6.7 | 8.8 | ------ | ------ | 11.9 | ------ |
| 28 | .88 | 81 | 196 | 202 | 32 | 57 | 350 | 353 | 10.1 | 11.2 | 1.12 | 1.24 | 11.9 | ------ |
| 29 | 1.19 | 1.02 | 197 | 186 | 110 | 118 | 448 | 348 | 11.3 | 11.9 | 1.08 | ------ | 12.3 | ------ |
| 30 | .93 | 1.17 | 184 | 269 | 101 | 114 | 390 | 337 | 10.7 | 12.1 | 1.04 | ------ | 12.3 | |
| 31 | 2.29 | 1.05 | 217 | 200 | 125 | 129 | 312 | 316 | 8.9 | 10.2 | ------ | ------ | 12.0 | ------ |

TABLE 4.—*Daily averaged values of meteorologic and temperature data for San Diego Aqueduct (July 25, 1973–July 23, 1974)*—Continued

| Day of month | Wind-speed (m/s) | | Wind azimuth[3] (degree) | | Solar radiation (W/m²) | | Atmospheric radiation (W/m²) | | Air temperature (°C) | | Vapor pressure (kPa) | | Water temperature (°C) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | COT[1] | SKN[2] | COT | SKN | COT | SKN | COT | SKN | COT | SKN | COT | SKN | COT | SKN |
| **January 1974** | | | | | | | | | | | | | | |
| 1 | 3.72 | 3.02 | 226 | 242 | 128 | 117 | ------ | 321 | 7.2 | 8.0 | ------ | 0.85 | 11.5 | ------ |
| 2 | 1.04 | ------ | 1 | ------ | 140 | ------ | 274 | ------ | 4.0 | ------ | 0.53 | ------ | 11.2 | ------ |
| 3 | ------ | ------ | 13 | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ |
| 4 | 2.44 | ------ | 233 | ------ | 18 | ------ | 346 | ------ | 4.7 | ------ | .64 | ------ | 10.1 | ------ |
| 5 | 1.63 | ------ | 217 | ------ | 95 | ------ | ------ | ------ | 5.7 | ------ | .76 | ------ | 10.5 | ------ |
| 6 | .84 | ------ | 188 | ------ | 18 | ------ | ------ | ------ | 7.0 | ------ | .89 | ------ | 10.7 | ------ |
| 7 | 1.13 | ------ | 10 | ------ | 15 | ------ | ------ | ------ | 7.3 | ------ | .94 | ------ | 10.7 | ------ |
| 8 | 1.66 | ------ | 239 | ------ | 51 | ------ | ------ | ------ | 7.6 | ------ | .92 | ------ | 10.8 | ------ |
| 9 | ------ | ------ | 88 | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ |
| 10 | .82 | ------ | 219 | ------ | 145 | ------ | 365 | ------ | 8.0 | ------ | .88 | ------ | 11.1 | ------ |
| 11 | 1.18 | ------ | 11 | ------ | 111 | ------ | 316 | ------ | 7.6 | ------ | .73 | ------ | 11.1 | ------ |
| 12 | 1.01 | ------ | 21 | ------ | 107 | ------ | 351 | ------ | 11.1 | ------ | .84 | ------ | 10.9 | ------ |
| 13 | .82 | ------ | 3 | ------ | 140 | ------ | 344 | ------ | 11.8 | ------ | .96 | ------ | 11.1 | ------ |
| 14 | 1.59 | ------ | 9 | ------ | 155 | ------ | 334 | ------ | 12.8 | ------ | ------ | ------ | 11.1 | ------ |
| 15 | .74 | ------ | 25 | ------ | 146 | ------ | 331 | ------ | 13.5 | ------ | ------ | ------ | 11.1 | ------ |
| 16 | .97 | ------ | 223 | ------ | 124 | ------ | 368 | ------ | 13.0 | ------ | 1.01 | ------ | 11.2 | ------ |
| 17 | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ |
| 18 | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ |
| 19 | 1.48 | ------ | 211 | ------ | 143 | ------ | 417 | ------ | 11.6 | ------ | 1.19 | ------ | 11.8 | ------ |
| 20 | 2.64 | ------ | 212 | ------ | 23 | ------ | ------ | ------ | 10.8 | ------ | 1.20 | ------ | 11.7 | ------ |
| 21 | 1.24 | ------ | 223 | ------ | 137 | ------ | 364 | ------ | 10.5 | ------ | .98 | ------ | 11.8 | ------ |
| 22 | 2.60 | ------ | 3 | ------ | 170 | ------ | 283 | ------ | 8.4 | ------ | .45 | ------ | 11.9 | ------ |
| 23 | 1.02 | ------ | 5 | ------ | 143 | ------ | 298 | ------ | 9.3 | ------ | ------ | ------ | 10.4 | ------ |
| 24 | 2.08 | ------ | 16 | ------ | 162 | 164 | 304 | 359 | 12.5 | 12.0 | ------ | ------ | 10.2 | 10.3 |
| 25 | 1.69 | ------ | 214 | ------ | 152 | 157 | 301 | 355 | 8.8 | 10.6 | ------ | ------ | 10.3 | 10.2 |
| 26 | 1.22 | ------ | 224 | ------ | 20 | 36 | 280 | 336 | 6.9 | 8.0 | .83 | ------ | 10.6 | 10.1 |
| 27 | .92 | ------ | 192 | ------ | 163 | 167 | 303 | 336 | 6.9 | 8.9 | ------ | ------ | 10.7 | 10.0 |
| 28 | .56 | ------ | 21 | ------ | 164 | 164 | 309 | 353 | 8.0 | 10.4 | ------ | ------ | 10.4 | 10.5 |
| 29 | .72 | ------ | 10 | ------ | 148 | 137 | 310 | 356 | 9.5 | 11.3 | ------ | ------ | 10.4 | 10.3 |
| 30 | .61 | ------ | 247 | ------ | 150 | 139 | 308 | 352 | 8.5 | 9.8 | ------ | ------ | 10.7 | 10.5 |
| 31 | .94 | ------ | 208 | ------ | 154 | 164 | 326 | 367 | 9.1 | 10.3 | ------ | ------ | 10.8 | 10.8 |
| **February 1974** | | | | | | | | | | | | | | |
| 1 | 1.04 | ------ | 194 | ------ | 69 | 68 | ------ | 341 | 6.7 | 7.8 | ------ | ------ | 10.8 | 10.7 |
| 2 | 1.43 | ------ | 24 | ------ | 178 | 180 | ------ | 340 | 8.1 | 10.6 | ------ | ------ | ------ | 10.9 |
| 3 | 1.87 | ------ | 30 | ------ | 178 | 182 | ------ | 351 | 10.4 | 13.5 | ------ | ------ | ------ | ------ |
| 4 | 1.09 | ------ | 228 | ------ | 179 | 180 | ------ | 358 | 11.1 | 13.9 | ------ | ------ | ------ | ------ |
| 5 | 1.52 | ------ | 19 | ------ | 181 | 185 | ------ | 350 | 9.5 | 12.0 | ------ | ------ | ------ | ------ |
| 6 | 1.61 | ------ | 23 | ------ | 185 | 185 | ------ | 332 | 7.3 | 9.8 | ------ | ------ | ------ | ------ |
| 7 | .83 | ------ | 49 | ------ | 186 | 193 | ------ | 336 | 7.5 | 10.0 | ------ | ------ | ------ | 10.6 |
| 8 | 4.09 | ------ | 32 | ------ | 191 | 195 | ------ | 335 | 10.4 | 11.0 | ------ | ------ | ------ | ------ |
| 9 | 1.12 | ------ | 189 | ------ | 163 | 161 | ------ | 347 | 9.1 | 12.0 | ------ | ------ | ------ | ------ |
| 10 | .80 | ------ | 211 | ------ | 191 | 198 | ------ | 353 | 10.0 | 12.8 | ------ | ------ | ------ | ------ |
| 11 | .84 | ------ | 193 | ------ | 147 | 149 | ------ | 348 | 9.6 | 11.5 | ------ | ------ | ------ | ------ |
| 12 | 2.30 | ------ | 215 | ------ | 183 | 190 | ------ | 357 | 9.8 | 12.2 | ------ | ------ | ------ | ------ |
| 13 | 1.98 | ------ | 213 | ------ | 166 | 197 | ------ | 342 | 8.7 | 9.7 | ------ | ------ | ------ | ------ |
| 14 | 1.01 | ------ | 46 | ------ | 192 | 191 | ------ | 343 | 8.4 | 9.5 | 0.61 | ------ | ------ | ------ |
| 15 | .68 | ------ | 268 | ------ | 184 | 185 | ------ | 363 | 11.5 | 12.8 | ------ | ------ | ------ | ------ |
| 16 | 1.76 | ------ | 209 | ------ | 186 | 194 | ------ | 356 | 10.1 | 11.9 | ------ | ------ | ------ | ------ |
| 17 | 2.36 | ------ | 230 | ------ | 132 | 169 | ------ | 352 | 9.2 | 10.6 | ------ | ------ | ------ | ------ |
| 18 | 1.05 | ------ | 216 | ------ | 195 | 202 | ------ | 351 | 8.4 | 10.6 | ------ | ------ | ------ | ------ |
| 19 | 1.57 | ------ | 235 | ------ | 90 | 76 | ------ | 331 | 6.5 | 8.2 | ------ | ------ | ------ | ------ |
| 20 | 1.70 | ------ | 82 | ------ | 209 | 212 | ------ | 353 | 9.2 | 10.7 | ------ | ------ | ------ | ------ |
| 21 | 1.07 | ------ | 25 | ------ | 196 | 209 | ------ | 361 | 8.5 | 11.9 | ------ | ------ | ------ | ------ |
| 22 | .69 | ------ | 208 | ------ | 203 | 211 | ------ | 365 | 9 1 | 11.7 | ------ | ------ | ------ | ------ |
| 23 | 2.37 | ------ | 42 | ------ | 213 | 220 | ------ | 368 | 10.4 | 13.3 | ------ | ------ | 11.5 | 11.4 |
| 24 | 1.89 | ------ | 72 | ------ | 220 | 229 | ------ | 380 | 11.2 | 14.3 | ------ | ------ | 11.8 | 11.5 |
| 25 | 1.41 | ------ | 22 | ------ | 223 | 230 | ------ | 393 | 11.6 | 15.5 | ------ | ------ | 11.2 | 11.7 |
| 26 | 1.54 | ------ | 209 | ------ | 217 | 225 | ------ | 385 | 12.0 | 14.0 | ------ | ------ | 11.2 | 11.2 |
| 27 | 1.11 | ------ | 200 | ------ | 223 | ------ | ------ | 371 | 10 7 | 12.4 | ------ | ------ | 11.6 | 11.5 |
| 28 | ------ | ------ | ------ | ------ | 37 | 79 | ------ | 364 | ------ | 11.8 | ------ | ------ | ------ | 11.7 |
| **March 1974** | | | | | | | | | | | | | | |
| 1 | ------ | ------ | ------ | ------ | ------ | 160 | ------ | 398 | ------ | 15.9 | ------ | ------ | ------ | 12.8 |
| 2 | ------ | ------ | ------ | ------ | ------ | 114 | ------ | 362 | ------ | 11.3 | ------ | ------ | ------ | 12.3 |
| 3 | ------ | ------ | ------ | ------ | ------ | 142 | ------ | 345 | ------ | 8.2 | ------ | ------ | ------ | 12.1 |
| 4 | ------ | ------ | ------ | ------ | ------ | 241 | ------ | 352 | ------ | 9.9 | ------ | ------ | ------ | 12.0 |
| 5 | ------ | ------ | ------ | ------ | ------ | 243 | ------ | ------ | ------ | 11.0 | ------ | ------ | ------ | 11.7 |
| 6 | 2.08 | 1.29 | 207 | 224 | 232 | 237 | ------ | ------ | 9.1 | 10.2 | 0.71 | 0.99 | ------ | 12.0 |
| 7 | 1.27 | 2.01 | 193 | 210 | 53 | 82 | ------ | 346 | 8.6 | 9.5 | .94 | ------ | ------ | 12.2 |
| 8 | 2.84 | 2.32 | 201 | 181 | 58 | 58 | 241 | 333 | 6.6 | 7.3 | .85 | ------ | 12.4 | 12.1 |
| 9 | 1.07 | .94 | 13 | 46 | 159 | 160 | 255 | 344 | 6.8 | 7.7 | .80 | ------ | 12.6 | 12.5 |
| 10 | .78 | .69 | 22 | ------ | 196 | ------ | 239 | ------ | 8.4 | ------ | .85 | ------ | 12.6 | ------ |
| 11 | .95 | 1 06 | 39 | ------ | 235 | ------ | 239 | ------ | 10.8 | ------ | .85 | ------ | 12.6 | ------ |
| 12 | 1.05 | .77 | 23 | ------ | 231 | ------ | 253 | ------ | 12.5 | ------ | .93 | ------ | 13.2 | ------ |
| 13 | .75 | 1 16 | 42 | ------ | 231 | ------ | 259 | ------ | 14.1 | ------ | 1.08 | ------ | 13.6 | ------ |
| 14 | .73 | .92 | 35 | 81 | 244 | 244 | 256 | 390 | 16 3 | 17.1 | .97 | ------ | 13.9 | 14.1 |
| 15 | .82 | 1.13 | 29 | 36 | 228 | 235 | 258 | 392 | 16.3 | 17.5 | 1.08 | ------ | 14.2 | 14.4 |
| 16 | .66 | .72 | 86 | 244 | 214 | 218 | 258 | 394 | 16.6 | 18.2 | 1.10 | ------ | 14.5 | 14.7 |
| 17 | 1.10 | 1.12 | 39 | 59 | 197 | 198 | 249 | 390 | 16.5 | 17.2 | ------ | ------ | 14.7 | 14.8 |
| 18 | .90 | .97 | 218 | 185 | 148 | 203 | 268 | 378 | 12.6 | 13.2 | ------ | ------ | 15.0 | 15.0 |
| 19 | 1.62 | 1.14 | 210 | 225 | 122 | 127 | 272 | 370 | 11.2 | 11.7 | ------ | ------ | 15.2 | 15.0 |
| 20 | 1.47 | .81 | 215 | 236 | 37 | 72 | 250 | 367 | 11.3 | 12.2 | ------ | 1.15 | 15.0 | 14.8 |
| 21 | 1.16 | 1.03 | 44 | 210 | 183 | 214 | 285 | 379 | 13 0 | 13.6 | ------ | 1.27 | 14.9 | 15.1 |
| 22 | 1.57 | 1.06 | 230 | 231 | 102 | ------ | 275 | 373 | 11.6 | ------ | ------ | ------ | 14.9 | ------ |
| 23 | 1.86 | .83 | 215 | 215 | 66 | ------ | 266 | 368 | 10.6 | ------ | ------ | ------ | 15.1 | ------ |
| 24 | 1.22 | 1.23 | 79 | 188 | 202 | 239 | 267 | ------ | 12.3 | 12.6 | 1.06 | ------ | ------ | ------ |
| 25 | 1.08 | .94 | 211 | 204 | 151 | 154 | 274 | ------ | 11.9 | 12.2 | 1.07 | ------ | ------ | ------ |
| 26 | 1.88 | 1.37 | 222 | 218 | 153 | 181 | 265 | ------ | 13.0 | 13.3 | 1.15 | 1.22 | 15.5 | ------ |
| 27 | 2.06 | 1.50 | 226 | 212 | 200 | 146 | 280 | ------ | 13.2 | 13.2 | 1.11 | 1.22 | 16.0 | ------ |
| 28 | 1.09 | .91 | 39 | 265 | 217 | 194 | 268 | ------ | 12.2 | 12.9 | 1.04 | 1.14 | 16.0 | ------ |
| 29 | 1.03 | 1.18 | 2 | 56 | 241 | 267 | 289 | ------ | 14 9 | 15.7 | 1.20 | ------ | 16.1 | ------ |
| 30 | 1.47 | 1 33 | 35 | 222 | 163 | 148 | 263 | ------ | 11.8 | 13.3 | 1.10 | ------ | 16.5 | ------ |
| 31 | 2.32 | 1.24 | 236 | 193 | 264 | 228 | 271 | ------ | 12.4 | ------ | ------ | ------ | 16.7 | ------ |

TABLE 4.—*Daily averaged values of meteorologic and temperature data for San Diego Aqueduct (July 25, 1973–July 23, 1974)*—Continued

| Day of month | Wind-speed (m/s) | | Wind azimuth[3] (degree) | | Solar radiation (W/m²) | | Atmospheric radiation (W/m²) | | Air temperature (°C) | | Vapor pressure (kPa) | | Water temperature (°C) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | COT[1] | SKN[2] | COT | SKN | COT | SKN | COT | SKN | COT | SKN | COT | SKN | COT | SKN |
| **April 1974** | | | | | | | | | | | | | | |
| 1 | 2.07 | 1.78 | 225 | 205 | 139 | 147 | 237 | ------ | 10.7 | ------ | ------ | ------ | 16.3 | ------ |
| 2 | 3.83 | 2.34 | 218 | 209 | 234 | 233 | 248 | ------ | 12.8 | 13.4 | 1.11 | ------ | 16.4 | ------ |
| 3 | 1.42 | 1.16 | 218 | 242 | 287 | 294 | 276 | ------ | 12.2 | 12.5 | .91 | 0.91 | 16.6 | ------ |
| 4 | 1.73 | 2.15 | 46 | 64 | 293 | 300 | 244 | ------ | 13.3 | 16.1 | ------ | ------ | 16.0 | ------ |
| 5 | 1.21 | 1.28 | 36 | 254 | 297 | 303 | 251 | ------ | 15.8 | 18.1 | .93 | ------ | 16.5 | ------ |
| 6 | 1.23 | 1.41 | 235 | 184 | 295 | 295 | 251 | ------ | 14.3 | 16.2 | ------ | ------ | 16.8 | ------ |
| 7 | .84 | 1.16 | 227 | 255 | 291 | 297 | 273 | ------ | 16.6 | 18.4 | ------ | ------ | 17.2 | ------ |
| 8 | 2.15 | 1.15 | 221 | 237 | 296 | 299 | 247 | ------ | 16.7 | 17.4 | ------ | ------ | 17.4 | ------ |
| 9 | 3.68 | 3.35 | 227 | 247 | 258 | 274 | 248 | ------ | 11.0 | 12.0 | .84 | ------ | 17.6 | ------ |
| 10 | 2.01 | 1.71 | 267 | 217 | 301 | 305 | 241 | ------ | 10.1 | 11.4 | ------ | .96 | 17.3 | ------ |
| 11 | 1.23 | 1.50 | 62 | 53 | 302 | 306 | 251 | ------ | 13.0 | 14.3 | 1.01 | .79 | 16.1 | ------ |
| 12 | 1.63 | 1.19 | 204 | 215 | 302 | 307 | 261 | ------ | 14.4 | 15.9 | ------ | .76 | 16.8 | ------ |
| 13 | 1.59 | 1.16 | 17 | 195 | 301 | 298 | 265 | ------ | 16.0 | 17.4 | ------ | ------ | 17.6 | ------ |
| 14 | 1.32 | 1.01 | 2 | 64 | 308 | 308 | 259 | ------ | ------ | 18.9 | ------ | ------ | 17.3 | ------ |
| 15 | 1.08 | 1.09 | 64 | 207 | 310 | 314 | 255 | ------ | ------ | 18.6 | ------ | ------ | 17.2 | ------ |
| 16 | 1.56 | 1.05 | 196 | 208 | 312 | 317 | 251 | ------ | ------ | 17.0 | ------ | .80 | 17.5 | ------ |
| 17 | 2.04 | 1.19 | 207 | 204 | 318 | 319 | 249 | ------ | ------ | 14.9 | ------ | .88 | 18.0 | ------ |
| 18 | 2.75 | 1.87 | 226 | 211 | 161 | 232 | 277 | ------ | ------ | 12.6 | .97 | 1.06 | 18.2 | ------ |
| 19 | 2.56 | 1.28 | 212 | 208 | 249 | 251 | 288 | ------ | ------ | 12.6 | ------ | 1.10 | 18.2 | 18.0 |
| 20 | 1.20 | .99 | 228 | 198 | 239 | 232 | 264 | ------ | ------ | 12.5 | ------ | 1.16 | 17.3 | 17.4 |
| 21 | 1.23 | 1.49 | 28 | 56 | 309 | 316 | 276 | ------ | ------ | 17.0 | ------ | 1.14 | 17.8 | 17.9 |
| 22 | 1.14 | 1.02 | 225 | 233 | 284 | 291 | 252 | ------ | ------ | 18.1 | ------ | .94 | 18.3 | 18.2 |
| 23 | 2.18 | 1.63 | 217 | 194 | 304 | 277 | 248 | ------ | ------ | 12.8 | ------ | 1.06 | 18.6 | 18.5 |
| 24 | 1.98 | 1.39 | 85 | 219 | 283 | 277 | ------ | ------ | ------ | 13.4 | .95 | .94 | 18.7 | 18.7 |
| 25 | 1.84 | 1.53 | 213 | 197 | 312 | 324 | ------ | 244 | 11.3 | 12.2 | .72 | .77 | 18.5 | 18.5 |
| 26 | 1.40 | 1.12 | 232 | 181 | 327 | 323 | ------ | 251 | 11.5 | 12.7 | ------ | .88 | 18.5 | 18.5 |
| 27 | 1.49 | 1.07 | 221 | 216 | 308 | 319 | ------ | 262 | 14.2 | 15.0 | ------ | .94 | 18.5 | 18.7 |
| 28 | 1.70 | 1.15 | 217 | 214 | 312 | 317 | ------ | 266 | 15.0 | 16.5 | ------ | 1.03 | 18.7 | 18.6 |
| 29 | 1.77 | 1.69 | 42 | 44 | 326 | 327 | ------ | 269 | 17.7 | 19.5 | ------ | .98 | 19.0 | 19.2 |
| 30 | 1.50 | 1.28 | 36 | 239 | 328 | 328 | ------ | 276 | 19.4 | 21.2 | ------ | 1.11 | 19.2 | 19.5 |
| **May 1974** | | | | | | | | | | | | | | |
| 1 | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ |
| 2 | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ |
| 3 | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ |
| 4 | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ |
| 5 | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ |
| 6 | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ |
| 7 | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ |
| 8 | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ |
| 9 | 1.59 | 1.38 | 234 | 212 | 142 | 150 | ------ | 303 | 15.8 | 15.2 | ------ | 1.42 | 20.8 | 20.6 |
| 10 | 1.75 | 1.24 | 225 | 206 | 224 | 257 | ------ | 299 | 16.4 | 16.1 | ------ | 1.38 | 20.9 | 20.9 |
| 11 | 1.72 | 1.37 | 216 | 237 | 301 | 323 | ------ | 305 | 17.9 | 18.2 | ------ | 1.54 | 21.1 | 21.3 |
| 12 | 2.14 | 1.30 | 213 | 203 | 216 | 220 | ------ | 306 | 15.2 | 16.0 | ------ | 1.47 | 21.4 | 21.1 |
| 13 | 3.15 | 1.46 | 217 | 213 | 238 | 273 | ------ | 306 | 15.7 | 16.0 | ------ | 1.36 | 21.4 | 21.3 |
| 14 | 2.84 | 1.48 | 226 | 229 | 164 | 213 | ------ | 307 | 14.2 | 14.9 | ------ | 1.23 | 21.2 | 20.7 |
| 15 | 2.79 | 1.53 | 229 | 225 | 85 | 97 | ------ | 303 | 13.9 | 15.3 | ------ | 1.34 | 21.1 | 20.4 |
| 16 | 3.53 | 1.73 | 219 | 221 | 275 | 261 | ------ | 310 | 14.4 | 15.7 | ------ | 1.27 | 21.4 | 21.0 |
| 17 | 3.06 | 1.54 | 222 | 218 | 278 | 283 | ------ | 314 | 14.0 | 15.4 | ------ | 1.19 | 21.3 | 20.7 |
| 18 | 3.37 | 1.63 | 218 | 208 | 271 | 241 | ------ | 302 | 12.9 | 14.2 | ------ | 1.07 | 20.9 | 20.5 |
| 19 | 2.54 | 2.18 | 255 | 194 | 299 | 213 | ------ | 296 | 11.6 | 12.8 | ------ | .93 | 20.4 | 19.7 |
| 20 | 1.39 | 1.17 | 66 | 235 | 352 | 350 | ------ | 333 | 14.8 | 17.2 | ------ | ------ | 19.7 | 20.0 |
| 21 | 1.20 | 1.37 | 261 | 230 | 333 | 334 | ------ | 356 | 18.9 | 20.7 | 0.81 | ------ | 20.0 | 20.0 |
| 22 | 1.07 | 1.20 | 229 | 189 | 328 | 339 | ------ | 367 | 19.3 | 20.6 | .73 | .99 | 20.8 | 20.7 |
| 23 | 2.47 | 1.35 | 236 | 201 | 338 | 331 | ------ | 345 | 16.9 | 16.9 | ------ | ------ | 21.5 | 21.3 |
| 24 | 1.21 | .93 | 48 | 236 | 333 | 336 | ------ | 365 | 20.0 | 19.7 | ------ | ------ | 21.6 | 21.9 |
| 25 | 1.31 | 1.45 | 37 | 81 | 338 | 334 | ------ | 396 | 25.3 | 26.7 | ------ | 1.36 | 21.7 | 22.0 |
| 26 | 1.22 | .96 | 239 | 197 | 331 | 337 | ------ | 404 | 26.3 | 26.9 | ------ | 1.65 | 22.5 | 22.6 |
| 27 | 2.21 | 1.14 | 215 | 198 | 332 | 337 | ------ | 383 | 22.6 | 23.0 | ------ | 1.49 | 23.0 | 22.9 |
| 28 | 2.23 | 1.38 | 225 | 227 | 326 | 334 | ------ | ------ | 17.6 | 18.5 | ------ | 1.41 | 23.2 | 23.2 |
| 29 | 3.49 | 1.34 | 218 | 212 | 280 | 291 | ------ | ------ | 16.4 | 16.7 | ------ | 1.32 | 22.7 | 22.7 |
| 30 | 5.17 | 1.42 | 220 | 219 | 307 | 312 | ------ | ------ | 16.5 | 16.2 | 1.22 | 1.24 | 22.3 | 22.3 |
| 31 | 4.84 | 1.30 | 227 | 224 | 232 | 291 | ------ | ------ | 15.9 | 16.2 | 1.25 | 1.28 | 22.4 | 22.1 |
| **June 1974** | | | | | | | | | | | | | | |
| 1 | 3.01 | 1.34 | 232 | 222 | 266 | 309 | ------ | ------ | 18.1 | 18.2 | 1.28 | 1.35 | 22.5 | 22.5 |
| 2 | 2.50 | 1.06 | 220 | 206 | 280 | 313 | ------ | ------ | 17.4 | 18.6 | 1.30 | 1.52 | 22.8 | 22.8 |
| 3 | 1.94 | 1.02 | 235 | 225 | 251 | 243 | ------ | ------ | 17.2 | 16.8 | ------ | 1.46 | 22.9 | 22.6 |
| 4 | 2.58 | 1.21 | 206 | 211 | 290 | 299 | ------ | ------ | 18.9 | 17.9 | ------ | 1.53 | 23.2 | 23.2 |
| 5 | 3.69 | 1.28 | 211 | 227 | 315 | 317 | ------ | ------ | 19.7 | 19.6 | 1.43 | 1.58 | 23.2 | 23.2 |
| 6 | 4.29 | 1.37 | 212 | 204 | 313 | 301 | 383 | ------ | 18.6 | 18.8 | 1.37 | 1.66 | 23.3 | 23.2 |
| 7 | 4.85 | 1.51 | 219 | 233 | 74 | 71 | 394 | ------ | 15.4 | 15.3 | 1.40 | 1.50 | 23.4 | 22.5 |
| 8 | 4.08 | 1.42 | 213 | 230 | 341 | 343 | 356 | ------ | 20.1 | 19.2 | 1.28 | 1.48 | 23.6 | 23.6 |
| 9 | 2.92 | 1.51 | 239 | 238 | 345 | 348 | 318 | ------ | 21.0 | 20.8 | 1.24 | ------ | 22.7 | 23.3 |
| 10 | 3.16 | 1.05 | 231 | 200 | 333 | 335 | 330 | ------ | 21.7 | 20.0 | 1.34 | ------ | 22.8 | 22.8 |
| 11 | 2.11 | 1.11 | 51 | 200 | 310 | 324 | 340 | ------ | 21.5 | 20.0 | ------ | ------ | 23.5 | 23.5 |
| 12 | 2.12 | 1.05 | 85 | 207 | 312 | 334 | 409 | ------ | 22.0 | 21.1 | ------ | ------ | 24.0 | 24.1 |
| 13 | 2.04 | 1.04 | 89 | 199 | 323 | 326 | 327 | ------ | 22.9 | 20.6 | 1.32 | 1.73 | 24.2 | 24.2 |
| 14 | 3.08 | .91 | 57 | 234 | 349 | 340 | 295 | ------ | 24.1 | 24.1 | 1.17 | 1.61 | 24.4 | 24.5 |
| 15 | 3.16 | 1.02 | 53 | 210 | 346 | 341 | 317 | ------ | 26.5 | 27.7 | 1.00 | ------ | 24.5 | 24.7 |
| 16 | 3.97 | 1.43 | 210 | 212 | 351 | 353 | 300 | ------ | 23.1 | 24.7 | .94 | ------ | 24.5 | 24.4 |
| 17 | 3.63 | 1.19 | 201 | 216 | 351 | 355 | 298 | ------ | 20.2 | 22.0 | .90 | ------ | 24.6 | 24.3 |
| 18 | 3.96 | 1.42 | 215 | 213 | 350 | 357 | 304 | ------ | 19.1 | 20.2 | 1.00 | ------ | 24.6 | 24.3 |
| 19 | 2.10 | 1.13 | 61 | 217 | 343 | 357 | 298 | ------ | 19.9 | 20.0 | ------ | 1.31 | 24.4 | 24.3 |
| 20 | 3.08 | 1.10 | 208 | 214 | 353 | 359 | 309 | ------ | 22.4 | 22.7 | ------ | 1.13 | 24.4 | 24.4 |
| 21 | 3.08 | .96 | 207 | 203 | 354 | 360 | 310 | ------ | 23.5 | 24.0 | ------ | 1.04 | 24.4 | 24.4 |
| 22 | 1.89 | 1.13 | 60 | 215 | 340 | 355 | 315 | ------ | 24.8 | 26.8 | ------ | ------ | 24.8 | 24.8 |
| 23 | 2.12 | .98 | 56 | 216 | 333 | 343 | 325 | ------ | 26.9 | 29.2 | ------ | ------ | 25.0 | 25.1 |
| 24 | 3.50 | 1.11 | 59 | 259 | 337 | 343 | 317 | ------ | 28.6 | 30.1 | ------ | ------ | 25.1 | 25.3 |
| 25 | 3.20 | 1.24 | 59 | 234 | 332 | 346 | 318 | ------ | 27.9 | 30.4 | ------ | ------ | 25.5 | 25.5 |
| 26 | 2.37 | .92 | 57 | 202 | 334 | 338 | 328 | ------ | 28.5 | 29.2 | ------ | ------ | 25.3 | 25.5 |
| 27 | 1.91 | 1.13 | 248 | 208 | 333 | 342 | 325 | ------ | 28.8 | 29.2 | ------ | ------ | 25.4 | 25.4 |
| 28 | 3.09 | 1.16 | 205 | 199 | 346 | 356 | 302 | ------ | 28.0 | 29.8 | ------ | ------ | 25.5 | 25.5 |
| 29 | 3.64 | 1 29 | 208 | 205 | 348 | 360 | 297 | ------ | 24.3 | 25.1 | 1.26 | ------ | 25.5 | 25.3 |
| 30 | 4.18 | 1.30 | 217 | 218 | 349 | 362 | 294 | ------ | 22.0 | 21.3 | ------ | ------ | 25.3 | 25.1 |

TABLE 4.—*Daily averaged values of meteorologic and temperature data for San Diego Aqueduct (July 25, 1973–July 23, 1974)*—Continued

| Day of month | Wind-speed (m/s) | | Wind azimuth[3] (degree) | | Solar radiation (W/m²) | | Atmospheric radiation (W/m²) | | Air temperature (°C) | | Vapor pressure (kPa) | | Water temperature (°C) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | COT[1] | SKN[2] | COT | SKN | COT | SKN | COT | SKN | COT | SKN | COT | SKN | COT | SKN |
| **July 1974** | | | | | | | | | | | | | | |
| 1 | 3.49 | 1.41 | 215 | 207 | 330 | 317 | 335 | ------ | 19.6 | 18.7 | ------ | ------ | 24.8 | 24.7 |
| 2 | 3.95 | 1.51 | 217 | 227 | 316 | 337 | 391 | ------ | 19.6 | 19.4 | ------ | ------ | 24.8 | 24.6 |
| 3 | 3.15 | 1.13 | 212 | 218 | 346 | 354 | 355 | ------ | 22.3 | 22.5 | ------ | ------ | 24.7 | 24.6 |
| 4 | 1.75 | 1.07 | 60 | 222 | 331 | 341 | 315 | ------ | 25.4 | 26.3 | ------ | ------ | 24.9 | 24.8 |
| 5 | 3.14 | 1.22 | 216 | 192 | 341 | 346 | 298 | ------ | 25.8 | 25.9 | ------ | ------ | 25.2 | 25.1 |
| 6 | 4.12 | 1.44 | 222 | 214 | 361 | 361 | 276 | ------ | 22.6 | 23.1 | 1.10 | ------ | 25.2 | 25.1 |
| 7 | 4.25 | 1.52 | 213 | 205 | 349 | 345 | 390 | ------ | 20.1 | 20.6 | 1.28 | ------ | 24.8 | 24.8 |
| 8 | 4.43 | 1.59 | 216 | 209 | 338 | 344 | 393 | ------ | 19.3 | 19.8 | ------ | ------ | 24.4 | 24.2 |
| 9 | 3.76 | 1.36 | 226 | 219 | 343 | 343 | 301 | ------ | 20.4 | 20.3 | 1.34 | 1.47 | 24.5 | 24.3 |
| 10 | 4.00 | 1.67 | 231 | 215 | 306 | 302 | 360 | ------ | 18.8 | 19.1 | 1.75 | 1.61 | 24.9 | 24.5 |
| 11 | 3.26 | 1.25 | 226 | 218 | 330 | 344 | 363 | ------ | 20.8 | 20.6 | ------ | 1.43 | 24.7 | 24.8 |
| 12 | 2.30 | 1.21 | 248 | 222 | 332 | 346 | 331 | ------ | 22.8 | 22.6 | ------ | 1.43 | 24.5 | 24.6 |
| 13 | 2.50 | .95 | 247 | 214 | 272 | 235 | 316 | ------ | 25.3 | 24.5 | ------ | 1.46 | 24.9 | 24.6 |
| 14 | 2.35 | 1.12 | 73 | 32 | 135 | 114 | 306 | ------ | 26.4 | 25.6 | ------ | 1.71 | 25.2 | 24.9 |
| 15 | 3.03 | 1.07 | 39 | 184 | 286 | 269 | 346 | ------ | 26.0 | 24.9 | ------ | 1.85 | 25.1 | 25.2 |
| 16 | 2.73 | 1.31 | 266 | 194 | 320 | 333 | 332 | ------ | 26.4 | 26.8 | ------ | 1.44 | 25.5 | 25.5 |
| 17 | 2.21 | 1.14 | 71 | 204 | 321 | 342 | 307 | ------ | 26.8 | 27.4 | ------ | ------ | 25.8 | 25.8 |
| 18 | 3.94 | 1.84 | 223 | 237 | 331 | 343 | 318 | ------ | 26.7 | 27.3 | ------ | ------ | 25.9 | 25.8 |
| 19 | 3.43 | 1.52 | 200 | 216 | 209 | 225 | 334 | ------ | 26.5 | 27.1 | ------ | ------ | 26.0 | 25.9 |
| 20 | 3.12 | 1.38 | 67 | 199 | 318 | 328 | 355 | ------ | 26.9 | 27.3 | ------ | 1.69 | 25.8 | 26.0 |
| 21 | 3.24 | 1.20 | 229 | 206 | 319 | 322 | 319 | ------ | 25.2 | 25.2 | ------ | 1.19 | 25.7 | 25.6. |
| 22 | 3.20 | 1.35 | 218 | 223 | 274 | 330 | 306 | ------ | 24.8 | 24.9 | ------ | 1.94 | 26.3 | 25.9 |
| 23 | 2.13 | ------ | 202 | ------ | 216 | ------ | ------ | ------ | 26.0 | ------ | ------ | ------ | 26.1 | ------ |

[1]Cottonwood (upstream) end of canal.
[2]Skinner (downstream) end of canal.
[3]Direction from which the resultant wind comes measured clockwise from north.

and temperature data. Averages are included in table 4 only if sufficient data were present to adequately define the daily mean. The windspeed, solar radiation (shortwave), atmospheric radiation (longwave), and air temperatures represent averages of individual measurements. The wind azimuth represents the azimuth of the resultant wind vector for the day, and the water temperature represents the average obtained at all levels of measurement. A wind azimuth of zero represents a wind blowing from north to south. The vapor pressure was computed from the wet- and dry-bulb air temperatures for each 10-minute period and the results averaged. The conversion from wet- and dry-bulb temperatures to vapor pressures involved a two-step process. First the saturation vapor pressure of air at the wet-bulb temperature was computed using the formula

$$e_s = \exp\left[52.418 - 6788.6/(273.16 + TW) - 5.0016 \ln(273.16 + TW)\right] \quad (3)$$

in which $e_s$ is saturation vapor pressure in kilopascals, and $TW$ is wet-bulb temperature in degrees Celsius. The vapor pressure was then computed from

$$e_a = e_s - 96.0(0.00066)\,(TA - TW)\,(1 + 0.00115\,TW)\ldots \quad (4)$$

in which $e_a$ is vapor pressure of the air in kilopascals, $TA$ is dry-bulb temperature in degrees Celsius, the atmospheric pressure is assumed to be 96.0 kilopascals, and 0.00066 is the psychrometric constant.

Table 5 contains daily averages of all hydraulic data as well as daily rainfall values. The diversion discharge at EM–8 is not listed, because the mean daily value was always less than 0.1 m³/s. The diversion discharge at the So. End diversion was not measured but can be determined by continuity considerations, however. This diversion was zero prior to May 15, 1974.

The rain gages were serviced at approximately 0900 hours. The observed rainfall was assigned to the day preceding the date of observation. In some cases, the record had the word "trace" written in the rainfall column. In this case, the rainfall was recorded as 0.25 mm.

TABLE 5.—*Daily averaged values of hydraulic and rainfall data for San Diego Aqueduct (July 25, 1973–July 23, 1974)*

| Day of month | Stage (cm) Cottonwood | Stage (cm) Simpson | Stage (cm) Newport gage | Stage (cm) South end | Stage (cm) Skinner inlet | Discharge (m³/s) Cottonwood | Discharge (m³/s) Simpson | Discharge (m³/s) Skinner inlet | Rainfall[1] (mm) Cottonwood wood | Rainfall[1] (mm) Skinner |
|---|---|---|---|---|---|---|---|---|---|---|
| **July 1973** | | | | | | | | | | |
| 25 | 241 | ---------- | 193 | 190 | ---------- | 13.9 | 0.0 | ---------- | 0.0 | 0.0 |
| 26 | 240 | ---------- | 192 | 189 | ---------- | 13.7 | .0 | ---------- | .0 | .0 |
| 27 | 239 | ---------- | 191 | 189 | 95 | 13.7 | .0 | ---------- | .0 | .0 |
| 28 | 239 | ---------- | 191 | 190 | 170 | 13.7 | .0 | ---------- | .0 | .0 |
| 29 | 239 | ---------- | 191 | 190 | 170 | 13.7 | .0 | ---------- | .0 | .0 |
| 30 | 238 | ---------- | 191 | 190 | 170 | 13.6 | .0 | ---------- | .0 | .0 |
| 31 | 236 | 110 | 191 | 191 | 170 | 13.4 | .0 | ---------- | .0 | .0 |

See footnote at end of table.

TABLE 5.—*Daily averaged values of hydraulic and rainfall data for San Diego Aqueduct (July 25, 1973–July 23, 1974)*—Continued

| Day | Stage (cm) | | | | | Discharge (m³/s) | | | Rainfall[1] (mm) | |
|---|---|---|---|---|---|---|---|---|---|---|
| of month | Cottonwood | Simpson | Newport gage | South end | Skinner inlet | Cottonwood | Simpson | Skinner inlet | Cottonwood wood | Skinner |
| **August 1973** | | | | | | | | | | |
| 1 | 232 | 208 | 187 | 188 | 168 | 12.9 | 0.0 | --- | 0.0 | 0.0 |
| 2 | 229 | 205 | 183 | 184 | 164 | 12.6 | .0 | --- | .0 | .0 |
| 3 | 229 | 205 | 183 | 185 | 164 | 12.6 | .0 | --- | .0 | .0 |
| 4 | 230 | 206 | 183 | 186 | 164 | 12.6 | .0 | --- | .3 | .0 |
| 5 | 229 | 206 | 183 | 186 | 164 | 12.6 | .0 | --- | .0 | .0 |
| 6 | 229 | 205 | 183 | 186 | 164 | 12.6 | .0 | --- | .0 | .0 |
| 7 | 230 | 207 | 184 | 187 | 165 | 12.6 | .0 | --- | .0 | .0 |
| 8 | 231 | 207 | 184 | 187 | 165 | 12.8 | .0 | --- | .0 | .0 |
| 9 | 232 | 208 | 185 | 188 | 166 | 12.9 | .0 | --- | .0 | .0 |
| 10 | 232 | 208 | 185 | 188 | 166 | 12.9 | .0 | --- | .0 | .0 |
| 11 | 232 | 208 | 185 | 188 | 166 | 12.9 | .0 | --- | .0 | .0 |
| 12 | 232 | 208 | 185 | 188 | 166 | 12.9 | .0 | --- | .3 | .5 |
| 13 | 232 | 208 | 184 | 187 | 166 | 12.9 | .0 | --- | .0 | .0 |
| 14 | 232 | 208 | 184 | 187 | 166 | 13.0 | .0 | --- | .0 | .0 |
| 15 | 233 | 208 | 184 | 187 | 166 | 13.0 | .0 | --- | .0 | .0 |
| 16 | 233 | 208 | 184 | 187 | 166 | 13.0 | .0 | --- | .0 | .0 |
| 17 | 232 | 207 | 184 | 186 | 166 | 12.9 | .0 | --- | .0 | .0 |
| 18 | 232 | 207 | 184 | 187 | 166 | 12.9 | .0 | --- | .0 | .0 |
| 19 | 232 | 206 | 183 | 187 | 165 | 12.9 | .0 | --- | .0 | .0 |
| 20 | 231 | 206 | 183 | 186 | 165 | 12.8 | .0 | --- | .0 | .0 |
| 21 | 231 | 206 | 183 | 186 | 165 | 12.7 | .0 | --- | .0 | .0 |
| 22 | 232 | 206 | 183 | 186 | 166 | 12.8 | .0 | --- | .0 | .0 |
| 23 | 232 | 206 | 183 | 186 | 166 | 12.9 | .0 | --- | .0 | .0 |
| 24 | 233 | 208 | 185 | 188 | 167 | 13.0 | .0 | --- | .0 | .0 |
| 25 | 233 | 207 | 184 | 188 | 167 | 13.0 | .0 | --- | .0 | .0 |
| 26 | 233 | 207 | 184 | 187 | 167 | 13.0 | .0 | --- | .0 | .0 |
| 27 | 233 | 207 | 184 | 187 | 166 | 13.0 | .0 | --- | .0 | .0 |
| 28 | 233 | 207 | 184 | 187 | 166 | 13.0 | .0 | --- | .0 | .0 |
| 29 | 233 | 207 | 184 | 188 | 166 | 13.0 | .0 | --- | .0 | .0 |
| 30 | 233 | 207 | 184 | 188 | 167 | 13.0 | .0 | --- | .0 | .0 |
| 31 | 233 | 208 | 185 | 210 | 198 | 13.0 | .0 | --- | .0 | .0 |
| **September 1973** | | | | | | | | | | |
| 1 | 233 | 208 | 185 | 243 | 241 | 13.0 | 0.0 | --- | 0.0 | 0.0 |
| 2 | 233 | --- | 185 | 242 | 240 | 13.0 | .0 | --- | .0 | .0 |
| 3 | 233 | --- | 186 | 242 | 239 | 13.0 | .0 | --- | .0 | .0 |
| 4 | 233 | --- | 186 | 242 | 239 | 13.0 | .0 | --- | .0 | .0 |
| 5 | --- | --- | --- | --- | 219 | --- | .0 | --- | .0 | .0 |
| 6 | --- | --- | --- | --- | 166 | --- | .0 | --- | .0 | .0 |
| 7 | 232 | 205 | 183 | --- | 178 | 13.0 | .0 | --- | .0 | .0 |
| 8 | 232 | 204 | 183 | --- | 235 | 13.0 | .0 | --- | .0 | .0 |
| 9 | 232 | 204 | 183 | --- | 234 | 13.0 | .0 | --- | .0 | .0 |
| 10 | 232 | 204 | 183 | --- | 234 | 13.0 | .0 | --- | .0 | .0 |
| 11 | 232 | 204 | 183 | 273 | 237 | 13.0 | .0 | --- | .0 | .0 |
| 12 | 232 | 204 | 184 | 281 | 259 | 12.7 | .0 | --- | .0 | .0 |
| 13 | 228 | 200 | 181 | 291 | --- | 12.3 | .0 | --- | .0 | .0 |
| 14 | 227 | 199 | 179 | 260 | --- | 12.2 | .0 | --- | .0 | .0 |
| 15 | 225 | 197 | 176 | 182 | 164 | 12 0 | .0 | --- | .0 | .0 |
| 16 | 223 | 195 | 175 | 178 | 158 | 11 8 | .0 | --- | .0 | .0 |
| 17 | 224 | 196 | 175 | 179 | 158 | 11.9 | .0 | --- | .0 | .0 |
| 18 | 225 | 198 | 176 | 180 | 159 | 11.8 | .0 | --- | .0 | .0 |
| 19 | 226 | --- | 176 | 180 | 160 | 11.8 | .0 | --- | .0 | .0 |
| 20 | 226 | --- | 176 | 180 | 160 | 11.8 | .0 | --- | .0 | .0 |
| 21 | 226 | --- | 176 | 180 | 160 | 11.8 | .0 | --- | .0 | .0 |
| 22 | 225 | --- | 176 | 179 | 160 | 11.8 | .0 | --- | .0 | .0 |
| 23 | 225 | --- | 176 | 180 | 160 | 11.8 | .0 | --- | .0 | .0 |
| 24 | 225 | --- | 176 | 180 | 160 | 11.8 | .0 | --- | .0 | .0 |
| 25 | 224 | 197 | 175 | 179 | 159 | 11.8 | .0 | --- | .0 | .0 |
| 26 | 223 | 198 | 174 | 179 | 159 | 11.8 | .0 | --- | .0 | .0 |
| 27 | 226 | 200 | 176 | 180 | 160 | 12.0 | .0 | --- | .0 | .0 |
| 28 | 230 | 204 | 180 | 183 | 163 | 12.4 | .0 | --- | .0 | .0 |
| 29 | 232 | 207 | 182 | 185 | 165 | 12.7 | .0 | --- | .0 | .0 |
| 30 | 232 | 206 | 182 | 184 | 165 | 12.7 | .0 | --- | .0 | .0 |
| **October 1973** | | | | | | | | | | |
| 1 | 231 | 206 | 181 | 184 | 164 | 12.7 | 0.0 | --- | 0.0 | 0.0 |
| 2 | 231 | 206 | 181 | 185 | 165 | 12 7 | .0 | --- | .0 | .0 |
| 3 | 231 | 206 | 182 | 185 | 165 | 12.8 | .0 | --- | .0 | .0 |
| 4 | 228 | 205 | 180 | 184 | 164 | 12.7 | .0 | --- | .0 | .0 |
| 5 | 222 | 201 | 176 | 182 | 162 | 12.1 | .0 | --- | .0 | .0 |
| 6 | 218 | 198 | 174 | 180 | 160 | 11.6 | .0 | --- | .0 | .0 |
| 7 | 209 | 190 | 166 | 175 | 156 | 10.7 | .0 | --- | .0 | .0 |
| 8 | 203 | 184 | 160 | 170 | 151 | 10.0 | .0 | --- | .0 | .8 |
| 9 | 201 | 183 | 159 | 169 | 150 | 10.1 | .0 | --- | .0 | .0 |
| 10 | 197 | 180 | 156 | 167 | 149 | 9.9 | .0 | --- | .0 | .0 |
| 11 | 205 | 186 | 161 | 169 | 150 | 10 7 | .0 | --- | .0 | .0 |
| 12 | 210 | 196 | 172 | 180 | 158 | 11.2 | .0 | --- | .0 | .0 |
| 13 | 208 | 197 | 173 | 181 | 159 | 11.3 | .0 | --- | .0 | .0 |
| 14 | 208 | 197 | 173 | 181 | 159 | 11.3 | .0 | --- | .0 | .0 |
| 15 | 207 | 198 | 174 | 182 | 159 | 11.3 | .0 | --- | .0 | .0 |
| 16 | 205 | 198 | 174 | 183 | 159 | 11.3 | .0 | --- | .0 | .0 |
| 17 | 220 | 213 | 188 | --- | 166 | 13.2 | .0 | --- | .0 | .0 |
| 18 | 237 | 242 | 208 | --- | 181 | 15.6 | .0 | --- | .0 | .0 |
| 19 | 237 | 245 | 208 | 207 | 181 | 15.6 | .0 | --- | .0 | .0 |
| 20 | 237 | 245 | 208 | 207 | 181 | 15.6 | .0 | --- | .0 | .0 |
| 21 | 236 | 244 | 208 | 207 | 181 | 15.6 | .0 | --- | .0 | .0 |
| 22 | 236 | 244 | 207 | 206 | 181 | 15.6 | .0 | --- | .0 | .0 |
| 23 | 236 | 244 | 208 | 206 | 181 | 15.6 | .0 | --- | .0 | .0 |
| 24 | 237 | 241 | 206 | 205 | 180 | 15.6 | .6 | --- | .0 | .0 |
| 25 | 237 | 235 | 201 | 201 | 177 | 15.6 | 1.1 | --- | .0 | .0 |
| 26 | 237 | 232 | 198 | 198 | 175 | 15.6 | 1.3 | --- | .0 | .0 |
| 27 | 237 | 232 | 198 | 198 | 175 | 15.6 | 1.3 | --- | .0 | .0 |
| 28 | 237 | 231 | 198 | 198 | 175 | 15.6 | 1.3 | --- | .0 | .0 |
| 29 | 237 | 231 | 198 | 199 | 175 | 15.6 | 1.3 | --- | .0 | .0 |
| 30 | 238 | 231 | 199 | 199 | 175 | 15.6 | 1.3 | --- | .0 | .0 |
| 31 | 238 | 231 | 199 | 199 | 175 | 15.6 | 1.3 | --- | .0 | .0 |

TABLE 5.—*Daily averaged values of hydraulic and rainfall data for San Diego Aqueduct (July 25, 1973–July 23, 1974)*—Continued

| Day | Stage (cm) | | | | | Discharge ($m^3/s$) | | | Rainfall[1] (mm) | |
|---|---|---|---|---|---|---|---|---|---|---|
| of month | Cottonwood | Simpson | Newport gage | South end | Skinner inlet | Cottonwood | Simpson | Skinner inlet | Cottonwood | Skinner |
| **November 1973** | | | | | | | | | | |
| 1 | 239 | 232 | 199 | 199 | 175 | 15.6 | 1.3 | | 0.0 | 0.0 |
| 2 | 239 | 227 | 200 | 200 | 176 | 15.6 | 1.1 | | .0 | .0 |
| 3 | 239 | 224 | 203 | 201 | 178 | 15.6 | .9 | | .0 | .0 |
| 4 | 239 | 225 | 204 | 202 | 178 | 15.6 | .9 | | .0 | .0 |
| 5 | 239 | 224 | 203 | 201 | 178 | 15.6 | .9 | | .0 | .0 |
| 6 | 239 | 224 | 203 | 201 | 177 | 15.6 | .9 | | .0 | .0 |
| 7 | 240 | 224 | 203 | 200 | 177 | 15.6 | .9 | | .0 | .0 |
| 8 | 240 | 223 | 202 | 200 | 177 | 15.6 | .9 | | .0 | .0 |
| 9 | 240 | 222 | 201 | 199 | 176 | 15.6 | .9 | | .0 | .0 |
| 10 | 239 | 221 | 200 | 198 | 175 | 15.6 | .9 | | .0 | .0 |
| 11 | 239 | 221 | 200 | 198 | 175 | 15.6 | .9 | | .0 | .0 |
| 12 | 240 | 221 | 199 | 197 | 174 | 15.6 | .9 | | .0 | .0 |
| 13 | 238 | 219 | 197 | 195 | 173 | 15.7 | .9 | | .0 | .0 |
| 14 | 229 | 209 | 187 | 188 | 167 | 14.6 | .9 | | .0 | .0 |
| 15 | 224 | 203 | 181 | 184 | 163 | 13.9 | .9 | | .0 | .0 |
| 16 | 221 | 199 | 177 | 180 | 160 | 13.6 | .9 | | 1.8 | 1.3 |
| 17 | 219 | 200 | 178 | 181 | 160 | 13.3 | .4 | | 19.8 | 14.0 |
| 18 | 212 | 197 | | 181 | 159 | 12.5 | .0 | | 7.1 | 4.1 |
| 19 | 204 | 188 | | | 154 | 11.6 | .0 | | .0 | .0 |
| 20 | 186 | 171 | 151 | | 145 | 9.7 | .0 | | .0 | .0 |
| 21 | 174 | 157 | 135 | 148 | 134 | 8.5 | .0 | | .3 | .0 |
| 22 | 170 | 153 | 131 | 144 | 130 | 8.1 | .0 | | 12.7 | 17.5 |
| 23 | 161 | 144 | 125 | 140 | 127 | 7.3 | .0 | | .0 | .0 |
| 24 | 153 | 135 | 115 | 131 | 119 | 6.9 | .0 | | 2.8 | .8 |
| 25 | 153 | 135 | 115 | 131 | 119 | 6.9 | .0 | | .0 | 1.0 |
| 26 | 154 | 134 | 115 | 131 | 119 | 6.9 | .0 | | .0 | .0 |
| 27 | 154 | 135 | 115 | 132 | 119 | 6.9 | .0 | | .0 | .0 |
| 28 | 154 | 135 | 115 | 132 | 118 | 6.9 | .0 | | .0 | .0 |
| 29 | 155 | 135 | 115 | 132 | 119 | 6.9 | .0 | | .0 | .0 |
| 30 | 155 | 135 | 115 | 132 | 118 | 6.9 | .0 | | 1.3 | .0 |
| **December 1973** | | | | | | | | | | |
| 1 | 156 | 136 | 115 | 132 | 119 | 6.9 | .0 | | 0.0 | 1.3 |
| 2 | 156 | 137 | | 133 | 119 | 6.9 | .0 | | .0 | .0 |
| 3 | 156 | 138 | | 133 | 119 | 6.9 | .0 | | .0 | .0 |
| 4 | 155 | 138 | | 134 | 119 | 6.9 | .0 | | .0 | .0 |
| 5 | 155 | 136 | 117 | 134 | 119 | 6.9 | .0 | | .0 | .0 |
| 6 | 155 | 133 | 117 | 134 | 120 | 6.9 | .0 | | .0 | .0 |
| 7 | 155 | | 114 | 135 | 120 | 6.9 | .0 | | .0 | .0 |
| 8 | 154 | | 110 | 134 | 120 | 6.9 | .0 | | .0 | .0 |
| 9 | 154 | | 110 | 134 | 119 | 6.9 | .0 | | .0 | .0 |
| 10 | 175 | | 123 | 142 | 126 | 8.7 | .0 | | .0 | .0 |
| 11 | 205 | 169 | 156 | 172 | 152 | 11.7 | .0 | | .0 | .0 |
| 12 | 212 | 175 | 162 | 177 | 157 | 12.4 | .0 | | .0 | .0 |
| 13 | 211 | 169 | 154 | 172 | 153 | 11.9 | .7 | | .0 | .0 |
| 14 | 210 | 161 | 144 | 166 | 148 | 11.9 | 1.8 | | .0 | .0 |
| 15 | 210 | 158 | 140 | 162 | 145 | 11.9 | 2.1 | | .0 | .0 |
| 16 | 210 | 157 | 140 | 162 | 145 | 11.9 | 2.1 | | .0 | .0 |
| 17 | 209 | 157 | 139 | 162 | 145 | 11.9 | 2.1 | | .0 | .0 |
| 18 | 209 | 157 | 139 | 162 | 145 | 11.9 | 2.1 | | .0 | .0 |
| 19 | 209 | 158 | 139 | 162 | 145 | 11.9 | 2.1 | | .0 | .0 |
| 20 | 209 | 157 | 139 | 162 | 145 | 11.9 | 2.1 | | .0 | .0 |
| 21 | 205 | 162 | 144 | 165 | 148 | 11.3 | 1.2 | | .5 | 1.0 |
| 22 | 197 | 164 | 147 | 168 | 150 | 10.5 | .0 | | .0 | .0 |
| 23 | 197 | 165 | 147 | 169 | 150 | 10.5 | .0 | | .0 | .0 |
| 24 | 197 | 165 | 147 | 169 | 150 | 10.5 | .0 | | .0 | .0 |
| 25 | 197 | 165 | 147 | 169 | 150 | 10.5 | .0 | | .0 | .0 |
| 26 | 194 | 162 | 144 | 167 | 149 | 10.2 | .0 | | .0 | .0 |
| 27 | 232 | 193 | 178 | 184 | 166 | 14.9 | .0 | | .5 | .0 |
| 28 | 282 | 250 | 235 | 231 | 206 | 21.5 | .0 | | .0 | .0 |
| 29 | 289 | 260 | 245 | 238 | 212 | 22.7 | .0 | | .0 | .3 |
| 30 | 289 | 260 | 244 | 238 | 212 | 22.7 | .0 | | .0 | .0 |
| 31 | 289 | 259 | 244 | 238 | 212 | 22.7 | .0 | | 11.9 | .8 |
| **January 1974** | | | | | | | | | | |
| 1 | 289 | 260 | 243 | 238 | 213 | 22.7 | 0.0 | | 0.8 | 0.8 |
| 2 | 295 | 266 | 248 | 240 | 215 | 23.6 | .0 | | .0 | .0 |
| 3 | 305 | 278 | 260 | 245 | 221 | 25.4 | .0 | | .0 | .5 |
| 4 | 312 | 287 | 270 | 250 | 226 | 26.6 | .0 | | 59.7 | 53.6 |
| 5 | 314 | 289 | 271 | 151 | 227 | 27.0 | .0 | | 2.5 | 1.8 |
| 6 | 314 | 289 | 270 | 251 | 227 | 27.0 | .0 | | 29.5 | 18.5 |
| 7 | 312 | 284 | 264 | 249 | 225 | 26.6 | .0 | | 66.0 | 67.3 |
| 8 | 287 | 256 | 234 | 230 | 208 | 22.3 | .0 | | 5.6 | .5 |
| 9 | 286 | 255 | | 229 | 206 | 22.1 | .0 | | 1.5 | 1.0 |
| 10 | | 255 | | 232 | 211 | | .0 | | .0 | .0 |
| 11 | 285 | 257 | | 244 | 223 | 22.1 | .0 | | .0 | .0 |
| 12 | 286 | 242 | | 256 | 242 | 22.2 | .0 | | .0 | .0 |
| 13 | 268 | 199 | | 267 | 262 | 19.6 | .0 | | .0 | .0 |
| 14 | 218 | 166 | | 273 | 277 | 13.0 | .0 | | .0 | .0 |
| 15 | 191 | 161 | 143 | 277 | 282 | 9.8 | .0 | | .0 | .0 |
| 16 | 187 | 161 | 143 | 280 | 284 | 9.1 | .0 | | 2.8 | 1.0 |
| 17 | 163 | 143 | 127 | 283 | 287 | 7.6 | .0 | | .3 | .0 |
| 18 | 145 | 124 | 108 | 281 | 286 | 6.5 | .0 | | .0 | .0 |
| 19 | 145 | 123 | 108 | 208 | 284 | 6.5 | .0 | | .0 | .0 |
| 20 | 145 | 123 | 108 | 279 | 283 | 6.5 | .0 | | 4.3 | 2.3 |
| 21 | 147 | 125 | 110 | 278 | 282 | 5.9 | .0 | | .0 | .0 |
| 22 | 132 | 114 | 100 | 277 | 281 | 4.9 | .0 | | .0 | .0 |
| 23 | 122 | 104 | 88 | 271 | 276 | 4.1 | .0 | | .0 | .0 |
| 24 | 122 | 105 | 87 | 265 | 271 | 3.7 | .0 | | .0 | .0 |
| 25 | 122 | 105 | 86 | 260 | 265 | 3.7 | .0 | | .3 | .0 |
| 26 | 122 | 105 | 86 | 253 | 258 | 3.7 | .0 | | .0 | .0 |
| 27 | 122 | 105 | 86 | 248 | 253 | 3.7 | .0 | | .0 | .0 |
| 28 | 122 | 105 | 86 | 243 | 247 | 3.7 | .0 | | .0 | .0 |
| 29 | 122 | 105 | 85 | 235 | 237 | 3.7 | .0 | | .0 | .0 |
| 30 | 122 | 105 | 85 | 224 | 229 | 3.7 | .0 | | .0 | .0 |
| 31 | 123 | 105 | 85 | 212 | 218 | 3.7 | .0 | | .0 | .0 |

TABLE 5.—*Daily averaged values of hydraulic and rainfall data for San Diego Aqueduct (July 25, 1973–July 23, 1974)*—Continued

| Day | Stage (cm) | | | | | Discharge ($m^3/s$) | | | Rainfall[1] (mm) | |
|---|---|---|---|---|---|---|---|---|---|---|
| of month | Cottonwood | Simpson | Newport gage | South end | Skinner inlet | Cottonwood | Simpson | Skinner inlet | Cottonwood wood | Skinner |
| | | | | **February 1974** | | | | | | |
| 1 | 122 | 105 | 84 | 200 | 205 | 3.7 | 0.0 | --- | 0.0 | 0.0 |
| 2 | 89 | 100 | 82 | 188 | 193 | 3.0 | .0 | --- | .0 | .0 |
| 3 | 0 | 52 | 6 | 172 | 177 | .0 | .0 | 0.0 | .0 | .0 |
| 4 | 0 | 53 | 3 | 152 | 158 | .0 | .0 | .0 | .0 | .0 |
| 5 | 0 | --- | --- | 130 | 136 | .0 | .0 | .0 | .0 | .0 |
| 6 | 0 | --- | --- | 108 | 114 | .0 | .0 | .0 | .0 | .0 |
| 7 | 0 | --- | --- | 84 | 90 | .0 | .0 | .0 | .0 | .0 |
| 8 | 0 | --- | --- | 60 | 66 | .0 | .0 | .0 | .0 | .0 |
| 9 | 0 | --- | --- | 30 | 42 | .0 | .0 | .0 | .0 | .0 |
| 10 | 0 | --- | --- | 12 | 19 | .0 | .0 | .0 | .0 | .0 |
| 11 | 0 | --- | --- | 14 | 14 | .0 | .0 | .0 | .0 | .0 |
| 12 | 0 | --- | --- | --- | --- | .0 | .0 | .0 | .0 | .3 |
| 13 | 0 | --- | --- | --- | --- | .0 | .0 | .0 | .0 | .0 |
| 14 | 0 | --- | --- | --- | --- | .0 | .0 | .0 | .0 | .0 |
| 15 | 0 | --- | --- | --- | --- | .0 | .0 | .0 | .0 | .0 |
| 16 | 0 | --- | --- | --- | --- | .0 | .0 | .0 | .0 | .3 |
| 17 | 0 | --- | --- | --- | --- | .0 | .0 | .0 | .0 | .0 |
| 18 | 0 | --- | --- | --- | --- | .0 | .0 | .0 | .0 | .0 |
| 19 | 0 | --- | --- | --- | --- | .0 | .0 | .0 | .3 | 1.0 |
| 20 | 0 | --- | --- | --- | --- | .0 | .0 | .0 | .0 | .0 |
| 21 | 0 | --- | --- | --- | --- | .0 | .0 | .0 | .0 | .0 |
| 22 | 0 | --- | --- | --- | --- | .0 | .0 | .0 | .0 | .0 |
| 23 | 0 | --- | --- | --- | --- | .0 | .0 | .0 | .0 | .0 |
| 24 | 0 | --- | --- | --- | --- | .0 | .0 | .0 | .0 | .0 |
| 25 | 96 | 202 | --- | 200 | --- | 4.6 | .0 | --- | .0 | .0 |
| 26 | 184 | 223 | 196 | 200 | --- | 9.2 | .0 | --- | .0 | .0 |
| 27 | 215 | --- | 180 | --- | --- | 12.6 | .0 | --- | .0 | .0 |
| 28 | 196 | --- | 150 | --- | --- | 10.4 | .0 | --- | 1.3. | 2.3 |
| | | | | **March 1974** | | | | | | |
| 1 | 202 | 178 | 154 | --- | --- | --- | 0.0 | 10.7 | 9.4 | 7.1 |
| 2 | 215 | 191 | 168 | --- | --- | --- | .0 | 12.4 | 9.9 | 4.3 |
| 3 | 213 | 190 | 167 | --- | --- | --- | .0 | 12.5 | .0 | 4.1 |
| 4 | 250 | 220 | 197 | --- | --- | --- | .0 | 15.5 | .0 | .0 |
| 5 | 292 | 272 | 253 | --- | --- | --- | .0 | 23.3 | .0 | .0 |
| 6 | 294 | 274 | 254 | 237 | --- | --- | .0 | 23.5 | .0 | .3 |
| 7 | 297 | 278 | 257 | 238 | --- | --- | .0 | 24.1 | 20.6 | 13.2 |
| 8 | 295 | 275 | 256 | 238 | --- | --- | .0 | 24.0 | 21.6 | 14.2 |
| 9 | 291 | 271 | 251 | 233 | --- | --- | .0 | 23.0 | .0 | .0 |
| 10 | 291 | 271 | 251 | 233 | --- | --- | .0 | 23.2 | .0 | .0 |
| 11 | 292 | 271 | 251 | 235 | --- | --- | .0 | 23.2 | .0 | .0 |
| 12 | 294 | 275 | 254 | 236 | --- | --- | .0 | 23.7 | .0 | .0 |
| 13 | 294 | 275 | 254 | 236 | --- | --- | .0 | 23.5 | .0 | .0 |
| 14 | 294 | 275 | 254 | 236 | --- | --- | .0 | 23.6 | .0 | .0 |
| 15 | 294 | 275 | 254 | 236 | --- | --- | .0 | 23.5 | .0 | .0 |
| 16 | 294 | 274 | 254 | 236 | --- | --- | .0 | 23.4 | .0 | .0 |
| 17 | 294 | 274 | 253 | 236 | --- | --- | .0 | 23.5 | .0 | .0 |
| 18 | 248 | 232 | 214 | 215 | --- | --- | .0 | 19.0 | .0 | .0 |
| 19 | 217 | 194 | 170 | 178 | --- | --- | .0 | 12.9 | .0 | .0 |
| 20 | 214 | 191 | 166 | 175 | --- | 12.4 | .0 | --- | .3 | .0 |
| 21 | 214 | 190 | 166 | 174 | --- | 12.4 | .0 | --- | .0 | .0 |
| 22 | 214 | 190 | 166 | 184 | --- | 12.4 | .0 | --- | .0 | .0 |
| 23 | 214 | 191 | 166 | 196 | --- | 12.4 | .0 | --- | .0 | .0 |
| 24 | 155 | 144 | 123 | 189 | --- | 7.3 | .0 | --- | .0 | .0 |
| 25 | 125 | 95 | 74 | 145 | --- | 4.6 | .0 | --- | .3 | .8 |
| 26 | 192 | 167 | 145 | 250 | --- | 10.0 | .0 | --- | .3 | .8 |
| 27 | 164 | 160 | 138 | 232 | --- | 7.7 | .0 | --- | .5 | .5 |
| 28 | 166 | 135 | 108 | 152 | --- | --- | .0 | 5.5 | .0 | .0 |
| 29 | 279 | 256 | 236 | 270 | --- | --- | .0 | 19.9 | .0 | .0 |
| 30 | 279 | 256 | 235 | 242 | --- | --- | .0 | 20.3 | .0 | .3 |
| 31 | 279 | 256 | 235 | 240 | --- | --- | .0 | 20.3 | .0 | .0 |
| | | | | **April 1974** | | | | | | |
| 1 | 279 | 256 | 235 | 239 | --- | --- | 0.0 | 20.3 | 6.4 | 4.8 |
| 2 | 292 | 267 | --- | 243 | --- | --- | .0 | 21.5 | .0 | .0 |
| 3 | 307 | 286 | --- | 257 | --- | --- | .0 | 24.5 | .0 | .0 |
| 4 | 308 | 287 | 267 | 255 | --- | --- | .0 | 25.6 | .0 | .0 |
| 5 | 308 | 286 | 267 | 245 | --- | --- | .0 | 26.0 | .0 | .0 |
| 6 | 308 | 287 | 267 | 245 | --- | --- | .0 | 26.0 | .0 | .0 |
| 7 | 309 | 287 | 267 | 245 | --- | --- | .0 | 25.7 | .0 | .0 |
| 8 | 315 | 293 | 273 | 251 | --- | --- | .0 | 25.5 | .0 | .0 |
| 9 | 321 | 301 | 282 | 261 | --- | --- | .0 | 25.5 | .0 | .0 |
| 10 | 321 | 301 | 283 | 270 | --- | --- | .0 | 24.4 | .0 | .0 |
| 11 | 288 | 267 | 251 | 268 | --- | --- | .0 | 19.8 | .0 | .0 |
| 12 | 256 | 229 | 211 | 275 | --- | --- | .0 | 15.9 | .0 | .0 |
| 13 | 255 | 229 | 210 | 279 | --- | --- | .0 | 15.9 | .0 | .0 |
| 14 | 255 | 229 | 211 | 282 | --- | --- | .0 | 15.7 | .0 | .0 |
| 15 | 255 | 229 | 211 | 286 | --- | --- | .0 | 15.5 | .0 | .0 |
| 16 | 248 | 218 | 200 | 287 | --- | --- | .6 | 13.9 | .0 | .0 |
| 17 | 248 | 207 | 190 | 286 | --- | --- | 1.7 | 12.7 | .0 | .0 |
| 18 | 254 | 208 | 191 | 285 | --- | --- | 2.2 | 12.9 | .0 | .0 |
| 19 | 254 | 209 | 191 | 284 | --- | --- | 2.2 | 12.9 | .0 | .0 |
| 20 | 255 | 210 | 191 | 285 | --- | --- | 2.2 | 12.9 | .0 | .0 |
| 21 | 256 | 210 | 191 | 285 | --- | --- | 2.2 | 12.9 | .0 | .0 |
| 22 | 256 | 211 | 192 | 286 | --- | --- | 2.2 | 12.8 | .0 | .0 |
| 23 | 256 | 211 | 192 | 286 | --- | --- | 2.2 | 12.7 | .0 | .0 |
| 24 | 257 | 212 | 192 | 285 | --- | --- | 2.2 | 12.7 | .0 | .0 |
| 25 | 258 | 213 | 193 | 285 | --- | --- | 2.1 | 12.7 | .0 | .0 |
| 26 | 259 | 214 | 193 | 284 | --- | --- | 2.1 | 12.7 | .0 | .0 |
| 27 | 261 | 215 | 195 | 283 | --- | --- | 1.9 | 12.8 | .0 | .0 |
| 28 | 261 | 216 | 196 | 282 | --- | --- | 1.9 | 12.9 | .0 | .0 |
| 29 | 260 | 216 | 196 | 281 | --- | --- | 1.9 | 13.0 | .0 | .0 |
| 30 | 259 | 216 | 196 | 280 | --- | --- | 1.9 | 13.0 | .0 | .0 |

TABLE 5.—*Daily averaged values of hydraulic and rainfall data for San Diego Aqueduct (July 25, 1973–July 23, 1974)*—Continued

| Day | Stage (cm) | | | | | Discharge ($m^3/s$) | | | Rainfall[1] (mm) | |
|---|---|---|---|---|---|---|---|---|---|---|
| of month | Cottonwood | Simpson | Newport gage | South end | Skinner inlet | Cottonwood | Simpson | Skinner inlet | Cottonwood wood | Skinner |
| | | | | | **May 1974** | | | | | |
| 1 | ---------- | ---------- | ---------- | ---------- | ---------- | ---------- | ---------- | ---------- | 0.0 | 0.0 |
| 2 | ---------- | ---------- | ---------- | ---------- | ---------- | ---------- | ---------- | ---------- | .0 | .0 |
| 3 | ---------- | ---------- | ---------- | ---------- | ---------- | ---------- | ---------- | ---------- | .0 | .0 |
| 4 | ---------- | ---------- | ---------- | ---------- | ---------- | ---------- | ---------- | ---------- | .0 | .0 |
| 5 | ---------- | ---------- | ---------- | ---------- | ---------- | ---------- | ---------- | ---------- | .0 | .0 |
| 6 | ---------- | ---------- | ---------- | ---------- | ---------- | ---------- | ---------- | ---------- | .0 | .3 |
| 7 | ---------- | ---------- | ---------- | ---------- | ---------- | ---------- | ---------- | ---------- | .0 | .0 |
| 8 | 247 | 210 | 190 | 282 | ---------- | ---------- | 1.8 | 12.2 | .0 | .0 |
| 9 | 246 | 210 | 190 | 283 | ---------- | ---------- | 1.8 | 12.2 | .0 | .0 |
| 10 | 247 | 210 | 191 | 283 | ---------- | ---------- | 1.8 | 12.4 | .0 | .0 |
| 11 | 247 | 211 | 191 | 284 | ---------- | ---------- | 1.8 | 12.4 | .0 | .0 |
| 12 | 247 | 211 | 192 | 286 | ---------- | ---------- | 1.8 | 12.4 | .0 | .0 |
| 13 | 248 | 212 | 192 | 287 | ---------- | ---------- | 1.8 | 12.4 | .0 | .0 |
| 14 | 247 | 211 | 192 | 288 | ---------- | ---------- | 1.8 | 12.3 | .0 | .0 |
| 15 | 247 | 211 | 192 | 286 | ---------- | 14.8 | 1.8 | 9.9 | .0 | .0 |
| 16 | 247 | 211 | 191 | 283 | ---------- | 14.8 | 1.8 | 7.1 | .0 | .0 |
| 17 | 246 | 209 | 190 | 282 | ---------- | 14.6 | 1.8 | 7.2 | .0 | .0 |
| 18 | 245 | 208 | 189 | 280 | ---------- | 14.6 | 1.8 | 7.2 | .0 | .3 |
| 19 | 245 | 207 | 189 | 279 | ---------- | 14.5 | 1.8 | 7.4 | .0 | .0 |
| 20 | 248 | 210 | 192 | 278 | ---------- | 14.9 | 1.8 | 7.6 | .0 | .0 |
| 21 | 248 | 210 | 193 | 278 | ---------- | 14.9 | 1.8 | 7.8 | .0 | .0 |
| 22 | 247 | 210 | 193 | 278 | ---------- | 14.8 | 1.8 | 7.7 | .0 | .0 |
| 23 | 247 | 212 | 194 | 278 | ---------- | 14.8 | 1.8 | 7.8 | .0 | .0 |
| 24 | 247 | 214 | 195 | 278 | ---------- | 14.8 | 1.8 | 7.8 | .0 | .0 |
| 25 | 247 | 213 | 196 | 276 | ---------- | 14.8 | 1.8 | 7.8 | .0 | .0 |
| 26 | 248 | 215 | 197 | 275 | ---------- | 14.9 | 1.8 | 7.9 | .0 | .0 |
| 27 | 249 | 216 | 197 | 273 | ---------- | 15.1 | 1.8 | 8.0 | .0 | .0 |
| 28 | 252 | 217 | 195 | 271 | ---------- | 15.5 | 2.5 | 7.9 | .0 | .0 |
| 29 | 256 | 217 | 198 | 270 | ---------- | 15.9 | 2.2 | 8.0 | .0 | .0 |
| 30 | 257 | 217 | 199 | 270 | ---------- | 16.0 | 2.3 | 8.5 | .0 | .0 |
| 31 | 260 | 220 | 202 | 269 | ---------- | 16.5 | 2.3 | 8.5 | .0 | .0 |
| | | | | | **June 1974** | | | | | |
| 1 | 265 | 224 | 206 | 270 | ---------- | 17.0 | 2.4 | 8.9 | 0.0 | 0.0 |
| 2 | 266 | 225 | 206 | 270 | ---------- | 17.2 | 2.4 | 9.0 | .0 | .0 |
| 3 | 267 | 225 | 205 | 270 | ---------- | 17.3 | 2.5 | 9.1 | .0 | .0 |
| 4 | 267 | 230 | 211 | 270 | ---------- | 17.3 | 1.8 | 9.7 | .0 | .0 |
| 5 | 267 | 238 | 218 | 271 | ---------- | 17.4 | 1.1 | 10.7 | .0 | .0 |
| 6 | 267 | 237 | 217 | 271 | ---------- | 17.3 | 1.1 | 10.7 | .0 | .0 |
| 7 | 266 | 237 | 217 | 271 | ---------- | 17.2 | 1.1 | 10.6 | .0 | .0 |
| 8 | 267 | 237 | 217 | 271 | ---------- | 17.3 | 1.1 | 10.6 | .0 | .0 |
| 9 | 266 | 237 | 217 | 272 | ---------- | 17.2 | 1.1 | 10.7 | .0 | .0 |
| 10 | 265 | 237 | 216 | 273 | ---------- | 17.1 | 1.1 | 10.8 | .0 | .0 |
| 11 | 264 | 236 | 215 | 273 | ---------- | 17.0 | 1.1 | 10.8 | .0 | .0 |
| 12 | 265 | 236 | 216 | 272 | ---------- | 17.0 | 1.1 | 10.7 | .0 | .0 |
| 13 | 265 | 236 | 215 | 272 | ---------- | 17.0 | 1.1 | 10.6 | .0 | .0 |
| 14 | 265 | 236 | 216 | 273 | ---------- | 17.0 | 1.1 | 10.5 | .0 | .0 |
| 15 | 264 | 236 | 216 | 273 | ---------- | 17.0 | 1.1 | 10.5 | .0 | .0 |
| 16 | 264 | 236 | 215 | 273 | ---------- | 16.9 | 1.1 | 10.5 | .0 | .0 |
| 17 | 264 | 235 | 214 | 273 | ---------- | 16.9 | 1.1 | 10.5 | .0 | .0 |
| 18 | 267 | 237 | 217 | 273 | ---------- | 17.4 | 1.1 | 10.8 | .0 | .0 |
| 19 | 270 | 240 | 220 | 272 | ---------- | 17.7 | 1.1 | 11.2 | .0 | .0 |
| 20 | 270 | 240 | 220 | 272 | ---------- | 17.7 | 1.1 | 11.2 | .0 | .0 |
| 21 | 272 | 240 | 219 | 272 | ---------- | 18.0 | 1.4 | 11.1 | .0 | .0 |
| 22 | 274 | 239 | 219 | 272 | ---------- | 18.2 | 1.7 | 11.0 | .0 | .0 |
| 23 | 274 | 240 | 220 | 273 | ---------- | 18.2 | 1.7 | 11.2 | .0 | .0 |
| 24 | 275 | 239 | 218 | 273 | ---------- | 18.4 | 2.0 | 11.0 | .0 | .0 |
| 25 | 276 | 238 | 217 | 272 | ---------- | 18.5 | 2.2 | 10.4 | .0 | .0 |
| 26 | 279 | 239 | 218 | 272 | ---------- | 18.9 | 2.2 | 10.5 | .0 | .0 |
| 27 | 283 | 242 | 221 | 271 | ---------- | 19.5 | 2.4 | 10.9 | .0 | .0 |
| 28 | 285 | 243 | 223 | 271 | ---------- | 19.8 | 2.4 | 11.1 | .0 | .0 |
| 29 | 285 | 243 | 222 | 271 | ---------- | 19.7 | 2.4 | 11.1 | .0 | .0 |
| 30 | 285 | 243 | 222 | 270 | ---------- | 19.9 | 2.4 | 11.3 | .0 | .0 |
| | | | | | **July 1974** | | | | | |
| 1 | 285 | 243 | 222 | 270 | ---------- | 19.8 | 2.4 | 11.3 | 0.0 | 0.0 |
| 2 | 285 | 243 | 222 | 269 | ---------- | 19.8 | 2.4 | 11.2 | .0 | .0 |
| 3 | 285 | 243 | 222 | 268 | ---------- | 19.8 | 2.7 | 11.0 | .0 | .0 |
| 4 | 285 | 244 | 222 | 267 | ---------- | 19.9 | 2.8 | 10.8 | .0 | .0 |
| 5 | 288 | 246 | 224 | 267 | ---------- | 20.2 | 2.8 | 11.1 | .0 | .0 |
| 6 | 289 | 248 | 224 | 267 | ---------- | 20.4 | 2.8 | 11.2 | .0 | .0 |
| 7 | 288 | 247 | 224 | 266 | ---------- | 20.3 | 2.8 | 11.3 | .0 | .0 |
| 8 | 288 | 247 | 224 | 266 | ---------- | 20.2 | 2.8 | 11.3 | .0 | .0 |
| 9 | 290 | 250 | 227 | 266 | ---------- | 20.6 | 2.8 | 11.5 | .0 | .0 |
| 10 | 290 | 250 | 228 | 267 | ---------- | 20.6 | 2.8 | 11.4 | .0 | .0 |
| 11 | 290 | 250 | 228 | 267 | ---------- | 20.6 | 2.8 | 11.4 | .0 | .0 |
| 12 | 290 | 250 | 225 | 268 | ---------- | 20.6 | 2.8 | 11.4 | .0 | .0 |
| 13 | 290 | 249 | 224 | 268 | ---------- | 20.5 | 2.8 | 11.4 | .0 | .0 |
| 14 | 290 | 250 | 224 | 269 | ---------- | 20.6 | 2.8 | 11.3 | .0 | .0 |
| 15 | 290 | 249 | 225 | 271 | ---------- | 20.5 | 2.8 | 11.4 | .0 | .0 |
| 16 | 289 | 244 | 224 | 273 | ---------- | 20.3 | 2.8 | 11.4 | .0 | .0 |
| 17 | 288 | 240 | 223 | 273 | ---------- | 20.2 | 2.8 | 11.4 | .0 | .0 |
| 18 | 288 | 238 | 223 | ---------- | ---------- | 20.2 | 2.8 | 11.4 | .0 | .0 |
| 19 | 287 | 236 | 223 | ---------- | ---------- | 20.1 | 2.8 | 11.3 | .0 | .0 |
| 20 | 287 | 236 | 223 | ---------- | ---------- | 20.1 | 2.8 | 11.4 | .0 | .0 |
| 21 | 288 | 236 | 224 | ---------- | ---------- | 20.2 | 2.8 | 11.5 | .0 | .0 |
| 22 | 287 | 235 | 224 | ---------- | ---------- | 20.1 | 2.8 | 11.5 | .0 | .0 |
| 23 | 288 | 235 | 225 | ---------- | ---------- | 20.2 | 2.8 | 11.7 | 2.5 | .3 |

[1]Rainfall represents the accumulated amount between 0900 hours of the indicated day to 0900 hours of the following day.

## WIND

The average windspeed at Cottonwood during the 12-month period was 1.70 m/s, whereas that at Skinner averaged 1.24 m/s. The lower value at Skinner undoubtedly reflects the sheltering effect of the hill north of the anemometer. The yearly mean values of the supplementary windspeeds were 1.54 m/s at Cottonwood and 0.90 m/s at Skinner. The monthly mean windspeeds at Cottonwood and Skinner are shown in figure 21. A rather pronounced seasonal variation is seen at Cottonwood, but none is evident at Skinner. The frequency of occurrence of various daily average windspeeds is shown in figure 22. The uniform nature of the Skinner windspeed and the absence of high winds in comparison to Cottonwood is apparent. The highest wind gust observed at Cottonwood was 18.5 m/s and occurred at 1640 hours on July 18, 1974. The highest gust observed at Skinner was 9.9 m/s and occurred at 1420 hours on January 1, 1974.

A pronoumced diurnal variation in windspeed was observed at both stations. In order to illustrate this diurnal effect, the yearly mean windspeed was computed for each 10-minute interval of the day. The results of this averaging process are shown in figure 23. It can be seen that the windspeed is usually low at night and in the early morning hours (2200–0800) and usually fairly high in the late afternoon hours (1400–1800).

The daily-average windspeeds at Cottonwood and Skinner were poorly correlated. The correlation coefficient for the entire year was only 0.43. For the months of March and April the correlation coefficient was 0.80, but for the months of May through August it was 0.32, and for the months of September through December it was 0.46. The correlation between the daily-average primary and supplementary windspeeds was also poor. Considering the entire year, the correlation between

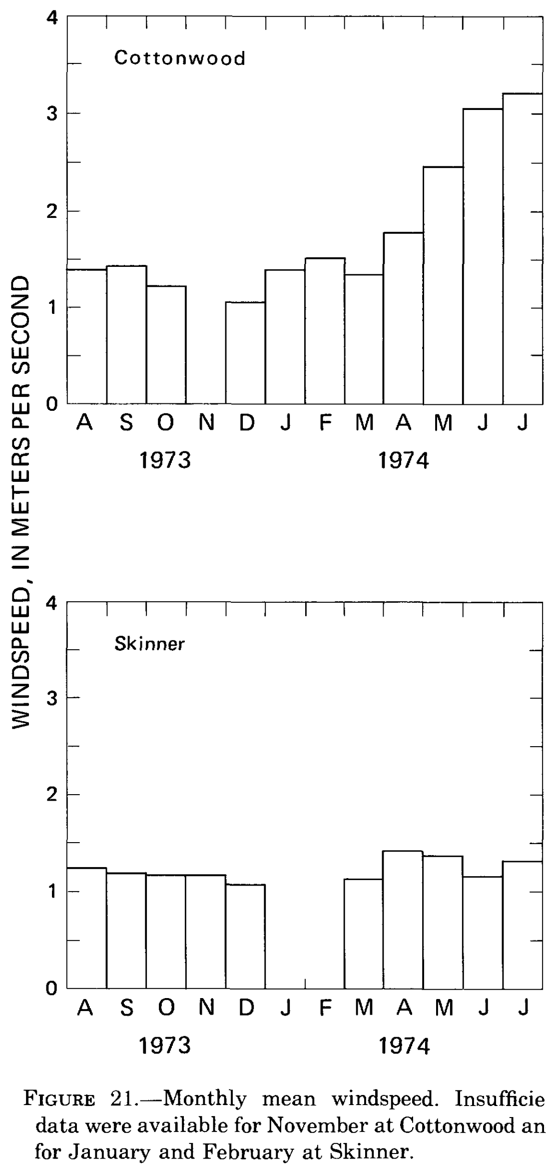


FIGURE 21.—Monthly mean windspeed. Insufficient data were available for November at Cottonwood and for January and February at Skinner.

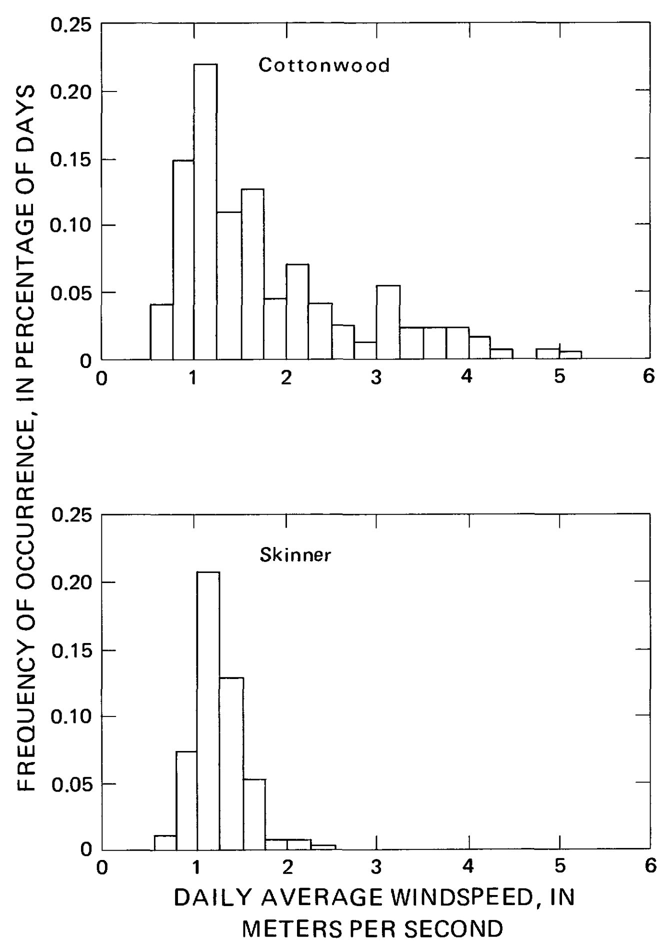


FIGURE 22.—Frequency of occurrence of daily windspeeds.

the primary and supplementary windspeeds was 0.64 at Cottonwood and 0.47 at Skinner. These low correlation coefficients highlight the difficulty in attempting to measure a representative windspeed for a reach of any open channel. Surface winds are extremely variable from point to point.

The wind direction was recorded continuously at both ends of the canal. The percentage of the time during which the wind was coming from each of eight sectors (numbered counterclockwise from the north) was tabulated by month and year. The results of this tabulation are shown in figure 24. At Cottonwood the wind is from sector 4 (south-southeast) the largest percentage of the time, but the percentage is fairly uniformly distributed among all sectors. The two lowest percentages, for winds from the west, are probably due to a slight sheltering effect of the Lakeview Mountains (fig. 1). The distribution of directions did not appear to vary with time of year. The largest percentage fell in sector 4 for every month of the year. Local topography obviously had a great effect on the measured wind directions at Skinner. Notice the sheltering effect of the hill to sectors 1, 2, 7, and 8 and of the dam to sector 4 (figs. 1, 6, 9, and 10). Sector 5 had the highest percentage for months March through September, and sector 3 had the largest percentage for the months of October through December.

The mean windspeed, average speed irrespective of direction, and the resultant windspeed (vectorial average speed) were computed for each day. The ratio of these two windspeeds is a measure of how consistent the wind direction is and is called the wind consistency.

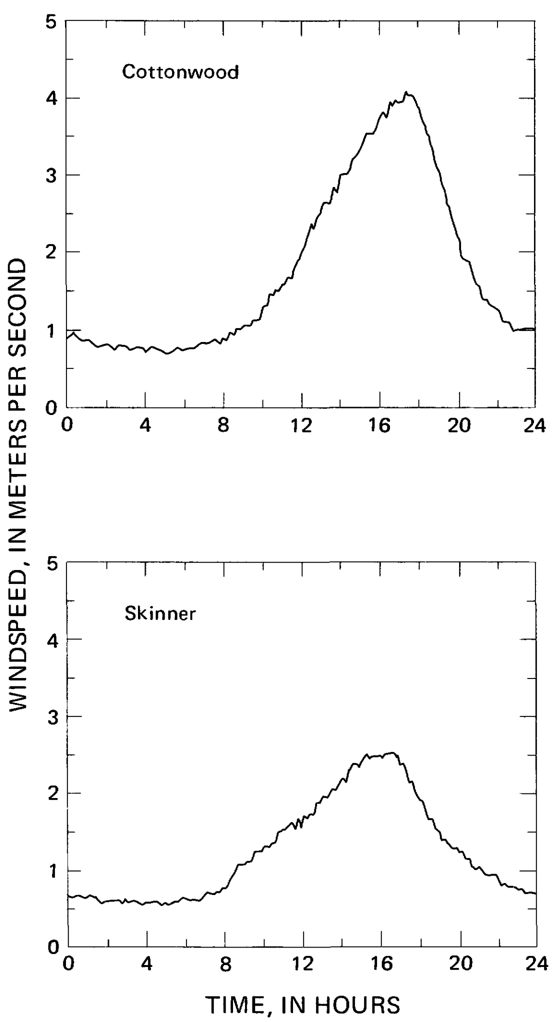


FIGURE 23.—Mean annual diurnal variation in windspeed, averaged by 10-minute time periods for the period July 24, 1973, to July 23, 1974.

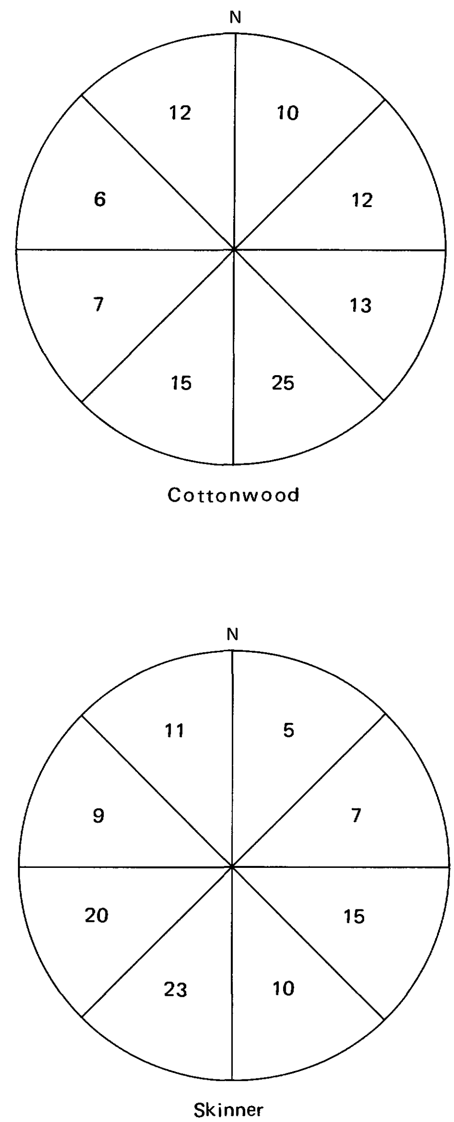


FIGURE 24.—Frequency of occurrence, in percentage of time, of winds from various directions.

The wind consistency was computed for each day and the monthly average determined by averaging the daily values. At Cottonwood the monthly average consistency varies from a low of 0.12 in February to a high of 0.76 in November, but no annual cycle was apparent. At Skinner the consistency values are probably less meaningful, but they varied from a low of 0.15 in December to a high of 0.71 in May. The months of May through August had values greater than 0.60, and October, November, and December had values less than 0.25. Other months had values between 0.38 and 0.49.

## RADIATION

The annual pattern of daily solar radiation is shown in figure 25. The yearly mean measured at Cottonwood and Skinner was 238 W/m$^2$ and 242 W/m$^2$, respectively, a difference of less than 2 percent. The daily values at Cottonwood and Skinner were highly correlated. The correlation coefficient between daily average values for the entire year was 0.97. The standard deviation of the difference between the daily means at the two ends of the canal was 21.4 W/m$^2$.

Also shown in figure 25 is the variation of the estimated clear-sky solar radiation. This value was computed using the procedure suggested by the Tennessee Valley Authority (1972). The clear-sky solar radiation was determined from

$$\Phi_{cs} = \frac{Io}{\pi r^2}(h_{ss} \sin \Phi \sin \delta + \cos \Phi \cos \delta \sin h_{ss}) \quad (5)$$

in which $\Phi_{cs}$ is clear-sky solar radiation, $Io$ is effective solar constant, $r$ is ratio of actual to mean Earth to Sun distance, $h_{ss}$ is hour angle of sunset in radians, $\Phi$ is latitude, and $\delta$ is declination of the Sun. The effective solar constant was varied by trial and error until the clear-sky curve appeared to form an envelope of the measured data. The value used in figure 25 is 1,046 W/m$^2$. The value of $r$ was approximated from

$$r = 1 + 0.017 \left(\cos \frac{360}{365}(186 - D)\right) \quad (6)$$

in which $D$ is Julian date (1 –365). The value of $h_{ss}$ was determined from

$$h_{ss} = \arccos \left(\frac{\sin \alpha_{ss} - \sin \Phi \sin \delta}{\cos \Phi \cos \delta}\right) \quad (7)$$

in which $\alpha_{ss}$ is solar altitude at sunset, which was assumed to be zero. The latitude of the Cottonwood and Skinner sensors was N. 33°47′ and N. 33°36′, respectively. The declination of the Sun was approximated by use of the expression

$$\delta = 23.45 \cos \left(\frac{360}{365}(172 - D)\right). \quad (8)$$

From equations 5, 6, 7, and 8 the yearly average clear-sky radiation at Cottonwood and Skinner is computed as 268.8 and 269.3 W/m$^2$, respectively, a difference of 0.2 percent.

The annual variation of atmospheric radiation is shown in figure 26. The estimated clear-sky atmospheric radiation is also shown for reference. The clear-sky value was computed from the formula presented by Idso and Jackson (1969)

$$\Phi_{ca} = \sigma (Ta + 273.16)^4 (1 - 0.261 \exp(-0.000777 (Ta)^2)) \quad (9)$$

in which $\Phi_{ca}$ is incoming clear-sky atmospheric radiation, $\sigma$ is Stefan-Boltzman constant ($5.671 \times 10^{-8}$ W/m$^2$), and $Ta$ is air temperature in degrees Celsius. The presence of clouds should increase the incoming

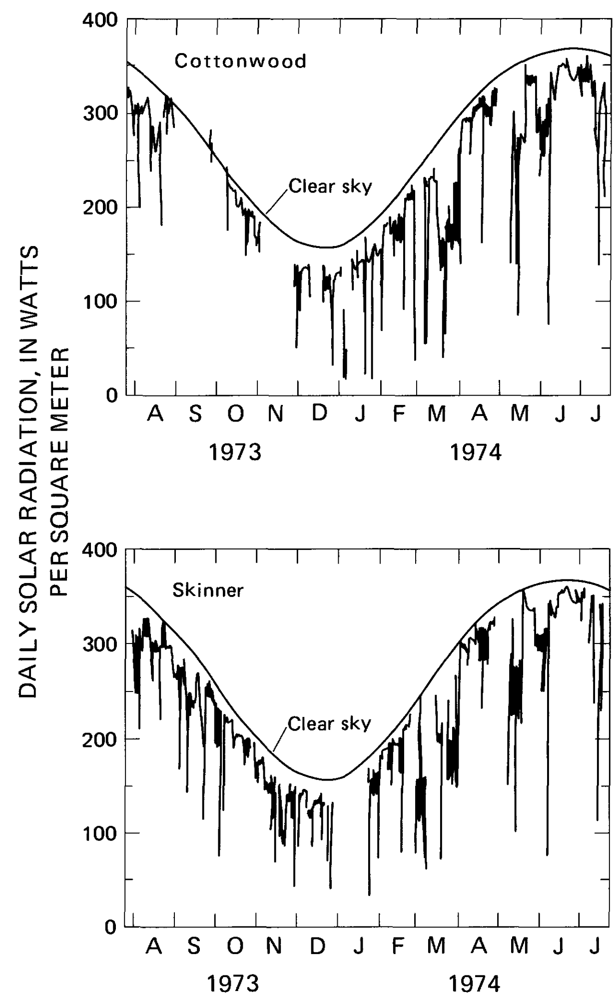


FIGURE 25.—Daily solar radiation.

atmospheric radiation over the clear-sky value by as much as 20 to 25 percent. The measured values would, therefore, be expected to be equal to or greater than the clear-sky values. In general, this appears to be the case as indicated in figure 26. Notable exceptions do occur, particularly at Cottonwood after March 1, 1974. After November 28, 1974, the atmospheric radiation at Cottonwood was determined for each 10-minute interval by subtracting the measured solar radiation from the all-wave radiation measured by a flat-plate radiometer.

The diurnal variation in atmospheric radiation, measured by the pyrgeometer for relatively clear days, is illustrated in figure 27. This mean diurnal variation was determined by averaging, on a time-period-by-time-period basis, the measured atmospheric radiation for 18 days. These days were selected between July 25, 1973, and December 1, 1973, from both Cottonwood and Skinner, such that the ratio of the measured solar to the computed clear-sky solar radiation was greater than 0.97. Also shown in figure 27 is the mean diurnal variation in atmospheric radiation as determined by subtracting the instantaneous value of the measured solar radiation from the instantaneous value of the all-wave radiation measured by the flat-plate radiometer. This curve represents an average of the 4 days after November 28, 1973, for which the ratio of the measured solar to computed clear-sky solar radiation was greater than 0.97. Unfortunately these 4 days are not included in the set of 18 days represented by the pyrgeometer, because it was impossible to select any clear-sky days during which both instruments were operating satisfactorily. The diurnal variation in the atmospheric radiation, as measured by the pyrgeometer, follows very closely the diurnal variation computed by equation 9. On the other hand, the flat plate, with the solar component deducted, indicates a much

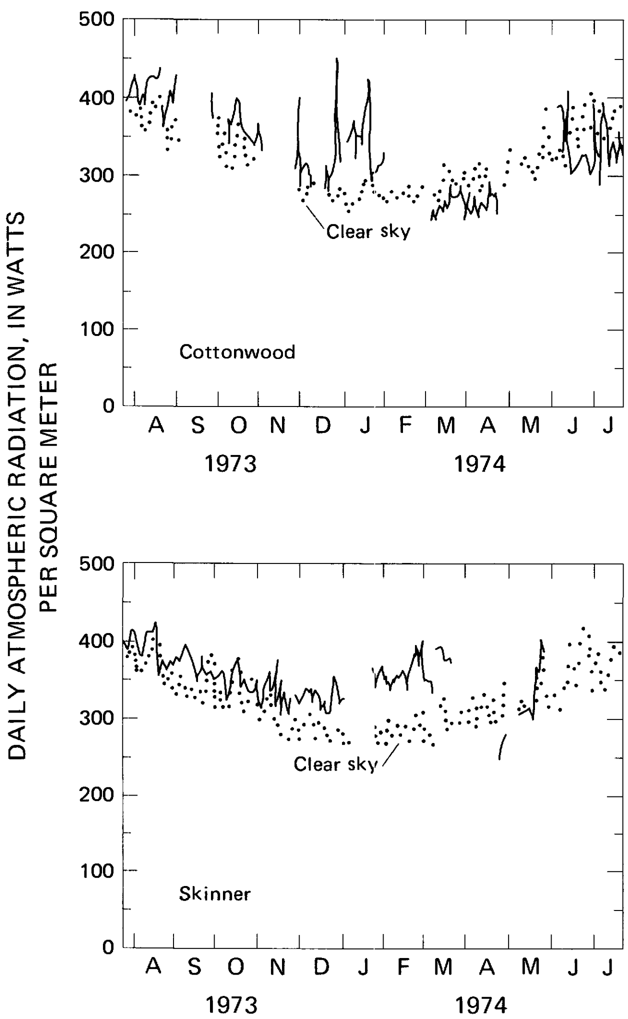


FIGURE 26.—Daily atmospheric radiation.

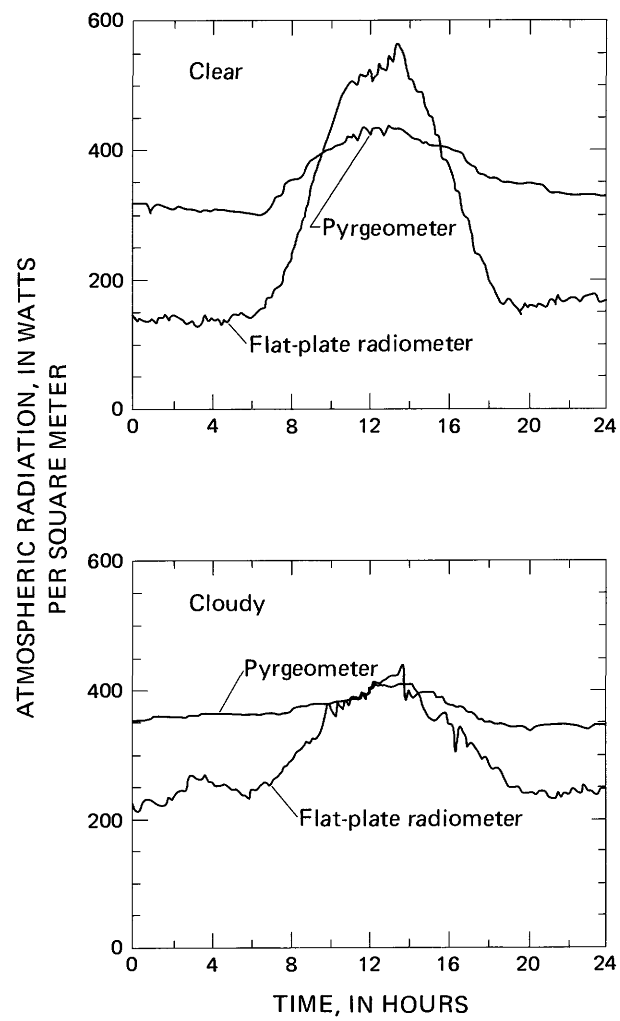


FIGURE 27.—Typical diurnal variation in atmospheric radiation as measured by the pyrgeometer and by subtracting the measured instantaneous solar radiation from the all-wave radiation measured by the flat-plate radiometer.

greater night-to-day variation. The mean value of these two curves should not be compared, because each curve represents the average of several but different days. The diurnal variation in the atmospheric radiation, as determined by deducting the solar radiation from the flat-plate all-wave radiation, appeared to be a function of the cloudiness. A comparison of the atmospheric radiation estimated by use of the pyrgeometer and the flat plate under cloudy to overcast conditions is also illustrated in figure 27. This figure represents the average of all days with a ratio of measured to clear-sky solar radiation of less than 0.60. Thirteen days are included in the pyrgeometer curve and 20 days in the flat-plate curve. From an inspection of figure 27, it would appear that the flat plate is overly sensitive to the solar component of the radiation spectrum. A. P. Jackman (oral commun., 1975) found flat plates to be overly sensitive to solar radiation.

### AIR TEMPERATURE

The annual pattern of daily average air temperature is shown in figure 28. The mean daily temperatures at Cottonwood and Skinner had a correlation coefficient of 0.99 for the period of record. This correlation coefficient remained stable throughout the year. The mean air temperatures at Cottonwood and Skinner were 17.06 and 17.90°C, respectively. The rather sheltered location of the Skinner station, on a south hillside, is undoubtedly reflected in its higher mean temperature. The standard deviation of the difference between the daily average temperatures at the two ends of the canal was 1.45°C.

### VAPOR PRESSURE

Other than atmospheric radiation, the vapor pressure of air proved to be the most difficult parameter to measure. More specifically the wet-bulb temperature was very difficult to measure continuously because of the problem of keeping the wick saturated. Overall, wet-bulb data are available for 44 and 56 percent of the 10-minute time periods at Cottonwood and Skinner, respectively.

The annual pattern of daily averaged vapor pressure values is shown in figure 29. Daily averages are shown in figure 29 only if more than 130 of the 144 possible 10-minute periods contained data. On a daily average basis the correlation between the Cottonwood and Skinner vapor pressures was good. The correlation coefficient was 0.96, and the standard deviation of the difference between the daily averaged values was 0.15 kPa (kilopascals). The mean value at Skinner was higher than that at Cottonwood by 0.10 kPa. This higher value undoubtedly reflects the nearness of Lake Skinner. The standard deviation among daily values was also higher at Skinner (0.38 kPa) than at Cottonwood (0.30 kPa). The higher variability at Skinner would also be expected because the presence or absence of the vapor blanket from Lake Skinner would depend on wind direction, which is of course quite variable.

Because of the large number of missing wet-bulb data and because most of the time complete data were available at either Cottonwood or Skinner, the transferability between Cottonwood and Skinner on a time-period-by-time-period basis was investigated. An obvious question arises: How can one best estimate the vapor pressure at one point given the dry- and wet-bulb temperatures at a remote site and the dry-bulb air temperature locally? There are four possible ways of estimating the vapor pressure under these conditions: (a) Assume it is the same as at the remote station (this method makes no use of the information known about the local dry-bulb temperature); (b) assume the wet-bulb temperature is the same at both stations (this method makes no use of the dry-bulb temperature at

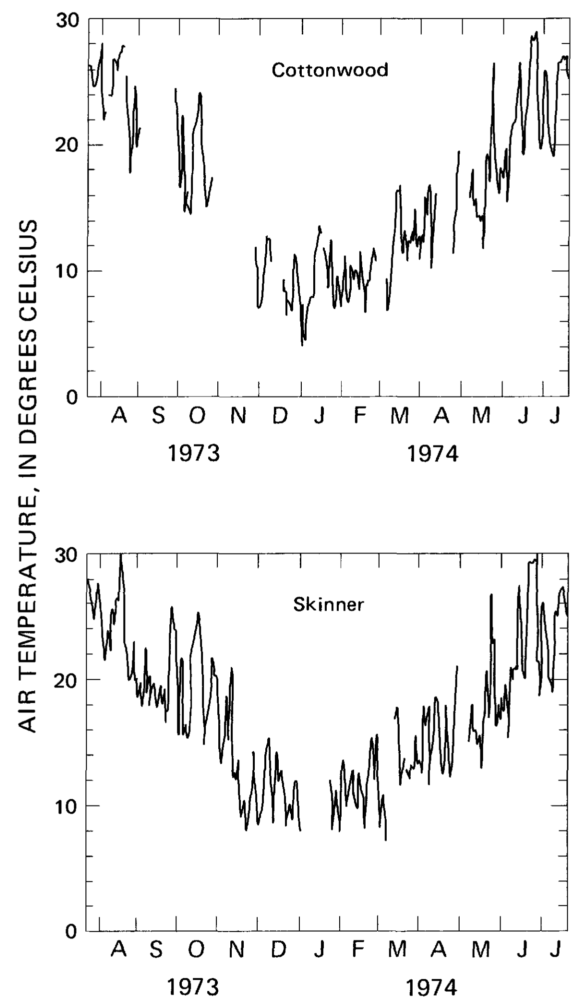


FIGURE 28.—Daily average air temperature.

the remote station); (c) assume wet-bulb depression (dry-bulb temperature minus the wet-bulb temperature) is the same at both stations; or (d) assume the relative humidity is the same at both stations.

Using the 11,688 10-minute periods for which complete data were available at both ends of the canal, the accuracy of these four transfer methods was checked by assuming one or the other of the wet-bulb temperatures was missing, estimating the vapor pressure by all four methods, and comparing the estimated value to the known local value. Morning, afternoon, and nighttime data were grouped separately to determine if time of day had any influence. The results are tabulated in table 6. In every case, transferring the vapor pressure directly resulted in the smallest root-mean-square error in the estimated vapor pressure. In two cases, the correlation ecoefficient resulting from the use of this method was slightly less than that resulting from the transfer of the wet-bulb temperature, but no particular significance is attached to this. While transferring the vapor pressure directly was clearly the most accurate procedure, the least accurate procedure is not as well defined. It appears that transfer of the wet-bulb depression is probably the least accurate. Even on a minute-by-minute basis, the vapor pressures are faily well correlated between sites. Very little diurnal variation in vapor pressure was observed. It is also interesting that the correlation is poorer between Cottonwood and Skinner and the errors larger at night than during the day. This is probably due to the fact that the lake influenced Skinner to a larger degree at night, when winds were light, than during the day. During the day, the average Skinner vapor pressures were 7.0 percent greater than Cottonwood values, whereas at night they were 7.7 percent greater.

TABLE 6.—*Comparisons of vapor pressures estimated by four data-transfer methods*

| Transferred quantity | Estimating Skinner vapor pressures | | Estimating Cottonwood vapor pressures | |
|---|---|---|---|---|
| | Correlation coefficient | Root-mean-square error | Correlation coefficient | Root-mean-square error |
| **All data** | | | | |
| Vapor pressure | 0.837 | 0.271 | 0.837 | 0.271 |
| Wet-bulb temperature | .825 | .327 | .774 | .326 |
| Wet-bulb depression | .528 | .700 | .780 | .348 |
| Relative humidity | .775 | .302 | .806 | .312 |
| **Morning (0600–1200 hours)** | | | | |
| Vapor pressure | 0.875 | 0.225 | 0.875 | 0.225 |
| Wet-bulb temperature | .860 | .304 | .801 | .302 |
| Wet-bulb depression | .631 | .509 | .833 | .283 |
| Relative humidity | .830 | .256 | .851 | .252 |
| **Afternoon (1200–1800 hours)** | | | | |
| Vapor pressure | 0.874 | 0.227 | 0.874 | 0.227 |
| Wet-bulb temperature | .834 | .313 | .781 | .312 |
| Wet-bulb depression | .581 | .606 | .823 | .289 |
| Relative humidity | .819 | .257 | .845 | .261 |
| **Night (1800–0600 hours)** | | | | |
| Vapor pressure | 0.767 | 0.383 | 0.767 | 0.383 |
| Wet-bulb temperature | .777 | .386 | .751 | .386 |
| Wet-bulb depression | .500 | 1.061 | .705 | .499 |
| Relative humidity | .723 | .415 | .734 | .447 |

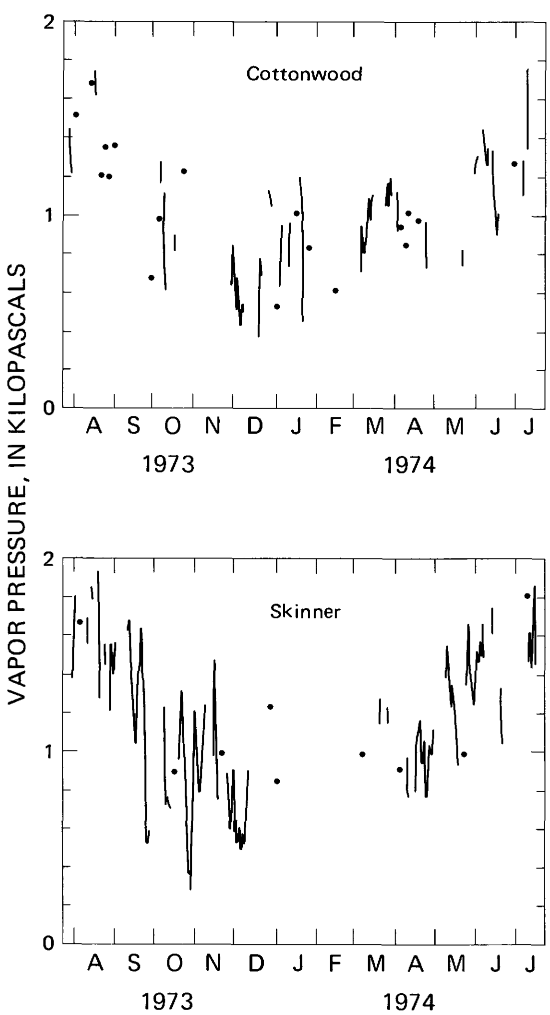


FIGURE 29.—Daily average vapor pressure.

## WATER TEMPERATURE

The annual pattern of the average water temperature in the canal is shown in figure 30. Daily average water temperatures at Cottonwood and Skinner were highly correlated with a correlation coefficient of 0.999 and a standard deviation of 0.28°C. There was always a slight warming trend as the water passed through the canal. The average increase in temperature was 0.02°C during January through April, 0.11°C during May through August, and 0.42°C during December. Water temperatures at Cottonwood are not available for September through November. The water temperature was always observed to be uniform in the vertical.

The diurnal variation in water temperature is illustrated in figure 31, which shows the annual mean obtained for each 10-minute period of the day. These curves were obtained by averaging all available temperature measurements at each individual time period. The mean annual diurnal range in temperature at Cottonwood is only 0.38°C as opposed to a range of 2.68°C at Skinner. The small diurnal variation in water temperature at Cottonwood results from the fact that the water entering the canal is diverted from the Colorado River Aqueduct, which passes under the San Jacinto Mountains just upstream of the entrance to the San Diego Aqueduct (fig. 1). The phase difference in the two distributions is also interesting. The Cottonwood temperature reached its low about midnight and its high at about 1100 hours, but the Skinner distributions reached a low at about 0730 hours and a high at about 1700 hours.

## DISCHARGE

Discharge values were provided by the Metropolitan Water District during days of constant flow. For each of these 209 days the average stage at Cottonwood was determined and Manning's $n$ computed. During the summer and early fall, July 24, 1973, to October 9, 1973, and May 1, 1974, to July 23, 1974, the $n$ value remained fairly constant. The mean of 114 computed $n$ values during these times was 0.0175 and the standard deviation was 0.0004. Even the extreme values of 0.0182 obtained on May 8 and 0.0165 obtained on May 22 would result in a variation of less than ± 5 percent. Starting about the first of October, the $n$ values started steadily decreasing with time until October 18 when the $n$ value was 0.0151. From October 18, 1973, to December 26, 1973, the values again remained fairly steady. The 53 values available during the latter period averaged 0.0152 and had a standard deviation of 0.0004. During the winter and spring months, the $n$ values varied widely in what appeared to be a random pattern, but a moving average seemed to increase more or less uniformly with time to about 0.0175. The 38

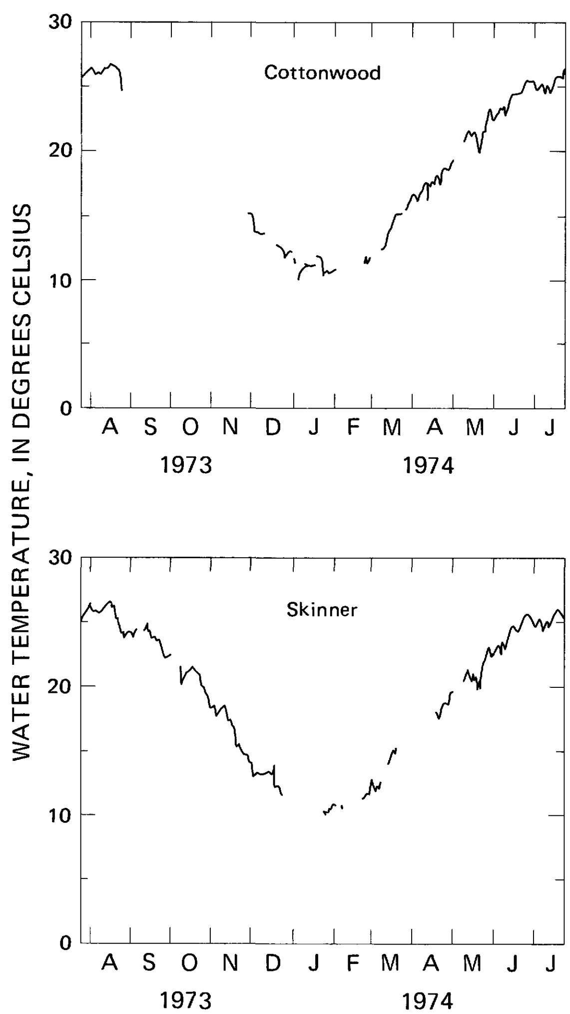


FIGURE 30.—Daily mean water temperature, averaged over depth.

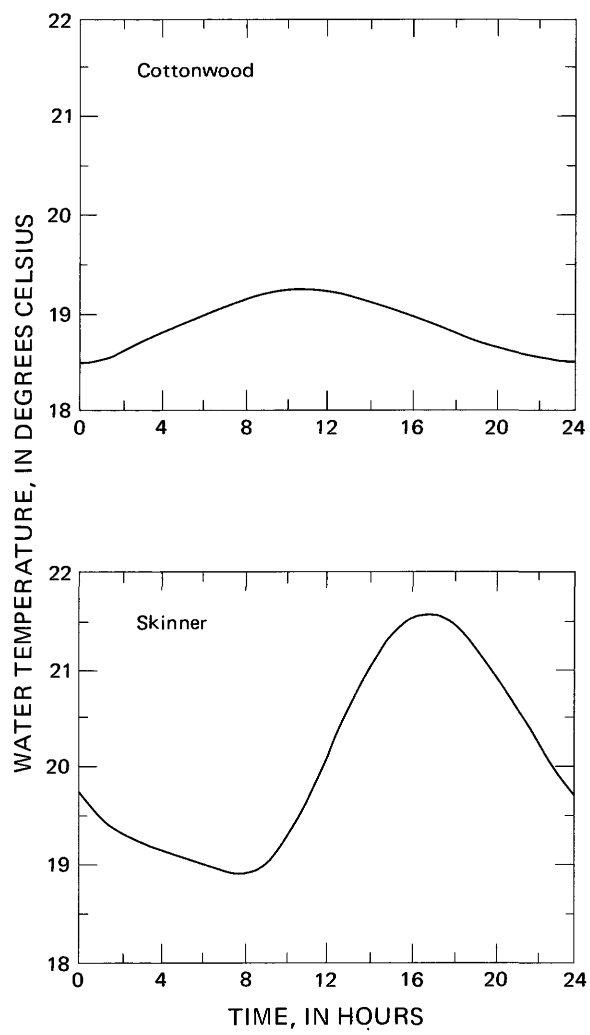


FIGURE 31.—Mean diurnal variation in water temperature.

values available for the period of January 16 to May 1, 1973, averaged 0.0170 and had a standard deviation of 0.0015. Extreme values of 0.0139 occurred on January 19, 1974, and 0.0191 on April 27, 1974. Local operators attribute these shifts in the *n* values to biological activity of the water. Apparently algae and scum have some tendency to form at certain times of the year, varying the roughness of the concrete.

## SUMMARY AND CONCLUSIONS

Meteorologic and hydraulic variables which influence the energy budget of the San Diego Aqueduct in southern California were continuously monitored for a 1-year period beginning July 24, 1973. The incoming solar and atmospheric radiation, windspeed and direction, water temperature, and wet- and dry-bulb air temperature were recorded on 10-minute intervals at each end of the 26-km canal, and flow rates and stages were determined on hourly intervals at five locations. These data are available on magnetic tape and can be obtained by contacting the Automatic Data Processing Unit, U.S. Geological Survey, Water Resources Division, Reston, VA 22092. A detailed description of the study site, the instrumentation, and the procedures used has been given, as well as all other information necessary for the use of these data by interested persons. A general analysis of the spatial and temporal variability of the recorded data, as well as the daily mean values of all data, have been presented. From an analysis of these data, the following conclusions are drawn:

1. A pronounced diurnal variation in windspeed was observed at each end of the canal. Windspeeds were typically quite low during the early morning hours and at a maximum during the late afternoon.
2. Daily average windspeeds are quite variable from point to point, apparently depending on the local topography.
3. Solar radiation measured at Cottonwood was highly correlated to that measured at Skinner. The standard deviation between daily average values, obtained 26 km apart, was 21.4 $W/m^2$, and the mean difference was 4 $W/m^2$. This parameter is relatively easy to measure by use of pyranometers, and an accuracy of $\pm$ 2 percent can be expected.
4. Atmospheric radiation values are difficult to monitor accurately, and results obtained by use of different instrument types are not always comparable.
5. Vapor pressure is another parameter which is difficult to accurately monitor on a continuous basis, but it is fairly uniform spatially. Instantaneous measurements taken simultaneously but 26 km apart had a correlation coefficient of 0.837 and a standard deviation of 0.27 kPa. The mean difference was 0.10 kPa.
6. At a point where only the dry-bulb temperature is known, the most accurate method to estimate the vapor pressure is to compute it from the wet- and dry-bulb temperatures obtained at a remote site.
7. Flow resistance, as defined by Manning's *n*, in the concrete-lined San Diego Aqueduct varied significantly with time of year. Local operators attribute this variation to biological growths.

## REFERENCES CITED

Idso, S. B., and Jackson, R. D., 1969, Thermal radiation from the atmosphere: Journal of Geophysical Research, v. 74, no. 23, p. 5397–5403.

Tennessee Valley Authority, 1972, Heat and mass transfer between a water surface and the atmosphere: Norris, Tennessee, Tennessee Valley Authority, Laboratory Report, no. 14.

Thackston, E. L., and Parker, F. L., 1971, Effect of geographical location on cooling pond requirements and performance: Nashville, Tennessee, Vanderbilt University, School of Engineering, report no. 5, 234 p.

Thornthwaite, W. C., 1931, The climate of North America according to a new classification: Geographical Review, v. 21, p. 633–655.

U.S. Geological Survey, 1970, National atlas of the United States of America: Washington, U.S. Government Printing Office, 417 p.

GPO 689-143