DEVELOPMENT OF THERMAL MODELS FOR HUNGRY HORSE RESERVOIR AND LAKE KOOCANUSA, NORTHWESTERN MONTANA AND BRITISH COLUMBIA

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U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Report 91-4134

Prepared in cooperation with the

MONTANA DEPARTMENT OF FISH, WILDLIFE AND PARKS

Helena, Montana
February 1992

U.S. DEPARTMENT OF THE INTERIOR

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CONTENTS

ILLUSTRATIONS

TABLES

CONVERSION FACTORS AND VERTICAL DATUM

Multiply	By	To obtain
calorie per square centimeter per minute ($cal/cm^2/min$)	0.0256	British thermal unit (BTU) per square inch per minute
Celsius degree (C°)	1.8	Fahrenheit degree (F°)
centimeter per minute per minute	0.3937	inch per minute per minute
cubic kilometer (km^3)	0.2399	cubic mile
cubic meter per day	35.31	cubic foot per day
kilocalorie	3.968	British thermal unit (BTU)
kilocalorie per kilogram per Celsius degree	1.0	British thermal unit (BTU) per pound per Fahrenheit degree
kilocalorie per square meter per day	0.3688	British thermal unit (BTU) per square foot per day
kilogram per cubic meter	0.0624	pound per cubic foot
kilogram per cubic meter per day	0.0624	pound per cubic foot per day
kilometer (km)	0.6214	mile
meter (m)	3.281	foot
meter per day	0.00002589	mile per hour
meter per day per day	3.281	foot per day per day
millimeter (mm)	0.0394	inch
square kilometer (km^2)	0.3891	square mile
square meter	10.76	square foot
square meter per day	10.76	square foot per day

Temperature in degrees Celsius (°C) can be converted to degrees Fahrenheit (°F) by the equation:

$$°F = 9/5\ (°C) + 32$$

Sea level: In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929--A geodetic datum derived from a general adjustment of the first-order level nets of the United States and Canada, formerly called Sea Level Datum of 1929.

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ABSTRACT

Thermal models were developed to simulate temperature profiles in Hungry Horse Reservoir and Lake Koocanusa in northwestern Montana. The results of the modeling effort will be useful to the Montana Department of Fish, Wildlife and Parks in evaluating the effects of alternative seasonal reservoir-drawdown schedules on fish production.

The thermal models for Hungry Horse Reservoir and Lake Koocanusa were calibrated using 1984 data and verified using 1985 data. Initial values for unmeasured variables were based on 1965 data.

Using data sets for 1984 and 1985, the thermal models simulated temperature profiles that differed from measured temperature profiles by less than about 2 Celsius degrees in the epilimnion and hypolimnion of both reservoirs. Differences between simulated and measured temperatures in the thermocline generally were less than 5 Celsius degrees. Simulated outflow temperatures for both reservoirs followed trends that were similar to measured temperatures. Differences between simulated and measured temperatures in outflow from both reservoirs range from 0 to 5 Celsius degrees.

Comparisons of simulated temperature to measured temperature in Hungry Horse Reservoir and Lake Koocanusa indicate that the models were successfully calibrated and verified. Therefore, development and use of similar models for similar reservoirs of northwestern Montana probably is valid. However, simulation results might be improved by changes in data collection and in the model routines.

INTRODUCTION

The Federal Columbia River Power System, which includes streams in the States of Washington, Oregon, Idaho, and Montana, was completed in 1975. The system has 28 dams and a total storage capacity of 24.7 km^3 of water. Habitat for anadromous and nonmigratory fish in the Columbia River basin has been affected adversely by the construction of these dams. In addition, logging, grazing, and farming practices have contributed to habitat degradation. These factors, coupled with fish harvesting, have resulted in a depleted fishery (Northwest Power Planning Council, 1982). The Northwest Power Planning Council has been directed to develop a program to protect, mitigate detrimental effects upon, and enhance fish and wildlife on the Columbia River and its tributaries. Through the Pacific Northwest Electric Power Planning and Conservation Act of 1980, the Bonneville Power Administration has the authority and responsibility to conduct programs adopted by the council to address fish and wildlife issues related to the development and operation of hydroelectric facilities in the Columbia River drainage.

The Montana Department of Fish, Wildlife and Parks has contracted with the Bonneville Power Administration to quantify seasonal water levels needed to maintain or enhance principal gamefish species in Hungry Horse Reservoir and Lake Koocanusa (fig. 1). These reservoirs, which are in northwestern Montana, are part of the Federal Columbia River Power System.

Present (1987) reservoir-drawdown schedules for Hungry Horse Reservoir and Lake Koocanusa may not be optimum for the production of fish. Increasing the water levels of the reservoirs during specified periods, while maintaining levels

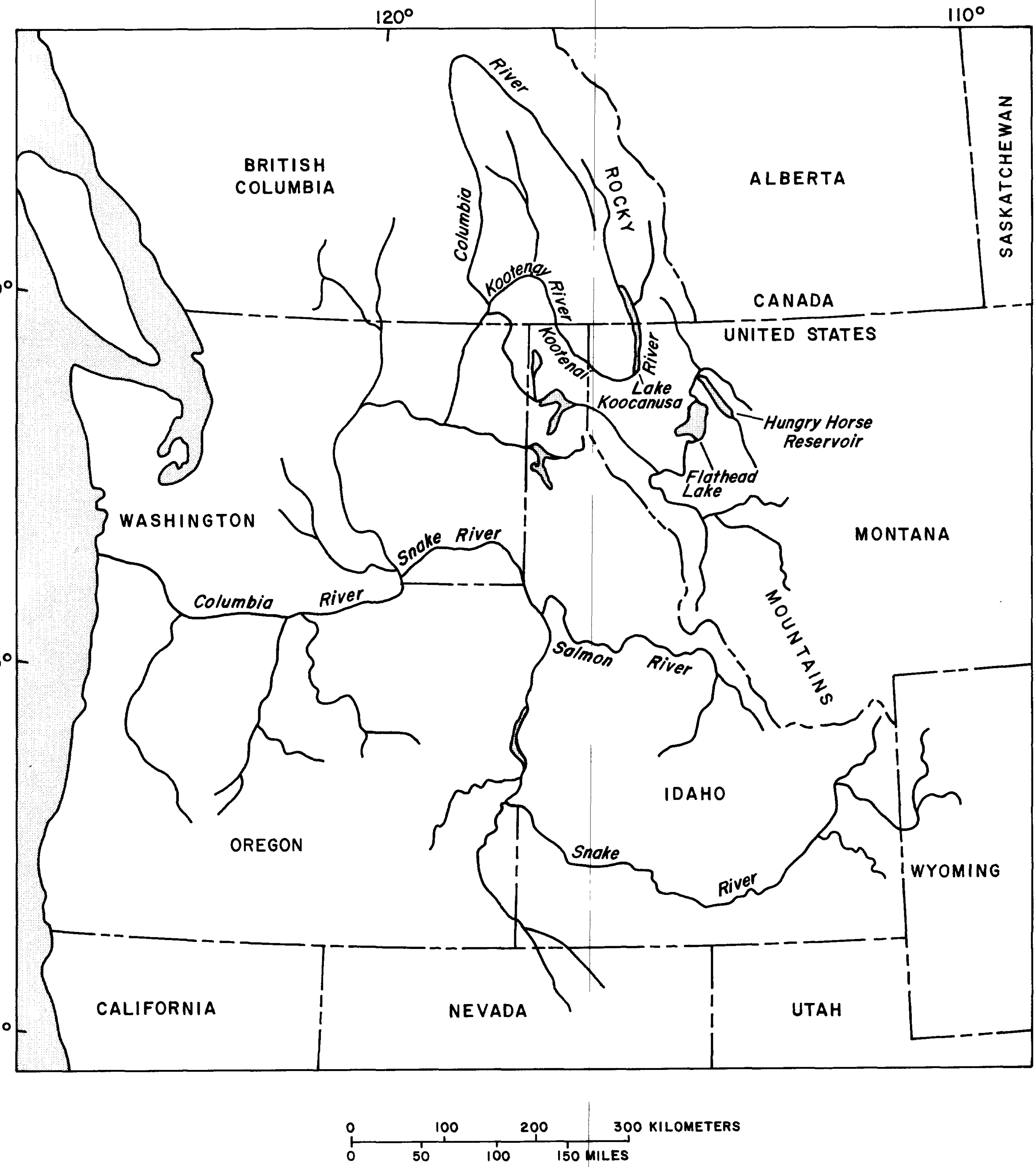

Figure 1.--Location of Hungry Horse Reservoir, Lake Koocanusa, and drainage of the Columbia River.

protective against flooding and allowing flows needed for hydroelectric power, could provide additional areas favorable to spawning and growth of fish. Other interests, such as recreational development of the shoreline, could create additional demands for various water levels during the yearly operation of the reservoirs.

The Montana Department of Fish, Wildlife and Parks is collecting and evaluating limnological data from Hungry Horse Reservoir and Lake Koocanusa to determine the effects of alternative seasonal reservoir-drawdown schedules on fish production. Part of the evaluation consists of determining how changes in water temperature with depth might affect fish. In 1986-87, the U.S. Geological Survey, in cooperation with the Montana Department of Fish, Wildlife and Parks, evaluated a thermal modeling computer program for the two reservoirs. The results of the modeling effort will be useful to that State agency in the development of a comprehensive management plan for the two reservoirs.

Purpose and Scope

This report describes the use of the modeling computer program of Adams (1974) to develop models to simulate temperature profiles and outflow temperatures for Hungry Horse Reservoir and Lake Koocanusa. Specific objectives were to describe operation of the modeling program, to develop input data sets for the modeling program, to calibrate and verify models of the two reservoirs, to analyze the simulation results, and to evaluate methods that might improve the simulation results.

The modeling computer program described herein contains both thermal and water-quality aspects. In this report only the temperature aspect is evaluated.

Input data for both reservoir models are for the periods April through December of 1984 and 1985. Formatted input for these 2 years of reservoir operation was used for calibration and verification to coincide with limnological data collected by the Montana Department of Fish, Wildlife and Parks.

Physical Setting

Northwestern Montana is characterized by a succession of northwest-trending mountain ranges and intermontane valleys of the northern Rocky Mountains. Hungry Horse Reservoir and Lake Koocanusa are located on major tributaries in upstream reaches of the Columbia River basin in valleys flanked by steep mountains.

Hungry Horse Reservoir is located in the downstream reaches of the South Fork Flathead River (fig. 2). Hungry Horse Dam, which is 8.0 km upstream from the confluence with the Flathead River, was completed in 1953. Full-pool elevation of 1,085.1 m was first achieved in July 1954. At full pool, the reservoir is 53.1 km long and has a surface area of about 96.1 km^2. Maximum volume is about 4.24 km^3 at a water depth at the dam of 149 m. Retention time in Hungry Horse Reservoir ranges from 0.84 to 2.51 years (May and McMullin, 1984).

The drainage basin of the South Fork Flathead River is underlain principally by Precambrian sedimentary rocks (Ross, 1959). The land is mostly covered with moderate to sparse stands of coniferous trees, with mainly brush and some deciduous trees in the lower valleys.

On the basis of 39 years of record (1947-85) collected at Hungry Horse Dam, the mean annual precipitation is 838 mm, with about 50 percent of the total occurring from October to February. Mean annual temperature for the period of record is 6.1 °C. Maximum temperatures generally are in July, which has a mean monthly temperature of 18.5 °C. Minimum temperatures most commonly are in January, which has a mean monthly temperature of -5.8 °C (U.S. Department of Commerce, issued annually).

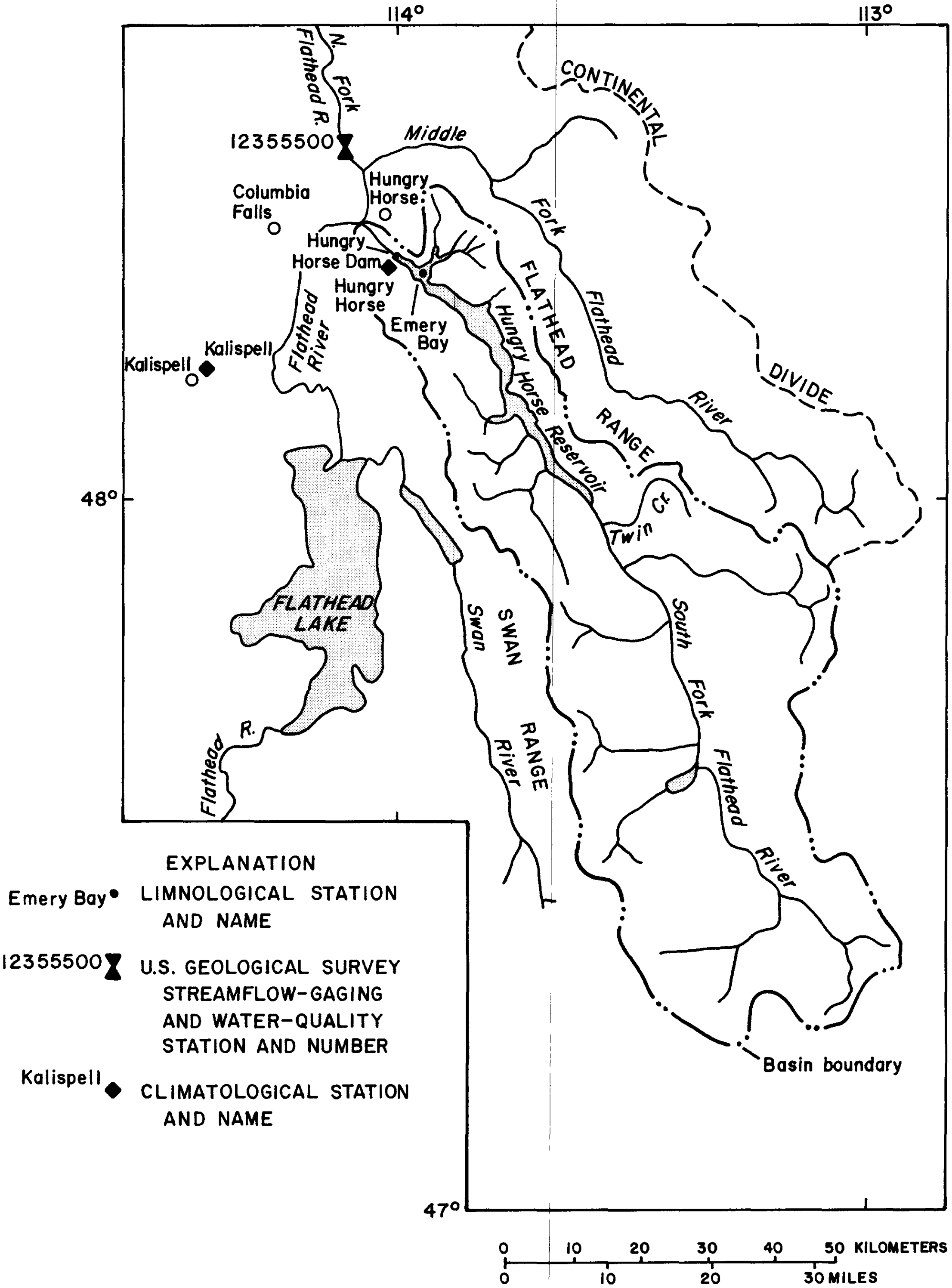

Figure 2.--Drainage to Hungry Horse Reservoir and nearby areas.

Lake Koocanusa is located in the middle reach of the Kootenai River (Kootenai in Montana, Kootenay in British Columbia), straddling the boundary between southeastern British Columbia and northwestern Montana (fig. 3). Libby Dam, which impounds Lake Koocanusa, was completed in 1972. Full-pool elevation of 749.5 m was first achieved in July 1974. At full pool, the reservoir is 148 km long and has a surface area of about 188.2 km^2. Maximum volume is about 7.16 km^3 at a water depth at the dam of about 107 m. Retention time in Lake Koocanusa ranges from 0.14 to 0.66 year (Woods, 1982).

The drainage basin of the Kootenai River is underlain principally by folded, faulted, and metamorphosed Precambrian sedimentary rocks (Coffin, 1970; Water Resources Service, 1976). Near Canal Flats, British Columbia, the Kootenay River enters the Rocky Mountain Trench, a broad valley underlain with Pleistocene and Holocene deposits of silt, sand, and gravel into which the river is incised about 60 to 90 m (Coffin, 1970). From the Tobacco River (fig. 3) to Libby Dam, the reservoir is near the Purcell Mountains. The mountains in the basin are densely forested with conifers; vegetation in valleys along the river is a mix of grasses and stands of coniferous trees. Riparian vegetation consists of brush and deciduous trees.

On the basis of data collected from 1979 to 1985 at Libby Dam, the median annual precipitation is 396 mm, with about 40 percent occurring from April to July and about 40 percent occurring from September to December. The median annual mean temperature for years with complete record (1979-85) is 7.4 °C. Maximum temperatures generally are in July and August, which have a median monthly mean temperature of 19.2 °C. Minimum temperatures generally are in January and December, which have a median monthly mean temperature of -4.0 °C (U.S. Department of Commerce, issued annually).

MODELING COMPUTER PROGRAM

Applicability

The applicability of the modeling computer program used in this study has been demonstrated with data from Flaming Gorge Reservoir in Utah and Wyoming (Adams, 1974) and Fontana Reservoir in Tennessee (Markofsky and Harleman, 1971). Adams reported that the simulated and measured temperature profiles were in good agreement near the surface of Flaming Gorge Reservoir, whereas differences near the bottom were 1-2 C° as the result of an apparent formation of a second thermocline. Comparison of simulated and measured reservoir-outflow temperatures indicated that the time of peak temperature was predicted correctly, but the simulated peak temperature was 1.3 C° less than the actual outflow temperature.

Adams (1974) found that the modeling program, applied to Flaming Gorge Reservoir, was relatively insensitive to changes in the mixing ratio, r_m, radiation-absorption coefficient, η, and fraction of solar radiation absorbed at the surface, β. Adams also found substantial sensitivity to the area reduction factor, a_r; as a result of decreasing a_r, the temperature in the epilimnion decreased and no changes were observed in the lower regions of the reservoir.

Markofsky and Harleman (1971) determined that the temperatures for Fontana Reservoir were simulated within ± 2 C°, even though the general shapes of the temperature profiles had some discrepancy. The simulated reservoir-outflow temperatures were consistently less than measured values, reportedly because of underestimated input values of solar radiation.

Program Description

The modeling computer program of Adams (1974) is based on modifications of programs developed by Huber and Harleman (1968) and Markofsky and Harleman (1971). The modeling program describes time-dependent, one-dimensional, vertical variation in temperature and water quality; it is based on the absorption and transmission of solar radiation, convection due to surface cooling, and advection due to inflows and outflows (Adams, 1975). The program was initially developed as a predictive tool for pre-impoundment studies.

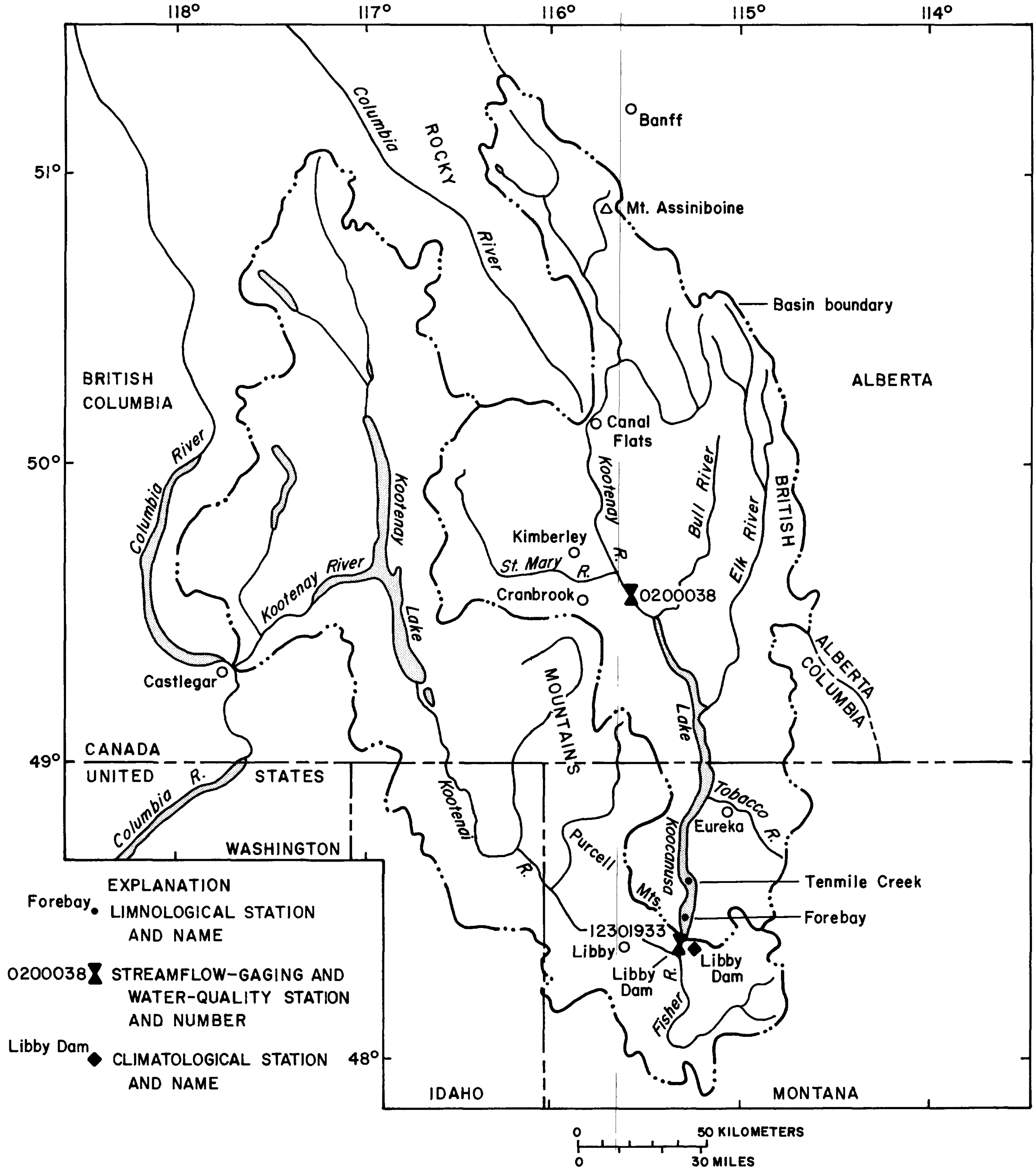

Figure 3.--Drainage to Lake Koocanusa and nearby areas.

An idealized reservoir is shown schematically in figure 4 as a series of horizontal elements, or control volume slices. Each slice has a bottom elevation, y, a horizontal area, A(y), and a thickness, Δy, which is chosen according to stability criteria. A part of the combined river inflow enters the slice at the upstream end, u_i (all inflows are combined for a one-dimensional model), and a part of the outflow through the dam, Q_{out}, leaves the slice at the downstream end, u_o. Heat also enters the slice through the horizontal surface by transmission of solar radiation, vertical advection, and diffusion. The equation governing the temperature distribution is formulated by considering the conservation of mass and heat within a typical slice and then mixing by vertical flows according to density until the condition is stable.

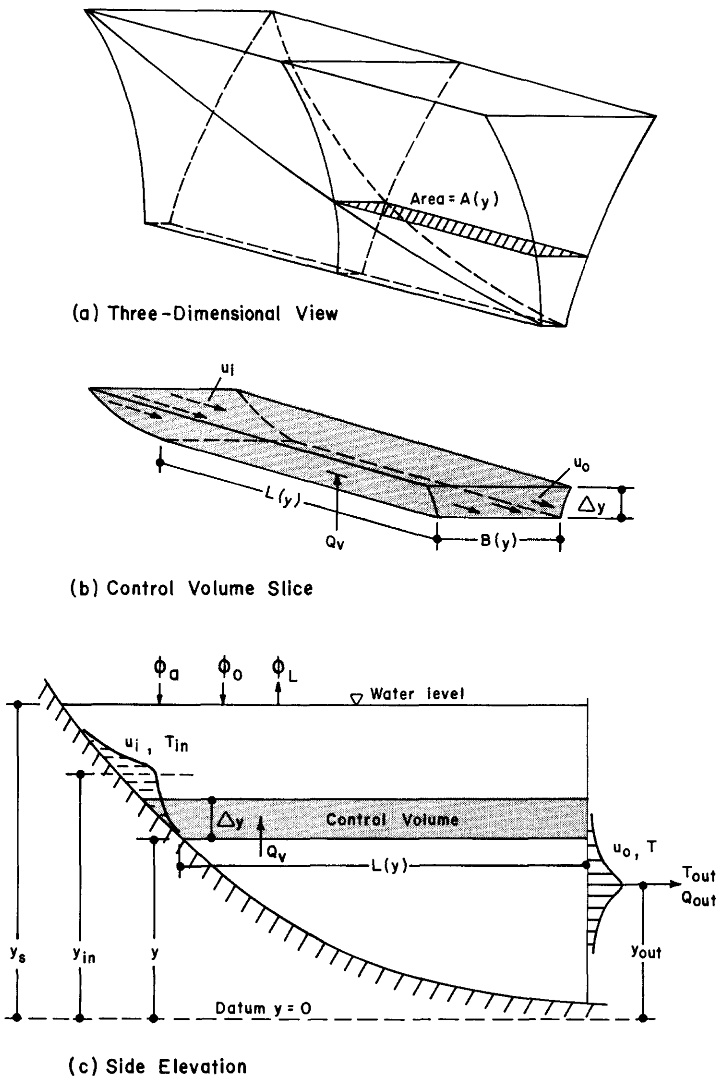

Figure 4.--Concept for a mathematical model of an idealized reservoir (from Adams, 1975).

(y = bottom elevation of control volume slice, A(y) = area at y, Δy = thickness of slice, L(y) = length of slice, B(y) = width of slice, u_i = portion of inflow to slice, u_o = portion of outflow from slice, Q_v = vertical flow in slice, T_{in} = inflow temperature, T = temperature of slice, T_{out} = outflow temperature, Q_{out} = outflow from reservoir, y_s = surface elevation, y_{in} = inflow elevation, y_{out} = outflow elevation, ϕ_a = atmospheric radiation flux, ϕ_o = solar radiation flux, and ϕ_L = surface heat loss.)

In developing the models of Hungry Horse Reservoir and Lake Koocanusa, certain assumptions were made that consider the mechanisms of diffusion, convection, radiation absorption, and heat advection. One principal assumption is that lines of equal temperature (isotherms) in a stratified reservoir are horizontal planes; hence, thermal gradients exist in the vertical direction only. This assumption has been observed in many deep reservoirs and has the effect of decreasing the problem from three dimensions to a problem of essentially one dimension.

Another principal assumption is that heat transported by turbulent mixing is accounted for only in the epilimnion (upper level of reservoir) and only when the temperature-induced density profile is unstable. Previous modeling computer programs for simulation of thermal stratification in lakes and reservoirs commonly have included turbulent-diffusion coefficients for heat as important numerical variables. In general, these diffusion coefficients are functions of depth and time. Because in many instances these functional relations cannot be specified without analysis, such simulations tend to lose their predictive value. For any given simulation, turbulent-diffusion coefficients that will match onsite data can always be found. However, it is difficult to determine to what extent these coefficients represent diffusion or merely the effect of simplifications or inaccuracies.

The thermal modeling program does not require assigned values for turbulent-diffusion coefficients. When the temperature profile in the epilimnion develops an unstable density gradient, vertical mixing is induced to produce a surface layer of uniform temperature. Thus, even though the surface layer may have turbulence due to wind shear and wave motion, heat transfer is assumed to be dominated by convection currents and surface cooling effects. These currents are assumed to eliminate near-surface temperature gradients and to replace the role of gradient-driven turbulent diffusion.

In the hypolimnion (lower level of reservoir), vertical temperature gradients are small and diffusive heat transport will not be substantial even with turbulence. In the thermocline (middle level of reservoir), the density stratification will tend to inhibit turbulence, although not necessarily eliminate it altogether. The thermal model used in this study neglects turbulent diffusion but considers all other forms of heat transport as accurately as possible.

Other assumptions are as follows:

(1) Solar radiation is transmitted only vertically. This assumption is not exact, owing to refraction at the water surface and the fact that a large proportion of the short-wave radiation comes from the sky when the solar angle is small. This assumption does not lead to substantial errors.

(2) The sides and bottom of the reservoir are insulated. Conservation of heat at the water surface and at the reservoir bottom gives boundary conditions for the model. The only heat crossing the boundaries (apart from the surface) is by water inflow and outflow.

(3) Solar-radiation energy, transmitted by the water and intercepted by the reservoir sides, is distributed uniformly over the cross section at the depth of interception. Violation of this assumption may be critical in lakes and reservoirs that have both clear water and a rapid change of area with depth near the surface.

The modeling program has two important characteristics:

(1) Variations of area with depth are considered. This relation affects both the vertical advection of heat and the distribution of the solar-radiation energy.

(2) Solar radiation is absorbed directly in the body of the fluid as well as at the surface. The absorption characteristics depend on turbidity (Sverdrup and others, 1942).

Initial temperature conditions in the reservoir may be specified in two ways. The temperature profile can be specified as isothermal or varying with depth, such as along a measured profile.

A listing of the FORTRAN modeling program used in this study is given in table 2 (Supplemental Information section at back of report). Adams (1974) gives a detailed description of all equations and variables used in the program.

Input Variables

The required format and a brief description of input variables for the modeling program are given in table 3 (Supplemental Information section at back of report). Several of the input variables that pertain to the water-quality part of the program are required in the input data set to allow the program to run to completion. These variables are indicated by "water quality" in table 3.

Lines 1-5 of input establish boundary conditions and specify methods of variable calculation for each simulation run. Several options are provided for calculation, depending on availability of data and formula preferences (Adams, 1974). Once values for these variables have been determined for a specific reservoir, they generally will not be changed in subsequent simulations for the same time period. Lines or line groups 6-18 include the major data input for the modeling program. Most of these input lines are used in the calculation of heat transfer. Lines or line groups 19-27 generally deal with information to be used in the water-quality options of the program. The last lines or line groups, 28-40, contain reservoir-geometry data such as surface-area changes at various elevations, reservoir-outlet elevations, and climatological data such as wind and cloud cover.

Output

Output from the modeling program consists of initial conditions, boundary conditions, temperature-profile data and values for various coefficients at requested timesteps, and outflow temperatures. The simulated profile temperatures are for an area near the dam of each reservoir but outside any disruptive effect caused by the vortex at the dam. The simulated outflow temperatures would compare with measured streamflow temperatures immediately downstream from the dam of each reservoir.

Program Changes

The modeling program of Adams (1974) uses one outflow elevation. However, Libby Dam contains a multiple-release system of water outflow. Therefore, for Lake Koocanusa, the modeling program was modified to accept variable outflow elevations at specified time steps. Changes made to the program to accommodate a multiple-outlet system are identified in table 1.

DEVELOPMENT OF INPUT DATA SETS

Reservoir simulation requires extensive data sets for physical characteristics, hydrologic characteristics, and climate. A complete set of input data was developed for Hungry Horse Reservoir and Lake Koocanusa for 1984 and 1985. Many of the input data for 1984 and 1985 were estimated or obtained from other locations. The methods used to estimate data are described in the following sections. Because the hydrologic and climatological data for Hungry Horse Reservoir are most complete for 1965, these data were used to estimate initial calibration values for 1984 and 1985. Input data sets used for each reservoir and each year of simulation are included in tables 4-7 (Supplemental Information section at back of report).

Physical Characteristics of Dam and Reservoir Setting

Values of variables describing physical characteristics of the dam and reservoir setting of Hungry Horse Reservoir and Lake Koocanusa are essentially static for different years of simulation. Other than major modifications to the dam, the only changes that could affect the physical characteristics of the reservoir setting are changes in reservoir length, width, and bottom configuration as a result

Table 1.--*Changes made to the FORTRAN modeling program*[1] *to accommodate the multiple-release system of Lake Koocanusa*

Action		Lines involved	Location
THIS		DIMENSION WH(20),AA(70),XXL(70)	MAIN0220
CHANGED TO		DIMENSION WH(20),AA(70),XXL(70),YYOUT(366),JJOUT(366)	MAIN0220
THIS		1 MIXED,KATRAD,INITIAL	MAIN0310
CHANGED TO		1 MIXED,KATRAD,INITIAL,MULOUT	MAIN0310
THIS		READ (7,1520) NTI,NTA,NSIGH,NFIN,NSURF,NDD,NQI,NQO	MAIN0340
CHANGED TO		READ (7,1520) NTI,NTA,NSIGH,NFIN,NSURF,NDD,NQI,NQO,NOUT	MAIN0340
THIS		GO TO 180	MAIN1020
DELETED BEFORE	170	READ (7,1540) DCLOUD,NCLOUD	MAIN1030
THIS	 174 173	GO TO (173,174),MULOUT READ (7,1530) (YYOUT(I),I=1,NOUT) READ (7,1520) (JJOUT(I),I=1,NOUT) CONTINUE	
INSERTED BEFORE	180	DO 190 I=1,JMP	MAIN1050
THIS		WRITE (6,1620) KDIF,KSUR,KOH,KQ,KLOSS,KAREA,EVPCON,DELCON,KMIX	MAIN1540
CHANGED TO		WRITE (6,1620) KDIF,KSUR,KOH,KQ,KLOSS,KAREA,EVPCON,DELCON,KMIX, $INITIAL,MULOUT	MAIN1540
THIS	500	GO TO (510,900), KQ	MAIN2380
CHANGED TO	500 502 501	CONTINUE GO TO (501,502),MULOUT YOUT=YYOUT(N) JOUT=JJOUT(N) CONTINUE GO TO (510,900), KQ	MAIN2380
THIS		2 'CONST IN EQN FOR OUTFLOW DELTA='F5.2,7X,'KMIX='I2)	MAIN5680
CHANGED TO		2 'CONST IN EQN FOR OUTFLOW DELTA='F5.2,7X,'KMIX=',I2,2X,'INITIAL=' 3,I2,2X,'MULOUT=',I2)	MAIN5680

[1] Of Adams (1974).

of erosion and sedimentation. Surveys of erosion and sedimentation in either reservoir are not available. Therefore, estimates of length, width, and bottom configuration are based on maps available prior to reservoir filling.

Hydrologic Characteristics

Hydrologic characteristics of reservoirs--such as outflow, surface elevation, surface area, volume of water (contents), inflow, and inflow water temperature--vary with time. Values of variables describing the hydrologic characteristics were determined or estimated for the periods of simulation.

For variables related to elevation, the modeling program utilizes a pre-selected, finite number of equidistant elevations referred to as grid points. The maximum number of grid points allowed in the modeling program to describe elevation is 70. For simulations of Hungry Horse Reservoir and Lake Koocanusa, the bottom of the reservoir was set to grid number 0 and the maximum reservoir-surface elevation (JMP, line 29, table 3) was set to grid number 69. Elevations for outflow are entered in line group 39 and grid numbers for these elevations are entered in line group 40 (table 3).

The modeling program requires one inflow water temperature. The methods of determining inflow water temperature differed between the two reservoirs.

Hungry Horse Reservoir

Outflow data for Hungry Horse Reservoir were determined by adjusting the estimated flow through the penstocks with flow data collected at station 12362500 (South Fork Flathead River near Columbia Falls, Mont., fig. 5). The outlet elevation is the elevation of the Hungry Horse Dam power-house intake, through which most releases from the reservoir occur (Harrold Taylor, U.S. Bureau of Reclamation, Boise, Idaho, written commun., 1986). The outlet elevation of 1,011.63 m corresponds to grid 36, which was set equal to JOUT on line 3.

Reservoir-surface elevations were based on actual measurements. Reservoir-surface areas were determined from area-capacity tables for every 3.05-m increment in elevation and were input as line group 31. The 3.05-m interval is based on the number of grid points and a maximum reservoir-surface elevation (JMP) of 1,085.34 m. Elevation data and area-capacity tables were provided by Irene Collins (U.S. Bureau of Reclamation, Boise, Idaho, written commun., 1986).

Reservoir volumes for various water-surface elevations are calculated in the modeling program from reservoir lengths and widths. The reservoir lengths were determined from profiles of the South Fork Flathead River prior to reservoir construction (Blessing and others, 1937). Reservoir lengths were input as line group 32 (table 3). Average reservoir widths, in meters, were estimated by dividing reservoir-surface area by length. The constants OMEGA (ω) and BZ (B_o) included in line 4 (table 3) for estimating width during simulation were determined from the following equation (Adams, 1974):

$$B = B_o e^{\omega y} \qquad (1)$$

where

- B is average width, in meters;
- B_o is coefficient of base e;
- e is natural logarithm base equal to 2.7183;
- ω is slope; and
- y is elevation, in meters.

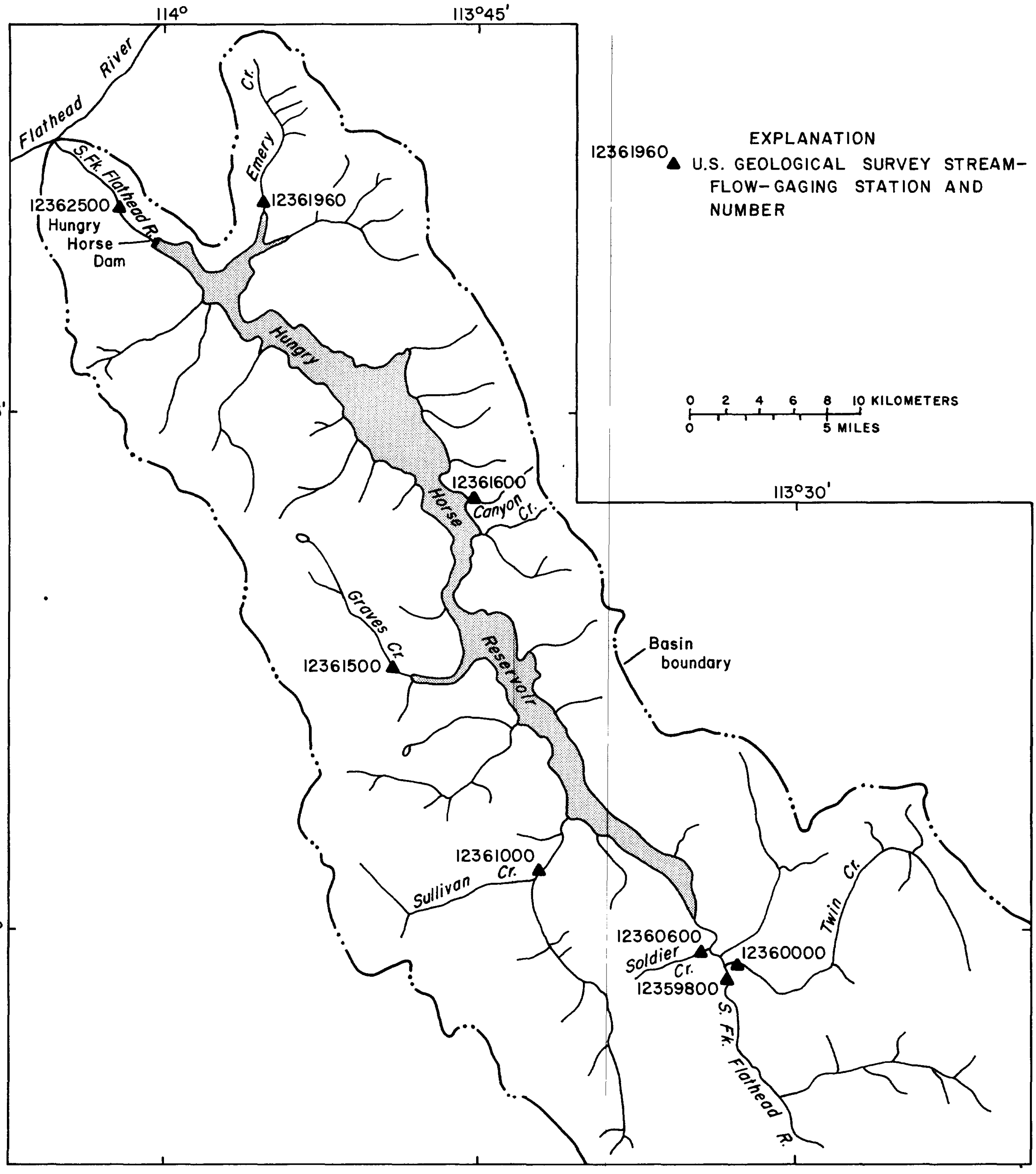

Figure 5.--Continuous-streamflow and water-temperature stations for Hungry Horse Reservoir during 1965 (modified from Simons and Rorabaugh, 1971).

The resulting equation for Hungry Horse Reservoir is:

$$B = (2.03 \times 10^{-4})\ e^{(1.46 \times 10^{-2})(y)} \qquad (2)$$

Equation 2 explains 99 percent of the variation ($r^2 = 0.99$) in average width (fig. 6) and has a correlation coefficient that is significant at the 0.01 level ([p > F] = 0.0001). Values for the coefficients of equation 1 were obtained by using linear regression analysis of width and the logarithm of elevation. The average slope at the inlet of the reservoir (line 19, table 3) was determined from the slope of the upstream 36 percent of the length of the reservoir at full pool.

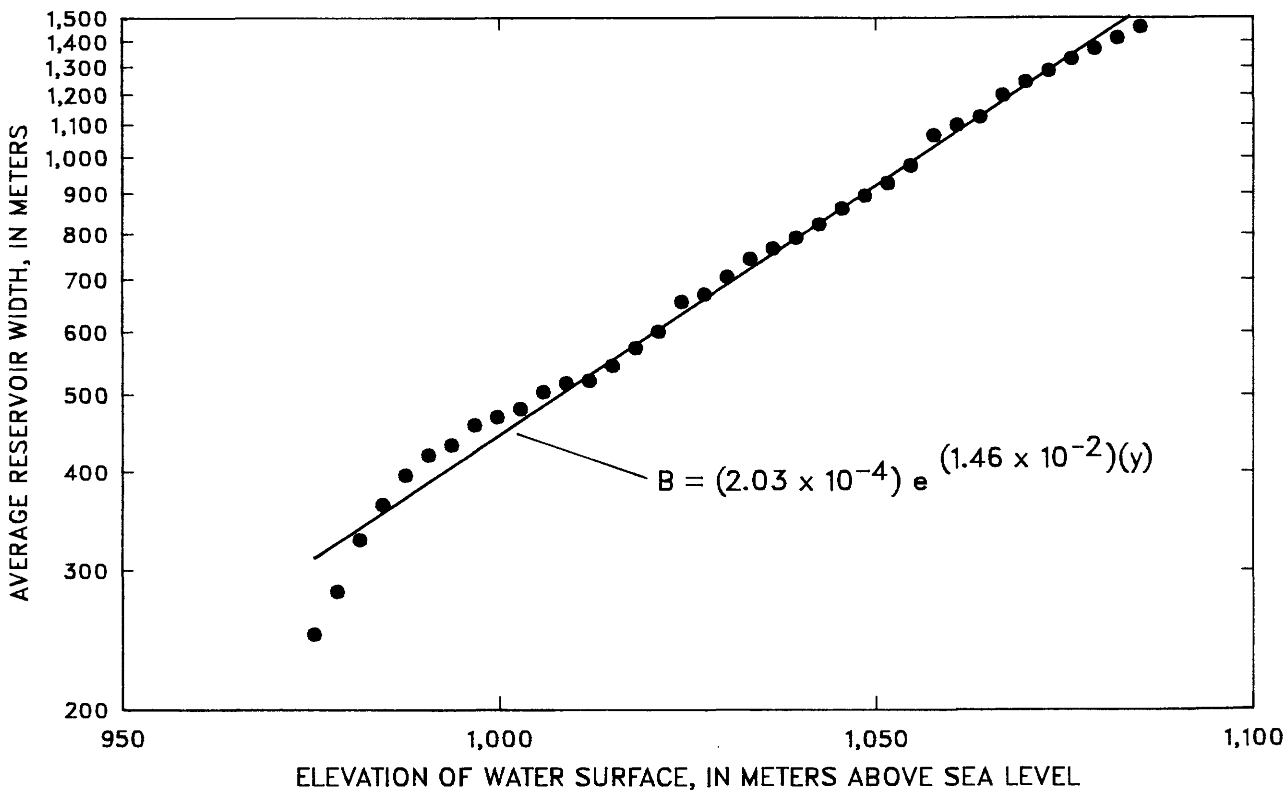

Figure 6.--Change in width of Hungry Horse Reservoir with change in water-surface elevation. (B = average width, y = elevation.)

Inflow to Hungry Horse Reservoir was estimated on the basis of measured outflow and change in capacity. Estimates of inflow may be in error as a result of changes in bank storage around the reservoir (Simons and Rorabaugh, 1971) or evaporation from the reservoir water surface, or both.

Inflow water temperature was measured for 1965 at U.S. Geological Survey streamflow-gaging stations established for a study by Simons and Rorabaugh (1971) (fig. 5). Continuous-streamflow and water-temperature data were collected at the following stations:

12359800	South Fork Flathead River above Twin Creek, near Hungry Horse, Mont.
12360000	Twin Creek near Hungry Horse, Mont.
12360600	Soldier Creek near Hungry Horse, Mont.
12361000	Sullivan Creek near Hungry Horse, Mont.
12361500	Graves Creek near Hungry Horse, Mont.
12361600	Canyon Creek near Hungry Horse, Mont.
12361960	Emery Creek near Hungry Horse, Mont.

Temperature data were incomplete at various times for each of these stations. For stations with few missing data, values were interpolated. For stations with many missing data, values were estimated by regression equations developed using data from stations having similar temperatures. The daily mean temperature input for Hungry Horse Reservoir was obtained by discharge-weighting the temperature values from each of the seven stations.

After 1966, collection of continuous water-temperature data was discontinued at the above stations except for station 12359800. Collection of water-temperature data at that station was discontinued in 1982. A regression equation was developed between station 12359800 and station 12355500 (North Fork Flathead River near Columbia Falls, Mont., fig. 2). Data collected from March to December 1980 were used to develop the regression equation, because those data were the most recent complete set of concurrent data for both streams. The resulting regression equation on untransformed data explains 97 percent of the variation in temperature in the South Fork Flathead River ($r^2 = 0.97$) and has a correlation coefficient that is significant at the 0.01 level ($[p > F] < 0.0001$). Daily mean temperatures in the North Fork Flathead River then were used to estimate 1984 and 1985 inflow water temperatures. These resulting inflow temperatures are assumed to be similar to the discharge-weighted temperatures, because water temperatures were similar among all streams flowing into Hungry Horse Reservoir in 1965.

Lake Koocanusa

Outflow data for Lake Koocanusa were determined by adjusting the estimated flow through the penstocks with flow data collected at station 12301933 (Kootenai River below Libby Dam, near Libby, Mont., fig. 3). Outlet elevations correspond to the elevations of bulkheads at various depths which selectively withdraw water of specific temperatures to satisfy downstream requirements for fisheries in the Kootenai River. The outlet elevations and corresponding grid numbers vary according to bulkhead elevations as shown in the data sets for 1984 and 1985 (tables 6 and 7). Most releases from Lake Koocanusa flow through the penstock intake. Information on bulkhead placement and other reservoir operations were obtained from James Helms (U.S. Army Corps of Engineers, Seattle, Wash., written commun., 1985).

Reservoir-surface elevations were based on actual measurements. Reservoir-surface areas were determined from area-capacity tables for every 3.05-m increment in elevation and were input as line group 31. The 3.05-m interval is based on the number of grid points and a maximum reservoir-surface elevation (JMP) of 749.5 m. Elevation data and area-capacity tables were provided by Nicholas A. Dodge (U.S. Army Corps of Engineers, Portland, Oreg., written commun., 1985).

Reservoir volumes for various water-surface elevations are calculated in the modeling program from reservoir lengths and widths. The reservoir lengths were determined from profiles of the Kootenai River prior to reservoir construction (U.S. Geological Survey, 1938). Reservoir lengths were input as line group 32 (table 3). Average reservoir widths, in meters, were estimated by dividing reservoir-surface area by length. The constants OMEGA (ω) and BZ (B_0) included in line 4 (table 3) for estimating width during simulation were determined from equation 1. The resulting equation for Lake Koocanusa is:

$$B = (5.40 \times 10^{-2})\, e^{(1.37 \times 10^{-2})(y)} \qquad (3)$$

Equation 3 explains 86 percent of the variation ($r^2 = 0.86$) in average width (fig. 7) and has a correlation coefficient that is significant at the 0.01 level ($[p > F] = 0.0001$). The average slope at the inlet of the reservoir was determined from the slope of the upstream 38 percent of the length of the reservoir at full pool.

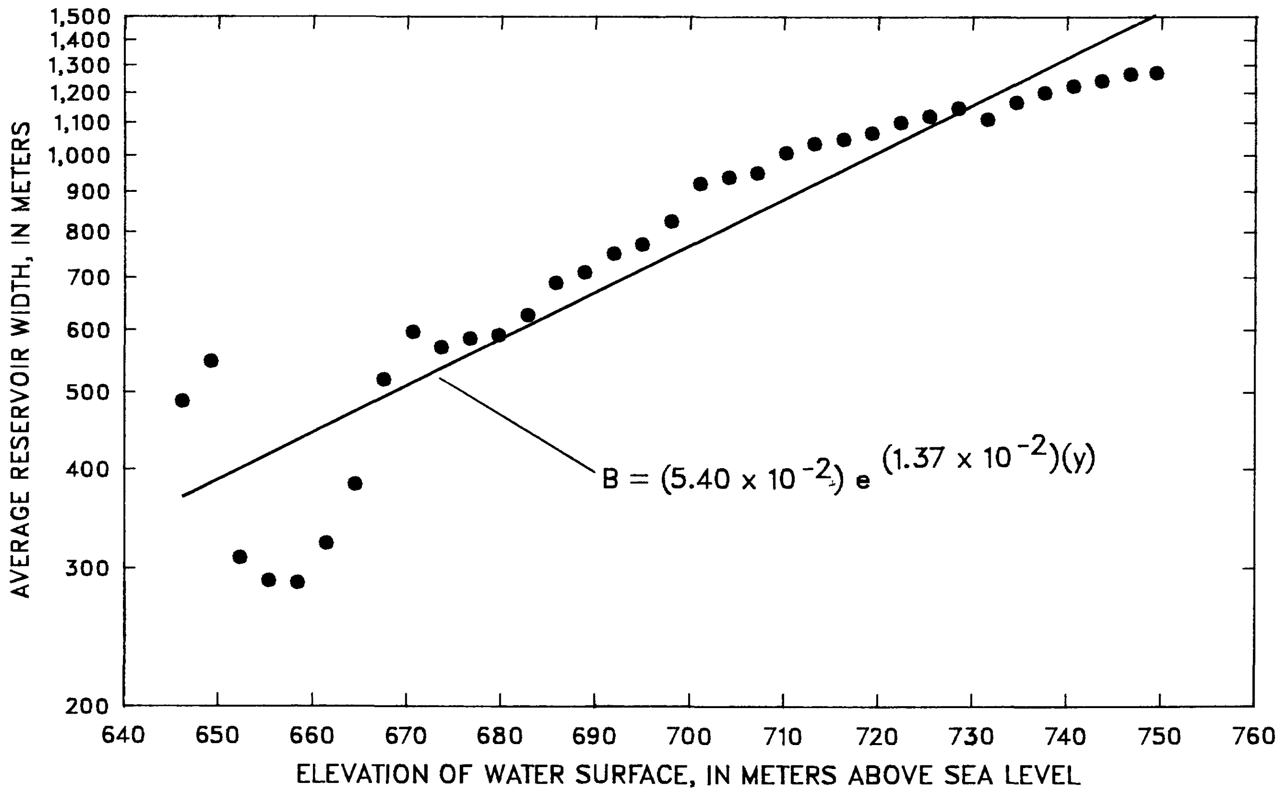

Figure 7.--Change in width of Lake Koocanusa with change in water-surface elevation. (B = average width, y = elevation.)

Inflow to Lake Koocanusa was estimated on the basis of measured outflow and change in capacity. Estimates of inflow may be in error as a result of changes in bank storage around the reservoir (Simons and Rorabaugh, 1971) or evaporation from the reservoir water surface, or both.

Continuous water-temperature data were not collected for inflow to Lake Koocanusa. However, water temperature was measured by the Province of British Columbia at station 0200038 (Kootenay River at Picture Valley, B.C.; fig. 3). Instantaneous temperatures measured once monthly at this station in 1984 and 1985 were used to develop a regression equation with data collected at station 12355500 (fig. 2). The resulting regression equation explains 97 percent of the variation in temperature of the Kootenay River ($r^2 = 0.97$) and has a correlation coefficient that is significant at the 0.01 level ($[p > F] < 0.0001$). Daily mean temperature of the North Fork Flathead River then was used to estimate 1984 and 1985 daily mean inflow water temperatures.

Climate

Air Temperature

Air temperature is collected at Hungry Horse Dam (fig. 2) and Libby Dam (fig. 3) as part of the National Weather Service climatological network. These data are published as minimum and maximum daily air temperature by the U.S. Department of Commerce (issued monthly). The average value between the daily minimum and maximum air temperatures for each weather station was used to estimate the daily mean temperature.

Relative Humidity

Percent-relative-humidity data were not collected at either reservoir site in 1965, 1984, or 1985. The Kalispell climatological station (fig. 2), which is at the Kalispell airport, is the nearest site of relative humidity measurement. The station is about 28.9 km west of Hungry Horse Reservoir and 78.8 km southeast of Lake Koocanusa.

For 1965, the percent-relative-humidity data consisted only of monthly mean values from the Kalispell climatological station. The National Weather Service made instantaneous measurements every third hour of each day, then averaged the measurements for each third hour. The result was a monthly mean value for each of the eight third-hour periods. The eight monthly mean values were then averaged to give a single monthly mean value. That value was used as daily input for the appropriate month.

For 1984 and 1985, percent-relative-humidity data from the U.S. Department of Commerce (issued monthly) consisted of instantaneous measurements for every third hour for each day. The mean relative humidity for each day was computed and used as daily mean input for both reservoirs.

Radiation

Although not complete, some radiation data were collected at Hungry Horse Reservoir in 1965 by Simons and Rorabaugh (1971). The data were for solar (short-wave) and atmospheric (long-wave) radiation. Because the 1965 data represented actual radiation, these data were used for initial calibration of the modeling program. Radiation data were not available for 1984 and 1985. If radiation data are not available, the program can calculate solar and atmospheric radiation. Solar radiation is calculated in terms of the solar constant (1.98 $cal/cm^2/min$), solar angle, cloud cover, and other atmospheric factors. Calculated values for solar radiation may be accurate only within about 15 percent (Anderson, 1954). Atmospheric radiation is calculated as a function of air temperature and cloud cover. The error associated with this calculation has not been reported.

Key radiation coefficients were initially estimated using 1965 data. Then, the 1984 and 1985 simulations for both reservoirs were made using the option for model-calculated values of solar and atmospheric radiation. As an example of solar-radiation input, model-calculated values for 1984 were input as line group 14 for Lake Koocanusa (table 6).

The depth of solar-radiation absorption affects the profile of water temperature in reservoirs. Solar radiation is absorbed directly into the body of the fluid, as well as at the surface. Input to the modeling program includes a radiation-absorption coefficient, η, which is ETA on line 5, and the fraction of radiation absorbed at the water surface, β, which is BETA on line 5 (table 3). Transmission of radiation at a given depth is determined by the equation (Dake and Harleman, 1966):

$$\phi_y = (1-\beta)\phi_o e^{-\eta y} \tag{4}$$

where

ϕ_y is transmitted solar radiation at depth y,
β is fraction of ϕ_o absorbed at the water surface,
ϕ_o is net solar radiation incident at the water surface,
e is natural logarithm base equal to 2.7183,
η is radiation-absorption coefficient of light for the reservoir water, and
y is depth of water.

The fraction of radiation absorbed at the water surface in both reservoirs was estimated by graphical methods. Plots of the fraction of light remaining, ϕ_y/ϕ_o, versus depth were constructed similar to figure 8. Plots were constructed for each reservoir using light-penetration data collected throughout the reservoirs near the middle of each month. Where the straight line, or an extension of the straight line, intersects the vertical axis, $e^{-\eta y}$ equals 1, which results in ϕ_y/ϕ_o equaling $(1-\beta)$. A mean β was calculated for each reservoir for each year of model simulation.

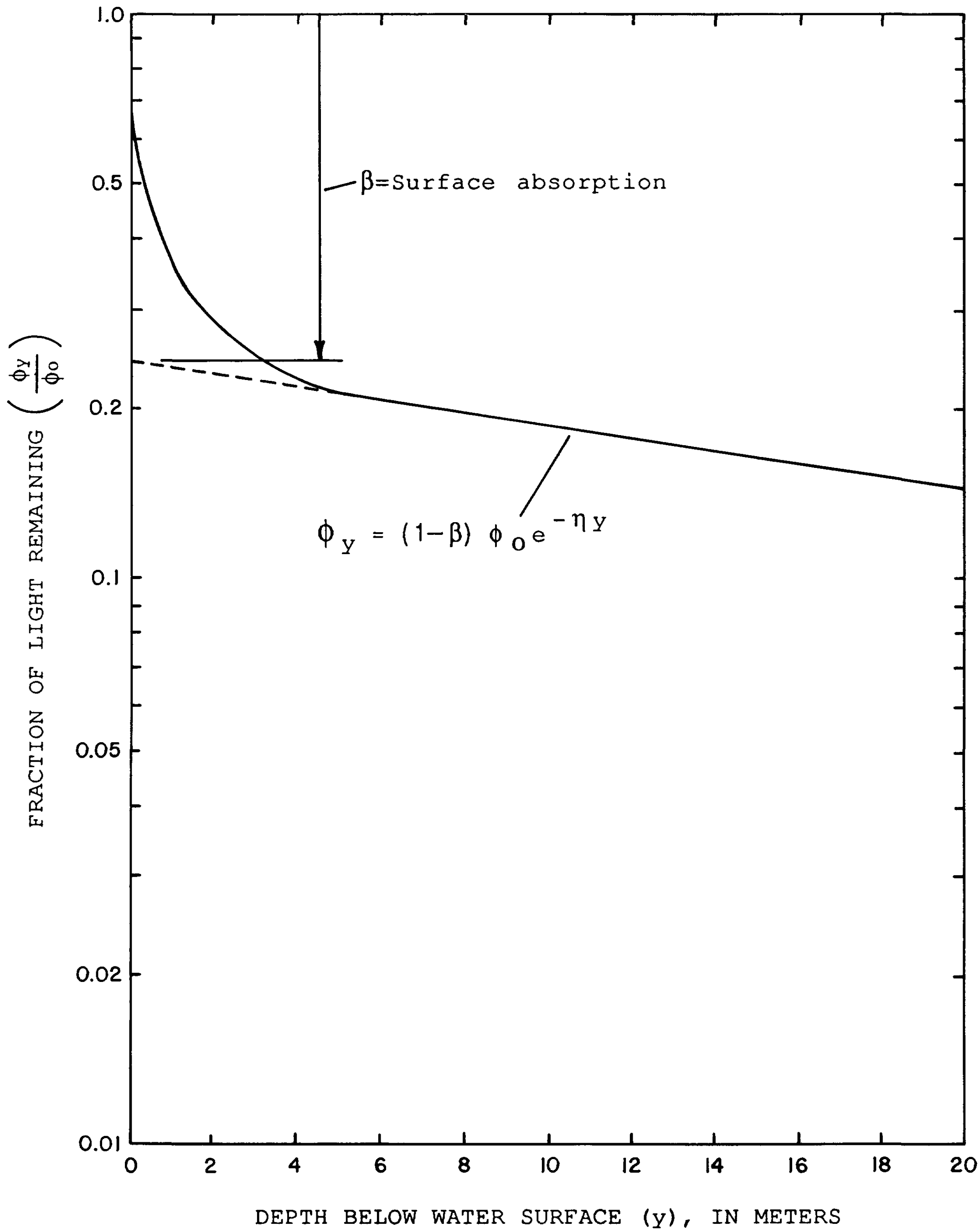

Figure 8.--Example of penetration of radiation into a reservoir (from Adams, 1975). (ϕ_y = radiation at depth y, β = fraction of solar radiation absorbed at water surface, ϕ_o = radiation at surface, η = radiation-absorption coefficient, and y = depth of water.)

To calculate the radiation-absorption coefficient, the mean depth at which incident light was 1 percent was determined for each reservoir. These values plus the mean β were used in equation 4 to determine a radiation-absorption coefficient for each reservoir.

Wind Speed and Cloud Cover

Data for wind speed and cloud cover in 1965, 1984, and 1985 for both reservoirs were obtained from the climatological station in Kalispell, Mont. (U.S. Department of Commerce, issued monthly). Total wind speed, in meters per day, was estimated from mean daily speeds, in miles per hour. Daily cloud cover, in tenths of total cover, is the average of several observations made from sunrise to sunset. Wind speed is entered as line group 33, and cloud cover is entered as line group 37 (table 3).

CALIBRATION AND VERIFICATION OF THE THERMAL MODELS

Models of Hungry Horse Reservoir and Lake Koocanusa were developed to determine if observed temperature profiles could be simulated using known or estimated input data. Development of the models required calibration and verification. Calibration, if successful, consists of an adjustment of input data within a reasonable range that results in simulated water-temperature profiles that are in acceptable agreement with the measured profiles. Verification, if successful, consists of an additional simulation with a different input data set that results in acceptable agreement between the simulated and measured profiles without adjustment of input data that do not change with time. Calibration and verification simulations were also used to compare simulated and measured outflow temperatures for each reservoir.

Initial isothermal temperatures for use in the models were selected between 4.0 and 4.5 °C for stability reasons. The maximum density of pure water, in the absence of air, occurs at a temperature of 3.98 °C. Therefore, colder water generally does not occur beneath water at 3.98 °C unless it has a large dissolved-solids concentration, which increases water density. Use of an initial isothermal temperature of 3.98 °C creates instability, because the model is unable to select a mixing level for inflow water at a slightly different temperature.

During initial calibration, values for the following variables were determined (see table 3):

KOH = 1	Koh's equation for computing withdrawal thickness	Line 3,
KLOSS = 3	Rohwer field-evaporation formula	Line 3,
MIXED = 2	Number of grid spaces in surface layer for entrance mixing	Line 3,
EVPCON = 0.01	Constant, a, in evaporation formula of Rohwer	Line 4,
SPREAD = 1.96	Number of outflow standard deviations	Line 5,
SIGMA = 4.0	Inflow standard deviation	Line 5,
DELCON = 1.0	One-half the value of the constant used to predict withdrawal thickness	Line 5,
RMIX = 1.0	Mixing ratio, which is an indication of the vertical extent of mixing due to turbulence	Line 5,
DD = 0.01245	Values of diffusion coefficients of heat	Line group 16,
VISCOUS = 0.0864	Viscosity of water	Line 19,
THICK1 = 2	Thickness of surface layer for lag time	Line 28,
THICK2 = 2	Thickness of subsurface layer for lag time	Line 28, and
ARF = 1.0	Area reduction factor; decrease of surface area exposed to solar radiation because of steepness of reservoir sides	Line 30.

When solar radiation was computed in the model, the following variables were input:

DDPL = 0.07	Distance depletion factor	Line 34, and
RG = 0.07	Ground reflectivity	Line 34.

For both Hungry Horse Reservoir and Lake Koocanusa, calibration of the models was accomplished using 1984 data and verification was accomplished using 1985 data. Initial values for unmeasured variables were estimated based on 1965 data. The time period for the first simulations of both reservoirs was March 1 through December 31, 1984. However, the simulations were interrupted in the early stages because of model-predicted subzero temperatures. Because the modeling program does not include provisions for ice formation, the data sets for each reservoir subsequently were changed to start during periods of no ice cover. Starting dates for calibration simulations were changed to April 18, 1984, for Hungry Horse Reservoir and April 2, 1984, for Lake Koocanusa. Similarly, starting dates for verification simulations were April 26, 1985, for Hungry Horse Reservoir and April 18, 1985, for Lake Koocanusa.

Simulated profile temperatures for Hungry Horse Reservoir would compare to temperatures measured at the Emery Bay limnological station (fig. 2). Simulated profile temperatures for Lake Koocanusa would compare to measured temperatures at the Forebay and Tenmile Creek limnological stations (fig. 3). Simulated outflow temperatures for Hungry Horse Reservoir would compare with measured streamflow temperatures at station 12362500 (fig. 5). Simulated outflow temperatures for Lake Koocanusa would compare with measured streamflow temperatures at station 12301933 (fig. 3).

Hungry Horse Reservoir

During initial calibration, using 1984 data, simulated water temperatures in the epilimnion were warmer than the water temperature measured in May. Simulated water temperatures in the hypolimnion remained at the initial isothermal temperature of 4.5 °C. To simulate a greater diffusion of heat from the surface to water at lower depths, the diffusion coefficient was increased gradually from 0.01245 to 0.01645. The area reduction factor was changed from 1.0 to 0.9, but the change resulted in subzero water temperatures by mid-December; therefore, the original value of 1.0 was maintained. The mixing ratio was increased gradually from 1.0 to 5.0. The result was simulated surface temperatures within about 3 C° of measured temperatures on May 29 and within 0.3 C° on June 25. The initial isothermal temperature was decreased from 4.5 to 4.2 °C to compare more closely to the hypolimnionic temperatures throughout the simulation.

Plots of simulated and measured temperature profiles in Hungry Horse Reservoir for 1984 are shown in figure 9. Except for the surface temperature of May 29, where the difference between simulated and measured temperature was about 3 C°, the epilimnionic and hypolimnionic temperatures were within about 1 C° through October. In November, the simulated and measured temperature differences were about 2 C° in the epilimnion. In the thermocline, temperature differences generally ranged from 0 to about 5 C°.

The results of verification, using 1985 data, were acceptable. Simulated surface temperatues followed the same pattern of change as the measured surface temperatures, even though the measured surface temperatures for 1985 were more variable than those for 1984. Measured surface temperatures increased from 12.0 °C on May 31 to 15.5 °C on June 11, decreased to 14.0 °C on June 25, increased to 21.5 °C on July 10, and then gradually decreased to 6.0 °C on November 14. Measured hypolimnionic temperatures during 1985 varied from 2.5 °C to 4.0 °C: simulated hypolimnionic temperatures were relatively constant at 4.2 °C, which is the isothermal temperature used for the initial condition in the model.

Plots of simulated and measured temperature profiles in Hungry Horse Reservoir for 1985 are shown in figure 10. Differences between simulated and measured temperatures in the epilimnion and hypolimnion were similar to the plots for 1984 and

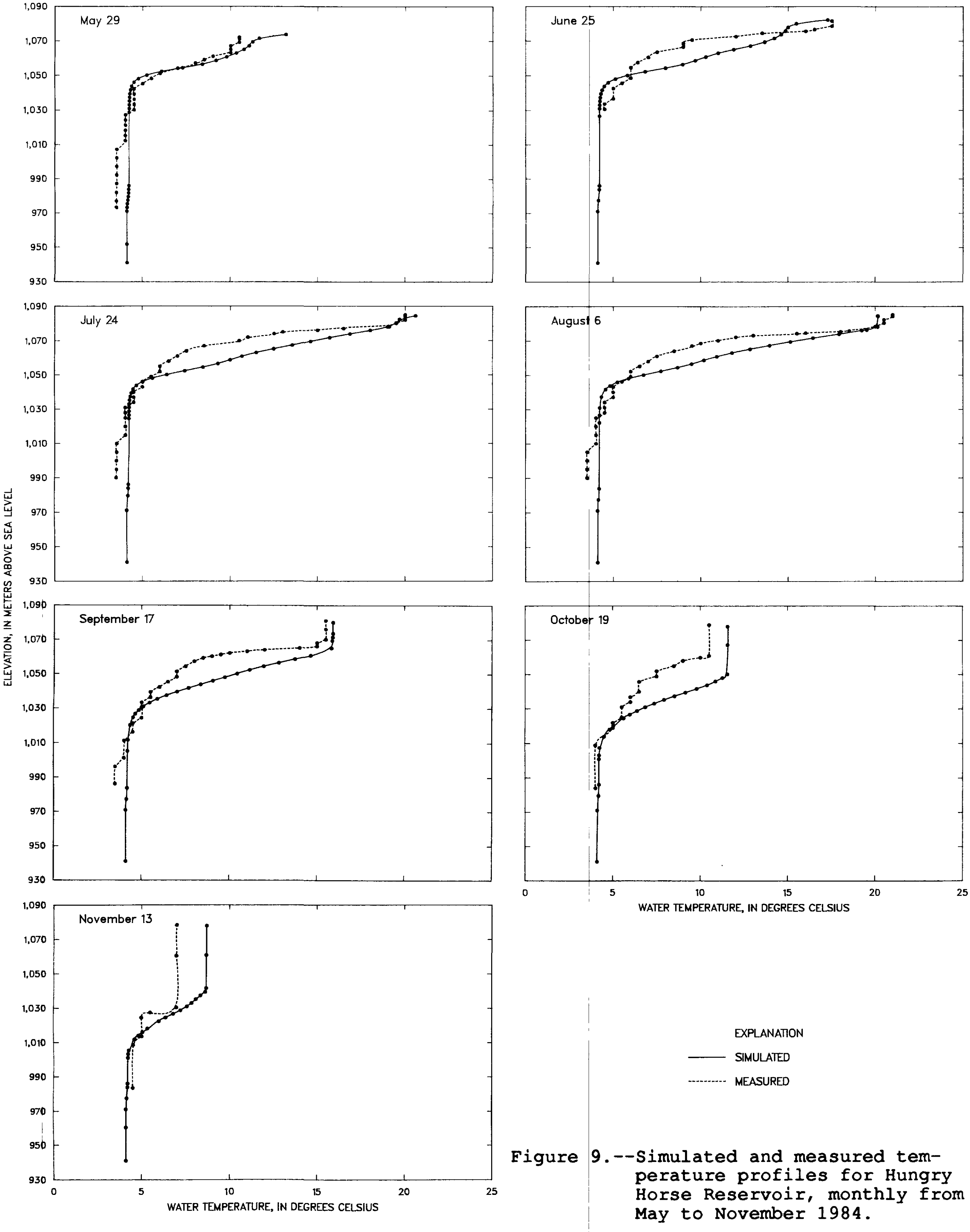

Figure 9.--Simulated and measured temperature profiles for Hungry Horse Reservoir, monthly from May to November 1984.

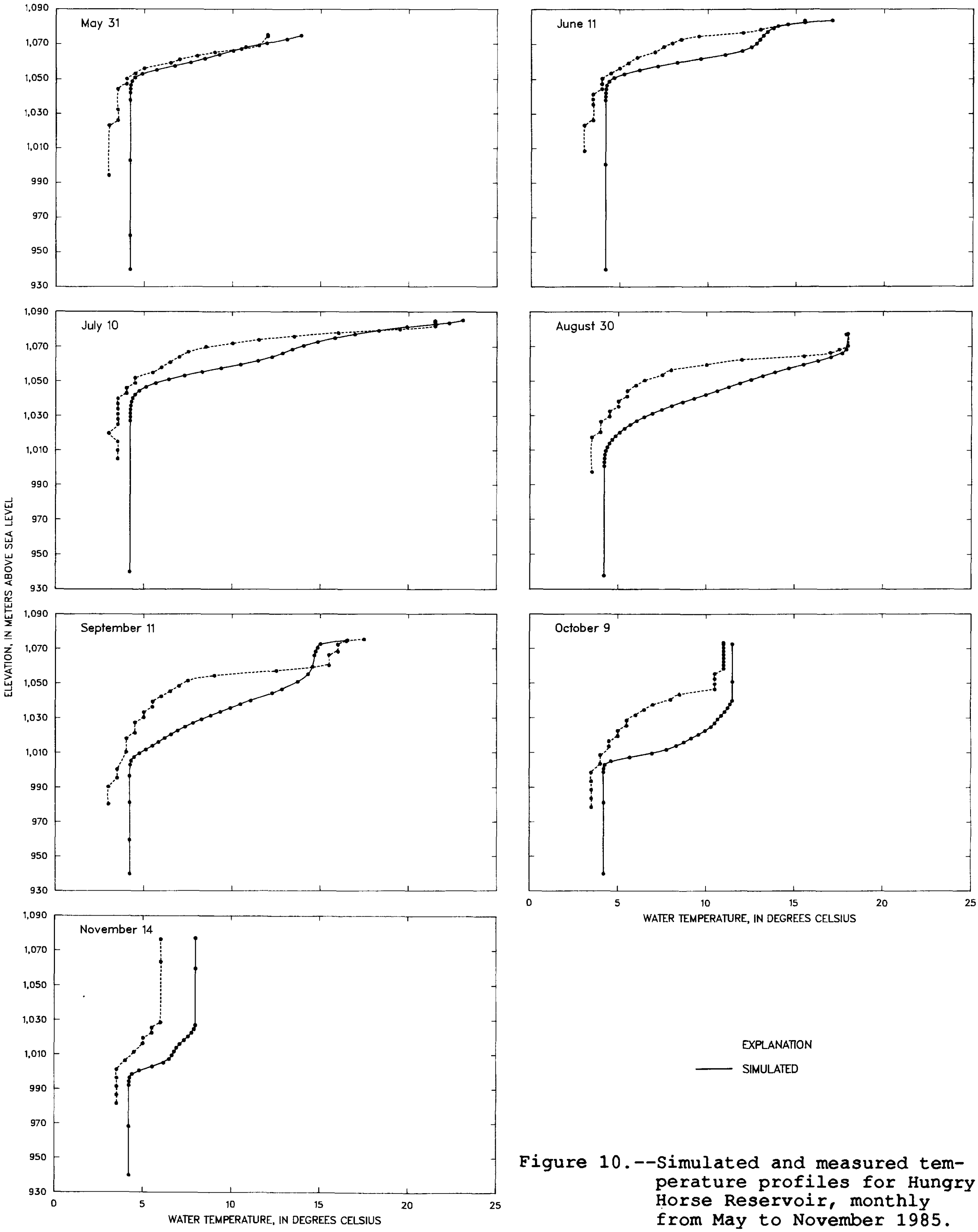

Figure 10.--Simulated and measured temperature profiles for Hungry Horse Reservoir, monthly from May to November 1985.

ranged from about 0 to 2 C°. In August, September, and October, however, maximum temperature differences in the thermocline varied from 5 to 7 C° over a depth range of about 20 to 40 m. For both 1984 and 1985, simulated temperatures were generally warmer than measured temperatures in the thermocline.

Simulated and measured outflow temperatures for Hungry Horse Reservoir are shown in figure 11. Differences between simulated and measured outflow temperatures for 1984 varied from 0 to 2 C°. Simulated outflow temperatures for 1984 show a steady increase compared to a more irregular pattern for measured outflow temperatures. This condition most likely is a result of ambient air temperatures affecting measured temperatures in the South Fork Flathead River. Differences between simulated and measured outflow temperatures for 1985 varied from 0 to 3 C°. Both curves for 1985 show a definite peak at about day 300 and a trough at about day 350. However, as with the 1984 data, the temperature for 1985 was less variable for the simulated values than for the measured values. Simulated outflow temperatures were generally cooler for 1984 but warmer for 1985 than measured outflow temperatures.

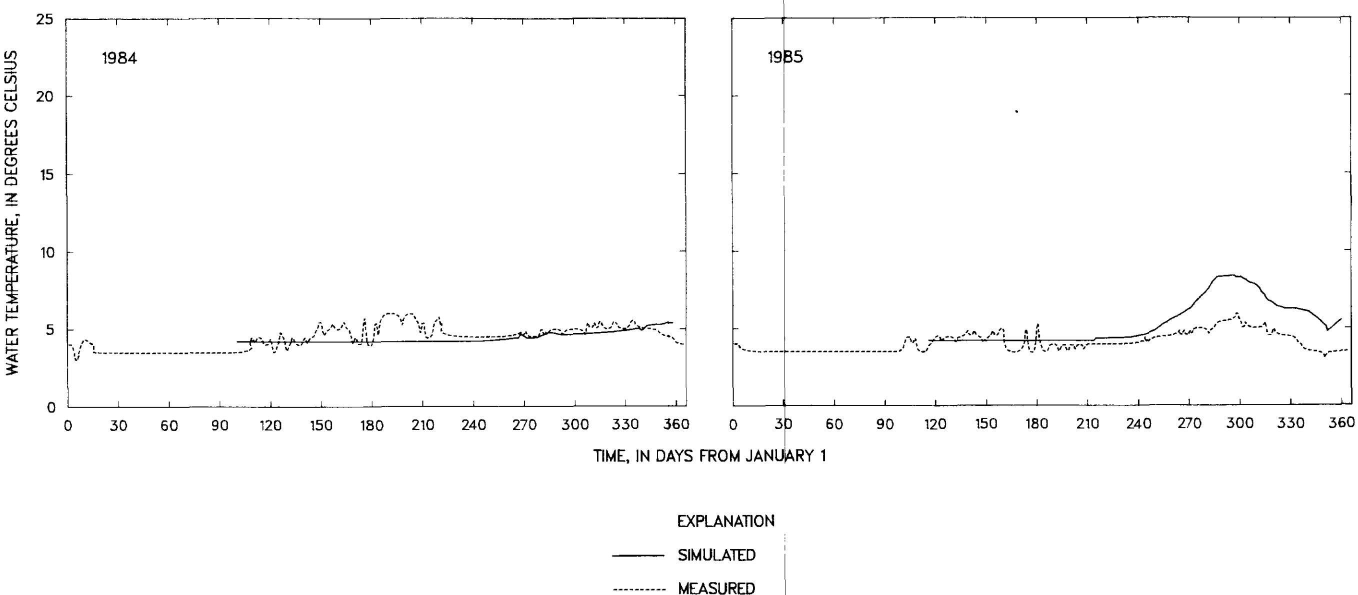

Figure 11.--Simulated and measured outflow temperatures for Hungry Horse Reservoir, 1984 and 1985.

Lake Koocanusa

Values determined during calibration of the model for Hungry Horse Reservoir were used initially for calibration of the model for Lake Koocanusa. The initial isothermal temperature of 4.5 °C was selected on the basis of measured hypolimnionic temperatures of 4.5 °C for May through July 1984.

During initial calibration, using 1984 data, simulated surface temperatures were more than twice the measured values. To simulate a greater diffusion of heat to water at lower depths, the diffusion coefficient was increased gradually from 0.01245 to 0.01645 and the mixing ratio was increased gradually from 1 to 10. Increasing the diffusion coefficient allowed heat to disperse more quickly by conduction. Increasing the mixing ratio increased the movement of heat by convection. To further decrease the temperature in the epilimnion but not change temperatures in the lower region of the reservoir, the area reduction factor was changed from 1.0 to 0.9. Decreasing the area reduction factor effectively reduced the surface area of the reservoir that receives solar radiation.

Plots of simulated and measured temperature profiles in Lake Koocanusa for 1984 are shown in figure 12. Except for May 16, simulated and measured temperature profiles have similar shapes. Temperature differences in the epilimnion and hypolimnion generally ranged from 0 to 2 C°. For May 16, the temperature difference in the epilimnion was 4.5 C°. The simulated thermocline indicated a more pronounced thermal stratification than was measured. This stratification was most pronounced in the October profile. Differences between simulated and measured temperatures in the thermocline ranged from 0 to 5 C°.

The results of verification, using 1985 data, were acceptable. Simulated surface temperatures followed the same pattern of change as the measured surface temperatures. Simulated temperatures in the hypolimnion also followed the same general pattern as the measured temperatures.

Plots of simulated and measured temperature profiles in Lake Koocanusa for 1985 are shown in figure 13. Temperature differences between both profiles generally ranged from 0 to 2 C° at all depths. However, differences between simulated and measured temperatures were 3 to 4 C° in the thermocline for May 15, October 9, and November 5, and 4 C° at the surface on August 15. For both 1984 (fig. 12) and 1985 (fig. 13), the plotted simulated temperatures generally were warmer in the upper thermocline but cooler in the lower thermocline than were measured temperatures.

Simulated and measured outflow temperatures for Lake Koocanusa are shown in figure 14. The simulated and measured temperatures follow the same overall, seasonal increase and decrease with time; however, measured outflow temperatures are more variable than simulated outflow temperatures. The variability in measured outflow temperatures could be the result of sampling error or water-surface oscillations within the reservoir that are not accounted for by the model. The stepped changes in simulated outflow temperature reflect changed water-release elevations. Differences between simulated and measured outflow temperatures range from about 0 to 5 C° for both 1984 for 1985. In early October 1984 (about 274 days after January 1), simulated outflow temperature abruptly decreased, then increased. This temperature change coincides with similar changes in air temperature and inflow water temperature. During the summer of both years, simulated outflow temperatures were warmer than measured outflow temperatures.

ANALYSIS OF SIMULATION RESULTS

Simulated temperature profiles and outflow temperatures for both reservoirs are considered to be acceptable and within errors experienced for similar models of other reservoirs. Considering the lack of input data that are specific to each reservoir, the errors were expected to be larger than those observed. The significance of differences between simulated and measured temperatures will depend on temperature tolerances of organisms to which the modeling results will be compared.

The simulated temperatures that have resulted from the variable values determined in this study indicate that the models were successfully calibrated and verified. Therefore, development and use of similar models for similar reservoirs of northwestern Montana probably is valid.

IMPROVEMENTS IN TEMPERATURE PREDICTION

Many of the input data used for the 1984 and 1985 simulations were estimated from data collected at sites not located at Hungry Horse Reservoir or Lake Koocanusa. Inflow water temperatures for both reservoirs were estimated from daily mean streamflow temperatures of the North Fork Flathead River near Columbia Falls. This stream is not an upstream tributary to either reservoir. Although good regressions were developed for estimating inflow temperatures, data from the streams actually tributary to each reservoir might improve simulated temperature profiles.

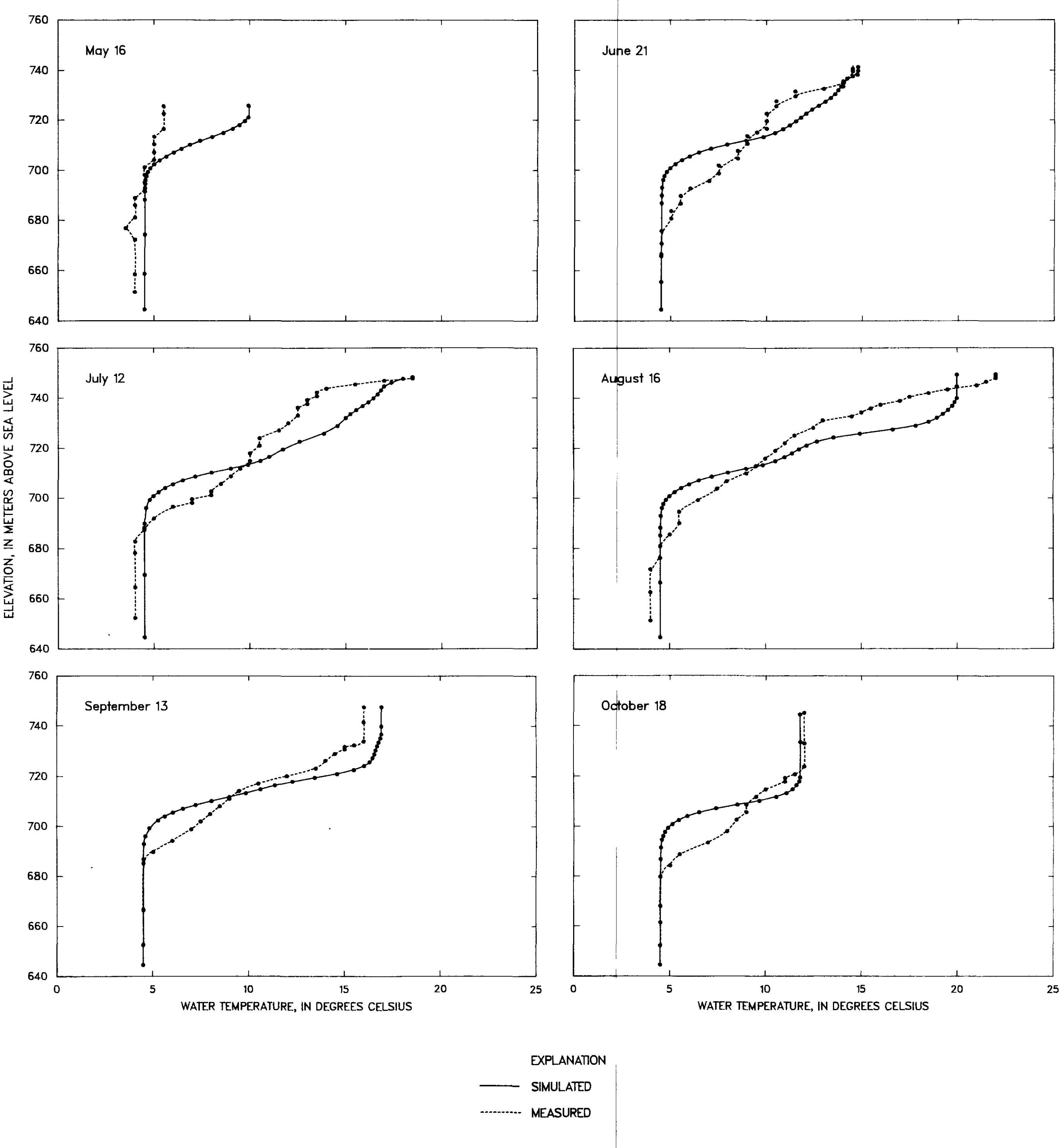

Figure 12.--Simulated and measured temperature profiles for Lake Koocanusa, monthly from May to October 1984.

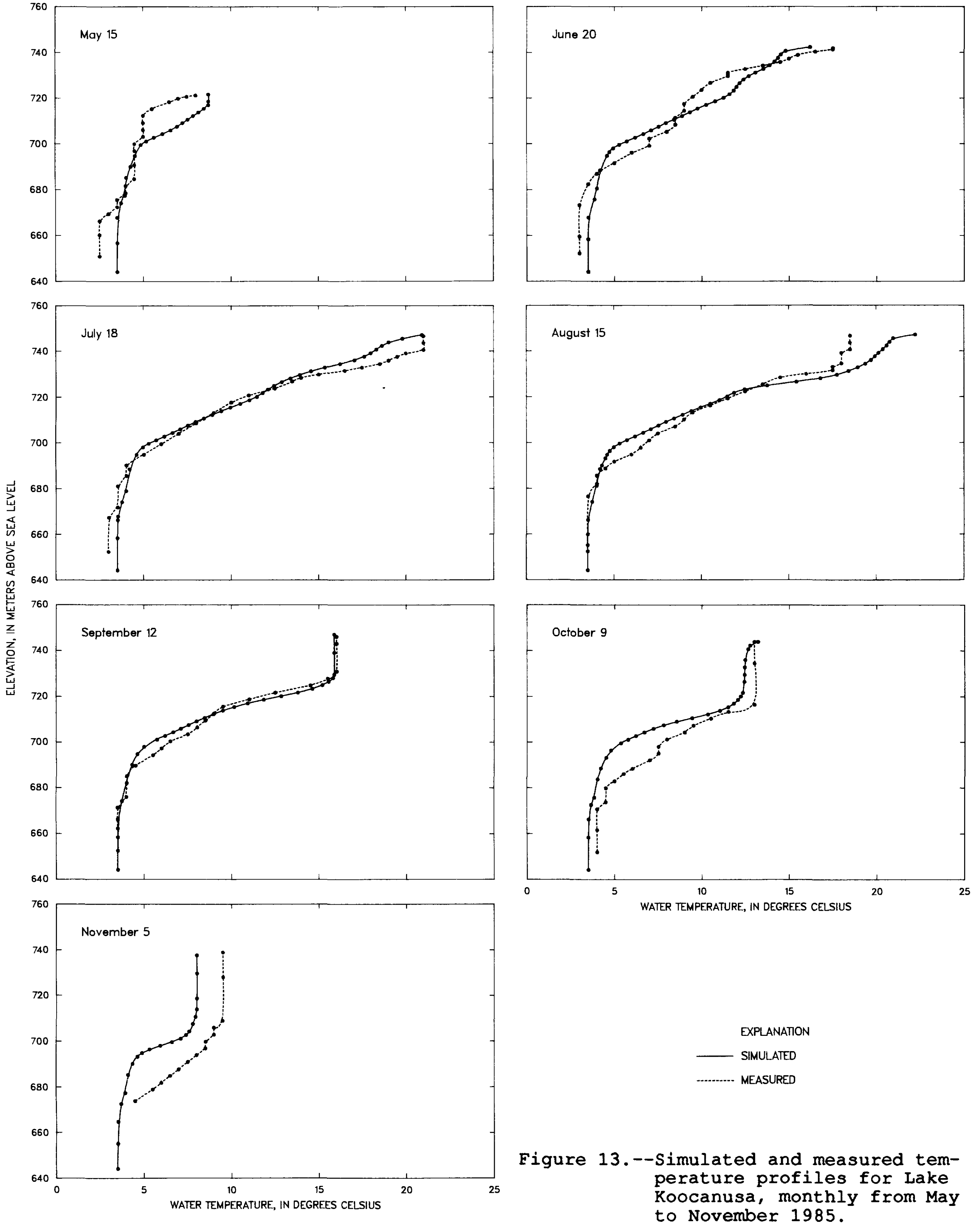

Figure 13.--Simulated and measured temperature profiles for Lake Koocanusa, monthly from May to November 1985.

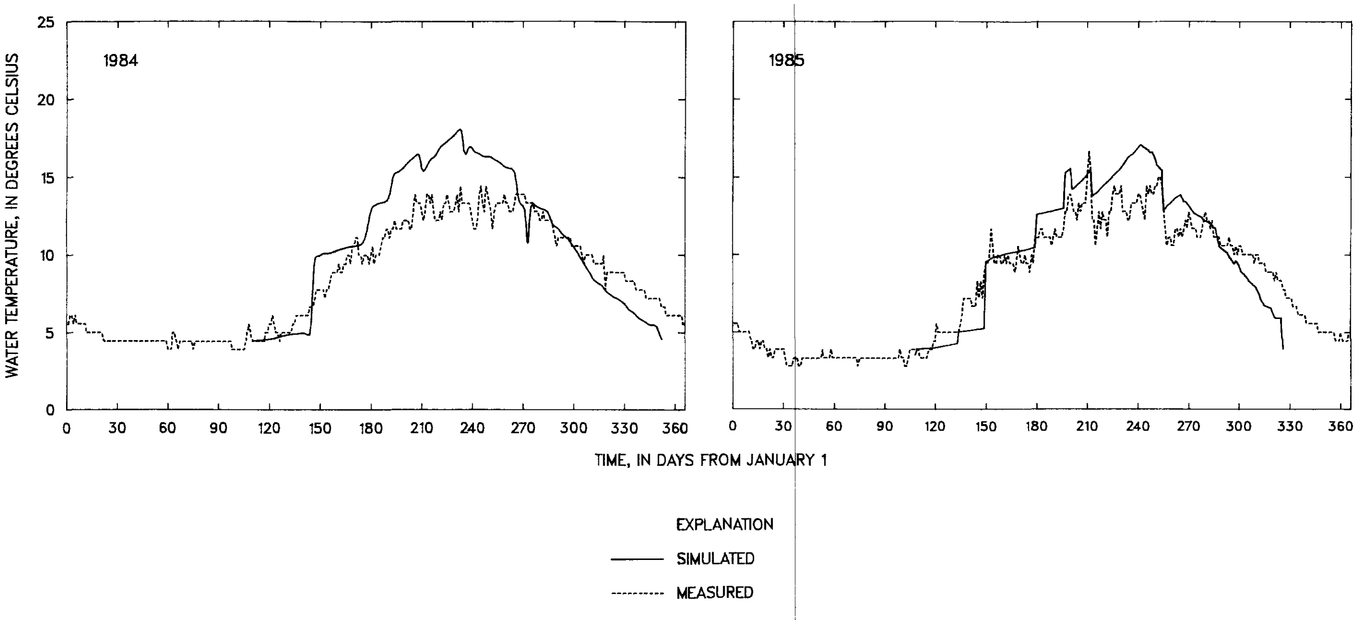

Figure 14.--Simulated and measured outflow temperatures for Lake Koocanusa, 1984 and 1985.

Daily climatological conditions account for major heat gain to, and loss from, the reservoir. Climatological data other than air temperature were available only from Kalispell, Mont. Data for percent relative humidity, solar radiation, wind speed, and cloud cover might be different at reservoir sites. Data could be collected at the reservoir sites to develop correlations with data collected at Kalispell. On the basis of the correlations, data from Kalispell could be used not only for future simulations, but also to improve model calibration.

Two changes to the modeling program might improve simulated temperature profiles. These changes involve absorption of radiation and mixing of lake waters.

The equation used in the modeling program for absorption of solar radiation at various depths is generally accepted (see eq. 4). In the program, coefficient values for equation 4 are specified as data input; the same values are used throughout the time period. However, in most reservoir systems, the absorption of light by a body of water can change seasonally. Generally, large inflows during spring can increase suspended sediment in reservoirs and substantially affect the depth to which radiation is absorbed. Radiation absorption also can be affected in spring by an increase in phytoplankton growth as a result of additional nutrient loading. Later, in summer, increased water temperatures promote renewed phytoplankton growth, which also can affect the depth to which radiation is absorbed. Therefore, the modeling program could be modified to accept several values of radiation absorption coefficients to reflect seasonal changes in the absorption of radiation.

Heat transport by mixing is accounted for in the program only in the epilimnion and only when the density profile is unstable. When the temperature profile in the epilimnion develops an unstable density gradient, vertical mixing is induced to produce a surface layer of uniform temperature. Thus, even though wind shear and wave motion may create turbulence in the surface layer, the program assumes that heat transfer will be dominated by convection currents and surface cooling. The accuracy of simulated temperature profiles might be improved by including a computer routine that accounts for wind stresses on the water surface. The modeled wind stresses would cause mixing, particularly when a neutral or unstable density gradient is created by surface cooling.

SUMMARY AND CONCLUSIONS

A modeling computer program of Adams (1974) was used to develop models to simulate temperature profiles in Hungry Horse Reservoir and Lake Koocanusa for 1984 and 1985. The results of the modeling effort will be useful to the Montana Department of Fish, Wildlife and Parks in evaluating the effects of alternative seasonal reservoir-drawdown schedules on fish production.

The modeling computer program of this study has been used previously to develop models for Flaming Gorge Reservoir in Utah and Wyoming and Fontana Reservoir in Tennessee. Simulated temperatures in both of these reservoirs were considered to be in good agreement with measured temperatures.

The modeling program is time dependent, is one dimensional, and describes vertical variation in temperature and water quality; it is based on the absorption and transmission of solar radiation, convection due to surface cooling, and advection due to inflows and outflows. Although the modeling program can be used to simulate vertical variation in water quality, only the temperature aspect was evaluated in this study. The modeling program was modified to accommodate a multiple-outlet release system as used for Lake Koocanusa.

Complete input data sets were developed for both reservoirs for 1984 and 1985. Inflow water temperatures were estimated from regression equations based on daily mean temperatures in the North Fork Flathead River near Columbia Falls, Mont. Data for percent relative humidity, wind speed, and cloud cover for both reservoirs were obtained from a National Weather Service climatological station at Kalispell, Mont.

The thermal models for Hungry Horse Reservoir and Lake Koocanusa were calibrated using 1984 data and verified using 1985 data. Initial values for unmeasured variables were estimated based on 1965 data.

For Hungry Horse Reservoir, plots of simulated and measured temperature profiles in 1984 indicate differences within about 1 C° in the epilimnion and hypolimnion from June through October. In the thermocline, temperature differences generally ranged from 0 to about 5 C°. Plots of simulated and measured temperature profiles for 1985 showed differences in the epilimnion and hypolimnion that were similar to those for 1984. However, in August, September, and October, maximum temperature differences in the thermocline varied from 5 to 7 C° over a depth range of about 20 to 40 m. Simulated temperatures generally were warmer than measured temperatures in the thermocline. Simulated and measured outflow temperatures for 1984 and 1985 show similar trends in seasonal variations, with temperature differences ranging from 0 to 3 C°. Simulated outflow temperatures were generally cooler in 1984 but warmer in 1985 than measured outflow temperatures.

For Lake Koocanusa, plots of simulated and measured temperature profiles in 1984 indicate differences of about 2 C° or less in the epilimnion and hypolimnion. The simulated thermocline had a more pronounced thermal stratification than was measured in the reservoir. Differences between simulated and measured temperatures in the thermocline ranged from 0 to 5 C°. Temperature differences between simulated and measured profiles for 1985 generally ranged from 0 to 2 C° at all depths. For both years, simulated temperatures were warmer in the upper thermocline but cooler in the lower thermocline than were measured temperatures. Plots of simulated and measured outflow temperature show similar seasonal trends; temperature differences range from about 0 to 5 C° in both 1984 and 1985. During the summer of both years, simulated outflow temperatures were warmer than measured outflow temperatures.

Comparisons of simulated temperature to measured temperature in Hungry Horse Reservoir and Lake Koocanusa indicate that the models were successfully calibrated and verified. Therefore, development and use of similar models for similar reservoirs of northwestern Montana probably is valid. Even so, simulated temperature profiles in future evaluations might be improved by obtaining inflow-temperature data and climatological data that are more appropriate to the reservoirs. In addition, changes in model routines that would allow input of seasonal radiation-absorption variations and wind-induced mixing might better represent processes occurring in Hungry Horse Reservoir and Lake Koocanusa.

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SUPPLEMENTAL INFORMATION

Table 2.--*Listing of FORTRAN modeling program*

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C*********************************************************************
C  DEE BRIANE ADAMS,1974, *****MASSACHUSETTS INSTITUTE OF TECHNOLOGY****
C*********************************************************************
C  RESERVOIR STRATIFICATION AND CONCENTRATION PREDICTION PROGRAM, 1974.
      COMMON T(70,2),EL(70),XL(70),A(70),TI(366),TA(366),SIGH(366)
      COMMON FIN(366),WIND(366),DD(366),QI(366),QO(366),P(50),NPR
      COMMON UOMAX(2),UIMAX(2),DTTI,DTTA,DTSIGH,DTFIN,DTWIND,DTDD,DTQI
      COMMON DTQO,JM,JOUT,JIN,KDIF,KSUR,KOH,KQ,KLOSS,YSUR,YOUT,DT,DY
      COMMON TSTOP,EVPCON,OMEGA,BZ,SPREAD,SIGMAI,SIGMAO,ETADY,TVARI
      COMMON TVARO,EVAP,RAD,TAIR,PSI,DERIV,HAFDEL,EPSIL,GJ
      COMMON YBOT,NN,BETA,DAJM,DELCON,V( 70,1),UI( 70,1),DTT
      COMMON RHO,HCAP,KMIX,RMIX,JMIXB,MIXED,QMIX,KAREA,DATRAD,ATRAD(366)
      COMMON AR,WINDY,CO,CI,B( 70),S( 70),EX( 70),EXO( 70),ARF,UO( 70,1)
      COMMON QIN(366),TIN(366),CC(20,70,2),CCC(20,366),COUT(20,366)
      COMMON CCT(20,366),QQMIX(70),XINF(70),OUTF(70),MIXH,MM
      COMMON SURF(366),GRAV,SLOPE,VISCOS,LAGTIM(366)
      COMMON PMASOT(20),PMASIN(20),ET,NTRAC(20),ITR,ISTO,ISO1,ISO2
      COMMON ISTON,ISTO1,THICK1,THICK2,DOXLE(70,20),DO(366),BOD(366)
      COMMON NLEVE(366),VOL,NW,NDET,Z,Z1,DDOC,NGDET,DBOD,JEUP
      COMMON NBOUND,NGRID,NCONTR
      COMMON KATRAD,DCLOUD,NCLOUD,CLOUD(366)
      DIMENSION WH(20),AA(70),XXL(70),YYOUT(366),JJOUT(366)
      DIMENSION CONC(366),TEMPT(366),XND(366),CP(70)
      COMMON DPT(366),DYPLT(16),NPLT,IDAY,NDAY,ELMAX,XLAT,DDPL,RG,KSLRAD
      EQUIVALENCE (N,NN)
C READ IN ALL DATA FOR PROGRAM.
      READ (7,1510) (WH(I),I=1,20)
      WRITE(6,1510) (WH(I),I=1,20)
      READ (7,1510) (WH(I),I=1,20)
      READ (7,1520) JM,JOUT,KDIF,KSUR,KOH ,KQ,KLOSS,NPRINT,KAREA,KMIX,
     1 MIXED,KATRAD,INITIAL,MULOUT
      READ (7,1550) YSUR,YOUT,DT,TSTOP,TZERO,EVPCON,OMEGA,BZ
      READ (7,1530) SPREAD,SIGMAI,ETA,BETA,RHO,HCAP,DELCON,RMIX
      READ (7,1520) NTI,NTA,NSIGH,NFIN,NSURF,NDD,NQI,NQO,NOUT
      READ (7,1530) DTTI,DTTA,DTSIGH,DTFIN,DSURF,DTDD,DTQI,DTQO
      READ(7,1520) IDAY,NDAY,KSLRAD
      READ(7,1520)NPLT
      READ(7,1530) (DYPLT(I),I=1,NPLT)
      READ (7,1530) (TI(I),I=1,NTI)
      READ (7,1530) (TA(I),I=1,NTA)
      READ (7,1530) (SIGH(I),I=1,NSIGH)
      GO TO (10,20),KSLRAD
10    CONTINUE
      READ (7,1530) (FIN(I),I=1,NFIN)
20    CONTINUE
      READ (7,1530) (SURF(I),I=1,NSURF)
      READ (7,1530) (DD(I),I=1,NDD)
      READ (7,1530) (QI(I),I=1,NQI)
      READ (7,1530) (QO(I),I=1,NQO)
      READ(7,30) SLOPE,GRAV,VISCOS
30    FORMAT(3F12.2)
      READ(7,1520) NGDET,NBOUND,NGRID,NCONTR
C  NBOUND=1=EUPHOTIC ZONE SATURATED
C  NBOUND=2=SATURATION OF ARBITRARY SURFACE LAYER THICKNESS TO BE SPECIF
C  NBOUND=3=ZERO SURFACE LAYER THICKNESS FOR SATURATION.
C  NGDET=1=DETENTION TIME MODEL
C  NGDET=2=DO CALCULATION
      GO TO (40,60),NGDET
C  READ DATA FOR PULSE INJECTION.
40    READ(7,50) ITR,(NTRAC(I),I=1,ITR)
50    FORMAT (I5/16I5)
      READ(7,1520) NDET
      NDOCA=10000
```

```
      GO TO 110                                                         MAIN0640
C  READ DATA FOR DO,BOD PREDICTIONS.                                    MAIN0650
60    READ(7,1520) NDISSO,NBOD                                          MAIN0660
      READ(7,1530) DDOC,DBOD                                            MAIN0670
      READ(7,1530)  (DO(I),I=1,NDISSO)                                  MAIN0680
      READ(7,1530)(BOD(I),I=1,NBOD)                                     MAIN0690
      READ (7,1520) NPROF                                               MAIN0700
C  NPROF=1=UNIFORM INITIAL DC,BCD PROFILES.                             MAIN0710
C  NPROF=2=LINEAR INITIAL DO,BOD PROFILES.                              MAIN0720
      GO TO (70,80),NPROF                                               MAIN0730
70    READ(7,1530) DOI,BODI                                             MAIN0740
      GO TO 90                                                          MAIN0750
80    READ (7,1530) DOB,DOT,BODB,BODT                                   MAIN0760
90    CONTINUE                                                          MAIN0770
      ITR=2                                                             MAIN0780
      NTRAC(1)=-2                                                       MAIN0790
      NTRAC(2)=-1                                                       MAIN0800
      READ (7,100) Z,Z1,NDOCA                                           MAIN0810
100   FORMAT(2F10.5,I5)                                                 MAIN0820
110   CONTINUE                                                          MAIN0830
      READ (7,1530) THICK1,THICK2                                       MAIN0840
      DY = (YSUR-YOUT)/FLOAT(JM-JOUT)                                   MAIN0850
      YBOT = YOUT-DY*FLOAT(JOUT-1)                                      MAIN0860
      GO TO (200,120), KAREA                                            MAIN0870
C READ IN DATA FOR OTHER THAN LABORATORY RESERVOIR IF INDICATED.        MAIN0880
120   READ (7,1520) NAA,NXXL,NWIND,NATRAD,JMP                           MAIN0890
      READ (7,1530) DAA,DXXL,DTWIND,DATRAD,AAB,XXLB,ARF                 MAIN0900
      READ (7,1530)  (AA(I),I=1,NAA)                                    MAIN0910
      READ (7,1530)  (XXL(I),I=1,NXXL)                                  MAIN0920
      READ (7,1530)  (WIND(I),I=1,NWIND)                                MAIN0930
      DO 130 I=1,NWIND                                                  MAIN0940
      WIND(I)=WIND(I)/86400.                                            MAIN0950
130   CONTINUE                                                          MAIN0960
      GO TO (150,140),KSLRAD                                            MAIN0970
140   READ(7,1530)ELMAX,XLAT,DDPL,RG                                    MAIN0980
150   CONTINUE                                                          MAIN0990
      GO TO (160,170),KATRAD                                            MAIN1000
160   READ (7,1530)  (ATRAD(I),I=1,NATRAD)                              MAIN1010
170   READ (7,1540) DCLOUD,NCLOUD                                       MAIN1030
      READ (7,1530)  (CLOUD(I),I=1,NCLOUD)                              MAIN1040
C   INITIAL=1 FOR INITIAL ISOTHERMAL TEMP=TZERO
C   INITIAL=2 FOR INITIAL TEMP PROFILE TO BE READ IN
      GO TO (171,172),INITIAL
172   READ (7,1530)  (T(I,1),I=1,JMP)
171   CONTINUE
      GO TO (173,174),MULOUT
174   READ (7,1530)  (YYOUT(I),I=1,NOUT)
      READ (7,1520)  (JJOUT(I),I=1,NOUT)
173   CONTINUE
180   DO 190 I=1,JMP                                                    MAIN1050
      GO TO (181,182),INITIAL
181   T(I,1)  = TZERO                                                   MAIN1060
182   CONTINUE
      T(I,2)=T(I,1)                                                     MAIN1070
      EL(I)  = YBOT+DY*FLOAT(I-1)                                       MAIN1080
      RA =  (EL(I)-AAB)/DAA                                             MAIN1090
      L = RA                                                            MAIN1100
      A(I)  = AA(L+1)+(RA-FLOAT(L))*(AA(L+2)-AA(L+1))                   MAIN1110
      A(I)  = A(I)*ARF                                                  MAIN1120
      RA =  (EL(I)-XXLB)/DXXL                                           MAIN1130
      L = RA                                                            MAIN1140
      XL(I)  = XXL(L+1)+(RA-FLOAT(L))*(XXL(L+2)-XXL(L+1))               MAIN1150
190   B(I)=BZ*ARF*EXP(OMEGA*EL(I))                                      MAIN1160
```

Table 2.--*Listing of FORTRAN modeling program*--Continued

```
C THE NUMBER 0.3989423=1.0/SQRT(2*PI).
      P(32) = 0.3989423/BZ/ARF
      P(33) = OMEGA*OMEGA/2.0
      P(34) = YOUT*OMEGA
      P(35) = P(32)*EXP(-P(33)*SIGMAI*SIGMAI)
      GO TO 240
200   JMP = JM+IFIX((33.0-YSUR)/DY+0.5)
C THE NUMBER 0.01308866=1.0/30.48/SQRT(2*PI).
      CO = 0.01308866
      CI = 0.01308866
      ARF = 1.0
      AR = 0.7888E-10    *(TA(1)+273.16)**4
      P(22) = SIGMAI/CI
      DO 230 I=1,JMP
      B(I) = 30.48
      EL(I) = YBOT+DY*FLOAT(I-1)
      GO TO (201,202),INITIAL
201   T(I,1) = TZERO
202   CONTINUE
      IF (EL(I)-22.4)210,220,220
210   XL(I) = 10.0*(EL(I)+87.0)
      GO TO 230
220   XL(I) = 1093.5
230   A(I) = XL(I)*30.48
240   BB = DT/A(JOUT+1)/DY
      EO=(A(1)+A(JM))/2.0+A(JM)*(SURF(1)-EL(JM))/DY
      JM1=JM-1
      DO 250 I=2,JM1
250   EO=EO+A(I)
      EO=EO*DY*TZERO*0.1E04
      DTT=DT
      BBETA = QOUT(0)*BB
      WRITE (6,1510) (WH(I),I=1,20)
      WRITE (6,1560) JM,YSUR,RHO
      WRITE (6,1570) JOUT,YOUT,HCAP
      WRITE (6,1580) DY,YBOT,ETA
      WRITE (6,1590) DT,TZERO,BETA
      WRITE (6,1600) BBETA,SIGMAI,OMEGA
      WRITE (6,1610) TSTOP,SPREAD,BZ
      WRITE (6,1620) KDIF,KSUR,KOH,KQ,KLOSS,KAREA,EVPCON,DELCON,KMIX,
     $INITIAL,MULOUT
      WRITE (6,1730) MIXED,RMIX,ARF
C INITIALIZE MANY VARIABLES.
      DO 270 N=1,366
      QIN(N)=0.0
      TIN(N)=0.0
      DO 260 M=1,ITR
      CCC(M,N)=0.0
      COUT(M,N)=0.0
      PMASOT(M)=0.0
      PMASIN(M)=0.0
260   CCT(M,N)=0.0
270   CONTINUE
      DO 290 I=1,70
      DO 280 M=1,ITR
      CC(M,I,1)=0.0
280   CC(M,I,2)=0.0
      OUTF(I)=0.0
      QQMIX(I)=0.0
290   XINF(I)=0.0
      GO TO (360,300),NGDET
300   GO TO (330,310),NPROF
310   DO 320 J=1,JM
```

Table 2.--*Listing of FORTRAN modeling program*--Continued

```
      CC(1,J,1)=DOB+(FLOAT(J)*DY-DY)/(YSUR-YBOT)*(DOT-DOB)
      CC(1,J,2)=CC(1,J,1)
      CC(2,J,1)=BODB+(FLOAT(J)*DY-DY)/(YSUR-YBOT)*(BODT-BODB)
320   CC(2,J,2)=CC(2,J,1)
      GO TO 350
330   DO 340 J=1,JM
      CC(1,J,1)=DOI
      CC(1,J,2)=DOI
      CC(2,J,2)=BODI
340   CC(2,J,1)=BODI
350   CONTINUE
360   CONTINUE
      NW=0
      VOL=(A(1)+A(JM))*DY/2.
      DO 370 J=2,JM1
370   VOL=VOL+A(J)*DY
      CONTINUE
      NPR=NPRINT
      JXM=JM
      N = 0
      JMIXB = JM-MIXED
      QMIX = 0.0
      ET = 0.0
      RAD = 0.0
      EVAP = 0.0
      E2=0.0
      E3=0.0
      TAIR = 0.0
      EPSIL = 0.0
      HAFDEL = 0.0
      NDO1=NDOCA-1
      JIN = JM
      YSURP = YSUR
      ETADY = ETA*DY
      TVARI = 2.0*SIGMAI*SIGMAI
      DO 400 I=1,JMP
      S(I) = (DY*FLOAT(I-1))**2
      ARG = S(I)/TVARI
      IF (ARG-20.0)380,380,390
380   EX(I) = EXP(-ARG)
      GO TO 400
390   EX(I) = 0.0
400   CONTINUE
      P(25) = FLOAT(MIXED)*(B(JM)+B(JMIXB))
      IF(P(25)-0.0)420,410,420
410   P(25)=0.000001
420   P(31) = OMEGA*SIGMAI*SIGMAI
      GO TO (430,440), KDIF
430   DIF = D(1,1)
440    IF (JM-50)450,450,460
450   JP = JM
      GO TO 470
460   JP = 50
470   GO TO (500,480), KQ
480   UIMAX(1)=0.0
      UOMAX(1) = 0.0
      DO 490 J=1,JM
      SIGMAO = 1.0
      UI(J,1) = 0.0
490   V(J,1) = 0.0
C  STATEMENT 500 IS BEGINNING OF MAIN ITERATION LOOP OF PROGRAM.
500   CONTINUE
      GO TO (501,502),MULOUT
```

```
502    YOUT=YYOUT(N)
       JOUT=JJOUT(N)
501    CONTINUE
       GO TO (510,900), KQ
510    GO TO (540,520), KMIX
C MIX INFLOW WATER IF INDICATED.
520    QQ =QQIN(N+1)
       P(29) = RMIX/DY*2.0/P(25)
       QMIX = RMIX*QQ
       TP = 0.0
       DO 530 J=JMIXB,JM
530    TP = TP+T(J,1)
       TP = TP/FLOAT(MIXED+1)
       TS = (TTIN(N+1)+TP*RMIX)/(1.0+RMIX)
       GO TO 550
540    TS =TTIN(N+1)
550    CONTINUE
       RHOI=1.-(((TS-3.9863)**2/508929.2)*(TS+288.9414)/(TS+68.12963))
C  LOCATE ACTUAL LEVEL OF DAYS INPUT
       DO 560 I=1,JM
       J=JM+1-I
       RHOR=1.-(((T(J,1)-3.9863)**2/508929.2)*(T(J,1)+288.9414)/(T(J,1)+
      168.12963))
       DLRHO=RHOR-RHOI
       IF(DLRHO.GT.0.) GO TO 570
560    CONTINUE
570    JIN=J+1
       IF(JIN-JM)590,590,580
580    JIN=JM
590    CONTINUE
       NW=NW+1
       JEUP=JM-4.6/ETA/DY
       GO TO (630,600),NGDET
600    IF(JIN-JEUP)620,610,610
610    NLEVE(N+1)=1
       GO TO 630
620    NLEVE(N+1)=2
630    CONTINUE
       GO TO (710,640),KSUR
C COMPUTATIONS WHEN SURFACE ELEVATION VARIES WITH TIME.
640    RA = (ET+DT)/DSURF
       TSUR=T(JM,1)
       L = RA
       YSUR = SURF(L+1)+(RA-FLOAT(L))*(SURF(L+2)-SURF(L+1))
       DYS = (YSUR+YSURP)/2.0-EL(JM)
       IF (ABS(DYS)-DY/2.0)710,710,650
650    M = 1+IFIX((ABS(DYS)-DY/2.0)/DY)
       JM = JM+IFIX(SIGN(1.0,DYS))*M
       T(JM,1)=TSUR
       JMIXB = JM-MIXED
       P(25) = FLOAT(MIXED)*(B(JM)+B(JMIXB))
       IF (JM-50)660,660,670
660    JP = JM
       GO TO 680
670    JP = 50
680    IF (DYS)710,710,690
690    JJM = JM-M
       DO 700 I=1,M
       J = JM+1-I
700    CONTINUE
710    N=N+1
       NDO1=NDO1+1
```

Table 2.--*Listing of FORTRAN modeling program*--Continued

```
      ET = ET+DT
      MM=0
      DO 730 I=1,ITR
      IF (N-NTRAC(I))730,720,720
720   MM=MM+1
730   CONTINUE
      IF (MM)780,780,740
740   CONTINUE
C  NEW SURFACE CONCENTRATIONS DUE TO CHANGE IN SURFACE ELEVATION.
      DO 770 M=1,MM
      IF(JM-JXM)750,770,760
C  IF SURFACE FELL.
750   CC(M,JM,1)=2.0*CC(M,JM,1)+CC(M,JXM,1)*A(JXM)/A(JM)
      GO TO 770
760   CC(M,JXM,1)=0.5* CC(M,JXM,1)*A(JXM)/(A(JXM)+0.5*A(JM))
      CC(M,JM,1)=CC(M,JXM,1)
770   CONTINUE
C  THIS IS THE LAGTIME DETERMINATION.
780   CONTINUE
      JXM=JM
      QLIT=QQIN(N)*(1.0+RMIX)/B(JM)
      IF(JM-2-JIN)790,790,800
790   VELF=QLIT/THICK1
      JIN=JM
      XLAG=XL(JM)/VELF
      GO TO 830
800   RHOS=1.-(((T(JM,1)-3.9863)**2/508929.2)*(T(JM,1)+288.9414)/(T(JM,1
     1)+68.12963))
      DELRHO=ABS(RHOS-RHOI)
      GPRIME=GRAV*DELRHO
      GO TO (820,810),KAREA
810   SLOPE=(EL(JM)-EL(JIN))/(XL(JM)-XL(JIN))
820   CONTINUE
      DFLOW=(1.92)*(QLIT*VISCOS/GPRIME/SLOPE)**0.33
      VELF=QLIT/DFLOW
      HVELF=QLIT/THICK2
      SLDIST=FLOAT(JM-JIN)*DY/SLOPE
      XLAG=SLDIST/VELF+XL(JIN)/HVELF
830   LAGTIM(N)=XLAG/DT
C  END OF THE LAGTIME DETERMINATION.
      ML=N+LAGTIM(N)
      QIN(ML)=QIN(ML)+QQIN(N)
      TIN(ML)=(TIN(ML)*(QIN(ML)-QQIN(N))+TTIN(N)*QQIN(N))/QIN(ML)
      WRITE(6,840) N,LAGTIM(N)
840   FORMAT('LAGTIME(',I3,')=',I3)
      TP=0.0
      DO 850 J=JMIXB,JM
850   TP=TP+T(J,1)
      TP=TP/FLOAT(MIXED+1)
      TS=(TIN(N)+TP*RMIX)/(1.0+RMIX)
      RHOI=1.-(((TS-3.9863)**2/508929.2)*(TS+288.9414)/(TS+68.12963))
      DO 860 I=1,JM
      J = JM+1-I
      RHOR=1.-(((T(J,1)-3.9863)**2/508929.2)*(T(J,1)+288.9414)/(T(J,1)+
     168.12963))
      DLRHO=RHOR-RHOI
      IF(DLRHO.GT.0.) GO TO 870
860   CONTINUE
870   JIN=J+1
      IF(JIN-JM)890,880,880
880   JIN=JM
890   CONTINUE
      QQ=QIN(N)
```

Table 2.--*Listing of FORTRAN modeling program*--Continued

```
      F = TIN(N)
      QMIX=RMIX*QQ
      CALL SPEED(N)
      P(24) = TS
900   GJ = (FLXIN(N)+FLXIN(N+1))/ARF
C ASSURES THAT V*DT/DY LESS THAN UNITY FOR STABILITY.
      VVV=ABS(V(2,1))
      DO 920 J=3,JM
      IF(VVV-ABS(V(J,1)))910,920,920
910   VVV=ABS(V(J,1))
920   CONTINUE
      VM=DY/DTT
      IF(VVV-VM)940,930,930
930   DT=DY/VVV
      IDT=DTT/DT+1
      DT=DTT/IDT
      GO TO 950
940   IDT=1
C  END STABILITY CHECK.
950   DO 1180 M=1,IDT
      CALL SPEED(N)
C SUB SPEED COMPUTES WITHDRAWAL THICKNESS AND VELOCITIES AT EACH TIME ST
C  SUB XMIX CALCULATES COMPOSITION OF INFLOW.
      CALL XMIX(N)
C  SUB SPECAL CALCULATES DISTRIBUTION OF SPECIFIED INPUTS OF DO,BOD.
      CALL SPECAL(N)
      JMM=JM-1
      DO 1030 J=2,JMM
      DELTA=(1.0-BETA)*FLXIN(N)*(EXP(-ETA*(EL(JM)-EL(J)-DY/2.0))*A(J)-
     1EXP(-ETA*(EL(JM)-EL(J)+DY/2.0))*A(J-1))/A(J)/DY/HCAP/RHO
C  CHECKS DIRECTION OF VELOCITY TO ASSURE PROPER TEMPERATURE AND CONCENT
C  ASSIGNMENT.
      IF(V(J,1))960,960,990
960   IF(V(J+1,1))970,970,980
970   DELTB=(V(J,1)*T(J,1)*(A(J)+A(J-1))/2.0-V(J+1,1)*T(J+1,1)*(A(J+1)+
     1A(J))/2.0)/A(J)/DY
      GO TO 1020
980   DELTB=(V(J,1)*T(J,1)*(A(J)+A(J-1))/2.0-V(J+1,1)*T(J,1)*(A(J+1)+
     1A(J))/2.0)/A(J)/DY
      GO TO 1020
990   IF(V(J+1,1))1010,1010,1000
1000  DELTB=(V(J,1)*T(J-1,1)*(A(J)+A(J-1))/2.0-V(J+1,1)*T(J,1)*(A(J+1)+
     1A(J))/2.0)/A(J)/DY
      GO TO 1020
1010  DELTB=(V(J,1)*T(J-1,1)*(A(J)+A(J-1))/2.0-V(J+1,1)*T(J+1,1)*(A(J+1)
     1+A(J))/2.0)/A(J)/DY
1020  DELTE=(UI(J,1)*TS-UO(J,1)*T(J,1))*B(J)*DY/A(J)/DY
      DELTC=DD(1)*(T(J+1,1)+T(J-1,1)-2.0*T(J,1))/DY/DY
      DELTD=DD(1)*(T(J-1,1)-T(J+1,1))*(A(J-1)-A(J+1))/A(J)/DY/DY/4.0
      DELT=(DELTA+DELTB+DELTC+DELTD+DELTE)*DT
1030  T(J,2)=T(J,1)+DELT
      IF (V(JM,1))1050,1040,1040
1040  DELTJM=DT*((1.0-BETA)*FLXIN(N)*(A(JM)-EXP(-ETA*DY/2.0)*
     1A(JM-1))/A(JM)/DY*2.0/HCAP/RHO+
     2V(JM,1)*(T(JM-1,1)-T(JM,1))/DY*2.0+UI(JM,1)*(TS-T(JM,1))*B(JM)
     3/A(JM)-DD(1)*(T(JM,1)-T(JM-1,1))
     4 /DY/DY*2.0+(BETA*FLXIN(N)-FLXOUT(N))/RHO/HCAP/DY*2.0)
      GO TO 1060
1050  DELTJM=DT*((1.0-BETA)*FLXIN(N)*(A(JM)-EXP(-ETA*DY/2.0)*
     1A(JM-1))/A(JM)/DY*2.0/HCAP/RHO+UI(JM,1)*(TS-T(JM,1))*B(JM)
     2/A(JM)-DD(1)*(T(JM,1)-T(JM-1,1))
     3 /DY/DY*2.0+(BETA*FLXIN(N)-FLXOUT(N))/RHO/HCAP/DY*2.0)
1060  T(JM,2)=T(JM,1)+DELTJM
```

```
      FLUXOT=FLXOUT(N)
      IF(V(2,1))1080,1070,1070
1070  DELT1=DT*((1.0-BETA)*FLXIN(N)*EXP(-ETA*(EL(JM)-EL(1)-DY/2.0))
     1/RHO/HCAP-V(2,1)*T(1,1)*2.0/DY+(UI(1,1)*TS-UO(1,1)*T(1,1))*B(1
     2)/(A(1)+A(2))*2.0+DD(1)*(T(2,1)-T(1,1))/DY/DY*2.0
     3+(1.0-BETA)*FLXIN(N)*EXP(-ETA*(EL(JM)-EL(1)+DY/4.0))/DY/2.0/RHO/
     4HCAP)
      GO TO 1090
1080  DELT1=DT*((1.0-BETA)*FLXIN(N)*EXP(-ETA*(EL(JM)-EL(1)-DY/2.0))
     1/RHO/HCAP-V(2,1)*T(2,1)*2.0/DY+(UI(1,1)*TS-UO(1,1)*T(1,1))*B(1
     2)/(A(1)+A(2))*2.0+DD(1)*(T(2,1)-T(1,1))/DY/DY*2.0
     3+(1.0-BETA)*FLXIN(N)*EXP(-ETA*(EL(JM)-EL(1)+DY/4.0))/DY/2.0/RHO/
     4HCAP)
1090  T(1,2)=T(1,1)+DELT1
      GO TO (1100,1120),KAREA
1100  DO 1110 J=1,JM
      PHIM=0.79E-10*(T(J,1)+273.0)**4-AR
      DELT=(2.0*(XL(J)+B(J))*PHIM/RHO/HCAP/A(J))*DT
      FLUXOT=FLUXOT+PHIM*2.0*(XL(J)+B(J))*DT*DY
1110  T(J,2)=T(J,2)-DELT
1120  DO 1130 J=1,JM
1130  T(J,1)=T(J,2)
      YSURP = YSUR
C CHECK REASONABLENESS OF RESULTS.
      IF (ABS(T(JM,2))-100.0)1150,1140,1140
1140  TSTOP = ET
      GO TO 1210
C SUB AVER MIXES SURFACE LAYERS IN THE EVENT OF A SURFACE INSTABILITY.
1150  RHSS=1.-(((T(JM,2)-3.9863)**2/508929.2)*(T(JM,2)+288.9414)/(T(JM,2
     1)+68.12963))
      JZ=JM-1
      ROSS=1.-(((T(JZ,2)-3.9863)**2/508929.2)*(T(JZ,2)+288.9414)/(T(JZ,2
     1)+68.12963))
      IF(ROSS-RHSS)1160,1170,1170
1160  CONTINUE
C  SUB AVER PERFORMS CONVECTIVE MIXING OF TEMPERATURE IN MIXING LAYERS.
      CALL AVER(N)
C  SUB SPECAV PERFORMS CONVECTIVE MIXING OF SPECIFIED MATERIAL IN MIXING
      CALL SPECAV(N)
1170  CONTINUE
      CALL SPECOT(N)
C  SUB SPECOT CALCULATES PROPORTION OF SPECIFIED MATERIAL IN OUTFLOW.
      CONC(N)=COUT(1,N)
1180  CONTINUE
      DT=DTT
C  SUB TOUT CALCULATES OUTFLOW TEMPERATURE.
      CALL TOUT(YNT,YNT1)
      TOUTC = YNT/YNT1
      TEMPT(N)=TOUTC
      TOUTF = 1.8*TOUTC+32.0
      DO 1190 J=1,JM
      CP(J)=CC(1,J,2)
1190  CONTINUE
      DO 1200 I=1,NPLT
      IF(ET.EQ.DYPLT(I)) GO TO 1220
1200  CONTINUE
      IF(N-NPR)1320,1320,1210
1210  NPR = NPR+NPRINT
1220  CALL DBAPLT(T,EL,J,0,1)
      CALL DBAPLT(CP,EL,J,1,1)
      WRITE (6,1510) (WH(I),I=1,20)
      WRITE (6,1630) ET,YSUR,F
      WRITE (6,1640) N,EL(JM),TAIR
```

Table 2.--*Listing of FORTRAN modeling program*--Continued

```
      WRITE (6,1650) JM,EL(JIN),PSI
      F = FLXIN(N)
      WRITE (6,1660) JIN,EVAP,F
      QOU = QOUT(N)
      BBETA = QOU*BB
      WRITE (6,1750) BBETA,AR,WINDY
      QQ = QIN(N) .
      WRITE (6,1670) DIF,RAD,QQ
      WRITE (6,1680) DERIV,FLUXOT,QOU
      GO TO (1230,1250), KQ
1230  F = 2.0*HAFDEL
      WRITE (6,1690) EPSIL,F,SIGMAO
      WRITE (6,1700) UOMAX(1),UIMAX(1),TOUTC,TOUTF
      GO TO (1250,1240), KMIX
1240  WRITE (6,1740) TP,TS
1250  WRITE (6,1710)
      DO 1260 I=1,10
1260  WRITE (6,1720) (J,EL(J),T(J,1),J=I,JP,10)
      IF (JM-50)1320,1320,1270
1270  WRITE (6,1710)
      IF (JM-60)1280,1290,1290
1280  LL = JM
      GO TO 1300
1290  LL = 60
1300  DO 1310 I=51,LL
1310  WRITE (6,1720) (J,EL(J),T(J,1),J=I,JM,10)
1320  DO 1330 I=1,NPLT
      IF(ET.EQ.DYPLT(I)) GO TO 1341
1330  CONTINUE
      IF(NDOCA-NDO1)1450,1340,1450
1340  NDO1=0
1341  CONTINUE
      WRITE(6,1350) ET
1350  FORMAT(' ELAPSED TIME =',F10.5)
      WRITE(6,1360)
1360  FORMAT  (/5('    J     ELEV    CONCEN.'))
      DO 1370 I=1,10
1370  WRITE (6,1720) (J,EL(J),CC(1,J,2),  J=I,JP,10)
      IF(JM-50)1430,1430,1380
1380  IF(JM-60)1390,1400,1400
1390  LL=JM
      GO TO 1410
1400  LL=60
1410  WRITE(6,1360)
      DO 1420 I=51,LL
1420  WRITE (6,1720) (J,EL(J),CC(1,J,2),  J=I,JM,10)
1430  WRITE (6,1440) COUT(1,N)
1440  FORMAT(//' CONCENTRATION IN OUTFLOW IN PREVIOUS TIMESTEP =',F10.5)
1450  IF (ET-TSTOP)500,1460,1460
1460  CONTINUE
      NSTOP=TSTOP
      INC=NSTOP/5
      WRITE(6,1490)
      DO 1470 I=1,INC
1470  WRITE(6,1500) (IN,TEMPT(IN),CONC(IN), IN=I,NSTOP,INC)
      JJ=0
      DO 1480 I=1,100
      JJ=JJ+3
      XND(I)=FLOAT(JJ)
      TEMPT(I)=TEMPT(JJ)
      CONC(I)=CONC(JJ)
1480  CONTINUE
      CALL DBAPLT(XND,TEMPT,I,1,1)
```

```
      CALL DBAPLT(XND,CONC,I,1,1)
1490  FORMAT(/5(3X,'DAY',3X,'TEMP',3X,'CONC',2X))
1500  FORMAT(5(2X,I4,2F7.2,2X))
1510  FORMAT (20A4)
1520  FORMAT (16I5)
1530  FORMAT (8F10.5)
1540  FORMAT (F5.0,I5)
1550  FORMAT (6F10.5,2E10.3)
1560  FORMAT (' NUMBER OF GRID POINTS='I3,17X,'SURFACE ELEVATION='F7.2,
     118X,'DENSITY='E12.5)
1570  FORMAT (' OUTLET LEVEL='I3,  26X,'OUTLET ELEVATION='F8.2,18X,
     1'HEAT CAPACITY='F8.5)
1580  FORMAT (' DY='F6.2,33X,'BOTTOM ELEVATION='F8.2,18X,'ETA='F6.3)
1590  FORMAT (' DT='F6.2,33X,'INITIAL TEMPERATURE='F6.2,17X,'BETA='F5.2)
1600  FORMAT (' BRIAN BETA='F5.2,26X,'INFLOW STD. DEV.='F6.2,20X,'COEF.
     1OMEGA IN AREA FORMULA='E12.5)
1610  FORMAT (' STOP AT TIME='F7.2,22X,'OUTFLOW SPREAD CONST.='F5.2,16X,
     1'WIDTH AT Y=0 IN AREA FORMULA='E12.5)
1620  FORMAT (' KDIF='I2,15X,'KSUR='I2,13X,'KOH ='I2,15X,'KQ='I2,16X,
     1'KLOSS='I2,13X,'KAREA='I2/' EVAPORATION CONSTANT='E11.4,10X,
     2 'CONST IN EQN FOR OUTFLOW DELTA='F5.2,7X,'KMIX=',I2,2X,'INITIAL='
     3,I2,2X,'MULOUT=',I2)
1630  FORMAT (  ' ELAPSED TIME='F7.2,22X,'ACTUAL SURFACE ELEVATION='
     1F7.2,11X,'INFLOW TEMPERATURE='F6.2)
1640  FORMAT (' NO. OF TIME STEPS='I4,20X,'SURFACE ELEVATION USED='
     1F9.2,11X,'AIR TEMPERATURE='F6.2)
1650  FORMAT (' NO. OF GRID POINTS='I3,20X,'ELEVATION OF INFLOW='F7.2,
     116X,'RELATIVE HUMIDITY='F5.2)
1660  FORMAT (' LEVEL OF INFLOW='I3,23X,'EVAPORATION FLUX='E12.5,14X,
     1'INSOLATION FLUX='E12.5)
1670  FORMAT (' DIFFUSION COEFFICIENT='E12.5,8X,'RADIATION FLUX='E12.5,
     116X,'INFLOW RATE='F11.1)
1680  FORMAT (' OUTFLOW TEMP GRADIENT='F8.5,12X,'HEAT LOSS FLUX='E12.5,
     116X,'OUTFLOW RATE='F10.1)
1690  FORMAT (' EPSILON='E11.4,23X,'WITHDRAWAL THICKNESS='F7.2,15X,
     1'OUTFLOW STD. DEV.='F6.2)
1700  FORMAT (' MAX SINK VELOCITY='F9.3,15X,'MAX SOURCE VELOCITY='F9.3,
     112X,'$$OUTFLOW TEMPERATURE='F6.2,' C AND 'F6.2,' F.')
1710  FORMAT (/5('    J    ELEV    TEMP(C)'))
1720  FORMAT (5(I4,F7.1,F10.2,1X))
1730  FORMAT (' NO. GRID SPACES IN MIXED LAYER='I3,8X,'MIXING RATIO='
     1F5.2,25X,'AREA REDUCTION FACTOR='F5.2)
1740  FORMAT (' TEMP OF MIXING LAYER='F6.2,15X,'MIXED INFLOW TEMP='
     1F6.2)
1750  FORMAT (' BRIAN BETA='F5.2,26X,'ATMOSPHERIC RADIATION='E12.5,
     1 9X,'WIND SPEED='F5.2)
      CLOSE (6)
      CLOSE (7)
      STOP
      END
      SUBROUTINE  DBAPLT ( X, Y, N, LX, LY )
C     GENERAL SCALING AND POINT PLOTTING PROGRAM
C     X = VECTOR OF ABCISSA VALUES
C     Y = VECTOR OF ORDINATE VALUES
C     N = NUMBER OF POINTS
C     LX= SCALE OPTION FOR X-AXIS   L = 0 ; SCALE ZERO IS ACTUAL ZERO (MA
C     LY= SCALE OPTION FOR Y-AXIS   L = 1 ; SCALE ZERO UNRESTRICTED
C
C
      DIMENSION  X(N), Y(N), IA(101),IY(1000)
      DATA  NSTAR / '*' /
      DATA  IMINUS /'-'/
C     CHECK  N
```

Table 2.--*Listing of FORTRAN modeling program*--Continued

```
      IF ( N - 1 )720,720,10                                            DBAT0140
C    FIND MINIMA AND MAXIMA                                             DBAT0150
10    XHI = X(1)                                                        DBAT0160
      XLO = X(1)                                                        DBAT0170
      YHI = Y(1)                                                        DBAT0180
      YLO = Y(1)                                                        DBAT0190
      DO  90 I = 2, N                                                   DBAT0200
      IF ( Y(I) - YHI )30,30,20                                         DBAT0210
20    YHI = Y(I)                                                        DBAT0220
      GO TO 50                                                          DBAT0230
30    IF ( YLO - Y(I) )50,50,40                                         DBAT0240
40    YLO = Y(I)                                                        DBAT0250
50    IF ( X(I) - XHI )70,70,60                                         DBAT0260
60    XHI = X(I)                                                        DBAT0270
      GO TO 90                                                          DBAT0280
70    IF ( XLO - X(I) )90,90,80                                         DBAT0290
80    XLO = X(I)                                                        DBAT0300
90    CONTINUE                                                          DBAT0310
      WRITE ( 6,680 )                                                   DBAT0320
      WRITE ( 6,700 ) XHI, XLO, YHI, YLO                                DBAT0330
      DO  460 NC = 1, 2                                                 DBAT0340
C    DEVELOP SCALES                                                     DBAT0350
      GO TO (100,110 ), NC                                              DBAT0360
100   CHI = XHI                                                         DBAT0370
      CLO = XLO                                                         DBAT0380
      L = LX                                                            DBAT0390
      GO TO 120                                                         DABT0400
110   CHI = YHI                                                         DBAT0410
      CLO=YLO                                                           DBAT0420
        L=LY                                                            DBAT0430
120   J = 1                                                             DBAT0440
C    SET RANGE PARAMETERS                                               DBAT0450
      IF ( L - 1 )130,190,710                                           DBAT0460
130   IF ( CLO )140,190,170                                             DBAT0470
140   IF ( CHI )150,160,190                                             DBAT0480
150   R = CLO/CHI                                                       DBAT0490
      IF ( R - 2. )190,160,160                                          DBAT0500
160   CHI = -CLO                                                        DBAT0510
      J = 2                                                             DBAT0520
      GO TO 180                                                         DBAT0530
170   R = CHI/CLO                                                       DBAT0540
      IF ( R - 2. )190,180,180                                          DBAT0550
180   CLO = 0.                                                          DBAT0560
190   D = CHI - CLO                                                     DBAT0570
      L = 0                                                             DBAT0580
      IF ( D )710,740,210                                               DBAT0590
C    NORMALIZE RANGE TO BE BETWEEN 1 AND 10 AND STORE MULTIPLIER        DBAT0600
200    D = 10. * D                                                      DBAT0610
      L = 1 + L                                                         DBAT0620
210   IF ( D - 1.005 )200,240,230                                       DBAT0630
220   D = .1 * D                                                        DBAT0640
      L = L - 1                                                         DBAT0650
230   IF ( D - 10.05 )240,220,220                                       DBAT0660
C    CALCULATE SCALING FACTORS                                          DBAT0670
240   AULT = 10. ** L                                                   DBAT0680
250   SLO = CLO * AULT                                                  DBAT0690
      IF ( SLO )260,300,270                                             DBAT0700
260   SLO = SLO - 1.                                                    DBAT0710
270   ICLO = SLO                                                        DBAT0720
      SLO = ICLO                                                        DBAT0730
      D = CHI*AULT - SLO                                                DBAT0740
      GO TO (280,300 ), NC                                              DBAT0750
280   IF ( D - 10.05 )300,290,290                                       DBAT0760
```

Table 2.--*Listing of FORTRAN modeling program*--Continued

```
290   AULT = .1 * AULT
      GO TO 250
300   L = -L
      M = 1
      IF ( D - 10.05 )310,390,390
310   IF ( D - 5.025 )320,390,390
320   GO TO  (330,350 ), NC
330   IF ( D - 3.35 )340,380,380
340   IF ( D - 2.01 )360,360,370
350   IF ( D - 2.01 )360,380,380
360   M = 2 + M
370   M = 1 + M
380   M = 1 + M
390   FACT = 10 * M * ( 3 - 2*J )
C     PRINT SCALE INFORMATION AND CONVERT COORDINATES
      CLO = SLO
      WRITE ( 6,690 ) L, L
      IB = IMINUS * ( J-1 )
      GO TO  (440,400 ), NC
400   WRITE ( 6,630 ) SLO, IB, IB
      DO  410 I = 1, N
C     SCALE AND ROUND Y VECTOR AND CONVERT TO POSITIVE INTEGER
410   IY(I) = FACT * ( Y(I)*AULT - CLO ) + .5
      INC = 10 / M
      GO TO  (430,420 ), J
420   YHI = YLO
430   IYHI = FACT * ( YHI*AULT - CLO ) + .5
      GO TO  460
440   WRITE ( 6,620 ) SLO, IB, IB
C     SCALE AND ROUND X VECTOR TO POSITIVE VALUE 1. TO 101.
      DO  450 I = 1, N
450   X(I) = FACT * ( X(I) * AULT - CLO ) + 1.5
      RFACTX = 1. / FACT
      RAULTX = 1. / AULT
      CLOX = CLO
      K = M
460   CONTINUE
C     NOW PRINT THE GRAPH
C
C     PRINT THE TOP ABCISSA SCALE
470   GO TO  (480,490,500,710,510 ), K
480   WRITE ( 6,640 )
      GO TO 520
490   WRITE ( 6,650 )
      GO TO 520
500   WRITE ( 6,660 )
      GO TO 520
510   WRITE ( 6,670 )
520   IF ( J )710,590,530
530   L = 5 * ( IYHI/5 + 1 )
      IORD = INC * L
C     CLEAR THE PRINT LINE
540   DO 550 I = 1, 101
550   IA(I) = 0
      DO 570 I = 1, N
C     SEARCH FOR POINTS ON THIS LINE
      IF ( L - IY(I) )570,560,570
C     SET A CHARACTER IN POSITION
560   IX = X(I)
      IA(IX) = NSTAR
570   CONTINUE
C     PRINT THIS LINE
      WRITE ( 6,610 ) IORD, IA, IORD
```

```
      IORD = IORD - INC                                              DBAT1400
      L = L - 1                                                      DBAT1410
      IF ( L + 1 )710,580,540                                        DBAT1420
580   J = 0                                                          DBAT1430
C     PRINT THE LOWER ABCISSA SCALE                                  DBAT1440
      GO TO 470                                                      DBAT1450
C     APPLY INVERSE TRANSFORMATION TO RESTORE X VECTOR               DBAT1460
590   DO  600 I = 1, N                                               DBAT1470
600   X(I) = (( X(I) - 1.5 )*RFACTX + CLOX ) * RAULTX                DBAT1480
      RETURN                                                         DBAT1490
610   FORMAT ( I12, 101A1, I4 )                                      DBAT1500
620   FORMAT (11X,21HABCISSA  (X-AXIS)  0=,F8.2,3H * ,1A1,21H(10)   SCADBAT1510
     1LE UNIT= ,1A1,4H(10)/ )                                        DBAT1520
630   FORMAT (11X,21HORDINATE (Y-AXIS)  0=,F8.2,3H * ,1A1,21H(10)  100 ODBAT1530
     1N SCALE= ,1A1,4H(10)/ )                                        DBAT1540
640   FORMAT (12X,40H0++++*++++1++++*++++2++++*++++3++++*++++,40H4++++*+DBAT1550
     1+++5++++*++++6++++*++++7++++*++++,21H8++++*++++9++++*++++0 )   DBAT1560
650   FORMAT(12X,40H0 + + + + * + + + + 1 + + + + * + + + + ,40H2 + + + DBAT1570
     1+ * + + + + 3 + + + + * + + + + ,21H4 + + + + * + + + + 5 )    DBAT1580
660   FORMAT(12X,40H0  +  +  +  +  *  +  +  +  +  1  +  +  +,40H  +  *  DBAT1590
     1+  +  +  +  2  +  +  +  +  *  + ,21H +  +  +  3  +  +  +  )    DBAT1600
670   FORMAT(12X,40H0++++*++++*++++*++++*++++V++++*++++*++++,40H*++++*++DBAT1610
     1++1++++*++++*++++*++++*++++V++++,21H*++++*++++*++++*++++2 )    DBAT1620
680   FORMAT ('1      XMAX              XMIN              YMAX              YMIN')DBAT1630
690   FORMAT ( 47X, I3, 19X, I3 )                                    DBAT1640
700   FORMAT ( 4( 4X, E11.4 ) / )                                    DBAT1650
710   STOP                                                           DBAT1660
720   WRITE ( 6,730 ) N                                              DBAT1670
      RETURN                                                         DBAT1680
730   FORMAT ( 'OTHE ROUTINE CAN''T WORK ON', I8, '  POINTS' )       DBAT1690
740   WRITE ( 6,750 )                                                DBAT1700
      RETURN                                                         DBAT1710
750   FORMAT ( 'OAT LEAST ONE COORDINATE IS CONSTANT. NO SCALING IS POSSDBAT1720
     1IBLE')                                                         DBAT1730
      END                                                            DBAT1750
      FUNCTION FLXOUT(N)                                             FLXT0010
C CALCULATION OF SURFACE LOSSES DUE TO EVAPORATION, CONDUCTION, AND RADIFLXT0020
      COMMON T(70,2),EL(70),XL(70),A(70),TI(366),TA(366),SIGH(366)   FLXT0030
      COMMON FIN(366),WIND(366),DD(366),QI(366),QO(366),P(50),NPR    FLXT0040
      COMMON UOMAX(2),UIMAX(2),DTTI,DTTA,DTSIGH,DTFIN,DTWIND,DTDD,DTQI  FLXT0050
      COMMON DTQO,JM,JOUT,JIN,KDIF,KSUR,KOH,KQ,KLOSS,YSUR,YOUT,DT,DY FLXT0060
      COMMON TSTOP,EVPCON,OMEGA,BZ,SPREAD,SIGMAI,SIGMAO,ETADY,TVARI  FLXT0070
      COMMON TVARO,EVAP,RAD,TAIR,PSI,DERIV,HAFDEL,EPSIL,GJ           FLXT0080
      COMMON YBOT,NN,BETA,DAJM,DELCON,V( 70,1),UI( 70,1),DTT         FLXT0090
      COMMON RHO,HCAP,KMIX,RMIX,JMIXB,MIXED,QMIX,KAREA,DATRAD,ATRAD(366)FLXT0100
      COMMON AR,WINDY,CO,CI,B( 70),S( 70),EX( 70),EXO( 70),ARF,UO( 70,1)FLXT0110
      COMMON QIN(366),TIN(366),CC(20,70,2),CCC(20,366),COUT(20,366)  FLXT0120
      COMMON CCT(20,366),QQMIX(70),XINF(70),OUTF(70),MIXH,MM         FLXT0130
      COMMON SURF(366),GRAV,SLOPE,VISCOS,LAGTIM(366)                 FLXT0140
      COMMON PMASOT(20),PMASIN(20),ET,NTRAC(20),ITR,ISTO,ISO1,ISO2   FLXT0150
      COMMON ISTON,ISTO1,THICK1,THICK2,DOXLE(70,20),DO(366),BOD(366) FLXT0160
      COMMON NLEVE(366),VOL,NW,NDET,Z,Z1,DDOC,NGDET,DBOD,JEUP        FLXT0170
      COMMON NBOUND,NGRID,NCONTR                                     FLXT0180
      COMMON KATRAD,DCLOUD,NCLOUD,CLOUD(366)                         FLXT0190
      COMMON DPT(366),DYPLT(16),NPLT,IDAY,NDAY,ELMAX,XLAT,DDPL,RG,KSLRADFLXT0200
C KLOSS = 1 FOR LABORATORY USING ROHWER FORMULA.                     FLXT0210
C         2 FOR FIELD USING KOHLER FORMULA.                          FLXT0220
C         3 FOR FIELD USING ROHWER FORMULA.                          FLXT0230
      TVARO = 1.0                                                    FLXT0240
      ET=DTT*FLOAT(N)                                                FLXT0250
      R = ET/DTTA                                                    FLXT0260
      L = R                                                          FLXT0270
      RR = R-FLOAT(L)                                                FLXT0280
```

Table 2.--*Listing of FORTRAN modeling program*--Continued

```
      TAIR = TA(L+1)+RR*(TA(L+2)-TA(L+1))
      R = ET/DTSIGH
      L = R
      RR = R-FLOAT(L)
      PSI = SIGH(L+1)+RR*(SIGH(L+2)-SIGH(L+1))
      TS = T(JM,1)
      H = 597.3-0.56*TS
C PARABOLIC APPROXIMATION FOR VAPOR PRESSURES IN MM HG.
      ES = 0.0418*TS*TS-0.6216*TS+13.0068
      EA = PSI*(0.0418*TAIR*TAIR-0.6216*TAIR+13.0068)
      DE = ES-EA
      GO TO (10,20,20), KLOSS
C CALCULATIONS FOR LABORATORY USE ROHWER FORMULA.
10    CHI = RHO*(H*DE+TS*HCAP*DE+269.1*(TS-TAIR))
      EVAP = CHI*EVPCON
C UNITS OF RADIATION ARE CAL/CM-CM-MIN.
      AR = 0.7888E-10    *(TAIR+273.16)**4
      RAD = 0.7888E-10    *(273.16+TS)**4-AR
      W = 0.0
      P(30) = EVAP+RAD
      FLXOUT = P(30)
      RETURN
C FOR FIELD DATA, WIND SPEED IS IN M/SEC.
20    R = ET/DTWIND
      L = R
      W = WIND(L+1)+(R-FLOAT(L))*(WIND(L+2)-WIND(L+1))
      WINDY=W
C FOR FIELD, ATMOSPHERIC RADIATION IS INCLUDED AS AN INPUT TO PROGRAM.
C CALCULATION OF ATMOSPHERIC RADIATION
C UNIT OF RADIATION ARE KCAL/M-M-DAY
      GO TO (30,40),KATRAD
30    R=ET/DATRAD
      L = R
      AR = ATRAD(L+1)+(R-FLOAT(L))*(ATRAD(L+2)-ATRAD(L+1))
      RAD = 1.13587E-6*(TS+273.16)**4-AR
      GO TO 50
C ATMOSPHERIC RADIATION IS CALCULATED HERE
40    R=ET/DCLOUD
      L=R
      CL=CLOUD(L+1)+(R-FLOAT(L))*(CLOUD(L+2)-CLOUD(L+1))
      AR=(0.937E-5*(TAIR+273.16)**6*(1.0+0.17*CL**2))*1.13587E-6
      RAD=1.13587E-6*((TS+273.16)**4-0.937E-5*(TAIR+273.16)**6*(1.0+0.17
     1*CL**2))
50    GO TO (10,60,70), KLOSS
C CALCULATION OF FIELD EVAPORATION USING KOHLER FORMULA.
C VAPOR PRESSURES IN MB.
60    DE = DE/0.750062
      EVAP=EVAPCON*W*DE
      EVAPE=(RHO*(H+(HCAP*TS)))*EVAP
      P(30)=EVAPE+RAD
      FLXOUT = P(30)/ARF
      RETURN
C CALCULATION OF FIELD EVAPORATION USING ROHWER FORMULA.
70    CHI = RHO*(H*DE+TS*HCAP*DE+269.1*(TS-TAIR))
      FW = 0.0308+0.0185*W
      EVAP = CHI*FW*EVPCON
      P(30) = EVAP+RAD
      FLXOUT = P(30)/ARF
      RETURN
      END
      SUBROUTINE TOUT(YNT,YNT1)
C COMPUTE WEIGHTED AVERAGE OF OUTFLOW TEMPERATURE.
C USE COMPUTED INSTEAD OF GIVEN OUTFLOW RATE FOR YNT1.
```

```
C YNT1 WILL BE GREATER THAN QOUT FOR NARROW WITHDRAWAL LAYERS.          TOUT0040
C HENCE, USE SAME METHOD TO CALCULATE Q IN BOTH YNT AND YNT1.           TOUT0050
C CALCULATED TOUT =YNT/YNT1.                                            TOUT0060
C UNITS OF RADIATION ARE KCAL/M-M-DAY.                                  TOUT0070
      COMMON T(70,2),EL(70),XL(70),A(70),TI(366),TA(366),SIGH(366)      TOUT0080
      COMMON FIN(366),WIND(366),DD(366),QI(366),QO(366),P(50),NPR       TOUT0090
      COMMON UOMAX(2),UIMAX(2),DTTI,DTTA,DTSIGH,DTFIN,DTWIND,DTDD,DTQI  TOUT0100
      COMMON DTQO,JM,JOUT,JIN,KDIF,KSUR,KOH,KQ,KLOSS,YSUR,YOUT,DT,DY    TOUT0110
      COMMON TSTOP,EVPCON,OMEGA,BZ,SPREAD,SIGMAI,SIGMAO,ETADY,TVARI     TOUT0120
      COMMON TVARO,EVAP,RAD,TAIR,PSI,DERIV,HAFDEL,EPSIL,GJ              TOUT0130
      COMMON YBOT,NN,BETA,DAJM,DELCON,V( 70,1),UI( 70,1),DTT            TOUT0140
      COMMON RHO,HCAP,KMIX,RMIX,JMIXB,MIXED,QMIX,KAREA,DATRAD,ATRAD(366)TOUT0150
      COMMON AR,WINDY,CO,CI,B( 70),S( 70),EX( 70),EXO( 70),ARF,UO( 70,1)TOUT0160
      COMMON QIN(366),TIN(366),CC(20,70,2),CCC(20,366),COUT(20,366)     TOUT0170
      COMMON CCT(20,366),QQMIX(70),XINF(70),OUTF(70),MIXH,MM            TOUT0180
      COMMON SURF(366),GRAV,SLOPE,VISCOS,LAGTIM(366)                    TOUT0190
      COMMON PMASOT(20),PMASIN(20),ET,NTRAC(20),ITR,ISTO,ISO1,ISO2      TOUT0200
      COMMON ISTON,ISTO1,THICK1,THICK2,DOXLE(70,20),DO(366),BOD(366)    TOUT0210
      COMMON NLEVE(366),VOL,NW,NDET,Z,Z1,DDOC,NGDET,DBOD,JEUP           TOUT0220
      COMMON NBOUND,NGRID,NCONTR                                        TOUT0230
      COMMON KATRAD,DCLOUD,NCLOUD,CLOUD(366)                            TOUT0240
      COMMON DPT(366),DYPLT(16),NPLT,IDAY,NDAY,ELMAX,XLAT,DDPL,RG,KSLRADTOUT0250
      YNT = 0.0                                                         TOUT0260
      YNT1 = 0.0                                                        TOUT0270
      JUM = JM                                                          TOUT0280
      M = JM-1                                                          TOUT0290
      IF ((M+1)/2-M/2)10,20,10                                          TOUT0300
10    YNT = 1.5*(T(JM,1)*B(JM)*EXO(JM)+T(JM-1,1)*B(JM-1)*EXO(JM-1))     TOUT0310
      YNT1 = 1.5*(B(JM)*EXO(JM)+B(JM-1)*EXO(JM-1))                      TOUT0320
      JUM = JM-1                                                        TOUT0330
20    YNT = YNT+T(1,1)*B(1)*EXO(1)-T(JUM,1)*B(JUM)*EXO(JUM)             TOUT0340
      YNT1 = YNT1+B(1)*EXO(1)-B(JUM)*EXO(JUM)                           TOUT0350
      M = JUM-1                                                         TOUT0360
      DO 30 J=2,M,2                                                     TOUT0370
      YNT = YNT+4.0*T(J,1)*B(J)*EXO(J)+2.0*T(J+1,1)*B(J+1)*EXO(J+1)     TOUT0380
30    YNT1 = YNT1+4.0*B(J)*EXO(J)+2.0*B(J+1)*EXO(J+1)                   TOUT0390
      YNT = YNT*DY/3.0                                                  TOUT0400
      YNT1 = YNT1*DY/3.0                                                TOUT0410
      RETURN                                                            TOUT0420
      END                                                               TOUT0430
      SUBROUTINE SPEED(N)                                               SPED0010
C COMPUTATION OF VERTICAL AND SOURCE AND SINK VELOCITIES.               SPED0020
C ALSO, COMPUTATION OF WITHDRAWAL THICKNESS.                            SPED0030
C SOURCE AND SINK VELOCITIES ARE ASSUMED TO HAVE GAUSSIAN DISTRIBUTION. SPED0040
C VARIABLE WIDTH ACCOUNTED FOR IN CALCULATIONS BY ASSUMING EXP DISTRIBUTSPED0050
C FORMUAL USED FOR WIDTH IS B(Y) = BZ*EXP(OMEGA*Y).                     SPED0060
C APPROXIMATION FORMULA (FUNCT PROB) USED TO EVALUATE PROBABILITY INTEGRSPED0070
      COMMON T(70,2),EL(70),XL(70),A(70),TI(366),TA(366),SIGH(366)      SPED0080
      COMMON FIN(366),WIND(366),DD(366),QI(366),QO(366),P(50),NPR       SPED0090
      COMMON UOMAX(2),UIMAX(2),DTTI,DTTA,DTSIGH,DTFIN,DTWIND,DTDD,DTQI  SPED0100
      COMMON DTQO,JM,JOUT,JIN,KDIF,KSUR,KOH,KQ,KLOSS,YSUR,YOUT,DT,DY    SPED0110
      COMMON TSTOP,EVPCON,OMEGA,BZ,SPREAD,SIGMAI,SIGMAO,ETADY,TVARI     SPED0120
      COMMON TVARO,EVAP,RAD,TAIR,PSI,DERIV,HAFDEL,EPSIL,GJ              SPED0130
      COMMON YBOT,NN,BEAT,DAJM,DELCON,V( 70,1),UI( 70,1),DTT            SPED0140
      COMMON RHO,HCAP,KMIX,RMIX,JMIXB,MIXED,QMIX,KAREA,DATRAD,ATRAD(366)SPED0150
      COMMON AR,WINDY,CO,CI,B( 70),S( 70),EX( 70),EXO( 70),ARF,UO( 70,1)SPED0160
      COMMON QIN(366),TIN(366),CC(20,70,2),CCC(20,366),COUT(20,366)     SPED0170
      COMMON CCT(20,366),QQMIX(70),XINF(70),OUTF(70),MIXH,MM            SPED0180
      COMMON SURF(366),GRAV,SLOPE,VISCOS,LAGTIM(366)                    SPED0190
      COMMON PMASOT(20),PMASIN(20),ET,NTRAC(20),ITR,ISTO,ISO1,ISO2      SPED0200
      COMMON ISTON,ISTO1,THICK1,THICK2,DOXLE(70,20),DO(366),BOD(366)    SPED0210
      COMMON NLEVE(366),VOL,NW,NDET,Z,Z1,DDOC,NGDET,DBOD,JEUP           SPED0220
      COMMON NBOUND,NGRID,NCONTR                                        SPED0230
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Table 2.--*Listing of FORTRAN modeling program*--Continued

```
      COMMON KATRAD,DCLOUD,NCLOUD,CLOUD(366)                            SPED0240
      COMMON DPT(366),DYPLT(16),NPLT,IDAY,NDAY,ELMAX,XLAT,DDPL,RG,KSLRADSPED0250
C COMPUTE WITHDRAWAL THICKNESS.                                         SPED0260
C NOTE THAT ONLY HALF THE WITHDRAWAL THICKNESS IS COMPUTED.             SPED0270
      DERIV = (T(JOUT+1,1)-T(JOUT-1,1))/2.0/DY                          SPED0280
C  CRITERION FOR EXISTANCE OF A WITHDRAWAL LAYER.                       SPED0290
      IF(DERIV-0.001)10,10,40                                           SPED0300
10    JOUT1=JOUT+2                                                      SPED0310
      DO 20 J=JOUT1,JM                                                  SPED0320
      IF((T(J+1,1)-T(J,1))/DY-.001)20,30,30                             SPED0330
20    CONTINUE                                                          SPED0340
      SIGMAO=100.0*DY                                                   SPED0350
      GO TO 100                                                         SPED0360
30    HAFDEL=FLOAT(J-JOUT)*DY                                           SPED0370
      SIGMAO=HAFDEL/SPREAD                                              SPED0380
      GO TO 100                                                         SPED0390
40    EPSIL=2.*ABS(T(JOUT,1)-4.)/(151000.-ABS(T(JOUT,1)-4.)**2)*DERIV   SPED0400
      GO TO (60,50), KOH                                                SPED0410
C CALCULATION OF WITHDRAWAL THICKNESS USING KAO FORMULA.                SPED0420
50    QPUW = (QOUT(N)+QOUT(N+1))*0.5/B(JOUT)                            SPED0430
      HAFDEL = DELCON*SQRT(QPUW)/EPSIL**0.25                            SPED0440
      GO TO 70                                                          SPED0450
C CALCULATION OF WITHDRAWAL THICKNESS USING KOH FORMULA.                SPED0460
60    HAFDEL = DELCON/EPSIL**0.1666667                                  SPED0470
70    SIGMAO = HAFDEL/SPREAD                                            SPED0480
      IF(SIGMAO)80,80,90                                                SPED0490
80    SIGMAO=1.0                                                        SPED0500
90    CONTINUE                                                          SPED0510
100   TVARO = 2.0*SIGMAO*SIGMAO                                         SPED0520
      OMSOSQ = SIGMAO*SIGMAO*OMEGA                                      SPED0530
C FIRST COMPUTE MAXIMUM VELOCITIES, THEN OTHERS.                        SPED0540
      XXI = PROB(YBOT,EL(JIN)+P(31),SIGMAI)                             SPED0550
      XXO = PROB(YBOT,YOUT+OMSOSQ,SIGMAO)                               SPED0560
      GO TO (110,140), KAREA                                            SPED0570
110   IF (YSUR-YOUT-2.58*SIGMAO)150,150,120                             SPED0580
120   IF (YOUT-YBOT-2.58*SIGMAO)150,130,130                             SPED0590
130   UOMAX(1) = QOUT(N)/SIGMAO*CO                                      SPED0600
      GO TO 160                                                         SPED0610
140   CO = P(32)*EXP(-P(33)*SIGMAO*SIGMAO-P(34))                        SPED0620
150   XO = CO/SIGMAO/(PROB(EL(JM),YOUT+OMSOSQ,SIGMAO)-XXO)              SPED0630
      UOMAX(1) = QOUT(N)*XO                                             SPED0640
      GO TO (160,180),KAREA                                             SPED0650
160   IF (EL(JM)-EL(JIN)-2.58*SIGMAI)180,180,170                        SPED0660
170   UIMAX(1) = QIN(N)/SIGMAI*CI                                       SPED0670
      GO TO 230                                                         SPED0680
180   IF(JM-JIN)190,190,220                                             SPED0690
C  THIS IS THE UNIFORM VELOCITY DISTRIBUTION IF THE FLOW IS SURFACE FLOWSPED0700
C  ISTO IS THE NUMBER OF GRID POINTS BELOW SURFACE INTO WHICH FLOW WILL SPED0710
190   ISTO=THICK1/DY-0.5                                                SPED0720
      ISTON=JM-ISTO-1                                                   SPED0730
      DO 200 I=1,ISTON                                                  SPED0740
200   UI(I,1)=0.                                                        SPED0750
      ISTO1=ISTON+1                                                     SPED0760
      DO 210 I=ISTO1,JM                                                 SPED0770
      UI(I,1)=QIN(N)/(ISTO+.5)/DY/B(I)  *(1.0+RMIX)                     SPED0780
210   CONTINUE                                                          SPED0790
      GO TO 250                                                         SPED0800
220   CI = P(35)*EXP(-EL(JIN)*OMEGA)                                    SPED0810
      P(22) = SIGMAI/CI                                                 SPED0820
      XI = CI/SIGMAI/(PROB(EL(JM),EL(JIN)+P(31),SIGMAI)-XXI)            SPED0830
      UIMAX(1) = QIN(N)*XI                                              SPED0840
230   GO TO (250,240), KMIX                                             SPED0850
240   UIMAX(1) = UIMAX(1)*(1.0+RMIX)                                    SPED0860
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      YY = QIN(N)*RMIX/P(25)                                          SPED0870
      ZZ = QMIX/P(25)                                                 SPED0880
250   SAO = SIGMAO/CO                                                 SPED0890
C COMPUTE VERTICAL ADVECTIVE VELOCITY AND SOURCE VELOCITY.             SPED0900
      DO 280 J=1,JM                                                   SPED0910
      XO = SAO*(PROB(EL(J),YOUT+OMSOSQ,SIGMAO)-XXO)                   SPED0920
      IF(JM-JIN)270,270,260                                           SPED0930
260   XI = P(22)*(PROB(EL(J),EL(JIN)+P(31),SIGMAI)-XXI)               SPED0940
      I = IABS(J-JIN)+1                                               SPED0950
      UI(J,1) = UIMAX(1)*EX(I)                                        SPED0960
270   CONTINUE                                                        SPED0970
280   CONTINUE                                                        SPED0980
C COMPUTE EXPONENTIAL PART OF SINK VELOCITY FOR USE IN SUB TOUT AND FUNCSPED0990
      IF (JM-2*JOUT+1)290,290,300                                     SPED1000
290   LUP = JOUT-1                                                    SPED1010
      LDN = JM-JOUT                                                   SPED1020
      IS = -1                                                         SPED1030
      GO TO 310                                                       SPED1040
300   LUP = JM-JOUT                                                   SPED1050
      LDN = JOUT-1                                                    SPED1060
      IS = 1                                                          SPED1070
310   EXO(JOUT) = 1.0                                                 SPED1080
      DO 360 I=1,LUP                                                  SPED1090
      J = JOUT+IS*I                                                   SPED1100
      ARG = S(I+1)/TVARO                                              SPED1110
      IF (ARG-20.0)320,330,330                                        SPED1120
320   EXO(J) = EXP(-ARG)                                              SPED1130
      GO TO 340                                                       SPED1140
330   EXO(J)=0.0                                                      SPED1150
340   IF (I-LDN)350,350,360                                           SPED1160
350   JJ = JOUT-IS*I                                                  SPED1170
      EXO(JJ) = EXO(J)                                                SPED1180
360   CONTINUE                                                        SPED1190
      IF(JM-JIN)370,370,400                                           SPED1200
370   ISO2=JM-ISTO                                                    SPED1210
      ISO1=ISO2-1                                                     SPED1220
      DO 380 J=1,ISO1                                                 SPED1230
380   UO(J,1) =UOMAX(1)*EXO(J)                                        SPED1240
      DO 390 J=ISTO1,JM                                               SPED1250
      UO(J,1)=UOMAX(1)*EXO(J)                                         SPED1260
390   CONTINUE                                                        SPED1270
400   DO 440 J=1,JM                                                   SPED1280
      GO TO (430,410),KMIX                                            SPED1290
410   IF(J-JMIXB)430,420,420                                          SPED1300
420   QQMIX(J)=QIN(N)*RMIX/(MIXED+1)                                  SPED1310
      UO(J,1)=QQMIX(J)/B(J)/DY                                        SPED1320
      IF(J.EQ.JM) UO(JM,1)=2.0*UO(J,1)                                SPED1330
      GO TO 440                                                       SPED1340
430   UO(J,1)=0.0                                                     SPED1350
440   UO(J,1)=UO(J,1)+UOMAX(1)*EXO(J)                                 SPED1360
      CONTINUE                                                        SPED1370
      V(1,1)=0.0                                                      SPED1380
      V(2,1)=(UI(1,1)-UO(1,1))*B(1)*DY/(A(1)+A(2))                    SPED1390
      JMX=JM+1                                                        SPED1400
      DO 450 J=3,JMX                                                  SPED1410
      V(J,1)=(V(J-1,1)*(A(J-2)+A(J-1))/2.0+(UI(J-1,1)-UO(J-1,1))*B(J-1) SPED1420
     1*DY)/(A(J)+A(J-1))*2.0                                          SPED1430
450   CONTINUE                                                        SPED1440
      RETURN                                                          SPED1450
      END                                                             SPED1460
      SUBROUTINE AVER(N)                                              AVER0010
C PERFORMS CONVECTIVE MIXING OF SURFACE LAYERS.                       AVER0020
      COMMON T(70,2),EL(70),XL(70),A(70),TI(366),TA(366),SIGH(366)    AVER0030
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Table 2.--*Listing of FORTRAN modeling program*--Continued

```
      COMMON FIN(366),WIND(366),DD(366),QI(366),QO(366),P(50),NPR       AVER0040
      COMMON UOMAX(2),UIMAX(2),DTTI,DTTA,DTSIGH,DTFIN,DTWIND,DTDD,DTQI  AVER0050
      COMMON DTQO,JM,JOUT,JIN,KDIF,KSUR,KOH,KQ,KLOSS,YSUR,YOUT,DT,DY    AVER0060
      COMMON TSTOP,EVPCON,OMEGA,BZ,SPREAD,SIGMAI,SIGMAO,ETADY,TVARI     AVER0070
      COMMON TVARO,EVAP,RAD,TAIR,PSI,DERIV,HAFDEL,EPSIL,GJ              AVER0080
      COMMON YBOT,NN,BETA,DAJM,DELCON,V( 70,1),UI( 70,1),DTT            AVER0090
      COMMON RHO,HCAP,KMIX,RMIX,JMIXB,MIXED,QMIX,KAREA,DATRAD,ATRAD(366)AVER0100
      COMMON AR,WINDY,CO,CI,B( 70),S( 70),EX( 70),EXO( 70),ARF,UO( 70,1)AVER0110
      COMMON QIN(366),TIN(366),CC(20,70,2),CCC(20,366),COUT(20,366)     AVER0120
      COMMON CCT(20,366),QQMIX(70),XNIF(70),OUTF(70),MIXH,MM            AVER0130
      COMMON SURF(366),GRAV,SLOPE,VISCOS,LAGTIM(366)                    AVER0140
      COMMON PMASOT(20),PMASIN(20),ET,NTRAC(20),ITR,ISTO,ISO1,ISO2      AVER0150
      COMMON ISTON,ISTO1,THICK1,THICK2,DOXLE(70,20),DO(366),BOD(366)    AVER0160
      COMMON NLEVE(366),VOL,NW,NDET,Z,Z1,DDOC,NGDET,DBOD,JEUP           AVER0170
      COMMON NBOUND,NGRID,NCONTR                                        AVER0180
      COMMON KATRAD,DCLOUD,NCLOUD,CLOUD(366)                            AVER0190
      COMMON DPT(366),DYPLT(16),NPLT,IDAY,NDAY,ELMAX,XLAT,DDPL,RG,KSLRADAVER0200
      DIMENSION VV(70),W(70),WH(20),TT(70),AA(70),XXL(70),C3(70)        AVER0210
      AV1=0.0                                                           AVER0220
      AV2=0.0                                                           AVER0230
      JMM=JM-1                                                          AVER0240
      DO 110 I=1,JMM                                                    AVER0250
      J=JM-I+1                                                          AVER0260
      JJ=J-1                                                            AVER0270
      IF(T(J,1)-T(JJ,1))10,100,100                                      AVER0280
10    CONTINUE                                                          AVER0290
      IF(J-2)20,20,30                                                   AVER0300
20    T(2,1)=(T(2,1)*A(2)+T(1,1)*A(1)/2.0)/(A(2)+A(1)/2.0)              AVER0310
      T(1,1)=T(2,1)                                                     AVER0320
      GO TO 100                                                         AVER0330
30    DO 70 K=1,JJ                                                      AVER0340
      KJ=J+1-K                                                          AVER0350
      KJJ=KJ-1                                                          AVER0360
      IF(JM-KJ)40,40,50                                                 AVER0370
40    FAC=0.5                                                           AVER0380
      GO TO 60                                                          AVER0390
50    FAC=1.0                                                           AVER0400
60    AV1=AV1+T(KJ,1)*A(KJ)*FAC                                         AVER0410
      AV2=AV2+A(KJ)*FAC                                                 AVER0420
      TAV=AV1/AV2                                                       AVER0430
      IF(TAV-T(KJJ,1))70,80,80                                          AVER0440
70    CONTINUE                                                          AVER0450
80    IF(J.EQ.JM) MIXH=K                                                AVER0460
      DO 90 L=KJ,J                                                      AVER0470
90    T(L,1)=TAV                                                        AVER0480
100   AV1=0.0                                                           AVER0490
      AV2=0.0                                                           AVER0500
110   CONTINUE                                                          AVER0510
      RETURN                                                            AVER0520
      END                                                               AVER0530
      FUNCTION PROB(Y,YAV,SIG)                                          PROB0010
C COMPUTES AREA UNDER NORMAL ERROR CURVE BY RATIONAL APPROXIMATION.     PROB0020
      XX = (Y-YAV)/SIG                                                  PROB0030
      X = ABS(XX)                                                       PROB0040
      IF(X-10.0)20,20,10                                                PROB0050
10    X=10.0                                                            PROB0060
20    XT = 1.0/(1.0+0.33267*X)                                          PROB0070
      XA = EXP(-X*X/2.0)*0.398423                                       PROB0080
      XA = XA*(0.4361836*XT-0.1201676*XT*XT+0.937298*XT**3)             PROB0090
      IF (XX)30,30,40                                                   PROB0100
30    PROB = XA                                                         PROB0110
      RETURN                                                            PROB0120
40    PROB= 1.0-XA                                                      PROB0130
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      RETURN
      END
      FUNCTION TTIN(N)
C COMPUTE INFLOW TEMPERATURE FROM READ IN VALUES.
C LINEAR INTERPOLATION BETWEEN READ IN VALUES.
      COMMON T(70,2),EL(70),XL(70),A(70),TI(366),TA(366),SIGH(366)
      COMMON FIN(366),WIND(366),DD(366),QI(366),QO(366),P(50),NPR
      COMMON UOMAX(2),UIMAX(2),DTTI,DTTA,DTSIGH,DTFIN,DTWIND,DTDD,DTQI
      COMMON DTQO,JM,JOUT,JIN,KDIF,KSUR,KOH,KQ,KLOSS,YSUR,YOUT,DT,DY
      COMMON TSTOP,EVPCON,OMEGA,BZ,SPREAD,SIGMAI,SIGMAO,ETADY,TAVRI
      COMMON TVARO,EVAP,RAD,TAIR,PSI,DERIV,HAFDEL,EPSIL,GJ
      COMMON YBOT,NN,BETA,DAJM,DELCON,V( 70,1),UI( 70,1),DTT
      COMMON RHO,HCAP,KMIX,RMIX,JMIXB,MIXED,QMIX,KAREA,DATRAD,ATRAD(366)
      COMMON AR,WINDY,CO,CI,B( 70),S( 70),EX( 70),EXO( 70),ARF,UO( 70,1)
      COMMON QIN(366),TIN(366),CC(20,70,2),CCC(20,366),COUT(20,366)
      COMMON CCT(20,366),QQMIX(70),XINF(70),OUTF(70),MIXH,MM
      COMMON SURF(366),GRAV,SLOPE,VISCOS,LAGTIM(366)
      COMMON PMASOT(20),PMASIN(20),ET,NTRAC(20),ITR,ISTO,ISO1,ISO2
      COMMON ISTON,ISTO1,THICK1,THICK2,DOXLE(70,20),DO(366),BOD(366)
      COMMON NLEVE(366),VOL,NW,NDET,Z,Z1,DDOC,NGDET,DBOD,JEUP
      COMMON NBOUND,NGRID,NCONTR
      COMMON KATRAD,DCLOUD,NCLOUD,CLOUD(366)
      COMMON DPT(366),DYPLT(16),NPLT,IDAY,NDAY,ELMAX,XLAT,DDPL,RG,KSLRAD
      ET=DTT*FLOAT(N)
      R = ET/DTTI
      L = R
      RR = R-FLOAT(L)
      TTIN=TI(L+1)+RR*(TI(L+2)-TI(L+1))
      RETURN
      END
      FUNCTION FLXIN(N)
C COMPUTE INCOMING SOLAR RADIATION FROM READ IN VALUES.
C READ IN VALUES TREATED AS A STEP FUNCTION.
      COMMON T(70,2),EL(70),XL(70),A(70),TI(366),TA(366),SIGH(366)
      COMMON FIN(366),WIND(366),DD(366),QI(366),QO(366),P(50),NPR
      COMMON UOMAX(2),UIMAX(2),DTTI,DTTA,DTSIGH,DTFIN,DTWIND,DTDD,DTQI
      COMMON DTQO,JM,JOUT,JIN,KDIF,KSUR,KOH,KQ,KLOSS,YSUR,YOUT,DT,DY
      COMMON TSTOP,EVPCON,OMEGA,BZ,SPREAD,SIGMAI,SIGMAO,ETADY,TVARI
      COMMON TVARO,EVAP,RAD,TAIR,PSI,DERIV,HAFDEL,EPSIL,GJ
      COMMON YBOT,NN,BETA,DAJM,DELCON,V( 70,1),UI( 70,1),DTT
      COMMON RHO,HCAP,KMIX,RMIX,JMIXB,MIXED,QMIX,KAREA,DATRAD,ATRAD(366)
      COMMON AR,WINDY,CO,CI,B( 70),S( 70),EX( 70),EXO( 70),ARF,UO( 70,1)
      COMMON QIN(366),TIN(366),CC(20,70,2),CCC(20,366),COUT(20,366)
      COMMON CCT(20,366),QQMIX(70),XNIF(70),OUTF(70),MIXH,MM
      COMMON SURF(366),GRAV,SLOPE,VISCOS,LAGTIM(366)
      COMMON PMASOT(20),PMASIN(20),ET,NTRAC(20),ITR,ISTO,ISO1,ISO2
      COMMON ISTON,ISTO1,THICK1,THICK2,DOXLE(70,20),DO(366),BOD(366)
      COMMON NLEVE(366),VOL,NW,NDET,Z,Z1,DDOC,NGDET,DBOD,JEUP
      COMMON NBOUND,NGRID,NCONTR
      COMMON KATRAD,DCLOUD,NCLOUD,CLOUD(366)
      COMMON DPT(366),DYPLT(16),NPLT,IDAY,NDAY,ELMAX,XLAT,DDPL,RG,KSLRAD
      IF(KSLRAD.EQ.2) GO TO 10
      ET=DTT*FLOAT(N)
      R = ET/DTFIN
      L = R
      FLXIN = FIN(L+1)
      RETURN
10    CONTINUE
C COMPUTE DEW POINT FROM RELATIVE HUMIDITY,AIR TEMPERATURE
      J=N+IDAY
      IF(TA(N).LT.0.)GO TO 20
      EA=SIGH(N)* EXP(2.3026*((7.5*TA(N))/(TA(N)+237.3)+0.7858))
      DPT(J)=(237.3*(ALOG10(EA)-0.7858))/(7.5+0.7858-ALOG10(EA))
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Table 2.--*Listing of FORTRAN modeling program*--Continued

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      GO TO 30                                                          FLXN0340
20    EA=SIGH(N)* EXP(2.3026*((9.5*TA(N))/(TA(N)+265.5)+0.7858))       FLXN0350
      DPT(J)=(265.5*(ALOG10(EA)-0.7858))/(9.5+0.7858-ALOG10(EA))        FLXN0360
30    CONTINUE                                                          FLXN0370
C COMPUTE SOLAR RADIATION                                               FLXN0380
      X12=XLAT*3.14159/180.                                             FLXN0390
      X1= SIN(X12)                                                      FLXN0400
      X2= COS(X12)                                                      FLXN0410
      X3=((288.-6.5E-3*ELMAX)/288.)**5.256                              FLXN0420
C ENTER DAY LOOP                                                        FLXN0430
      SSOL=0.                                                           FLXN0440
C ATMOSPHERIC WATER CONTENT                                             FLXN0450
      W=0.85* EXP(0.11+6.14E-2*DPT(J))                                  FLXN0460
      X186MN=186-J                                                      FLXN0470
C DISTANCE EARTH-SUN                                                    FLXN0480
      R=1.+1.7E-2* COS(3.14159*X186MN/182.5)                            FLXN0490
      X172MN=172-J                                                      FLXN0500
      CO=0.40928* COS(3.14159*X172MN/182.5)                             FLXN0510
      C9=1164./R**2                                                     FLXN0520
C COMPUTE HOUR ANGLE OF SUNSET                                          FLXN0530
      XJ1=-X1* SIN(CO)/(X2* COS(CO))                                    FLXN0540
      IF(XJ1.EQ..0)GO TO 40                                             FLXN0550
      XJ2= SQRT(1.-XJ1**2)                                              FLXN0560
      XJ3= ATAN2(XJ2,XJ1)*180./3.14159                                  FLXN0570
      IF(XJ3.GT.0.)GO TO 50                                             FLXN0580
      TO=180.+XJ3                                                       FLXN0590
      GO TO 60                                                          FLXN0600
40    TO=90                                                             FLXN0610
      GO TO 60                                                          FLXN0620
50    TO=XJ3                                                            FLXN0630
60    TO=TO*4./60.                                                      FLXN0640
      NTO=TO                                                            FLXN0650
C ENTER HOUR LOOP TO INTEGRATE SOLAR RADIATION OVER SUNSHINE DURATION   FLXN0660
      DO 120 I=1,NTO                                                    FLXN0670
      XIMOP5=I-0.5                                                      FLXN0680
C SINUS OF SOLAR ALTITUDE                                               FLXN0690
      SINA=X1* SIN(CO)+X2* COS(CO)* COS(XIMOP5*3.14159/12.)             FLXN0700
      A7= ATAN2(SINA, SQRT(1.-SINA**2))*180./3.14159                    FLXN0710
C OPTICAL AIR MASS AFTER KASTEN                                         FLXN0720
      XM7=X3/(SINA+0.15*(1./(A7+3.885)**1.253))                         FLXN0730
C ATMOSPHERIC TRANSMISSION AFTER KIMBALL USING ORLOB-SELNA FORMULAS     FLXN0740
      A1= EXP(-(.465+.134*W)*(.129+.171* EXP(-.88*XM7))*XM7)            FLXN0750
      A2= EXP(-(.465+.134*W)*(.179+.421* EXP(-.721*XM7))*XM7)           FLXN0760
      A3=A2+(1.-A1-DDPL)/2.                                             FLXN0770
      A0=A3/(1.-RG*0.5*(1.-A1+DDPL))                                    FLXN0780
C SOLAR RADIATION REACHING THE SURFACE                                  FLXN0790
      X=C9*SINA*A0                                                      FLXN0800
      IF(CLOUD(N).EQ.0.)GO TO 70                                        FLXN0810
      IF(CLOUD(N).LT.0.5)GO TO 80                                       FLXN0820
      IF(CLOUD(N).LT.0.9)GO TO 90                                       FLXN0830
      IF(CLOUD(N).EQ.1.)GO TO 100                                       FLXN0840
C TOTAL SOLAR RADIATION REFLECTIVITY AFTER ANDERSON                     FLXN0850
70    RO=1.-1.18*(1./A7**(0.77))                                        FLXN0860
      GO TO 110                                                         FLXN0870
80    RO=1.-2.2*(1./A7**(0.97))                                         FLXN0880
      GO TO 110                                                         FLXN0890
90    RO=1.-0.95*(1./A7**(0.75))                                        FLXN0900
      GO TO 110                                                         FLXN0910
100   RO=1.-0.33*(1./A7**(0.45))                                        FLXN0920
110   SOL=X*RO                                                          FLXN0930
      SSOL=SSOL+SOL                                                     FLXN0940
120   CONTINUE                                                          FLXN0950
      RSOL=0.5*(TO-NTO)*SOL                                             FLXN0960
```

Table 2.--*Listing of FORTRAN modeling program*--Continued

```
      SSOL=SSOL+RSOL
C DAILY TOTAL SOLAR RADIATION ENTERING THE WATER SURFACE IN KCAL/M**2-DA
      FIN(N)=SSOL*(1.-0.65*(CLOUD(N)/10.)**2)*2.
      FLXIN=FIN(N)
      RETURN
      END
      FUNCTION QQIN(N)
C COMPUTE INFLOW RATE FROM READ IN VALUES.
C READ IN VALUES TREATED AS A STEP FUNCTION.
      COMMON T(70,2),EL(70),XL(70),A(70),TI(366),TA(366),SIGH(366)
      COMMON FIN(366),WIND(366),DD(366),QI(366),QO(366),P(50),NPR
      COMMON UOMAX(2),UIMAX(2),DTTI,DTTA,DTSIGH,DTFIN,DTWIND,DTDD,DTQI
      COMMON DTQO,JM,JOUT,JIN,KDIF,KSUR,KOH,KQ,KLOSS,YSUR,YOUT,DT,DY
      COMMON TSTOP,EVPCON,OMEGA,BZ,SPREAD,SIGMAI,SIGMAO,ETADY,TVARI
      COMMON TVARO,EVAP,RAD,TAIR,PSI,DERIV,HAFDEL,EPSIL,GJ
      COMMON YBOT,NN,BETA,DAJM,DELCON,V( 70,1),UI( 70,1),DTT
      COMMON RHO,HCAP,KMIX,RMIX,JMIXB,MIXED,QMIX,KAREA,DATRAD,ATRAD(366)
      COMMON AR,WINDY,CO,CI,B( 70),S( 70),EX( 70),EXO( 70),ARF,UO( 70,1)
      COMMON QIN(366),TIN(366),CC(20,70,2),CCC(20,366),COUT(20,366)
      COMMON CCT(20,366),QQMIX(70),XINF(70),OUTF(70),MIXH,MM
      COMMON SURF(366),GRAV,SLOPE,VISCOS,LAGTIM(366)
      COMMON PMASOT(20),PMASIN(20),ET,NTRAC(20),ITR,ISTO,ISO1,ISO2
      COMMON ISTON,ISTO1,THICK1,THICK2,DOXLE(70,20),DO(366),BOD(366)
      COMMON NLEVE(366),VOL,NW,NDET,Z,Z1,DDOC,NGDET,DBOD,JEUP
      COMMON NBOUND,NGRID,NCONTR
      COMMON KATRAD,DCLOUD,NCLOUD,CLOUD(366)
      COMMON DPT(366),DYPLT(16),NPLT,IDAY,NDAY,ELMAX,XLAT,DDPL,RG,KSLRAD
      ET=DTT*FLOAT(N)
      R = ET/DTQI
      L = R
      QQIN=QI(L+1)
      RETURN
      END
      FUNCTION QOUT(N)
C COMPUTE OUTFLOW RATE FROM READ IN VALUES.
C READ IN VALUES TREATED AS A STEP FUNCTION.
      COMMON T(70,2),EL(70),XL(70),A(70),TI(366),TA(366),SIGH(366)
      COMMON FIN(366),WIND(366),DD(366),QI(366),QO(366),P(50),NPR
      COMMON UOMAX(2),UIMAX(2),DTTI,DTTA,DTSIGH,DTFIN,DTWIND,DTDD,DTQI
      COMMON DTQO,JM,JOUT,JIN,KDIF,KSUR,KOH,KQ,KLOSS,YSUR,YOUT,DT,DY
      COMMON TSTOP,EVPCON,OMEGA,BZ,SPREAD,SIGMAI,SIGMAO,ETADY,TVARI
      COMMON TVARO,EVAP,RAD,TAIR,PSI,DERIV,HAFDEL,EPSIL,GJ
      COMMON YBOT,NN,BETA,DAJM,DELCON,V( 70,1),UI( 70,1),DTT
      COMMON RHO,HCAP,KMIX,RMIX,JMIXB,MIXED,QMIX,KAREA,DATRAD,ATRAD(366)
      COMMON AR,WINDY,CO,CI,B( 70),S( 70),EX( 70),EXO( 70),ARF,UO( 70,1)
      COMMON QIN(366),TIN(366),CC(20,70,2),CCC(20,366),COUT(20,366)
      COMMON CCT(20,366),QQMIX(70),XINF(70),OUTF(70),MIXH,MM
      COMMON SURF(366),GRAV,SLOPE,VISCOS,LAGTIM(366)
      COMMON PMASOT(20),PMASIN(20),ET,NTRAC(20),ITR,ISTO,ISO1,ISO2
      COMMON ISTON,ISTO1,THICK1,THICK2,DOXLE(70,20),DO(366),BOD(366)
      COMMON NLEVE(366),VOL,NW,NDET,Z,Z1,DDOC,NGDET,DBOD,JEUP
      COMMON NBOUND,NGRID,NCONTR
      COMMON KATRAD,DCLOUD,NCLOUD,CLOUD(366)
      COMMON DPT(366),DYPLT(16),NPLT,IDAY,NDAY,ELMAX,XLAT,DDPL,RG,KSLRAD
      ET=DTT*FLOAT(N)
      R = ET/DTQO
      L = R
      QOUT = QO(L+1)
      RETURN
      END
      FUNCTION D(J,N)
C COMPUTE DIFFUSIVITY FROM READ IN VALUES.
C ANY ASSUMED VARIATION OF THE DIFFUSIVITY MAY BE PROGRAMMED IN THIS FUN
```

Table 2.--*Listing of FORTRAN modeling program*--Continued

```
C HERE, A CONSTANT VALUE OF D IS ASSUMED.
      COMMON T(70,2),EL(70),XL(70),A(70),TI(366),TA(366),SIGH(366)
      COMMON FIN(366),WIND(366),DD(366),QI(366),QO(366),P(50),NPR
      COMMON UOMAX(2),UIMAX(2),DTTI,DTTA,DTSIGH,DTFIN,DTWIND,DTDD,DTQI
      COMMON DTQO,JM,JOUT,JIN,KDIF,KSUR,KOH,KQ,KLOSS,YSUR,YOUT,DT,DY
      COMMON TSTOP,EVPCON,OMEGA,BZ,SPREAD,SIGMAI,SIGMAO,ETADY,TVARI
      COMMON TVARO,EVAP,RAD,TAIR,PSI,DERIV,HAFDEL,EPSIL,GJ
      COMMON YBOT,NN,BETA,DAJM,DELCON,V( 70,1),UI( 70,1),DTT
      COMMON RHO,HCAP,KMIX,RMIX,JMIXB,MIXED,QMIX,KAREA,DATRAD,ATRAD(366)
      COMMON AR,WINDY,CO,CI,B( 70),S( 70),EX( 70),EXO( 70),ARF,UO( 70,1)
      COMMON QIN(366),TIN(366),CC(20,70,2),CCC(20,366),COUT(20,366)
      COMMON CCT(20,366),QQMIX(70),XINF(70),OUTF(70),MIXH,MM
      COMMON SURF(366),GRAV,SLOPE,VISCOS,LAGTIM(366)
      COMMON PMASOT(20),PMASIN(20),ET,NTRAC(20),ITR,ISTO,ISO1,ISO2
      COMMON ISTON,ISTO1,THICK1,THICK2,DOXLE(70,20),DO(366),BOD(366)
      COMMON NLEVE(366),VOL,NW,NDET,Z,Z1,DDOC,NGDET,DBOD,JEUP
      COMMON NBOUND,NGRID,NCONTR
      COMMON KATRAD,DCLOUD,NCLOUD,CLOUD(366)
      COMMON DPT(366),DYPLT(16),NPLT,IDAY,NDAY,ELMAX,XLAT,DDPL,RG,KSLRAD
      D = DD(1)
      RETURN
      END
      SUBROUTINE XMIX(N)
C   CALCULATION OF COMPOSITION OF INFLOW
      COMMON T(70,2),EL(70),XL(70),A(70),TI(366),TA(366),SIGH(366)
      COMMON FIN(366),WIND(366),DD(366),QI(366),QO(366),P(50),NPR
      COMMON UOMAX(2),UIMAX(2),DTTI,DTTA,DTSIGH,DTFIN,DTWIND,DTDD,DTQI
      COMMON DTQO,JM,JOUT,JIN,KDIF,KSUR,KOH,KQ,KLOSS,YSUR,YOUT,DT,DY
      COMMON TSTOP,EVPCON,OMEGA,BZ,SPREAD,SIGMAI,SIGAMO,ETADY,TVARI
      COMMON TVARO,EVAP,RAD,TAIR,PSI,DERIV,HAFDEL,EPSIL,GJ
      COMMON YBOT,NN,BETA,DAJM,DELCON,V( 70,1),UI( 70,1),DTT
      COMMON RHO,HCAP,KMIX,RMIX,JMIXB,MIXED,QMIX,KAREA,DATRAD,ATRAD(366)
      COMMON AR,WINDY,CO,CI,B( 70),S( 70),EX( 70),EXO( 70),ARF,UO( 70,1)
      COMMON QIN(366),TIN(366),CC(20,70,2),CCC(20,366),COUT(20,366)
      COMMON CCT(20,366),QQMIX(70),XINF(70),OUTF(70),MIXH,MM
      COMMON SURF(366),GRAV,SLOPE,VISCOS,LAGTIM(366)
      COMMON PMASOT(20),PMASIN(20),ET,NTRAC(20),ITR,ISTO,ISO1,ISO2
      COMMON ISTON,ISTO1,THICK1,THICK2,DOXLE(70,20),DO(366),BOD(366)
      COMMON NLEVE(366),VOL,NW,NDET,Z,Z1,DDOC,NGDET,DBOD,JEUP
      COMMON NBOUND,NGRID,NCONTR
      COMMON KATRAD,DCLOUD,NCLOUD,CLOUD(366)
      COMMON DPT(366),DYPLT(16),NPLT,IDAY,NDAY,ELMAX,XLAT,DDPL,RG,KSLRAD
      XQ=QIN(N)*(1.0+RMIX)
      IF(XQ.EQ.0.0) GO TO 140
      JMIXB=JM-MIXED
      JMM=JM-1
      GO TO (10,150),NGDET
C  PULSE INJECTION CALCULATION.
10    IF(MM)50,50,20
20    CONTINUE
      DO 40 M=1,MM
      YQ=0.0
      DO 30 I=JMIXB,JM
30    YQ=YQ+QQMIX(I)*CC(M,I,1)
      CONTINUE
40    CCC(M,N)=YQ/XQ
50    CONTINUE
      IF(N-40)70,70,60
60    NX=40
      GO TO 80
70    NX=N
80    DO 130 I=1,NX
      NLM=N+1-I
```

Table 2.--*Listing of FORTRAN modeling program*--Continued

```
      IF(N-(NLM+LAGTIM(NLM)))130,90,130                                 XMIX0420
90    IF(MM)130,130,100                                                 XMIX0430
100   DO 120 M=1,ITR                                                    XMIX0440
      IF(NLM-NTRAC(M))120,110,120                                       XMIX0450
110   CCC(M,N)=QQIN(NLM)/XQ +YQ/XQ                                      XMIX0460
      CONTINUE                                                          XMIX0470
120   CONTINUE                                                          XMIX0480
130   CONTINUE                                                          XMIX0490
140   CONTINUE                                                          XMIX0500
      RETURN                                                            XMIX0510
C  DO,BOD CALCULATION.                                                  XMIX0520
150   MM=2                                                              XMIX0530
      YQ=QQMIX(JM)*CC(1,JM,1)                                           XMIX0540
      YQQ=QQMIX(JM)*CC(2,JM,1)                                          XMIX0550
      DO 160 J=JMIXB,JMM                                                XMIX0560
      YQ=YQ+QQMIX(J)*CC(1,J,1)                                          XMIX0570
160   YQQ=YQQ+CC(2,J,1)*QQMIX(J)                                        XMIX0580
      CCC(1,N)=YQ/XQ                                                    XMIX0590
      CCC(2,N)=YQQ/XQ                                                   XMIX0600
      IF(N-60)180,180,170                                               XMIX0610
170   NX=60                                                             XMIX0620
      GO TO 190                                                         XMIX0630
180   NX=N                                                              XMIX0640
190   CONTINUE                                                          XMIX0650
      DO 210 I=1,NX                                                     XMIX0660
      NLM=N+1-I                                                         XMIX0670
      IF(N-(NLM+LAGTIM(NLM)))210,200,210                                XMIX0680
200   CCC(1,N)=CCC(1,N)+QQIN(NLM)*DDO(NLM)/XQ                           XMIX0690
      CCC(2,N)=CCC(2,N)+QQIN(NLM)*BBOD(NLM)/XQ                          XMIX0700
210   CONTINUE                                                          XMIX0710
      RETURN                                                            XMIX0720
      END                                                               XMIX0730
      SUBROUTINE SPECAL(N)                                              SPEL0010
C    CALCULATION OF DISTRIBUTION OF SPECIFIED INPUTS                    SPEL0020
      COMMON T(70,2),EL(70),XL(70),A(70),TI(366),TA(366),SIGH(366)      SPEL0030
      COMMON FIN(366),WIND(366),DD(366),QI(366),QA(366),P(50),NPR       SPEL0040
      COMMON UOMAX(2),UIMAX(2),DTTI,DTTA,DTSIGH,DTFIN,DTWIND,DTDD,DTQI  SPEL0050
      COMMON DTQO,JM,JOUT,JIN,KDIF,KSUR,KOH,KQ,KLOSS,YSUR,YOUT,DT,DY    SPEL0060
      COMMON TSTOP,EVPCON,OMEGA,BZ,SPREAD,SIGMAI,SIGMAO,ETADY,TVARI     SPEL0070
      COMMON TVARO,EVAP,RAD,TAIR,PSI,DERIV,HAFDEL,EPSIL,GJ              SPEL0080
      COMMON YBOT,NN,BETA,DAJM,DELCON,V( 70,1),UI( 70,1),DTT            SPEL0090
      COMMON RHO,HCAP,KMIX,RMIX,JMIXB,MIXED,QMIX,KAREA,DATRAD,ATRAD(366)SPEL0100
      COMMON AR,WINDY,CO,CI,B( 70),S( 70),EX( 70),EXO( 70),ARF,UO( 70,1)SPEL0110
      COMMON QIN(366),TIN(366),CC(20,70,2),CCC(20,366),COUT(20,366)     SPEL0120
      COMMON CCT(20,366),QQMIX(70),XINF(70),OUTF(70),MIXH,MM            SPEL0130
      COMMON SURF(366),GRAV,SLOPE,VISCOS,LAGTIM(366)                    SPEL0140
      COMMON PMASOT(20),PMASIN(20),ET,NTRAC(20),ITR,ISTO,ISO1,ISO2      SPEL0150
      COMMON ISTON,ISTO1,THICK1,THICK2,DOXLE(70,20),DO(366),BOD(366)    SPEL0160
      COMMON NLEVE(366),VOL,NW,NDET,Z,Z1,DDOC,NGDET,DBOD,JEUP           SPEL0170
      COMMON NBOUND,NGRID,NCONTR                                        SPEL0180
      COMMON KATRAD,DCLOUD,NCLOUD,CLOUD(366)                            SPEL0190
      COMMON DPT(366),DYPLT(16),NPLT,IDAY,NDAY,ELMAX,XLAT,DDPL,RG,KSLRADSPEL0200
      DOSA=0.0                                                          SPEL0210
      JMM=JM-1                                                          SPEL0220
      DO 30 I=2,JMM                                                     SPEL0230
      IF(V(I,1))10,10,20                                                SPEL0240
10    OUTF(I)=(UO(I,1)*B(I)*DY-V(I,1)*(A(I)+A(I-1))/2.0)*DT             SPEL0250
      XINF(I)=-V(I+1,1)*(A(I)+A(I+1))/2.0*DT                            SPEL0260
      CONTINUE                                                          SPEL0270
      GO TO 30                                                          SPEL0280
20    OUTF(I)=(UO(I,1)*B(I)*DY+V(I+1,1)*(A(I)+A(I+1))/2.0)*DT           SPEL0290
      XINF(I)=V(I,1)*(A(I)+A(I-1))/2.0*DT                               SPEL0300
      CONTINUE                                                          SPEL0310
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30     CONTINUE                                                          SPEL0320
       IF(MM)420,420,40                                                  SPEL0330
40     CONTINUE                                                          SPEL0340
       DO 410 M=1,MM                                                     SPEL0350
       DO 210 I=2,JMM                                                    SPEL0360
       CONST1=0.0                                                        SPEL0370
       CONST2=0.0                                                        SPEL0380
       GO TO (120,50),NGDET                                              SPEL0390
50     CONTINUE                                                          SPEL0400
       GO TO (120,60),NCONTR                                             SPEL0410
60     IF(I -JEUP)80,80,70                                               SPEL0420
70     CONST1=0.0                                                        SPEL0430
       CONST2=0.0                                                        SPEL0440
       GO TO 120                                                         SPEL0450
80     IF(M-1)90,90,100                                                  SPEL0460
90     CONST1=Z                                                          SPEL0470
       CONST2=Z1                                                         SPEL0480
       GO TO 110                                                         SPEL0490
100    CONST1=Z                                                          SPEL0500
       CONST2=0.0                                                        SPEL0510
110    CONTINUE                                                          SPEL0520
120    CONTINUE                                                          SPEL0530
       IF(V(I,1))130,130,160                                             SPEL0540
130    IF(V(I+1,1))140,140,150                                           SPEL0550
140    CC(M,I,2)=(CC(M,I,1)*A(I)*DY-OUTF(I)*CC(M,I,1)+CCC(M,N)*UI(I,1)*  SPEL0560
      1DT*B(I)*DY+XINF(I)*CC(M,I+1,1))/A(I)/DY-CONST1*CC(2,I,1)*DT       SPEL0570
       GO TO 190                                                         SPEL0580
150    CC(M,I,2)=(CC(M,I,1)*A(I)*DY-OUTF(I)*CC(M,I,1)+CCC(M,N)*UI(I,1)*  SPEL0590
      1DT*B(I)*DY+XINF(I)*CC(M,I,1))/A(I)/DY -CONST1*CC(2,I,1)*DT        SPEL0600
       GO TO 190                                                         SPEL0610
160    IF(V(I+1,1))180,180,170                                           SPEL0620
170    CC(M,I,2)=(CC(M,I,1)*A(I)*DY-OUTF(I)*CC(M,I,1)+CCC(M,N)*UI(I,1)*  SPEL0630
      1DT*B(I)*DY+XINF(I)*CC(M,I-1,1))/A(I)/DY -CONST1*CC(2,I,1)*DT      SPEL0640
       GO TO 190                                                         SPEL0650
180    CC(M,I,2)=(CC(M,I,1)*A(I)*DY-UO(I,1)*B(I)*DY*DT*CC(M,I,1)         SPEL0660
      1-V(I+1,1)*(A(I)+A(I+1))/2.0*DT*CC(M,I+1,1)+CCC(M,N)*UI(I,1)*      SPEL0670
      2DT*B(I)*DY+XINF(I)*CC(M,I-1,1))/A(I)/DY -CONST1*CC(2,I,1)*DT      SPEL0680
190    IF (CC(M,I,2) -0.1E-30)200,200,210                                SPEL0690
200    CC(M,I,2)=0.0                                                     SPEL0700
210    CONTINUE                                                          SPEL0710
C  CALCULATION ON SURFACE LAYER.                                         SPEL0720
       GO TO(270,220), NGDET                                             SPEL0730
220    CONTINUE                                                          SPEL0740
       GO TO(270,230),NCONTR                                             SPEL0750
230    J=JM                                                              SPEL0760
       DOSA=14.4776-0.3579*T(J,1)+0.0043*(T(J,1)**2)                     SPEL0770
       CONST1=0.0                                                        SPEL0780
       IF(M-1)240,240,250                                                SPEL0790
240    CONST2=Z1                                                         SPEL0800
       GO TO 260                                                         SPEL0810
250    CONST2=0.0                                                        SPEL0820
260    CONTINUE                                                          SPEL0830
270    CONTINUE                                                          SPEL0840
       IF(V(JM,1))280,280,290                                            SPEL0850
280    CC(M,JM,2)=(CC(M,JM,1)*A(JM)*DY/2.0-(UO(JM,1)*B(JM)*DY/2.0*CC(M,JMSPEL0860
      1,1)-CCC(M,N)*UI(JM,1)*B(JM)*DY/2.0-V(JM,1)*(A(JM)+A(JM-1))/2.0*   SPEL0870
      2CC(M,JM,1))*DT)/A(JM)/DY*2.0     -CONST1*CC(2,JM,1)*DT            SPEL0880
      3 +CONST2*(DOSA-CC(1,JM,1))*DT                                     SPEL0890
       GO TO 300                                                         SPEL0900
290    CC(M,JM,2)=(CC(M,JM,1)*A(JM)*DY/2.0-(UO(JM,1)*B(JM)*DY/2.0*CC(M,JMSPEL0910
      1,1)-CCC(M,N)*UI(JM,1)*B(JM)*DY/2.0-V(JM,1)*(A(JM)+A(JM-1))/2.0*   SPEL0920
      2CC(M,JM-1,1))*DT)/A(JM)/DY*2.0 -CONST1*CC(2,JM,1)*DT              SPEL0930
      3 +CONST2*(DOSA-CC(1,JM,1))*DT                                     SPEL0940
```

Table 2.--*Listing of FORTRAN modeling program*--Continued

```
300   GO TO (340,310), NGDET                                           SPEL0950
310   CONTINUE                                                         SPEL0960
      IF(M-1)320,320,330                                               SPEL0970
320   CONST1=Z                                                         SPEL0980
      CONST2=Z1                                                        SPEL0990
      GO TO 340                                                        SPEL1000
330   CONST1=Z                                                         SPEL1010
      CONST2=0.0                                                       SPEL1020
C  CALCULATION ON BOTTOM LAYER.                                        SPEL1030
340   IF(V(2,1))350,350,360                                            SPEL1040
350   CC(M,1,2)=(CC(M,1,1)*A(1)*DY/2.0-(UO(1,1)*B(1)*DY/2.0*CC(M,1,1)- SPEL1050
     1CCC(M,N)*UI(1,1)*B(1)*DY/2.0+V(2,1)*(A(1)+A(2))/2.0*CC(M,2,1))*DT)SPEL1060
     2/A(1)/DY/0.5 -CONST1*CC(2,1,1)*DT                                SPEL1070
      GO TO 370                                                        SPEL1080
360   CC(M,1,2)=(CC(M,1,1)*A(1)*DY/2.0-(UO(1,1)*B(1)*DY/2.0*CC(M,1,1)- SPEL1090
     1CCC(M,N)*UI(1,1)*B(1)*DY/2.0+V(2,1)*(A(1)+A(2))/2.0*CC(M,1,1))*DT)SPEL1100
     2/A(1)/DY*2.0 -CONST1*CC(2,1,1)*DT                                SPEL1110
370   CONTINUE                                                         SPEL1120
      IF(CC(M,JM,2)-0.1E-30)380,380,390                                SPEL1130
380   CC(M,JM,2)=0.0                                                   SPEL1140
390   CONTINUE                                                         SPEL1150
      IF(CC(M,1,2) -0.1E-30)400,400,410                                SPEL1160
400   CC(M,1,2)=0.0                                                    SPEL1170
410   CONTINUE                                                         SPEL1180
420   CONTINUE                                                         SPEL1190
      GO TO (540,430),NGDET                                            SPEL1200
430   CONTINUE                                                         SPEL1210
      GO TO (540,440),NCONTR                                           SPEL1220
440   DO 480 J=1,JM                                                    SPEL1230
      DOSA=14.4776-0.3579*T(J,2)+0.0043*(T(J,2)**2)                    SPEL1240
      IF(CC(1,J,2))450,450,460                                         SPEL1250
450   CC(1,J,2)=0.                                                     SPEL1260
      GO TO 480                                                        SPEL1270
460   IF(CC(1,J,2)-DOSA)480,480,470                                    SPEL1280
470   CC(1,J,2)=DOSA                                                   SPEL1290
480   CONTINUE                                                         SPEL1300
C  SURFACE ASSUMPTION FOR DO.                                          SPEL1310
      GO TO (490,510,540),NBOUND                                       SPEL1320
490   DO 500 J=JEUP,JM                                                 SPEL1330
      DOSA=14.4776-0.3579*T(J,2)+0.0043*(T(J,2)**2)                    SPEL1340
500   CC(1,J,2)=DOSA                                                   SPEL1350
      GO TO 530                                                        SPEL1360
510   KCALC=JM-NGRID                                                   SPEL1370
      DO 520 J=KCALC,JM                                                SPEL1380
      DOSA=14.4776-0.3579*T(J,2)+0.0043*(T(J,2)**2)                    SPEL1390
520   CC(1,J,2)=DOSA                                                   SPEL1400
530   CONTINUE                                                         SPEL1410
540   CONTINUE                                                         SPEL1420
      RETURN                                                           SPEL1430
      END                                                              SPEL1440
      SUBROUTINE SPECAV(N)                                             SPEV0010
C  AVERAGING OF SPECIFIED MATERIAL IN MIXED LAYERS                     SPEV0020
      COMMON T(70,2),EL(70),XL(70),A(70),TI(366),TA(366),SIGH(366)     SPEV0030
      COMMON FIN(366),WIND(366),DD(366),QI(366),QO(366),P(50),NPR      SPEV0040
      COMMON UOMAX(2),UIMAX(2),DTTI,DTTA,DTSIGH,DTFIN,DTWIND,DTDD,DTQI SPEV0050
      COMMON DTQO,JM,JOUT,JIN,KDIF,KSUR,KOH,KQ,KLOSS,YSUR,YOUT,DT,DY   SPEV0060
      COMMON TSTOP,EVPCON,OMEGA,BZ,SPREAD,SIGMAI,SIGMAO,ETADY,TVARI    SPEV0070
      COMMON TVARO,EVAP,RAD,TAIR,PSI,DERIV,HAFDEL,EPSIL,GJ             SPEV0080
      COMMON YBOT,NN,BETA,DAJM,DELCON,V( 70,1),UI( 70,1),DTT           SPEV0090
      COMMON RHO,HCAP,KMIX,RMIX,JMIXB,MIXED,QMIX,KAREA,DATRAD,ATRAD(366)SPEV0100
      COMMON AR,WINDY,CO,CI,B( 70),S( 70),EX( 70),EXO( 70),ARF,UO( 70,1)SPEV0110
      COMMON QIN(366),TIN(366),CC(20,70,2),CCC(20,366),COUT(20,366)    SPEV0120
      COMMON CCT(20,366),QQMIX(70),XINF(70),OUTF(70),MIXH,MM           SPEV0130
```

```
      COMMON SURF(366),GRAV,SLOPE,VISCOS,LAGTIM(366)                    SPEV0140
      COMMON PMASOT(20),PMASIN(20),ET,NTRAC(20),ITR,ISTO,ISO1,ISO2      SPEV0150
      COMMON ISTON,ISTO1,THICK1,THICK2,DOXLE(70,20),DO(366),BOD(366)    SPEV0160
      COMMON NLEVE(366),VOL,NW,NDET,Z,Z1,DDOC,NGDET,DBOD,JEUP           SPEV0170
      COMMON NBOUND,NGRID,NCONTR                                        SPEV0180
      COMMON KATRAD,DCLOUD,NCLOUD,CLOUD(366)                            SPEV0190
      COMMON DPT(366),DYPLT(16),NPLT,IDAY,NDAY,ELMAX,XLAT,DDPL,RG,KSLRADSPEV0200
      JMIXH=JM-MIXH+1                                                   SPEV0210
      IF(MM)120,120,10                                                  SPEV0220
10    CONTINUE                                                          SPEV0230
      DO 40 M=1,MM                                                      SPEV0240
      XCC=0.0                                                           SPEV0250
      XA=0.0                                                            SPEV0260
      JMM=JM-1                                                          SPEV0270
      DO 20 J=JMIXH,JMM                                                 SPEV0280
      XCC=CC(M,J,2)*A(J)*DY+XCC                                         SPEV0290
20    XA=XA+A(J)*DY                                                     SPEV0300
      XCC=XCC+CC(M,JM,2)*A(JM)*DY/2.0                                   SPEV0310
      XA=XA+A(JM)*DY/2.0                                                SPEV0320
      DO 30 I=JMIXH,JM                                                  SPEV0330
30    CC(M,I,2)= XCC/XA                                                 SPEV0340
40    CONTINUE                                                          SPEV0350
      GO TO (110,50),NGDET                                              SPEV0360
50    CONTINUE                                                          SPEV0370
      GO TO (110,60),NCONTR                                             SPEV0380
C  DO CALCULATIONS.                                                     SPEV0390
60    DO 100 J=JMIXH,JM                                                 SPEV0400
      DOSA=14.4776-0.3579*T(J,2)+0.0043*(T(J,2)**2)                     SPEV0410
      IF(CC(1,J,2))70,70,80                                             SPEV0420
70    CC(1,J,2)=0.                                                      SPEV0430
      GO TO 100                                                         SPEV0440
80    IF(CC(1,J,2)-DOSA)100,100,90                                      SPEV0450
90    CC(1,J,2)=DOSA                                                    SPEV0460
100   CONTINUE                                                          SPEV0470
110   CONTINUE                                                          SPEV0480
120   CONTINUE                                                          SPEV0490
      RETURN                                                            SPEV0500
      END                                                               SPEV0510
      SUBROUTINE SPECOT(N)                                              SPET0010
C PROPORTION OF SPECIFIED INFLOWS IN OUTFLOWS                           SPET0020
      COMMON T(70,2),EL(70),XL(70),A(70),TI(366),TA(366),SIGH(366)      SPET0030
      COMMON FIN(366),WIND(366),DD(366),QI(366),QO(366),P(50),NPR       SPET0040
      COMMON UOMAX(2),UIMAX(2),DTTI,DTTA,DTSIGH,DTFIN,DTWIND,DTDD,DTQI  SPET0050
      COMMON DTQO,JM,JOUT,JIN,KDIF,KSUR,KOH,KQ,KLOSS,YSUR,YOUT,DT,DY    SPET0060
      COMMON TSTOP,EVPCON,OMEGA,BZ,SPREAD,SIGMAI,SIGMAO,ETADY,TVARI     SPET0070
      COMMON TVARO,EVAP,RAD,TAIR,PSI,DERIV,HAFDEL,EPSIL,GJ              SPET0080
      COMMON YBOT,NN,BETA,DAJM,DELCON,V( 70,1),UI( 70,1),DTT            SPET0090
      COMMON RHO,HCAP,KMIX,RMIX,JMIXB,MIXED,QMIX,KAREA,DATRAD,ATRAD(366)SPET0100
      COMMON AR,WINDY,CO,CI,B( 70),S( 70),EX( 70),EXO( 70),ARF,UO( 70,1)SPET0110
      COMMON QIN(366),TIN(366),CC(20,70,2),CCC(20,366),COUT(20,366)     SPET0120
      COMMON CCT(20,366),QQMIX(70),XINF(70),OUTF(70),MIXH,MM            SPET0130
      COMMON SURF(366),GRAV,SLOPE,VISCOS,LAGTIM(366)                    SPET0140
      COMMON PMASOT(20),PMASIN(20),ET,NTRAC(20),ITR,ISTO,ISO1,ISO2      SPET0150
      COMMON ISTON,ISTO1,THICK1,THICK2,DOXLE(70,20),DO(366),BOD(366)    SPET0160
      COMMON NLEVE(366),VOL,NW,NDET,Z,Z1,DDOC,NGDET,DBOD,JEUP           SPET0170
      COMMON NBOUND,NGRID,NCONTR                                        SPET0180
      COMMON KATRAD,DCLOUD,NCLOUD,CLOUD(366)                            SPET0190
      COMMON DPT(366),DYPLT(16),NPLT,IDAY,NDAY,ELMAX,XLAT,DDPL,RG,KSLRADSPET0200
      JMM=JM-1                                                          SPET0210
      IF(MM)200,200,10                                                  SPET0220
10    CONTINUE                                                          SPET0230
      DO 110 M=1,MM                                                     SPET0240
      XC=CC(M,JM,1)*(B(JM)*DY/2.0*UO(JM,1)-QQMIX(JM))+CC(M,1,1)*B(1)*DY/SPET0250
```

```
     1 2.0*UO(1,1)
      XCC=CC(M,JM,2)*A(JM)*DY/2.0+CC(M,1,2)*A(1)*DY/2.0
      DO 50 J=2,JMM
      IF(J-JMIXB)20,30,30
20    XC=XC+CC(M,J,1)*UO(J,1)*B(J)*DY
      GO TO 40
30    XC=XC+CC(M,J,1)*(UO(J,1)*B(J)*DY -QQMIX(J))
40    XCC=XCC+CC(M,J,2)*A(J)*DY
50    CONTINUE
      IF(QOUT(N))60,60,80
60    COUT(M,N)=0.
      CCT(M,N)=0.
      GO TO (70,110),NGDET
70    NM=NTRAC(M)
      GO TO 100
80    XF=QOUT(N)*DT
      XC=XC*DT
      COUT(M,N)=XC/XF
      GO TO (90,110),NGDET
90    NM=NTRAC(M)
      CCT(M,N)=XC/QQIN(NM)/DTT/XF
100   CONTINUE
      PMASIN(M)=XCC/QQIN(NM)/DTT
      PMASOT(M)=CCT(M,N)*XF+PMASOT(M)
110   CONTINUE
      GO TO (120,170),NGDET
120   IF(NW-NDET)170,130,170
130   WRITE(6,140) ET
140   FORMAT (' ELAPSED TIME =', F7.2)
      WRITE(6,150)
150   FORMAT(' TRACE COUT/MASSIN   COUT       TRACOT      % REMAINING')
      WRITE(6,160)(M,CCT(M,N),COUT(M,N),PMASOT(M),PMASIN(M),M=1,MM)
160   FORMAT(I4,4E12.5)
      NW=0
170   DO 190 M=1,MM
      DO 180 I=1,JM
180   CC(M,I,1)=CC(M,I,2)
190   CONTINUE
200   CONTINUE
      RETURN
      END
      FUNCTION DDO(N)
C  COMPUTE INPUT DO FROM READ IN VALUES
      COMMON T(70,2),EL(70),XL(70),A(70),TI(366),TA(366),SIGH(366)
      COMMON FIN(366),WIND(366),DD(366),QI(366),QO(366),P(50),NPR
      COMMON UOMAX(2),UIMAX(2),DTTI,DTTA,DTSIGH,DTFIN,DTWIND,DTDD,DTQI
      COMMON DTQO,JM,JOUT,JIN,KDIF,KSUR,KOH,KQ,KLOSS,YSUR,YOUT,DT,DY
      COMMON TSTOP,EVPCON,OMEGA,BZ,SPREAD,SIGMAI,SIGMAO,ETADY,TVARI
      COMMON TVARO,EVAP,RAD,TAIR,PSI,DERIV,HAFDEL,EPSIL,GJ
      COMMON YBOT,NN,BETA,DAJM,DELCON,V( 70,1),UI( 70,1),DTT
      COMMON RHO,HCAP,KMIX,RMIX,JMIXB,MIXED,QMIX,KAREA,DATRAD,ATRAD(366)
      COMMON AR,WINDY,CO,CI,B( 70),S( 70),EX( 70),EXO( 70),ARF,UO( 70,1)
      COMMON QIN(366),TIN(366),CC(20,70,2),CCC(20,366),COUT(20,366)
      COMMON CCT(20,366),QQMIX(70),XINF(70),OUTF(70),MIXH,MM
      COMMON SURF(366),GRAV,SLOPE,VISCOS,LAGTIM(366)
      COMMON PMASOT(20),PMASIN(20),ET,NTRAC(20),ITR,ISTO,ISO1,ISO2
      COMMON ISTON,ISTO1,THICK1,THICK2,DOXLE(70,20),DO(366),BOD(366)
      COMMON NLEVE(366),VOL,NW,NDET,Z,Z1,DDOC,NGDET,DBOD,JEUP
      COMMON NBOUND,NGRID,NCONTR
      COMMON KATRAD,DCLOUD,NCLOUD,CLOUD(366)
      COMMON DPT(366),DYPLT(16),NPLT,IDAY,NDAY,ELMAX,XLAT,DDPL,RG,KSLRAD
      ET=DTT*FLOAT(N)
      R=ET/DDOC
```

Table 2.--*Listing of FORTRAN modeling program*--Continued

```
      L=R
      NGOT=NLEVE(N)
      DDO=DO(L+1)
      IF(LAGTIM(N))30,30,10
10    GO TO (30,20),NGOT
C  SUBSURFACE ENTRANCE
20    DDO=DO(L+1)-BBOD(N)*( 1.-EXP(LAGTIM(N)*DTT*(-Z)))/(EXP(LAGTIM(N)
     1*DTT*(-Z)))
30    CONTINUE
      RETURN
      END
      FUNCTION BBOD(N)
C  CALCULATES INPUT BOD FROM READ IN VALUES
      COMMON T(70,2),EL(70),XL(70),A(70),TI(366),TA(366),SIGH(366)
      COMMON FIN(366),WIND(366),DD(366),QI(366),QO(366),P(50),NPR
      COMMON UOMAX(2),UIMAX(2),DTTI,DTTA,DTSIGH,DTFIN,DTWIND,DTDD,DTQI
      COMMON DTQO,JM,JOUT,JIN,KDIF,KSUR,KOH,KQ,KLOSS,YSUR,YOUT,DT,DY
      COMMON TSTOP,EVPCON,OMEGA,BZ,SPREAD,SIGMAI,SIGMAO,ETADY,TVARI
      COMMON TVARO,EVAP,RAD,TAIR,PSI,DERIV,HAFDEL,EPSIL,GJ
      COMMON YBOT,NN,BETA,DAJM,DELCON,V( 70,1),UI( 70,1),DTT
      COMMON RHO,HCAP,KMIX,RMIX,JMIXB,MIXED,QMIX,KAREA,DATRAD,ATRAD(366)
      COMMON AR,WINDY,CO,CI,B( 70),S( 70),EX( 70),EXO( 70),ARF,UO( 70,1)
      COMMON QIN(366),TIN(366),CC(20,70,2),CCC(20,366),COUT(20,366)
      COMMON CCT(20,366),QQMIX(70),XINF(70),OUTF(70),MIXH,MM
      COMMON SURF(366),GRAV,SLOPE,VISCOS,LAGTIM(366)
      COMMON PMASOT(20),PMASIN(20),ET,NTRAC(20),ITR,ISTO,ISO1,ISO2
      COMMON ISTON,ISTO1,THICK1,THICK2,DOXLE(70,20),DO(366),BOD(366)
      COMMON NLEVE(366),VOL,NW,NDET,Z,Z1,DDOC,NGDET,DBOD,JEUP
      COMMON NBOUND,NGRID,NCONTR
      COMMON KATRAD,DCLOUD,NCLOUD,CLOUD(366)
      COMMON DPT(366),DYPLT(16),NPLT,IDAY,NDAY,ELMAX,XLAT,DDPL,RG,KSLRAD
      ET=DTT*FLOAT(N)
      R=ET/DBOD
      L=R
      NGOT=NLEVE(N)
      GO TO (10,20),NGOT
10    BBOD=BOD(L+1)
      GO TO 30
C  SUBSURFACE ENTRANCE
20    BBOD=BOD(L+1)*(    EXP(LAGTIM(N)*DTT*(-Z)))
30    CONTINUE
      RETURN
      END
```

Table 3.--*Input variables for the modeling program*

[B.O.D., biochemical oxygen demand; D.O., dissolved oxygen]

<u>Line 1</u>, FORMAT 20A4

WH = Alphanumeric variable used to print a title at beginning of output. Anything printed in this line will appear as the first line of output.

<u>Line 2</u>, FORMAT 20A4

WH = Alphanumeric variable used to list units used in computation prior to output at each time step.

<u>Line 3</u>, FORMAT 16I5

JM = Number of the grid point corresponding to the initial surface elevation. (reservoir bottom grid = 0)
JOUT = Number of the grid point corresponding to outlet elevation.
KDIF = 1 for a constant diffusion coefficient.
= 2 for a variable diffusion coefficient.
KSUR = 1 for a constant surface elevation.
= 2 for a variable surface elevation.
KOH = 1 for use of Koh's equation 2-49 of Markofsky and Harleman (1971) for computing the withdrawal thickness.
= 2 for use of Kao's equation 4-26 of Huber and Harleman (1968).
KQ = 1 for computations with inflow and outflow.
= 2 for computation with no inflow or outflow.
KLOSS = 1 for laboratory evaporation formula (eq. 5-8) (Adams, 1974).
= 2 for Kohler field evaporation formula (Kohler, 1954).
= 3 for Rohwer field evaporation formula (Rohwer, 1931).
NRPRINT = Number of time steps between printouts of calculations.
KAREA = 1 for laboratory reservoir calculations.
= 2 for calculations for any other reservoir.
KMIX = 1 for no entrance mixing.
= 2 to include entrance mixing.
MIXED = Number of grid spaces in surface layer for entrance mixing (defines d_m in eq. 2-58; Adams, 1974).
KATRAD = 1 atmospheric radiation read in program.
= 2 atmospheric radiation computed in program.
INITIAL = 1 initial temperature profile is isothermal.
= 2 initial temperature profile is not isothermal.
MULOUT = 1 release of water through single outlet.
= 2 release of water through multiple outlet.

<u>Line 4</u>, FORMAT 8F10.5

YSUR = Surface elevation at beginning of calculations (in meters above sea level).
YOUT = Initial elevation of outlet (in meters above sea level).
DT = Time step, Δt.
TSTOP = Time at which progress ceases calculations.
TZERO = Initial isothermal reservoir temperature (in degrees Celsius). Add line group 38 if initial temperature profiles are used.
EVPCON = Constant, a, in evaporation formulas of Chapter 5 (Adams, 1974) for KLOSS = 1 or 2. For KLOSS = 3, EVPCON = 0.01.
OMEGA = Constant ω of eq. 1 of this report for estimating reservoir width from elevation.
BZ = Constant B_o of eq. 1 of this report for estimating reservoir width from elevation.

<u>Line 5</u>, FORMAT 8F10.5

SPREAD = Number of outflow standard deviations, σ_o, equal to one-half the withdrawal thickness (eq. 2-11; Adams, 1974).

Line 5, FORMAT 8F10.5--Contiuned

SIGMA = Inflow standard deviation, σ_i (eq. 2.2-2; Adams, 1974).
ETA = Radiation-absorption coefficient, η (eq. 4 of this report).
BETA = Fraction of solar radiation absorbed at the water surface, β (eq. 4 of this report).
RHO = Water density, ρ (in kilograms per cubic meter).
HCAP = Water specific heat, c_p (in kilocalories per kilogram per Celsius degree).
DELCON = One-half the value of the constant of eq. 2.6 used to predict the withdrawal thickness, δ (Adams, 1974).
RMIX = Mixing ratio, r_m (eq. 2-20; Adams, 1974).

Line 6, FORMAT 16I5

NTI = Number of inflow temperatures to be read in.
NTA = Number of air temperatures to be read in.
NSIGH = Number of relative humidities to be read in.
NFIN = Number of insolation values to be read in.
NSURF = Number of surface elevations to be read in.
NDD = Number of diffusion coefficients to be read in.
NQI = Number of inflow rates to be read in.
NQO = Number of outflow rates to be read in.
NOUT = Number of outlet elevations to be read in.

Line 7, FORMAT 8F10.5

DTTI = Time interval (in days) between input values of TI.
DTTA = Time interval (in days) between input values of TA.
DTSIGH = Time interval (in days) between input values of SIGH.
DTFIN = Time interval (in days) between input values of FIN.
DSURF = Time interval (in days) between input values of SURF.
DTDD = Time interval (in days) between input values of DD.
DTQI = Time interval (in days) between input values of QI.
DTQO = Time interval (in days) between input values of QO.

Line 8, FORMAT 16I5

IDAY = Day of year at beginning of simulation.
NDAY = Day of year at end of simulation.
KSLRAD = 1 read in solar radiation, ϕ_o (in kilocalories per square meter per day).
= 2 compute solar radiation, ϕ_o (in kilocalories per square meter per day).

Line 9, FORMAT 16I5

NPLT = Number of days for which data and plots are desired other than the regular interval of output.

Line 10, FORMAT 8F10.5

DYPLT = Values of days for extra plots.

Line Group 11, FORMAT 8F10.5

TI = Values of inflow temperatures, T_{in} (in degrees Celsius).

Line Group 12, FORMAT 8F10.5

TA = Values of air temperatures, T_a (in degrees Celsius).

Line Group 13, FORMAT 8F10.5

SIGH = Values of relative humidities, ψ (in decimal form).

Table 3.--*Input variables for the modeling program*--Continued

<u>Line Group 14</u>, FORMAT 8F10.5

FIN = Values of solar radiation, ϕ_o (in kilocalories per square meter per day). (Omit if KSLRAD = 2.)

<u>Line Group 15</u>, FORMAT 8F10.5

SURF = Values of surface elevations, y_s (in meters above sea level).

<u>Line Group 16</u>, FORMAT 8F10.5

DD = Values of diffusion coefficients of heat, D (in square meters per day).

<u>Line Group 17</u>, Format 8F10.5

QI = Values of inflow rates, Q_i (in cubic meters per day).

<u>Line Group 18</u>, FORMAT 8F10.5

QO = Values of outflow rates, Q_o (in cubic meters per day).

<u>Line 19</u>, FORMAT 3F12.2

SLOPE = Average slope at the inlet end of the reservoir.
GRAV = Acceleration of gravity = 3528000 centimeters per minute per minute (KAREA = 1) and 73156608000 meters per day per day (KAREA = 2).
VISCOUS = Viscosity of water (in kilograms per cubic meter per day).

<u>Line 20</u>, FORMAT 16I5

NGDET = 1 for pulse injection solution (water quality).
= 2 for D.O. calculation (water quality).
NBOUND = 1 for entire euphotic zone saturated (water quality).
= 2 for specified number of grid points for saturated region (water quality).
= 3 for no saturation assumption; reaeration or continuous chemical injection only mechanism (water quality).
NGRID = Number of grid points for saturated region (water quality).
NCONTR = 1 for chemical-continuous injection (water quality).
= 2 for D.O. calculation (water quality).

<u>Line 21</u>, FORMAT 16I5

ITR = Number of pulse injections to be traced (if NGDET = 1) (water quality).
or
NDISSO = Number of input D.O. values to be read in (if NGDET = 2) (water quality).
NBOD = Number of input B.O.D. values to be read in (water quality).

The following sequence holds if NGDET = 1.

<u>Line Group 22</u>, FORMAT 16I5

NTRAC(1) = Time steps at which pulse injections were input (water quality).

<u>Line 23</u>, FORMAT I5

NDET = Number of time steps to be passed between printout of TRACOT (water quality).

Go to line 25.

The following sequence holds if NGDET = 2.

Table 3.--*Input variables for the modeling program*--Continued

Line 22, FORMAT 2F10.5

DDOC = Time interval (in days) between input values of D.O. (water quality).

DBOD = Time interval (in days) between input values of B.O.D. (water quality).

Line Group 23, FORMAT 8F10.5

DO = Values of inflow D.O. (in percent saturation) (water quality).

Line Group 24, FORMAT 8F10.5

BOD = Values of inflow B.O.D. (in milligrams per liter) (water quality).

Line 25, FORMAT I5

NPROF = 1 for a constant initial B.O.D. and D.O. profile (water quality).
= 2 for a linear initial B.O.D. and D.O. profile (water quality).

Line 26, FORMAT 4F10.5

If NPROF = 1

DOI = Initial D.O. value (in percent saturation) (water quality).
BODI = Initial B.O.D. value (in milligrams per liter) (water quality).

or if NPROF = 2

DOB = Initial D.O. value (in percent saturation) at the reservoir bottom (water quality).
DOT = Initial D.O. value (in percent saturation) at the reservoir surface (water quality).
BODB = Initial B.O.D. value (in milligrams per liter) at the reservoir bottom (water quality).
BODT = Initial B.O.D. value (in milligrams per liter) at the reservoir surface (water quality).

Line 27, FORMAT 2F10.5, I5

Z = First-order decay constant (per day) for B.O.D. (water quality).
Z1 = First-order reaeration constant (per day) at surface (water quality).
DOCA = Time interval between printout of D.O. profiles (water quality).

Line 28, FORMAT 2F10.5

THICK1 = Thickness of surface layer for lag-time calculation (eq. 2-13; Adams, 1974).
THICK2 = Thickness of subsurface layer for lag-time calculation (eq. 2-13; Adams, 1974).

If lag time is not to be considered, set THICK1 and THICK2 = 0.00001 meter.

The following parameters are read in when KAREA = 2.

Line 29, FORMAT 16I5

NAA = Number of areas to be read in.
NXXL = Number of lengths to be read in.
NWIND = Number of wind values to be read in (units).
NATRAD = Number of atmospheric-radiation values to be read in or computed.
JMP = Number of grid points, which cannot be larger than 70, for which program variables need to be initialized. (This needs to be the maximum value of JM expected to occur in the calculations.)

Table 3.--*Input variables for the modeling program*--Continued

Line 30, FORMAT 8F10.5

DAA = Vertical distance interval between input values of AA (in meters).
DXXL = Vertical distance interval between input values of XXL (in meters).
DTWIND = Time interval (in days) between input values of WIND.
DATRAD = Time interval (in days) between input values of ATRAD.
AAB = Elevation of first (lowest) value of AA (in meters above sea level).
XXLB = Elevation of first (lowest) value of XXL (in meters above sea level).
ARF = Area reduction factor, a_r (eq. 6-1; Adams, 1974).

Line Group 31, FORMAT 8F10.5

AA = Values of horizontal cross-sectional areas, A (in square meters).

Line Group 32, FORMAT 8F10.5

XXL = Values of reservoir lengths, L (in meters).

Line Group 33, FORMAT 8F10.5

WIND = Values of wind speeds, w (in meters per day).

Line 34, FORMAT 8F10.5 (If KSLRAD = 2)

ELMAX = Maximum elevation of reservoir (in meters above sea level).
XLAT = Latitude of reservoir.
DDPL = Distance depletion factor.
RG = Ground reflectivity.

Line Group 35, FORMAT 8F10.5

ATRAD = Values of atmospheric radiation, ϕ_a (in kilocalories per square meter per day). (Omit if KATRAD = 2.)[a]

Line 36, FORMAT 16I5

DCLOUD = Time interval (in days) between values of CLOUD.
NCLOUD = Number of values of CLOUD.

Line Group 37, FORMAT 8F10.5

CLOUD = Values of cloud cover (in decimal form).

Line Group 38, FORMAT 8F10.5

T = Initial temperature values (in degrees Celsius) for all grid values.

Line Group 39, FORMAT 8F10.5

YYOUT = Values of outflow elevations (in meters above sea level).

Line Group 40, FORMAT 16I5

JJOUT = Grid values for outflow elevations.

Table 4.--*Input data for Hungry Horse Reservoir, April 18-December 31, 1984*

```
HUNGRY HORSE RESERVOIR FOR THE PERIOD APRIL 18, 1984 THROUGH DECEMBER 31, 1984
Units are meters, days, kilocalories, or degrees Celsius
   59   34    1    2    1    1    3   30    2    2    2    2    1    1
   1065.10   1011.63        1.      250.       4.2       .01  1.46E-2   2.03E-4
      1.96       4.0       .27       .57      997.      .998       1.        5.
  258  258  258    0  258    2  258  258
        1.        1.        1.        1.        1.      257.       1.        1.
  109  366    2
    8
       42.       69.       98.      111.      141.      153.      185.      210.
   4.00000   4.00000   4.00000   4.50000   5.00000   4.50000   4.00000   3.50000
   3.00000   4.00000   4.00000   4.00000   4.50000   5.00000   5.90000   5.50000
   5.00000   5.50000   5.00000   5.90000   6.40000   6.40000   5.90000   5.50000
   5.90000   6.90000   7.90000   6.90000   5.50000   5.90000   6.90000   6.40000
   5.90000   5.50000   5.90000   6.90000   5.90000   6.40000   5.90000   6.90000
   7.90000   8.90000   8.40000   6.40000   5.90000   6.90000   7.40000   6.90000
   6.90000   6.90000   7.40000   6.90000   6.40000   6.90000   7.90000   8.40000
   8.40000   8.90000   9.40000   9.40000   9.40000   8.90000   9.40000   9.40000
   8.90000   7.90000   8.90000  10.40000  10.80000  10.80000  11.30000  11.30000
  11.30000   9.40000   9.40000  10.40000  11.30000  11.80000  12.30000  12.30000
  11.80000  11.30000  11.80000  12.30000  13.30000  13.80000  13.30000  13.30000
  13.80000  14.80000  15.30000  15.30000  15.30000  14.80000  14.30000  13.30000
  13.80000  14.80000  15.80000  16.20000  15.80000  15.80000  15.80000  14.80000
  14.80000  15.80000  15.80000  14.80000  15.30000  15.80000  15.30000  14.30000
  14.80000  15.80000  16.20000  14.80000  13.80000  14.80000  14.80000  15.30000
  15.80000  16.20000  16.20000  15.30000  13.80000  13.80000  14.30000  14.80000
  14.80000  14.30000  14.30000  13.30000  11.80000  11.80000  11.30000  10.40000
  10.80000  10.80000  11.30000  11.80000  12.80000  11.80000   9.40000   9.40000
  10.40000  10.40000   9.90000   9.90000   9.40000   9.40000   9.40000   9.90000
  10.80000  11.30000  11.30000  10.40000   8.90000   7.90000   6.90000   5.90000
   6.40000   6.90000   5.90000   5.90000   5.90000   6.40000   6.90000   7.40000
   7.90000   8.40000   8.40000   7.90000   7.90000   8.40000   8.40000   8.40000
   7.40000   6.90000   6.40000   5.90000   5.00000   5.00000   4.50000   4.50000
   4.00000   3.50000   3.00000   3.00000   3.00000   3.50000   4.00000   4.00000
   3.00000   2.50000   2.00000   1.50000   0.50000   0.00000   0.00000   1.50000
   1.50000   1.50000   2.00000   2.50000   2.00000   1.50000   1.00000   2.00000
   2.50000   3.50000   3.00000   2.00000   0.50000   0.10000   0.10000   0.50000
   2.00000   2.50000   2.00000   1.50000   1.50000   0.50000   0.10000   0.00000
   0.10000   0.50000   1.00000   0.50000   0.00000   0.00000   0.00000   0.00000
   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
   0.00000   0.00000
  12.20000  10.00000   7.20000   8.30000  11.90000   7.50000   3.30000   3.10000
   3.30000   2.20000   7.20000   6.90000   7.20000   7.50000   7.80000   6.40000
   4.70000   8.10000   6.90000   6.10000   8.10000  10.60000   6.90000   5.60000
   7.20000  10.00000  12.20000  11.90000   7.50000   5.60000  10.80000  15.60000
  13.10000  11.10000   4.20000  11.40000   7.20000   9.40000  10.30000   8.60000
  13.60000  13.10000  20.60000  15.00000   6.90000  12.20000  14.40000  15.00000
  10.30000   9.20000  11.10000  10.80000   8.60000  10.60000  11.10000  14.70000
  15.80000  14.20000  16.90000  20.80000  19.20000  15.60000  16.40000  17.80000
  15.60000   9.20000  10.60000  19.40000  18.10000  20.00000  22.80000  19.70000
  24.70000  20.00000  15.60000  16.70000  17.80000  21.10000  20.00000  22.50000
  19.70000  20.00000  16.90000  16.70000  18.60000  23.60000  20.80000  21.10000
  21.10000  19.20000  19.70000  24.70000  21.90000  22.50000  24.20000  20.00000
  16.90000  19.20000  23.60000  25.60000  26.10000  23.10000  24.70000  20.30000
  16.90000  20.30000  20.60000  18.60000  21.10000  20.80000  19.20000  17.50000
  21.90000  23.60000  21.70000  23.90000  20.60000  21.70000  15.30000  19.20000
  21.70000  22.50000  24.40000  22.80000  19.40000  16.10000  17.20000  23.60000
  21.70000  21.40000  21.70000  20.00000  19.20000  14.40000  13.60000  14.40000
  11.10000  11.90000  14.20000  13.30000  20.00000  18.10000   8.60000   8.10000
  11.10000  10.80000   9.40000  10.00000   8.60000   8.30000  10.00000  12.80000
```

Table 4.--*Input data for Hungry Horse Reservoir, April 18-December 31, 1984*--Continued

12.20000	17.80000	18.90000	19.40000	8.90000	4.40000	3.60000	1.90000
3.60000	4.20000	1.90000	3.30000	1.70000	3.10000	5.80000	8.60000
9.20000	10.00000	10.60000	7.80000	7.20000	11.40000	10.00000	13.30000
10.60000	8.30000	7.50000	4.20000	4.40000	3.30000	1.40000	1.40000
0.00000	-1.40000	-1.10000	-0.60000	0.30000	-0.60000	0.80000	6.70000
-2.20000	-3.10000	-1.70000	-3.30000	-6.10000	-12.20000	-4.40000	3.60000
4.40000	3.60000	0.60000	2.80000	2.50000	-1.40000	0.00000	3.30000
2.50000	5.60000	3.30000	-1.70000	-4.40000	-3.10000	-3.30000	0.00000
2.80000	0.60000	-1.40000	-0.60000	-1.70000	-3.30000	-4.20000	-3.60000
-0.80000	0.60000	-1.10000	-1.40000	-2.80000	-6.90000	-11.90000	-11.10000
-11.90000	-10.00000	-6.10000	-0.30000	0.80000	-0.60000	-4.70000	-5.30000
-2.20000	0.60000	-8.60000	-9.70000	-13.90000	-12.80000	-10.30000	-6.10000
-3.30000	0.00000	-6.70000	-10.30000	-5.60000	-0.30000	-8.90000	-14.40000
-12.80000	-15.00000						
0.74	0.72	0.71	0.61	0.45	0.53	0.45	0.51
0.38	0.37	0.50	0.35	0.41	0.60	0.66	0.68
0.63	0.82	0.80	0.67	0.60	0.49	0.60	0.78
0.62	0.52	0.82	0.86	0.70	0.46	0.51	0.77
0.58	0.60	0.51	0.65	0.72	0.61	0.80	0.65
0.56	0.53	0.60	0.38	0.43	0.48	0.53	0.75
0.76	0.80	0.71	0.70	0.78	0.61	0.62	0.63
0.79	0.75	0.67	0.60	0.57	0.47	0.56	0.65
0.86	0.86	0.74	0.67	0.58	0.50	0.51	0.56
0.55	0.46	0.62	0.58	0.60	0.60	0.60	0.53
0.50	0.54	0.61	0.55	0.43	0.38	0.45	0.50
0.50	0.48	0.45	0.44	0.39	0.38	0.43	0.37
0.35	0.49	0.43	0.44	0.71	0.63	0.71	0.66
0.53	0.56	0.68	0.67	0.57	0.60	0.62	0.50
0.52	0.46	0.41	0.55	0.63	0.51	0.50	0.50
0.45	0.55	0.53	0.48	0.43	0.43	0.37	0.46
0.47	0.44	0.40	0.29	0.28	0.34	0.66	0.86
0.65	0.65	0.53	0.59	0.48	0.52	0.43	0.81
0.73	0.78	0.75	0.76	0.80	0.66	0.62	0.66
0.61	0.58	0.63	0.86	0.77	0.65	0.48	0.57
0.67	0.59	0.56	0.66	0.61	0.60	0.64	0.67
0.69	0.61	0.62	0.69	0.70	0.69	0.68	0.68
0.78	0.71	0.63	0.69	0.77	0.81	0.80	0.68
0.71	0.62	0.70	0.74	0.78	0.83	0.82	0.85
0.78	0.79	0.81	0.74	0.73	0.79	0.83	0.63
0.60	0.64	0.71	0.58	0.70	0.76	0.83	0.78
0.87	0.82	0.66	0.68	0.71	0.75	0.80	0.71
0.83	0.85	0.87	0.87	0.83	0.79	0.70	0.88
0.88	0.72	0.86	0.88	0.83	0.69	0.64	0.72
0.74	0.92	0.90	0.88	0.81	0.74	0.75	0.81
0.70	0.72	0.69	0.77	0.72	0.76	0.81	0.74
0.81	0.70	0.71	0.80	0.76	0.72	0.63	0.72
0.66	0.65						
1065.1	1065.5	1065.8	1066.2	1066.4	1066.7	1066.9	1067.0
1067.1	1067.2	1067.4	1067.4	1067.4	1067.2	1067.0	1066.8
1066.7	1066.8	1066.9	1066.9	1067.0	1066.9	1066.9	1067.0
1067.1	1067.3	1067.4	1067.6	1068.0	1068.3	1068.5	1068.9
1069.3	1069.8	1070.1	1070.5	1070.8	1071.0	1071.3	1071.6
1071.8	1072.2	1072.7	1073.4	1073.9	1074.3	1074.6	1074.9
1075.3	1075.6	1075.9	1076.2	1076.4	1076.7	1076.9	1077.2
1077.5	1077.8	1078.1	1078.6	1079.0	1079.3	1081.1	1079.9
1080.3	1080.7	1081.0	1081.3	1081.6	1081.9	1082.1	1082.3
1082.5	1082.7	1082.9	1083.1	1083.2	1083.4	1083.5	1083.7
1083.8	1083.9	1084.0	1084.1	1084.2	1084.3	1084.4	1084.4
1084.5	1084.5	1084.6	1084.7	1084.7	1084.8	1084.8	1084.9
1084.9	1084.9	1085.0	1085.0	1085.0	1085.0	1085.1	1085.1

Table 4.--*Input data for Hungry Horse Reservoir, April 18-December 31, 1984*--Continued

1085.1	1085.1	1085.0	1085.1	1085.1	1085.1	1085.1	1085.1
1085.1	1085.2	1085.2	1085.2	1085.2	1085.2	1085.2	1085.2
1085.2	1085.2	1085.2	1085.1	1085.1	1085.0	1084.9	1084.7
1084.5	1084.4	1084.3	1084.1	1083.8	1083.6	1083.4	1083.2
1083.1	1083.0	1083.0	1082.8	1082.6	1082.4	1082.2	1082.1
1082.1	1082.0	1081.9	1081.8	1081.7	1081.6	1081.6	1081.4
1081.2	1081.0	1080.8	1080.8	1080.8	1080.8	1080.8	1080.7
1080.7	1080.7	1080.6	1080.6	1080.5	1080.5	1080.4	1080.2
1080.0	1079.8	1079.6	1079.5	1079.5	1079.5	1079.4	1079.3
1079.2	1079.1	1079.0	1079.0	1079.0	1078.9	1078.9	1078.9
1078.9	1078.8	1078.8	1078.8	1078.7	1078.7	1078.7	1078.7
1078.7	1078.7	1078.7	1078.7	1078.6	1078.6	1078.6	1078.6
1078.6	1078.6	1078.6	1078.5	1078.5	1078.5	1078.5	1078.5
1078.5	1078.4	1078.4	1078.4	1078.4	1078.4	1078.4	1078.4
1078.3	1078.3	1078.3	1078.2	1078.2	1078.2	1078.2	1078.1
1078.1	1078.1	1078.0	1078.0	1077.9	1077.9	1077.8	1077.7
1077.7	1077.6	1077.6	1077.5	1077.5	1077.5	1077.4	1077.4
1077.4	1077.3	1077.2	1077.0	1076.8	1076.6	1076.4	1076.2
1075.9	1075.7	1075.4	1075.2	1074.9	1074.9	1074.8	1074.7
1074.6	1074.5						
0.01645	0.01645						
20468219.8	23522562.6	26899088.7	21835033.6	19826618.2	21087505.7	14410405.2	14218935.3
11789481.8	10465390.9	17612173.8	523636.6	9824914.8	8021549.6	8381243.9	10574669.4
6622534.6	7219994.1	6376205.2	5734309.9	7609149.1	8892597.0	11384397.5	10908720.2
10867000.6	12680447.0	18144986.2	31064006.0	33090675.3	27062101.2	24587061.9	28245397.5
39740125.8	35818552.7	27988057.1	29735143.6	27206884.3	23629614.5	22936530.1	20994817.1
21382039.0	24759690.7	45974924.6	56875765.8	41524723.3	30397446.0	27141038.2	26146764.9
27409781.2	27200057.4	27503179.4	23607396.6	22329185.1	21830629.2	20962909.6	23189588.5
24526525.6	29833851.5	35936199.7	40667794.5	38767385.2	34025391.1	29371999.2	31624762.0
38409819.7	38986872.1	30796902.4	27899577.2	29653882.0	32690802.9	32127086.1	29239034.6
28104089.0	22303296.9	19059637.4	16866994.9	16775750.0	13945714.5	17152768.3	13848646.0
12222974.6	10496075.0	10779817.5	9630190.5	8517267.1	7957122.7	8505032.6	7920419.2
6842339.6	7174310.5	6156400.2	6721634.0	5838303.2	5542228.3	4518298.5	4449491.7
4716105.9	4542473.9	3997011.0	4751170.0	5211798.9	3894241.2	4192860.9	4636777.4
3954092.4	3859054.8	4256186.6	3963977.8	3866101.8	3772605.8	2569244.9	2172847.1
7159629.1	2419984.0	2329448.7	2490944.1	570127.7	3831845.2	2062736.6	2163059.5
2324554.9	1915922.6	2121462.2	1825387.3	1825387.3	1574775.8	1894096.3	3365710.8
1769108.6	1212218.7	2655596.0	1673679.5	614661.3	2199542.8	1217724.2	3511081.1
2613998.7	1960578.5	1679992.5	1642481.6	2291619.6	3858149.4	1727609.2	4007312.4
1908484.0	3212583.8	2302630.7	1989721.1	2151828.2	1951182.5	1676224.3	1734338.2
2549865.5	1712609.7	1118942.9	4365979.0	4048395.9	3801454.8	2039295.3	2306619.1
1589065.7	3201964.3	2170816.2	1630247.1	1901657.2	2395099.0	2495837.9	3119797.4
1862090.8	4617300.1	1473033.7	2082311.8	2764996.9	2268276.2	1913475.7	2419984.0
2564351.1	2826169.4	1959966.8	3778013.4	2544775.9	2530094.5	2234019.6	1438777.1
2011351.7	2011351.7	1196534.1	2011351.7	1318879.0	2992558.6	2992558.6	4903587.4
4216008.5	3927274.3	2855532.2	3645880.9	915140.6	3511301.4	4233136.8	2123909.1
3954190.2	2657333.3	2400408.8	2659780.2	2649992.6	2331895.6	3083093.9	2566798.0
3601836.7	3291080.4	4027597.2	3283739.7	2400408.8	3251930.0	1495055.8	3083093.9
2943620.6	3112456.7	2378386.7	822158.4	3154054.0	2378386.7	2344130.1	2757656.2
3232354.8	2904470.2	2591267.0	2319661.1	2038267.6	939609.6	1245472.1	357247.4
1074189.1	863755.7	3932168.1	3256823.8	3200545.1	2835957.0	1913475.7	2172847.1
2738081.0	1208768.6	1629635.3	1977095.1	1083976.7	2104333.9	1639422.9	3070859.4
2373492.9	2679355.4	2593713.9	1223450.0	3895464.6	890671.6	3626305.7	1331113.5
5030826.2	1578250.4						
643534.7	663109.9	1103551.9	653322.3	655769.2	645981.6	3085540.8	4152389.1
4350588.0	2471368.9	513849.0	523636.6	14488094.3	23343425.1	22814894.7	23996747.3
14172444.2	508955.2	504061.4	3217673.4	1328666.6	15633243.5	8992357.1	7597624.2
467357.9	467357.9	12371525.9	16186242.9	5111573.9	5522653.1	7044624.8	611725.0
658216.1	5816281.1	4548786.9	670450.6	2361258.4	5581378.7	521189.7	516295.9
533424.2	543211.8	1847409.4	621512.6	567680.8	543211.8	494273.8	486933.1

Table 4.--*Input data for Hungry Horse Reservoir, April 18-December 31, 1984*--Continued

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  516295.9  516295.9  560340.1  550552.5  567680.8  587256.0  496720.7  650875.4
  692472.7 3927274.3 4132813.9 3621411.9 3694818.9 3677690.6 3687478.2 3670349.9
 3670349.9 3704606.5 1164724.4  660663.0 4499848.9 6019373.8 9711745.711647243.5
11647243.5 1306644.5  616618.8 4666238.1 2588820.1  523636.6  572574.6  623959.5
  589702.9  565233.9  565233.9  550552.5  572574.6  579915.3  560340.1  543211.8
  526083.5 2437112.3  530977.3  504061.4  508955.2  508955.2  508955.2  477145.5
  460017.2  570127.7  592149.8 2764996.9 4928056.4  489380.0 1071742.2 4353034.9
 3670349.9 4710282.3 7093562.8 2608395.3  486933.1 1169618.2 1088870.5  396397.8
 5975329.6  643534.7 1145149.2 1602719.4 1754427.2 2943620.6 1766661.7 2163059.5
 2916704.7 3396297.1 3009686.9 3009686.9 3009686.9 9692170.516081026.222462541.1
21902201.011451491.511451491.522102846.822462541.122061249.522633824.122484563.2
11409894.210472731.6 5652338.816964357.019599668.222584886.122440519.0 8830861.7
 8434464.0 9454821.2 9396095.6 9934413.611798951.311598305.5 8769689.216895843.8
22362218.217429268.016724560.8 5760002.4 5676807.8 5701276.8 3396297.1 4477826.8
 6202891.3 5101786.3 5970435.8 5701276.8 5701276.8 5701276.814436709.416147092.5
17874603.822800213.322592226.8 5708617.5 5615635.3 5118914.6 5799152.817605444.8
 5821174.917480652.9 5760002.4 5676807.8 4443570.2 4428888.8 4404419.8 4423995.0
 4453357.8 4453357.8 4453357.8 4453357.8 4575702.8 5162958.8 5162958.8 5162958.8
 3141819.5 3655668.5 3670349.9 4436229.5 5060189.0 5324454.2 5268175.5 3937061.9
 3694818.9 3694818.9 3694818.9 3694818.9 4203774.0 4404419.8 4379950.8 4379950.8
 4379950.8 4326119.0 3768225.8 3802482.4 3694818.9 4030044.1 4086322.8 4636875.3
 5016144.8 4925609.5 4967206.8 4967206.8 4967206.8 4967206.8 5194768.5 5608294.6
 5823621.8 5840750.1 5848090.8 5848090.8 5838303.2 5823621.8 6672696.0 7289314.8
 7291761.7 7340699.7 6264063.7 5848090.8 5532440.7 5427224.0 5799152.8 5799152.8
 5845643.9 5872559.8 7587836.619332956.118439837.719462641.822883407.919651053.1
23098735.123145226.223318956.123367894.122893195.5 6070758.7 7820292.111940871.5
11940871.511940871.5
   0.00275  73156608000.0.0864
    2    3    1    1
    2    2
      257.      257.
      100.      100.
       10.       10.
    1
      100.       10.
        0.        0.   30
       2.0       2.0
   51   51  258  258   69
      3.05      3.05        1.        1.    935.74    935.74       1.0
       0.0   80940.0  145692.0  194256.0  412794.0  603003.0  857964.0 1173630.0
 1396215.0 1647129.0 2063970.0 2909793.0 4111752.0 4896870.0 5928855.0 7151049.0
 8514888.0 9813975.011198049.011979120.013257972.014395179.015386694.017033823.0
18268158.019583433.021064635.022792704.024840486.026876127.029450019.031756809.0
34524957.036665820.038956422.041663865.044363214.047289195.050231364.053837241.0
59745861.062756829.065549259.071085555.075751746.079673289.083647443.087864417.0
91992357.096120297.0100248237.
       0.0    1930.8    3378.9    4666.1    6484.3    7642.7    9654.0   11263.0
   13065.1   14094.8   15526.8   16814.1   18342.6   19710.2   21045.7   21818.0
   23443.1   24794.7   26661.1   27723.1   28962.0   30731.9   32083.5   33805.1
   35349.7   37602.3   38744.7   39806.7   41335.2   40981.2   43941.8   45019.8
   46435.7   47835.6   49251.5   50651.3   51504.1   52887.8   54126.8   55108.2
   56073.6   57151.7   58294.1   59372.1   60916.7   62010.9   62895.8   64134.7
   65100.1   65840.3   66580.4
  177633.6  251004.0  320512.8  390021.6  463392.0  451807.2  312789.6  451807.2
  579240.0  320512.8  289620.0  320512.8  166048.8  258727.2  521316.0  382298.4
  281896.8  220111.2  181495.2  266450.4  251004.0  625579.2  335959.2  231696.0
  308928.0  308928.0  239419.2  289620.0  498146.4  393883.2  305066.4  262588.8
  548347.2  305066.4  347544.0  455668.8  293481.6  200803.2  177633.6  324374.4
  212388.0  266450.4  374575.2  621717.6  405468.0  212388.0  177633.6  181495.2
  293481.6  243280.8  359128.8  359128.8  332097.6  312789.6  305066.4  266450.4
```

Table 4.--*Input data for Hungry Horse Reservoir, April 18-December 31, 1984*--Continued

196941.6	231696.0	247142.4	312789.6	235557.6	247142.4	231696.0	366852.0
366852.0	139017.6	166048.8	231696.0	301204.8	347544.0	374575.2	204664.8
362990.4	436360.8	355267.2	220111.2	193080.0	289620.0	274173.6	324374.4
251004.0	247142.4	154464.0	220111.2	216249.6	274173.6	274173.6	227834.4
200803.2	196941.6	258727.2	274173.6	316651.2	316651.2	297343.2	305066.4
262588.8	185356.8	177633.6	343682.4	204664.8	243280.8	243280.8	293481.6
227834.4	254865.6	208526.4	305066.4	281896.8	243280.8	305066.4	308928.0
208526.4	220111.2	289620.0	328236.0	308928.0	270312.0	173772.0	223972.8
289620.0	220111.2	308928.0	258727.2	235557.6	139017.6	293481.6	289620.0
270312.0	220111.2	413191.2	691226.4	401606.4	223972.8	223972.8	270312.0
339820.8	135156.0	270312.0	212388.0	324374.4	544485.6	366852.0	177633.6
227834.4	189218.4	200803.2	227834.4	212388.0	285758.4	189218.4	158325.6
154464.0	243280.8	169910.4	258727.2	227834.4	474976.8	583101.6	239419.2
258727.2	598548.0	146740.8	150602.4	96540.0	142879.2	100401.6	54062.4
131294.4	196941.6	181495.2	108124.8	119709.6	108124.8	135156.0	104263.2
220111.2	444084.0	471115.2	362990.4	88816.8	108124.8	123571.2	278035.2
158325.6	166048.8	57924.0	54062.4	88816.8	162187.2	467253.6	440222.4
289620.0	351405.6	227834.4	405468.0	463392.0	65647.2	266450.4	486561.6
401606.4	181495.2	251004.0	335959.2	220111.2	200803.2	142879.2	289620.0
123571.2	262588.8	339820.8	108124.8	146740.8	84955.2	42477.6	231696.0
61785.6	50200.8	38616.0	0.0	61785.6	111986.4	81093.6	173772.0
274173.6	370713.6	223972.8	88816.8	61785.6	50200.8	84955.2	46339.2
104263.2	42477.6	177633.6	247142.4	278035.2	142879.2	131294.4	81093.6
563793.6	590824.8	695088.0	297343.2	220111.2	73370.4	92678.4	355267.2
382298.4	517454.4	96540.0	57924.0	436360.8	235557.6	621717.6	274173.6
362990.4	127432.8						
1085.34	48.1350	.07	.07				
1 258							
1.00	1.00	1.00	1.00	0.80	0.80	0.50	0.70
1.00	0.60	1.00	0.70	0.90	1.00	0.90	1.00
0.60	0.90	1.00	0.60	1.00	0.50	0.80	1.00
0.70	0.80	1.00	1.00	1.00	0.60	0.80	1.00
0.80	0.80	0.50	0.90	0.90	0.90	1.00	0.60
0.70	0.00	0.90	0.60	0.60	0.80	0.70	1.00
1.00	1.00	0.90	1.00	0.90	0.90	1.00	0.90
0.90	0.60	0.50	0.40	0.40	0.40	0.80	0.90
1.00	1.00	0.30	0.40	0.80	0.30	0.40	0.00
0.70	0.70	0.90	0.50	0.50	0.70	0.20	0.40
0.10	0.30	0.40	0.00	0.30	0.60	0.30	0.00
0.00	0.00	0.00	0.30	0.00	0.40	0.20	0.10
0.80	0.20	0.20	0.80	0.80	1.00	1.00	0.70
0.30	1.00	0.60	0.30	0.70	0.60	0.50	0.40
0.00	0.00	0.60	0.90	0.60	0.10	0.10	0.20
0.80	0.20	0.30	0.10	0.00	0.00	0.50	0.40
0.40	0.30	0.60	0.70	0.90	0.90	0.40	1.00
1.00	0.50	0.80	1.00	0.70	1.00	1.00	0.90
0.90	0.90	1.00	0.90	0.50	0.10	0.90	0.50
0.00	0.00	0.80	1.00	1.00	1.00	1.00	0.40
0.90	1.00	0.00	0.10	0.00	0.60	0.40	1.00
0.20	0.50	0.40	0.80	0.80	0.00	0.00	0.90
1.00	0.90	0.80	1.00	0.90	1.00	1.00	1.00
1.00	0.90	1.00	1.00	1.00	1.00	1.00	1.00
1.00	0.90	0.80	1.00	0.20	1.00	1.00	1.00
1.00	0.60	1.00	0.90	1.00	1.00	1.00	1.00
1.00	1.00	0.60	0.10	1.00	0.90	1.00	1.00
1.00	1.00	0.70	1.00	0.80	0.80	1.00	1.00
1.00	1.00	1.00	1.00	1.00	0.00	0.80	1.00
1.00	1.00	1.00	1.00	1.00	0.90	1.00	1.00
1.00	1.00	0.90	1.00	0.50	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	0.30						

Table 5.--*Input data for Hungry Horse Reservoir, April 26-December 31, 1985*

```
HUNGRY HORSE RESERVOIR FOR THE PERIOD APRIL 26, 1985 THROUGH DECEMBER 31, 1985
Units are meters, days, kilocalories, or degrees Celsius
   58   34    1    2    1    1    3   30    2    2    2    2    1    1
   1063.90   1011.63        1.      245.       4.2       .01   1.46E-2   2.03E-4
      1.96       4.0       .31       .59      997.      .998        1.        5.
  250  250  250    0  250    2  250  250
        1.        1.        1.        1.        1.      249.        1.        1.
  116  365    2
   8
       26.       47.       76.      109.      127.      139.      167.      203.
   3.50000   4.50000   5.50000   5.50000   5.50000   5.90000   5.90000   5.50000
   4.50000   4.00000   5.00000   5.50000   4.50000   5.00000   5.50000   5.50000
   5.00000   5.90000   6.40000   6.90000   7.40000   7.40000   7.40000   7.40000
   6.90000   7.40000   7.40000   7.90000   7.90000   7.90000   7.40000   7.40000
   7.40000   7.40000   6.90000   7.40000   8.40000   7.90000   7.40000   7.90000
   7.40000   7.40000   7.90000   6.90000   6.90000   7.40000   8.40000   9.40000
   9.40000   8.40000   9.40000   9.90000  10.40000  10.80000  11.80000  11.30000
   9.90000  10.80000  10.80000   9.90000   8.90000   9.90000  11.30000  12.80000
  13.30000  13.30000  13.30000  13.80000  14.30000  14.30000  14.80000  14.80000
  14.80000  15.30000  15.80000  16.20000  15.80000  15.30000  15.30000  14.80000
  15.30000  15.80000  15.30000  14.30000  14.80000  15.30000  16.20000  16.20000
  16.20000  15.30000  15.80000  15.80000  15.80000  15.80000  16.20000  16.20000
  15.80000  16.20000  15.80000  15.30000  16.20000  15.30000  14.80000  14.30000
  12.80000  11.80000  10.80000  11.30000  12.30000  11.80000  12.30000  11.80000
  10.80000  11.80000  13.30000  13.80000  13.80000  11.80000  11.80000  12.80000
  13.80000  14.80000  14.80000  14.30000  14.30000  14.30000  13.30000  11.80000
  11.80000  11.80000  11.30000  10.80000  11.30000   8.90000   6.90000   7.90000
   8.40000   9.90000  11.80000  10.80000   9.90000   9.90000   9.40000   8.40000
   8.40000   7.90000   7.90000   8.40000   9.40000   8.40000   7.40000   7.90000
   7.90000   7.90000   6.90000   5.00000   4.50000   5.00000   5.50000   5.50000
   6.40000   5.90000   6.40000   5.90000   3.50000   2.00000   1.50000   3.00000
   4.00000   4.50000   5.00000   4.50000   5.50000   5.50000   5.00000   5.00000
   5.00000   5.50000   5.50000   5.00000   4.50000   4.00000   5.00000   4.00000
   4.00000   4.50000   3.00000   2.50000   2.50000   2.50000   3.00000   4.50000
   4.50000   3.00000   2.50000   3.00000   2.00000   1.00000   0.00000   0.00000
   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
   0.00000   0.00000
   2.50000   7.50000   8.10000  10.00000   9.20000  12.50000  14.70000  14.70000
  11.10000   2.50000  10.00000  11.90000  10.80000  10.00000   9.70000   7.50000
   3.30000   6.40000  10.30000  10.80000  13.30000  13.90000  16.70000  18.90000
  16.40000  18.60000  18.10000  19.70000  20.60000  18.30000  16.40000  14.40000
  13.10000  10.80000   8.60000   5.80000  12.20000  14.20000   7.80000  11.90000
  11.90000  10.30000  10.80000  13.90000  11.40000  13.30000  13.90000  16.90000
  20.30000  13.90000  16.70000  16.10000  15.00000  17.80000  19.70000  21.40000
  15.30000  16.40000  18.60000  15.30000  10.60000  11.90000  13.90000  19.20000
  22.20000  19.70000  21.40000  22.20000  21.10000  23.10000  23.30000  22.50000
  23.60000  22.50000  25.00000  26.70000  25.60000  23.60000  23.60000  20.80000
  20.60000  22.20000  22.50000  15.00000  18.10000  21.70000  24.20000  22.80000
  25.00000  20.00000  18.60000  21.90000  23.90000  22.20000  22.20000  20.60000
  19.40000  21.10000  19.20000  17.80000  20.00000  19.40000  16.70000  17.80000
  20.00000  10.80000  13.90000   9.20000  14.20000   8.60000  13.60000  14.40000
  13.10000  13.30000  15.30000  16.10000  18.90000  15.30000  11.40000  12.80000
  16.10000  18.10000  19.20000  18.60000  15.60000  16.10000  18.30000  16.70000
  14.20000  14.40000  14.40000  11.10000  14.40000   9.20000   2.80000   5.00000
   6.40000   8.90000  13.60000  15.60000   9.20000  12.80000  11.40000  12.50000
   8.30000   6.40000   5.60000   6.90000   5.80000   5.80000   7.80000   3.30000
   6.70000   8.30000  10.00000  -1.70000  -1.70000   1.40000   6.90000   8.60000
```

Table 5.--*Input data for Hungry Horse Reservoir, April 26-December 31, 1985*--Continued

6.40000	5.30000	5.30000	7.20000	0.00000	-3.90000	-4.20000	-2.80000
3.10000	4.20000	3.30000	5.30000	6.90000	10.60000	7.80000	6.10000
4.40000	7.80000	8.10000	8.90000	3.30000	3.60000	5.30000	4.20000
5.80000	8.10000	4.70000	1.40000	2.50000	1.40000	2.20000	6.40000
6.40000	6.10000	2.50000	1.10000	0.60000	-3.90000	-6.70000	-12.20000
-8.90000	-10.30000	-6.90000	-5.80000	-3.60000	-5.60000	-12.20000	-13.10000
-12.50000	-13.90000	-16.40000	-18.60000	-18.10000	-15.30000	-19.70000	-20.60000
-19.40000	-18.60000	-16.10000	-19.20000	-17.50000	-13.60000	-3.30000	-3.90000
-4.70000	0.00000	-1.40000	-5.30000	-11.70000	-14.20000	-11.90000	-8.10000
-7.80000	-5.30000	-4.20000	-1.10000	-0.80000	-3.90000	-2.50000	-3.30000
-4.40000	-5.30000	-7.50000	-8.30000	-5.60000	-6.70000	-7.50000	-9.40000
-8.10000	-5.30000						
0.59	0.56	0.63	0.48	0.46	0.44	0.42	0.50
0.48	0.47	0.45	0.53	0.62	0.51	0.52	0.45
0.45	0.44	0.56	0.47	0.39	0.47	0.53	0.57
0.58	0.67	0.65	0.53	0.67	0.72	0.59	0.77
0.87	0.88	0.90	0.71	0.52	0.93	0.75	0.79
0.84	0.89	0.79	0.66	0.64	0.62	0.55	0.61
0.50	0.73	0.55	0.57	0.42	0.57	0.61	0.72
0.68	0.44	0.51	0.49	0.64	0.61	0.55	0.51
0.47	0.47	0.55	0.48	0.49	0.50	0.45	0.47
0.50	0.49	0.51	0.49	0.48	0.49	0.45	0.44
0.45	0.38	0.52	0.49	0.47	0.45	0.48	0.45
0.63	0.67	0.56	0.49	0.40	0.28	0.33	0.39
0.51	0.60	0.82	0.67	0.67	0.60	0.53	0.48
0.54	0.65	0.83	0.63	0.77	0.70	0.61	0.75
0.65	0.60	0.53	0.53	0.71	0.78	0.81	0.68
0.61	0.55	0.48	0.59	0.65	0.57	0.47	0.52
0.51	0.53	0.73	0.62	0.70	0.82	0.68	0.70
0.60	0.62	0.70	0.85	0.70	0.81	0.83	0.74
0.87	0.80	0.91	0.84	0.71	0.78	0.67	0.76
0.76	0.70	0.47	0.64	0.68	0.68	0.75	0.87
0.69	0.73	0.68	0.81	0.60	0.69	0.68	0.64
0.70	0.71	0.57	0.72	0.63	0.73	0.72	0.77
0.70	0.79	0.81	0.63	0.79	0.89	0.66	0.93
0.86	0.67	0.79	0.83	0.76	0.90	0.82	0.86
0.87	0.78	0.77	0.97	0.88	0.58	0.52	0.56
0.74	0.84	0.85	0.94	0.90	0.71	0.61	0.82
0.71	0.64	0.60	0.77	0.70	0.68	0.68	0.72
0.70	0.66	0.56	0.62	0.77	0.85	0.90	0.94
0.94	0.97	0.63	0.79	0.78	0.83	0.87	0.91
0.91	0.92	0.92	0.93	0.96	0.96	0.95	0.95
0.94	0.94	0.93	0.92	0.92	0.91	0.88	0.92
0.88	0.92						
1063.9	1064.0	1064.2	1064.4	1064.7	1065.0	1065.5	1066.2
1066.9	1067.4	1067.8	1068.2	1068.6	1068.9	1069.3	1069.6
1069.9	1070.2	1070.4	1070.7	1071.0	1071.4	1071.9	1072.4
1073.0	1073.7	1074.3	1075.0	1075.7	1076.4	1077.1	1077.6
1078.0	1078.4	1078.9	1079.2	1079.6	1080.0	1080.4	1080.7
1081.0	1081.3	1081.8	1082.5	1082.9	1083.2	1083.4	1083.6
1083.8	1083.9	1084.0	1084.1	1084.2	1084.3	1084.4	1084.4
1084.5	1084.6	1084.7	1084.8	1084.8	1084.8	1084.9	1084.9
1084.9	1085.0	1085.0	1085.0	1085.0	1085.0	1084.9	1084.8
1084.8	1084.8	1084.8	1084.8	1084.7	1084.6	1084.4	1084.4
1084.4	1084.4	1084.3	1084.2	1084.1	1084.0	1084.0	1083.9
1082.3	1083.8	1083.7	1083.5	1083.2	1083.0	1082.9	1082.7
1082.6	1082.4	1082.2	1082.2	1082.1	1082.1	1082.0	1081.9
1081.7	1081.5	1081.4	1081.3	1081.1	1080.9	1080.6	1080.4
1080.2	1080.1	1080.0	1079.8	1079.6	1079.4	1079.1	1078.9
1078.8	1078.7	1078.4	1078.2	1077.9	1077.7	1077.4	1077.3

Table 5.--*Input data for Hungry Horse Reservoir, April 26-December 31, 1985*--Continued

1077.2	1077.1	1076.8	1076.6	1076.4	1076.2	1076.1	1075.9
1075.7	1075.5	1075.3	1075.2	1075.1	1075.1	1075.1	1075.0
1074.9	1074.9	1075.0	1075.0	1075.0	1075.0	1075.0	1075.0
1075.0	1074.9	1074.9	1074.8	1074.8	1074.7	1074.5	1074.3
1074.2	1074.1	1074.0	1073.8	1073.8	1073.7	1073.5	1073.3
1073.1	1072.9	1072.6	1072.4	1072.5	1072.5	1072.6	1072.7
1072.7	1072.8	1072.9	1073.0	1073.1	1073.2	1073.3	1073.5
1073.6	1073.8	1074.0	1074.1	1074.2	1074.4	1074.5	1074.7
1075.0	1075.2	1075.4	1075.6	1075.8	1075.9	1076.0	1076.1
1076.2	1076.3	1076.4	1076.4	1076.5	1076.6	1076.7	1076.7
1076.7	1076.8	1076.8	1076.8	1076.8	1076.8	1076.8	1076.8
1076.8	1076.8	1076.8	1076.8	1076.8	1076.8	1076.8	1076.8
1076.8	1076.8	1076.8	1076.7	1076.7	1076.7	1076.6	1076.6
1076.6	1076.6	1076.4	1076.2	1076.0	1075.8	1075.6	1075.3
1075.0	1074.8	1074.5	1074.3	1074.0	1073.7	1073.5	1073.2
1072.9	1072.6						
0.01645	0.01645						
8595959.4	9660360.8	9481737.1	14713209.1	20186924.2	23558752.3	35321000.1	48898847.6
49916758.0	36006132.1	29179281.3	26049696.4	28951719.6	29047148.7	27187504.8	27481132.8
23492686.0	20446295.6	18784850.6	19279124.3	24911887.9	30334218.1	38648784.0	43285659.3
50305815.1	51335960.0	55353769.6	56552750.5	56215078.4	64938276.5	54340753.0	42644571.5
38873898.7	34638315.0	42624996.3	33463803.1	30094421.9	33965417.5	34819385.6	30463903.8
29570785.3	29861966.4	48436383.6	58512717.4	42624996.3	33546997.7	29813028.4	29098533.6
27889765.1	26103528.2	24199840.0	22991071.5	21033551.6	18236745.0	17546719.2	17845241.0
16298800.2	14182231.8	12378866.6	11412341.1	10844660.4	9334923.1	8708516.8	8600853.2
7318677.6	8170198.8	8799052.0	7355381.1	7463044.7	7365168.7	6139271.9	6555244.8
5906816.4	5852984.6	4991675.8	4720069.9	4556127.6	4375057.0	4499848.9	4340800.4
3525982.8	3665456.1	3878336.3	3516195.2	3689925.1	2941173.7	3124691.2	2894682.6
2938726.8	3716841.0	3119797.4	2471368.9	1661445.0	2415090.2	2429771.6	1901241.2
2390621.2	3371828.1	1071742.2	3342465.3	1455905.4	2324554.9	2050502.1	1656551.2
3313102.5	1118233.3	3107562.9	3457469.6	3900358.4	2488497.2	2312320.4	3670349.9
4228243.0	3087987.7	2801700.4	2231572.7	2397961.9	5038166.9	3012133.8	2202209.9
2182634.7	2185081.6	3362040.5	1671232.6	3161394.7	2297639.0	1431436.4	2637758.1
1181852.7	2985217.9	902906.1	3670349.9	4754326.5	6709399.5	5816281.1	5074870.4
6410877.7	5762449.3	4193986.4	13881263.1	12244287.1	10115484.2	10629333.2	9753343.0
11664371.8	12718985.7	11879699.0	10651355.3	11576283.4	10996368.2	9723980.2	9454821.2
9334923.1	8549468.3	7942637.1	7624540.1	7122925.6	6728974.7	7233036.1	5823621.8
7277080.3	6212678.9	6036502.1	5760002.4	6706952.6	6215125.8	5375839.1	4976994.4
5742874.1	4509636.5	4509636.5	7734650.6	5742874.1	6714293.3	6254276.2	6748549.9
5999798.6	6251829.3	6998133.7	8713410.6	5740427.2	10404218.4	10651355.3	13859241.0
14253191.9	12951441.2	12148858.0	12799733.4	9489077.8	13930201.1	12254074.7	16002725.4
20475658.4	21973161.1	17656829.7	16115282.8	15253974.0	12645578.7	8219136.8	8478508.2
7959765.4	7443469.5	7211014.0	7475279.2	7741991.3	6185763.0	5397861.2	5657232.6
4925609.5	5082211.1	3180969.9	3180969.9	4734751.3	3782907.2	3415872.3	4600171.8
3719287.9	4255158.9	2539882.1	2982771.0	2664674.0	4942737.8	3915039.8	3822057.6
3242142.4	3768225.8	2787019.0	3293527.3	2596160.8	2270723.1	2327001.8	3124691.2
2831063.2	3090434.6	2855532.2	4022703.4	1981988.9	3161394.7	2466475.1	2356364.6
1999117.2	3124691.2	3180969.9	2280510.7	1808259.0	2006457.9	3132031.9	2287851.4
3107562.9	1083976.7						
418419.9	433101.3	440442.0	452676.5	474698.6	464911.0	508955.2	540764.9
572574.6	550552.5	533424.2	513849.0	528530.4	526083.5	528530.4	526083.5
523636.6	523636.6	501614.5	528530.4	535871.1	567680.8	604384.3	638640.9
677791.3	694919.6	704707.2	731623.1	1490162.0	1468139.9	714494.8	677791.3
655769.2	638640.9	655769.2	623959.5	623959.5	619065.7	623959.5	609278.1
604384.3	599490.5	621512.6	631300.2	631300.2	4037384.8	15403234.9	11630115.2
9731320.9	14470966.0	11715756.7	11642349.7	11671712.5	12278543.7	11872358.3	11887039.7
11759800.9	562787.0	535871.1	7267292.7	7157182.2	8199561.6	7289314.8	7181651.2
508955.2	508955.2	7663690.5	7355381.1	12285884.4	9352051.4	13232834.7	12797286.5
10805510.0	6149059.5	4103451.1	4127920.1	8109026.3	19178801.4	18278342.3	8312119.0
5796705.9	5652338.8	9552697.2	14864916.9	13621891.8	5779577.6	5676807.8	9420564.6

Table 5.--*Input data for Hungry Horse Reservoir, April 26-December 31, 1985*--Continued

```
11451491.5 9675042.214468519.123974725.222584886.122538395.016900737.614953005.3
16861587.217275113.317527144.0 7881464.6 7414106.7 7147394.6 7441022.616976591.5
17500228.122682762.112224711.911598305.522009864.622633824.122283917.422396474.8
22682762.112315247.211757354.020957697.723172142.123172142.123120757.223098735.1
12496317.812917184.623049797.123172142.123404597.623441301.123191717.312222265.0
12063216.513088467.623441301.123360553.423666415.923808336.013328263.818285683.0
23766738.823637053.123637053.121283135.417426821.112334822.412356844.519129863.4
16599768.9 9263963.0 9660360.8 9170980.8 9109808.3 9021719.911204354.710196231.9
12295672.012251627.812136623.5 9599188.3 9589400.717338732.719817442.323759398.1
15307805.816761264.317138086.916369760.311935977.713949776.318070355.818547501.3
24248778.024248778.024248778.023994300.4 1759321.0  853968.1  579915.3  579915.3
  572574.6  577468.4  582362.2  572574.6  560340.1  535871.1  535871.1  535871.1
  523636.6  528530.4  552999.4  462464.1  460017.2  460017.2  460017.2  460017.2
  489380.0  508955.2  508955.2  508955.2  508955.2  469804.8  447782.7  447782.7
  447782.7  447782.7  474698.6  479592.4  486933.1  486933.1  474698.6  474698.6
 2593713.9 1455905.4 3180969.9 3180969.9 3180969.9 3264164.5 3415872.3 3562686.3
 3719287.9 4255158.9 4353034.9 4536552.4 4477826.8 4683366.4 3396297.1 3303314.9
 3760885.1 3768225.8 3824504.5 4587937.3 5187427.8 5897028.8 5693936.1 5456586.8
 5162958.8 5162958.815031306.117752258.819856592.723367894.123710460.123710460.1
23710460.123849933.323906212.023906212.023852380.223842592.623979619.023999194.2
24079941.924028557.0
   0.00275   73156608000.0.0864
   2    3    1    1
   2    2
     249.      249.
     100.      100.
      10.       10.
   1
     100.       10.
       0.        0.   30
      2.0       2.0
  51   51  250  250   69
     3.05      3.05        1.        1.    935.74    935.74       1.0
      0.0   80940.0  145692.0  194256.0  412794.0  603003.0  857964.0 1173630.0
 1396215.0 1647129.0 2063970.0 2909793.0 4111752.0 4896870.0 5928855.0 7151049.0
 8514888.0 9813975.011198049.011979120.013257972.014395179.015386694.017033823.0
18268158.019583433.021064635.022792704.024840486.026876127.029450019.031756809.0
34524957.036665820.038956422.041663865.044363214.047289195.050231364.053837241.0
59745861.062756829.065549259.071085555.075751746.079673289.083647443.087864417.0
91992357.096120297.0100248237.
      0.0    1930.8    3378.9    4666.1    6484.3    7642.7    9654.0   11263.0
  13065.1   14094.8   15526.8   16814.1   18342.6   19710.2   21045.7   21818.0
  23443.1   24794.7   26661.1   27723.1   28962.0   30731.9   32083.5   33805.1
  35349.7   37602.3   38744.7   39806.7   41335.2   40981.2   43941.8   45019.8
  46435.7   47835.6   49251.5   50651.3   51504.1   52887.8   54126.8   55108.2
  56073.6   57151.7   58294.1   59372.1   60916.7   62010.9   62895.8   64134.7
  65100.1   65840.3   66580.4
  362990.4  505869.6  278035.2  343682.4  208526.4  247142.4  312789.6  374575.2
  486561.6  362990.4  243280.8  243280.8  189218.4  235557.6  320512.8  575378.4
  262588.8  308928.0  258727.2  405468.0  405468.0  220111.2  146740.8  227834.4
  270312.0  223972.8  223972.8  247142.4  305066.4  332097.6  478838.4  262588.8
  266450.4  289620.0  459530.4  258727.2  359128.8  297343.2  158325.6  332097.6
  312789.6  308928.0  509731.2  343682.4  181495.2  220111.2  339820.8  339820.8
  444084.0  293481.6  444084.0  212388.0  266450.4  154464.0  274173.6  328236.0
  247142.4  390021.6  335959.2  359128.8  177633.6  247142.4  239419.2  243280.8
  355267.2  312789.6  208526.4  254865.6  223972.8  189218.4  305066.4  196941.6
  285758.4  177633.6  200803.2  266450.4  243280.8  266450.4  305066.4  235557.6
  281896.8  308928.0  486561.6  227834.4  166048.8  142879.2  173772.0  281896.8
  266450.4  243280.8  139017.6  223972.8  258727.2  536762.4  548347.2  444084.0
  173772.0  270312.0  285758.4  258727.2  200803.2  177633.6  185356.8  262588.8
```

Table 5.--*Input data for Hungry Horse Reservoir, April 26-December 31, 1985*--Continued

386160.0	177633.6	235557.6	254865.6	278035.2	142879.2	258727.2	351405.6
185356.8	227834.4	220111.2	227834.4	177633.6	270312.0	181495.2	158325.6
216249.6	274173.6	285758.4	266450.4	247142.4	247142.4	351405.6	270312.0
274173.6	362990.4	285758.4	355267.2	362990.4	764596.8	652610.4	652610.4
563793.6	274173.6	216249.6	378436.8	343682.4	243280.8	328236.0	490423.2
251004.0	216249.6	115848.0	196941.6	471115.2	278035.2	258727.2	177633.6
193080.0	305066.4	563793.6	96540.0	100401.6	146740.8	135156.0	231696.0
196941.6	150602.4	173772.0	768458.4	613994.4	177633.6	177633.6	96540.0
181495.2	254865.6	413191.2	459530.4	413191.2	335959.2	251004.0	154464.0
177633.6	108124.8	266450.4	494284.8	359128.8	239419.2	502008.0	100401.6
108124.8	393883.2	146740.8	212388.0	343682.4	474976.8	432499.2	451807.2
343682.4	432499.2	355267.2	146740.8	343682.4	888168.0	579240.0	567655.2
177633.6	92678.4	92678.4	57924.0	169910.4	807074.4	540624.0	169910.4
540624.0	722119.2	505869.6	119709.6	447945.6	876583.2	525177.6	258727.2
196941.6	583101.6	641025.6	251004.0	166048.8	135156.0	127432.8	46339.2
57924.0	146740.8	687364.8	278035.2	223972.8	46339.2	38616.0	92678.4
104263.2	81093.6	131294.4	65647.2	88816.8	100401.6	123571.2	150602.4
69508.8	111986.4	73370.4	131294.4	88816.8	88816.8	162187.2	139017.6
73370.4	42477.6						
1085.34	48.1350	.07	.07				
1 250							
1.00	1.00	1.00	0.50	0.60	1.00	1.00	0.90
0.90	0.60	1.00	1.00	0.90	0.70	0.90	0.80
0.40	0.00	0.90	0.00	0.00	0.00	0.00	0.50
0.30	0.50	0.80	0.60	0.70	0.80	0.80	0.60
1.00	1.00	1.00	0.50	0.80	1.00	0.60	1.00
1.00	1.00	0.90	0.90	0.70	0.50	0.30	0.90
1.00	0.80	0.80	0.40	0.10	0.00	0.10	0.70
0.30	0.00	0.50	0.50	0.80	0.10	0.10	0.30
0.80	0.30	0.60	0.10	0.00	0.50	0.30	0.20
0.50	0.00	0.00	0.10	0.60	0.20	0.20	0.30
0.10	0.10	0.40	0.00	0.00	0.50	0.00	0.80
0.60	0.30	0.00	0.00	0.70	0.40	0.60	0.80
0.80	0.70	1.00	0.60	0.50	0.40	0.10	0.80
1.00	1.00	1.00	0.50	0.80	0.60	0.80	1.00
0.70	0.00	0.00	1.00	1.00	0.90	0.70	0.00
0.70	0.20	0.70	0.80	0.50	0.10	0.30	0.70
0.90	0.90	0.90	0.60	1.00	1.00	0.80	0.90
0.90	0.20	0.50	1.00	0.70	1.00	0.90	1.00
1.00	0.90	1.00	1.00	0.90	0.60	0.80	0.50
0.00	0.70	0.80	0.00	0.00	0.00	1.00	1.00
0.20	0.30	0.70	1.00	1.00	0.80	0.80	1.00
1.00	0.90	0.90	1.00	1.00	1.00	0.60	0.60
0.90	0.80	1.00	0.90	0.90	1.00	0.80	1.00
0.50	0.60	0.60	0.80	1.00	1.00	1.00	1.00
1.00	0.90	0.70	1.00	1.00	1.00	0.70	0.20
0.50	0.30	0.70	1.00	1.00	1.00	0.90	0.90
1.00	1.00	0.90	1.00	1.00	1.00	0.90	0.90
0.60	1.00	1.00	0.00	1.00	1.00	1.00	1.00
1.00	1.00	0.70	0.70	0.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	0.90	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.90	1.00						

Table 6.--*Input data for Lake Koocanusa, April 2-December 31, 1984*

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LAKE KOOCANUSA FOR THE PERIOD APRIL 2, 1984 THROUGH DECEMBER 31, 1984
Units are meters, days, kilocalories, or degrees Celsius
   51   22    1    2    1    1    3   30    2    2    2    2    1    2
     722.6    677.30        1.      270.       4.5  0.010000   1.37E-2   5.40E-2
      1.96       4.0       .33       .60      997.      .998        1.       10.
  274  274  274  274  274    2  274  274  274
        1.        1.        1.        1.        1.      273.        1.        1.
   93  366    1
    8
       45.       72.       81.      100.      107.      134.      163.      200.
   4.20000   4.70000   5.70000   5.70000   5.20000   4.20000   4.70000   4.70000
   4.70000   4.20000   4.20000   5.20000   5.70000   6.80000   7.30000   6.30000
   4.70000   4.70000   4.70000   5.20000   5.70000   5.20000   4.70000   4.20000
   3.60000   4.70000   4.70000   4.70000   5.20000   5.70000   6.80000   6.30000
   5.70000   6.30000   5.70000   6.80000   7.30000   7.30000   6.80000   6.30000
   6.80000   7.80000   8.90000   7.80000   6.30000   6.80000   7.80000   7.30000
   6.80000   6.30000   6.80000   7.80000   6.80000   7.30000   6.80000   7.80000
   8.90000   9.90000   9.40000   7.30000   6.80000   7.80000   8.30000   7.80000
   7.80000   7.80000   8.30000   7.80000   7.30000   7.80000   8.90000   9.40000
   9.40000   9.90000  10.40000  10.40000  10.40000   9.90000  10.40000  10.40000
   9.90000   8.90000   9.90000  11.50000  12.00000  12.00000  12.50000  12.50000
  12.50000  10.40000  10.40000  11.50000  12.50000  13.00000  13.60000  13.60000
  13.00000  12.50000  13.00000  13.60000  14.60000  15.10000  14.60000  14.60000
  15.10000  16.20000  16.70000  16.70000  16.70000  16.20000  15.60000  14.60000
  15.10000  16.20000  17.20000  17.70000  17.20000  17.20000  17.20000  16.20000
  16.20000  17.20000  17.20000  16.20000  16.70000  17.20000  16.70000  15.60000
  16.20000  17.20000  17.70000  16.20000  15.10000  16.20000  16.20000  16.70000
  17.20000  17.70000  17.70000  16.70000  15.10000  15.10000  15.60000  16.20000
  16.20000  15.60000  15.60000  14.60000  13.00000  13.00000  12.50000  11.50000
  12.00000  12.00000  12.50000  13.00000  14.10000  13.00000  10.40000  10.40000
  11.50000  11.50000  10.90000  10.90000  10.40000  10.40000  10.40000  10.90000
  12.00000  12.50000  12.50000  11.50000   9.90000   8.90000   7.80000   6.80000
   7.30000   7.80000   6.80000   6.80000   6.80000   7.30000   7.80000   8.30000
   8.90000   9.40000   9.40000   8.90000   8.90000   9.40000   9.40000   9.40000
   8.30000   7.80000   7.30000   6.80000   5.70000   5.70000   5.20000   5.20000
   4.70000   4.20000   3.60000   3.60000   3.60000   4.20000   4.70000   4.70000
   3.60000   3.10000   2.60000   2.10000   1.00000   0.00000   0.00000   2.10000
   2.10000   2.10000   2.60000   3.10000   2.60000   2.10000   1.60000   2.60000
   3.10000   4.20000   3.60000   2.60000   1.00000   0.50000   0.50000   1.00000
   2.60000   3.10000   2.60000   2.10000   2.10000   1.00000   0.50000   0.00000
   0.50000   1.00000   1.60000   1.00000   0.00000   0.00000   0.00000   0.00000
   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
   0.00000   0.00000
   5.00000   5.80000   6.10000   6.70000  10.30000   4.40000   6.70000   4.40000
   5.60000   5.30000   3.60000   4.70000   6.70000   9.40000  11.40000  15.80000
  10.80000  10.00000   8.90000   7.50000   9.70000  10.30000   4.70000   4.40000
   4.40000   2.80000   4.20000   3.90000   5.60000   6.70000  10.00000   7.20000
   4.70000   5.30000   5.30000   7.80000  10.00000  10.30000   8.30000   8.10000
   8.10000  10.00000  12.20000  12.20000   7.80000   6.40000  10.80000  12.50000
  10.80000   8.30000   7.80000  11.10000   8.90000   8.60000   9.40000   7.80000
  11.40000  14.70000  19.20000  14.40000   8.10000  10.80000  11.90000  12.50000
  11.10000  10.80000  10.60000  13.30000   9.70000   8.60000  13.60000  15.00000
  15.80000  12.80000  18.10000  19.20000  15.60000  15.00000  16.40000  18.10000
  19.20000  10.60000  10.80000  14.40000  19.70000  19.40000  20.60000  18.90000
  22.20000  14.70000  13.30000  16.90000  17.80000  18.30000  20.30000  20.30000
  17.50000  17.20000  16.70000  18.30000  20.30000  20.80000  19.20000  18.60000
  18.60000  20.60000  23.30000  23.10000  22.80000  20.60000  19.40000  15.30000
  20.60000  21.10000  23.10000  25.60000  27.80000  25.60000  25.80000  21.10000
  19.70000  22.80000  22.80000  19.40000  21.40000  20.30000  23.10000  16.40000
  18.60000  21.90000  24.70000  23.30000  22.20000  20.00000  17.50000  18.90000
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22.20000	23.60000	24.40000	20.30000	16.40000	15.00000	18.90000	20.80000
19.40000	19.70000	20.00000	20.80000	17.80000	13.30000	15.80000	13.30000
12.80000	12.50000	15.60000	15.30000	18.90000	20.30000	12.50000	13.60000
15.30000	14.70000	12.80000	12.80000	9.40000	10.00000	11.10000	11.10000
14.70000	17.50000	19.40000	16.10000	11.90000	8.30000	7.80000	3.90000
5.00000	8.90000	4.70000	5.60000	5.00000	5.60000	7.50000	10.00000
12.80000	11.90000	12.80000	10.30000	8.10000	11.70000	13.30000	13.90000
11.10000	9.70000	9.70000	6.90000	3.60000	2.80000	4.20000	3.90000
1.70000	-0.30000	1.40000	1.90000	2.80000	-0.30000	4.70000	6.90000
2.50000	1.40000	2.80000	0.60000	-1.70000	-5.30000	-5.00000	1.40000
5.60000	4.20000	4.20000	2.20000	3.90000	2.80000	0.60000	3.10000
5.00000	5.30000	3.30000	1.10000	0.60000	0.30000	1.10000	0.80000
2.80000	1.90000	2.50000	1.70000	0.30000	1.70000	0.60000	0.00000
-2.20000	1.10000	1.70000	0.60000	-1.40000	-5.00000	-6.70000	-6.10000
-8.30000	-7.50000	-5.60000	-0.30000	1.40000	-0.80000	-4.20000	-3.90000
-1.70000	-2.20000	-3.60000	-5.60000	-10.30000	-11.70000	-8.90000	-8.60000
-4.20000	0.60000	-3.30000	-5.60000	-1.40000	-0.60000	-2.80000	-6.70000
-10.00000	-11.70000						
0.53	0.52	0.49	0.71	0.67	0.53	0.74	0.57
0.61	0.57	0.70	0.56	0.51	0.41	0.36	0.65
0.74	0.72	0.71	0.61	0.45	0.53	0.45	0.51
0.38	0.37	0.50	0.35	0.41	0.60	0.66	0.68
0.63	0.82	0.80	0.67	0.60	0.49	0.60	0.78
0.62	0.52	0.82	0.86	0.70	0.46	0.51	0.77
0.58	0.60	0.51	0.65	0.72	0.61	0.80	0.65
0.56	0.53	0.60	0.38	0.43	0.48	0.53	0.75
0.76	0.80	0.71	0.70	0.78	0.61	0.62	0.63
0.79	0.75	0.67	0.60	0.57	0.47	0.56	0.65
0.86	0.86	0.74	0.67	0.58	0.50	0.51	0.56
0.55	0.46	0.62	0.58	0.60	0.60	0.60	0.53
0.50	0.54	0.61	0.55	0.43	0.38	0.45	0.50
0.50	0.48	0.45	0.44	0.39	0.38	0.43	0.37
0.35	0.49	0.43	0.44	0.71	0.63	0.71	0.66
0.53	0.56	0.68	0.67	0.57	0.60	0.62	0.50
0.52	0.46	0.41	0.55	0.63	0.51	0.50	0.50
0.45	0.55	0.53	0.48	0.43	0.43	0.37	0.46
0.47	0.44	0.40	0.29	0.28	0.34	0.66	0.86
0.65	0.65	0.53	0.59	0.48	0.52	0.43	0.81
0.73	0.78	0.75	0.76	0.80	0.66	0.62	0.66
0.61	0.58	0.63	0.86	0.77	0.65	0.48	0.57
0.67	0.59	0.56	0.66	0.61	0.60	0.64	0.67
0.69	0.61	0.62	0.69	0.70	0.69	0.68	0.68
0.78	0.71	0.63	0.69	0.77	0.81	0.80	0.68
0.71	0.62	0.70	0.74	0.78	0.83	0.82	0.85
0.78	0.79	0.81	0.74	0.73	0.79	0.83	0.63
0.60	0.64	0.71	0.58	0.70	0.76	0.83	0.78
0.87	0.82	0.66	0.68	0.71	0.75	0.80	0.71
0.83	0.85	0.87	0.87	0.83	0.79	0.70	0.88
0.88	0.72	0.86	0.88	0.83	0.69	0.64	0.72
0.74	0.92	0.90	0.88	0.81	0.74	0.75	0.81
0.70	0.72	0.69	0.77	0.72	0.76	0.81	0.74
0.81	0.70	0.71	0.80	0.76	0.72	0.63	0.72
0.66	0.65						
4912.161	5009.136	5059.858	4980.975	5071.136	5167.468	5214.137	5347.602
5374.948	5373.682	5484.746	5570.975	5618.965	5654.911	5704.835	5564.425
5677.377	5750.644	5823.923	5929.951	6021.632	6031.763	6190.635	6107.948
6180.770	6261.296	6240.065	6347.074	6275.055	6313.043	6215.771	6363.928
6482.559	6368.093	6479.259	6546.707	6549.241	6663.222	6669.243	6624.402
6745.155	6785.384	6617.799	6631.281	6830.656	7005.792	6943.875	6790.882
6971.531	7034.916	7124.836	6935.901	6975.512	7051.305	7036.360	7191.990
7183.674	7106.106	6929.968	7301.813	7382.412	7326.226	7306.280	7157.932
7202.775	7204.826	7212.646	7217.455	7224.444	7330.306	7285.476	7202.464

Table 6.--*Input data for Lake Koocanusa, April 2-December 31, 1984*--Continued

7086.144	7297.913	7205.244	7205.326	7327.397	7407.861	7325.134	7133.696
6982.855	7272.581	7349.793	7291.041	7208.478	7274.509	7224.334	7186.294
7137.952	7386.472	7221.000	7247.365	7196.669	7158.386	7075.853	7114.800
7200.560	7158.106	7100.956	7049.206	7114.287	7145.705	7080.181	6996.212
6973.121	6916.391	6848.997	6873.289	6868.217	6928.226	6888.344	6976.166
6878.439	6708.303	6680.172	6579.685	6159.487	6291.947	6168.028	6383.452
6470.351	6320.201	6205.807	6262.187	6263.136	6236.834	6099.794	6283.720
6161.070	6089.109	6079.330	5860.584	5867.092	5944.590	5958.304	5882.484
5823.206	5637.571	5695.007	5791.426	5814.797	5785.579	5767.801	5587.017
5555.966	5520.255	5517.297	5525.710	5438.008	5399.160	5199.441	5132.404
5176.854	5140.626	5073.093	4996.568	4937.308	4830.973	4941.022	4644.158
4586.856	4522.571	4589.571	4455.395	4519.830	4451.370	4360.187	4366.094
4221.229	4132.562	4058.783	3986.561	4134.938	4163.454	4155.744	4062.808
3947.690	3945.979	3877.459	3798.438	3749.959	3736.613	3607.278	3579.093
3423.471	3449.644	3329.847	3328.613	3295.712	3165.862	3096.353	3020.598
3061.888	2957.686	2978.151	2973.024	2848.744	2888.299	2829.576	2800.758
2763.198	2641.522	2671.925	2618.063	2562.109	2530.000	2535.302	2469.144
2469.166	2349.008	2343.769	2358.601	2240.292	2299.283	2256.033	2206.717
2151.314	2080.283	2072.533	1973.022	2005.166	1970.900	1942.776	1901.841
1849.948	1822.939	1778.499	1693.869	1769.561	1650.659	1705.769	1688.046
1644.253	1622.822	1549.320	1576.281	1515.550	1491.427	1530.266	1501.037
1490.378	1471.346	1442.302	1429.651	1424.089	1343.269	1368.455	1401.969
1394.203	1375.068	1360.151	1334.076	1324.130	1236.860	1328.867	1319.269
1312.474	1308.285	1219.196	1308.298	1268.805	1317.606	1310.219	1311.911
1299.979	1294.455	1306.155	1311.911	1306.031	1310.588	1327.093	1339.360
1355.498	1245.455						
722.6	722.6	722.5	722.5	722.5	722.5	722.5	722.5
722.5	722.5	722.5	722.5	722.5	722.5	722.5	722.5
722.6	722.7	722.9	723.0	723.2	723.4	723.6	723.7
723.9	724.0	724.1	724.1	724.2	724.3	724.3	724.4
724.4	724.5	724.6	724.6	724.7	724.7	724.8	724.9
725.0	725.1	725.1	725.2	725.5	725.7	726.0	726.2
726.5	726.9	727.2	727.5	727.8	728.1	728.4	728.6
728.9	729.1	729.4	729.9	730.6	731.2	731.6	731.9
732.3	732.6	733.0	733.4	734.0	734.5	734.9	735.4
735.8	736.4	737.0	737.6	738.4	739.0	739.6	740.1
740.6	741.1	741.6	742.1	742.6	743.1	743.6	744.1
744.7	745.2	745.8	746.2	746.5	746.7	746.9	747.2
747.5	747.8	748.0	748.2	748.3	748.3	748.4	748.5
748.6	748.7	748.8	748.9	748.9	748.9	748.9	749.0
749.0	749.0	749.1	749.1	749.1	749.2	749.4	749.5
749.5	749.5	749.4	749.3	749.3	749.4	749.4	749.4
749.4	749.3	749.3	749.3	749.4	749.4	749.4	749.4
749.4	749.3	749.3	749.4	749.3	749.2	749.1	748.9
748.8	748.6	748.5	748.3	748.3	748.2	748.1	748.1
748.0	748.0	748.0	748.0	747.9	747.8	747.7	747.7
747.7	747.7	747.6	747.6	747.6	747.6	747.6	747.6
747.6	747.5	747.4	747.3	747.2	747.2	747.2	747.2
747.1	747.1	747.0	746.9	746.9	746.8	746.8	746.7
746.6	746.4	746.3	746.2	746.2	746.2	746.2	746.1
745.9	745.9	745.8	745.8	745.8	745.6	745.4	745.2
745.0	744.9	744.9	744.9	744.9	744.7	744.6	744.4
744.2	744.1	744.0	743.7	743.5	743.4	743.3	743.2
743.2	743.3	743.2	743.0	742.8	742.6	742.4	742.3
742.1	741.8	741.6	741.4	741.2	740.9	740.7	740.6
740.4	740.1	740.0	739.9	739.7	739.6	739.4	739.2
738.9	738.7	738.4	738.3	738.2	738.0	737.7	737.5
737.2	736.9	736.6	736.4	736.1	735.8	735.6	735.3
734.9	734.7	734.5	734.3	734.0	733.6	733.2	732.9
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729.6	729.2						
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29118108.823245549.123490239.123490239.122756169.110276979.610032289.626181829.0
29118108.841107918.444533578.245757028.220064579.210521669.625203069.038416328.5
40373848.440129158.420798649.210276979.6 9787599.626671208.925203069.025203069.0
24713689.024224309.010032289.614681399.433277838.748203928.148203928.141841988.3
48448618.148448618.140129158.436458808.536214118.631565008.724224309.024224309.0
19819889.219575199.219575199.223979619.023245549.137192878.536703498.519085819.2
15170779.419575199.219330509.219085819.220064579.223490239.1 9542909.6 9787599.6
24713689.036214118.636703498.536703498.528384038.917617679.3 9787599.625203069.0
31320318.728139348.928384038.930830938.819575199.212723879.528628728.930830938.8
36703498.536458808.542576058.319330509.2 9787599.6 9787599.623734929.139395088.4
19575199.222756169.119085819.2 9787599.633277838.745757028.246001718.245757028.2
45267648.210032289.6 9787599.6 9787599.620309269.237682258.542086678.346491098.1
34011908.633277838.738171638.547959238.145757028.234745978.610032289.6 9787599.6
```

Table 6.--*Input data for Lake Koocanusa, April 2-December 31, 1984*--Continued

```
 9787599.6 9787599.634990668.642576058.347469858.144778268.230096868.832299078.7
46980478.148937998.048693308.148203928.148448618.148448618.126671208.936214118.6
48203928.139639778.431320318.731565008.731320318.731075628.834745978.646980478.1
46980478.148203928.143310128.333277838.734501288.636214118.649182688.047714548.1
46491098.146491098.146246408.246001718.245757028.245757028.255299937.854810557.8
53342417.934011908.634011908.651874277.955544627.858970287.656768077.743310128.3
58725597.758725597.758725597.758725597.758725597.758725597.758480907.758236217.7
58236217.747714548.1
    .000585  73156608000.0.0864
     2    3    1    1
     2    2
       273.       273.
       100.       100.
        10.        10.
     1
       100.        10.
         0.         0.   30
        2.0        2.0
    37   37  274  274   69
       3.05       3.05         1.         1.     643.13     643.13        0.9
         0.    352089.    704623.   1622199.   2607442.   4237654.   6542137.   9522591.
  13742762.  17303394.  21364275.  24803820.  28051902.  32885315.  39053752.  44093401.
  49223418.  53347230.  60970564.  68924538.  74151400.  78287070.  85696965.  90709053.
  95691477.101076010.108039926.113956195.120595541.132481418.146394681.156040422.
164915857.173265951.181404428.188748033.196236035.
        0.0      724.0     1287.2     5245.3     9026.5    14738.4    20273.4    24859.0
    26484.1    29010.3    37473.6    42397.1    47481.6    52421.2    56749.4    62107.4
    65582.8    69203.1    73949.6    74818.5    79001.9    82364.7    85035.6    87610.0
    91165.9    94657.5    98132.9   101608.4   105067.7   119387.8   125421.6   130087.7
   134802.0   139500.3   143217.1   148510.7   153804.3
   266450.4   220111.2   135156.0   162187.2   266450.4   401606.4   212388.0   332097.6
   401606.4   444084.0   308928.0   312789.6   181495.2   339820.8   332097.6   239419.2
   177633.6   251004.0   320512.8   390021.6   463392.0   451807.2   312789.6   451807.2
   579240.0   320512.8   289620.0   320512.8   166048.8   258727.2   521316.0   382298.4
   281896.8   220111.2   181495.2   266450.4   251004.0   625579.2   335959.2   231696.0
   308928.0   308928.0   239419.2   289620.0   498146.4   393883.2   305066.4   262588.8
   548347.2   305066.4   347544.0   455668.8   293481.6   200803.2   177633.6   324374.4
   212388.0   266450.4   374575.2   621717.6   405468.0   212388.0   177633.6   181495.2
   293481.6   243280.8   359128.8   359128.8   332097.6   312789.6   305066.4   266450.4
   196941.6   231696.0   247142.4   312789.6   235557.6   247142.4   231696.0   366852.0
   366852.0   139017.6   166048.8   231696.0   301204.8   347544.0   374575.2   204664.8
   362990.4   436360.8   355267.2   220111.2   193080.0   289620.0   274173.6   324374.4
   251004.0   247142.4   154464.0   220111.2   216249.6   274173.6   274173.6   227834.4
   200803.2   196941.6   258727.2   274173.6   316651.2   316651.2   297343.2   305066.4
   262588.8   185356.8   177633.6   343682.4   204664.8   243280.8   243280.8   293481.6
   227834.4   254865.6   208526.4   305066.4   281896.8   243280.8   305066.4   308928.0
   208526.4   220111.2   289620.0   328236.0   308928.0   270312.0   173772.0   223972.8
   289620.0   220111.2   308928.0   258727.2   235557.6   139017.6   293481.6   289620.0
   270312.0   220111.2   413191.2   691226.4   401606.4   223972.8   223972.8   270312.0
   339820.8   135156.0   270312.0   212388.0   324374.4   544485.6   366852.0   177633.6
   227834.4   189218.4   200803.2   227834.4   212388.0   285758.4   189218.4   158325.6
   154464.0   243280.8   169910.4   258727.2   227834.4   474976.8   583101.6   239419.2
   258727.2   598548.0   146740.8   150602.4    96540.0   142879.2   100401.6    54062.4
   131294.4   196941.6   181495.2   108124.8   119709.6   108124.8   135156.0   104263.2
   220111.2   444084.0   471115.2   362990.4    88816.8   108124.8   123571.2   278035.2
   158325.6   166048.8    57924.0    54062.4    88816.8   162187.2   467253.6   440222.4
   289620.0   351405.6   227834.4   405468.0   463392.0    65647.2   266450.4   486561.6
   401606.4   181495.2   251004.0   335959.2   220111.2   200803.2   142879.2   289620.0
   123571.2   262588.8   339820.8   108124.8   146740.8    84955.2    42477.6   231696.0
    61785.6    50200.8    38616.0        0.0    61785.6   111986.4    81093.6   173772.0
   274173.6   370713.6   223972.8    88816.8    61785.6    50200.8    84955.2    46339.2
   104263.2    42477.6   177633.6   247142.4   278035.2   142879.2   131294.4    81093.6
```

Table 6.--*Input data for Lake Koocanusa, April 2-December 31, 1984*--Continued

563793.6	590824.8	695088.0	297343.2	220111.2	73370.4	92678.4	355267.2
382298.4	517454.4	96540.0	57924.0	436360.8	235557.6	621717.6	274173.6
362990.4	127432.8						
1 274							
0.20	0.50	0.80	0.90	1.00	0.90	1.00	0.70
1.00	0.90	1.00	0.70	0.70	0.20	0.40	1.00
1.00	1.00	1.00	1.00	0.80	0.80	0.50	0.70
1.00	0.60	1.00	0.70	0.90	1.00	0.90	1.00
0.60	0.90	1.00	0.60	1.00	0.50	0.80	1.00
0.70	0.80	1.00	1.00	1.00	0.60	0.80	1.00
0.80	0.80	0.50	0.90	0.90	0.90	1.00	0.60
0.70	0.00	0.90	0.60	0.60	0.80	0.70	1.00
1.00	1.00	0.90	1.00	0.90	0.90	1.00	0.90
0.90	0.60	0.50	0.40	0.40	0.40	0.80	0.90
1.00	1.00	0.30	0.40	0.80	0.30	0.40	0.00
0.70	0.70	0.90	0.50	0.50	0.70	0.20	0.40
0.10	0.30	0.40	0.00	0.30	0.60	0.30	0.00
0.00	0.00	0.00	0.30	0.00	0.40	0.20	0.10
0.80	0.20	0.20	0.80	0.80	1.00	1.00	0.70
0.30	1.00	0.60	0.30	0.70	0.60	0.50	0.40
0.00	0.00	0.60	0.90	0.60	0.10	0.10	0.20
0.80	0.20	0.30	0.10	0.00	0.00	0.50	0.40
0.40	0.30	0.60	0.70	0.90	0.90	0.40	1.00
1.00	0.50	0.80	1.00	0.70	1.00	1.00	0.90
0.90	0.90	1.00	0.90	0.50	0.10	0.90	0.50
0.00	0.00	0.80	1.00	1.00	1.00	1.00	0.40
0.90	1.00	0.00	0.10	0.00	0.60	0.40	1.00
0.20	0.50	0.40	0.80	0.80	0.00	0.00	0.90
1.00	0.90	0.80	1.00	0.90	1.00	1.00	1.00
1.00	0.90	1.00	1.00	1.00	1.00	1.00	1.00
1.00	0.90	0.80	1.00	0.20	1.00	1.00	1.00
1.00	0.60	1.00	0.90	1.00	1.00	1.00	1.00
1.00	1.00	0.60	0.10	1.00	0.90	1.00	1.00
1.00	1.00	0.70	1.00	0.80	0.80	1.00	1.00
1.00	1.00	1.00	1.00	1.00	0.00	0.80	1.00
1.00	1.00	1.00	1.00	1.00	0.90	1.00	1.00
1.00	1.00	0.90	1.00	0.50	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1.00	0.30						
677.30000	677.30000	677.30000	677.30000	677.30000	677.30000	677.30000	677.30000
677.30000	677.30000	677.30000	677.30000	677.30000	677.30000	677.30000	677.30000
677.30000	677.30000	677.30000	677.30000	677.30000	677.30000	677.30000	677.30000
677.30000	677.30000	677.30000	677.30000	677.30000	677.30000	677.30000	677.30000
677.30000	677.30000	677.30000	677.30000	677.30000	677.30000	677.30000	677.30000
677.30000	677.30000	696.20000	696.20000	696.20000	696.20000	696.20000	696.20000
696.20000	696.20000	696.20000	696.20000	715.10000	715.10000	715.10000	715.10000
715.10000	715.10000	715.10000	715.10000	715.10000	715.10000	715.10000	715.10000
715.10000	715.10000	715.10000	715.10000	715.10000	715.10000	715.10000	715.10000
715.10000	715.10000	715.10000	715.10000	715.10000	715.10000	715.10000	715.10000
715.10000	715.10000	715.10000	715.10000	715.10000	715.10000	724.50000	724.50000
724.50000	724.50000	724.50000	724.50000	724.50000	724.50000	724.50000	724.50000
724.50000	724.50000	724.50000	730.90000	730.90000	730.90000	730.90000	730.90000
730.90000	730.90000	730.90000	730.90000	730.90000	730.90000	730.90000	730.90000
730.90000	730.90000	730.90000	730.90000	727.90000	727.90000	727.90000	727.90000
727.90000	727.90000	727.90000	727.90000	727.90000	727.90000	727.90000	727.90000
727.90000	727.90000	727.90000	727.90000	727.90000	727.90000	727.90000	727.90000
727.90000	727.90000	727.90000	727.90000	727.90000	724.50000	724.50000	724.50000
724.50000	724.50000	724.50000	724.50000	724.50000	724.50000	724.50000	724.50000
724.50000	724.50000	724.50000	724.50000	724.50000	724.50000	724.50000	724.50000
724.50000	724.50000	724.50000	724.50000	724.50000	724.50000	724.50000	724.50000
724.50000	724.50000	724.50000	724.50000	724.50000	724.50000	724.50000	724.50000
724.50000	724.50000	724.50000	724.50000	724.50000	724.50000	724.50000	724.50000

Table 6.--*Input data for Lake Koocanusa, April 2-December 31, 1984*--Continued

724.50000	724.50000	724.50000	724.50000	724.50000	724.50000	724.50000	724.50000
724.50000	724.50000	724.50000	724.50000	724.50000	724.50000	724.50000	724.50000
724.50000	724.50000	724.50000	724.50000	724.50000	724.50000	724.50000	724.50000
724.50000	724.50000	724.50000	724.50000	724.50000	724.50000	724.50000	724.50000
724.50000	721.50000	721.50000	721.50000	721.50000	721.50000	721.50000	721.50000
721.50000	721.50000	721.50000	721.50000	721.50000	721.50000	721.50000	721.50000
721.50000	721.50000	721.50000	721.50000	721.50000	721.50000	715.10000	715.10000
715.10000	715.10000	715.10000	715.10000	715.10000	715.10000	715.10000	715.10000
715.10000	715.10000	715.10000	715.10000	715.10000	715.10000	715.10000	715.10000
715.10000	715.10000	715.10000	715.10000	696.20000	696.20000	696.20000	696.20000
696.20000	696.20000	696.20000	696.20000	696.20000	677.30000	677.30000	677.30000
677.30000	677.30000						

23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23
23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23
23	23	23	23	23	23	23	23	23	23	35	35	35	35	35	35
35	35	35	35	47	47	47	47	47	47	47	47	47	47	47	47
47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47
47	47	47	47	47	47	53	53	53	53	53	53	53	53	53	53
53	53	53	57	57	57	57	57	57	57	57	57	57	57	57	57
57	57	57	57	55	55	55	55	55	55	55	55	55	55	55	55
55	55	55	55	55	55	55	55	55	55	55	55	55	53	53	53
53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53
53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53
53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53
53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53
53	53	53	53	53	53	53	53	53	51	51	51	51	51	51	51
51	51	51	51	51	51	51	51	51	51	51	51	51	51	47	47
47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47
47	47	47	47	35	35	35	35	35	35	35	35	35	23	23	23
23	23														

Table 7.--*Input data for Lake Koocanusa, April 18-December 31, 1985*

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LAKE KOOCANUSA FOR THE PERIOD APRIL 18, 1985 THROUGH DECEMBER 31, 1985
Units are meters, days, kilocalories, or degrees Celsius
  46   22    1    2    1    1    3   30    2    2    2    2    2    2
    715.30    677.30        1.      250.       4.5       .01   1.37E-2   5.40E-2
      1.96       4.0       .37       .65      997.      .998        1.       10.
 258  258  258    0  258    2  258  258  258
        1.        1.        1.        1.        1.      257.        1.        1.
 108  365    2
   8
       28.       64.       83.      118.      148.      175.      202.      238.
   4.70000   3.10000   3.10000   3.60000   3.60000   4.70000   4.70000   4.70000
   4.20000   5.20000   6.30000   6.30000   6.30000   6.80000   6.80000   6.30000
   5.20000   4.70000   5.70000   6.30000   5.20000   5.70000   6.30000   6.30000
   5.70000   6.80000   7.30000   7.80000   8.30000   8.30000   8.30000   8.30000
   7.80000   8.30000   8.30000   8.90000   8.90000   8.90000   8.30000   8.30000
   8.30000   8.30000   7.80000   8.30000   9.40000   8.90000   8.30000   8.90000
   8.30000   8.30000   8.90000   7.80000   7.80000   8.30000   9.40000  10.40000
  10.40000   9.40000  10.40000  10.90000  11.50000  12.00000  13.00000  12.50000
  10.90000  12.00000  12.00000  10.90000   9.90000  10.90000  12.50000  14.10000
  14.60000  14.60000  14.60000  15.10000  15.60000  15.60000  16.20000  16.20000
  16.20000  16.70000  17.20000  17.70000  17.20000  16.70000  16.70000  16.20000
  16.70000  17.20000  16.70000  15.60000  16.20000  16.70000  17.70000  17.70000
  17.70000  16.70000  17.20000  17.20000  17.20000  17.20000  17.70000  17.70000
  17.20000  17.70000  17.20000  16.70000  17.70000  16.70000  16.20000  15.60000
  14.10000  13.00000  12.00000  12.50000  13.60000  13.00000  13.60000  13.00000
  12.00000  13.00000  14.60000  15.10000  15.10000  13.00000  13.00000  14.10000
  15.10000  16.20000  16.20000  15.60000  15.60000  15.60000  14.60000  13.00000
  13.00000  13.00000  12.50000  12.00000  12.50000   9.90000   7.80000   8.90000
   9.40000  10.90000  13.00000  12.00000  10.90000  10.90000  10.40000   9.40000
   9.40000   8.90000   8.90000   9.40000  10.40000   9.40000   8.30000   8.90000
   8.90000   8.90000   7.80000   5.70000   5.20000   5.70000   6.30000   6.30000
   7.30000   6.80000   7.30000   6.80000   4.20000   2.60000   2.10000   3.60000
   4.70000   5.20000   5.70000   5.20000   6.30000   6.30000   5.70000   5.70000
   5.70000   6.30000   6.30000   5.70000   5.20000   4.70000   5.70000   4.70000
   4.70000   5.20000   3.60000   3.10000   3.10000   3.10000   3.60000   5.20000
   5.20000   3.60000   3.10000   3.60000   2.60000   1.60000   0.00000   0.00000
   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000   0.00000
   0.00000   0.00000
  10.80000  10.00000   8.90000   7.50000   9.70000  10.30000   4.70000   4.40000
   4.40000   2.80000   4.20000   3.90000   5.60000   6.70000  10.00000   7.20000
   4.70000   5.30000   5.30000   7.80000  10.00000  10.30000   8.30000   8.10000
   8.10000  10.00000  12.20000  12.20000   7.80000   6.40000  10.80000  12.50000
  10.80000   8.30000   7.80000  11.10000   8.90000   8.60000   9.40000   7.80000
  11.40000  14.70000  19.20000  14.40000   8.10000  10.80000  11.90000  12.50000
  11.10000  10.80000  10.60000  13.30000   9.70000   8.60000  13.60000  15.00000
  15.80000  12.80000  18.10000  19.20000  15.60000  15.00000  16.40000  18.10000
  19.20000  10.60000  10.80000  14.40000  19.70000  19.40000  20.60000  18.90000
  22.20000  14.70000  13.30000  16.90000  17.80000  18.30000  20.30000  20.30000
  17.50000  17.20000  16.70000  18.30000  20.30000  20.80000  19.20000  18.60000
  18.60000  20.60000  23.30000  23.10000  22.80000  20.60000  19.40000  15.30000
  20.60000  21.10000  23.10000  25.60000  27.80000  25.60000  25.80000  21.10000
  19.70000  22.80000  22.80000  19.40000  21.40000  20.30000  23.10000  16.40000
  18.60000  21.90000  24.70000  23.30000  22.20000  20.00000  17.50000  18.90000
  22.20000  23.60000  24.40000  20.30000  16.40000  15.00000  18.90000  20.80000
  19.40000  19.70000  20.00000  20.80000  17.80000  13.30000  15.80000  13.30000
  12.80000  12.50000  15.60000  15.30000  18.90000  20.30000  12.50000  13.60000
  15.30000  14.70000  12.80000  12.80000   9.40000  10.00000  11.10000  11.10000
```

Table 7.--*Input data for Lake Koocanusa, April 18-December 31, 1985*--Continued

14.70000	17.50000	19.40000	16.10000	11.90000	8.30000	7.80000	3.90000
5.00000	8.90000	4.70000	5.60000	5.00000	5.60000	7.50000	10.00000
12.80000	11.90000	12.80000	10.30000	8.10000	11.70000	13.30000	13.90000
11.10000	9.70000	9.70000	6.90000	3.60000	2.80000	4.20000	3.90000
1.70000	-0.30000	1.40000	1.90000	2.80000	-0.30000	4.70000	6.90000
2.50000	1.40000	2.80000	0.60000	-1.70000	-5.30000	-5.00000	1.40000
5.60000	4.20000	4.20000	2.20000	3.90000	2.80000	0.60000	3.10000
5.00000	5.30000	3.30000	1.10000	0.60000	0.30000	1.10000	0.80000
2.80000	1.90000	2.50000	1.70000	0.30000	1.70000	0.60000	0.00000
-2.20000	1.10000	1.70000	0.60000	-1.40000	-5.00000	-6.70000	-6.10000
-8.30000	-7.50000	-5.60000	-0.30000	1.40000	-0.80000	-4.20000	-3.90000
-1.70000	-2.20000	-3.60000	-5.60000	-10.30000	-11.70000	-8.90000	-8.60000
-4.20000	0.60000	-3.30000	-5.60000	-1.40000	-0.60000	-2.80000	-6.70000
-10.00000	-11.70000						
0.52	0.69	0.48	0.50	0.63	0.62	0.50	0.65
0.59	0.56	0.63	0.48	0.46	0.44	0.42	0.50
0.48	0.47	0.45	0.53	0.62	0.51	0.52	0.45
0.45	0.44	0.56	0.47	0.39	0.47	0.53	0.57
0.58	0.67	0.65	0.53	0.67	0.72	0.59	0.77
0.87	0.88	0.90	0.71	0.52	0.93	0.75	0.79
0.84	0.89	0.79	0.66	0.64	0.62	0.55	0.61
0.50	0.73	0.55	0.57	0.42	0.57	0.61	0.72
0.68	0.44	0.51	0.49	0.64	0.61	0.55	0.51
0.47	0.47	0.55	0.48	0.49	0.50	0.45	0.47
0.50	0.49	0.51	0.49	0.48	0.49	0.45	0.44
0.45	0.38	0.52	0.49	0.47	0.45	0.48	0.45
0.63	0.67	0.56	0.49	0.40	0.28	0.33	0.39
0.51	0.60	0.82	0.67	0.67	0.60	0.53	0.48
0.54	0.65	0.83	0.63	0.77	0.70	0.61	0.75
0.65	0.60	0.53	0.53	0.71	0.78	0.81	0.68
0.61	0.55	0.48	0.59	0.65	0.57	0.47	0.52
0.51	0.53	0.73	0.62	0.70	0.82	0.68	0.70
0.60	0.62	0.70	0.85	0.70	0.81	0.83	0.74
0.87	0.80	0.91	0.84	0.71	0.78	0.67	0.76
0.76	0.70	0.47	0.64	0.68	0.68	0.75	0.87
0.69	0.73	0.68	0.81	0.60	0.69	0.68	0.64
0.70	0.71	0.57	0.72	0.63	0.73	0.72	0.77
0.70	0.79	0.81	0.63	0.79	0.89	0.66	0.93
0.86	0.67	0.79	0.83	0.76	0.90	0.82	0.86
0.87	0.78	0.77	0.97	0.88	0.58	0.52	0.56
0.74	0.84	0.85	0.94	0.90	0.71	0.61	0.82
0.71	0.64	0.60	0.77	0.70	0.68	0.68	0.72
0.70	0.66	0.56	0.62	0.77	0.85	0.90	0.94
0.94	0.97	0.63	0.79	0.78	0.83	0.87	0.91
0.91	0.92	0.92	0.93	0.96	0.96	0.95	0.95
0.94	0.94	0.93	0.92	0.92	0.91	0.88	0.92
0.88	0.92						
715.3	715.5	715.7	715.9	716.0	716.1	716.2	716.3
716.4	716.5	716.6	716.7	716.9	717.1	717.3	717.6
718.0	718.4	718.7	719.1	719.3	719.6	719.9	720.2
720.5	720.8	721.0	721.2	721.5	721.8	722.3	722.9
723.7	724.6	725.5	726.5	727.5	728.5	729.5	730.4
731.1	731.7	732.3	732.9	733.4	733.9	734.4	734.9
735.3	735.7	736.2	736.7	737.4	738.0	738.5	739.0
739.3	739.7	740.1	740.5	740.9	741.2	741.5	741.8
742.2	742.5	742.8	743.0	743.2	743.4	743.6	743.7
743.9	744.0	744.3	744.4	744.6	744.8	745.0	745.1
745.3	745.4	745.6	745.7	745.8	746.0	746.1	746.2
746.3	746.4	746.5	746.5	746.6	746.6	746.6	746.7
746.7	746.7	746.7	746.7	746.7	746.7	746.7	746.7
746.6	746.6	746.5	746.5	746.6	746.6	746.6	746.6
746.5	746.5	746.6	746.6	746.6	746.6	746.6	746.6

746.6	746.6	746.7	746.7	746.7	746.6	746.6	746.6
746.6	746.6	746.6	746.6	746.6	746.5	746.5	746.4
746.4	746.4	746.3	746.2	746.1	746.1	746.0	746.0
746.0	746.0	746.0	746.1	746.2	746.2	746.3	746.3
746.3	746.2	746.2	746.1	746.0	745.9	745.8	745.8
745.6	745.5	745.4	745.3	745.2	745.1	744.9	744.8
744.7	744.6	744.5	744.4	744.2	744.0	743.8	743.6
743.5	743.3	743.2	743.0	742.8	742.6	742.4	742.2
742.0	741.8	741.5	741.3	741.1	740.9	740.7	740.6
740.4	740.2	740.0	739.8	739.7	739.5	739.3	739.1
738.9	738.8	738.9	739.0	739.0	739.0	738.8	738.6
738.3	738.0	737.8	737.5	737.3	737.0	736.8	736.5
736.3	736.0	735.7	735.4	735.1	734.9	734.6	734.3
734.0	733.7	733.3	733.0	732.7	732.4	732.2	731.9
731.6	731.3	731.2	731.2	731.2	731.1	731.1	731.1
731.1	731.1	731.1	731.1	731.1	731.1	731.1	731.0
730.7	730.4	730.1	729.8	729.4	729.1	728.8	728.4
728.1	727.8						
0.01645	0.01645						
26671209.	26181829.	20553959.	21288029.	18841129.	14192019.	19330509.	15415469.
14681399.	13947329.	19085819.	23979619.	25692449.	27405279.	30586249.	39395088.
45022958.	46246408.	39150398.	34745979.	42086678.	39884468.	38416328.	37192879.
36458809.	34011909.	31809699.	33033149.	37926948.	48448618.	64842847.	85396807.
103503866.	114025535.	119164025.	123813135.	127728175.	137271085.	134824185.	118919335.
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17128299.	15170779.	15170779.	16883609.	16149539.	16394229.	14926089.	14681399.
16638919.	15904849.	14681399.	13213259.	16394229.	15415469.	16638919.	15170779.
16638919.	16883609.	17617679.	17372989.	16149539.	15170779.	16883609.	16883609.
14192019.	13457949.	14192019.	13213259.	17862369.	12968569.	14436709.	12234500.
12968569.	9542910.	13702639.	10276980.	17617679.	17617679.	15660159.	13457949.
13213259.	13702639.	18841129.	12968569.	32543769.	33033149.	24713689.	26671209.
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19085819.	22022099.	22266789.	18351749.	19575199.	18351749.	20798649.	20798649.
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12723879.	11989810.	12479190.	12723879.	14192019.	19575199.	10276980.	14926089.
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12723879.	14436709.	10032290.	11745120.	8074770.	7096010.	10521670.	6117250.
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7340699.7	7340699.7	7340699.7	7340699.7	7340699.7	7340699.7	7340699.7	7340699.7
7340699.7	7340699.7	7340699.7	7340699.7	7340699.7	7340699.7	7340699.7	7340699.7
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7340699.7	7340699.7	7340699.7	7340699.7	7340699.7	7340699.7	7340699.7	7340699.7
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7340699.7	7340699.7	7340699.7	7340699.7	7340699.7	7340699.7	7340699.7	7340699.7
7340699.7	7340699.7	7340699.7	12723879.5	8074769.7	7340699.7	7585389.7	7340699.7
7340699.7	7340699.7	7340699.7	7340699.7	7340699.7	7340699.7	7340699.7	7340699.7

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    2    3    1    1
    2    2
       257.       257.
       100.       100.
        10.        10.
    1
       100.        10.
         0.         0.   30
        2.0        2.0
   37   37  258  258   69
       3.05       3.05         1.         1.     643.13     643.13        0.9
         0.    352089.    704623.   1622199.   2607442.   4237654.   6542137.   9522591.
  13742762.  17303394.  21364275.  24803820.  28051902.  32885315.  39053752.  44093401.
  49223418.  53347230.  60970564.  68924538.  74151400.  78287070.  85696965.  90709053.
  95691477.101076010.108039926.113956195.120595541.132481418.146394681.156040422.
164915857.173265951.181404428.188748033.196236035.
        0.0      724.0     1287.2     5245.3     9026.5    14738.4    20273.4    24859.0
    26484.1    29010.3    37473.6    42397.1    47481.6    52421.2    56749.4    62107.4
    65582.8    69203.1    73949.6    74818.5    79001.9    82364.7    85035.6    87610.0
    91165.9    94657.5    98132.9   101608.4   105067.7   119387.8   125421.6   130087.7
   134802.0   139500.3   143217.1   148510.7   153804.3
   397744.8   390021.6   579240.0   471115.2   386160.0   598548.0   351405.6   139017.6
   362990.4   505869.6   278035.2   343682.4   208526.4   247142.4   312789.6   374575.2
   486561.6   362990.4   243280.8   243280.8   189218.4   235557.6   320512.8   575378.4
   262588.8   308928.0   258727.2   405468.0   405468.0   220111.2   146740.8   227834.4
   270312.0   223972.8   223972.8   247142.4   305066.4   332097.6   478838.4   262588.8
   266450.4   289620.0   459530.4   258727.2   359128.8   297343.2   158325.6   332097.6
   312789.6   308928.0   509731.2   343682.4   181495.2   220111.2   339820.8   339820.8
   444084.0   293481.6   444084.0   212388.0   266450.4   154464.0   274173.6   328236.0
   247142.4   390021.6   335959.2   359128.8   177633.6   247142.4   239419.2   243280.8
   355267.2   312789.6   208526.4   254865.6   223972.8   189218.4   305066.4   196941.6
   285758.4   177633.6   200803.2   266450.4   243280.8   266450.4   305066.4   235557.6
   281896.8   308928.0   486561.6   227834.4   166048.8   142879.2   173772.0   281896.8
   266450.4   243280.8   139017.6   223972.8   258727.2   536762.4   548347.2   444084.0
   173772.0   270312.0   285758.4   258727.2   200803.2   177633.6   185356.8   262588.8
   386160.0   177633.6   235557.6   254865.6   278035.2   142879.2   258727.2   351405.6
   185356.8   227834.4   220111.2   227834.4   177633.6   270312.0   181495.2   158325.6
   216249.6   274173.6   285758.4   266450.4   247142.4   247142.4   351405.6   270312.0
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251004.0	216249.6	115848.0	196941.6	471115.2	278035.2	258727.2	177633.6
193080.0	305066.4	563793.6	96540.0	100401.6	146740.8	135156.0	231696.0
196941.6	150602.4	173772.0	768458.4	613994.4	177633.6	177633.6	96540.0
181495.2	254865.6	413191.2	459530.4	413191.2	335959.2	251004.0	154464.0
177633.6	108124.8	266450.4	494284.8	359128.8	239419.2	502008.0	100401.6
108124.8	393883.2	146740.8	212388.0	343682.4	474976.8	432499.2	451807.2
343682.4	432499.2	355267.2	146740.8	343682.4	888168.0	579240.0	567655.2
177633.6	92678.4	92678.4	57924.0	169910.4	807074.4	540624.0	169910.4
540624.0	722119.2	505869.6	119709.6	447945.6	876583.2	525177.6	258727.2
196941.6	583101.6	641025.6	251004.0	166048.8	135156.0	127432.8	46339.2
57924.0	146740.8	687364.8	278035.2	223972.8	46339.2	38616.0	92678.4
104263.2	81093.6	131294.4	65647.2	88816.8	100401.6	123571.2	150602.4
69508.8	111986.4	73370.4	131294.4	88816.8	88816.8	162187.2	139017.6
73370.4	42477.6						
749.50	48.5400	.07	.07				
1 258							
1.00	1.00	1.00	1.00	1.00	0.90	0.90	0.90
1.00	1.00	1.00	0.50	0.60	1.00	1.00	0.90
0.90	0.60	1.00	1.00	0.90	0.70	0.90	0.80
0.40	0.00	0.90	0.00	0.00	0.00	0.00	0.50
0.30	0.50	0.80	0.60	0.70	0.80	0.80	0.60
1.00	1.00	1.00	0.50	0.80	1.00	0.60	1.00
1.00	1.00	0.90	0.90	0.70	0.50	0.30	0.90
1.00	0.80	0.80	0.40	0.10	0.00	0.10	0.70
0.30	0.00	0.50	0.50	0.80	0.10	0.10	0.30
0.80	0.30	0.60	0.10	0.00	0.50	0.30	0.20
0.50	0.00	0.00	0.10	0.60	0.20	0.20	0.30
0.10	0.10	0.40	0.00	0.00	0.50	0.00	0.80
0.60	0.30	0.00	0.00	0.70	0.40	0.60	0.80
0.80	0.70	1.00	0.60	0.50	0.40	0.10	0.80
1.00	1.00	1.00	0.50	0.80	0.60	0.80	1.00
0.70	0.00	0.00	1.00	1.00	0.90	0.70	0.00
0.70	0.20	0.70	0.80	0.50	0.10	0.30	0.70
0.90	0.90	0.90	0.60	1.00	1.00	0.80	0.90
0.90	0.20	0.50	1.00	0.70	1.00	0.90	1.00
1.00	0.90	1.00	1.00	0.90	0.60	0.80	0.50
0.00	0.70	0.80	0.00	0.00	0.00	1.00	1.00
0.20	0.30	0.70	1.00	1.00	0.80	0.80	1.00
1.00	0.90	0.90	1.00	1.00	1.00	0.60	0.60
0.90	0.80	1.00	0.90	0.90	1.00	0.80	1.00
0.50	0.60	0.60	0.80	1.00	1.00	1.00	1.00
1.00	0.90	0.70	1.00	1.00	1.00	0.70	0.20
0.50	0.30	0.70	1.00	1.00	1.00	0.90	0.90
1.00	1.00	0.90	1.00	1.00	1.00	0.90	0.90
0.60	1.00	1.00	0.00	1.00	1.00	1.00	1.00
1.00	1.00	0.70	0.70	0.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	0.90	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.90	1.00						
3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
3.5	3.5	3.5	3.5	3.5	3.7	4.0	4.0
4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.3
4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
4.5	4.5	4.5	4.7	5.0	5.5	5.5	5.5
5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5
5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5
5.5	5.5	5.5	5.5	5.5			
677.30000	677.30000	677.30000	677.30000	677.30000	677.30000	677.30000	677.30000
677.30000	677.30000	677.30000	677.30000	677.30000	677.30000	677.30000	677.30000

677.30000	677.30000	677.30000	677.30000	677.30000	677.30000	677.30000	677.30000
677.30000	696.20000	696.20000	696.20000	696.20000	696.20000	696.20000	696.20000
696.20000	696.20000	696.20000	696.20000	696.20000	696.20000	696.20000	696.20000
696.20000	715.10000	715.10000	715.10000	715.10000	715.10000	715.10000	715.10000
715.10000	715.10000	715.10000	715.10000	715.10000	715.10000	715.10000	715.10000
715.10000	715.10000	715.10000	715.10000	715.10000	715.10000	715.10000	715.10000
715.10000	715.10000	715.10000	715.10000	715.10000	715.10000	715.10000	724.50000
724.50000	724.50000	724.50000	724.50000	724.50000	724.50000	724.50000	724.50000
724.50000	724.50000	724.50000	724.50000	724.50000	724.50000	724.50000	724.50000
730.90000	730.90000	730.90000	730.90000	727.90000	727.90000	727.90000	727.90000
727.90000	727.90000	727.90000	727.90000	727.90000	727.90000	727.90000	727.90000
724.50000	724.50000	724.50000	724.50000	724.50000	724.50000	724.50000	724.50000
724.50000	724.50000	724.50000	724.50000	724.50000	724.50000	724.50000	724.50000
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724.50000	724.50000	724.50000	724.50000	724.50000	724.50000	724.50000	724.50000
724.50000	724.50000	724.50000	724.50000	724.50000	724.50000	724.50000	724.50000
724.50000	724.50000	718.40000	718.40000	718.40000	718.40000	718.40000	718.40000
718.40000	718.40000	718.40000	718.40000	718.40000	718.40000	718.40000	718.40000
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677.30000	677.30000						

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47	47	47	47	47	47	47	53	53	53	53	53	53	53	53	53
53	53	53	53	53	53	53	53	57	57	57	57	55	55	55	55
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23	23														

*U.S. GOVERNMENT PRINTING OFFICE 1992-0-673-207/50021