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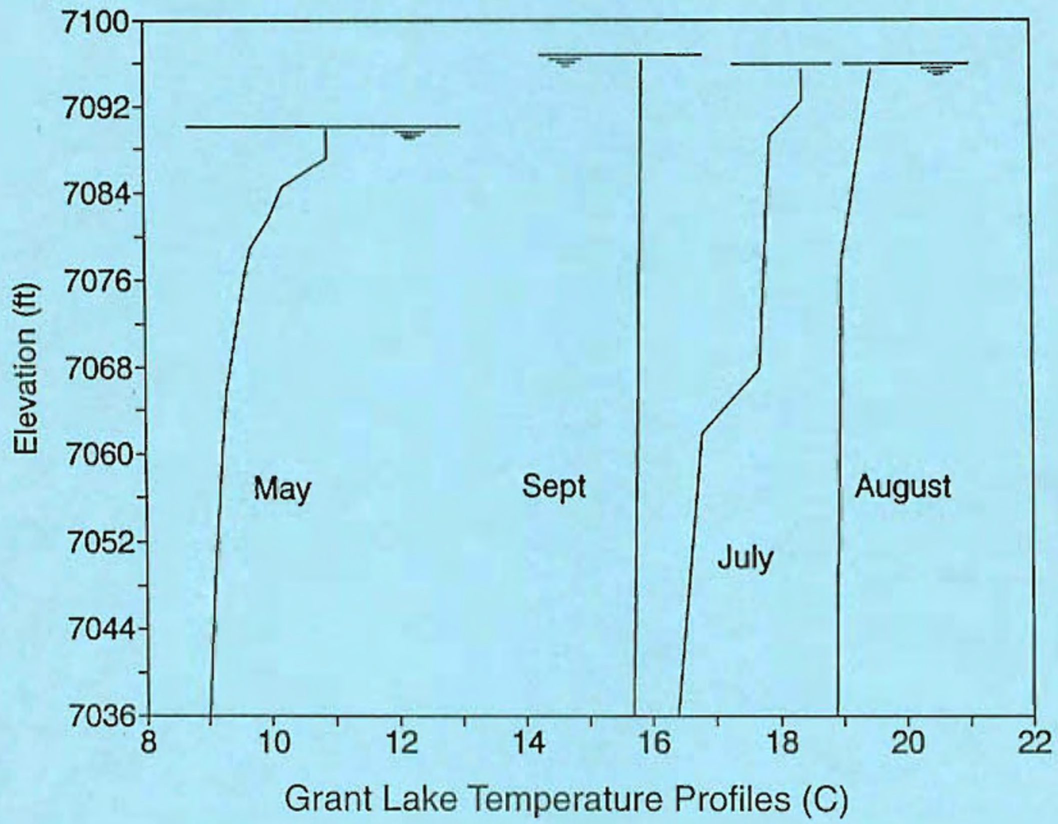
Summer Thermal Characteristics of Grant Lake Mono County California

Feasibility Study No. 2



PREPARED BY

Trihey & Associates

Aquatic Resource Specialists

DECEMBER 1993

SUMMER THERMAL CHARACTERISTICS

OF GRANT LAKE

MONO COUNTY, CALIFORNIA

Feasibility Study No. 2

Prepared for the

The Rush Creek Restoration Planning Team

by

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and
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December 7, 1993

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Memorandum

To: RTC members and Attorneys

From: Woody Trihey Woody

Date: December 9, 1993

Subject: Transmittal of Reservoir Temperature Report

The enclosed report "Summer Thermal Characteristics of Grant Lake, Mono County California" was prepared by Mr. Reg Cullen to summarize the findings of Feasibility Study #2. The purpose of that feasibility study was to identify and evaluate opportunities for decreasing the temperature of water being released from Grant Lake Reservoir into Mono Ditch during the late summer and early fall.

Although the reservoir temperature modeling study performed by Mr. Cullen could be improved upon by collecting on site data and performing further analysis, it is unlikely that undertaking such work would result in his conclusions being substantially altered.

Mr. Cullen's conclusions are (1) lower release water temperatures could be achieved by maintaining a full or near-full reservoir from July through September and (2) the shallow depth of Grant Lake in association with the high winds which frequent the area prevent thermal stratification from becoming well established in Grant Lake. Hence, construction of a multi-level outlet does not appear to hold much promise for providing colder release water temperatures.

Mr. Cullen concludes that the most technically sound and least cost approach for attaining cooler release water temperatures from Grant Lake during late summer is simply to maintain a near-full reservoir throughout the summer.

cc: Planning Team

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This report presents results of an investigation of summer water temperatures in Grant Lake, Mono County, California. Grant Lake is owned by the Los Angeles Department of Water and Power and operated by their Aqueduct Division as a water supply reservoir for the City of Los Angeles. Rush Creek is the main inflow to Grant Lake although significant inflow has been provided historically form Lee Vining, Walker, and Parker by Lee Vining conduit. The Mono Craters Aqueduct and Rush Creek (Mono Ditch) are the outflows form Rush Creek. The outflow temperature from Grant Lake was recorded in the Mono Ditch during 1991 and 1992. Daily Maximum stream temperatures in the Mono Ditch exceeded 20°C during August for both years.

This report addresses the question: Can Grant Lake be managed to provide cold water releases in the late summer? Trout growth is inhibited by temperatures above approximately 20°C, and even higher temperatures can be lethal. Cold water releases from Grant Lake in the late summer would aid in the restoration and benefit the downstream brown trout *(Salmo trutta)* fishery by providing habitat conditions which allow for the optimal growth of fish. Essentially, cold water releases from Grant Lake would replace diminished cold spring water which made an excellent historic fishery in the Rush Creek bottomlands. This investigation is undertaken to see if this replacement could be done.

The main tool used to address this question of cold water releases from Grant Lake is a numerical model called THERM (U. S. Army Corps of Engineers, 1986). The THERM temperature model for Grant Lake was calibrated for the summer of 1991 and validated for the summer of 1992. Results from calibration and validations show that the reservoir temperature model can predict daily outflow water temperatures from Grant Lake within ± 3°C. Collection of additional meteorologic data would permit more accurate modeling, however the ± 3°C tolerance of the modeling used to support this feasibility study is small enough to determine if outflow water temperature from the reservoir can be significantly lowered through changes in the operation of the reservoir.

The most efficient method to provide cool water releases from Grant Lake in late summer is to increase the water surface elevation of the lake above 7110 ft in early summer and maintain water surface elevation above 7110 ft through August. Outflow temperatures from Grant Lake can be reduced by at least 2°C during the summer months without expending funds for any structural modification of the existing outlet simply by increasing the water surface elevation of the Lake in May.

The simulations also show that constructing a multiple port outlet to provide selective withdrawal of water from different elevations (and presumably at different temperature) within the reservoir provides little reliable benefit in reducing reservoir outflow temperature, because winds frequently mix the shallow reservoir and prevent thermal stratification.

1.0
INTRODUCTION

This report presents a temperature investigation of Grant Lake[1] in Mono County, California (Figure 1-1). Grant Lake is owned by the Los Angeles Department of Water and Power (LADWP) and operated by their Aqueduct Division as a water supply reservoir for the City of Los Angeles. The current Grant Lake Dam was constructed in 1940 and has a capacity of 47,525 ac-ft at the spill way elevation of 7130 ft MSL (depth of 94 ft), while the dam crest is at 7145 ft MSL. Rush Creek, with an average annual discharge of 83 cfs (60,000 ac-ft), is the main inflow to Grant Lake. The Lee Vining diversion has traditionally delivered an additional annual average flow of 55 cfs (40,000 ac-ft) into Grant Lake. Stream flow is primarily derived from melting snow and approximately two thirds of the total annual run off occurs during the months of May, June, and July. Prior to 1941, discharge from Grant lake was used for local irrigation and Rush Creek flowed into Mono Lake. After 1941, discharge from Grant Lake was diverted south to supply water to the city of Los Angeles. Since 1985, courts have ruled that the discharge from Grant Lake must flow into Mono Lake, essentially rewatering dry sections of Rush Creek.

The purpose of this investigation is to determine if Grant Lake can be operated differently or whether the outlet can be modified to provide colder release water temperatures during mid and late summer. Colder temperatures from Grant Lake could improve thermal conditions for brown trout downstream from the reservoir. Lowering high stream temperatures in the summer and/or decreasing magnitude of thermal cycles can both have metabolic effects on fish which allow them to grow larger and have increased survivorship from year to year. The outflow water temperature form Grant Lake for 1991 and 1992 were recorded in the Mono Ditch (Figure 1-2 and Appendix A).

[1]Grant Reservoir was created in 1941 by the completion of a dam on Grant Lake. However, this report will continue to use the term "Grant Lake" when referring to Grant Reservoir in an effort to be consistent with the more common nomenclature for this body of fresh water.

Raleigh et. al. (1986) and Needham (1969) state that water temperature is probably the single most important environmental variable determining the suitability of brown trout streams. They cite 27.2°C as the upper limiting near lethal water temperature for brown trout, the range of 12 to 19°C as optimal for the good growth and survival of brown trout, and a lower lethal limit of 0°C. A temperature of 20°C appears suitable as an upper limit for long-term growth of brown trout (Armour, 1993). The California Department of Fish and Game views water temperatures greater than 20°C as stressful for brown trout.

The effects of large diel fluctuations of stream temperature on trout are discussed by Hokanson et al. (1977) and Hughes et al. (1978). Hokanson et al. (1977) studied rainbow trout (O. mykiss) fed to excess and found that 15.5 to 17.3 °C was the optimum range for growth when subjected to a daily temperature sine amplitude of ± 3.8°C about the mean temperature. It is believed that these fluctuations in temperature allow fish to feed at high efficiency during the hotter parts of the day while the colder period allows the fish a metabolic rest. They found that temperatures fluctuating around the nominal mean of 22°C, near or at the trouts's thermal limit, increased mortality significantly when compared to lower mean temperatures.

Hughes et al. (1978) studied the effects of persistent elevation of temperature above ambient levels on the food consumption and growth of juvenile salmonids held in aquaria. They found temperature elevations above ambient levels generally increased metabolic rates and reduced growth rates. Only at the highest levels of food supply were the growth rates of fish held at higher temperatures nearly equal to those of the controls. They state that at high temperatures, growth may be much less than at intermediate temperatures because of higher maintenance metabolic costs and reduced food intake. They found that the macroinvertebrates most preyed upon by salmonids were generally more abundant in the control streams than in the heated streams.

Daily amplitudes in water temperature of 7.5°C were common in the Rush Creek bottomlands in August for the years of 1991 and 1992 (Cullen, 1991, and 1992). It is thought that the daily swings in stream temperature which currently exist in Rush Creek are causing metabolic stress to the brown trout. Historically, the existence of springs, and the contribution these springs made to the stream temperature of Rush Creek, is thought to have moderated Rush Creek such that stream temperature was not a problem to fish in the bottomlands.

This report completes Feasibility Study No. 2, the ability to make cold water releases from Grant Lake, as approved by the EL Dorado County Superior Court (Mono Lake Water Rights Cases, 1992) in conjunction with ongoing efforts to restore the fisheries in the Mono Basin (Mono Lake Water Rights Cases, 1990). The reader is directed to the following documents for a more detailed discussion of the fisheries problems this report addresses: 1) <u>A Conceptual Plan for the Restoration of Aquatic and Riparian Habitats in Rush and Lee Vining Creeks, Mono County, California</u> (Trihey and English, 1991), 2) <u>Comparison of Historical and Existing Conditions on Lower Rush Creek Mono County, California</u> (Katzel and Taylor, 1993) and 3) 1991 Water Quality Monitoring of Rush and Lee Vining Creeks (Cullen, 1992), and 4) 1992 Water Quality Monitoring of Rush and Lee Vining Creeks During Construction (Cullen, 1993).

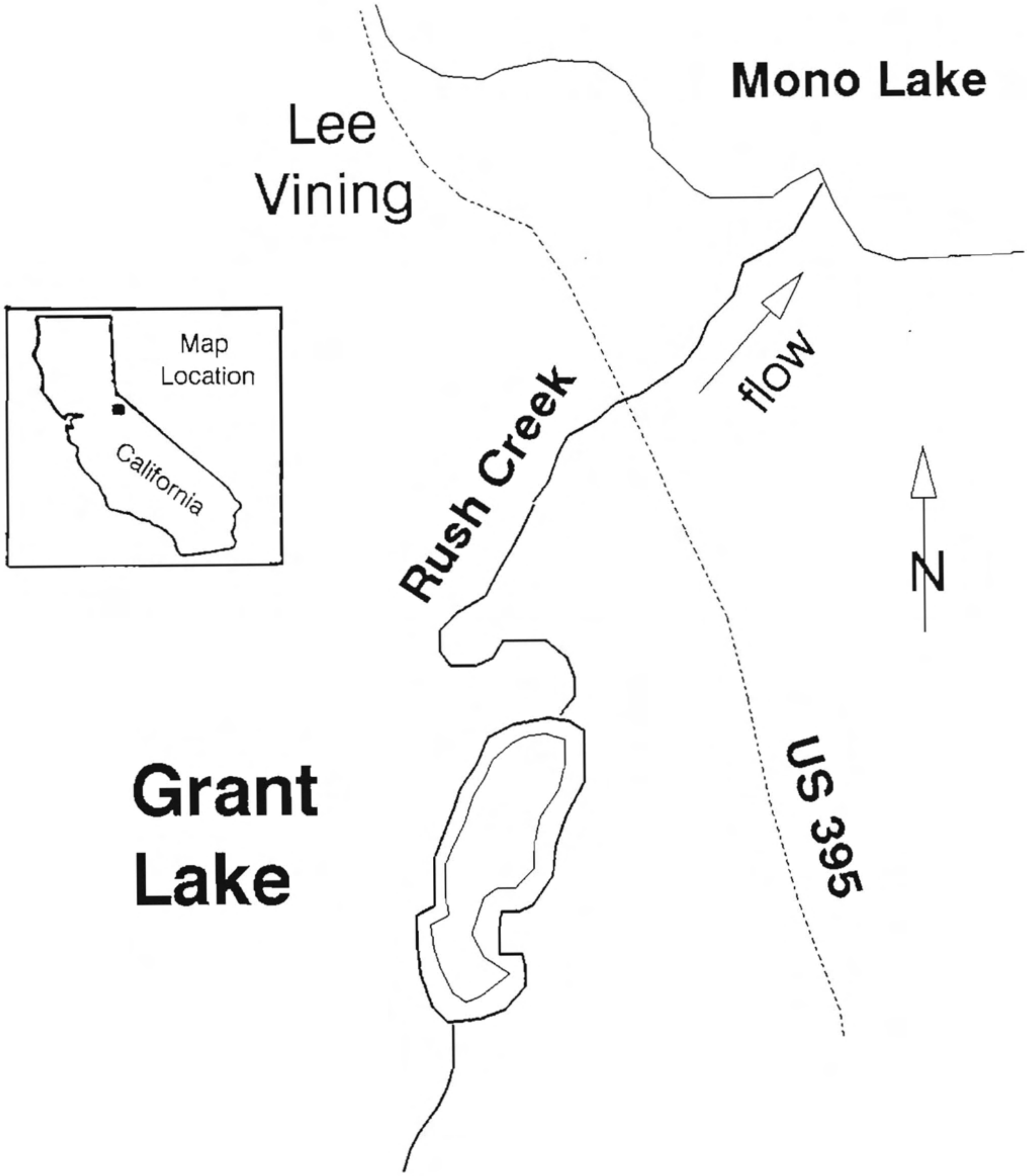

Figure 1-1. Location Map of Grant Lake, Mono County, California

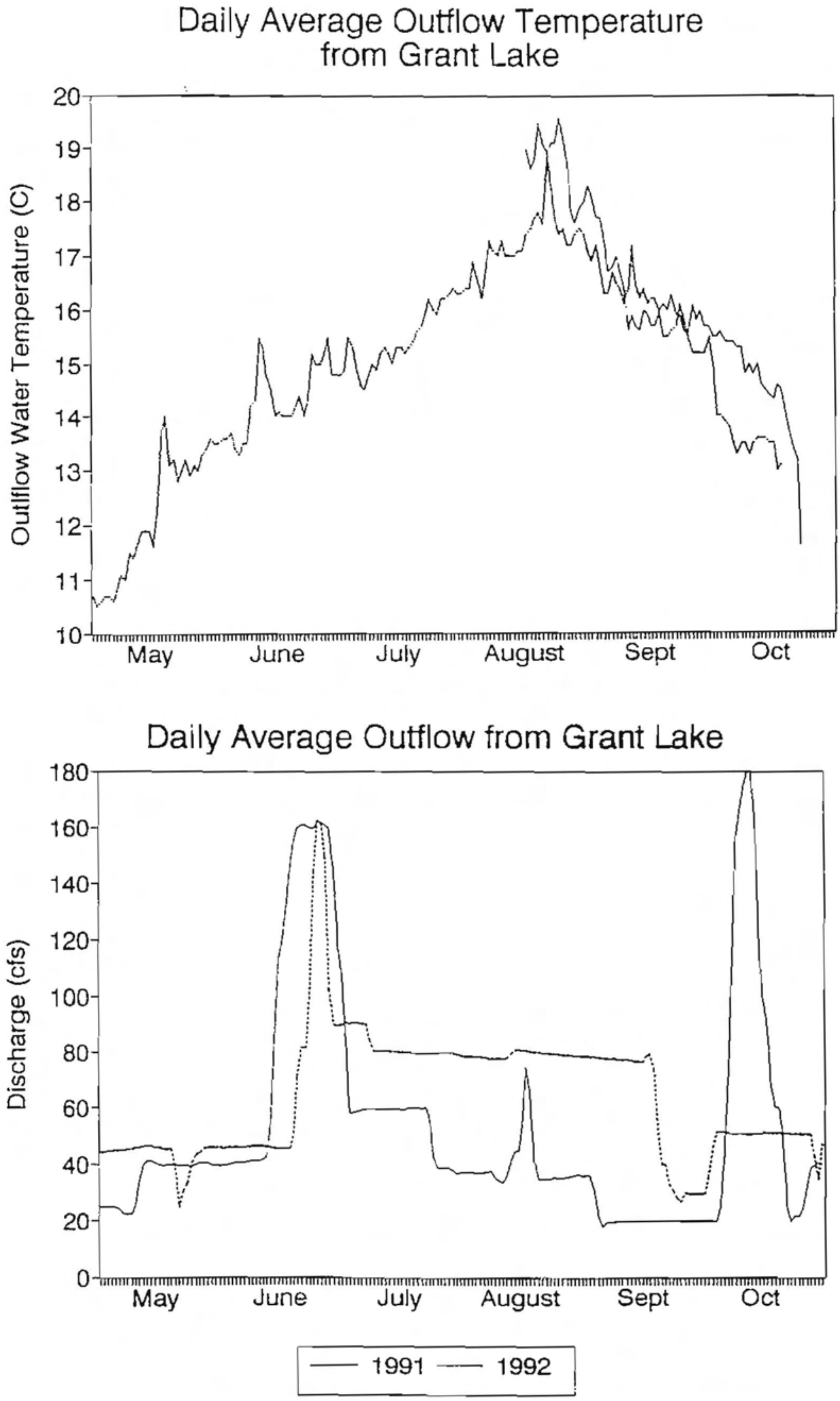

Figure 1-2. 1991 and 1992 Daily Average Outflow Water Temperatures (Mono Ditch) and Outflow Discharge for Grant Lake.

2.0
RESERVOIR TERMINOLOGY

There are three longitudinal zones in a reservoir between the river inflow and the dam (Thornton, 1990). These zones are called the riverine, transition, and lacustrine (Figure 2-1a). The riverine zone is typically narrow, well-mixed, and has decreasing water speeds. The transition zone typically has sharply decreasing water speeds and high sedimentation rates. The lacustrine zone is the deepest area of a reservoir and is where thermal stratification occurs (if it can). The boundaries of these zones, particularly the riverine and transition, are transient and influenced by the water surface elevation of the reservoir and inflow rate. As the volume of the reservoir increases the lacustrine zone becomes larger and more stable. A low reservoir storage volume can greatly expand the size of the riverine and transition zones at the expense of the lacustrine zone.

Three vertical zones exist when the lacustrine zone becomes thermally stratified (Goldman and Horne, 1983). These vertical zones are called the epilimnion, metalimnion, and hypolimnion (Figure 2-1b). The epilimnion is the surface layer of the reservoir which responds most quickly to changes in air temperature. The hypolimnion is the cooler and denser deep-water region of the reservoir. The metalimnion, or thermocline, is the zone of transition between epilimnion and hypolimnion.

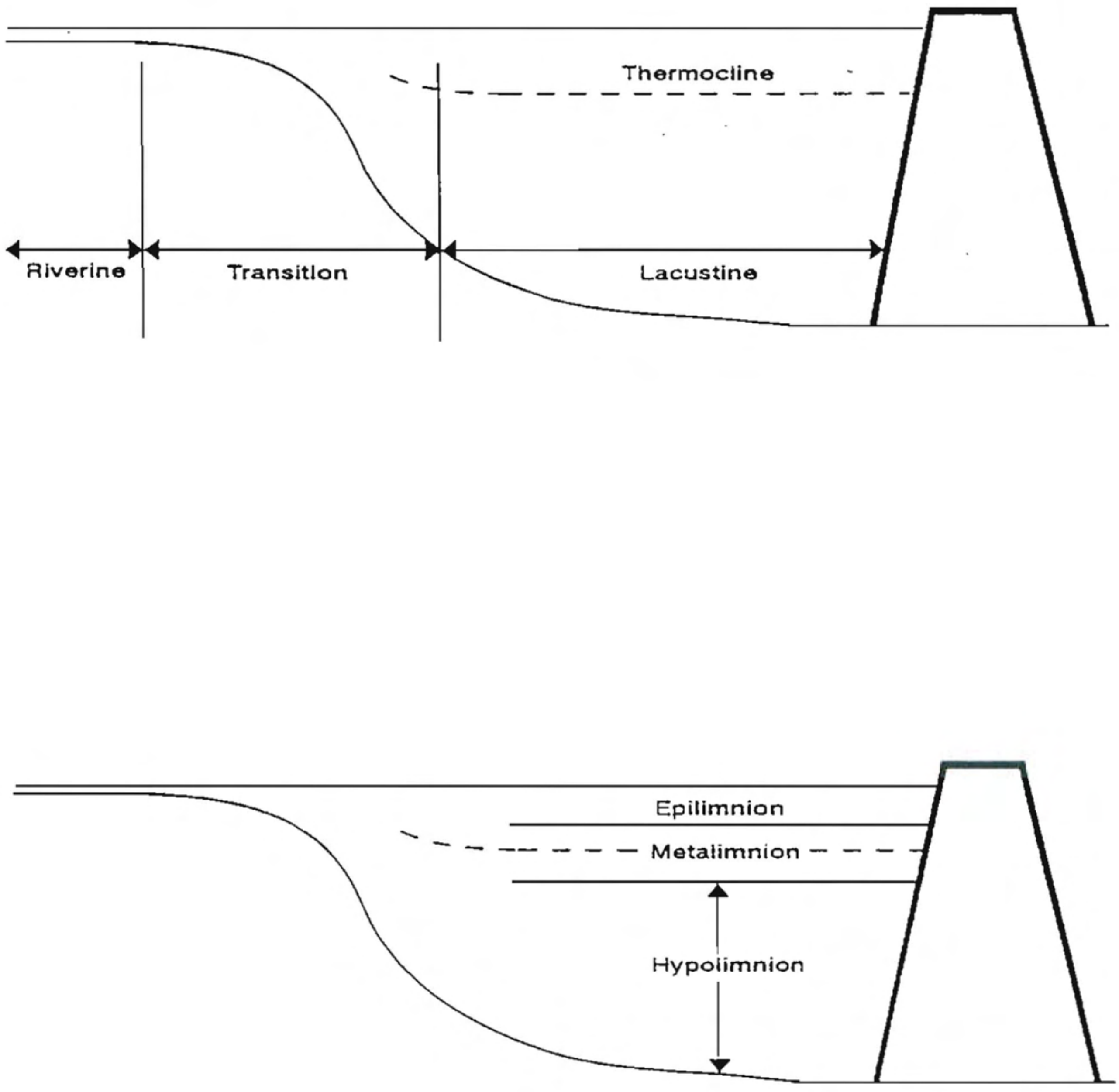

Figure 2-1. Schematic Illustration of Longitudinal (top) and Vertical (bottom) Zones Found in a Reservoir

3.0
GRANT LAKE OPERATIONAL CRITERIA

The Los Angeles Department of Water and Power (LADWP) owns and operates Grant Lake. Generally, the lake is used to temporarily store water to be exported to the City of Los Angeles. Several requests were made to the LADWP Aqueduct Division to inform the authors of the general operating policies for Grant Lake. The authors were informed that no operational criteria existed. Therefore, this report assumes that the reservoir simulations developed for this study need not be restricted by the policies of LADWP.

However, we know that recent Court decisions have affected the operation of Grant Lake. Court rulings have set interim minimum outflows from Grant Lake (Mono Lake Water Rights Cases, 1990), required an increase in storage volume of Grant Lake (Mono Lake Water Rights Cases, 1991b), and specified the route outflows from the lake must take (Mono Lake Water Rights Cases, 1989 and 1991a). In essence, these court rulings state LADWP may not export any water from Grant Lake until the water surface elevation of Mono Lake reaches 6377 ft.

It appears it is not LADWP's normal practice to allow water storage buildup in the reservoir which will result in a release of uncontrolled flows via the Grant Lake spillway. LADWP attempts to maintain a low storage level in Grant Lake at the beginning of the spring runoff season in an attempt to avoid uncontrolled releases later in the year. Figure 3-1 shows Grant Lake water surface elevations and storage volumes on the first day of the month for 10 years. LADWP appears to feel the dam will operate safely at high storage levels (Nagel, personal communication); that is, near the spillway crest of 7130 ft MSL. Discharges of about 300 cfs have occurred at water surface elevations greater than 7110 ft MSL.

The California State Division of Safety of Dams (DSD) has jurisdiction over the dam and reservoir because the dam height (87 ft) is greater than the DSD jurisdictional minimum of 25 ft. While DSD has the authority to restrict the maximum storage elevation of Grant Lake, no such restrictions currently exist. Thus the reservoir model may potentially fill the reservoir to its spillway elevation pending sufficient reservoir inflow.

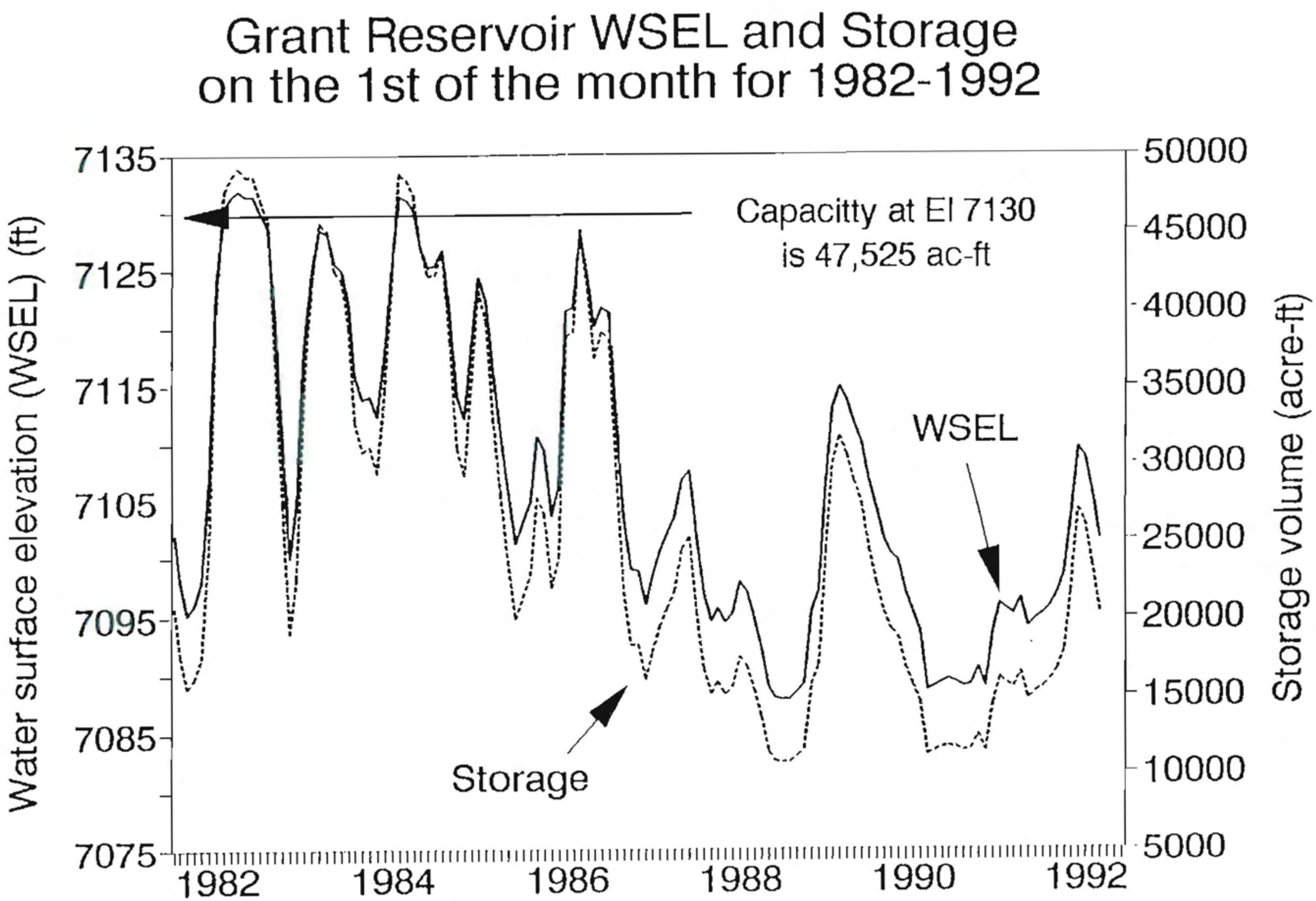

Figure 3-1. Grant Lake Water Surface Elevations and Storage Volumes on the First Day of the Month From 1982 to 1992

MODEL OPERATIONAL CRITERIA FOR GRANT LAKE

- INFLOW: Maximum inflow is constrained only by the upstream hydrograph plus additions from the Lee Vining Conduit. Model simulation inflows were always less than 250 cfs.

- OUTFLOW: Maximum outflow is constrained by hydraulics and the plumbing of the outlet for the lake. Discharges of 350 cfs have historically been released from Grant Lake. However, simulation outflows were always less than 200 cfs.

- MAXIMUM WSEL: The crest of the spillway is at EL 7130 ft-MSL. Simulation WSELS were always less than or equal to 7120 ft-MSL.

- MINIMUM WSEL: The outlet is located at 7066.9 ft-MSL. Simulation WSELS were always greater than 7080 ft-MSL.

4.0
THERM NUMERICAL MODEL

Explaining the physical processes that influence the temperature of water in a reservoir is a complex task. Forecasting the temperature of water being released from a reservoir is even more complex. For that reason, computer models are often used to predict the thermal structure of a reservoir. We used the computer model THERM to simulate reservoir temperature profiles and to predict outflow temperatures from Grant Lake in the summer months of June, July, and August. Simulations always began in May and ended in September to bracket the hottest months of the year.

THERM, an independent submodel of the CE-QUAL-R1 model (U.S. Army Corps of Engineers, 1986), describes the vertical distribution of thermal energy in a reservoir. Conceptually, the reservoir is divided into horizontal layers and each layer has uniform characteristics. The physical processes simulated by THERM include heat input from solar radiation, heat loss to the atmosphere by evaporative cooling and convection, heat transfer among layers via convection and mixing, and changes in reservoir volume due to inflows, outflows, and evaporation. The model distributes river water flowing into the reservoir among the layers according to density (which is determine by inflow temperature). The inflow is assigned to water layers in the reservoir having densities (temperatures) similar to that of the inflow. Outflowing water is withdrawn from layers as a function of the water densities, discharge rates, and the elevation and configuration of outlet gates. A daily time step was used for the model calibration, validation, and simulations discussed in this report.

The major assumption associated with application of the THERM model is that a one-dimensional model can yield sufficiently accurate reservoir temperature profiles to be useful to the analysts. The one-dimensional assumption means that the reservoir may be divided into a series of well-mixed horizontal layers. The authors decided THERM was an appropriate reservoir model to use because: 1) The bathymetry of Grant Lake is shaped such that a hypolimnion could exist, 2) past experience with modeling reservoirs in the range of 60 to 100 ft deep indicates that a one dimensional model is sufficiently accurate to forecast thermal profiles, (especially for the purpose of feasibility studies), and 3) input data for a more complex (e.g., two-dimensional) reservoir model are not available. Some aspects and limitations associated with the one-dimensional assumption are:

1. longitudinal and lateral variations in temperature within the reservoir cannot be simulated,
2. all reservoir inflow and constituents are instantaneously dispersed throughout the layers, and
3. temperature profiles are most representative of conditions in the deepest part of the reservoir (the lacustrine zone).

The standard analytical steps to applying the THERM model are: input data collection, model calibration, model validation, and simulation of alternative reservoir operation practices. For this feasibility study, the year 1991 was selected for model calibration because it was the only year for which sufficient vertical temperature profile and outflow water temperature data were available to calibrate the model. The year 1992 was selected for model validation because a complete record of daily reservoir outflow temperatures, the factor most affecting the downstream fishery in Rush Creek, was available for the summer.

5.0
DATA SOURCES

THERM requires input describing six main areas: hydrology, meteorology, reservoir morphometry, outlet and dam configuration, temperature of inflowing water, and chemical qualities of the reservoir and inflowing water. A listing of the input parameters used in our application of the THERM model is found in Appendix B. Input data was required for May through September of 1991 (for model calibration) and 1992 (for model validation).

5.1 HYDROLOGY

Discharge data into and out of Grant Lake as well as the lake's water surface elevation were obtained from daily records reported by LADWP. The discharge into Grant Lake was predominately from Rush Creek but some water also came from the Lee Vining conduit. The discharge out of Grant Lake is controlled by a 48-inch rotovalve in an outlet pipe at elevation 7066.9 ft-MSL. This valve is in the shaft-house located on the northeast side of the reservoir approximately one half mile from the deepest part of the Lake. Average monthly discharges and water surface elevations from May to September for the years 1991 and 1992 are found in Table 5-1. Daily discharge and water surface elevation data for the months of May to September for the years 1991 and 1992 are found in Appendix C.

5.2 METEOROLOGY

THERM requires input values for air temperature, dew point, percent possible cloud, air pressure, and speed of the wind for each time step. A complete listing of meteorology input for 1991 and 1992 is found in Appendix D.

Daily air temperatures for 1991 and 1992 were recorded downstream of Grant Lake in the Mono Gate No. 1 Return Ditch (Mono Ditch). Air temperature was also recorded upstream of Grant Lake near the discharge measuring flume in 1992. These air temperatures were recorded by portable field monitors stations accurate to $\pm 1/2°C$. The other meteorologic parameters of percent possible cloud, dew point, atmospheric pressure, and speed of the wind were not recorded on site because of cost and time constraints[2]. Instead, meteorologic data was obtained from the nearest National Oceanic and Atmospheric Administration (NOAA) weather station at Bishop Airport and regression equations developed to allow the NOAA data to be transferred to Grant Lake. See Appendix D for the regression equations developed to transfer NOAA data to the Mono Basin and a listing of their applications to yield air temperature and dew point at Mono Ditch.

Table 5-1.
Average Monthly Discharges and Water Surface Elevations for Grant Lake

Month	Discharge In (cfs)		Discharge Out (cfs)		WSEL (ft)			
	1991	1992	1991	1992	1991 Elevation	1991 Depth*	1992 Elevation	1992 Depth*
May	92	135	35	44	7090	54	7107	71
June	133	67	100	71	7097	61	7110	74
July	67	43	56	83	7096	60	7107	71
August	49	34	40	79	7095	59	7104	67
September	48	51	21	60	7096	60	7101	65

*Datum = 7036 ft MSL.

The meteorologic parameters of atmospheric pressure and percent possible cloud at Bishop were used as input data for the model because no site specific data were available. Velocity of the wind was also used from the NOAA station at Bishop because it was the most readily available source of reliable data. Because the THERM model is insensitive to air pressure, site specific data are not required. Thus, the values from Bishop were not corrected for the difference in elevation between Bishop and Grant Lake. Percent cloud is an important input parameter but in the absence of better data we calibrated the model using values from Bishop.

[2]Such data could be collected to improve accuracy of the model developed for this feasibility study, and we recommend doing so if the reservoir is to be actively managed to obtain cooler outflow temperatures during summer.

A linear regression of 1992 air temperatures recorded in Mono Ditch with those measured at the NOAA weather station at Bishop revealed that Mono Ditch temperatures could be predicted with a maximum error of $\pm 2°C$. Through sensitivity analysis, this error in air temperature was found to be insignificant in effecting the thermal structure of metalimnion and hypolimnion (though it was found to be significant in influencing the temperature of the epilimnion). The dew point from Bishop was adjusted for use in the model by subtracting 6.4°C, the same reduction as that found in average air temperatures between Bishop and the Mono Basin. This technique of determining dew points at Grant Lake assumes the relative humidities are approximately the same at both Bishop and the lake.

5.3 RESERVOIR MORPHOMETRY

THERM uses two exponential equations to represent the shape of the reservoir. Reservoir shape is used to determine volume, area, and width of water in each horizontal layer of the reservoir. The first equation solves for area and volume while the second equation solves for reservoir layer width. The coefficients for the area and volume equation were developed from regression analysis of two tables provided by LADWP: Grant Lake Usable Storage and Grant Lake Surface Area (LADWP, 1972). The coefficients for the width equation were developed from analysis of LADWP map N 205-B (LADWP, 1930).

Parameterization of the water surface elevation was checked by comparing the predicted reservoir surface elevation with measured values from the LADWP gage and by comparing predicted reservoir volumes and surface areas with the tables provided by LADWP. Figures 5-1 and 5-2 verify that the simulations of how reservoir surface area and volume vary with surface elevation using the parameters in THERM closely match the LADWP data.

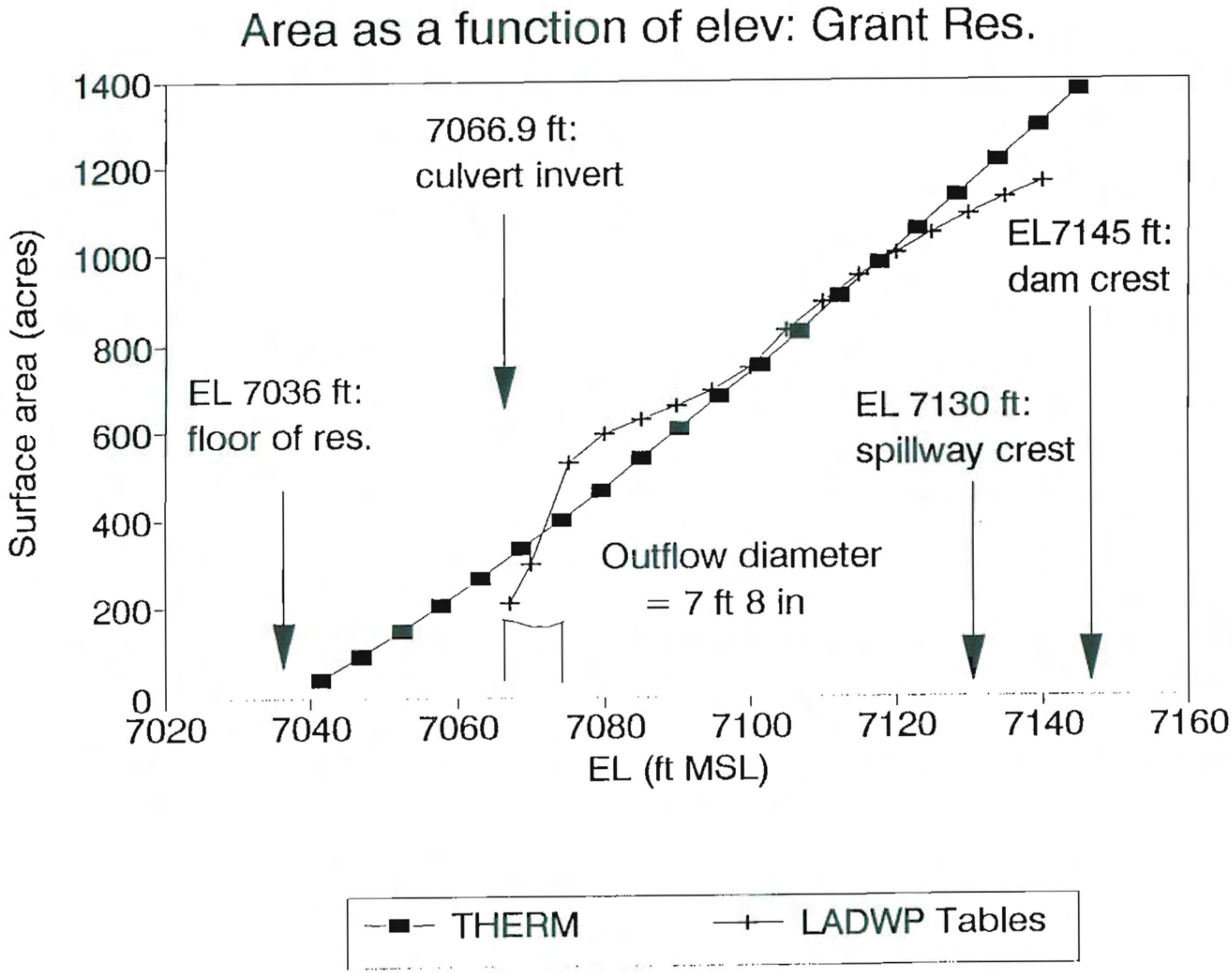

Figure 5-1. Grant Lake Surface Area Parameterization

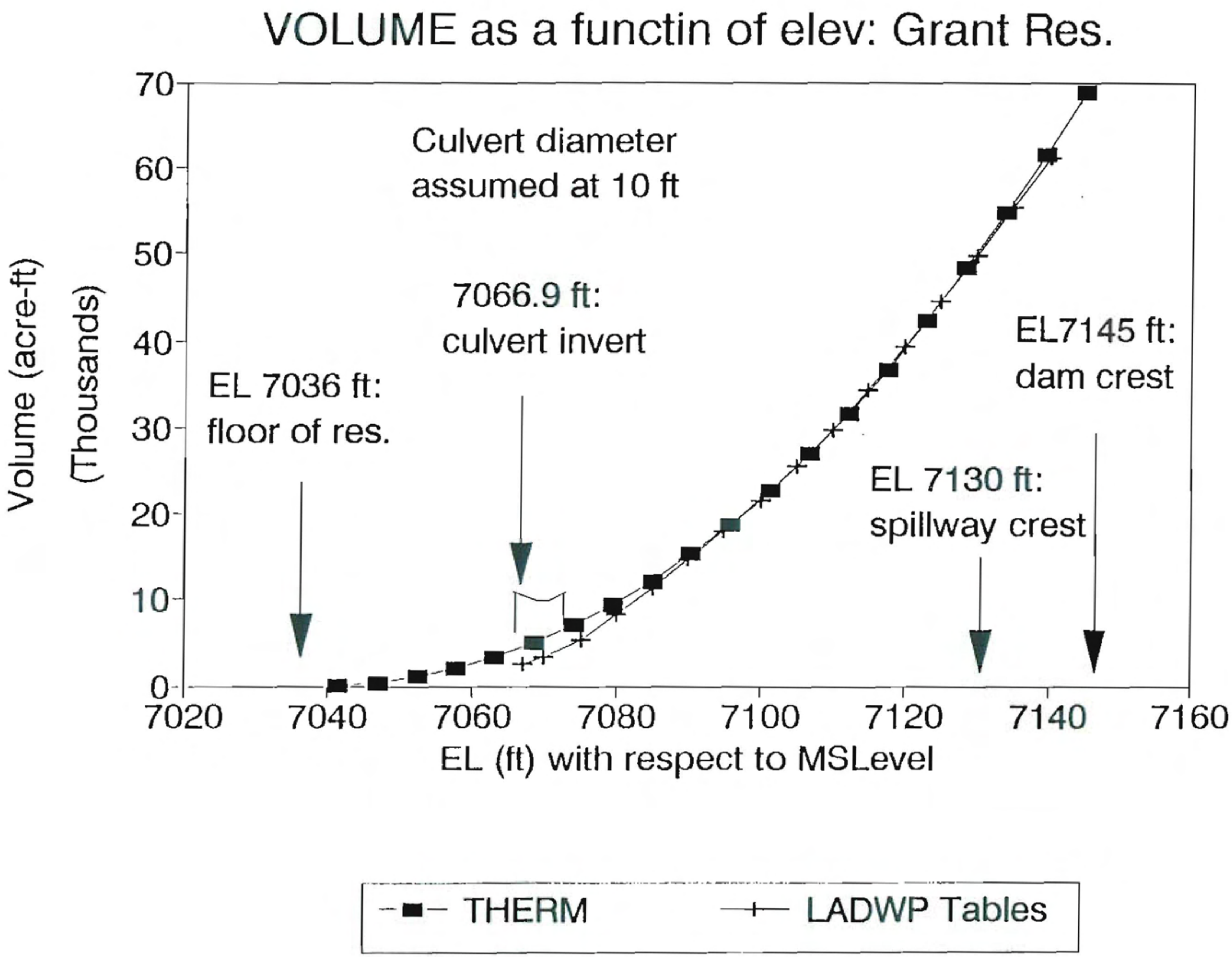

Figure 5-2. Grant Lake Capacity Parameterization

5.4 CONFIGURATION OF LAKE OUTLET

The outflow from Grant Lake is controlled at a shaft house located on the northeast side of the lake. Two valves are operated to control the lake outflow: 1) a 48-inch rotovalve used to regulate the flow and 2) a 48-inch gate valve used as an isolator. The circular outflow pipe from Grant Lake has a diameter of 7 ft 8 inches and the invert is at 7066.9 ft MSL. This means that releases from Grant Lake are made about 30 ft above the bottom of the reservoir of 7036 ft MSL and that 2,000 ac-ft are unavailable for release from the reservoir (dead storage). The outflow pipe downstream from the shaft house is called the Mono Craters Tunnel, a horseshoe shaped conduit with a vertical diameter of 9 ft.

Flow diversions into Rush Creek downstream of Grant Lake are controlled at Mono Gate No. 1 which is located at the junction of the circular outflow pipe from Grant Lake and the Mono Craters Tunnel. Water released through Mono Gate No. 1 enters the head of the Mono Return Ditch and flows approximately 1.5 miles north easterly to Rush Creek. Water flowing into the Mono Craters Tunnel at Mono Gate No. 1 flows south approximately 12 miles to the Owens Valley. Stop logs are stacked horizontally in the Mono craters Tunnel at Mono Gate No.1 to deflect some or all of the outflow from Grant Lake into the Mono Ditch. Some negligible leakage into the Mono Craters Tunnel does occur when the stop logs are used.

5.5 INFLOW TEMPERATURE

A field monitoring station was established in 1992 upstream of the reservoir to record the temperature of Rush Creek as it flows into Grant Lake. No such data were available for 1991, so inflow temperatures were estimated by correlating air temperature data. A regression equation between 1992 air temperatures at Bishop and 1992 inflowing water temperatures for is:

$$0.51 * \text{Air Temperature at Bishop} + 2.9 = \text{Inflow Water Temperature}$$

This equation, along with 1991 air temperatures at Bishop, was used to estimate the 1991 temperature of Rush Creek flowing into Grant Lake.

5.6 CHEMICAL QUALITIES OF GRANT LAKE AND RUSH CREEK

The concentrations of suspended sediment and total dissolved solids are used by the model primarily in the calculation of the density of the water and, secondarily, to help calculate direct solar heating of the epilimnion. No data were available for Grant Lake for these two parameters so they were estimated to be 2 mg/L and 35 mg/L, respectively. The values used in this modeling had been used for modeling of other clear water reservoirs in California.

6.0
MODEL CALIBRATION

Model calibration is the adjustment of input parameters until the model closely reproduces known values. The Grant Lake model was calibrated to match measured values for three parameters: 1) reservoir water surface elevations (which checks that the inflows, outflows, and reservoir storage are adequately represented), 2) reservoir water temperature profiles (which checks that the thermal structure is accurately modeled), and 3) outflow water temperatures (which ensures that this output parameter, used to evaluate effects on downstream fish, is accurately modeled).

6.1 RESERVOIR WATER SURFACE ELEVATION CALIBRATION

Calibration of reservoir water surface elevations of 1991 checked that the parameters describing the shape of the reservoir are sufficiently accurate, and that the data for inflow and outflow rates accurately describe the water budget of the reservoir. THERM slightly underpredicts 1991 water surface elevations (Figure 6-1) and the maximum error of 1.4 ft occurs on June 19. The absolute error is 16 percent of the 9-ft variation in water surface elevation from May 15 to June 19. This maximum 1.4-ft elevation differential corresponds to a storage volume error of 1,017 ac-ft, or a 6 percent error in total volume.

These errors could result from inaccuracies in stream gages, or from sediment deposits in the reservoir that somewhat invalidate the depth-volume regression developed from a 1930 map of the lake. The error is small compared to total reservoir elevation and volume, and is not expected to affect simulation results.

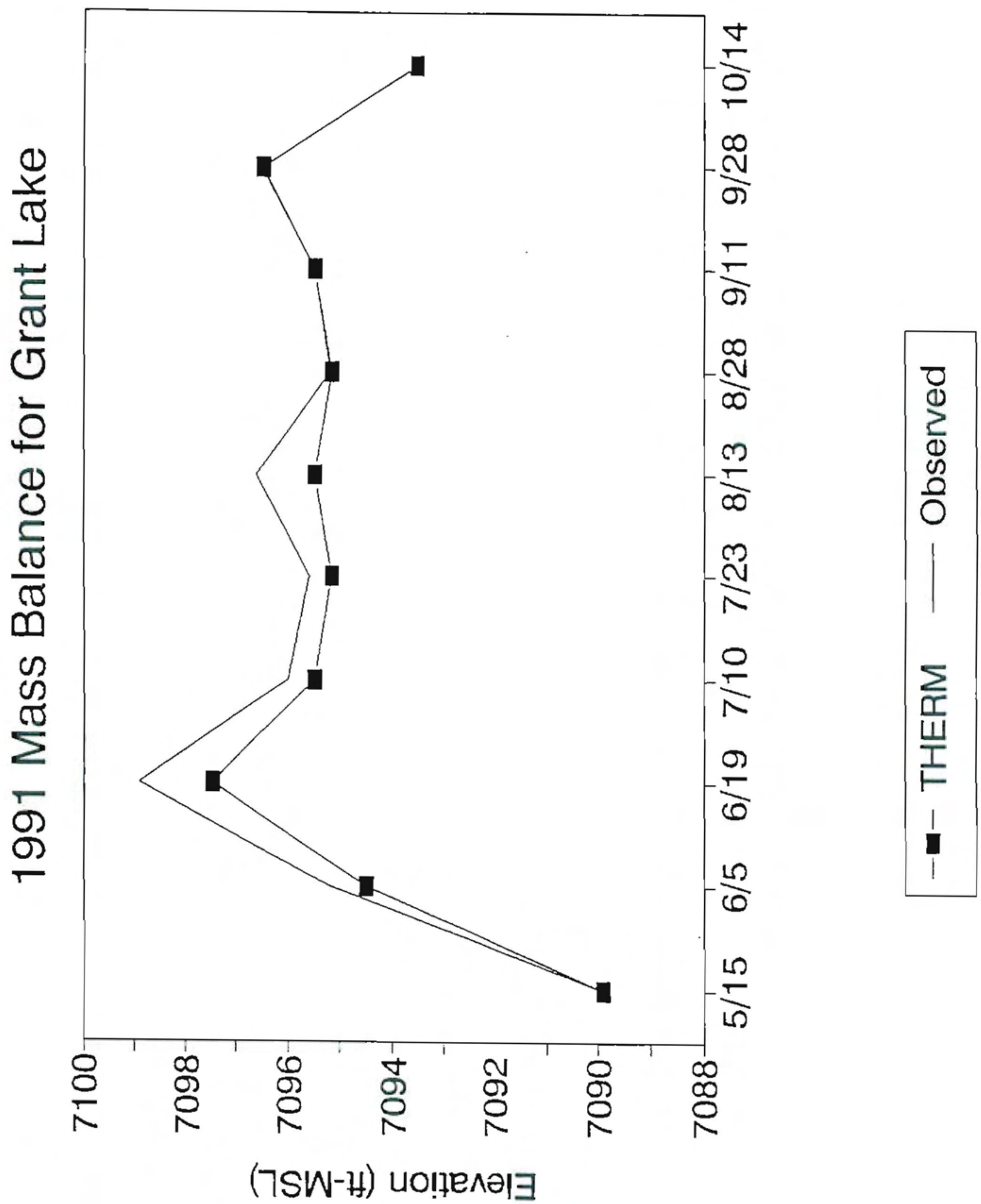

Figure 6-1. Grant Lake Water Surface Elevations From May 16 to October 15, 1991 (Calibration Year)

6.2 RESERVOIR WATER TEMPERATURE PROFILE CALIBRATION

The THERM temperature predictions were calibrated by adjusting model coefficients that control the effects of wind and solar radiation. Wind coefficients are commonly used for calibration of reservoir models because: 1) models are sensitive to wind speeds, which control evaporative cooling and mixing among upper layers, and 2) accurately measured values of wind speed at the reservoir are rarely available. The model was sensitive to the wind parameters AA and BB, which are both empirical coefficients used to calculate evaporative and convective heat fluxes. The parameter TURB, a dust attenuation coefficient which controls the influx of solar radiation through the atmosphere, was also found to have a strong effect on the shape of the thermal profile. These two wind and one atmospheric parameters, along with the mixing coefficients CDIFW and CDIFF, were adjusted until the best overall results were achieved for the water temperature calibration. See Appendix E for further discussion of the calibration parameters used in the thermal modeling of Grant Lake.

The model was calibrated to reproduce reservoir temperature profiles collected by Jones & Stokes Associates in 1991. They measured thermal profiles about twice a month from May 15 to September 28, 1991. A comparison of these in situ reservoir thermal profiles with results from THERM is shown in both pages of Figure 6-2.

Figure 6-2 shows that the THERM calibration reproduces the vertically-averaged reservoir temperature fairly well, and predicts stratification with approximately the same magnitude, depth, and frequency as observed[3]. However, THERM predicts stratification at different times than was observed in the measured temperature profiles. This is most likely because the wind data used for the model does not represent the timing of high winds (which cause the reservoir to mix) that actually occurred in 1991 at Grant Lake. Calibration that accurately predicts the

[3]Both THERM and the 1991 field data show periods when stratification occurs and periods when the reservoir is vertically mixed.

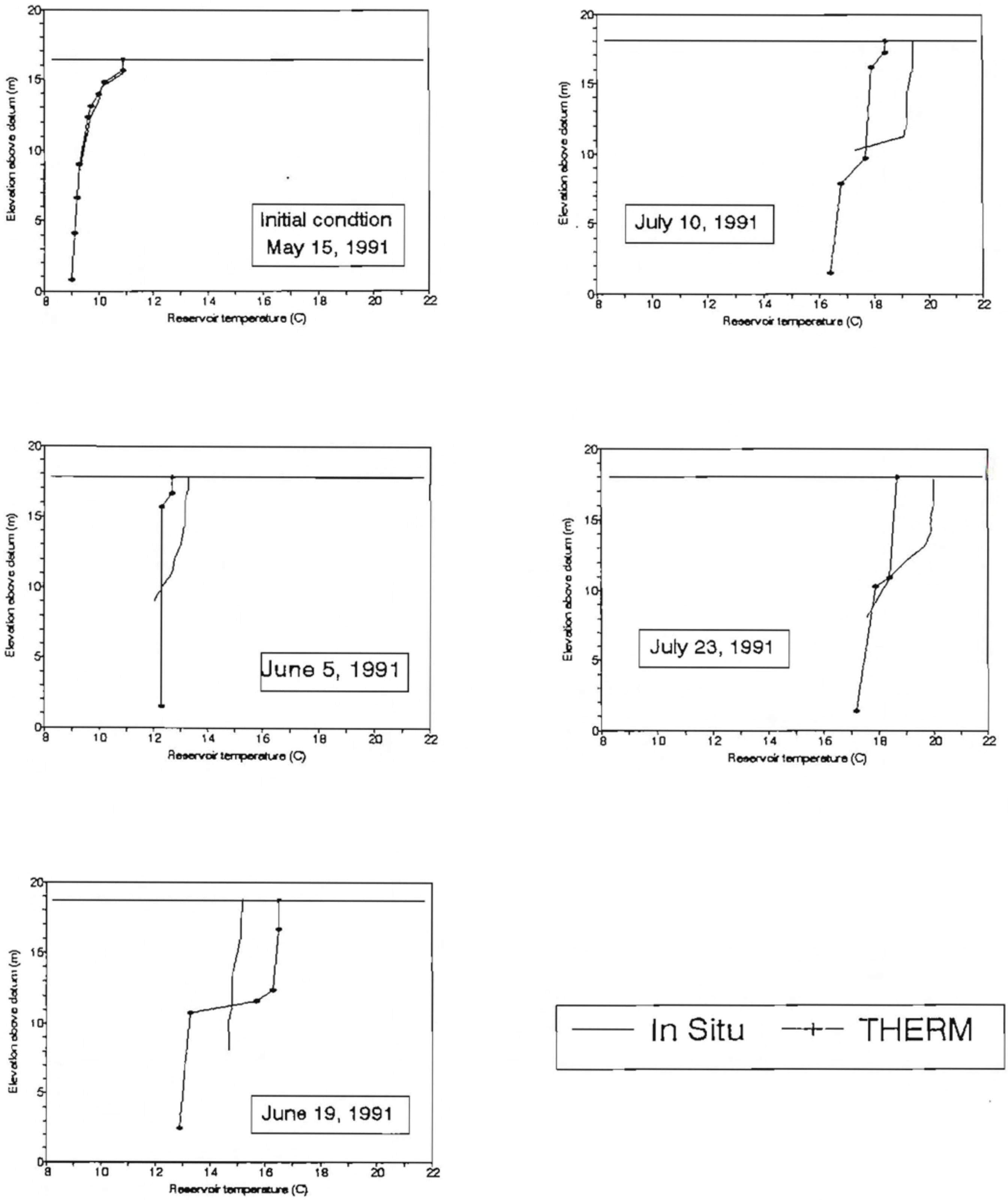

Figure 6-2. Grant Lake Water Temperature Profiles for 1991 (Calibration Year): THERM and In Situ

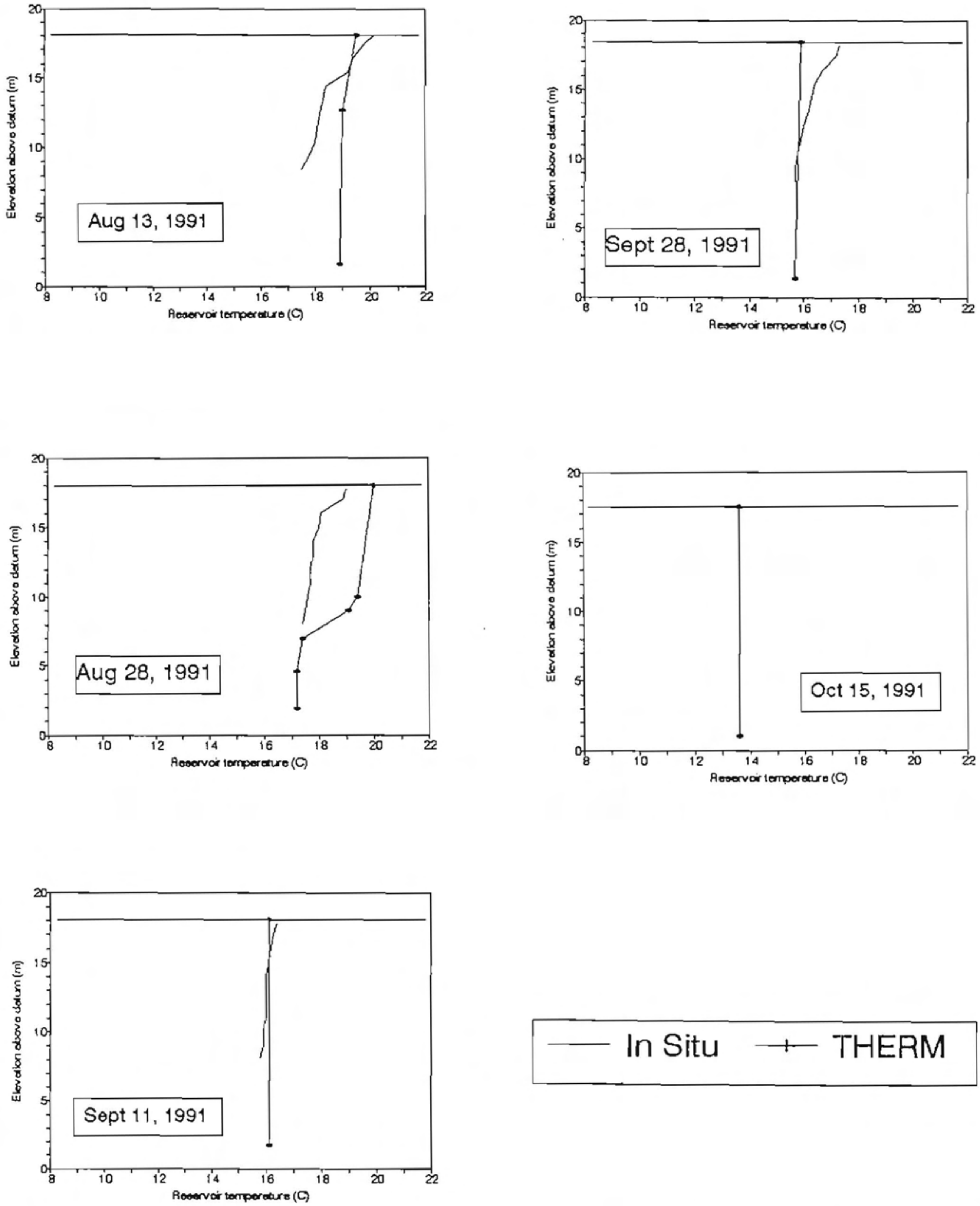

Figure 6-2. Grant Lake Water Temperature Profiles for 1991 (Calibration Year): THERM and In Situ (continued)

timing of stratification and mixing events would require that on-site wind data be collected. Despite the inability to match observed mixing events, the calibrated THERM model appears to accurately reproduce the physical processes controlling temperatures in Grant Lake. Also, all the calibrated input parameters remained within reasonable ranges. Therefore, the calibration was deemed acceptable for assessing the feasibility of modifying reservoir operation or configuration of the reservoir outlet to obtain cooler outflow temperatures during mid-summer and early fall.

6.3 LAKE OUTFLOW WATER TEMPERATURE CALIBRATION

Lake outflow temperatures from THERM were checked by comparing them to stream temperatures recorded in 1991 in the Mono Ditch. Comparisons could only occur from late August to September because the field monitors were not installed until late August 1991; just prior to commencing compliance monitoring of stream temperatures for the 1991 restoration construction program. Results from THERM simulations and in situ recorded stream temperatures are shown in Figure 6-3. For the three dates that modeled and measured outflow temperatures are compared, THERM underpredicts and overpredicts by 0.7°C average error and +2°C maximum error. As stated above, the inconsistency between predicted and observed temperatures is most likely attributable to insufficient on-site data being available.

6.4 WIND SPEED SENSITIVITY ANALYSIS

Wind speed is an important input parameter for the model THERM. However, wind speeds were not collected at Grant Lake because lead time and funding were unavailable for this data collection. Wind speeds used for this study were from the NOAA weather station office in Bishop, about 60 miles south of Grant Lake. The daily speed of wind at Bishop was used as the daily speed of wind in the Mono Basin for lack of any basis for adjusting the wind speeds. Monthly wind speeds from LADWP's meteorological station at the Cain Ranch were available up to 1982 but did not cover the period of interest nor were values reported on a daily basis.

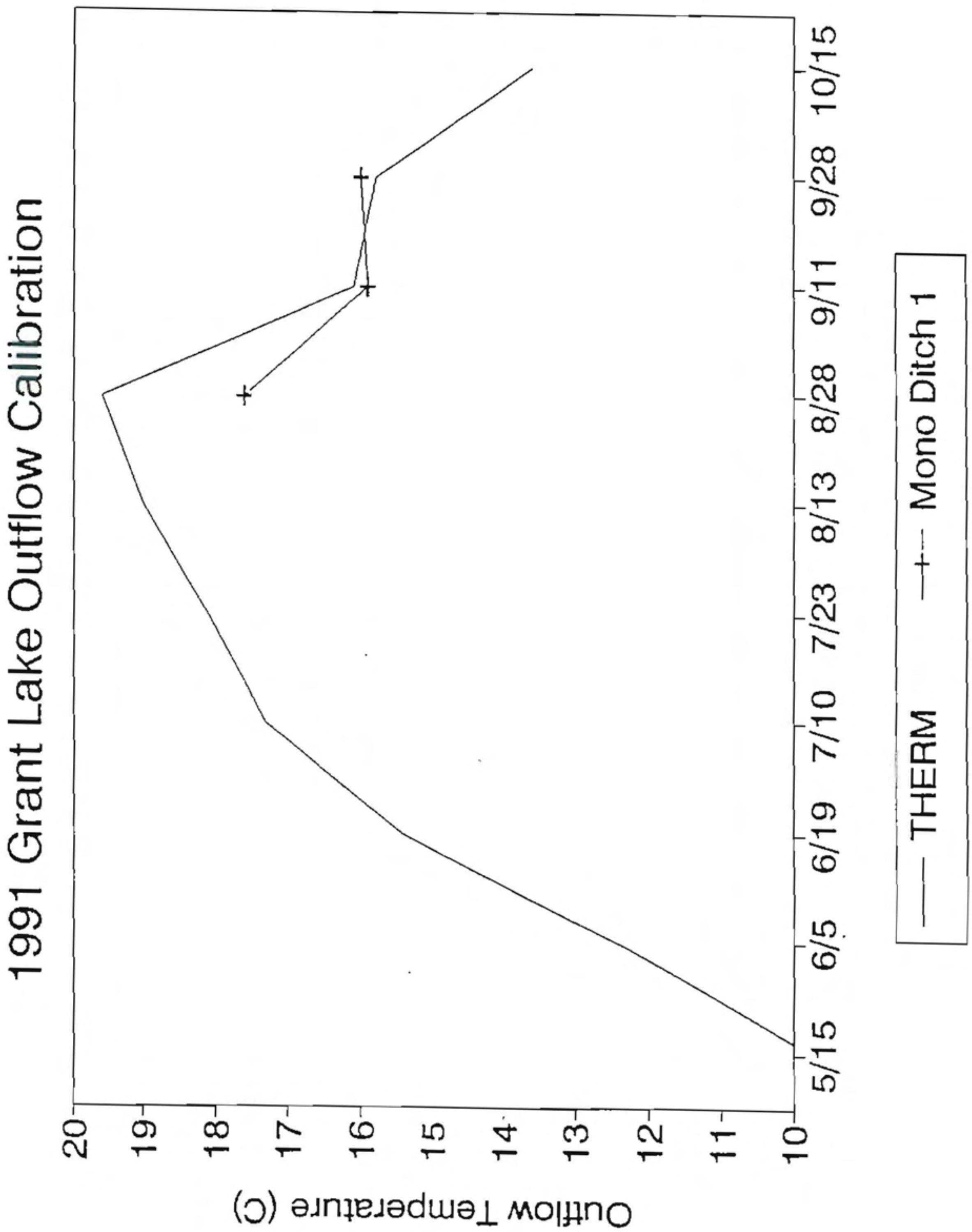

Figure 6-3. Grant Lake Outflow Water Temperatures for 1991 (Calibration Year)

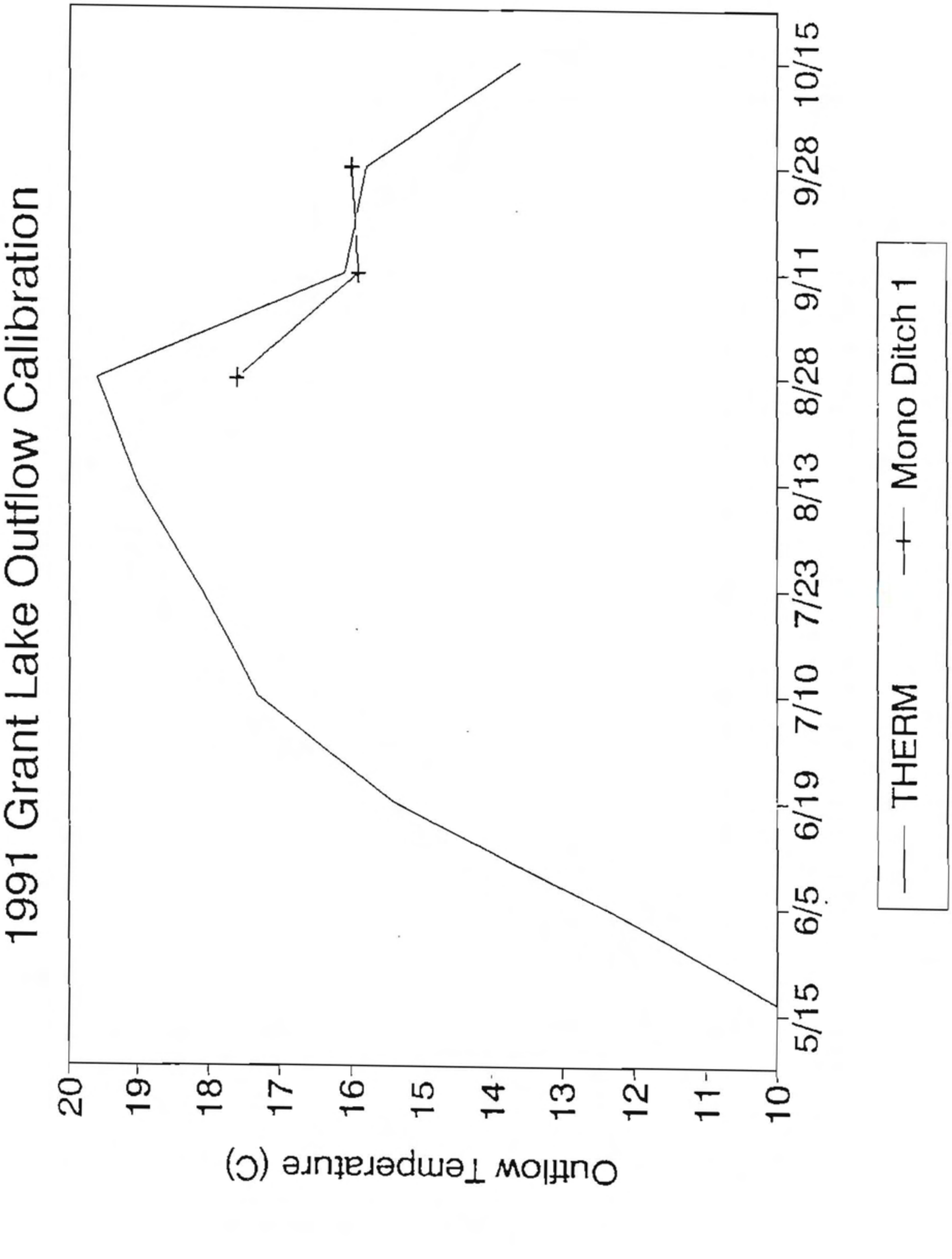

Figure 6-3. Grant Lake Outflow Water Temperatures for 1991 (Calibration Year)

As the speed of the wind decreases there should be an associated decrease in mechanical mixing due to the wind. This decrease in mixing should increase the onset and strength of thermal stratification within the reservoir which means a well developed hypolimnion with reserves of cooler water is more likely to exist in the summer months. Additionally, as the speed of the wind decreases there should be an associated decrease in evaporative cooling, which would cause the reservoir to warm.

Conversely, as the speed of the wind increases there should be an associated increase in mechanical mixing due to the wind. This increase in mixing should decrease the onset and strength of thermal stratification within the reservoir. Additionally, as the speed of the wind increases, there should be an associated increase in evaporative cooling, which would cause the epilimnion and the reservoir to cool.

The sensitivity of the calibrated model to wind speeds was determined by running the model with wind speeds from Bishop multiplied by five different percents: 150, 125, 100, 75, and 50. It is seen in Figure 6-4 that the outflow temperature is somewhat sensitive to the speed of the wind. Outflow temperature varied on any day by about 2°C according to the different percent multiplier. The use of on-site wind speeds would increase the accuracy of the model but most likely not significantly change the model simulation results.

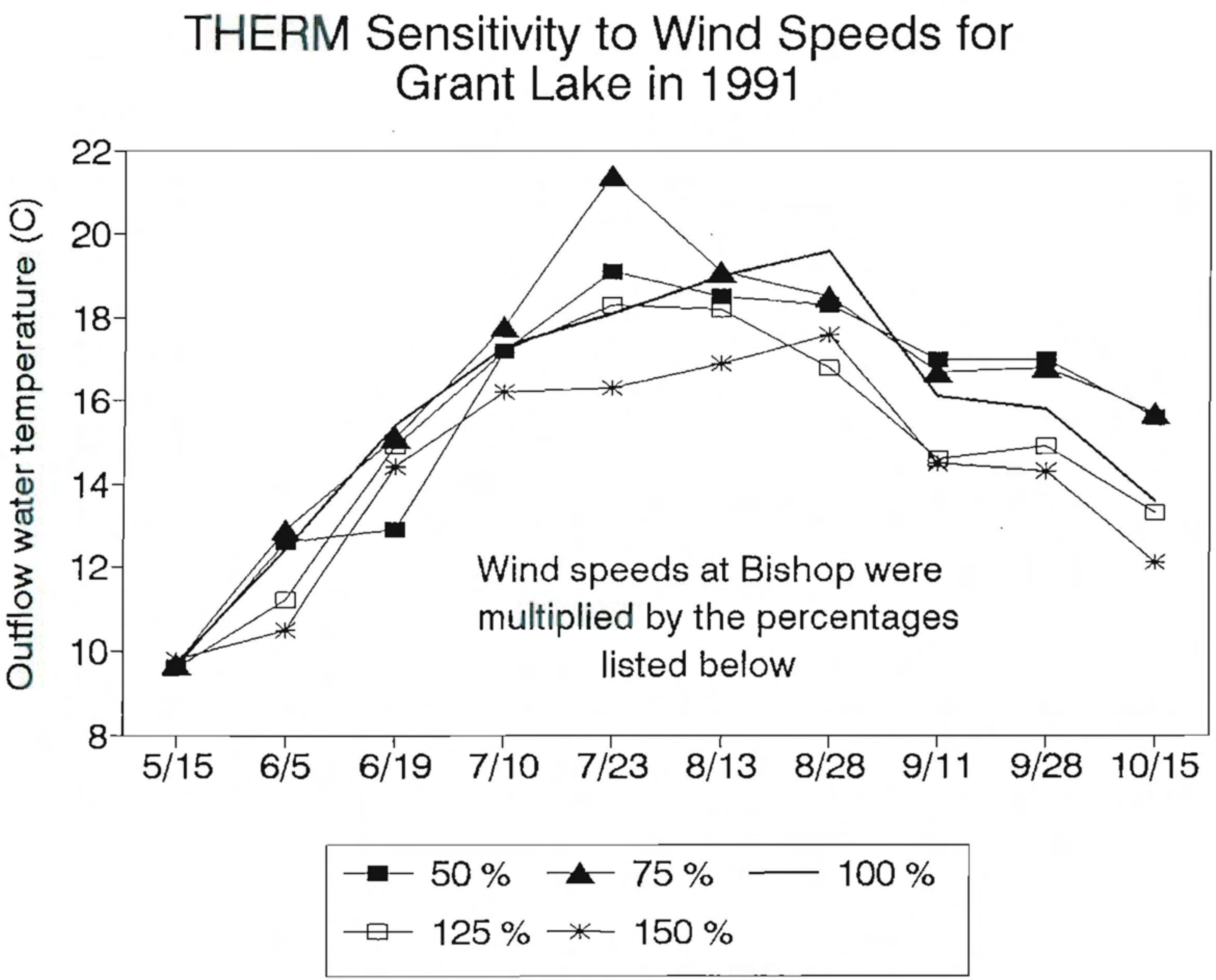

Figure 6-4. Wind Speed Sensitivity Analysis For 1991 (Calibration Year)

7.0 MODEL VALIDATION

The validity of the reservoir model calibration was tested by using it to simulate conditions in the year 1992. An input data set (meteorological, hydrologic, etc.) was assembled for 1992 using the same basic data sources as for 1991. Calibration could only be checked for mass balance (water surface elevations) and outflow water temperatures because thermal profiles were not collected for Grant Lake in 1992. However, the accuracy of the thermal profile near the outlet pipe can be inferred by examining the comparison between the outflow temperatures measured in Mono Ditch and those predicted by THERM.

7.1 RESERVOIR WATER SURFACE ELEVATION VALIDATION

The model's ability to predict reservoir elevations and volumes was checked by comparing predicted elevations to those recorded by LADWP (Figure 7-1). THERM underpredicts water surface elevations by an average of 0.9 ft with a maximum error of -2.2 ft on September 28, 1992. Recall that THERM had also slightly underpredicted the water surface elevations for the calibration year of 1991 and this was thought to be associated with stream gage error or sedimentation.

7.2 RESERVOIR OUTFLOW WATER TEMPERATURE VALIDATION

THERM underpredicts and overpredicts outflow water temperatures for the validation year 1992. The maximum error of +3.5°C occurs on July 23, 1992 (Figure 7-2). Essentially, this overprediction means thermal energy in the model simulations is moving towards the hypolimnion faster than actually occurred. In the absence of local meteorological data and reservoir temperature profiles for 1992, the cause of differences between simulated and observed outflow temperatures cannot be determined.

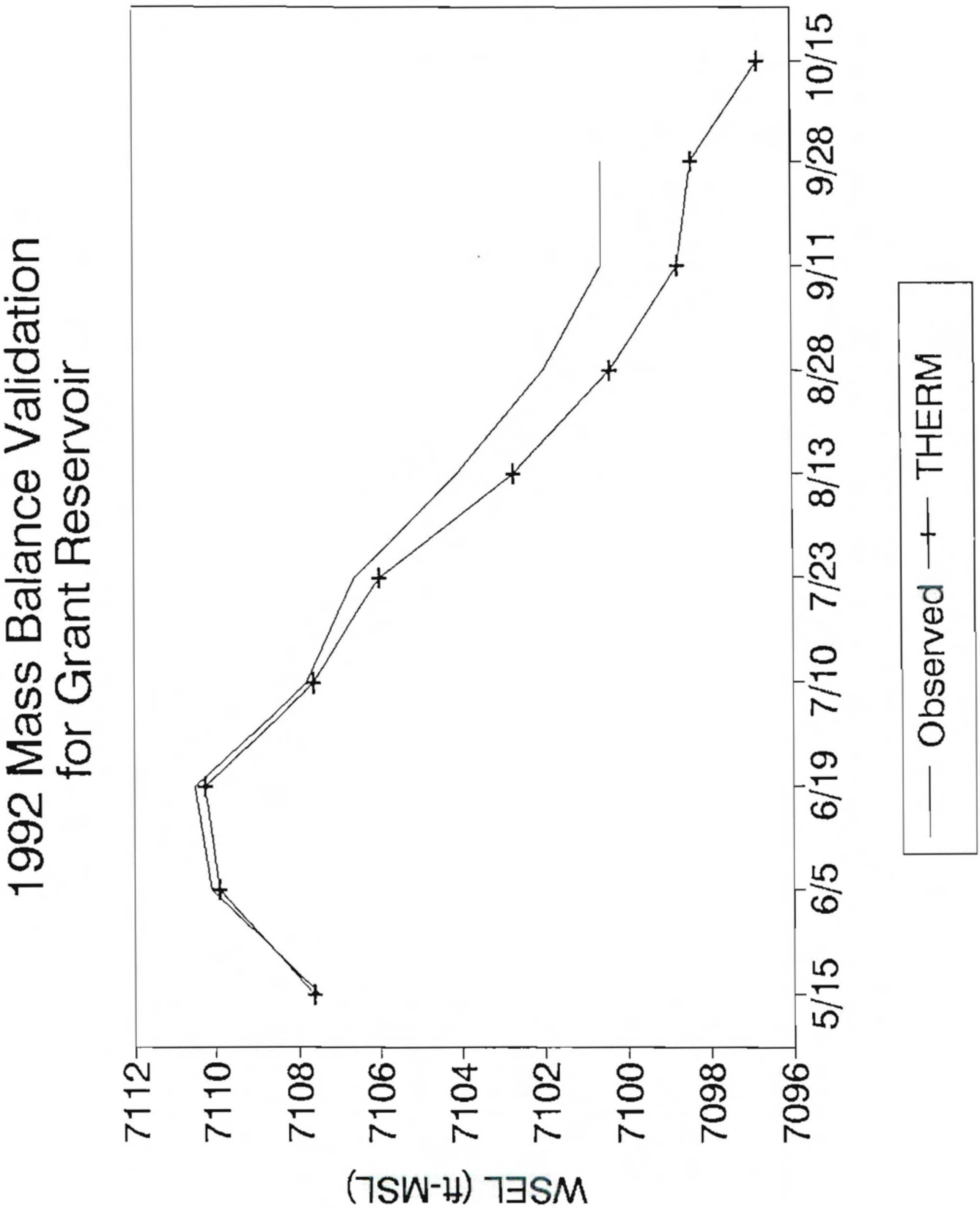

Figure 7-1. Grant Lake Water Surface Elevations From May 15 to October 15, 1992 (Validation Year)

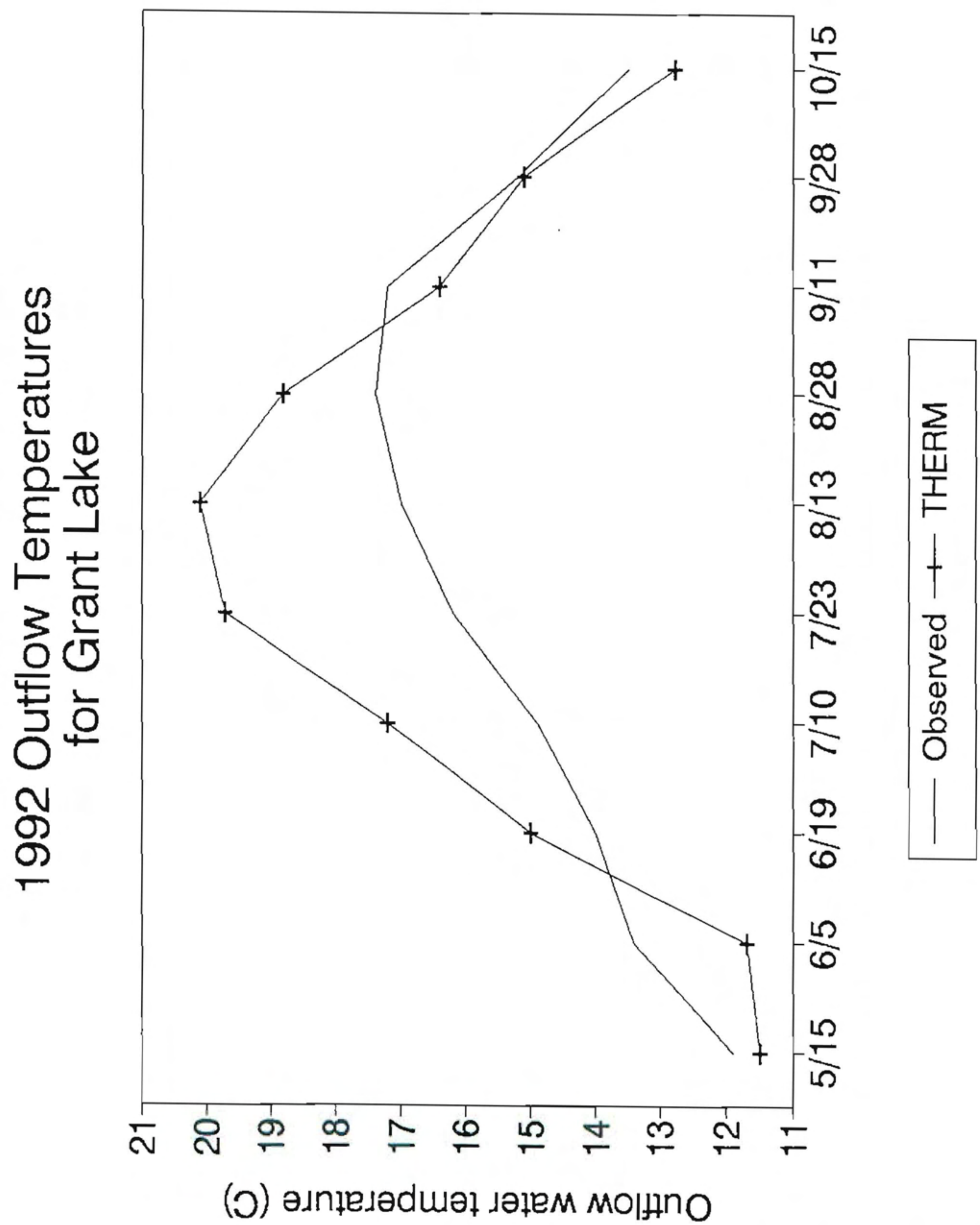

Figure 7-2. Grant Lake Outflow Water Temperatures From May 15 to October 15, 1992 (Validation Year)

8.0
SIMULATIONS

The numerical model THERM was used to simulate alternative reservoir management scenarios by using the 1991 calibration parameters with varied conditions. The time period simulated was from May to October; the hottest part of the year and bracketing the seasons of late spring, summer, and early fall. Summer conditions of the reservoir start being determined in May as a large discharge of cool water enters the reservoir. The summer is the main period of interest in this study when high air temperatures along Rush Creek provide stress to fish. By October, the air temperatures along Rush Creek have cooled and are no longer providing stress to fish. Three types of scenarios were simulated:

1. higher initial water surface elevations at the start of the simulation period,
2. selective withdrawal through the use of a multiple level outflow structure, and
3. higher initial water surface elevations in conjunction with the use of selective withdrawal (a combination of Scenarios 1 and 2 above).

Scenario 1. Higher initial water surface elevations at the start of the simulation period.

The temperature of a reservoir is determined by the rates at which heat energy enters and leaves the reservoir and by the volume of water stored. Increasing the elevation of a reservoir (and storage volume) is expected to decrease the rate at which it heats in summer and, possibly, to allow more stratification of cold water near the low elevation release port. The larger the volume of water a reservoir contains the more heat energy will be required to raise the average temperature of the water. Therefore, a small body of water will react more quickly to changes in air temperature than a large body of water because the small body of water has less mass which requires energy absorption.

In Scenario 1 the initial vertical temperature profile was the same for each of the four scenarios simulated (7090, 7100, 7110, and 7120 ft MSL). However, the depth of water was different for each simulation and the initial hypolimnetic temperature of about 9°C was assumed between the metalimnion and the floor of the reservoir.

Scenario 2. Selective withdrawal through the use of a multiple level outflow structure.

A multiple level outflow structure is used to withdraw outflow water from different levels within a stratified reservoir. The rationale for a multiple level outlet structure at Grant Lake is that selective withdrawal would allow for the blending of warm epilimnetic and cold hypolimnetic waters which would yield optimal temperatures in Rush Creek for the growth of brown trout. A multiple level outflow structure would also allow for the skimming and release of epilimnetic waters in the late spring and early summer; this would cause the removal of the warmest waters from the reservoir and preserve deeper, cooler water for release in late summer or early fall. The model simulates selective withdrawal operation by automatically blending water from different levels to attempt to keep the temperature below the specified value (17°C in this case) while preserving as much cold water as possible in the hypolimnion.

The outflow target temperature of 17°C was specified for all selective withdrawal simulations. This 17°C temperature is near optimum for trout. Also, a release temperature of 17°C would most likely prevent the daily average temperature of Rush Creek from exceeding 20°C. If a simulation run evacuated all water with temperatures less than or equal to 17°C then THERM attempts to release the coolest water for the remainder of the simulation.

THERM simulates selective withdrawal through a multiple level outlet, with the objective of keeping outlet temperatures below a specified (target) value. The model user selects the number and elevation of outlet ports; in this case, we simulated scenarios with one, two, three, and four ports. The elevations of these outlet ports varied slightly with respect to initial water surface elevation. The following guidelines were used for assuming the elevation of the outlet ports:

One Port: The lone port was the existing port within the reservoir at elevation 7069.9 ft MSL. The intention of this scenario was to describe baseline conditions. This lone port within the hypolimnion would remove cold water until the metalimnion increased in depth and then only warm water could be released.

Two Ports: One port was placed within the epilimnion and the other port was placed within the hypolimnion. This arrangement allowed for the blending of warm and cold water in order to meet release target temperatures. The two ports were designed to allow for the removal of warm water from the reservoir when air temperatures are cold and for the removal of cold water when air temperatures are hot.

Three Ports: One port was always placed within the epilimnion and one port placed within the hypolimnion. The third port was placed at approximately the half-way point between the other two ports. The third (and fourth discussed below) port allows more control over release elevations, possibly allowing more cold water to be retained within the hypolimnion.

Four Ports: One port was always placed within the epilimnion and one port placed within the hypolimnion. The other two ports were equally spaced between the high and low ports.

Scenario 3. Altering initial water surface elevations in conjunction with the use of selective withdrawal.

Increasing initial water surface elevations in conjunction with a multiple level outflow structure was evaluated because it was thought that greater reservoir depths might make the reservoir stratify more completely, which would make selective withdrawal more effective. This scenario requires a combination of simulations from Scenarios 1 and 2 above.

9.0 RESULTS FROM SIMULATIONS

Scenario 1. Increasing the initial water surface elevations at the start of the simulation period.

Outflow water temperatures were simulated from the 1991 calibration file using four different initial water surface elevations. These initial water surface elevations were 7090, 7100, 7110, and 7120 ft MSL. The elevation 7090 ft MSL was the initial water surface elevation for the calibration year 1991. Generally, the results show that the outflow water temperature decreases in the summer months when the depth of the reservoir is increased in the spring (Figure 9-1). Increasing the initial water surface elevation to 7100, 7110, and 7120 ft MSL caused the outflow water temperature to fall by an average of 1.1°C, 1.8°C, and 2.0°C respectively during the spring and fall months (Table 9-1).

A low water surface elevation means the storage volume of the reservoir is low. Reservoir temperature fluctuations are more pronounced with a low storage volume because the amount of thermal mass available to accept and release heat energy is also low. Essentially, this means a reservoir with a low storage volume is more responsive to changes in air temperature than a reservoir with a high storage volume.

This phenomenon of reservoir response to air temperatures as a function of storage volume can be seen in Figure 9-1. Air temperatures are higher than outflow temperatures from Grant Lake prior to September 11. So, the lake is heating up for all four initial water surface elevations. However, the warmest outflow temperatures occur in association with the lowest initial water surface elevation and the coolest outflow temperatures are associated with the highest initial water surface elevations. After September 11th in Figure 9-1, the air temperature is lower than the temperature of the outflow. Note how the simulation with the lowest water surface elevation (and volume) is most responsive to the decreased air temperature.

By October 14 the set of curves has completely inverted to where the warmest outflow temperatures are now associated with the highest water surface elevation and volume. This means having a fuller reservoir in the spring can provide a double benefit to the downstream fishery: 1) cooler water in the summer and 2) warmer water in the fall. Both alterations in the outflow temperatures mean there is a longer growing season for fish, which has the potential to yield bigger fish.

Scenario 2. Selective withdrawal through a multiple level outflow structure.

Selective withdrawal by itself appears to have little influence on the outflow water temperature. Figures 9-2 through 9-5 show that for a given initial water surface elevation, varying the number of outlet ports (locations within the water column) from which water could be released is not expected to significantly change the outflow water temperature. However, more control was exhibited over the outflow water temperature for short time periods as the number of ports increased. Also, the outflow water temperature was slightly cooler as the number of ports increased for a given initial water surface elevation. The authors point out that the data point on July 24 on graph Figure 9-2a (initial WSEL = 7090) violate this pattern because the model opened the hypolimnetic outlet (with access to cold water) just prior to July 24.

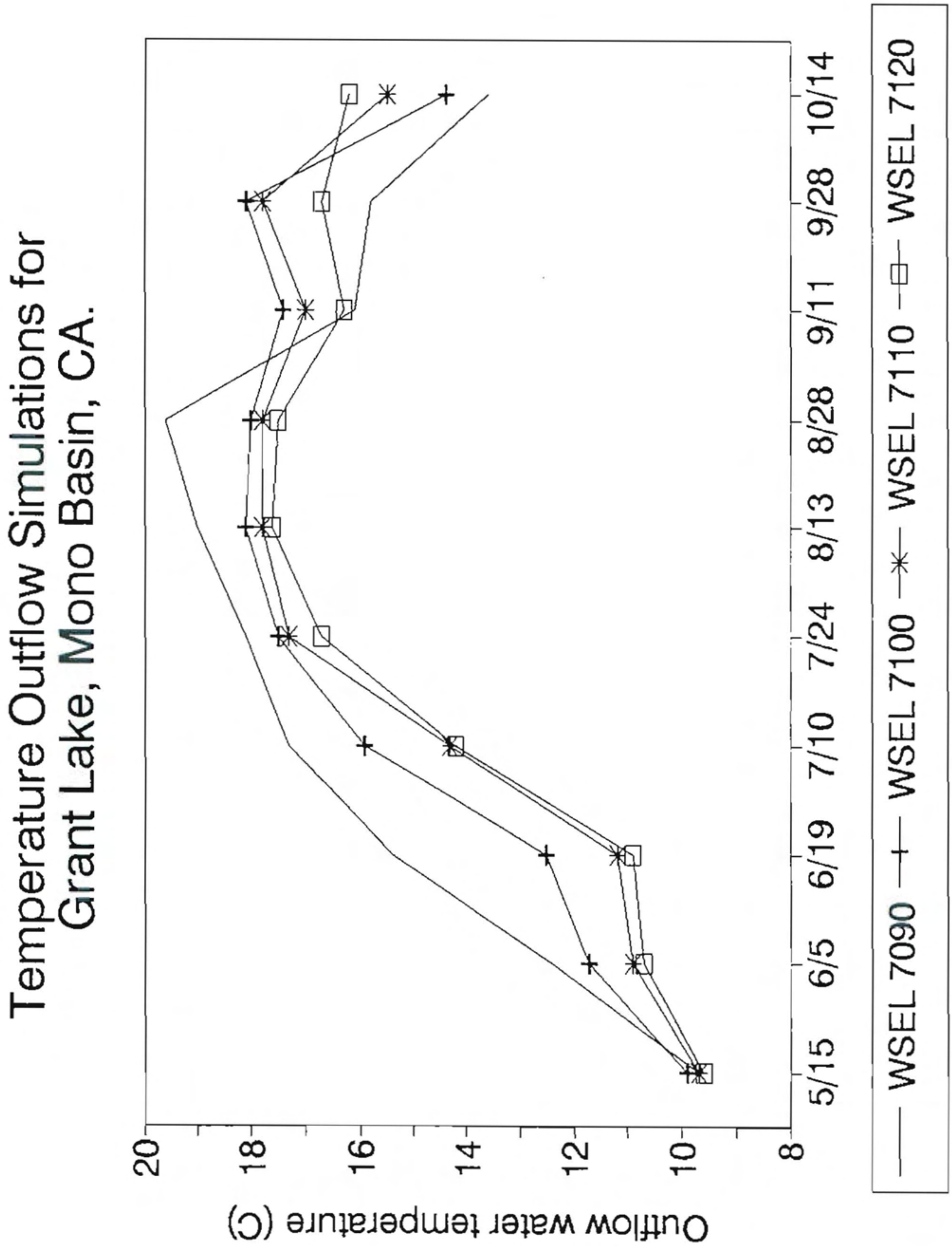

Figure 9-1. Simulation Results For Scenario 1: Varying Initial Water Surface Elevations

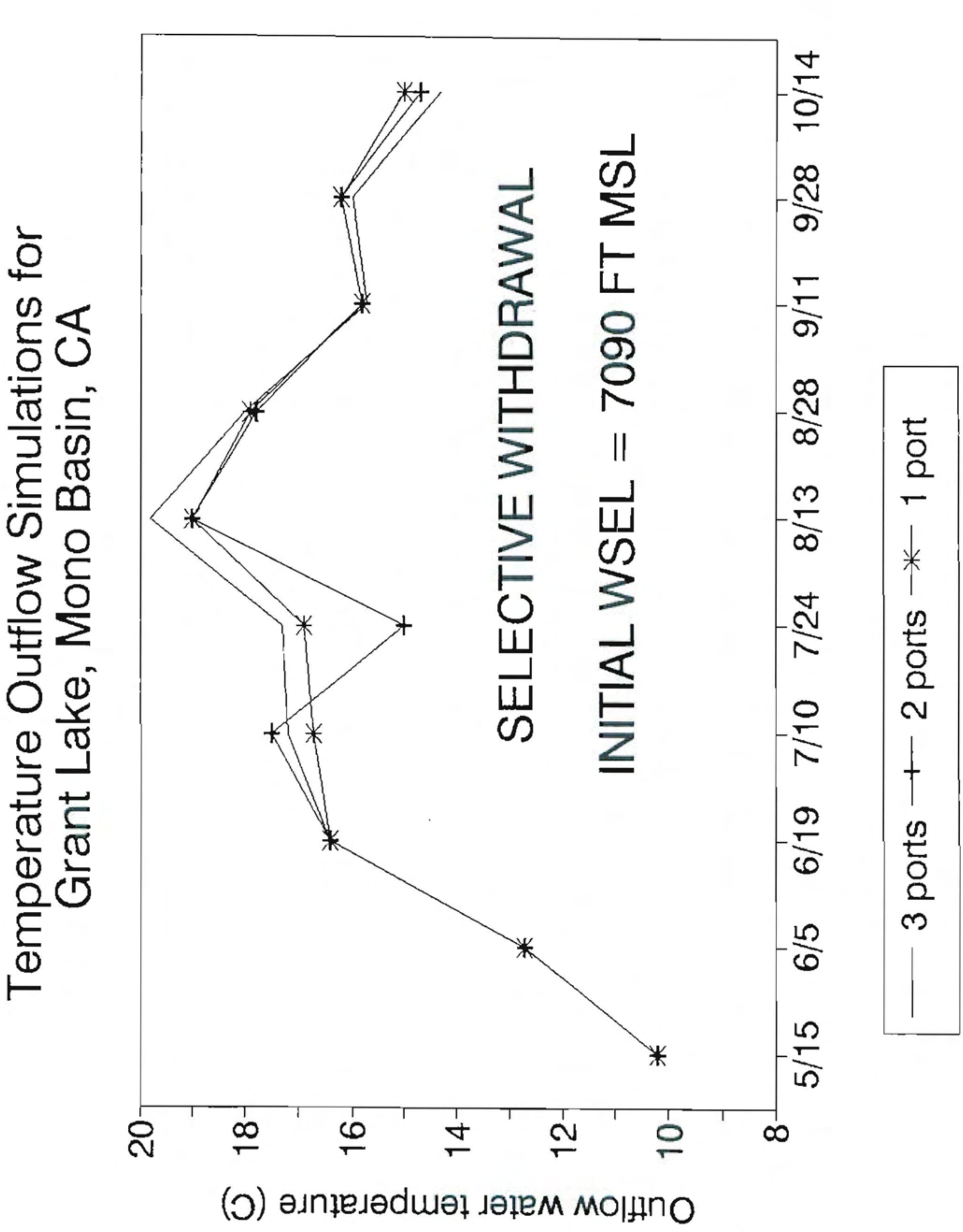

Figure 9-2. Simulation Results for Scenario 2: Outflow Water Temperature of Grant Lake With an Initial Water Surface Elevation of 7090 ft MSL

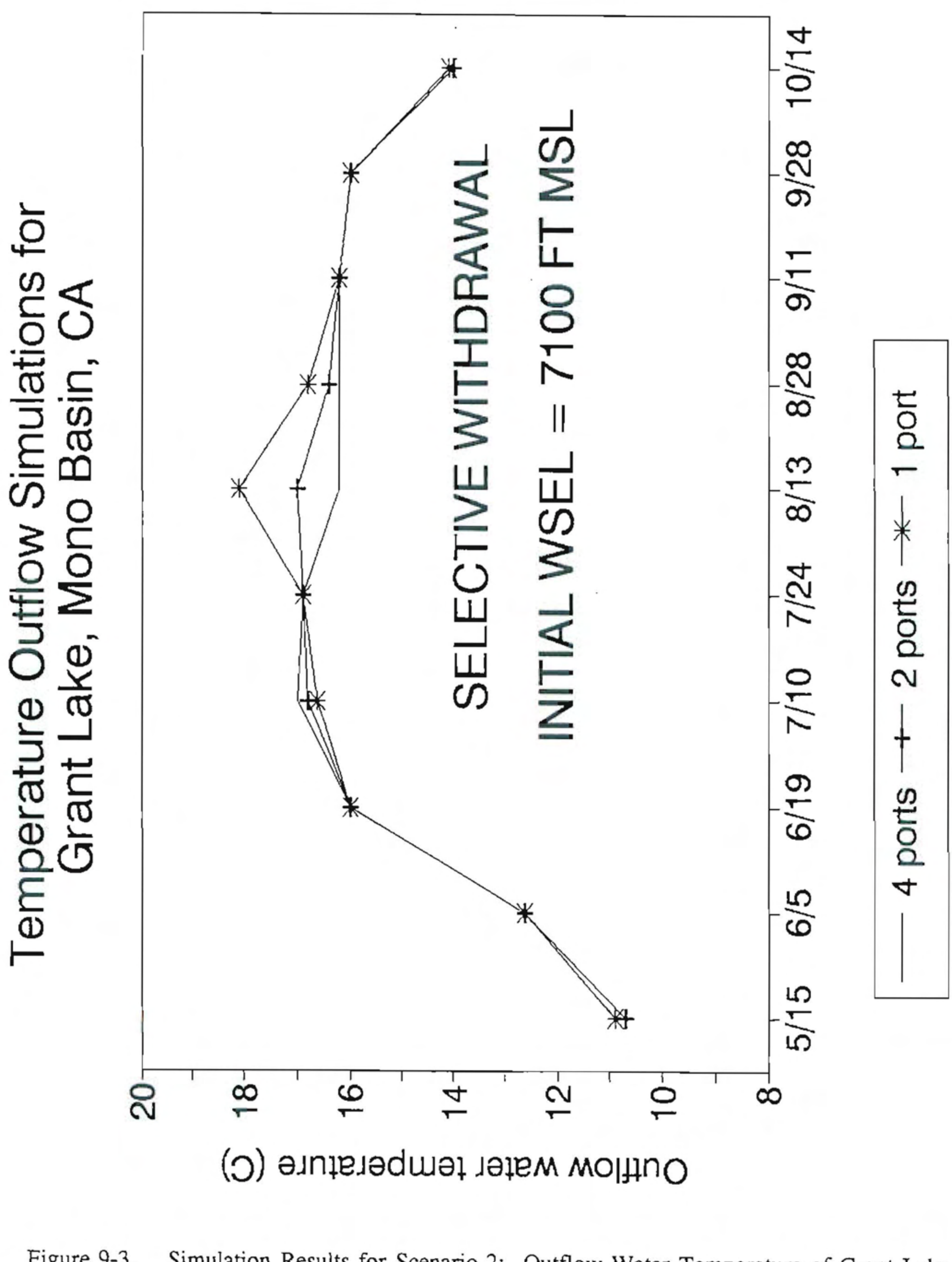

Figure 9-3. Simulation Results for Scenario 2: Outflow Water Temperature of Grant Lake With an Initial Water Surface Elevation of 7100 ft MSL

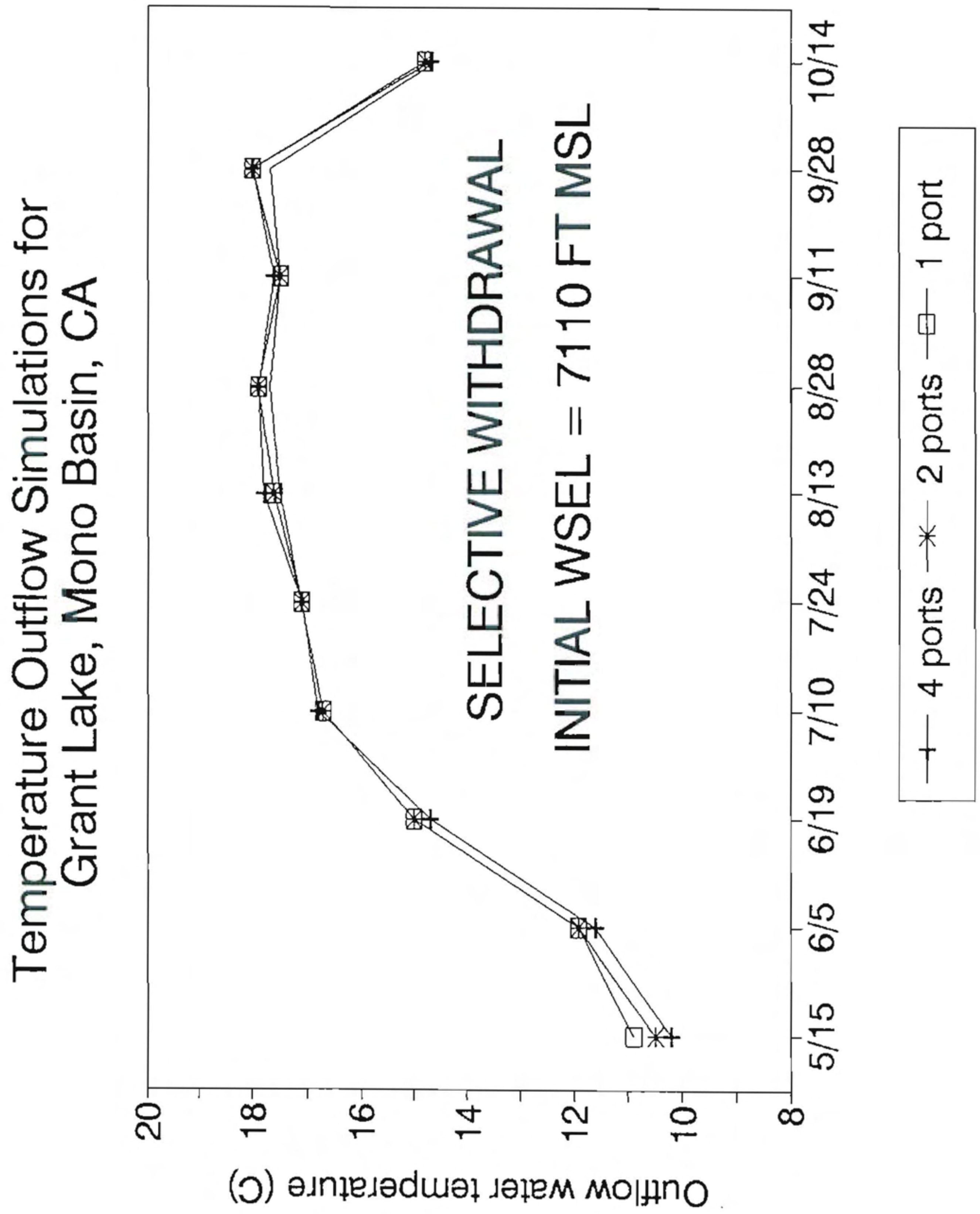

Figure 9-4. Simulation Results for Scenario 2: Outflow Water Temperature of Grant Lake With an Initial Water Surface Elevation of 7110 ft MSL

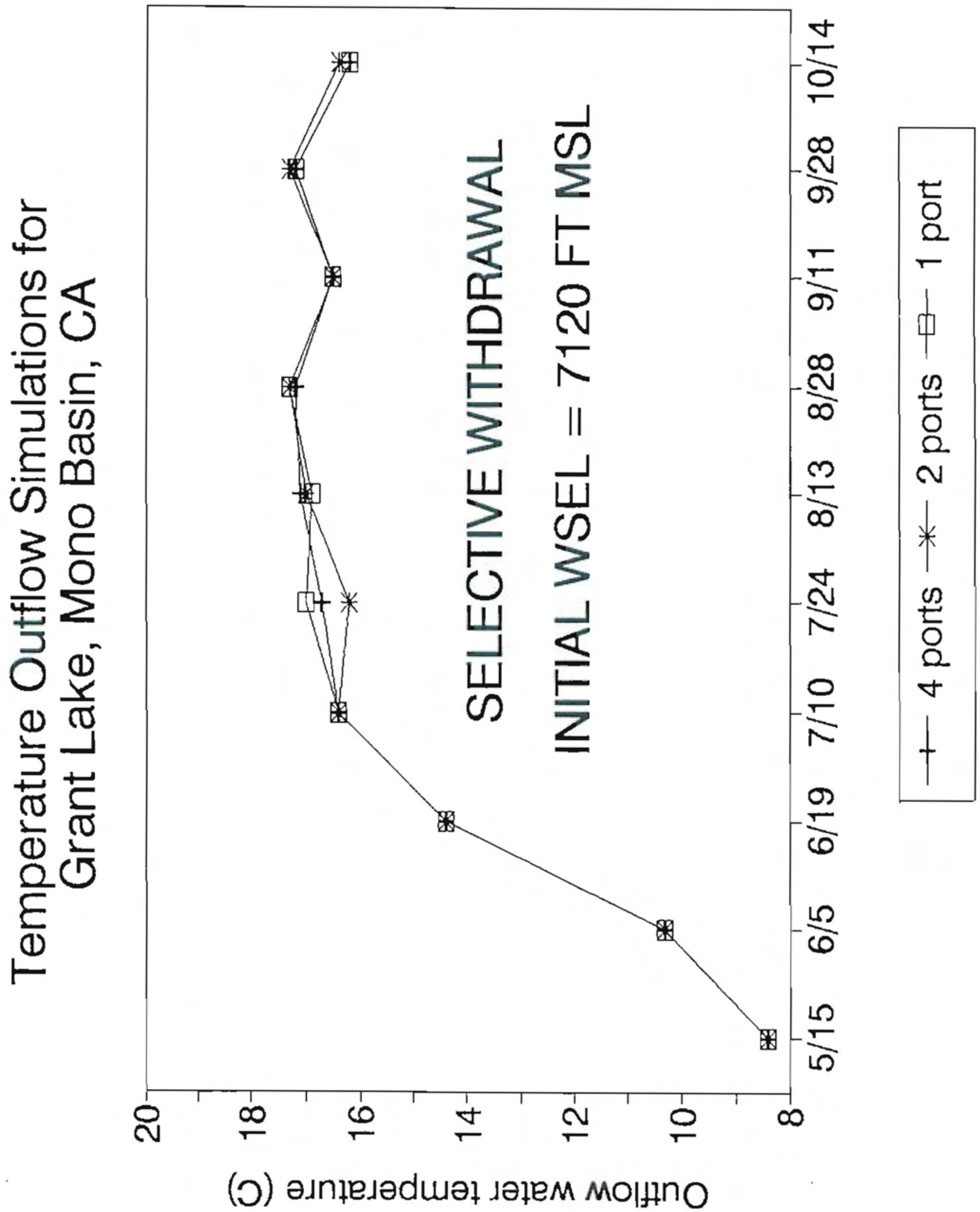

Figure 9-5. Simulation Results for Scenario 2: Outflow Water Temperature of Grant Lake With an Initial Water Surface Elevation of 7120 ft MSL

Table 9-1.

Simulation Scenario 1: Outflow Water Temperatures From Four Different Initial Water Surface Elevations[a]

Date	Initial WSEL				Incremental Temperature Decrease		
	7090 ft MSL	7100 ft MSL	7110 ft MSL	7120 ft MSL	7090 minus 7100 ft MSL	7090 minus 7110 ft MSL	7090 minus 7120 ft MSL
5/5	9.7	9.9	9.7	9.6	-0.2	0.0	0.1
6/5	12.4	11.7	10.9	10.7	0.7	1.5	1.7
6/19	15.4	12.5	11.2	10.9	2.9	4.2	4.5
7/10	17.3	15.9	14.3	14.2	1.4	3.0	3.1
7/24	18.1	17.5	17.3	16.7	0.6	0.8	1.4
8/13	19.0	18.1	17.8	17.6	0.9	1.2	1.4
8/28	19.6	18.0	17.8	17.5	1.6	1.8	2.1
				Average	1.1	1.8	2.0

[a]For the period from May 15 to August 28 of calibration year 1991.

The reason that selective withdrawal is predicted to be ineffective in reducing outlet temperatures is that the reservoir is probably periodically mixed by high wind speeds. **Selective withdrawal can control temperatures and preserve cold water for release during late summer only if the reservoir remains thermally stratified during summer.** The calibration data show that the reservoir is occasionally mixed (Figure 6-2) and making selective withdrawals apparently does not cause stratification sufficient to prevent such mixing.

The sensitivity of the model to wind speeds was determined by running the two port selective withdrawal simulation with wind speeds from Bishop multiplied by five different percents: 150, 125, 100, 75, and 50. Prior to July 10 and after August 28 the outflows generally follow the pattern, as shown in Figure 9-6, that the warmest outflow temperatures are simulated with the slowest winds (50 and 75%) while the coolest outflow temperatures are simulated with the fastest winds (150 and 125%).

Scenario 3. Altering initial water surface elevations in conjunction with the use of selective withdrawal.

From review of the graphs of Figures 9-1 through 9-5 it is seen that increasing the initial water surface elevation reduces temperatures more than does selective withdrawal. Even when the initial elevation is raised to 7120 ft, the reservoir does not stratify consistently enough for selective withdrawal to be effective.

10.0 CONCLUSIONS

1. **The modeling effort is acceptable for the feasibility study. However, the data base requires additional on site information for more accurate forecasts.** The THERM calibration for 1991 (the year used for simulation of alternative temperature control scenarios) accurately reproduced the average reservoir temperatures, and the magnitude, depth, and frequency (but not timing) of stratification. The model validation indicated that simulated 1992 outlet temperatures were generally 3°C higher than measured values. Significant improvements in calibration or temperature predictions are unlikely without: (1) collection of on-site data (especially dew point, wind speed, solar radiation, percent possible sun, and reservoir temperature profiles), and (2) verification of hydrologic measurements (e.g., stream gage accuracy and the relationship between storage volume and water surface elevation for Grant Lake).

2. **Filling the reservoir in early spring and maintaining a near full reservoir through the summer should provide cooler outflow temperatures.** Increasing the storage volume in the reservoir (especially by filling it with spring runoff) appears capable of reducing the temperature of water released into Rush Creek by at least 2°C (based on 1991 conditions). Filling the reservoir in spring would not require any structural modifications or financial investments. And, the resulting downstream temperatures and the response of fish populations to those temperatures would be easy to monitor.

3. **Constructing an outlet structure at Grant Lake to provide for selective withdrawal is not advised.** Mixing from winds and other causes eliminates thermal stratification within the reservoir and thus prevents the development of a cool hypolimnion. Increasing the depth of the lake during summer (conclusion # 2) would decrease the frequency of vertical mixing. The average temperature of water released from the lake might be altered by utilizing selective withdrawal whenever there is stratification. However, the amount of

time during the year that stratification is sufficient to permit selective withdrawal is highly questionable. Installation of a multiple-level outlet structure to permit selective withdrawal of water from different depths in the lake should not be considered further unless data collected after the operation of the lake has been changed to maintain a near full reservoir during the summer show that: (1) further reduction of outflow temperature is needed, and (2) the frequency and duration of vertical stratification is sufficient to permit selective withdrawal during the summer.

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12.0
APPENDICES

APPENDIX A.
1991 AND 1992 OUTFLOW TEMPERATURES FROM GRANT LAKE

1991 Rush Creek Water Temperatures (°C) in Mono Ditch about 1.1 miles downstream from Mono Gate 1.

		August	
Day	Avg	Max	Min
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16	19.0	20.0	18.0
17	18.6	19.5	18.0
18	18.8	19.5	18.0
19	19.5	21.0	18.0
20	19.1	21.0	18.0
21	18.9	20.5	18.0
22	19.1	20.5	18.0
23	19.1	20.0	18.0
24	19.6	21.0	19.0
25	19.2	21.0	18.5
26	18.7	20.0	17.5
27	17.8	19.0	17.0
28	17.6	19.5	16.5
29	17.9	19.5	17.0
30	18.0	19.5	17.0
31	18.3	19.5	17.5
Mean	18.7	20.1	17.7

Appendix A.
Listing of Input Parameters for THERM (cont)

1991 Rush Creek Water Temperatures (°C) in Mono Ditch about 1.1 miles downstream from Mono Gate 1.

Day	September Avg	September Max	September Min	October Avg	October Max	October Min
1	18.1	19.5	17.5	15.5	18.0	14.0
2	17.7	19.0	17.0	15.5	17.5	14.0
3	17.7	19.0	17.0	15.6	18.0	14.5
4	17.3	19.0	16.5	15.4	17.5	14.0
5	16.7	18.5	15.5	15.4	17.5	14.0
6	16.8	18.5	16.0	15.4	17.5	14.5
7	17.0	19.0	16.0	15.3	17.5	14.0
8	16.7	19.0	15.5	15.3	17.5	14.0
9	16.4	18.0	15.5	14.8	16.5	14.0
10	15.6	17.5	14.5	15.0	17.0	14.0
11	15.9	19.0	14.0	14.8	16.0	14.0
12	15.7	18.5	14.0	15.0	16.5	14.0
13	15.6	18.5	14.0	14.6	16.5	13.5
14	16.0	19.0	14.0	14.5	16.5	13.5
15	15.9	18.5	14.0	14.4	16.5	13.5
16	15.7	19.0	14.0	14.3	16.5	13.5
17	15.7	18.5	14.0	14.6	16.5	13.5
18	16.0	19.0	14.0	14.5	16.5	13.5
19	16.1	19.0	14.5	14.1	16.0	13.0
20	16.0	18.5	14.5	13.7	15.5	12.5
21	16.3	19.0	14.5	13.4	15.5	12.5
22	15.9	18.5	14.5	13.2	15.0	12.0
23	15.9	18.5	14.5	11.6	13.5	10.5
24	15.6	18.0	14.0			
25	15.5	17.5	14.5			
26	16.1	18.0	15.0			
27	15.8	18.0	14.5			
28	16.0	18.5	15.0			
29	15.7	17.0	15.0			
30	15.7	18.0	14.5			
31						
Mean	16.2	18.5	14.9	14.6	16.6	13.5

1992 Rush Creek Water Temperatures (°C) about 1.1 miles downstream from Mono Gate 1.

	April			May		
Day	Avg	Max	Min	Avg	Max	Min
1				10.7	12.0	10.0
2				10.5	12.0	9.5
3				10.6	12.5	9.5
4				10.7	11.5	10.0
5				10.7	11.5	10.5
6				10.6	11.5	10.0
7				10.8	12.5	10.0
8				11.1	13.0	10.0
9				11.0	12.5	10.0
10				11.5	13.5	10.0
11				11.4	13.0	10.0
12				11.6	13.0	10.5
13				11.9	13.5	10.5
14				11.9	13.0	10.5
15				11.9	13.5	10.5
16				11.6	13.0	11.0
17				12.4	14.5	10.5
18				13.7	14.5	13.0
19				14.0	16.0	12.5
20				13.1	15.0	12.0
21				13.2	15.5	12.0
22				12.8	15.0	11.5
23	9.3	11.0	8.5	13.0	15.0	12.0
24	9.1	10.5	8.0	13.2	15.5	12.0
25	10.0	11.5	9.0	12.9	14.0	12.0
26	10.0	11.5	9.0	13.1	14.5	12.0
27	10.6	12.0	9.5	13.0	14.0	12.0
28	10.3	11.5	9.5	13.3	14.5	12.5
29	11.5	13.5	10.0	13.4	15.0	12.5
30	10.9	12.5	10.0	13.6	15.0	13.0
31				13.5	15.0	12.5
Mean	10.2	11.7	9.2	12.1	13.7	11.1

Appendix A.
Listing of Input Parameters for THERM (cont)

1992 Rush Creek Water Temperatures (°C) in Mono Ditch about 1.1 miles downstream from Mono Gate 1 (continued).

	June			July		
Day	Avg	Max	Min	Avg	Max	Min
1	13.5	15.0	12.5	14.8	15.5	14.5
2	13.6	15.5	12.5	14.9	16.0	14.0
3	13.6	15.5	12.5	15.5	16.5	15.0
4	13.7	15.5	12.5	15.3	16.0	15.0
5	13.4	15.5	12.5	14.9	16.0	14.5
6	13.3	14.5	12.5	14.6	15.5	14.0
7	13.5	15.0	13.0	14.5	15.5	14.0
8	13.5	15.5	12.5	14.8	15.5	14.5
9	14.2	16.0	12.5	15.0	16.0	14.5
10	14.3	16.0	12.5	14.9	15.5	14.5
11	15.5	17.0	14.0	15.2	16.0	14.5
12	15.3	16.5	14.5	15.3	16.0	14.5
13	14.8	16.0	14.0	15.2	16.0	15.0
14	14.5	15.0	14.0	15.0	15.5	14.5
15	14.0	15.0	13.5	15.3	16.0	15.0
16	14.1	15.5	13.0	15.3	16.0	15.0
17	14.0	15.0	13.5	15.2	16.0	14.5
18	14.0	15.0	13.5	15.3	16.5	14.5
19	14.0	15.0	13.5	15.4	16.5	14.5
20	14.2	15.5	13.5	15.6	17.0	14.5
21	14.4	15.5	14.0	15.7	17.0	14.5
22	14.0	15.0	13.5	15.9	17.5	14.5
23	14.3	15.5	14.0	16.2	17.0	15.0
24	15.2	15.5	14.5	16.0	17.0	15.0
25	15.0	15.5	14.5	15.9	17.0	15.0
26	15.0	15.5	14.5	16.2	17.0	15.5
27	15.2	16.5	14.5	16.2	17.5	15.0
28	15.5	16.5	15.0	16.3	17.5	15.0
29	14.8	15.5	14.5	16.4	17.5	15.5
30	14.8	15.5	14.5	16.3	17.5	15.5
31				16.3	17.5	15.5
Mean	14.3	15.5	13.5	15.5	16.4	14.7

Appendix A.
Listing of Input Parameters for THERM (cont)

1992 Rush Creek Water Tempertures (C) in Mono Ditch about 1.1 miles downstream from Mono Gate 1 (continued).

	August			September		
Day	Avg	Max	Min	Avg	Max	Min
1	16.4	17.5	15.5	16.9	17.5	16.5
2	16.4	17.5	15.5	17.2	18.0	16.5
3	16.9	19.5	15.5	16.8	17.5	16.0
4	16.6	18.5	15.5	16.3	17.0	16.0
5	16.2	17.0	15.5	16.3	17.0	16.0
6	16.7	17.5	15.5	16.7	17.5	16.5
7	17.3	20.0	15.5	16.5	17.5	16.0
8	17.1	18.5	15.5	16.4	17.5	16.0
9	17.0	18.0	16.0	16.1	17.0	15.5
10	17.3	18.0	17.0	16.4	17.0	15.5
11	17.0	18.0	16.0	17.2	18.0	16.5
12	17.0	17.5	16.5	16.5	17.5	16.0
13	17.0	18.0	16.5	16.2	17.0	15.5
14	17.1	18.0	16.5	16.4	17.0	16.0
15	17.1	18.0	16.5	16.1	17.0	15.5
16	17.4	18.0	17.0	16.2	17.0	15.5
17	17.5	18.5	17.0	16.2	17.0	16.0
18	17.7	19.5	16.5	15.9	17.0	15.0
19	17.8	19.5	16.5	15.5	17.0	14.5
20	17.6	18.5	16.5	15.5	17.0	14.5
21	18.9	20.5	17.5	15.6	17.5	14.5
22	18.3	19.0	18.0	15.7	17.5	14.5
23	17.7	19.0	17.0	16.1	17.5	15.5
24	17.4	18.0	17.0	15.8	17.5	14.5
25	17.5	18.0	17.0	15.5	17.5	14.5
26	17.2	18.0	16.5	15.2	17.0	14.5
27	17.2	18.0	16.5	15.2	17.0	14.0
28	17.4	18.0	17.0	15.2	17.0	14.0
29	17.5	18.0	17.0	15.2	17.0	14.5
30	17.4	18.0	17.0	15.5	17.0	15.0
31	17.1	18.0	16.5			
Mean	17.3	18.3	16.4	16.1	17.3	15.4

Appendix A.
Listing of Input Parameters for THERM (cont)

1992 Rush Creek Water Tempertures (C) in Mono Ditch
about 1.1 miles downstream from Mono Gate 1 (continued).

	October		
Day	Avg	Max	Min
1	15.0	16.0	14.5
2	14.0	14.5	13.5
3	14.0	15.0	13.5
4	13.9	15.0	13.5
5	13.8	14.5	13.5
6	13.5	14.5	13.0
7	13.3	14.5	12.5
8	13.5	14.5	13.0
9	13.5	14.5	13.0
10	13.3	14.5	12.5
11	13.5	14.5	13.0
12	13.6	14.5	13.0
13	13.6	14.5	13.0
14	13.6	14.5	13.0
15	13.5	14.5	13.0
16	13.5	14.0	13.0
17	13.0	14.0	12.5
18	13.1	14.0	12.5
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
Mean	13.6	14.6	13.1

APPENDIX B.
LISTING OF INPUT PARAMETERS FOR THERM

The parameters are listed in the same order as found in the input data file.

1. Title: Five lines of information about the reservoir or other defining characteristics of the simulation.

2. The first Julian day for which initial meteorological, hydrological, and other update data are specified: Usually May 15.

3. The last Julian simulation day: Usually October 31th.

4. The computation interval: Always set at 24 hours.

5. The interval for tabular output: Either one or seven days.

6. The day initial temperature profile conditions are specified: Usually May 15.

7. The simulation year: Usually 1991 or 1992.

8. Mode of reservoir operation: Continuous operation was specified with all flow withdrawn from ports with discharges specified on a daily basis, or a downstream target temperature was specified with selective withdrawal used to meet the target temperature.

9. The number of inflow tributaries. Set to one: Rush Creek, since the Lee Vining Creek diversions were added to the Rush Creek inflow.

10. Number of initial horizontal layers in the reservoir: Set to 20.

11. Latitude and longitude: Set to 36.9°N and 119.1°W.

12. Dust attenuation factor: Constant value of 0.40.

13. Wind variables AA and BB: These coefficients were set to 2.5E-9 and 1.0E-9. The average values for these coefficients (Army Corps of Engineers 1986) are respectively, 3.1E-9 and 2.1E-9.

14. Reservoir length: Set to 3,420 m.

15. Maximum layer thickness: Set to 5 m, minimum thickness set to 0.4 m.

16. Initial thickness for each of the initial (20) layers specified.

17. Configuration of the outlet port: The centerline of the outlet pipe is at 10.9 m (35.8 ft) above the datum of 7,037 ft MSL. Diameter is approximately 10.5 feet (approximately 3 m).

18. The regression curve used to predict water surface area as a function of elevation. (The same coefficients are used to predict reservoir volume.) A1 = 90257 and A2 = 1.17655.

19. The regression curve used to predict reservoir width as a function of elevation. W1 = 52.711 and W2 = 0.92825.

20. Mixing coefficients: Sheltering, penetrative convection, and wind calibration parameters CDIFW and CDIFF: 0.9, 0.5, 0, and 0. The sheltering coefficient is the fraction of the total water surface area exposed to the wind and varies between 0 and 1. The penetrative convection is the part of the thermal kinetic energy available for entrainment and deep-ending of the epilimnion. CDIFW and CDIFF are used to compute eddy diffusion and represent the contributions of wind and advection, respectively.

21. Critical density of inflowing water: Set at 2.1. Determines which layer water is added to in the reservoir.

22. Light parameters: Extinction coefficient, solar radiation absorbed, and shading coefficient for suspended solids: 1.50, 0.55, and 0.50.

23. Number of initial layers for which initial conditions are specified. Always used eleven layers. Parameters required are temperature, elevation, and concentration of total dissolved solids, and suspended solids.

24. Weather data: Daily percent cloud cover, dry bulb temperatures, dewpoint, pressure, and speed of wind.

25. Outflow discharge and location of port: Daily values from the LADWP gate log unless selective withdrawal is used in simulations. The location of the outlet ports vary with selective withdrawal while discharge remained the same as that recorded by DWP.

26. Inflow discharge: Daily values from DWP records.

27. Inflow water temperature: Daily values from Datapod field monitors or regression equations.

28. Water quality: Total dissolved solids (TDS) and suspended solids (SSOL).

APPENDIX C.
HYDROLOGY DATA BASE USED TO CALIBRATE AND VALIDATE THERM

Table C-1. Flow Into Grant Reservoir (cfs)

Mo/ Day	1991 Rush Creek (cfs)	Plus 1991 LV Conduit (cfs)	Total 1991 Grant Inflow (cfs)	Total 1991 Grant Inflow (cms)	1991 Monthly Average Inflow (cfs)	1992 Rush Creek (cfs)	Plus 1992 LV Conduit (cfs)	Total 1992 Grant Inflow (cfs)	Total 1992 Grant Inflow (cms)	1992 Monthly Average Inflow (cfs)
May 1	24.2	21.0	45.2	1.3	91.5	80.5	73.2	153.7	4.4	134.7
2	23.5	21.0	44.5	1.3		78.4	50.9	129.3	3.7	
3	29.0	21.0	50.0	1.4		77.4	53.7	131.1	3.7	
4	31.9	21.0	52.9	1.5		78.4	61.9	140.3	4.0	
5	34.9	21.0	55.9	1.6		79.5	76.4	155.9	4.4	
6	38.1	21.0	59.1	1.7		80.5	90.2	170.7	4.8	
7	44.6	21.0	65.6	1.9		83.7	92.5	176.2	5.0	
8	65.4	21.0	86.4	2.4		92.3	84.8	177.1	5.0	
9	77.4	21.0	98.4	2.8		97.9	142.0	239.9	6.8	
10	76.4	21.0	97.4	2.8		97.9	136.0	233.9	6.6	
11	73.3	21.0	94.3	2.7		95.7	112.0	207.7	5.9	
12	70.3	21.0	91.3	2.6		96.8	97.7	194.5	5.5	
13	70.3	21.0	91.3	2.6		97.9	83.2	181.1	5.1	
14	70.3	21.0	91.3	2.6		97.9	61.2	159.1	4.5	
15	70.3	21.0	91.3	2.6		96.8	49.2	146.0	4.1	
16	73.3	21.0	94.3	2.7		96.8	31.3	128.1	3.6	
17	77.4	21.0	98.4	2.8		95.7	35.5	131.2	3.7	
18	74.3	21.0	95.3	2.7		91.2	28.6	119.8	3.4	
19	73.3	21.0	94.3	2.7		88.0	21.2	109.2	3.1	
20	72.3	21.0	93.3	2.6		83.7	9.2	92.9	2.6	
21	72.3	21.0	93.3	2.6		79.5	1.2	80.7	2.3	
22	72.3	21.0	93.3	2.6		76.4	1.2	77.6	2.2	
23	76.4	21.0	97.4	2.8		73.3	1.1	74.4	2.1	
24	91.2	21.0	112.2	3.2		74.3	1.1	75.4	2.1	
25	104.8	21.0	125.8	3.6		74.3	13.5	87.8	2.5	

Table C-1. Flow Into Grant Reservoir (cfs) (continued)

Mo/ Day	1991 Rush Creek (cfs)	Plus 1991 LV Conduit (cfs)	Total 1991 Grant Inflow (cfs)	Total 1991 Grant Inflow (cms)	1991 Monthly Average Inflow (cfs)	1992 Rush Creek (cfs)	Plus 1992 LV Conduit (cfs)	Total 1992 Grant Inflow (cfs)	Total 1992 Grant Inflow (cms)	1992 Monthly Average Inflow (cfs)
26	105.9	21.0	126.9	3.6		75.3	14.1	89.4	2.5	
27	101.3	21.0	122.3	3.5		78.4	16.4	94.8	2.7	
28	100.2	21.0	121.2	3.4		78.4	22.1	100.5	2.8	
29	99.0	21.0	120.0	3.4		82.6	24.5	107.1	3.0	
30	97.9	21.0	118.9	3.4		82.6	21.3	103.9	2.9	
31	93.4	21.0	114.4	3.2		83.7	22.2	105.9	3.0	
June 1	92.3	28.0	120.3	3.4	132.5	83.7	25.6	109.3	3.1	67.0
2	99.0	28.0	127.0	3.6		83.7	27.8	111.5	3.2	
3	115.4	28.0	143.4	4.1		83.7	17.6	101.3	2.9	
4	131.3	28.0	159.3	4.5		77.4	12.6	90.0	2.5	
5	137.7	28.0	165.7	4.7		74.3	11.2	85.5	2.4	
6	131.3	28.0	159.3	4.5		76.4	7.4	83.8	2.4	
7	125.1	28.0	153.1	4.3		73.3	1.3	74.6	2.1	
8	127.6	28.0	155.6	4.4		71.3	1.3	72.6	2.1	
9	128.8	28.0	156.8	4.4		67.3	1.4	68.7	1.9	
10	137.7	28.0	165.7	4.7		65.4	1.4	66.8	1.9	
11	145.4	28.0	173.4	4.9		63.5	1.2	64.7	1.8	
12	150.7	28.0	178.7	5.1		61.6	1.3	62.9	1.8	
13	137.7	28.0	165.7	4.7		61.6	1.3	62.9	1.8	
14	125.1	28.0	153.1	4.3		60.6	1.3	61.9	1.8	
15	114.2	28.0	142.2	4.0		58.7	1.2	59.9	1.7	
16	107.1	28.0	135.1	3.8		57.8	1.1	58.9	1.7	
17	102.5	28.0	130.5	3.7		56.0	1.1	57.1	1.6	
18	97.9	28.0	125.9	3.6		55.1	1.1	56.2	1.6	
19	93.4	28.0	121.4	3.4		53.3	1.1	54.4	1.5	
20	88.0	28.0	116.0	3.3		53.3	1.1	54.4	1.5	
21	82.6	28.0	110.6	3.1		52.4	1.1	53.5	1.5	

Table C-1. Flow Into Grant Reservoir (cfs) (continued)

Mo/ Day	1991 Rush Creek (cfs)	Plus 1991 LV Conduit (cfs)	Total 1991 Grant Inflow (cfs)	Total 1991 Grant Inflow (cms)	1991 Monthly Average Inflow (cfs)	1992 Rush Creek (cfs)	Plus 1992 LV Conduit (cfs)	Total 1992 Grant Inflow (cfs)	Total 1992 Grant Inflow (cms)	1992 Monthly Average Inflow (cfs)
22	79.5	28.0	107.5	3.0		50.6	1.1	51.7	1.5	
23	77.4	28.0	105.4	3.0		51.5	1.1	52.6	1.5	
24	76.4	28.0	104.4	3.0		53.3	1.1	54.4	1.5	
25	76.4	28.0	104.4	3.0		54.2	1.1	55.3	1.6	
26	74.3	28.0	102.3	2.9		53.3	2.3	55.6	1.6	
28	70.3	28.0	98.3	2.8		51.5	4.0	55.5	1.6	
29	70.3	28.0	98.3	2.8		52.4	1.9	54.3	1.5	
30	68.3	28.0	96.3	2.7		53.3	7.0	60.3	1.7	
July 1	68.3	4.0	72.3	2.0	67.0	52.4	10.1	62.5	1.8	43.0
2	72.3	4.0	76.3	2.2		52.4	10.4	62.8	1.8	
3	77.4	4.0	81.4	2.3		50.6	9.4	60.0	1.7	
4	82.6	4.0	86.6	2.5		49.7	4.9	54.6	1.5	
5	84.7	4.0	88.7	2.5		48.0	2.4	50.4	1.4	
6	83.7	4.0	87.7	2.5		47.1	2.4	49.5	1.4	
7	80.5	4.0	84.5	2.4		46.3	2.4	48.7	1.4	
8	77.4	4.0	81.4	2.3		46.3	1.2	47.5	1.3	
9	73.3	4.0	77.3	2.2		45.4	0.0	45.4	1.3	
10	69.3	4.0	73.3	2.1		38.1	0.0	38.1	1.1	
11	68.3	4.0	72.3	2.0		34.2	0.0	34.2	1.0	
12	67.3	4.0	71.3	2.0		36.5	0.0	36.5	1.0	
13	66.4	4.0	70.4	2.0		39.6	11.0	50.6	1.4	
14	64.4	4.0	68.4	1.9		40.5	1.0	41.5	1.2	
15	62.5	4.0	66.5	1.9		44.6	1.0	45.6	1.3	
16	59.7	4.0	63.7	1.8		45.4	1.0	46.4	1.3	
17	57.8	4.0	61.8	1.7		45.4	0.9	46.3	1.3	
18	56.0	4.0	60.0	1.7		42.9	1.0	43.9	1.2	
19	55.1	4.0	59.1	1.7		41.3	0.9	42.2	1.2	

Table C-1. Flow Into Grant Reservoir (cfs) (continued)

Mo/Day	1991 Rush Creek (cfs)	Plus 1991 LV Conduit (cfs)	Total 1991 Grant Inflow (cfs)	Total 1991 Grant Inflow (cms)	1991 Monthly Average Inflow (cfs)	1992 Rush Creek (cfs)	Plus 1992 LV Conduit (cfs)	Total 1992 Grant Inflow (cfs)	Total 1992 Grant Inflow (cms)	1992 Monthly Average Inflow (cfs)
20	55.1	4.0	59.1	1.7		38.8	0.9	39.7	1.1	
21	54.2	4.0	58.2	1.6		38.1	1.0	39.1	1.1	
22	53.3	4.0	57.3	1.6		36.5	0.9	37.4	1.1	
23	53.3	4.0	57.3	1.6		34.9	0.9	35.8	1.0	
24	52.4	4.0	56.4	1.6		33.4	0.9	34.3	1.0	
25	52.4	4.0	56.4	1.6		33.4	0.9	34.3	1.0	
26	51.5	4.0	55.5	1.6		32.7	0.9	33.6	1.0	
27	50.6	4.0	54.6	1.5		32.7	0.9	33.6	1.0	
28	49.7	4.0	53.7	1.5		31.9	0.9	32.8	0.9	
29	50.6	4.0	54.6	1.5		32.7	0.9	33.6	1.0	
30	50.6	4.0	54.6	1.5		36.5	0.9	37.4	1.1	
31	53.3	4.0	57.3	1.6		32.7	0.9	33.6	1.0	
Aug 1	53.3	3.0	56.3	1.6	49.1	31.9	0.9	32.8	0.9	33.7
2	49.7	3.0	52.7	1.5		31.9	0.9	32.8	0.9	
3	48.8	3.0	51.8	1.5		31.2	0.9	32.1	0.9	
4	48.8	3.0	51.8	1.5		30.5	0.9	31.4	0.9	
5	48.0	3.0	51.0	1.4		29.7	0.9	30.6	0.9	
6	47.1	3.0	50.1	1.4		29.7	0.9	30.6	0.9	
7	47.1	3.0	50.1	1.4		30.5	0.9	31.4	0.9	
8	46.3	3.0	49.3	1.4		29.0	0.9	29.9	0.8	
9	46.3	3.0	49.3	1.4		29.0	0.9	29.9	0.8	
10	45.4	3.0	48.4	1.4		29.0	0.9	29.9	0.8	
11	45.4	3.0	48.4	1.4		29.0	0.9	29.9	0.8	
12	45.4	3.0	48.4	1.4		29.7	0.9	30.6	0.9	
13	46.3	3.0	49.3	1.4		31.2	0.9	32.1	0.9	
14	46.3	3.0	49.3	1.4		31.2	0.9	32.1	0.9	
15	47.1	3.0	50.1	1.4		29.7	0.9	30.6	0.9	

Appendix C.
Hydrology Data Base Used to Calibrate and Validate THERM

Table C-1. Flow Into Grant Reservoir (cfs) (continued)

Mo/ Day	1991 Rush Creek (cfs)	Plus 1991 LV Conduit (cfs)	Total 1991 Grant Inflow (cfs)	Total 1991 Grant Inflow (cms)	1991 Monthly Average Inflow (cfs)	1992 Rush Creek (cfs)	Plus 1992 LV Conduit (cfs)	Total 1992 Grant Inflow (cfs)	Total 1992 Grant Inflow (cms)	1992 Monthly Average Inflow (cfs)
16	47.1	3.0	50.1	1.4		32.7	0.9	33.6	1.0	
17	46.3	3.0	49.3	1.4		33.4	0.9	34.3	1.0	
18	45.4	3.0	48.4	1.4		32.7	0.9	33.6	1.0	
19	45.4	3.0	48.4	1.4		32.7	0.9	33.6	1.0	
20	44.6	3.0	47.6	1.3		32.7	1.0	33.7	1.0	
21	44.6	3.0	47.6	1.3		32.7	1.0	33.7	1.0	
22	44.6	3.0	47.6	1.3		32.7	1.0	33.7	1.0	
23	44.6	3.0	47.6	1.3		30.5	0.9	31.4	0.9	
24	44.6	3.0	47.6	1.3		29.7	0.9	30.6	0.9	
25	44.6	3.0	47.6	1.3		29.7	0.9	30.6	0.9	
26	44.6	3.0	47.6	1.3		31.2	0.9	32.1	0.9	
27	43.7	3.0	46.7	1.3		38.8	0.9	39.7	1.1	
28	43.7	3.0	46.7	1.3		42.9	0.9	43.8	1.2	
29	44.6	3.0	47.6	1.3		43.7	0.9	44.6	1.3	
30	44.6	3.0	47.6	1.3		43.7	0.9	44.6	1.3	
31	43.7	3.0	46.7	1.3		44.6	1.0	45.6	1.3	
Sept 1	43.7	4.0	47.7	1.4	48.2	44.6	0.9	45.5	1.3	51.4
2	43.7	4.0	47.7	1.4		42.9	0.9	43.8	1.2	
3	42.9	4.0	46.9	1.3		42.1	0.9	43.0	1.2	
4	43.7	4.0	47.7	1.4		42.1	0.9	43.0	1.2	
5	46.3	4.0	50.3	1.4		42.9	0.9	43.8	1.2	
6	46.3	4.0	50.3	1.4		42.1	0.9	43.0	1.2	
7	46.3	4.0	50.3	1.4		42.1	3.9	46.0	1.3	
8	46.3	4.0	50.3	1.4		42.1	10.0	52.1	1.5	
9	47.1	4.0	51.1	1.4		42.1	11.2	53.3	1.5	
10	46.3	4.0	50.3	1.4		42.1	11.5	53.6	1.5	
11	45.4	4.0	49.4	1.4		41.3	12.6	53.9	1.5	

Table C-1. Flow Into Grant Reservoir (cfs) (continued)

Mo/ Day	1991 Rush Creek (cfs)	Plus 1991 LV Conduit (cfs)	Total 1991 Grant Inflow (cfs)	Total 1991 Grant Inflow (cms)	1991 Monthly Average Inflow (cfs)	1992 Rush Creek (cfs)	Plus 1992 LV Conduit (cfs)	Total 1992 Grant Inflow (cfs)	Total 1992 Grant Inflow (cms)	1992 Monthly Average Inflow (cfs)
12	46.3	4.0	50.3	1.4		41.3	12.6	53.9	1.5	
13	44.6	4.0	48.6	1.4		42.1	12.8	54.9	1.6	
14	43.7	4.0	47.7	1.4		42.1	13.1	55.2	1.6	
15	43.7	4.0	47.7	1.4		41.3	12.9	54.2	1.5	
16	42.9	4.0	46.9	1.3		41.3	13.1	54.4	1.5	
17	43.7	4.0	47.7	1.4		41.3	13.6	54.9	1.6	
18	42.9	4.0	46.9	1.3		41.3	14.2	55.5	1.6	
19	42.9	4.0	46.9	1.3		42.1	14.2	56.3	1.6	
20	43.7	4.0	47.7	1.4		42.1	13.7	55.8	1.6	
21	43.7	4.0	47.7	1.4		42.1	13.4	55.5	1.6	
22	42.9	4.0	46.9	1.3		41.3	13.3	54.6	1.5	
23	43.7	4.0	47.7	1.4		40.5	11.9	52.4	1.5	
24	42.9	4.0	46.9	1.3		41.3	11.3	52.6	1.5	
25	43.7	4.0	47.7	1.4		40.5	11.4	51.9	1.5	
26	43.7	4.0	47.7	1.4		41.3	11.5	52.8	1.5	
27	43.7	4.0	47.7	1.4		42.1	11.5	53.6	1.5	
28	42.9	4.0	46.9	1.3		41.3	9.3	50.6	1.4	
29	42.9	4.0	46.9	1.3		42.1	10.0	52.1	1.5	
30	42.9	4.0	46.9	1.3		40.5	9.9	50.4	1.4	
Oct 1		2.0	2.0	0.1	2.0		10.2	10.2	0.3	9.0
2		2.0	2.0	0.1			12.1	12.1	0.3	
3		2.0	2.0	0.1			12.3	12.3	0.3	
4		2.0	2.0	0.1			12.5	12.5	0.4	
5		2.0	2.0	0.1			12.3	12.3	0.3	
6		2.0	2.0	0.1			14.5	14.5	0.4	
7		2.0	2.0	0.1			20.8	20.8	0.6	
8		2.0	2.0	0.1			15.0	15.0	0.4	

Appendix C.
Hydrology Data Base Used to Calibrate and Validate THERM

Table C-1. Flow Into Grant Reservoir (cfs) (continued)

Mo/ Day	1991 Rush Creek (cfs)	Plus 1991 LV Conduit (cfs)	Total 1991 Grant Inflow (cfs)	Total 1991 Grant Inflow (cms)	1991 Monthly Average Inflow (cfs)	1992 Rush Creek (cfs)	Plus 1992 LV Conduit (cfs)	Total 1992 Grant Inflow (cfs)	Total 1992 Grant Inflow (cms)	1992 Monthly Average Inflow (cfs)
9		2.0	2.0	0.1			9.3	9.3	0.3	
10		2.0	2.0	0.1			7.1	7.1	0.2	
11		2.0	2.0	0.1			11.0	11.0	0.3	
12		2.0	2.0	0.1			13.5	13.5	0.4	
13		2.0	2.0	0.1			14.0	14.0	0.4	
14		2.0	2.0	0.1			14.0	14.0	0.4	
15		2.0	2.0	0.1			12.6	12.6	0.4	
16		2.0	2.0	0.1			12.5	12.5	0.4	
17		2.0	2.0	0.1			1.1	1.1	0.0	
18		2.0	2.0	0.1			12.0	12.0	0.3	
19		2.0	2.0	0.1			9.0	9.0	0.3	
20		2.0	2.0	0.1			10.7	10.7	0.3	
21		2.0	2.0	0.1			12.8	12.8	0.4	
22		2.0	2.0	0.1			11.3	11.3	0.3	
23		2.0	2.0	0.1			8.3	8.3	0.2	
24		2.0	2.0	0.1			4.5	4.5	0.1	
25		2.0	2.0	0.1			1.0	1.0	0.0	
26		2.0	2.0	0.1			1.0	1.0	0.0	
27		2.0	2.0	0.1			1.0	1.0	0.0	
28		2.0	2.0	0.1			1.0	1.0	0.0	
29		2.0	2.0	0.1			1.0	1.0	0.0	
30		2.0	2.0	0.1			1.0	1.0	0.0	
31		2.0	2.0	0.1			1.0	1.0	0.0	

Table C-2. Flow Out of Grant Reservoir (cfs)

Month	Day	1991 Qout (cfs)	1991 Qout (cms)	Monthly Average 1991 Qout (cfs)	1992 Qout (cfs)	1992 Qout (cms)	Monthly Average 1992 Qout (cfs)
MAY	1	25.0	0.7	34.9	44.5	1.3	43.6
	2	25.0	0.7		44.5	1.3	
	3	25.0	0.7		44.7	1.3	
	4	25.0	0.7		44.8	1.3	
	5	25.0	0.7		45.0	1.3	
	6	24.4	0.7		45.1	1.3	
	7	22.7	0.6		45.2	1.3	
	8	22.4	0.6		45.5	1.3	
	9	22.5	0.6		45.5	1.3	
	10	26.0	0.7		46.0	1.3	
	11	34.5	1.0		46.1	1.3	
	12	39.9	1.1		46.4	1.3	
	13	41.4	1.2		46.7	1.3	
	14	41.2	1.2		46.9	1.3	
	15	40.6	1.1		46.0	1.3	
	16	40.1	1.1		46.0	1.3	
	17	39.8	1.1		45.6	1.3	
	18	39.9	1.1		45.4	1.3	
	19	40.0	1.1		45.6	1.3	
	20	40.0	1.1		39.0	1.1	
	21	39.8	1.1		24.8	0.7	
	22	39.8	1.1		30.3	0.9	
	23	39.8	1.1		33.4	0.9	
	24	39.8	1.1		40.5	1.1	
	25	40.1	1.1		43.7	1.2	

Table C-2. Flow Out of Grant Reservoir (cfs) (continued)

Month	Day	1991 Qout (cfs)	1991 Qout (cms)	Monthly Average 1991 Qout (cfs)	1992 Qout (cfs)	1992 Qout (cms)	Monthly Average 1992 Qout (cfs)
	26	40.6	1.1		43.9	1.2	
	27	40.6	1.1		45.9	1.3	
	28	40.5	1.1		46.0	1.3	
	29	40.0	1.1		46.1	1.3	
	30	39.6	1.1		46.2	1.3	
	31	39.8	1.1		46.0	1.3	
JUNE	1	39.8	1.1	100.1	45.9	1.3	71.2
	2	40.0	1.1		46.0	1.3	
	3	40.4	1.1		46.0	1.3	
	4	40.5	1.1		46.1	1.3	
	5	40.6	1.1		46.2	1.3	
	6	40.8	1.2		46.2	1.3	
	7	41.1	1.2		46.2	1.3	
	8	41.2	1.2		46.3	1.3	
	9	41.5	1.2		46.3	1.3	
	10	41.3	1.2		46.3	1.3	
	11	41.8	1.2		46.3	1.3	
	12	42.6	1.2		46.2	1.3	
	13	53.8	1.5		46.0	1.3	
	14	81.2	2.3		45.9	1.3	
	15	113.0	3.2		45.7	1.3	
	16	119.0	3.4		45.7	1.3	
	17	129.0	3.7		45.7	1.3	
	18	145.0	4.1		45.7	1.3	
	19	155.0	4.4		50.7	1.4	

Table C-2. Flow Out of Grant Reservoir (cfs) (continued)

Month	Day	1991 Qout (cfs)	1991 Qout (cms)	Monthly Average 1991 Qout (cfs)	1992 Qout (cfs)	1992 Qout (cms)	Monthly Average 1992 Qout (cfs)
	20	160.0	4.5		71.2	2.0	
	21	161.0	4.6		81.9	2.3	
	22	161.0	4.6		81.5	2.3	
	23	160.0	4.5		103.6	2.9	
	24	160.0	4.5		144.4	4.1	
	25	162.0	4.6		163.0	4.6	
	26	162.0	4.6		161.9	4.6	
	27	161.0	4.6		148.0	4.2	
	28	160.0	4.5		102.3	2.9	
	29	143.0	4.0		90.0	2.5	
	30	117.0	3.3		89.6	2.5	
JULY	1	107.0	3.0	56.3	90.1	2.6	82.5
	2	83.5	2.4		90.9	2.6	
	3	58.0	1.6		90.5	2.6	
	4	58.3	1.7		90.6	2.6	
	5	58.8	1.7		90.6	2.6	
	6	59.1	1.7		90.5	2.6	
	7	59.3	1.7		90.3	2.6	
	8	59.7	1.7		84.6	2.4	
	9	59.8	1.7		80.5	2.3	
	10	59.4	1.7		80.5	2.3	
	11	59.4	1.7		80.5	2.3	
	12	59.4	1.7		80.4	2.3	
	13	59.4	1.7		80.4	2.3	
	14	59.4	1.7		80.4	2.3	

Table C-2. Flow Out of Grant Reservoir (cfs) (continued)

Month	Day	1991 Qout (cfs)	1991 Qout (cms)	Monthly Average 1991 Qout (cfs)	1992 Qout (cfs)	1992 Qout (cms)	Monthly Average 1992 Qout (cfs)
	15	59.4	1.7		80.0	2.3	
	16	59.3	1.7		80.0	2.3	
	17	59.4	1.7		80.0	2.3	
	18	60.0	1.7		80.0	2.3	
	19	60.2	1.7		79.9	2.3	
	20	60.0	1.7		79.8	2.3	
	21	59.7	1.7		79.7	2.3	
	22	60.0	1.7		79.7	2.3	
	23	56.7	1.6		79.9	2.3	
	24	43.3	1.2		79.9	2.3	
	25	39.1	1.1		79.9	2.3	
	26	39.0	1.1		80.0	2.3	
	27	39.1	1.1		80.2	2.3	
	28	39.0	1.1		80.1	2.3	
	29	38.1	1.1		79.9	2.3	
	30	36.9	1.0		79.5	2.3	
	31	37.1	1.1		79.1	2.2	
AUG.	1	37.3	1.1	39.7	78.9	2.2	79.2
	2	37.1	1.1		78.8	2.2	
	3	37.1	1.1		78.7	2.2	
	4	37.1	1.1		78.5	2.2	
	5	37.3	1.1		78.4	2.2	
	6	37.3	1.1		78.4	2.2	
	7	37.5	1.1		78.1	2.2	
	8	37.6	1.1		77.9	2.2	

Table C-2. Flow Out of Grant Reservoir (cfs) (continued)

Month	Day	1991 Qout (cfs)	1991 Qout (cms)	Monthly Average 1991 Qout (cfs)	1992 Qout (cfs)	1992 Qout (cms)	Monthly Average 1992 Qout (cfs)
	9	35.4	1.0		77.9	2.2	
	10	34.1	1.0		78.0	2.2	
	11	34.0	1.0		77.8	2.2	
	12	35.4	1.0		77.7	2.2	
	13	41.3	1.2		79.5	2.3	
	14	44.8	1.3		80.9	2.3	
	15	44.7	1.3		81.0	2.3	
	16	53.9	1.5		80.9	2.3	
	17	74.9	2.1		80.9	2.3	
	18	65.6	1.9		80.6	2.3	
	19	42.3	1.2		80.1	2.3	
	20	34.8	1.0		80.0	2.3	
	21	34.9	1.0		79.9	2.3	
	22	34.8	1.0		79.8	2.3	
	23	34.9	1.0		79.6	2.3	
	24	35.5	1.0		79.6	2.3	
	25	35.2	1.0		79.4	2.2	
	26	35.1	1.0		79.2	2.2	
	27	35.4	1.0		79.1	2.2	
	28	35.9	1.0		79.0	2.2	
	29	36.4	1.0		78.9	2.2	
	30	36.5	1.0		78.9	2.2	
	31	35.9	1.0		78.8	2.2	
SEPT	1	36.1	1.0	21.4	78.7	2.2	59.9
	2	36.4	1.0		78.5	2.2	

Table C-2. Flow Out of Grant Reservoir (cfs) (continued)

Month	Day	1991 Qout (cfs)	1991 Qout (cms)	Monthly Average 1991 Qout (cfs)	1992 Qout (cfs)	1992 Qout (cms)	Monthly Average 1992 Qout (cfs)
	3	31.3	0.9		78.3	2.2	
	4	21.3	0.6		78.1	2.2	
	5	18.0	0.5		78.0	2.2	
	6	19.7	0.6		77.9	2.2	
	7	19.7	0.6		77.7	2.2	
	8	19.7	0.6		77.6	2.2	
	9	19.9	0.6		77.5	2.2	
	10	20.0	0.6		77.4	2.2	
	11	20.0	0.6		77.3	2.2	
	12	20.0	0.6		77.0	2.2	
	13	20.0	0.6		76.7	2.2	
	14	20.0	0.6		76.7	2.2	
	15	20.0	0.6		76.4	2.2	
	16	20.0	0.6		78.6	2.2	
	17	20.0	0.6		79.8	2.3	
	18	20.0	0.6		73.5	2.1	
	19	20.0	0.6		53.0	1.5	
	20	20.0	0.6		40.1	1.1	
	21	20.0	0.6		40.3	1.1	
	22	20.0	0.6		33.3	0.9	
	23	20.0	0.6		30.8	0.9	
	24	20.0	0.6		28.3	0.8	
	25	20.0	0.6		26.7	0.8	
	26	20.0	0.6		30.1	0.9	
	27	20.0	0.6		29.7	0.8	

Table C-2. Flow Out of Grant Reservoir (cfs) (continued)

Month	Day	1991 Qout (cfs)	1991 Qout (cms)	Monthly Average 1991 Qout (cfs)	1992 Qout (cfs)	1992 Qout (cms)	Monthly Average 1992 Qout (cfs)
	28	20.0	0.6		29.8	0.8	
	29	20.0	0.6		29.9	0.8	
	30	20.0	0.6		29.8	0.8	
Oct	1	20.0	0.6	70.9	29.9	0.8	48.8
	2	20.0	0.6		35.5	1.0	
	3	20.0	0.6		46.0	1.3	
	4	20.0	0.6		51.6	1.5	
	5	25.0	0.7		51.4	1.5	
	6	44.0	1.2		51.4	1.5	
	7	68.0	1.9		51.3	1.5	
	8	107.0	3.0		51.0	1.4	
	9	155.0	4.4		51.0	1.4	
	10	166.0	4.7		51.1	1.4	
	11	175.0	5.0		51.0	1.4	
	12	180.0	5.1		51.0	1.4	
	13	180.0	5.1		51.0	1.4	
	14	164.0	4.6		50.9	1.4	
	15	117.0	3.3		51.0	1.4	
	16	100.0	2.8		51.1	1.4	
	17	91.0	2.6		51.1	1.4	
	18	68.0	1.9		51.1	1.4	
	19	60.0	1.7		51.1	1.4	
	20	60.0	1.7		51.1	1.4	
	21	50.0	1.4		51.0	1.4	
	22	25.0	0.7		51.1	1.4	

Table C-2. Flow Out of Grant Reservoir (cfs) (continued)

Month	Day	1991 Qout (cfs)	1991 Qout (cms)	Monthly Average 1991 Qout (cfs)	1992 Qout (cfs)	1992 Qout (cms)	Monthly Average 1992 Qout (cfs)
	23	20.0	0.6		50.9	1.4	
	24	22.0	0.6		50.9	1.4	
	25	22.0	0.6		50.9	1.4	
	26	25.0	0.7		50.9	1.4	
	27	33.0	0.9		50.8	1.4	
	28	39.0	1.1		50.7	1.4	
	29	40.0	1.1		43.3	1.2	
	30	41.0	1.2		35.0	1.0	
	31	40.0	1.1		47.6	1.3	

Table C-3. Water Surface Elevations (WSEL) and Storage for Grant Reservoir (ac-ft).
Note: The units of m-rel are meters relative to the datum of 7,036 ft.

Month	1991 Monthly Average WSEL (ft)	1991 LADWP WSEL (ft)	1991 WSEL (m-rel)	1991 Storage (ac-ft)	1992 Monthly Average WSEL (ft)	1992 LADWP WSEL (ft)	1992 WSEL (m-rel)	1992 Storage (ac-ft)
May 1	7090.4	7089.1	16.2	11350	7107.0	7103.4	20.5	21560
2		7089.1	16.2	11350		7103.6	20.6	21720
3		7089.0	16.2	11290		7103.9	20.7	21960
4		7089.0	16.2	11290		7104.0	20.7	22040
5		7089.0	16.2	11290		7104.3	20.8	22290
6		7089.0	16.2	11290		7104.6	20.9	22540
7		7089.0	16.2	11290		7104.9	21.0	22780
8		7089.1	16.2	11350		7105.2	21.1	23030
9		7089.1	16.2	11350		7105.4	21.2	23200
10		7089.5	16.3	11610		7106.0	21.3	23710
11		7089.6	16.3	11680		7106.3	21.4	23960
12		7089.8	16.4	11810		7106.7	21.5	24300
13		7089.9	16.4	11880		7107.1	21.7	24640
14		7089.8	16.4	11810		7107.3	21.7	24820
15		7089.9	16.4	11880		7107.5	21.8	24990
16		7090.0	16.5	11940		7107.6	21.8	25080
17		7090.1	16.5	12010		7107.8	21.9	25250
18		7090.2	16.5	12080		7108.0	21.9	25420
19		7090.5	16.6	12270		7108.3	22.0	25680
20		7090.6	16.6	12340		7108.3	22.0	25680
21		7090.7	16.7	12410		7108.5	22.1	25860
22		7090.8	16.7	12470		7108.6	22.1	25950
23		7090.9	16.7	12540		7108.7	22.2	26040
24		7091.0	16.8	12610		7108.7	22.2	26040
25		7091.3	16.9	12810		7108.8	22.2	26120
26		7091.7	17.0	13070		7108.9	22.2	26210
27		7092.1	17.1	13340		7109.0	22.2	26300

Table C-3. Water Surface Elevations (WSEL) and Storage for Grant Reservoir (ac-ft) (continued)

Month	1991 Monthly Average WSEL (ft)	1991 LADWP WSEL (ft)	1991 WSEL (m-rel)	1991 Storage (ac-ft)	1992 Monthly Average WSEL (ft)	1992 LADWP WSEL (ft)	1992 WSEL (m-rel)	1992 Storage (ac-ft)
28		7092.5	17.2	13610		7109.1	22.3	26390
29		7092.8	17.3	13820		7109.3	22.3	26560
30		7093.1	17.4	14020		7109.3	22.3	26560
31		7093.5	17.5	14290		7109.4	22.4	26650
June 1	7097.2	7093.7	17.6	14430	7110.0	7109.6	22.4	26830
2		7094.0	17.7	14640		7109.8	22.5	27010
3		7094.2	17.7	14770		7109.9	22.5	27100
4		7094.8	17.9	15190		7110.0	22.6	27190
5		7095.2	18.0	15460		7110.1	22.6	27280
6		7095.8	18.2	15880		7110.1	22.6	27280
7		7096.3	18.4	16240		7110.2	22.6	27370
8		7096.7	18.5	16450		7110.3	22.6	27460
9		7097.0	18.6	16730		7110.4	22.7	27550
10		7097.2	18.7	16880		7110.4	22.7	27550
11		7097.5	18.7	17090		7110.4	22.7	27550
12		7097.8	18.8	17310		7110.4	22.7	27550
13		7098.2	19.0	17600		7110.4	22.7	27550
14		7098.6	19.1	17890		7110.4	22.7	27550
15		7098.9	19.2	18110		7110.4	22.7	27550
16		7099.0	19.2	18180		7110.4	22.7	27550
17		7099.0	19.2	18180		7110.4	22.7	27550
18		7099.0	19.2	18180		7110.4	22.7	27550
19		7098.9	19.2	18110		7110.5	22.7	27640
20		7098.8	19.1	18040		7110.4	22.7	27550
21		7098.5	19.0	17820		7110.3	22.6	27460
22		7098.3	19.0	17670		7110.2	22.6	27370

Table C-3. Water Surface Elevations (WSEL) and Storage for Grant Reservoir (ac-ft) (continued)

Month	1991 Monthly Average WSEL (ft)	1991 LADWP WSEL (ft)	1991 WSEL (m-rel)	1991 Storage (ac-ft)	1992 Monthly Average WSEL (ft)	1992 LADWP WSEL (ft)	1992 WSEL (m-rel)	1992 Storage (ac-ft)
23		7098.1	18.9	17520		7110.1	22.6	27280
24		7097.9	18.9	17380		7109.8	22.5	27010
25		7097.6	18.8	17160		7109.5	22.4	26740
26		7097.4	18.7	17020		7109.3	22.3	26560
27		7097.1	18.6	16800		7109.1	22.3	26390
28		7096.8	18.5	16590		7109.0	22.2	26300
29		7096.6	18.5	16450		7108.9	22.2	26210
30		7096.3	18.4	16240		7108.8	22.2	26120
July 1	7095.8	7096.1	18.3	16100	7107.3	7108.7	22.2	26040
2		7096.0	18.3	16030		7108.6	22.1	25950
3		7095.8	18.2	15880		7108.5	22.1	25860
4		7095.8	18.2	15880		7108.5	22.1	25860
5		7095.8	18.2	15880		7108.4	22.1	25770
6		7095.8	18.2	15880		7108.3	22.0	25680
7		7095.8	18.2	15880		7108.1	22.0	25510
8		7096.0	18.3	16030		7108.0	21.9	25420
9		7096.0	18.3	16030		7107.9	21.9	25340
10		7096.0	18.3	16030		7107.8	21.9	25250
11		7096.0	18.3	16030		7107.8	21.9	25250
12		7096.1	18.3	16100		7107.6	21.8	25080
13		7096.1	18.3	16100		7107.6	21.8	25080
14		7096.0	18.3	16030		7107.6	21.8	25080
15		7096.0	18.3	16030		7107.4	21.8	24900
16		7096.0	18.3	16030		7107.3	21.7	24900
17		7096.0	18.3	16030		7107.3	21.7	24820
18		7095.9	18.3	15960		7107.2	21.7	24730

Appendix C.
Hydrology Data Base Used to Calibrate and Validate THERM

Table C-3. Water Surface Elevations (WSEL) and Storage for Grant Reservoir (ac-ft) (continued)

Month	1991 Monthly Average WSEL (ft)	1991 LADWP WSEL (ft)	1991 WSEL (m-rel)	1991 Storage (ac-ft)	1992 Monthly Average WSEL (ft)	1992 LADWP WSEL (ft)	1992 WSEL (m-rel)	1992 Storage (ac-ft)
19		7095.8	18.2	15880		7107.1	21.7	24640
20		7095.8	18.2	15880		7107.0	21.6	24560
21		7095.7	18.2	15820		7106.9	21.6	24470
22		7095.7	18.2	15820		7106.8	21.6	24390
23		7095.6	18.2	15740		7106.6	21.5	24220
24		7095.6	18.2	15740		7106.5	21.5	24130
25		7095.6	18.2	15740		7106.4	21.5	24050
26		7095.6	18.2	15740		7106.3	21.4	23960
27		7095.6	18.2	15740		7106.2	21.4	23880
28		7095.5	18.1	15680		7106.1	21.4	23790
29		7095.6	18.2	15740		7105.9	21.3	23620
30		7095.5	18.1	15680		7105.8	21.3	23540
31		7095.5	18.1	15680		7105.6	21.2	23370
August 1	7095.4	7095.6	18.2	15740	7103.7	7105.5	21.2	23280
2		7095.6	18.2	15740		7105.5	21.2	23280
3		7095.6	18.2	15740		7105.3	21.1	23120
4		7095.7	18.2	15820		7105.2	21.1	23030
5		7095.7	18.2	15820		7105.1	21.1	22950
6		7095.7	18.2	15820		7104.9	21.0	22780
7		7095.6	18.2	15740		7104.8	21.0	22700
8		7095.6	18.2	15740		7104.6	20.9	22540
9		7095.6	18.2	15740		7104.5	20.9	22450
10		7095.6	18.2	15740		7104.4	20.8	22370
11		7095.6	18.2	15740		7104.2	20.8	22210
12		7095.6	18.2	15740		7104.1	20.8	22130
13		7095.6	18.2	15740		7104.1	20.8	22130

Table C-3. Water Surface Elevations (WSEL) and Storage for Grant Reservoir (ac-ft) (continued)

Month	1991 Monthly Average WSEL (ft)	1991 LADWP WSEL (ft)	1991 WSEL (m-rel)	1991 Storage (ac-ft)	1992 Monthly Average WSEL (ft)	1992 LADWP WSEL (ft)	1992 WSEL (m-rel)	1992 Storage (ac-ft)
14		7095.5	18.1	15680		7104.0	20.7	22040
15		7095.5	18.1	15680		7103.8	20.7	21880
16		7095.5	18.1	15680		7103.7	20.6	21800
17		7095.5	18.1	15680		7103.6	20.6	21720
18		7095.4	18.1	15600		7103.5	20.6	21640
19		7095.4	18.1	15600		7103.4	20.5	21560
20		7095.3	18.1	15540		7103.2	20.5	21400
21		7095.3	18.1	15540		7103.1	20.5	21320
22		7095.2	18.0	15460		7102.9	20.4	21160
23		7095.2	18.0	15460		7102.8	20.4	21080
24		7095.2	18.0	15460		7102.6	20.3	20920
25		7095.2	18.0	15460		7102.5	20.3	20840
26		7095.2	18.0	15460		7102.3	20.2	20690
27		7095.2	18.0	15460		7102.2	20.2	20610
28		7095.2	18.0	15460		7102.0	20.1	20450
29		7095.2	18.0	15460		7102.0	20.1	20450
30		7095.2	18.0	15460		7101.9	20.1	20370
31		7095.2	18.0	15460		7101.8	20.1	20300
Sept. 1	7095.8	7095.2	18.0	15460	7100.7	7101.7	20.0	20220
2		7095.2	18.0	15460		7101.5	20.0	20060
3		7095.1	18.0	15400		7101.4	19.9	19990
4		7095.2	18.0	15460		7101.2	19.9	19830
5		7095.2	18.0	15460		7101.2	19.9	19830
6		7095.2	18.0	15460		7101.1	19.8	19760
7		7095.3	18.1	15540		7101.0	19.8	19680
8		7095.3	18.1	15540		7100.9	19.8	19600

Table C-3. Water Surface Elevations (WSEL) and Storage for Grant Reservoir (ac-ft) (continued)

Month	1991 Monthly Average WSEL (ft)	1991 LADWP WSEL (ft)	1991 WSEL (m-rel)	1991 Storage (ac-ft)	1992 Monthly Average WSEL (ft)	1992 LADWP WSEL (ft)	1992 WSEL (m-rel)	1992 Storage (ac-ft)
9		7095.4	18.1	15600		7100.8	19.8	19530
10		7095.4	18.1	15600		7100.8	19.8	19530
11		7095.5	18.1	15680		7100.6	19.7	19380
12		7095.5	18.1	15680		7100.6	19.7	19380
13		7095.6	18.2	15740		7100.5	19.7	19300
14		7095.7	18.2	15820		7100.4	19.6	19220
15		7095.8	18.2	15880		7100.3	19.6	19150
16		7095.8	18.2	15880		7100.2	19.6	19070
17		7095.8	18.2	15880		7100.1	19.5	19000
18		7095.9	18.3	15960		7100.2	19.6	19070
19		7095.9	18.3	15960		7100.2	19.6	19070
20		7096.0	18.3	16030		7100.3	19.6	19150
21		7096.1	18.3	16100		7100.3	19.6	19150
22		7096.1	18.3	16100		7100.3	19.6	19150
23		7096.2	18.3	16170		7100.4	19.6	19220
24		7096.2	18.3	16170		7100.5	19.7	19300
25		7096.2	18.3	16170		7100.5	19.7	19300
26		7096.2	18.3	16170		7100.5	19.7	19300
27		7096.3	18.4	16240		7100.6	19.7	19380
28		7096.5	18.4	16380		7100.6	19.7	19380
29		7096.5	18.4	16380		7100.7	19.7	19450
30		7096.5	18.4	16380		7100.7	19.7	19450

APPENDIX D.
METEOROLOGY DATA BASE USED TO CALIBRATE AND VALIDATE THERM

Grant Reservoir thermal simulations for 1991 calibration year; from calibration file CAL 64. Percent possible cloud, air pressure, and wind speeds are from the NOAA weather station office at the Bishop Airport. Air temperatures are from Datapod field monitors in Mono Return Ditch 1 from August 17 to October 22, 1991. Air temperatures for May 15 to August 16 are from the 1991 regression equation:

1.20062 * air temperature at Bishop - 10.7867 = air temp at Ditch 1

The average air temperature at Mono Return Ditch No. 1 was 6.4°C less that the air temperature at Bishop. Applying this same differential to the dew points yields:

Dew point at Bishop - 6.4°C = Dew point at Mono Return Ditch 1

	Percent Possible Cloud	Air Temp (°C)	Dew Point (°C)	Air Press (mb)	Wind Speed (km/hr)
May 15, 1991	0.00	9.2	-11.4	870.0	10.0
16	0.20	8.6	-7.9	870.0	22.0
17	0.20	2.6	-17.7	870.0	25.0
18	0.30	0.6	-14.0	870.0	19.0
19	0.40	1.2	-7.5	870.0	22.0
20	0.50	3.9	-7.5	870.0	23.0
21	0.80	7.2	-4.0	870.0	29.0
22	0.80	11.2	-3.3	870.0	23.0
23	0.80	11.2	-2.1	870.0	17.0
24	0.80	14.6	-1.6	870.0	13.0
25	0.60	13.9	-2.1	870.0	13.0
26	0.40	11.2	-4.9	870.0	12.0
27	0.20	9.9	-7.7	870.0	11.0
28	0.00	7.2	-9.0	870.0	11.0
29	0.80	7.2	-9.5	870.0	3.0
30	0.30	8.6	-8.6	870.0	27.0
31	0.20	7.2	-8.8	870.0	36.0
June 1, 1991	0.20	13.2	-7.3	870.0	24.0
2	0.20	13.9	-2.3	870.0	14.0
3	0.20	14.6	-2.1	870.0	7.0
4	0.30	13.9	-3.3	870.0	17.0
5	0.00	13.2	-10.3	870.0	17.0
6	0.00	10.6	-9.9	870.0	11.0
7	0.00	14.6	-9.2	870.0	11.0
8	0.20	13.9	-7.3	870.0	10.0
9	0.30	15.9	-5.1	870.0	9.0

Appendix D.
Meteorology Data Base Used to Calibrate and Validate THERM

	Percent Possible Cloud	Air Temp (°C)	Dew Point (°C)	Air Press (mb)	Wind Speed (km/hr)
10	0.40	17.2	-1.6	870.0	8.0
11	0.80	20.6	-0.1	870.0	9.0
12	0.20	17.9	-2.0	870.0	12.0
13	0.40	15.9	-4.7	870.0	8.0
14	0.00	16.6	-10.7	870.0	15.0
15	0.00	13.9	-10.7	870.0	15.0
16	0.10	15.2	-10.5	870.0	14.0
17	0.10	16.6	-10.3	870.0	14.0
18	0.10	16.6	-10.1	870.0	14.0
19	0.10	13.9	-10.1	870.0	14.0
20	0.10	10.6	-9.9	870.0	13.0
21	0.20	13.2	-9.7	870.0	14.0
22	0.20	13.9	-9.5	870.0	13.0
23	0.20	13.2	-9.4	870.0	15.0
24	0.20	11.2	-9.0	870.0	16.0
25	0.30	13.9	-6.8	870.0	15.0
26	0.50	10.6	-6.0	870.0	13.0
27	0.90	11.9	-4.0	870.0	12.0
28	0.30	11.2	-1.8	870.0	30.0
29	0.20	12.6	-1.4	870.0	25.0
30	0.10	15.2	-8.1	870.0	18.0
July 1, 1991	0.00	19.2	-0.1	873.0	10.0
2	0.00	21.2	-0.8	873.0	10.0
3	0.00	23.2	-3.3	873.0	16.0
4	0.10	23.9	-0.7	873.0	17.0
5	0.10	23.2	-0.1	873.0	19.0
6	0.30	21.2	5.3	873.0	21.0
7	0.70	20.6	6.7	873.0	22.0
8	0.90	20.6	7.9	873.0	24.0
9	0.10	19.2	5.6	873.0	10.0
10	0.10	20.6	-0.5	873.0	13.0
11	0.10	18.6	-2.1	873.0	15.0
12	0.00	18.6	-3.3	873.0	19.0
13	0.00	19.9	-4.2	873.0	21.0
14	0.00	19.2	-5.7	873.0	23.0
15	0.00	17.2	-7.7	873.0	25.0
16	0.10	17.2	-4.4	873.0	22.0
17	0.10	17.9	-3.1	873.0	19.0
18	0.20	18.6	-4.5	873.0	19.0
19	0.30	17.2	0.1	873.0	15.0
20	0.20	15.2	-2.0	873.0	15.0
21	0.10	16.6	-3.4	873.0	13.0
22	0.10	17.2	-5.7	873.0	12.0
23	0.10	18.6	-5.5	873.0	15.0
24	0.10	19.9	-1.6	873.0	12.0

Appendix D.
Meteorology Data Base Used to Calibrate and Validate THERM

	Percent Possible Cloud	Air Temp (°C)	Dew Point (°C)	Air Press (mb)	Wind Speed (km/hr)
25	0.00	19.2	-2.7	873.0	12.0
26	0.10	19.9	-2.7	873.0	12.0
27	0.00	20.6	-2.0	873.0	12.0
28	0.10	20.6	-2.1	873.0	13.0
29	0.20	21.2	-2.3	873.0	13.0
30	0.20	21.2	-2.5	873.0	14.0
31	0.30	19.2	-2.7	873.0	14.0
August 1, 1991	0.30	19.2	-2.7	900.0	14.0
2	0.40	19.9	-3.1	900.0	14.0
3	0.50	19.2	-3.4	900.0	15.0
4	0.60	17.2	-4.0	900.0	15.0
5	0.70	15.2	-4.9	900.0	16.0
6	0.00	12.6	-11.0	900.0	20.0
7	0.60	15.2	-2.3	900.0	22.0
8	0.00	17.2	-7.3	900.0	13.0
9	0.00	18.6	-6.6	900.0	14.0
10	0.30	17.9	-2.5	900.0	12.0
11	0.70	17.9	1.6	900.0	10.0
12	1.00	19.9	3.0	900.0	6.0
13	0.50	19.9	7.3	900.0	14.0
14	0.70	19.2	3.6	900.0	21.0
15	0.40	18.6	5.1	900.0	10.0
16	0.50	20.6	4.9	900.0	15.0
17	0.60	19.2	3.6	900.0	15.0
18	0.70	19.4	-2.0	900.0	15.0
19	0.80	18.8	-4.7	900.0	16.0
20	0.70	18.9	-4.7	900.0	17.0
21	0.60	19.2	-7.5	900.0	20.0
22	0.50	19.8	-7.5	900.0	20.0
23	0.40	20.3	-7.5	000.0	20.0
24	0.30	21.2	-4.7	900.0	19.0
25	0.20	22.8	-2.0	900.0	20.0
26	0.20	20.3	0.3	900.0	22.0
27	0.50	15.6	-11.6	900.0	29.0
28	0.00	12.6	-11.6	900.0	13.0
29	0.20	16.3	-10.3	900.0	17.0
30	0.00	17.9	-10.8	900.0	17.0
31	0.10	17.7	-8.8	900.0	15.0
Sept. 1, 1991	0.20	17.3	-6.6	875.0	15.0
2	0.30	17.1	-3.4	875.0	15.0
3	0.30	15.9	-0.3	875.0	14.0
4	0.40	12.7	-0.5	875.0	11.0
5	0.90	11.6	-0.1	875.0	20.0
6	1.00	12.3	7.5	875.0	17.0
7	0.90	13.6	6.4	875.0	18.0

Appendix D.
Meteorology Data Base Used to Calibrate and Validate THERM

	Percent Possible Cloud	Air Temp (°C)	Dew Point (°C)	Air Press (mb)	Wind Speed (km/hr)
8	0.70	12.6	3.6	875.0	19.0
9	0.70	9.3	-5.3	875.0	19.0
10	0.20	7.4	-3.4	875.0	11.0
11	0.30	9.3	-1.8	875.0	12.0
12	0.00	10.0	-5.5	875.0	9.0
13	0.00	12.3	-5.3	875.0	5.0
14	0.00	13.8	-5.7	875.0	7.0
15	0.00	13.4	-6.0	875.0	8.0
16	0.10	13.5	-7.1	875.0	10.0
17	0.00	14.4	-9.5	875.0	8.0
18	0.00	15.3	-7.1	875.0	10.0
19	0.00	16.4	-5.7	875.0	9.0
20	0.10	16.6	-4.7	875.0	7.0
21	0.00	15.4	-5.3	875.0	7.0
22	0.00	14.1	-5.7	875.0	8.0
23	0.00	14.4	-6.0	875.0	9.0
24	0.00	13.8	-9.4	875.0	9.0
25	0.10	13.9	-8.8	875.0	14.0
26	0.20	16.0	-7.0	875.0	9.0
27	0.30	14.0	-3.3	875.0	9.0
28	0.20	12.6	-2.5	875.0	10.0
29	0.20	12.9	-2.0	875.0	10.0
30	0.10	12.3	-1.2	875.0	12.0
October 1, 1991	0.00	13.3	-3.8	875.0	4.0
2	0.00	13.4	-5.8	875.0	8.0
3	0.00	13.6	-9.4	875.0	10.0
4	0.00	13.2	-9.2	875.0	10.0
5	0.40	13.5	-8.8	875.0	8.0
6	0.60	14.0	-8.6	875.0	7.0
7	0.80	13.6	-8.3	875.0	8.0
8	0.50	10.6	-6.8	875.0	11.0
9	0.30	10.9	-8.8	875.0	14.0
10	0.50	12.7	-8.3	875.0	6.0
11	0.70	12.3	-7.7	875.0	12.0
12	0.50	12.5	-8.3	875.0	10.0
13	0.30	12.0	-9.0	875.0	9.0
14	0.10	12.0	-9.7	875.0	9.0
15	0.00	11.7	-10.3	875.0	8.0
16	0.00	10.9	-10.7	875.0	6.0
17	0.00	10.8	-8.1	875.0	6.0
18	0.00	10.8	-7.3	875.0	8.0
19	0.00	10.0	-8.6	875.0	9.0
20	0.00	7.0	-10.1	875.0	10.0
21	0.00	7.6	-11.0	875.0	10.0
22	0.00	12.5	-12.3	875.0	10.0

Appendix D.
Meteorology Data Base Used to Calibrate and Validate THERM

	Percent Possible Cloud	Air Temp (°C)	Dew Point (°C)	Air Press (mb)	Wind Speed (km/hr)
23	0.00	10.0	-14.9	875.0	12.0
24	0.00	10.0	-14.5	875.0	8.0
25	0.00	10.0	-10.5	875.0	9.0
26	0.00	10.0	-11.6	875.0	17.0
27	0.00	10.0	-12.7	875.0	21.0
28	0.00	10.0	-13.8	875.0	26.0
29	0.00	10.0	-10.5	875.0	14.0
30	0.00	10.0	-16.4	875.0	27.0
31	0.00	10.0	-16.0	875.0	10.0

Grant Reservoir thermal simulations for 1992 validation year; from validation file VAL 64. Percent possible cloud, air pressure, and wind speeds are from the NOAA weather station office at the Bishop Airport. Air temperatures are from the Datapod field monitors in Mono Ditch 1 for the entire period of modeling. The average air temperature at Bishop was 6.2°C greater than the air temperature recorded at Mono Ditch 1. Preserving and applying this differential to dew point yields:

Dew point at Bishop - 6.2°C = Dew point at Mono Return Ditch 1

	Percent Possible Cloud	Air Temp (°C)	Dew Point (°C)	Air Press (mb)	Wind Velocity (km/hr)
May 15, 1992	0.10	13.8	-4.7	872.0	15.0
16	0.10	14.2	-4.9	872.0	12.0
17	0.00	14.6	-6.9	872.0	27.0
18	0.80	16.5	-8.2	872.0	28.0
19	0.50	14.4	-10.5	872.0	23.0
20	0.10	7.7	-11.2	872.0	12.0
21	0.10	10.8	-9.9	872.0	17.0
22	0.10	12.8	-11.0	872.0	8.0
23	0.20	14.5	-10.3	872.0	13.0
24	0.60	17.3	-8.2	872.0	10.0
25	0.00	16.6	-2.9	872.0	11.0
26	0.30	18.0	-2.9	872.0	12.0
27	0.60	14.9	-5.1	872.0	13.0
28	0.50	14.3	-1.4	872.0	12.0
29	0.70	15.0	-0.6	872.0	10.0
30	0.60	16.3	-4.0	872.0	9.0
31	0.20	17.6	0.1	872.0	14.0

Appendix D.
Meteorology Data Base Used to Calibrate and Validate THERM

	Percent Possible Cloud	Air Temp (°C)	Dew Point (°C)	Air Press (mb)	Wind Velocity (km/hr)
June 1, 1992	0.30	16.0	0.5	870.0	11.0
2	0.60	16.0	-0.1	870.0	13.0
3	0.20	18.9	0.1	870.0	11.0
4	0.00	19.0	-1.9	870.0	7.0
5	0.10	16.3	-4.9	870.0	10.0
6	1.00	14.5	-3.8	870.0	17.0
7	0.30	14.1	-1.8	870.0	14.0
8	0.00	14.0	-3.1	870.0	14.0
9	0.10	16.5	-2.3	870.0	21.0
10	0.20	16.7	-1.9	870.0	23.0
11	0.00	17.0	-3.4	870.0	24.0
12	0.00	12.1	-15.3	870.0	23.0
13	0.10	7.7	-13.1	870.0	8.0
14	0.50	7.5	-12.3	870.0	34.0
15	0.70	4.7	-6.2	870.0	18.0
16	0.00	9.1	-7.1	870.0	10.0
17	0.00	12.1	-4.7	870.0	17.0
18	0.10	11.8	-3.6	870.0	16.0
19	0.10	12.5	-3.8	870.0	12.0
20	0.20	14.6	-2.5	870.0	9.0
21	0.30	16.6	-4.3	870.0	16.0
22	0.40	18.0	-7.5	870.0	19.0
23	1.00	16.0	-6.4	870.0	17.0
24	0.40	13.7	-1.2	870.0	9.0
25	0.80	13.2	-2.1	870.0	12.0
26	0.00	16.5	1.4	870.0	15.0
27	0.00	19.2	-0.8	870.0	23.0
28	0.30	17.0	-2.7	870.0	22.0
29	0.90	13.7	-5.6	870.0	16.0
30	0.00	14.2	-6.6	870.0	12.0
July 1, 1992	0.00	12.7	-4.5	873.0	19.0
2	0.00	15.4	-4.9	873.0	14.0
3	0.00	17.5	-3.8	873.0	21.0
4	0.10	19.5	-4.2	873.0	15.0
5	0.10	18.0	-8.6	873.0	17.0
6	0.30	19.0	-4.0	873.0	15.0
7	0.70	19.0	-3.6	873.0	12.0
8	0.90	17.5	-1.2	873.0	14.0
9	0.10	18.4	3.2	873.0	14.0
10	0.10	18.7	2.7	873.0	12.0
11	0.10	17.8	4.9	873.0	14.0
12	0.00	12.5	4.5	873.0	18.0
13	0.00	15.9	6.0	873.0	12.0
14	0.00	15.0	4.2	873.0	12.0
15	0.00	15.9	3.6	873.0	9.0

Appendix D.
Meteorology Data Base Used to Calibrate and Validate THERM

	Percent Possible Cloud	Air Temp (°C)	Dew Point (°C)	Air Press (mb)	Wind Velocity (km/hr)
16	0.10	17.3	11.0	873.0	12.0
17	0.10	17.8	0.8	873.0	17.0
18	0.20	19.2	-2.1	873.0	8.0
19	0.30	18.8	-9.2	873.0	14.0
20	0.20	18.1	-8.2	873.0	14.0
21	0.10	17.7	-7.5	873.0	12.0
22	0.10	17.3	-5.6	873.0	9.0
23	0.10	16.2	-7.7	873.0	8.0
24	0.10	17.6	-7.1	873.0	11.0
25	0.00	19.0	-5.8	873.0	13.0
26	0.10	20.6	-7.5	873.0	13.0
27	0.00	20.8	-4.2	873.0	13.0
28	0.10	21.2	-3.2	873.0	9.0
29	0.20	21.2	-0.1	873.0	10.0
30	0.20	19.8	-3.4	873.0	17.0
31	0.30	20.8	-2.3	873.0	17.0
August 1, 1992	0.30	21.8	-0.8	875.0	10.0
2	0.40	22.1	-1.0	875.0	9.0
3	0.50	21.7	-1.9	875.0	12.0
4	0.60	21.4	-2.9	875.0	11.0
5	0.70	19.1	-1.9	875.0	19.0
6	0.00	18.3	5.3	875.0	11.0
7	0.60	19.3	-5.3	875.0	23.0
8	0.00	19.0	-5.5	875.0	16.0
9	0.00	21.0	-5.6	875.0	15.0
10	0.30	21.3	-4.2	875.0	14.0
11	0.70	19.6	0.8	875.0	19.0
12	1.00	17.2	2.5	875.0	19.0
13	0.50	15.8	5.3	875.0	13.0
14	0.70	15.7	5.5	875.0	12.0
15	0.40	17.3	5.5	875.0	16.0
16	0.20	19.5	6.0	875.0	8.0
17	0.20	20.8	4.5	875.0	12.0
18	0.20	21.7	1.9	875.0	14.0
19	0.20	20.5	-4.2	875.0	10.0
20	0.20	19.2	-4.2	875.0	9.0
21	0.20	20.0	-4.3	875.0	20.0
22	0.20	16.7	-12.7	875.0	12.0
23	0.20	12.6	-11.4	875.0	13.0
24	0.20	13.4	-11.0	875.0	15.0
25	0.20	14.0	-8.1	875.0	10.0
26	0.20	15.1	-9.2	875.0	10.0
27	0.50	16.3	-8.8	875.0	14.0
28	0.00	15.1	-3.8	875.0	8.0
29	0.20	16.3	-1.8	875.0	20.0

	Percent Possible Cloud	Air Temp (°C)	Dew Point (°C)	Air Press (mb)	Wind Velocity (km/hr)
30	0.00	12.0	-1.0	875.0	10.0
31	0.10	12.0	-2.5	875.0	8.0
Sept. 1, 1992	0.20	14.3	-2.7	874.0	10.0
2	0.30	15.0	-2.9	874.0	12.0
3	0.30	14.7	-3.1	874.0	14.0
4	0.40	11.8	-3.2	874.0	17.0
5	0.90	13.0	-5.6	874.0	11.0
6	1.00	13.5	-9.2	874.0	8.0
7	0.90	13.5	-6.2	874.0	12.0
8	0.70	14.8	-5.6	874.0	7.0
9	0.70	16.5	-6.8	874.0	9.0
10	0.20	17.4	-7.9	874.0	18.0
11	0.30	18.3	-6.2	874.0	14.0
12	0.00	12.8	-10.1	874.0	11.0
13	0.00	13.1	-8.8	874.0	14.0
14	0.00	12.7	-8.2	874.0	14.0
15	0.00	14.8	-10.3	874.0	14.0
16	0.10	15.0	-5.1	874.0	12.0
17	0.00	14.3	-3.8	874.0	11.0
18	0.00	10.8	2.3	874.0	15.0
19	0.00	12.8	-3.6	874.0	10.0
20	0.10	14.1	-3.2	874.0	11.0
21	0.00	15.9	-5.1	874.0	9.0
22	0.00	16.2	-2.9	874.0	14.0
23	0.00	16.7	-1.0	874.0	8.0
24	0.00	17.4	-7.1	874.0	9.0
25	0.10	10.1	-11.6	874.0	12.0
26	0.20	11.0	-11.0	874.0	10.0
27	0.30	13.3	-10.8	874.0	9.0
28	0.20	15.1	-11.8	874.0	12.0
29	0.20	16.2	-9.5	874.0	14.0
30	0.10	19.2	-3.1	874.0	17.0
October 1, 1992	0.50	17.0	-3.1	874.7	19.0
2	0.10	9.4	-11.9	870.7	23.0
3	0.00	6.1	-8.1	870.7	10.0
4	0.00	7.4	-4.2	870.7	12.0
5	0.30	9.2	-5.1	870.7	10.0
6	0.00	8.5	-7.3	870.7	17.0
7	0.20	9.2	-14.0	870.7	12.0
8	0.40	11.1	-13.2	870.7	7.0
9	0.00	11.3	-10.6	870.7	10.0
10	0.00	10.8	-7.9	870.0	9.0
11	0.00	12.0	-7.5	870.7	9.0
12	0.00	12.8	-11.0	870.7	12.0
13	0.00	12.6	-11.0	870.7	6.0

Appendix D.
Meteorology Data Base Used to Calibrate and Validate THERM

	Percent Possible Cloud	Air Temp (°C)	Dew Point (°C)	Air Press (mb)	Wind Velocity (km/hr)
14	0.10	10.6	-12.1	870.7	9.0
15	0.00	9.4	-8.2	870.7	6.0
16	0.30	10.6	-9.7	870.7	7.0
17	0.10	9.5	-8.4	870.7	15.0
18	0.20	11.1	-7.1	870.7	9.0
19	0.00	7.6	-6.8	870.7	9.0
20	0.40	10.0	-7.7	870.7	17.0
21	0.90	11.0	-4.9	870.7	8.0
22	0.10	9.0	-3.6	870.7	9.0
23	0.00	6.0	-4.9	870.7	7.0
24	0.70	7.5	1.0	870.7	12.0
25	0.20	9.5	0.5	870.7	9.0
26	0.20	8.5	-0.1	870.7	9.0
27	1.00	7.0	-0.5	870.7	5.0
28	0.80	5.0	1.0	870.7	10.0
29	0.70	7.0	-1.9	870.7	9.0
30	1.00	6.0	1.0	870.7	12.0
31	0.20	1.5	1.0	870.7	8.0

APPENDIX E.
SOURCE OR DETERMINATION OF SELECTED CALIBRATION PARAMETERS USED IN THERM

The following is a discussion of the selection for some of the input values used for THERM. See ACE (1986) for a detailed description of the algorithms and input parameters used in THERM and the sensitivity of the model to changes in values of the parameters.

1. Wind variables AA an BB. The model was found to be sensitive to these parameters. The temperature profiles changed their shape largely at the surface and ever more slightly with depth. Changing AA had an affect upon the magnitude of the difference between the surface temperature and temperature at zero elevation. Changing BB had an affect upon the location of the thermocline within the water column. AA = 2.5E-9, BB = 1.0E-9.

2. The regression curve used to predict water surface area as a function of elevation; the same coefficients are also used to predict reservoir volume. A1 = 90257 and A2 = 1.17655. These values were arrived at from an examination of area and capacity tables, Reference No. A-1494, provided by LADWP.

3. The regression curve used to predict reservoir width as a function of elevation. W1 = 115.0 and W2 = 0.684056; taken from a topographic map supplied by LADWP, Reference No. N 205-B.

4. The values of CDIFF and CDIFW were set to 0.

APPENDIX F.
THERM INPUT DATA DECK FOR 1991 CALIBRATION

This is the data desk assembled for the calibration year 1991. Outflow from this data deck produced the graphs in Section 6 of this report.

Appendix F.
THERM Input Data Deck For 1991 Calibration

```
TITLE   Grant Reservoir on Rush Creek, Mono Basin, CA; temperature profiles March, 1993; RC@T&A
TITLE   May 15 = Jday 135, Sept 30 = Jday 273, Oct 31 = Jday 304.
TITLE
TITLE   CAL 64
TITLE
JOB         135     274      24     168     135      91
MODE     NORMAL    PORT SPECIFY     YES
PHYS1         1      20    36.9   119.1    0.40 2.5E-09 1.0E-09  2144.5
PHYS2      3420     0.4     5.0
PHYS2+     0.82    0.82    0.82    0.82    0.82    0.82    0.82    0.82    0.82
PHYS2+     0.82    0.82    0.82    0.82    0.82    0.82    0.82    0.82    0.82
PHYS2+     0.82    0.82
OUTLET        1
PHYS3    10.918    2.62    2.62
CURVE     POWER
AREAC    90257. 1.17655
WIDTHC   115.00 .684056
MIXING     0.90    0.40 0.0E-05 0.0E-06     2.1
LIGHT      1.50    0.55    0.50
SSETL      10.0
INITO        11
INIT2       0.4     9.0    19.0      3.
INIT2       7.4     9.3    19.0      3.
INIT2       8.4     9.3    19.0      3.
INIT2       9.4     9.4    19.0      3.
INIT2      10.4     9.5    19.0      3.
INIT2      11.4     9.6    19.0      3.
INIT2      12.4     9.7    19.0      3.
INIT2      13.4    10.0    19.0      3.
INIT2      14.4    10.2    19.0      3.
INIT2      15.4    10.9    19.0      3.
INIT2      15.9    10.9    19.0      3.
FILES   PLTWC   R1PLT04 R1PLT11 R1PLT12
FILID   Grant Reservoir on Rush Creek; Mono Bas.
WEATH1       24     170
W2 May 15,         0.00     9.2   -11.4   870.0    10.0
W2 16  1991        0.20     8.6    -7.9   870.0    22.0
W2 17              0.20     2.6   -17.7   870.0    25.0
W2 18              0.30     0.6   -14.0   870.0    19.0
W2 19              0.40     1.2    -7.5   870.0    22.0
W2 20              0.50     3.9    -7.5   870.0    23.0
W2 21              0.80     7.2    -4.0   870.0    29.0
W2 22              0.80    11.2    -3.3   870.0    23.0
W2 23              0.80    11.2    -2.1   870.0    17.0
W2 24              0.80    14.6    -1.6   870.0    13.0
W2 25              0.60    13.9    -2.1   870.0    13.0
W2 26              0.40    11.2    -4.9   870.0    12.0
W2 27              0.20     9.9    -7.7   870.0    11.0
W2 28              0.00     7.2    -9.0   870.0    11.0
W2 29              0.80     7.2    -9.5   870.0     3.0
W2 30              0.30     8.6    -8.6   870.0    27.0
W2 31              0.20     7.2    -8.8   870.0    36.0
W2 JUNE 1991       0.20    13.2    -7.3   870.0    24.0
W2 2               0.20    13.9    -2.3   870.0    14.0
W2 3               0.20    14.6    -2.1   870.0     7.0
W2 4               0.30    13.9    -3.3   870.0    17.0
W2 5               0.00    13.2   -10.3   870.0    17.0
W2 6               0.00    10.6    -9.9   870.0    11.0
W2 7               0.00    14.6    -9.2   870.0    11.0
W2 8               0.20    13.9    -7.3   870.0    10.0
W2 9               0.30    15.9    -5.1   870.0     9.0
W210               0.40    17.2    -1.6   870.0     8.0
W211               0.80    20.6    -0.1   870.0     9.0
W212               0.20    17.9    -2.0   870.0    12.0
W213               0.40    15.9    -4.7   870.0     8.0
```

Appendix F.
THERM Input Data Deck For 1991 Calibration

W2 14	0.00	16.6	-10.7	870.0	15.0
W2 15	0.00	13.9	-10.7	870.0	15.0
W2 16	0.10	15.2	-10.5	870.0	14.0
W2 17	0.10	16.6	-10.3	870.0	14.0
W2 18	0.10	16.6	-10.1	870.0	14.0
W2 19	0.10	13.9	-10.1	870.0	14.0
W2 20	0.10	10.6	-9.9	870.0	13.0
W2 21	0.20	13.2	-9.7	870.0	14.0
W2 22	0.20	13.9	-9.5	870.0	13.0
W2 23	0.20	13.2	-9.4	870.0	15.0
W2 24	0.20	11.2	-9.0	870.0	16.0
W2 25	0.30	13.9	-6.8	870.0	15.0
W2 26	0.50	10.6	-6.0	870.0	13.0
W2 27	0.90	11.9	-4.0	870.0	12.0
W2 28	0.30	11.2	-1.8	870.0	30.0
W2 29	0.20	12.6	-1.4	870.0	25.0
W2 30	0.10	15.2	-8.1	870.0	18.0
W2 JULY 1 91	0.00	19.2	-0.1	873.0	10.0
W2 2	0.00	21.2	-0.8	873.0	10.0
W2 3	0.00	23.2	-3.3	873.0	16.0
W2 4	0.10	23.9	-0.7	873.0	17.0
W2 5	0.10	23.2	-0.1	873.0	19.0
W2 6	0.30	21.2	5.3	873.0	21.0
W2 7	0.70	20.6	6.7	873.0	22.0
W2 8	0.90	20.6	7.9	873.0	24.0
W2 9	0.10	19.2	5.6	873.0	10.0
W2 10	0.10	20.6	-0.5	873.0	13.0
W2 11	0.10	18.6	-2.1	873.0	15.0
W2 12	0.00	18.6	-3.3	873.0	19.0
W2 13	0.00	19.9	-4.2	873.0	21.0
W2 14	0.00	19.2	-5.7	873.0	23.0
W2 15	0.00	17.2	-7.7	873.0	25.0
W2 16	0.10	17.2	-4.4	873.0	22.0
W2 17	0.10	17.9	-3.1	873.0	19.0
W2 18	0.20	18.6	-4.5	873.0	19.0
W2 19	0.30	17.2	0.1	873.0	15.0
W2 20	0.20	15.2	-2.0	873.0	15.0
W2 21	0.10	16.6	-3.4	873.0	13.0
W2 22	0.10	17.2	-5.7	873.0	12.0
W2 23	0.10	18.6	-5.5	873.0	15.0
W2 24	0.10	19.9	-1.6	873.0	12.0
W2 25	0.00	19.2	-2.7	873.0	12.0
W2 26	0.10	19.9	-2.7	873.0	12.0
W2 27	0.00	20.6	-2.0	873.0	12.0
W2 28	0.10	20.6	-2.1	873.0	13.0
W2 29	0.20	21.2	-2.3	873.0	13.0
W2 30	0.20	21.2	-2.5	873.0	14.0
W2 31	0.30	19.2	-2.7	873.0	14.0
W2 AUG 1 91	0.30	19.2	-2.7	900.0	14.0
W2 2	0.40	19.9	-3.1	900.0	14.0
W2 3	0.50	19.2	-3.4	900.0	15.0
W2 4	0.60	17.2	-4.0	900.0	15.0
W2 5	0.70	15.2	-4.9	900.0	16.0
W2 6	0.00	12.6	-11.0	900.0	20.0
W2 7	0.60	15.2	-2.3	900.0	22.0
W2 8	0.00	17.2	-7.3	900.0	13.0
W2 9	0.00	18.6	-6.6	900.0	14.0
W2 10	0.30	17.9	-2.5	900.0	12.0
W2 11	0.70	17.9	1.6	900.0	10.0
W2 12	1.00	19.9	3.0	900.0	6.0
W2 13	0.50	19.9	7.3	900.0	14.0
W2 14	0.70	19.2	3.6	900.0	21.0
W2 15	0.40	18.6	5.1	900.0	10.0
W2 16	0.50	20.6	4.9	900.0	15.0
W2 17	0.60	19.9	3.6	900.0	15.0

Appendix F.
THERM Input Data Deck For 1991 Calibration

W2 18	0.70	18.6	-2.0	900.0	15.0
W2 19	0.80	18.6	-4.7	900.0	16.0
W2 20	0.70	17.2	-4.7	900.0	17.0
W2 21	0.60	17.9	-7.5	900.0	20.0
W2 22	0.50	19.2	-7.5	900.0	20.0
W2 23	0.40	23.2	-7.5	000.0	20.0
W2 24	0.30	19.9	-4.7	900.0	19.0
W2 25	0.20	18.6	-2.0	900.0	20.0
W2 26	0.20	17.9	0.3	900.0	22.0
W2 27	0.50	12.6	-11.6	900.0	29.0
W2 28	0.00	10.6	-11.6	900.0	13.0
W2 29	0.20	13.9	-10.3	900.0	17.0
W2 30	0.00	15.9	-10.8	900.0	17.0
W2 31	0.10	16.6	-8.8	900.0	15.0
W2 Sep 1 91	0.20	17.2	-6.6	875.0	15.0
W2 2	0.30	18.6	-3.4	875.0	15.0
W2 3	0.30	17.9	-0.3	875.0	14.0
W2 4	0.40	17.2	-0.5	875.0	11.0
W2 5	0.90	15.9	-0.1	875.0	20.0
W2 6	1.00	13.2	7.5	875.0	17.0
W2 7	0.90	13.9	6.4	875.0	18.0
W2 8	0.70	12.6	3.6	875.0	19.0
W2 9	0.70	10.6	-5.3	875.0	19.0
W2 10	0.20	8.6	-3.4	875.0	11.0
W2 11	0.30	10.6	-1.8	875.0	12.0
W2 12	0.00	11.2	-5.5	875.0	9.0
W2 13	0.00	12.6	-5.3	875.0	5.0
W2 14	0.00	23.9	-5.7	875.0	7.0
W2 15	0.00	15.2	-6.0	875.0	8.0
W2 16	0.10	15.2	-7.1	875.0	10.0
W2 17	0.00	13.9	-9.5	875.0	8.0
W2 18	0.00	15.2	-7.1	875.0	10.0
W2 19	0.00	15.9	-5.7	875.0	9.0
W2 20	0.10	15.2	-4.7	875.0	7.0
W2 21	0.00	16.6	-5.3	875.0	7.0
W2 22	0.00	16.6	-5.7	875.0	8.0
W2 23	0.00	15.2	-6.0	875.0	9.0
W2 24	0.00	13.9	-9.4	875.0	9.0
W2 25	0.10	13.9	-8.8	875.0	14.0
W2 26	0.20	15.2	-7.0	875.0	9.0
W2 27	0.30	11.9	-3.3	875.0	9.0
W2 28	0.20	11.9	-2.5	875.0	10.0
W2 29	0.20	12.9	-2.0	875.0	10.0
W2 30	0.10	13.9	-1.2	875.0	12.0
W2 OCt 87	0.10	10.0	1.0	870.0	5.0
W2 2	0.10	10.0	1.0	870.0	5.0
W2 3	0.10	10.0	1.0	870.0	5.0
W2 4	0.10	10.0	1.0	870.0	5.0
W2 5	0.10	10.0	1.0	870.0	5.0
W2 6	0.10	10.0	1.0	870.0	5.0
W2 7	0.10	10.0	1.0	870.0	5.0
W2 8	0.10	10.0	1.0	870.0	5.0
W2 9	0.10	10.0	1.0	870.0	5.0
W2 10	0.10	10.0	1.0	870.0	5.0
W2 11	0.10	10.0	1.0	870.0	5.0
W2 12	0.10	10.0	1.0	870.0	5.0
W2 13	0.10	10.0	1.0	870.0	5.0
W2 14	0.10	10.0	1.0	870.0	5.0
W2 15	0.10	10.0	1.0	870.0	5.0
W2 16	0.10	10.0	1.0	870.0	5.0
W2 17	0.10	10.0	1.0	870.0	5.0
W2 18	0.10	10.0	1.0	870.0	5.0
W2 19	0.10	10.0	1.0	870.0	5.0
W2 20	0.10	10.0	1.0	870.0	5.0
W2 21	0.10	10.0	1.0	870.0	5.0

Appendix F.
THERM Input Data Deck For 1991 Calibration

```
W2 22              0.10    10.0    1.0   870.0    5.0
W2 23              0.10     5.0    1.0   870.0    5.0
W2 24              0.10     5.0    1.3   870.0    5.0
W2 25              0.10     5.0    1.0   870.0    5.0
W2 26              0.10    ·5.0    1.0   870.0    5.0
W2 27              0.10     5.0    1.0   870.0    5.0
W2 28              0.10     5.0    1.0   870.0    5.0
W2 29              0.10     5.0    1.0   870.0    5.0
W2 30              0.10     5.0    1.0   870.0    5.0
W2 31              0.10     5.0    1.0   870.0    5.0
SOUTL1          24  170
SOUTL2 May 15        1     1.1     2              3              4
SOUTL2 16            1     1.1     2              3              4
SOUTL2 17            1     1.1     2              3              4
SOUTL2 18            1     1.1     2              3              4
SOUTL2 19            1     1.1     2              3              4
SOUTL2 20            1     1.1     2              3              4
SOUTL2 21            1     1.1     2              3              4
SOUTL2 22            1     1.1     2              3              4
SOUTL2 23            1     1.1     2              3              4
SOUTL2 24            1     1.1     2              3              4
SOUTL2 25            1     1.1     2              3              4
SOUTL2 26            1     1.1     2              3              4
SOUTL2 27            1     1.1     2              3              4
SOUTL2 28            1     1.1     2              3              4
SOUTL2 29            1     1.1     2              3              4
SOUTL2 30            1     1.1     2              3              4
SOUTL2 31            1     1.1     2              3              4
SOUTL2 June 1        1     1.1     2              3              4
SOUTL2 2             1     1.1     2              3              4
SOUTL2 3             1     1.1     2              3              4
SOUTL2 4             1     1.1     2              3              4
SOUTL2 5             1     1.1     2              3              4
SOUTL2 6             1     1.2     2              3              4
SOUTL2 7             1     1.2     2              3              4
SOUTL2 8             1     1.2     2              3              4
SOUTL2 9             1     1.2     2              3              4
SOUTL2 10            1     1.2     2              3              4
SOUTL2 11            1     1.2     2              3              4
SOUTL2 12            1     1.2     2              3              4
SOUTL2 13            1     1.5     2              3              4
SOUTL2 14            1     2.3     2              3              4
SOUTL2 15            1     3.2     2              3              4
SOUTL2 16            1     3.4     2              3              4
SOUTL2 17            1     3.7     2              3              4
SOUTL2 18            1     4.1     2              3              4
SOUTL2 19            1     4.4     2              3              4
SOUTL2 20            1     4.5     2              3              4
SOUTL2 21            1     4.6     2              3              4
SOUTL2 22            1     4.6     2              3              4
SOUTL2 JUNE 23       1     4.5     2              3              4
SOUTL2 24            1     4.5     2              3              4
SOUTL2 25            1     4.6     2              3              4
SOUTL2 26            1     4.6     2              3              4
SOUTL2 27            1     4.6     2              3              4
SOUTL2 28            1     4.5     2              3              4
SOUTL2 29            1     4.0     2              3              4
SOUTL2 30            1     3.3     2              3              4
SOUTL2 JULY 1        1     3.0     2              3              4
SOUTL2 2             1     2.4     2              3              4
SOUTL2 3             1     1.6     2              3              4
SOUTL2 4             1     1.7     2              3              4
SOUTL2 5             1     1.7     2              3              4
SOUTL2 6             1     1.7     2              3              4
SOUTL2 7             1     1.7     2              3              4
```

SOUTL2 8	1	1.7	2	3	4
SOUTL2 9	1	1.7	2	3	4
SOUTL2 10	1	1.7	2	3	4
SOUTL2 11	1	1.7	2	3	4
SOUTL2 12	1	1.7	2	3	4
SOUTL2 13	1	1.7	2	3	4
SOUTL2 14	1	1.7	2	3	4
SOUTL2 15	1	1.7	2	3	4
SOUTL2 16	1	1.7	2	3	4
SOUTL2 17	1	1.7	2	3	4
SOUTL2 18	1	1.7	2	3	4
SOUTL2 19	1	1.7	2	3	4
SOUTL2 20	1	1.7	2	3	4
SOUTL2 21	1	1.7	2	3	4
SOUTL2 22	1	1.7	2	3	4
SOUTL2 23	1	1.6	2	3	4
SOUTL2 24	1	1.2	2	3	4
SOUTL2 25	1	1.1	2	3	4
SOUTL2 26	1	1.1	2	3	4
SOUTL2 27	1	1.1	2	3	4
SOUTL2 28	1	1.1	2	3	4
SOUTL2 29	1	1.1	2	3	4
SOUTL2 30	1	1.0	2	3	4
SOUTL2 31	1	1.1	2	3	4
SOUTL2 AUG 1	1	1.1	2	3	4
SOUTL2 2	1	1.1	2	3	4
SOUTL2 3	1	1.1	2	3	4
SOUTL2 4	1	1.1	2	3	4
SOUTL2 5	1	1.1	2	3	4
SOUTL2 6	1	1.1	2	3	4
SOUTL2 7	1	1.1	2	3	4
SOUTL2 8	1	1.1	2	3	4
SOUTL2 9	1	1.0	2	3	4
SOUTL2 10	1	1.0	2	3	4
SOUTL2 11	1	1.0	2	3	4
SOUTL2 12	1	1.0	2	3	4
SOUTL2 13	1	1.2	2	3	4
SOUTL2 14	1	1.3	2	3	4
SOUTL2 15	1	1.3	2	3	4
SOUTL2 16	1	1.5	2	3	4
SOUTL2 17	1	2.1	2	3	4
SOUTL2 18	1	1.9	2	3	4
SOUTL2 19	1	1.2	2	3	4
SOUTL2 20	1	1.0	2	3	4
SOUTL2 21	1	1.0	2	3	4
SOUTL2 22	1	1.0	2	3	4
SOUTL2 23	1	1.0	2	3	4
SOUTL2 24	1	1.0	2	3	4
SOUTL2 25	1	1.0	2	3	4
SOUTL2 26	1	1.0	2	3	4
SOUTL2 27	1	1.0	2	3	4
SOUTL2 28	1	1.0	2	3	4
SOUTL2 29	1	1.0	2	3	4
SOUTL2 30	1	1.0	2	3	4
SOUTL2 31	1	1.0	2	3	4
SOUTL2 Sep 1 87	1	1.0	2	3	4
SOUTL2 2	1	1.0	2	3	4
SOUTL2 3	1	0.9	2	3	4
SOUTL2 4	1	0.6	2	3	4
SOUTL2 5	1	0.5	2	3	4
SOUTL2 6	1	0.6	2	3	4
SOUTL2 7	1	0.6	2	3	4
SOUTL2 8	1	0.6	2	3	4
SOUTL2 9	1	0.6	2	3	4
SOUTL2 10	1	0.6	2	3	4

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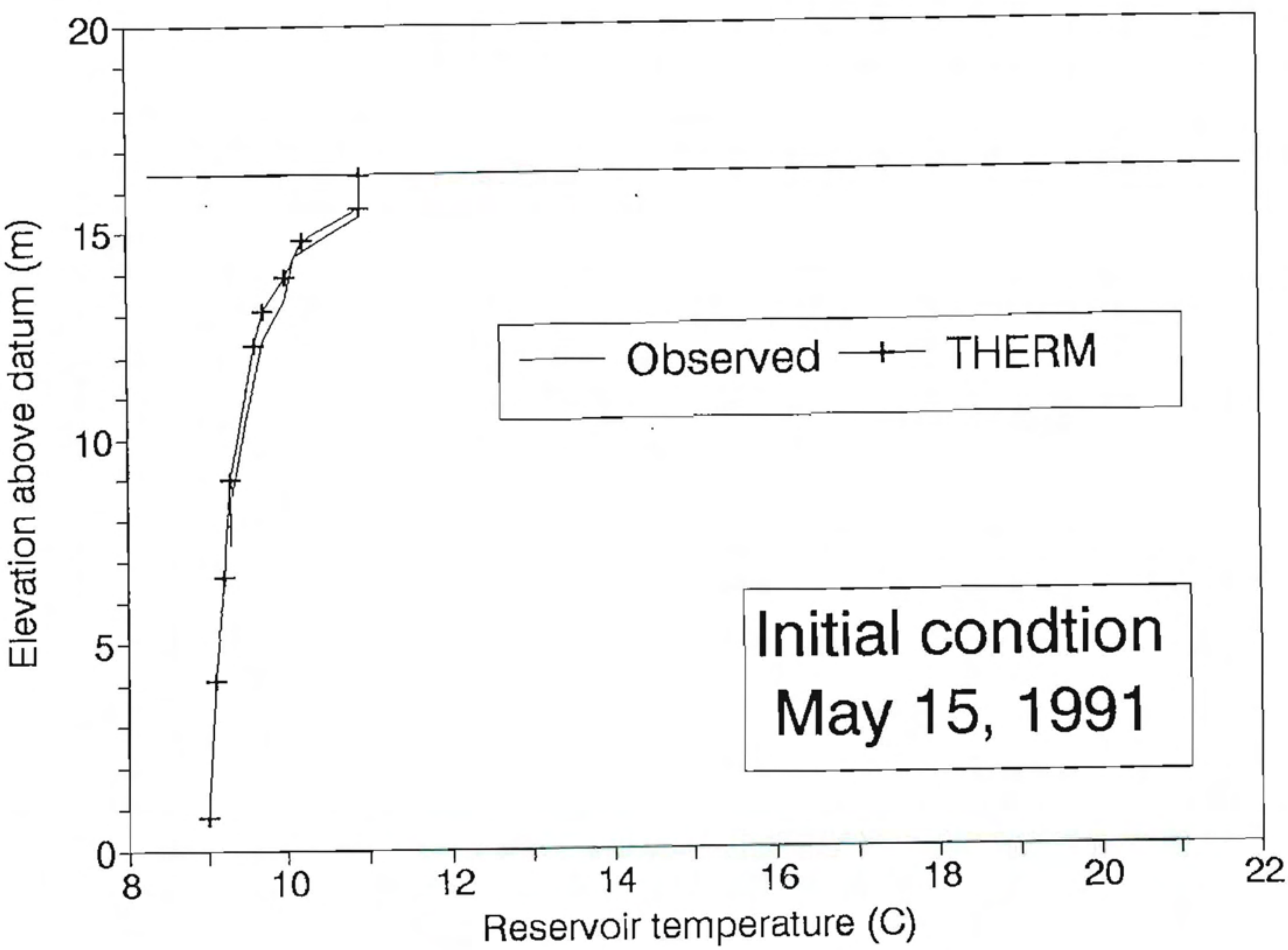
SOUTL2 11          1    0.6     2          3          4
SOUTL2 12          1    0.6     2          3          4
SOUTL2 13          1    0.6     2          3          4
SOUTL2 14          1    0.6     2          3          4
SOUTL2 15          1    0.6     2          3          4
SOUTL2 16          1    0.6     2          3          4
SOUTL2 17          1    0.6     2          3          4
SOUTL2 18          1    0.6     2          3          4
SOUTL2 19          1    0.6     2          3          4
SOUTL2 20          1    0.6     2          3          4
SOUTL2 21          1    0.6     2          3          4
SOUTL2 22          1    0.6     2          3          4
SOUTL2 23          1    0.6     2          3          4
SOUTL2 24          1    0.6     2          3          4
SOUTL2 25          1    0.6     2          3          4
SOUTL2 26          1    0.6     2          3          4
SOUTL2 27          1    0.6     2          3          4
SOUTL2 28          1    0.6     2          3          4
SOUTL2 29          1    0.6     2          3          4
SOUTL2 30          1    0.6     2          3          4
SOUTL2 Oct 1 87    1            2          3          4
SOUTL2 2           1            2          3          4
SOUTL2 3           1            2          3          4
SOUTL2 4           1            2          3          4
SOUTL2 5           1            2          3          4
SOUTL2 6           1            2          3          4
SOUTL2 7           1            2          3          4
SOUTL2 8           1            2          3          4
SOUTL2 9           1            2          3          4
SOUTL2 10          1            2          3          4
SOUTL2 11          1            2          3          4
SOUTL2 12          1            2          3          4
SOUTL2 13          1            2          3          4
SOUTL2 14          1            2          3          4
SOUTL2 15          1            2          3          4
SOUTL2 16          1            2          3          4
SOUTL2 17          1            2          3          4
SOUTL2 18          1            2          3          4
SOUTL2 19          1            2          3          4
SOUTL2 20          1            2          3          4
SOUTL2 21          1            2          3          4
SOUTL2 22          1            2          3          4
SOUTL2 23          1            2          3          4
SOUTL2 24          1            2          3          4
SOUTL2 25          1            2          3          4
SOUTL2 26          1            2          3          4
SOUTL2 27          1            2          3          4
SOUTL2 28          1            2          3          4
SOUTL2 29          1            2          3          4
SOUTL2 30          1            2          3          4
SOUTL2 31          1            2          3          4
Q1  QIN      24    19  start May 15, 1991.
Q2 91  1    2.6   2.7   2.8   2.7   2.7   2.6   2.6   2.6   2.8
Q2 91  2    3.2   3.6   3.6   3.5   3.4   3.4   3.4   3.2   3.4
Q2 91  3    3.6   4.1   4.5   4.7   4.5   4.3   4.4   4.4   4.7
Q2 91  4    4.9   5.1   4.7   4.3   4.0   3.8   3.7   3.6   3.4
Q2 91  5    3.3   3.1   3.0   3.0   3.0   3.0   2.9   2.8   2.8
Q2 91  6    2.8   2.7   2.0   2.2   2.3   2.5   2.5   2.5   2.4
Q2 91  7    2.3   2.2   2.1   2.0   2.0   2.0   1.9   1.9   1.8
Q2 91  8    1.7   1.7   1.7   1.7   1.6   1.6   1.6   1.6   1.6
Q2 91  9    1.6   1.5   1.5   1.5   1.5   1.6   1.6   1.5   1.5
Q2 91 10    1.5   1.4   1.4   1.4   1.4   1.4   1.4   1.4   1.4
Q2 91 11    1.4   1.4   1.4   1.4   1.4   1.4   1.4   1.3   1.3
Q2 91 12    1.3   1.3   1.3   1.3   1.3   1.3   1.3   1.3   1.3
Q2 91 13    1.3   1.4   1.4   1.3   1.4   1.4   1.4   1.4   1.4
```

```
Q2 91 14     1.4     1.4     1.4     1.4     1.4     1.4     1.4     1.3     1.4
Q2 91 15     1.3     1.3     1.4     1.4     1.3     1.4     1.3     1.4     1.4
Q2 91 16     1.4     1.3     1.3     1.3       1       1       1       1       1
Q2 91 17       1       1       1       1       1       1       1       1       1
Q2 91 18       1       1       1       1       1       1       1       1       1
Q2 91 19       1       1       1       1       1       1       1       1       1
WQ TEMP       24      19
TEMP    1   11.5    11.2     8.6     7.8     8.1     9.2    10.6    12.3    12.3
TEMP    2   13.8    13.5    12.3    11.8    10.6    10.6    11.2    10.6    13.2
TEMP    3   13.5    13.8    13.5    13.2    12.0    13.8    13.5    14.3    14.9
TEMP    4   16.3    15.2    14.3    14.6    13.5    14.0    14.6    14.6    13.5
TEMP    5   12.0    13.2    13.5    13.2    12.3    13.5    12.0    12.6    12.3
TEMP    6   12.9    14.0    15.7    16.6    17.5    17.7    17.5    16.6    16.3
TEMP    7   16.3    15.7    16.3    15.5    15.5    16.0    15.7    14.9    14.9
TEMP    8   15.2    15.5    14.9    14.0    14.6    14.9    15.5    16.0    15.7
TEMP    9   16.0    16.3    16.3    16.6    16.6    15.7    15.7    16.0    15.7
TEMP   10   14.9    14.0    12.9    14.0    14.9    15.5    15.2    15.2    16.0
TEMP   11   16.0    15.7    15.5    16.3    16.0    15.5    15.5    14.9    15.2
TEMP   12   15.7    17.5    16.0    15.5    15.2    12.9    12.0    13.5    14.3
TEMP   13   14.6    14.9    15.5    15.2    14.9    14.3    13.2    13.5    12.9
TEMP   14   12.0    11.2    12.0    12.3    12.9    13.5    14.0    14.0    13.5
TEMP   15   14.0    14.3    14.0    14.6    14.6    14.0    13.5    13.5    14.0
TEMP   16   12.6    12.6    12.9    13.5    13.0    13.0    13.0    13.0    13.0
TEMP   17   13.0    13.0    13.0    13.0    13.0    13.0    13.0    13.0    13.0
TEMP   18   13.0    13.0    13.0    13.0    13.0    13.0    13.0    13.0    13.0
TEMP   19   13.0    13.0    13.0    13.0    13.0    13.0    13.0    13.0    13.0
WQ TDS       168       3
TDS          23.     23.     24.     25.     26.     27.     28.     29.     30.
TDS          31.     33.     37.     38.     39.     39.     39.     40.     40.
TDS          41.     41.     41.     40.     40.     40.     40.
WQ SSOL      168       3
SSOL          2.      2.      2.      2.      2.       2      1.      1.      1.
SSOL          1.      1.      1.      2.      2.      2.      2.      2.      2.
SSOL          2.      2.      2.      1.      1.      1.      1.
```

APPENDIX G.
1991 GRANT RESERVOIR WATER TEMPERATURE PROFILES: CALIBRATION AND IN SITU

The in situ temperature profiles were collected at approximately biweekly intervals. The calibration profiles from THERM resulted from execution of the input data deck as shown in Appendix E. The following graphs are an enlarged duplicate of Figure 6-2.



Appendix G.
1991 Grant Reservoir Water Temperature Profiles: Calibration and In Situ

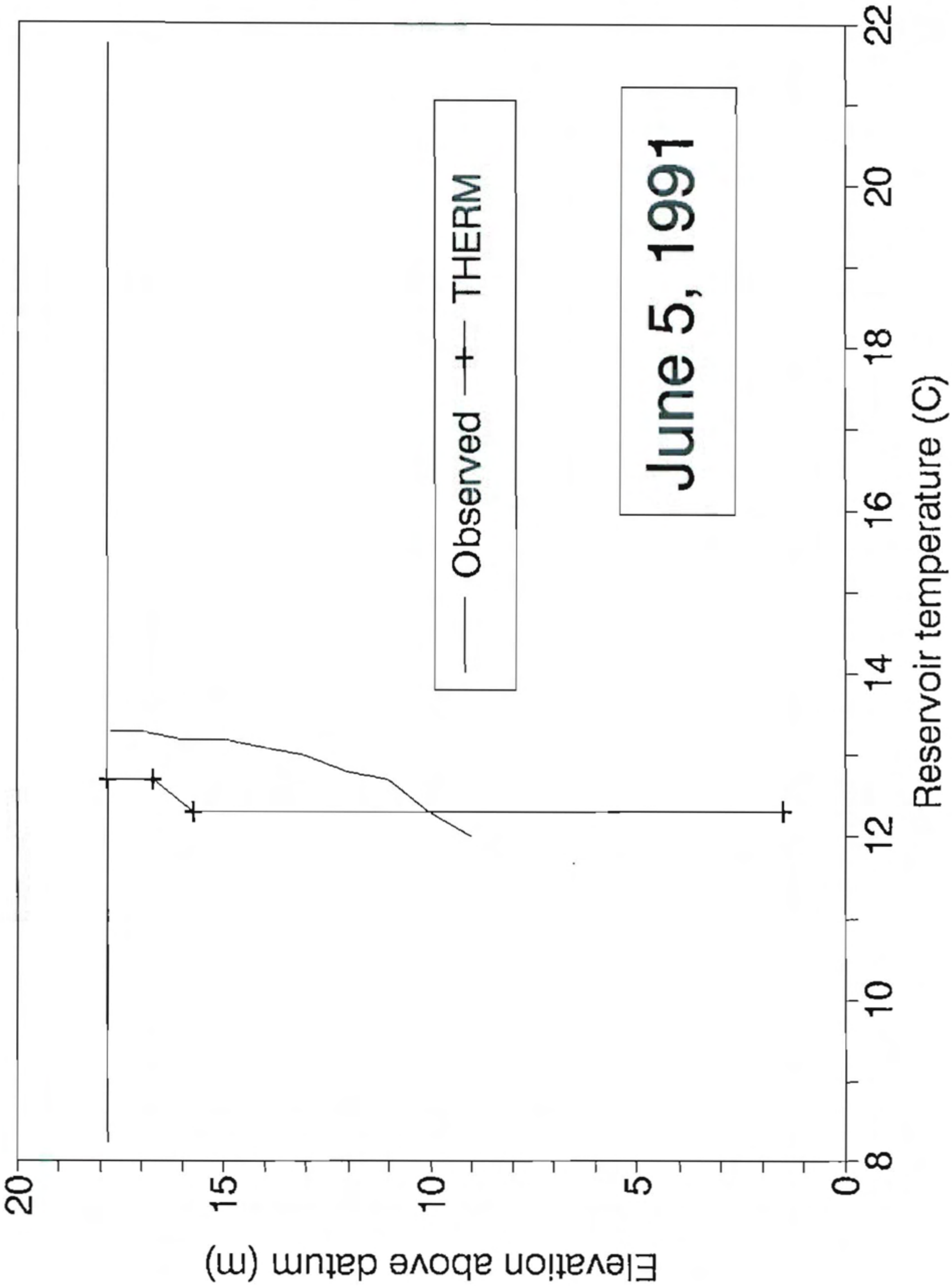


Figure G-1a. Grant Reservoir Water Temperature Profiles for 1991 (Calibration Year)

Appendix G.
1991 Grant Reservoir Water Temperature Profiles: Calibration and In Situ

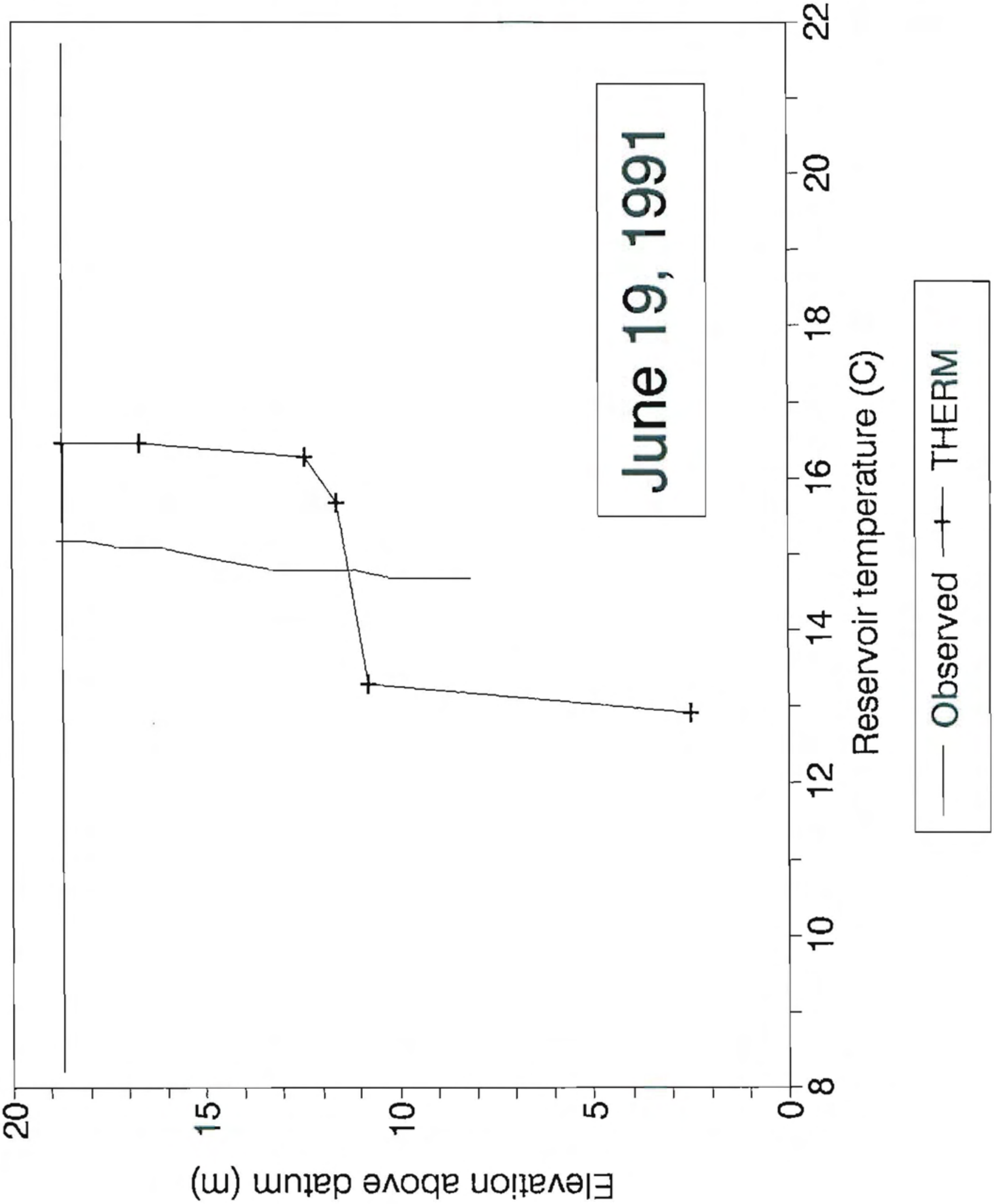


Figure G-1b. Grant Reservoir Water Temperature Profiles for 1991 (Calibration Year)

Appendix G.
1991 Grant Reservoir Water Temperature Profiles: Calibration and In Situ

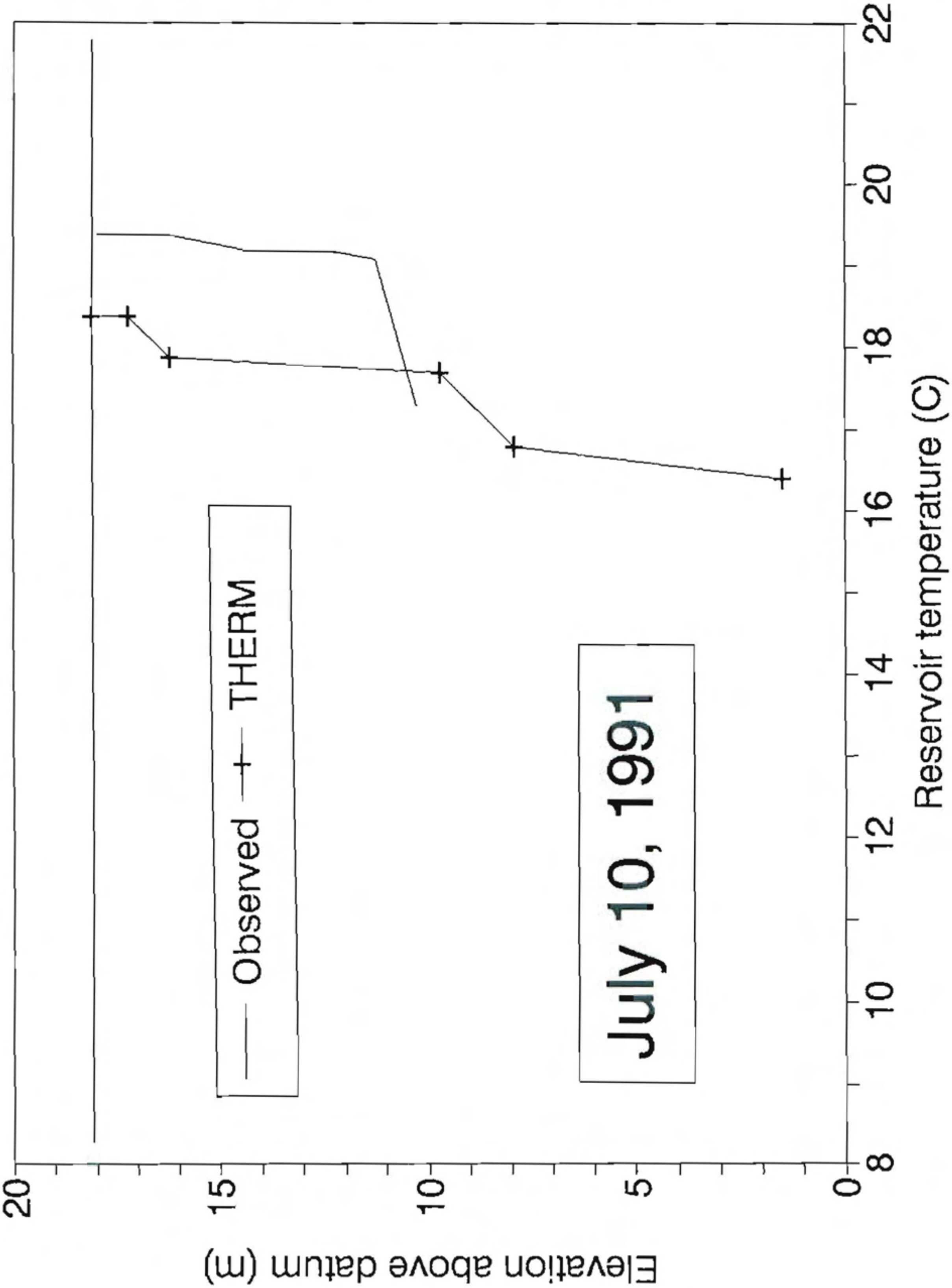


Figure G-1c. Grant Reservoir Water Temperature Profiles for 1991 (Calibration Year)

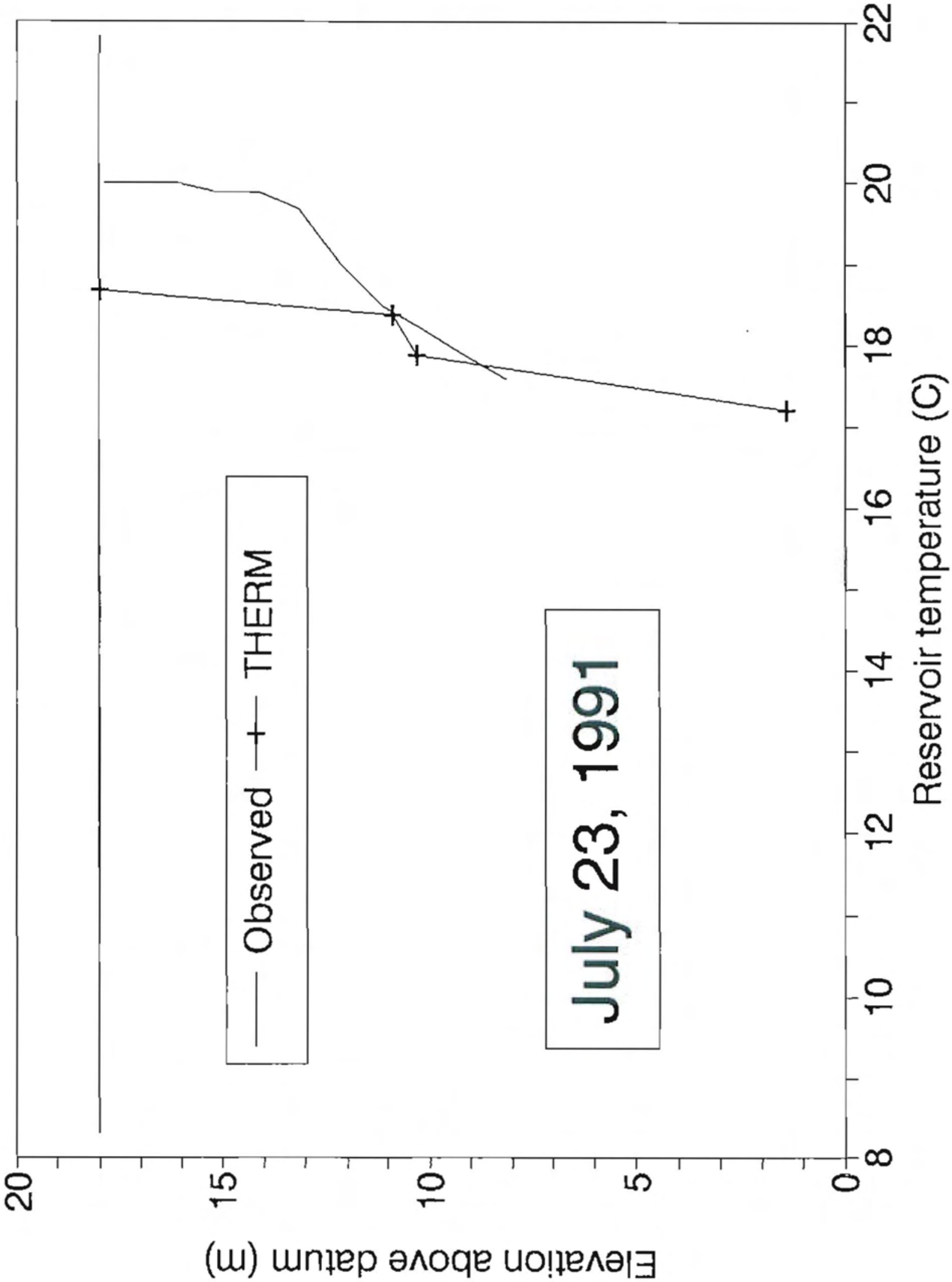


Figure G-1d. Grant Reservoir Water Temperature Profiles for 1991 (Calibration Year)

Appendix G.
1991 Grant Reservoir Water Temperature Profiles: Calibration and In Situ

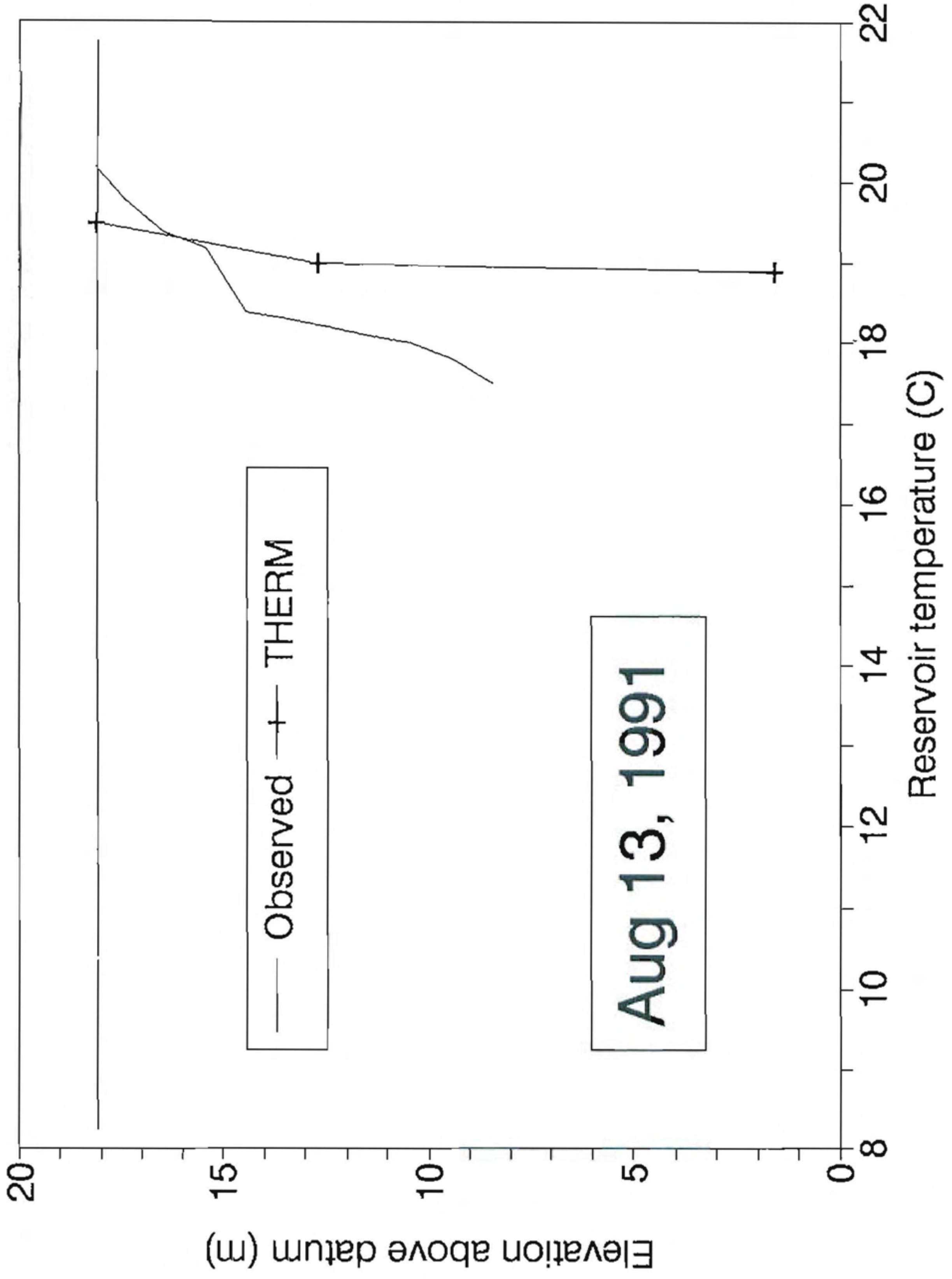


Figure G-1e. Grant Reservoir Water Temperature Profiles for 1991 (Calibration Year)

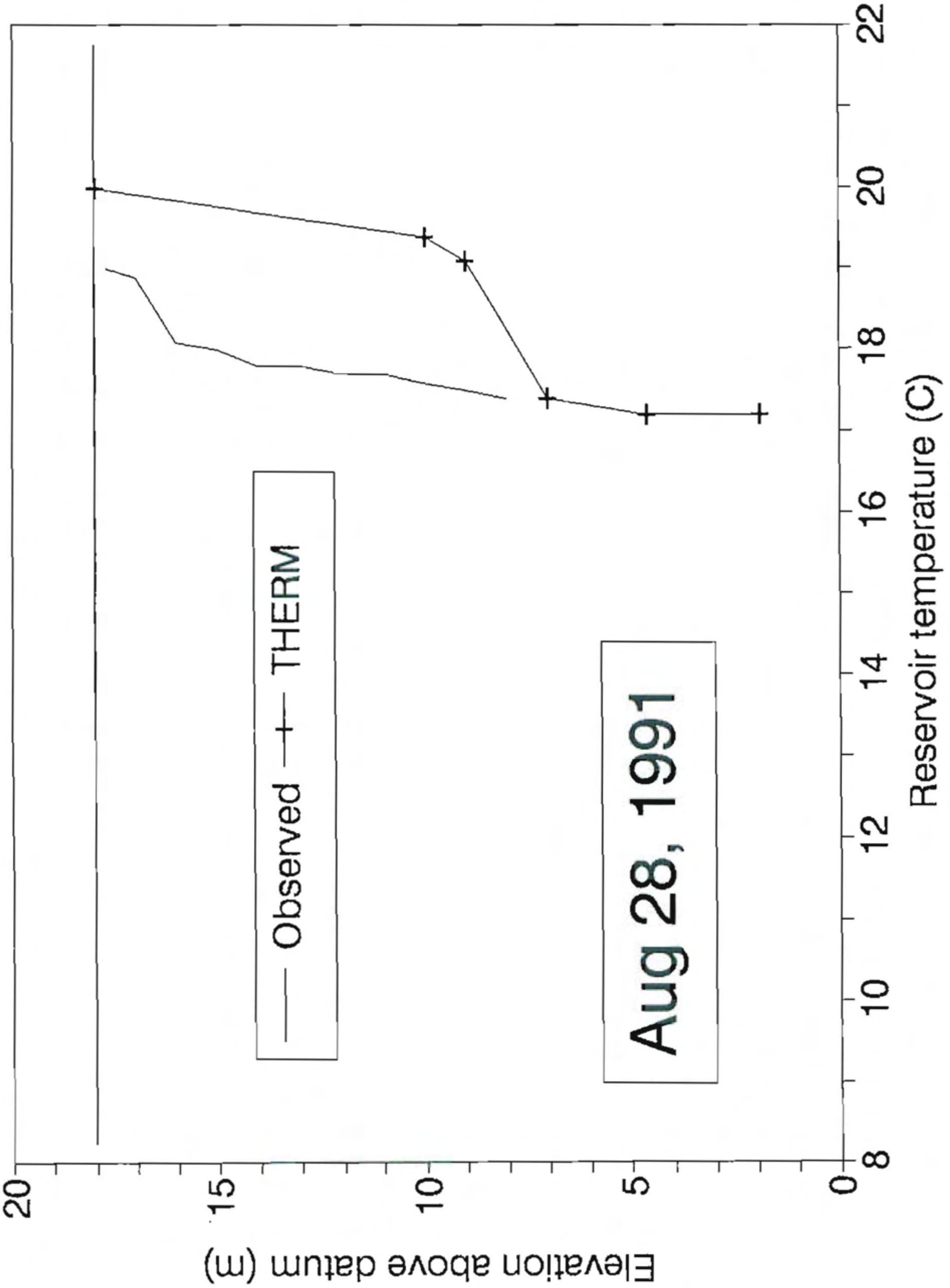


Figure G-1f. Grant Reservoir Water Temperature Profiles for 1991 (Calibration Year)

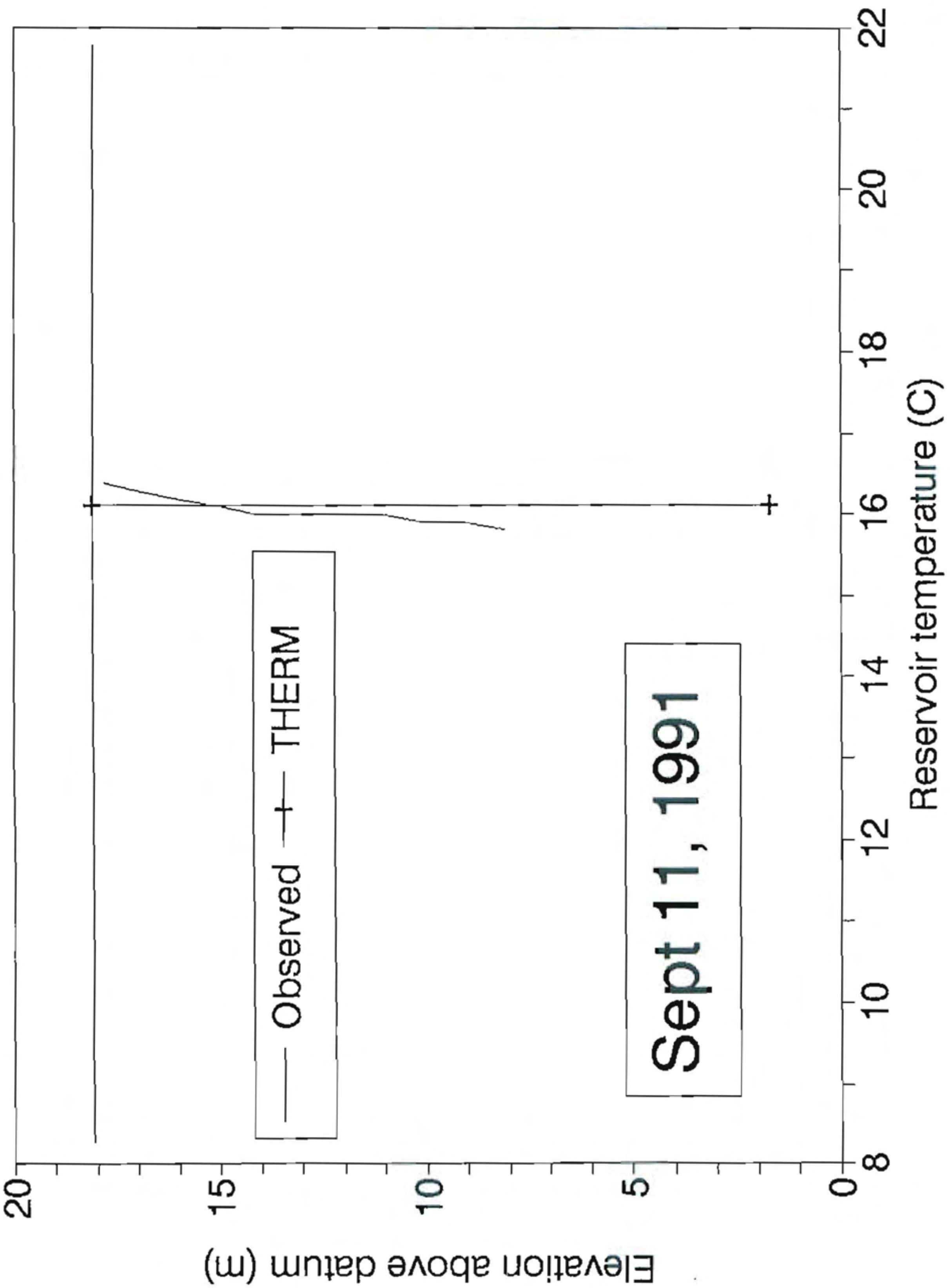


Figure G-1g. Grant Reservoir Water Temperature Profiles for 1991 (Calibration Year)

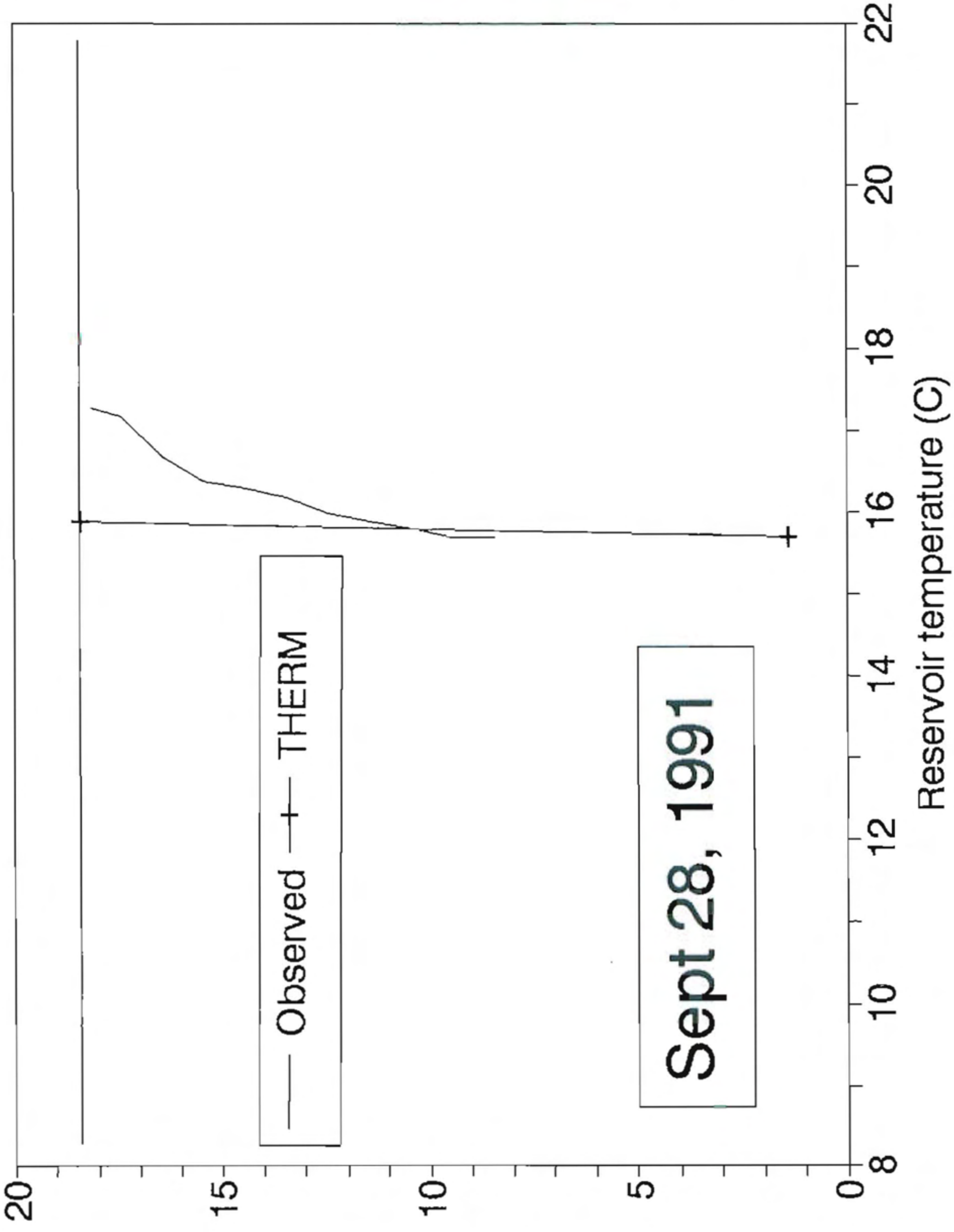


Figure G-1h. Grant Reservoir Water Temperature Profiles for 1991 (Calibration Year)

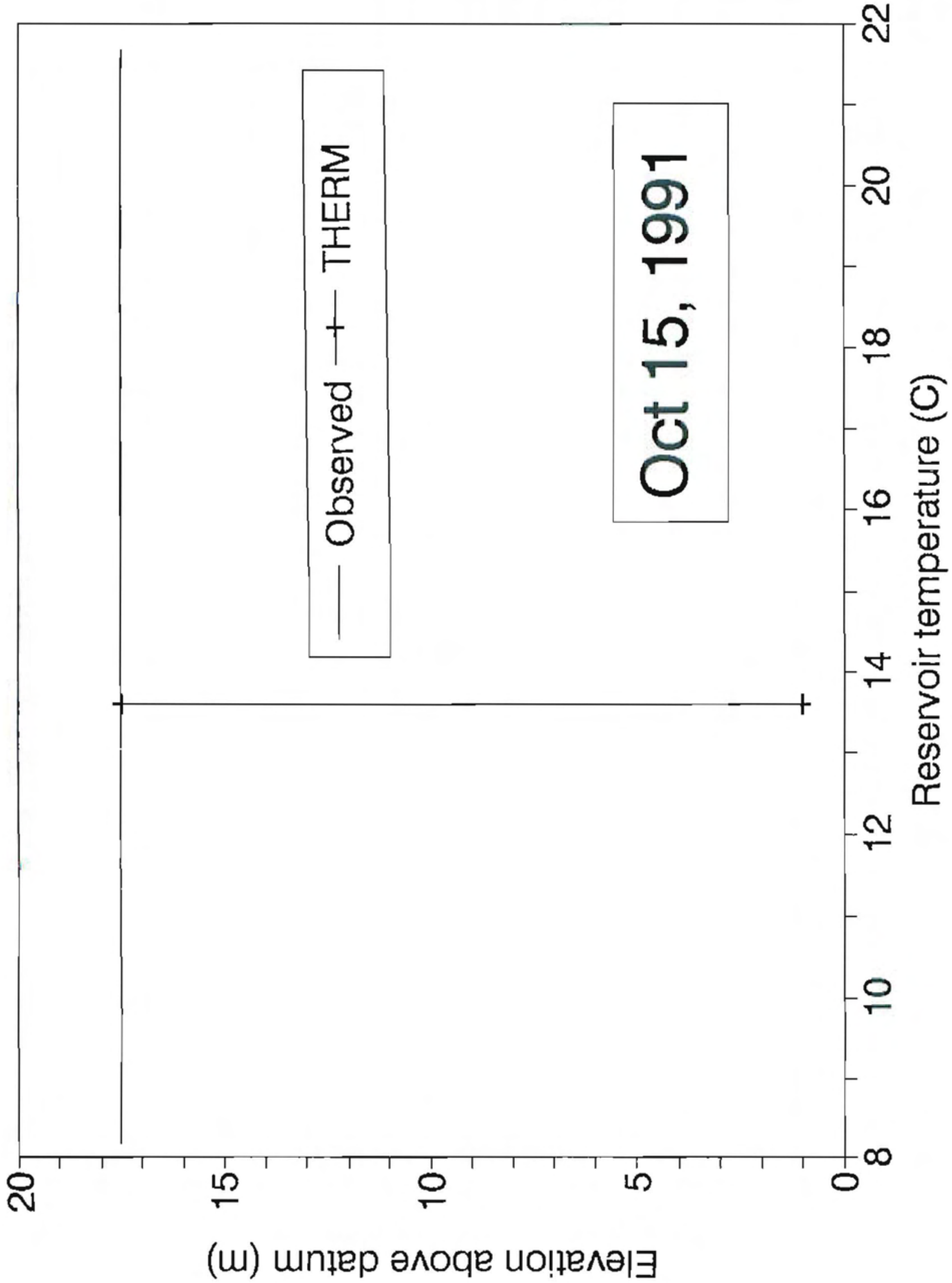


Figure G-1i. Grant Reservoir Water Temperature Profiles for 1991 (Calibration Year)