COMPLETION REPORT

PREDICTION OF HYDROTHERMAL REGIMES IN THE PROPOSED DARLINGTON RESERVOIR

by

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ABSTRACT

This research effort assesses the potential impact of the proposed Darlington Reservoir by addressing its predicted hydrothermal properties based on reservoir design, operation, and meteorological influences. The model CE-THERM-R1 is successfully calibrated to 1977 data for Okatibbee Lake, MS and is applied to the proposed reservoir for the summer stratification period during typical flow and reservoir operation. The projections of thermal stratification patterns within the Darlington Reservoir indicate that it will thermally stratify for approximately a four-month period. Downstream impacts must consider the effects arising from hypolimnetic waters being released during summer months. Operation of the reservoir and maintenance of downstream water quality (e.g. dissolved oxygen levels) may need to consider the biogeochemical processes that will occur in the reservoir, affecting the released bottom water quality.

ACKNOWLEDGEMENTS

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INTRODUCTION

The water quality of a reservoir greatly influences its range of potential resource uses. Prediction of water quality in future reservoirs is an important step in assessing the feasibility of meeting the planned objectives and potential uses for the system. An increasing environmental awareness has led to the use of water quality models to assess the effects of reservoir operation on both in-lake and downstream water quality (Martin et al., 1984; Effler et al., 1982).

The State of Louisiana has proposed the development of a flood control reservoir for the upper basin area of the Amite River. This reservoir, the Darlington Reservoir, is to be located north of Denham Springs, LA, at Darlington. The future reservoir development must address the water quality of the reservoir and its potential effects downstream due to water releases. Releases have the potential of a variety of impacts, depending on the operation and design of the reservoir and the location of the withdrawal port.

This research explores the potential impact of the proposed Darlington Reservoir by addressing its potential hydrothermal properties based on reservoir design, operation, and meteorological influences. The model CE-THERM-R1 is applied to the proposed reservoir for the summer stratification period during typical flows and reservoir operation.

A key part in any water quality modeling study is the accuracy of thermal stratification predictions. Thermal stratification is perhaps the most fundamental characteristic regulating the overall water quality of lentic systems (Wetzel, 1975). Stratification has a direct effect on reservoir water quality through mediation of biochemical processes, vertical transport of materials, and algal productivity. A water quality model must accurately simulate the dynamics of the thermal regime (e.g. onset of stratification, mixed layer depth, and turnover events) to provide accurate simulations of other water quality parameters (Johnson and Ford, 1981). Further, the temperature of water releases from the reservoir may be an important factor in assessing the impact of reservoir releases on downstream receiving waters. Additionally, the predictive capability of a stratification model may be used to assess the adequacy of a preliminary design, such as the location of drawoff ports and the various operational schemes for release to meet specific downstream water objectives (Owens, et al., 1985).

Models describing thermal stratification in lakes and reservoirs have been developed over the last 20 years and have reached a point where recent state-of-the-art models are applicable to a wide variety of systems (Harleman, 1982). One such model is the U.S. Army Corps of Engineers CE-THERM-R1 (Environmental Laboratory, 1982). This model has been demonstrated to be quite accurate in thermal stratification predictions by Johnson and Ford (1981). They were successful in applying the model to two Arkansas lakes (DeGray and Greeson), both of which are multipurpose reservoirs used for hydropower, flood control and recreation. This same model was used by Owens et al. (1985) to predict extremes in thermal stratification in a future flow augmentation reservoir in northern New Jersey.

RESERVOIR DESCRIPTION

The Darlington Reservoir is proposed to be located in the Parishes of East Feliciana and St. Helena on the Amite River, as shown in Figure 1. The Amite River is included in the Louisiana Natural and Scenic Rivers System. A summary of the reservoir's hydraulic features and pool elevations are presented in Tables 1 and 2, respectively. A more thorough documentation of the reservoir design and hydraulic characteristics are being prepared for the Office of Public Works, Louisiana Department of Transportation and Development (LADOTD), but are not available at the time of this writing. Conversations with the Office of Public Works (Lee, 1986) indicate that the reservoir will be operated at the 180.0 ft pool elevation as shown in Figure 2, with six 11'x11' concrete box conduits having invert elevations of 120.0' m.s.l. Anticipated discharges range from a minimum of 300 cfs to a maximum of 18,000 - 20,000 cfs. The drainage area of the reservoir will be 692 square miles.

The primary function of the proposed Darlington Reservoir is to reduce the flooding potential in the Amite River Basin south of the proposed earthen dam and to provide for water-related recreational activities (U.S. Army Corps of Engineers, 1986). The anticipated benefits of the dam include more than $136 million in damage reduction for the design flood (1983 flood).

MODEL DESCRIPTION

The U.S. Army Corps of Engineers has developed a one-dimensional thermal stratification model, CE-THERM-R1, which has been adopted for the stratification analysis of the Darlington

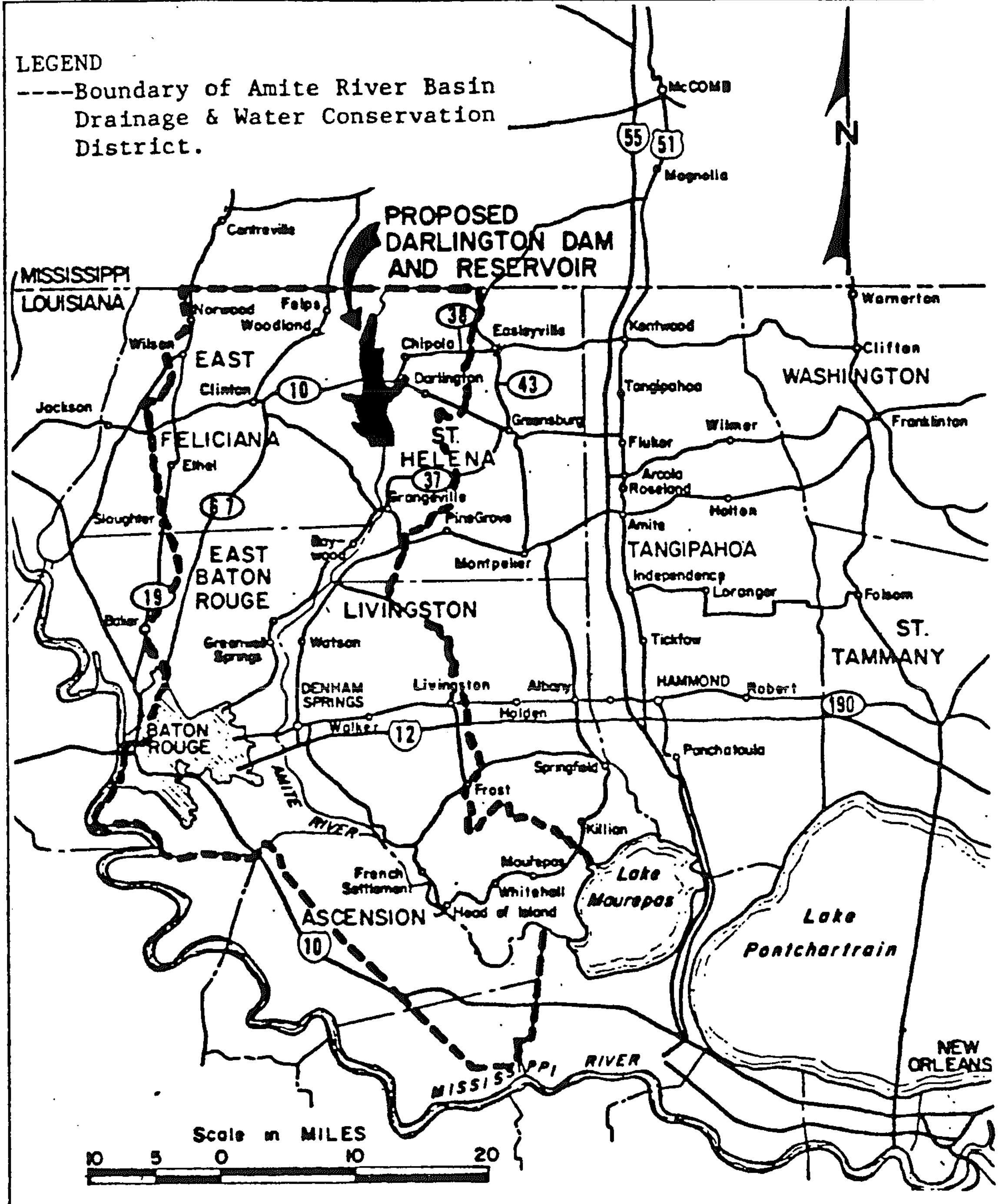


FIGURE 1. VICINITY MAP

PROPOSED
AMITE RIVER RESERVOIR

PROPOSED DAM AND RESERVOIR

on AMITE RIVER

Parish of EAST FELICIANA AND ST. HELENA

(from US Army Corps, 1986)

TABLE 1. SUMMARY OF HYDRAULIC FEATURES

DARLINGTON RESERVOIR

Dam:

Type: Earthfill
Length: → 19,550 Feet at the crest
Crest: Elevation 200.0 m.s.l.
Top Width: 25 feet
Fill Volume: 7,670,000 cubic yards

Spillway:

Location: Just east of river channel
Type: Gate controlled, gravity concrete, ogee weir section
Length: 90 feet (net opening)
Gates: Three 30 x 71-foot tainter gates
Sill: Elevation 120.0 m.s.l.

Outlet Works:

Location: Just east of river channel
Type: Gate-controlled conduits
Dimensions: One 10-foot by 10-foot box conduit
Invert Elevation: 120.0 m.s.l.
Length of Conduit: 540 feet
Capacity: At normal pool (Elevation 180.0): 4,450 c.f.s.
At maximum surcharge pool (Elevation 192): 5,100 c.f.s.
Turbine Generator: Operating range 200-2,000 c.f.s.

Design Floods:	Probable Maximum Flood	Reservoir Design Flood
Duration of storm, hour	48	32
Depth of rainfall, inches	30.1	10.3
Average infiltration, inches/hour	0.18	0.04
Inflow to reservoir, inches	21.7	9.14
Inflow to reservoir, acre-feet	796,000	335,400
Peak inflow to reservoir, c.f.s.	365,000	64,300
Reservoir elevation at start m.s.l.	165.0	170.0

Routing of Design Floods:

Probable Maximum Flood:	
Pool elevation at start	170.0
Maximum water surface elevation	192
Peak discharge, c.f.s.	166,400
Storage required, acre-feet	361,000

Design Flood (1983 Flood):	
Pool elevation at start	170.0
Maximum water surface elevation	184.9
Peak discharge, c.f.s.	9,300
Storage required, acre-feet	222,000

(from US Army Corps, 1986)

TABLE 2

Summary of Reservoir Pool Elevations: Darlington Reservoir

Elevation	Description
200	Top of dam
192	Maximum allowable water surface (approached only by probable maximum flood)
184.9	Design storm surcharge elevation (1983 Flood)
180	Normal pool elevation - maximum (June through November)
170	Normal pool elevation - minimum (December through May)
155.0	Conservation pool elevation (Water level to which surface may be drawn to maintain hydroelectric power generation during extended dry periods)
150.0	Minimum power pool elevation (elevation for rated head of hydroelectric turbine)
125	Turbine intake elevation (centerline)
118	Normal tailwater elevation (approximate)
114	Channel invert elevation (approximate)

Reservoir Features:

Feature	Elevation Ft. m.s.l.	Surface Area Acres	(Storage Capacity) Acre-feet	Runoff Inches	Total Storage Acre-Feet
Top of dam	200.0	23,000	-------	----	747,000
Maximum water surface:					
Probable maximum flood	192.0	19,500	392,000**	10.7	559,000
Reservoir design flood	184.9	17,200	222,000***	6.1	443,000
Maximum normal pool	180.0	15,300	298,000	8.1	361,000
Minimum normal pool	170.0	11,500	158,000	4.3	221,000
Spillway crest	155.0	6,200	30,000	0.8	93,000
Minimum power pool	150.0	4,800	-------	----	63,000
Outlet conduit invert	130.0	500	-------	----	2,500
River channel bed	114.3	------	-------	----	-------

Flood Reduction:

Flood Event	Design Flood (1983 Flood)
Dam Site	7.3 feet
Denham Springs	6.6 feet
Damage Reduction	More than $136 million

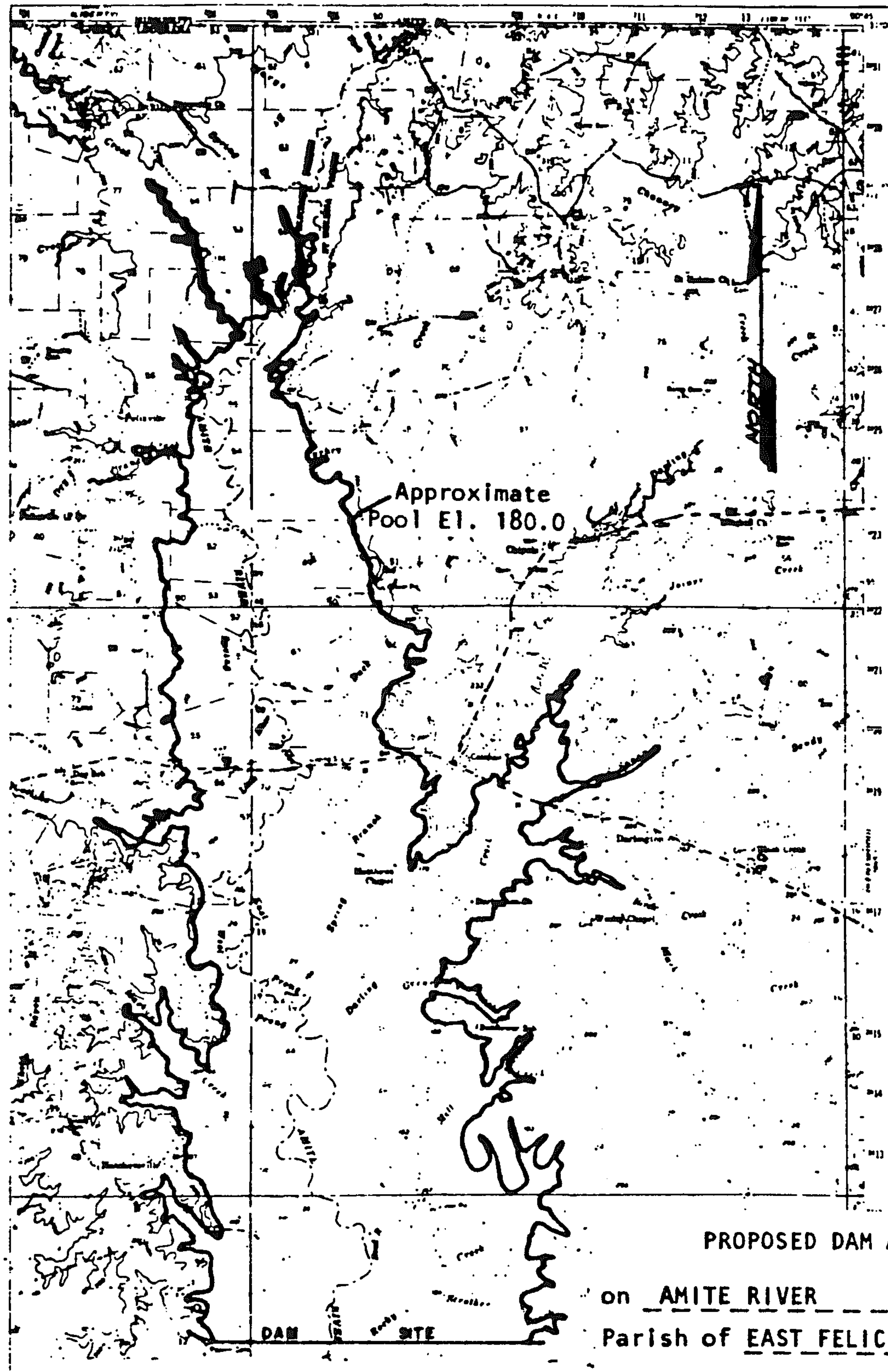
NOTES:

All data, including dam, spillway, outlet works, pool elevation, etc. is based on "Conceptua Stage Engineering and Economic Feasibility Report" by Louisiana Department of Transportation and Development, Office of Public Works, January, 1984, and is subject to change as project is further developed and additional studies are made.

Above reservoir level at start of event (elevation 165.0)

Above reservoir level at start of event (elevation 170.0)

(from US Army Corps, 1986)



NOTE:
AMITE RIVER
DAM LOCATION
(RIVER MILE 97.2)

PROPOSED DAM AND RESERVOIR

on AMITE RIVER

Parish of EAST FELICIANA AND ST. HELENA

FIGURE 2. LOCATION MAP

(from US Army Corps, 1986)

Reservoir. Based on computations of the densimetric Froude Number, it can be demonstrated that the application of the one-dimensional model is sufficient for the Darlington Reservoir.

CE-THERM-R1, a submodel of CE-QUAL-R1, simulates temperature, dissolved solids and suspended solids in reservoirs. This state-of-the-art model, described in detail in the user's manual (Environmental Laboratory, 1982), has the following features:

1. The model is one-dimensional with variations in the vertical direction considered only,
2. An integral energy approach is used in computing the effects of wind and convective cooling during formation of an upper mixed layer,
3. Calculation of the turbulent diffusivity below the upper mixed layer is based on wind, inflow and outflow rates, and
4. The model uses variable thickness layers in handling inflows and outflows at various depths.

CE-THERM-R1 has the capability to simulate inflow from two tributaries. Location of the inflow is determined by comparison of inflow density with the density of each layer. Withdrawals from the the reservoir can be simulated through as many as eight selective withdrawal ports and/or flood gates. The outflow can be specified for each individual port, or outflows and port operations required to meet at specific downstream temperature objective can determined by the model.

The model includes both entrainment and diffusion as mixing processes. Entrainment, a one-way advective process that sharpens gradients, is the process by which energy supplied by wind shear and convection deepens the upper mixed layer.

Diffusion, a two-way dispersive process by which gradients are always reduced, results from the combined effects of inflows, outflows, wind generated currents, turbulence, waves, etc. (Johnson and Ford, 1981).

DATA REQUIREMENTS

The CE-THERM-R1 model needs an extensive and detailed data set for its execution. For reservoirs not yet in existence, no data base is available to assess the accuracy and precision of the model predictions. Therefore, a surrogate reservoir system with similar characteristics and a sufficient data base is needed to test the model's ability to simulate the reservoir correctly. A major portion of the effort for this study was expended to obtain a good data set to calibrate and test the model. Given below is the list of data required for the model and the sources from which it was compiled for both the surrogate reservoir and proposed Darlington Reservoir systems:

1. Meteorological data recorded at the Baton Rouge, LA station (28 miles from the Darlington Reservoir site) were obtained from the National Weather Service. A computer program was written to convert the hourly average data to daily averages output in the format required by the model. Meteorological parameters needed by the model are:

    - cloud cover
    - dry bulb temperature
    - dew point temperature
    - air pressure
    - wind speed

2. Physical characteristics of the surrogate system, Okatibbee Lake, near Meridian, MS, were obtained from the U.S. Army Corps

of Engineers, Mobile, AL; characteristics for the proposed Darlington Reservoir were obtained from the Office of Public Works, LADOTD, including:

- number, elevation and area of outlet ports
- cross-section of the reservoir
- area-capacity curves
- length of major axis of the reservoir

3. The water quantity and quality information on Okatibbee Lake was obtained from the U.S. Army Corps of Engineers and a postimpoundment study by Theta Analysis, Inc. (1984) including:

   - daily average outflow
   - daily average stage heights of the lake
   - water quality of the lake sampled once every month
   - water quality of the tributaries sampled once every two months

   A weighted average based on the size of the drainage basin of the water quality of the tributaries was computed and fed to the model for Okatibbee Lake calibration runs. CE-THERM-R1 was used to calculate the pan evaporation rates from the meteorological data; the total inflow to the Okatibbee Lake was computed using the formula:

   $$\text{INFLOW} = (Hi - Hf) * A + PER * A * TIME + OUTFLOW$$

   where Hi is the initial stage height
   Hf is the final stage height
   A is the surface area of the lake
   PER is the pan evaporation rate

   Water quantity data for the Darlington Reservoir were obtained from U.S. Geological Survey records, including the daily average inflow and monthly water quality data on the inflowing tributary (Amite River). Water quality of the Darlington Reservoir was estimated to be similar to that of the Okatibbee Lake on initialization of the model runs, based on the assumption that as near to winter turnover conditions as possible would be the mostly likely time period for water quality (suspended and dissolved solids) similarity between the two reservoirs.

4. CE-THERM-R1 requires the determination of several model coefficients. The sheltering coefficient was estimated from the topographic map of the site of each reservoir; the settling rate of suspended solids and the self shading coefficient of suspended solids were obtained from recommended values in the CE-THERM-R1 user's manual (Environmental Laboratory, 1982). The extinction coefficient for solar radiation was calculated from Secchi disk depth measurements using the relationship presented by Field and Effler (1983).

The model input format, Okatibbee Lake input data set for calibration, and input data set for simulation of the Darlington Reservoir are included in Appendix I. Due to volume of output generated, model projections for calibration and simulation are presented in a separate volume.

MODEL CALIBRATION

By calibrating the model to the data base available for Okatibbee Lake the values of several system-specified model coefficients were optimized. This system was chosen because of its similarity to the proposed Darlington Reservoir in the following ways:

1. The two systems are located relatively close to each other (approximately 150 miles apart) in the same geographical region near the Gulf of Mexico, therefore

having similar weather conditions

2. The two systems have similar pool depths and other morphometric features, and

3. Both reservoirs are intended for flood protection, flow augmentation and a variety of recreational activities.

The calibration of CE-THERM-R1 for Okatibbee Lake was accomplished using measured temperature data documented in a postimpoundment study for the year 1977 (Theta Analysis, Inc. 1984); meteorological data available from the National Weather Service for Baton Rouge, LA; and reservoir operation characteristics available from U.S. Army Corps of Engineer records. The results of the calibration are presented in Figure 3 for four selected dates, comparing the model projections to observed thermal profiles in the reservoir. Entrainment coefficients for the penetrative convection fraction of solar radiation and the wind coefficients were adjusted to fine-tune the model.

After calibration the model successfully predicted the general trends exhibited in the 1977 data base. Temperature profiles in the observed data base for June and September were simulated very well by the model; the July and August observed data reflected a lesser degree of stratification (stability) than the model predicted. The mid-summer differences between the observed and predicted thermal structure of the reservoir may be reflected in the model not accounting for increased mixing events. It is suspected that the weather data from Baton Rouge, LA (approximately 175 miles away) may have failed to account for the effects of localized thunderstorms common to the Gulf region which could contribute to the reservoir mixing. However, the

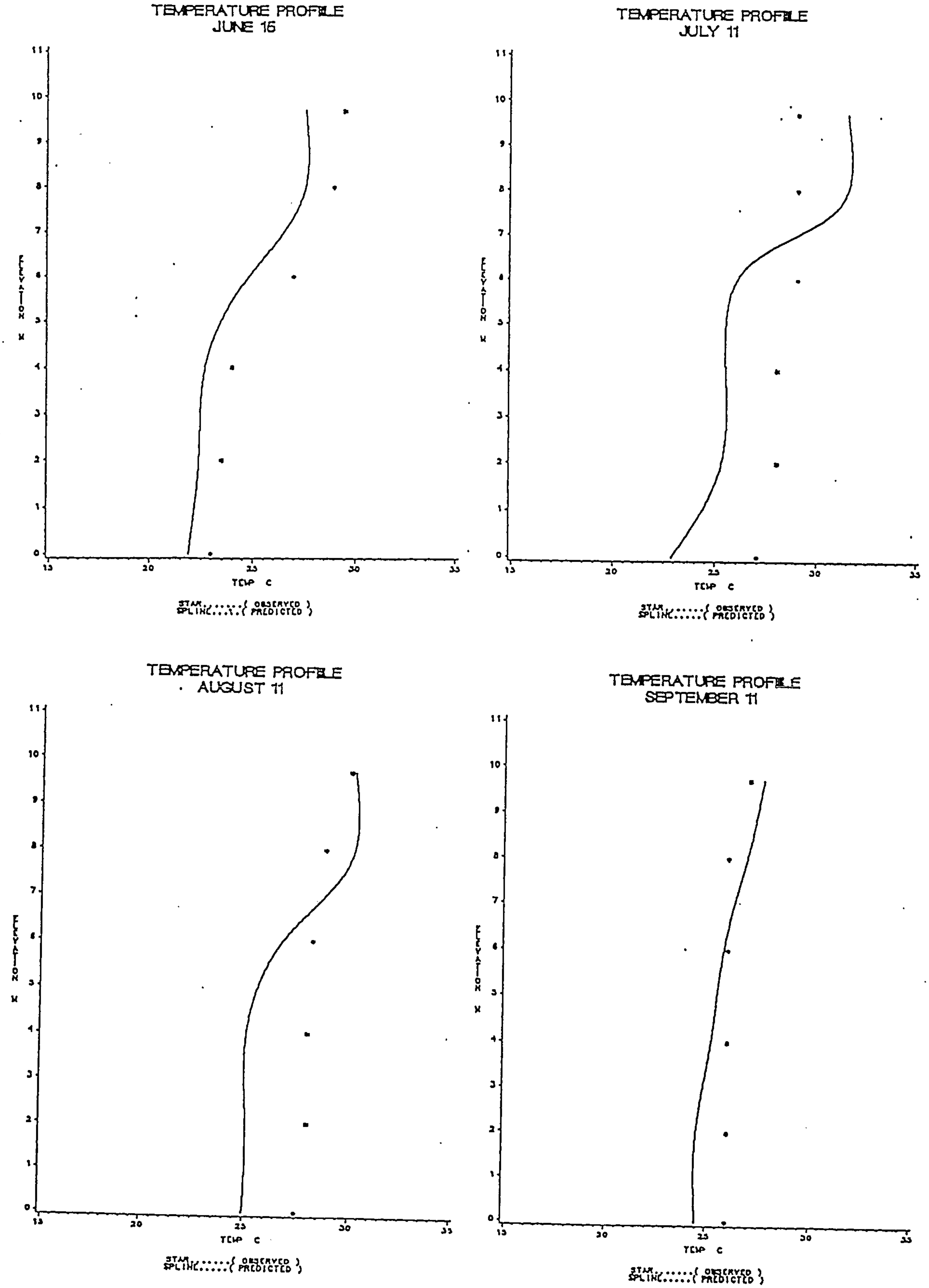


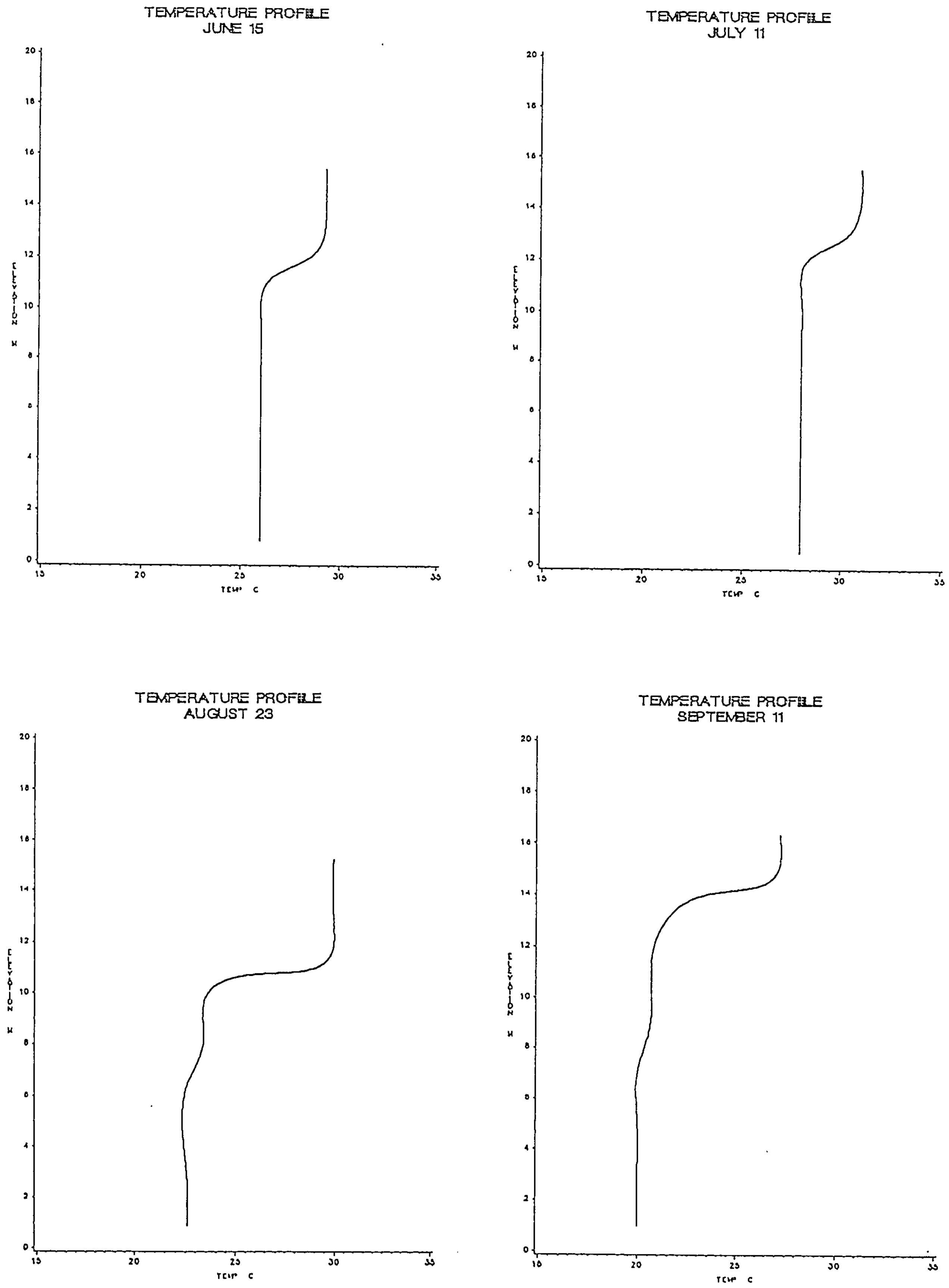
FIGURE 3. Model Calibration - Okatibbee Lake 1977 Thermal Profiles

overall performance of the calibration for the 1977 summer period is considered to be very good. Based on this performance it was assumed that the model together with coefficient values determined for Okatibbee Lake was applicable to the Darlington Reservoir.

MODEL APPLICATION TO THE DARLINGTON RESERVOIR

CE-THERM-R1 was applied to the data base developed for the proposed Darlington Reservior using a 1-day computational time step. This required daily averaging of the hourly weather data to be consistent. The model projections were run for the period May 28, 1977 to December 31, 1977. U.S. Geological Survey guage station discharge measurements at Amite River near Darlington indicate that 1977 was near average for flows in the watershed at this location. Simulations were limited to this time period based on limited calibration data available.

The thermal profiles projected by the model for four selected dates for the Darlington Reservoir are presented in Figure 4. The reservoir is projected to stratify in late spring and maintain stratification into September. Although not shown in Figure 4, by October 19th the reservoir reaches isothermal conditions top to bottom at 18 degrees Celsius. Temprary stratification does occur during warm periods in October and November. Mixed layer depths of 3 to 10 meters (16 - 30 feet) and metalimnetic thicknesses of 1-3 meters are predicted. The maximum temperatures of the surface waters are near 30 degrees Celsius with hypolimnetic maxima near 27 degrees Celsius.


TEMPERATURE PROFILE JUNE 15

TEMPERATURE PROFILE JULY 11

TEMPERATURE PROFILE AUGUST 23

TEMPERATURE PROFILE SEPTEMBER 11

FIGURE 4. Model Projection - Darlington Reservior 1977 Thermal Profiles.

DISCUSSION

The projections obtained for thermal stratification of the Darlington Reservoir are reflective of typical summer stratification of lakes in the region. Therefore, the proposed Darlington Reservoir will be subject to discharging hypolimnetic waters for approximately a four-month period during a "typical" summer. This time period may be sufficient for organic material buildup in the hypolimnion of the reservoir in levels high enough to produce low dissolved oxygen levels in the discharge. This scenerio depends on watershed wasteloads and and nutrient input to the reservoir; these control the biochemical processes affecting the trophic status and resultant water quality of the system. Establishment of the anticipated degree of eutrophy and resultant water quality of the reservoir, and subsequent downstream effects of the reservoir discharge requires additional study.

Since the model was successfully calibrated to only one season of data for a similar system, it is uncertain as to the accuracy of the model to simulate the characteristics of the reservoir during different climatic events. Similarly, to be used for detailed reservoir design and operational analysis purposes, the model should be verified using one or more additional seasons of data on the same or similar reservoirs and a wide range of climatic events. This verification would assure that system-specific model coefficients are properly adjusted to accurately simulate a wide range of conditions. Unfortunately, such data bases have not yet been found in the Gulf Coast region where similar climatic influences can be verified. Therefore, a detailed analysis of the reservoir characteristics and behavior during various weather conditions was not justified.

RECOMMENDATIONS

This study has completed the initial steps towards establishment of a hydrothermal model to assess the design and operation of the proposed Darlington Reservoir. The model CE-THERM-R1 has been successfully calibrated to only one season's data on a reservoir similar to the proposed Darlington Reservoir. Further data base development on similar reservoirs is recommended to develop a basis to verify the model's capabilities to predict a range of events. The data base development should include the monitoring of thermal and dissolved oxygen profiles, suspended and dissolved solids, light extinction, and chlorophyll a. Nutrients, N and P, are not necessary for the thermal model but may be included for future water quality work. This would enable the use of CE-THERM-R1 as well as other models in a detailed engineering assessment of this and other proposed reservoirs and their potential water quality and downstream impacts. This study has completed the initial steps towards establishment of a hydrothermal model to assess the design and operation of the proposed Darlington Reservoir.

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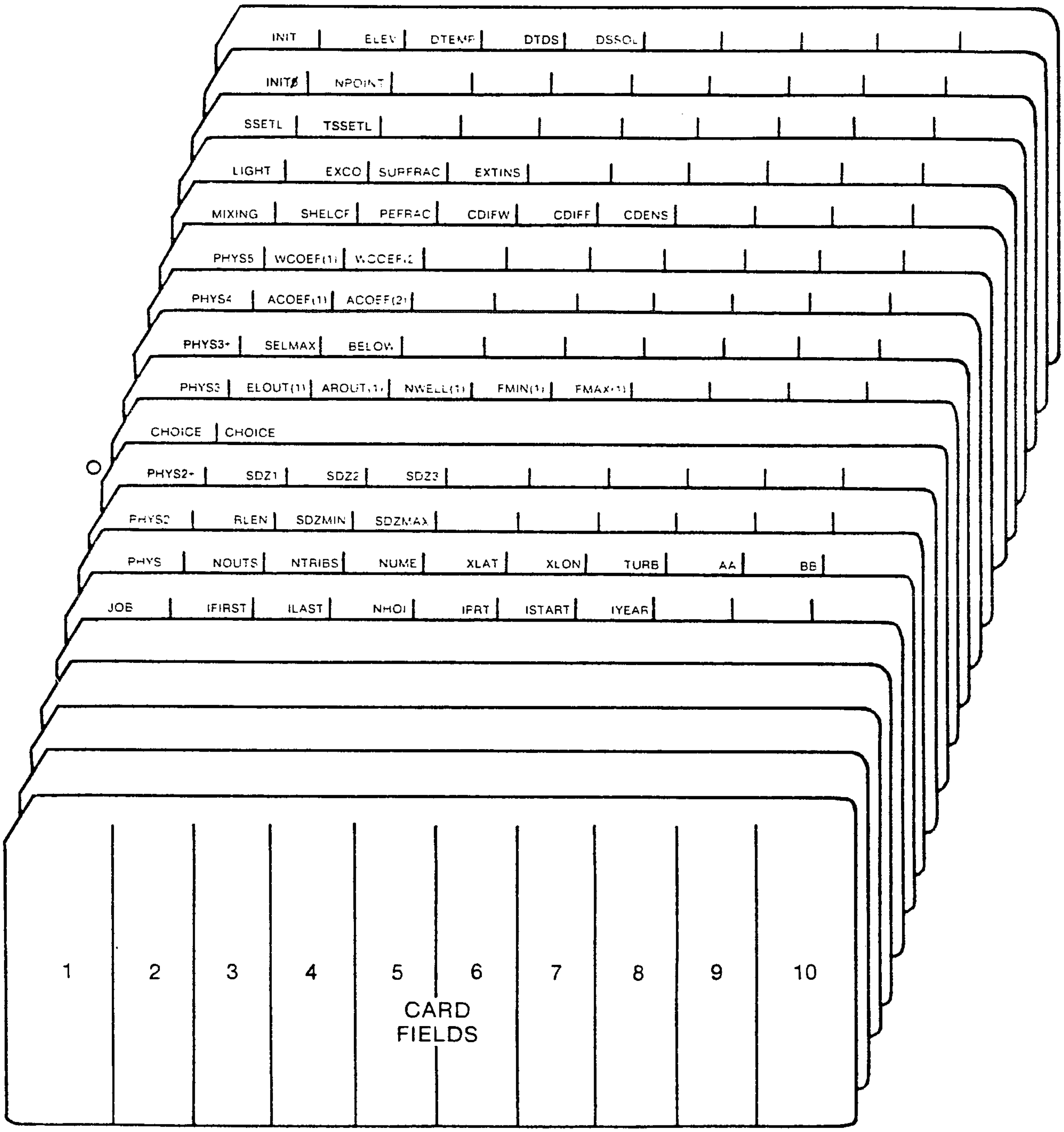
APPENDIX I

MODEL INPUT DATA

1

SUMMARY OF INPUT CARDS



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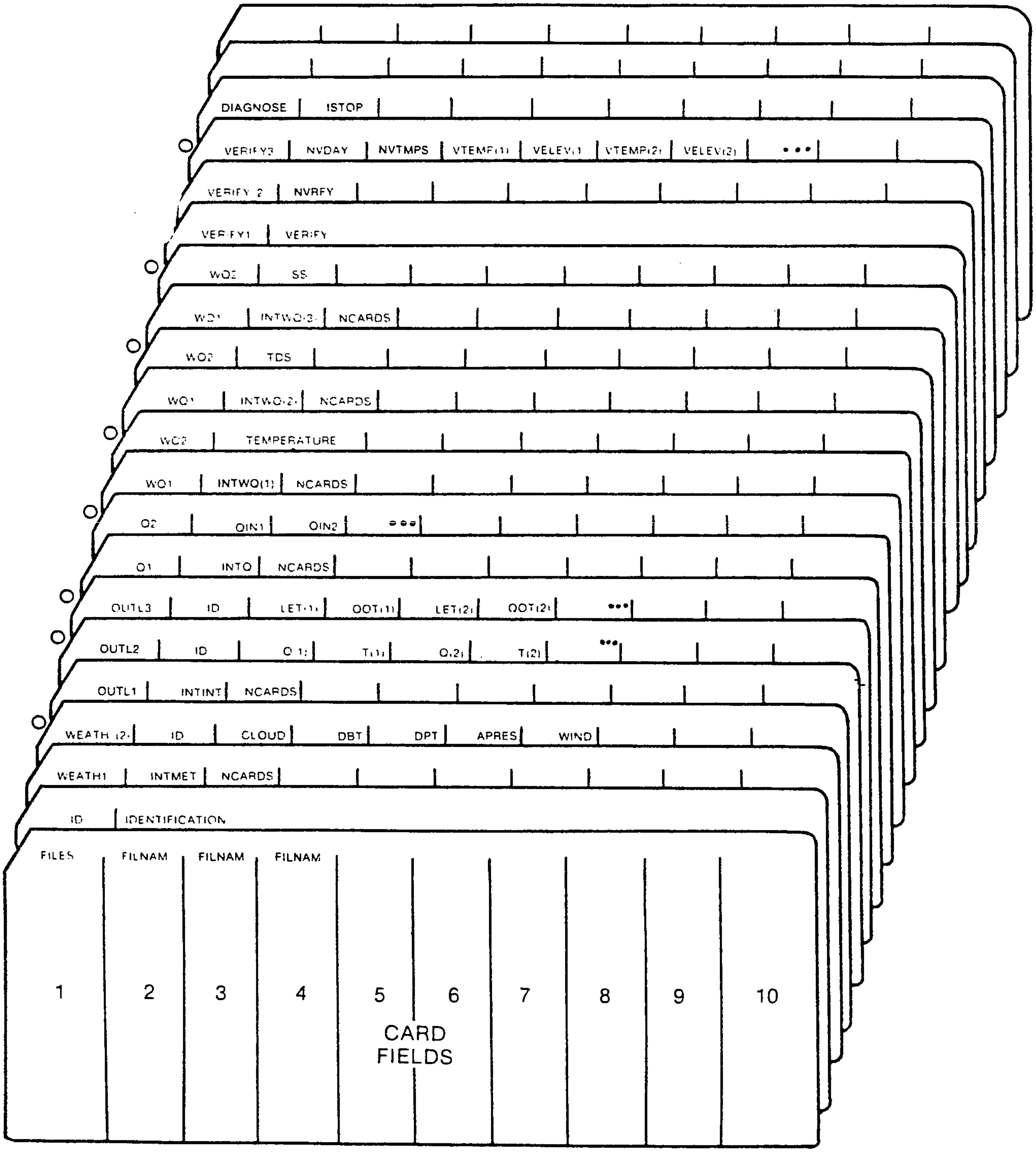

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HYS2+           1.0
HOICE    SPECIFIED
HYS3.1         1.37     5.C4
HYS4        50119.0     2.51
HYS5           28.5     1.61
XING           0.01     C.5C    0.001     C.001      0.5
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SETL            0.1
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HIT1            6.5     24.8      20.        6.
HIT1            8.5     27.0      44.       14.
HIT1           10.0     28.8      22.        8.
LES     BLTZ03   BLTZ04   BLTZ11   BLTZ12
)       HORRS DEBLER INFLOW ALGCRITHM
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ATHER 770627            0.25     28.79     20.92 1013.42          016
ATHER 770628            C.35     27.93     21.91 1014.10          008
ATHER 770629            C.43     29.37     22.45 1014.78          011
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ATHER 770704          0.30    28.56    20.30 1017.15       007
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ATHER 770706          0.10    28.19    20.04 1014.78       006
ATHER 770707          0.18    29.02    21.06 1013.09       007
ATHER 770708          0.30    28.56    21.47 1014.44       008
ATHER 770709          0.67    25.52    21.89 1016.13       006
ATHER 770710          0.81    25.27    20.69 1016.47       007
ATHER 770711          0.67    25.30    21.27 1016.81       008
ATHER 770712          0.67    26.89    22.24 1017.15       003
ATHER 770713          0.40    26.03    21.75 1017.83       006
ATHER 770714          0.21    28.10    20.85 1017.15       006
ATHER 770715          0.63    27.70    20.52 1016.47       010
ATHER 770716          0.30    27.08    20.20 1016.47       010
ATHER 770717          0.22    27.38    21.27 1015.80       008
ATHER 770718          0.54    26.85    21.47 1014.44       007
ATHER 770719          0.47    27.24    21.91 1013.76       007
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ATHER 770721          0.62    27.10    22.17 1015.80       006
ATHER 770722          0.54    28.49    23.07 1015.12       005
ATHER 770723          0.37    28.79    23.47 1014.44       006
ATHER 770724          0.30    28.86    23.33 1013.76       007
ATHER 770725          0.44    29.11    22.93 1013.42       007
ATHER 770726          0.82    26.98    22.75 1013.76       007
ATHER 770727          0.68    27.42    22.33 1013.09       006
ATHER 770728          0.57    27.86    22.80 1014.10       004
ATHER 770729          0.55    27.58    23.79 1015.12       006
ATHER 770730          0.33    28.88    23.26 1014.10       011
ATHER 770731          0.18    29.58    23.14 1013.09       011
ATHER 770801          0.50    27.84    23.26 1013.42       011
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UTFLOW       253       1    2.84
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NFLCW       2.50    3.44    3.24    2.75    2.02    1.59    1.96   10.84    7.32
NFLOW       3.24    3.04    2.50    1.65    2.50    2.98    2.39    1.76    1.62
NFLOW       2.61    2.95    0.43    0.91    1.96    1.96    1.62    2.13    4.91
NFLOW       4.71    4.03    3.32    2.13    2.30    1.96    1.96    2.27    3.83
NFLOW       3.12    2.78    2.78    2.30    2.44    7.44    4.99    2.30    2.44
NFLOW       2.61    4.00    9.17    7.44    4.74    3.78    4.06    3.24    2.78
NFLCW       2.44    1.59    1.45    1.28    0.97    1.68    1.96    0.65    0.68
NFLCW       1.11    0.97    0.82    3.04    1.90    0.82    0.82    1.53    1.33
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NFLOW       1.90    0.00    0.31    0.62    6.21   19.35   17.79    7.21    3.40
NFLOW       2.98    1.93    2.10
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Q2  TDS      90.     45.
Q1          2160       1
Q2    SS     20.      8.
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HYS2       10000.      0.5       2.0
HYS2+        1.0       1.0       1.0       1.0       1.0       1.0      1.0      1.0      1.0
HYS2+        1.0       1.0       1.0       1.0       1.0
HOICE    SPECIFIED
HYS3.1      1.65     67.66
HYS4         3.5      5.68
HYS5       18.75      2.12
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IGHT         0.9      0.55       0.1
SSE IL       0.1
NIT0          14
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EATHER 780510         0.13     23.10     15.06 1017.49        010
EATHER 780511         C.77     23.23     17.93 1016.13        016
EATHER 780512         0.90     24.90     21.33 1013.09        018
EATHER 780513         0.13     24.65     16.15 1014.10        016
EATHER 780514         0.00     22.96     11.33 1012.75        014
EATHER 780515         0.04     25.22     14.48 1005.98        019
EATHER 780516         0.56     24.07     20.73 1004.28        009
EATHER 780517         0.85     21.11     20.50 1008.35        014
EATHER 780518         C.57     24.92     22.33 1013.76        010
EATHER 780519         C.33     26.96     22.03 1016.81        005
EATHER 780520         C.35     26.59     21.98 1015.46        008
EATHER 780521         C.55     26.17     21.06 1014.10        005
EATHER 780522         0.24     26.31     20.90 1013.42        006
EATHER 780523         0.42     24.92     21. 8 1013.09        008
EATHER 780524         0.42     25.36     21.31 1013.42        009
EATHER 780525         0.42     25.66     21.52 1013.76        007
EATHER 780526         C.48     26.20     22.05 1014.44        006
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EATHER 780528         0.37     27.31     21.61 1011.73        008
EATHER 780529         C.36     27.33     20.22 1012.07        008
EATHER 780530         0.47     27.24     2C.43 1011.73        007
EATHER 780531         0.26     27.28     21.08 1012.07        009
EATHER 7806C1         C.57     26.45     21.63 1011.73        008
EATHER 780602         0.82     25.36     21.89 1011.39        008
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EATHER  780617      0.23    27.58    23.35 1018.50     013
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EATHER  780620      0.22    27.05    21.96 1014.44     008
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EATHER  780711      0.38    27.22    22.75 1013.42     010
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EATHER  780730      0.23    28.72    23.14 1014.10     011
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ATHER  780831        0.28     25.99      20.66 1015.46         010
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