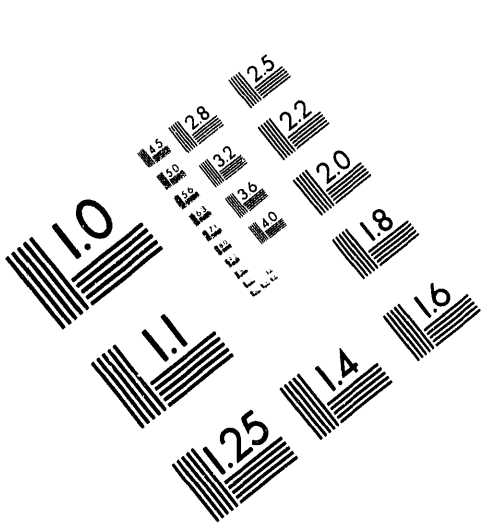

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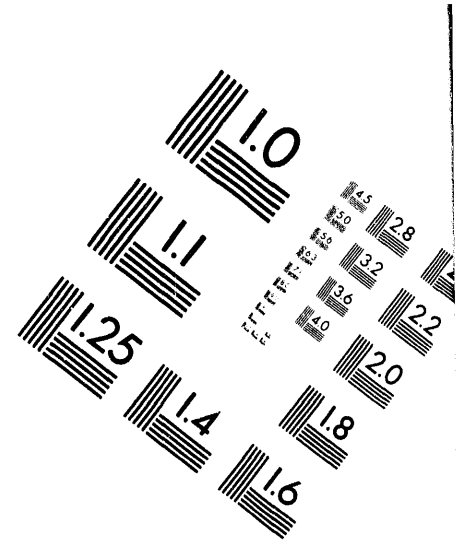

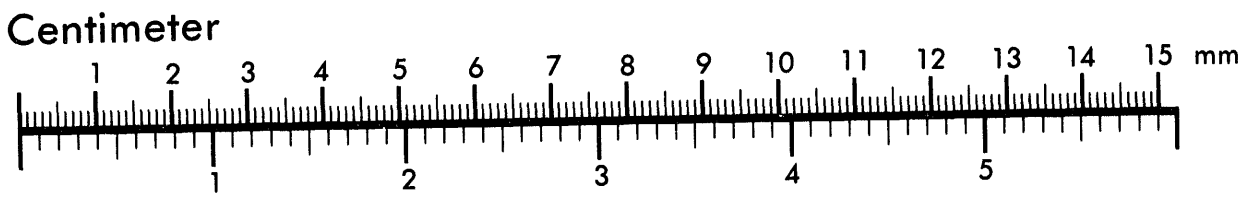

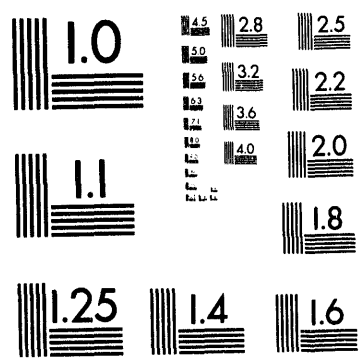

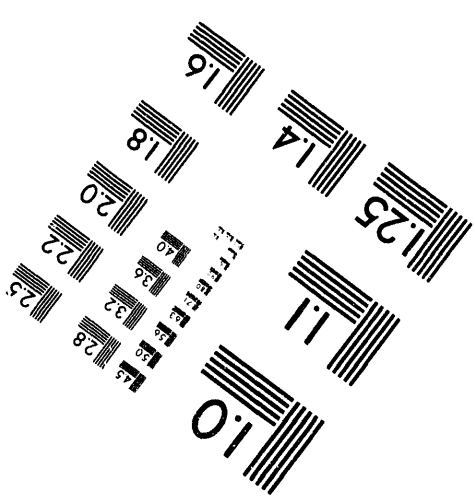

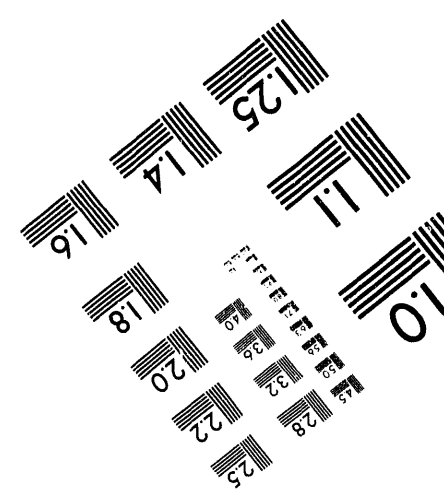

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EXPLOSIVES DEPARTMENT
WILMINGTON 98, DELAWARE

DPW-56-272
SR/H--777

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2-J. B. Tinker
3-H. W. Bellas
4-H. F. Measley
5-W File
6-M. H. Wahl-C. W. J. Wende
7-J. T. Carleton
8-Dale F. Babcock
9-CT File

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Date 1/28/89

June 18, 1956

MEMORANDUM TO FILE

FROM: DALE F. BABCOCK

DEEP VERSUS SHALLOW COOLING PONDS

(A resumé of a talk given by D. F. Babcock to AED Management on June 19)

Some months ago, the Engineering Department was requested to make an evaluation estimate of the cost of obtaining approximately 150,000 gpm of cooling water from shallow ponds or from cooling towers. Their conclusions (see DPWZ-5305) were (1) that both schemes were feasible and each produced cooling water of approximately the same annual average temperature, (2) the cooling towers could be built more quickly, largely because no additional engineering data were required before construction would start, and (3) the cooling ponds probably would be cheaper.

Data obtained from Clark Hill Reservoir in Georgia and Woods Reservoir in Tennessee indicated that significant reductions in the temperature of the cooling water could be made if the water were withdrawn from the deep portion of the reservoir rather than from the surface. Also, it appeared that the water from a reservoir 100 feet deep would be significantly colder than the water obtained from the reservoir only 40 feet deep. The studies reported herein were an attempt to evaluate the benefits that would accrue from obtaining cooling water from a deep lake rather than from a shallow pond.

MASTER

Diurnal Temperature Variation

There is considerable variation between the day and night temperature of the surface water of a shallow pond. Recent experimental work on the 12 foot deep ponds at SRP indicate that

[redacted]

the temperature of the surface water may swing by as much as 15°F during a 24 hour period. The temperature of the water down 10 feet or so has less than a 1°F diurnal variation. The temperature of the water obtained from cooling towers is intermediate between these extremes. The variation in the maximum daily temperature of the water that would have been obtained from a cooling tower during 1955 is presented as Chart No. 1. The average monthly temperature of the water from a cooling tower also is presented. If cooling tower water is used to cool a reactor, it is suggested that the annual average temperature should be increased by at least 3°F, when comparing the temperature of this water with water from a source which has only a moderate day to day temperature variation.

Proposals for Deep Lakes

The original Engineering Department estimate was based on placing a dam across Lower Three Runs Creek at coordinate East 82,000 and North 35,000. The depth of water impounded behind this dam would be about 55 feet. A considerably larger and deeper lake could be formed by placing a dam in Tinker Creek at coordinate East 80,000 and North 81,000. The water impounded behind this dam would have a depth of approximately 95 feet. Chart No. 2 gives a map showing the location of these two proposed lakes together with the principal operating areas and roads of SRP. Chart No. 3 gives data relating to the size of the two lakes. It is pointed out that the lake on Tinker Creek will require approximately 1-1/2 years to fill, if the filling rate is 150,000 gpm. This compares with only three months for the time required to fill the Lower Three Runs Creek. It was proposed that the pump house on Tinker Creek Lake be so constructed that water could be pumped from this lake when it was only partially filled.

Cooling Water Temperatures

The chief reason for looking at deep lakes as a source of cooling water was the hope that low temperature water could be obtained. In order that predictions could be made, data were obtained from the operation of Clark Hill Reservoir which has an area of about 35 square miles and a depth at the dam of approximately 150 feet and from Woods Reservoir which has an area of approximately six square miles and a depth at the dam of approximately 60 feet. Water is withdrawn through the penstocks of Clark Hill Dam at a depth of approximately 75 feet and at a rate so that the annual throughput is equal to twice the volume of water stored in the lake. It was believed that this condition gave a moderately close approximation to that obtainable when withdrawing water from Tinker Creek Lake at a depth of approximately 80 feet.

Water is withdrawn at the 40 foot level from Woods Reservoir and circulated back to an arm of this lake at a rate such that the turnover is longer than one year. With the exception of the very long turnover time, it is believed that this

condition gave a moderately close approximation to that obtainable when withdrawing water from Lower Three Runs Creek at a depth of approximately 40 feet.

The surface and sub-surface temperatures of these two reservoirs is shown on Chart 4. The temperatures existing in Woods Reservoir during the winter months will be colder than that obtainable at Savannah River but the temperatures during the remainder of the year are probably a good approximation of that obtainable from the Lower Three Runs Lake. This statement is borne out by a comparison with the crosses which represent the surface temperature of Woods Reservoir and the solid line which represents the surface temperature of the Savannah River.

Predicted Temperatures

Using the data referred to above, predictions have been made relating to the temperature of the water that could be withdrawn from the two deep lakes (see Chart No. 5). The average annual temperatures of 59°F predicted for the water from Tinker Creek is some 1-1/2°F colder than the average annual temperature of the water from Clark Hill. The reasons for this reduction are - 1) The turnover time in Tinker Creek will be 1-1/2 years; whereas, the turnover time at Clark Hill is only 1/2 year. Thus, the stored cold that is produced in the winter in Tinker Creek Lake should last longer than it lasts in Clark Hill. 2) No attempt is made in Clark Hill to withdraw the water into the penstocks in the optimum manner for the production of cold water. We hope to do a better job at Tinker Creek.

The predicted average annual temperature of the water from Lower Three Runs Creek is 63°F, which is some 2-1/2° warmer than that obtained from Woods Reservoir. This difference is ascribed to the very cold winter that was experienced at Woods Reservoir during 1955 and the shorter turnover time of the water from Lower Three Runs Creek.

The Engineering Department predicted 68°F as the average annual temperature of the water when withdrawn near the surface of Lower Three Runs Lake. Our method of prediction would have given a number perhaps 2°F colder. This is because the water would be withdrawn from perhaps an average depth of 10 feet, as opposed to surface withdrawal as assumed by the Engineering Department.

Costs

Chart No. 6 gives an estimate of a differential cost of building a dam and operating Tinker Creek Lake versus building a dam and operating Lower Three Runs Lake. The major added investment item for the Tinker Creek location is the extra cost of the dam. The figure of $1,440,000 was arrived at by ratioing the various cost items as given in the Engineering Department breakdown of the cost of the dam on Lower Three Runs Creek. The major costs favorable to

the Tinker Creek Site are - 1) the $1,000,000 lesser pumping charges over a 10 year period (the level of this lake is at an elevation of 260 feet versus 200 feet for Lower Three Runs Lake), and 2) the 2.4 million dollar credit for extra productivity. This latter figure was arrived at by saying that a 4°F colder temperature is equivalent to a 4% increase in the productivity of one area (or a 2% increase in productivity in each of two areas). The cost of operating an area for one year is about $6,000,000. Thus, on a 10 year basis the value of the extra productivity is given as 2.4 million dollars. This takes no credit for amortization of facilities, interest on investment, etc. If these other items are added, a figure up to $5,000,000 might be used as the value of the extra productivity.

No credit is taken in this estimate for the possible gain that would accrue from getting more water from this lake than the original 150,000 gpm. It is quite possible that we may eventually withdraw from this lake up to twice this amount of water. This added increment of water can be obtained very economically.

It is pointed out that the Tinker Creek Lake produces no road interferences; whereas, major road interferences will occur if a dam is built on Lower Three Runs Creek. The value of this road interference is placed at $500,000 which was arrived at by using the $300,000 figure given by Engineering as to the cost of installing a new by-pass road and saying that the value of the roads that are made obsolete was at least $200,000. It is pointed out that the Engineering Department estimate for the cost of reinstating all roads was in excess of $1,500,000 for the Lower Three Runs location.

Operation of Experimental Cooling Ponds

The data obtained recently from an experimental cooling pond is shown on Chart No. 7. When water from C Area, at a temperature of 144°F, is fed into the cooling ponds at a 600 gpm rate the effluent temperature of this water from the bottom of the second pond was 77°F, which was only some 5° warmer than the average wet bulb temperature during the period. It is also pointed out that this temperature is several degrees colder than the average "equilibrium" temperature.

Recommendations

The recommendations that were made are given in Chart No. 8. The consensus of the meeting was to accept recommendations 1 and 2. Recommendation 3 was also accepted in principle but the choice between A and B was left open.

Dale F. Babcock

DFB/s

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CHART 1

TEMPERATURE OF WATER FROM COOLING TOWER

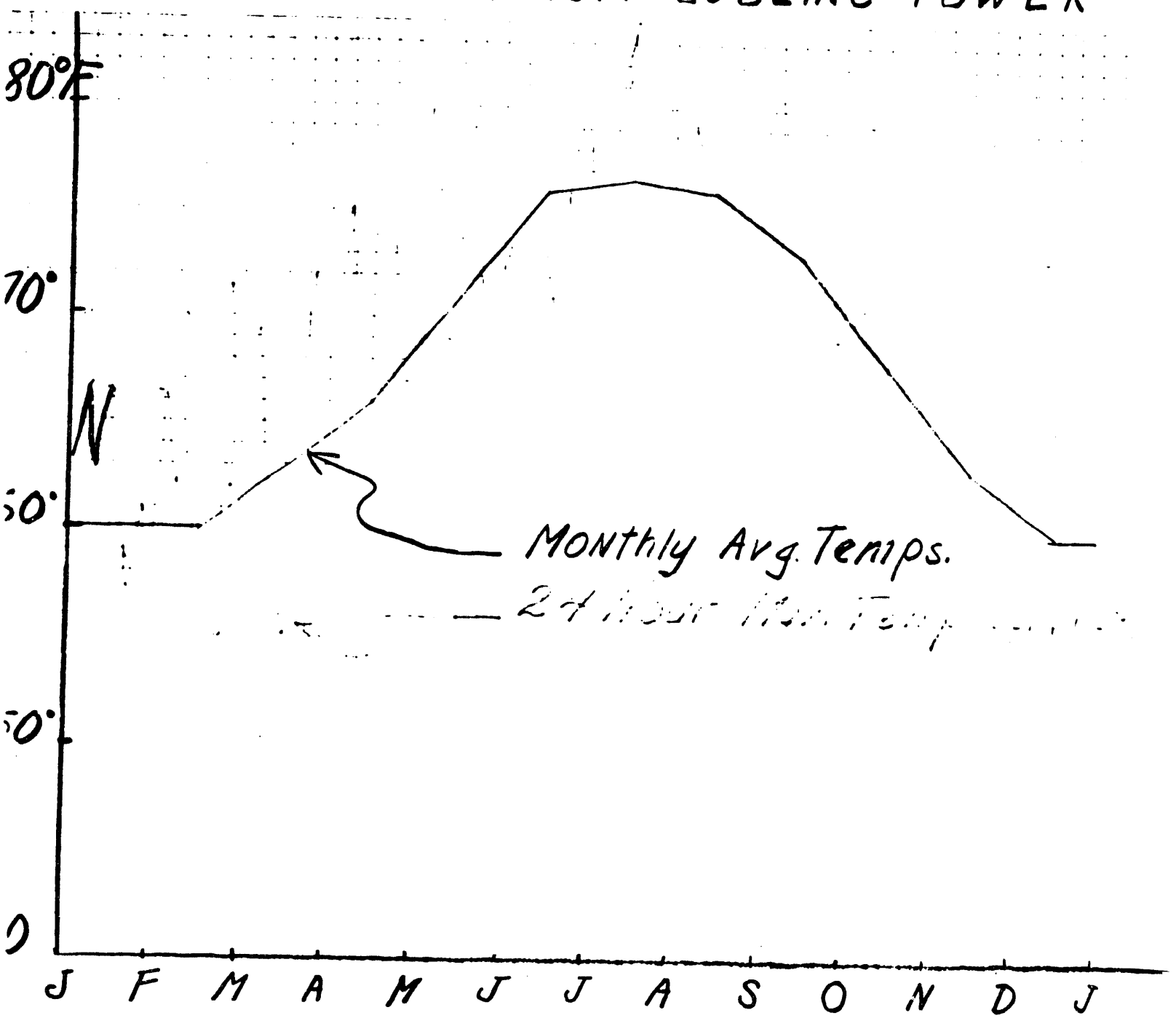

CHART 2

AREA MAP

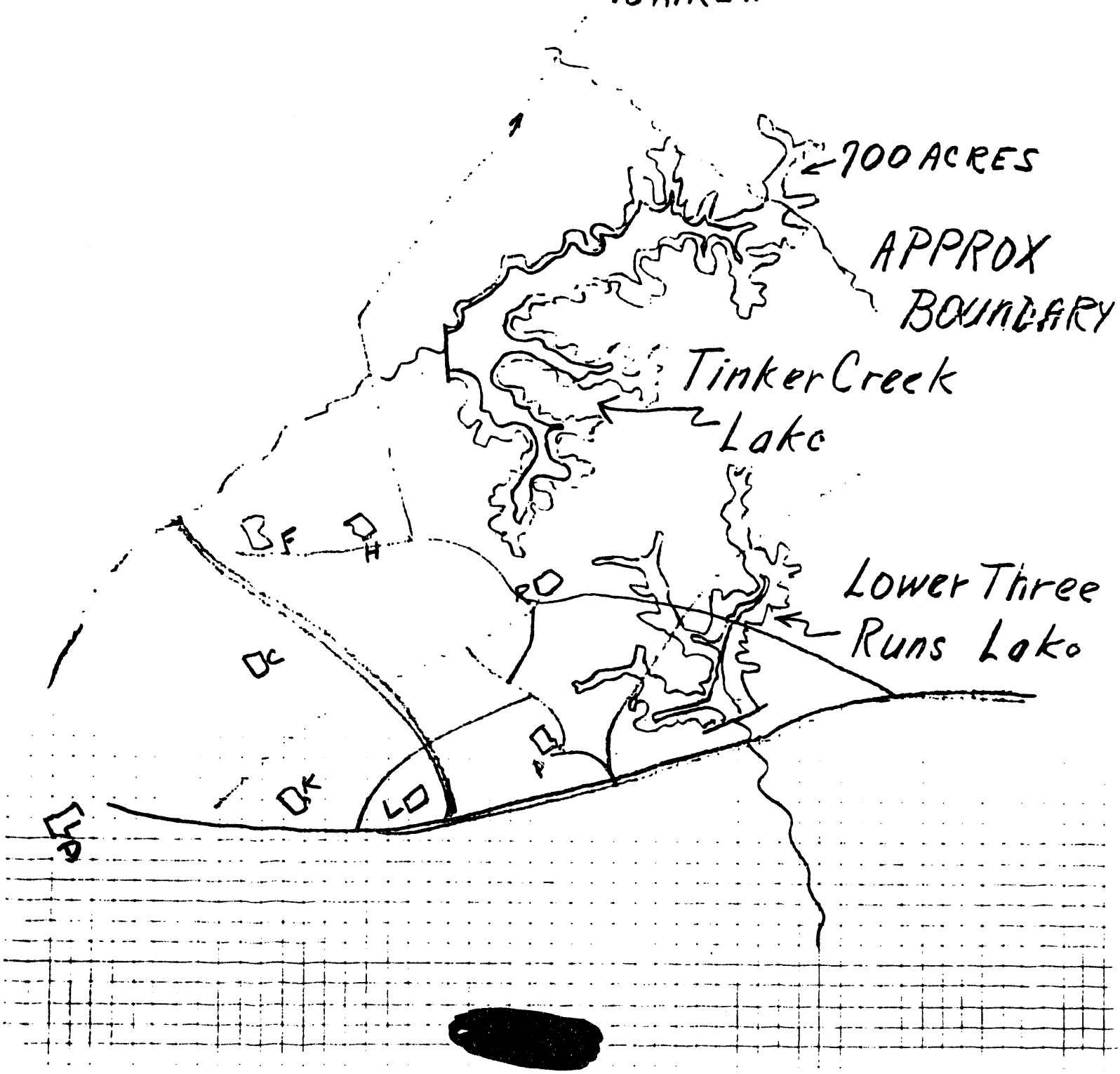

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CHART 3

LAKE DATA

	Tinker Cr. Lake	Lower T.R. Lake
AREA (acres)	8,000	2,400
VOLUME (acre feet)	317,000	60,000
Deeper than 20 ft	178,000	19,000
" " 40 ft	87,000	1,800
" " 60 ft	33,000	—
" " 80 ft	7,000	—
TIME TO FILL (days) (@ 150,000 gpm)	480	90
Lacking 20'	270	
" 40'	130	
" 60'	50	[redacted]

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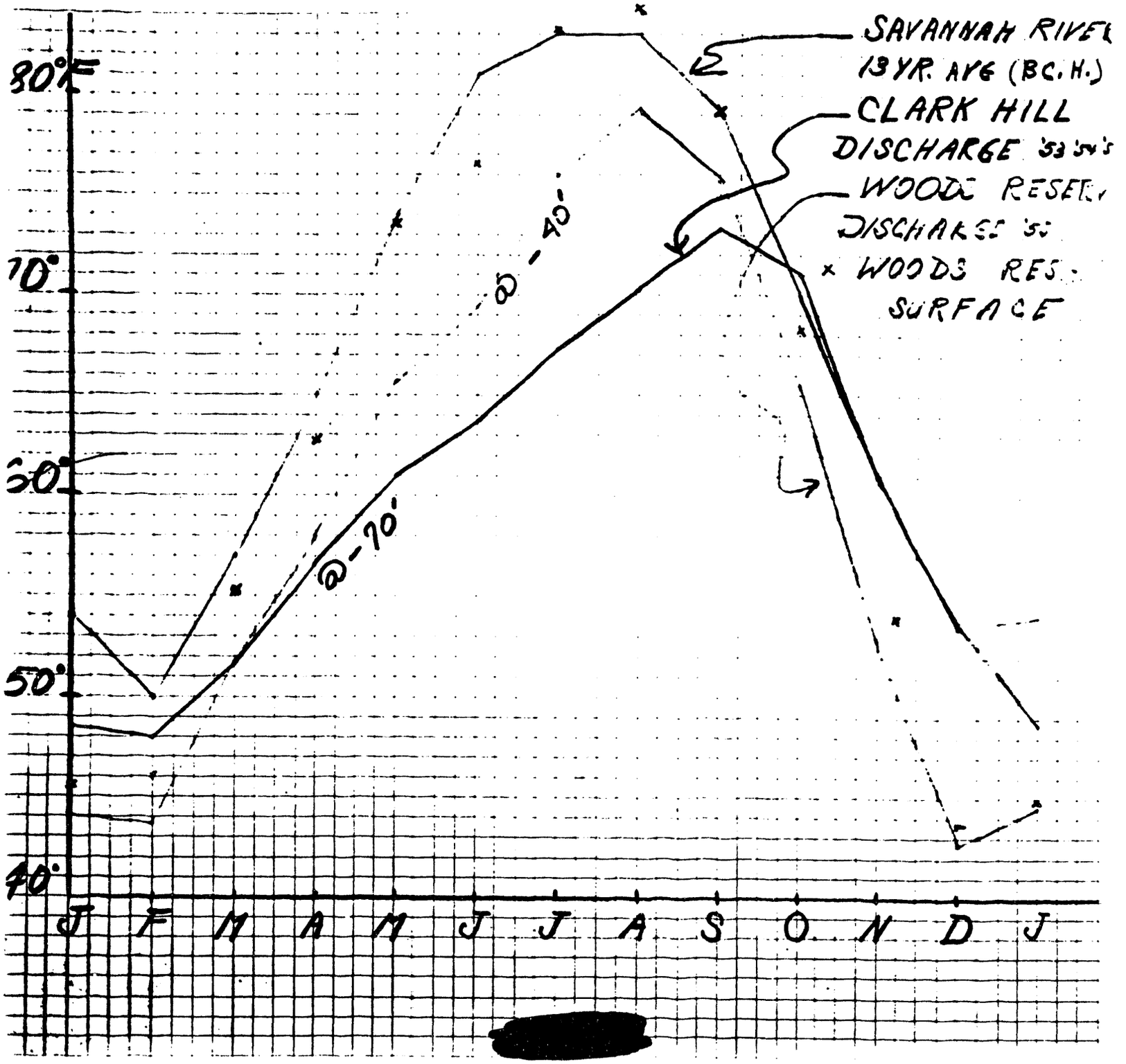
CHART 4

WATER TEMPERATURES



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EXPECTED TEMPERATURES

	TEMPERATURES °F		
	Annual Avg	J J A S Avg	High Month
Tinker Lake - 80'	59	68	73
Clark Hill - 75' ('53, '54, '55)	60.5	68.5	73.3
Lower T. R. Lake - 40'	63	74	78
Woods Res. - 40'	60.5	75.1	79.4
Lower T. R. Lake ~ - 10'	68	82	83
Savannah River 13yr Avg	67.3	81.3	83
Cooling Tower (5°F appr.)			
Monthly Avg. Temps	68	75	77
24 hr Max. Temps	71	77	80

CHART 6

TEST POND DATA

Lake Area	6 acres (3½ + 2½)
Feed Rate	600 gpm = 430 sq. ft/gpm
Temperature	62°C · 144°F

TEMPERATURES

(Daily Averages)

		MAX.	MIN.	AVG.
SURFACE	1st POND	95°F	84°F	91°F
"	2nd POND	88	77	84
BOTTOM DISCHARGE				
	1st POND	85	84	84
	2nd POND			~77
EQUILIBRIUM		97	72	83
WET BULB		79	65	72
DRY BULB		97	66	81

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CHART 7

DIFFERENTIAL COSTS

(Thousands of Dollars)

	Tinker Cr. Lake	Lower T.R Lake
DAM	1,440	
MOVING R-DISCHARGE	200	
COST of EXTRA PUMPS	100	
LAND 700 acres	100	
DELAY TIME ($1.8MM × 10% × 1/3 yr)	60	
ROAD RELOCATION		500
PUMPING COSTS (10yr total)		1,050
SUBTOTAL	1,900	1,550
EXTRA COST - TINKER	350	
VALUE of EXTRA PROUCT		2,400
NET		2,050

[redacted]

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CHART 8.

RECOMMENDATIONS

1. Accept Cooling Ponds as the Preferred Method
2. Ask Eng. Dept. for Evaluation Estimate Between Tinker Cr. Lake and Lower T.R Lake
3. Ask for Test Borings at
   a) Tinker Cr. Site or
   b) Both Tinker Cr. Site and Lower T.R Site.

DATE
FILMED
10/17/94
END