**A TEST SIMULATION
OF THE TEMPERATURES
OF THE DEERFIELD RIVER**

R. T. JASKE

DECEMBER 1967

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By

R. T. Jaske

Water and Land Resources
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INTRODUCTION

At the request of the Environmental and Sanitary Engineering Branch, Division of Reactor Development and Technology, USAEC, two test simulations involving adaptation of the digital simulation system were performed using actual data collected in two widely differing drainage basins. These basins were selected by the AEC and Battelle-Northwest as cases because of the adequate information available through existing data sources.

This report summarizes the results of the Deerfield simulation. It uses temperature records collected by the New England Power Company during the period of 1960 through 1963. Primary emphasis is accorded in the study to 1961, the first full operating year of the Yankee reactor project.

The Deerfield River (See Figure 1), aside from its historic past during colonial times and association with the renowned Hoosac Tunnel project in 1877, is a relatively small river flowing southward out of Vermont into the Connecticut River. It is highly developed for industry and hydro-power in a manner characteristic of the golden age of pre-1900 river development. Flows vary widely as a result of regulation, ranging from 100 to 5,000 cfs under ordinary seasonal circumstances. The hurricane-induced flood of 1938, however, produced an instantaneous peak flow on the order of 56,000 cfs and caused considerable local flooding. The geography is that of the New England Berkshire country featuring terrain highly convoluted with deep gorges and traversed by many sections of white rapid water. The entire region is heavily forested, more so now than in the preceding century as farming units, no longer economically productive, were allowed to return to their native state. These conditions thus have rendered the area ideally suited as an extreme case adaption to a simulation system. The New England Power Company generously cooperated in supplying test program data and consulting advice.

FIGURE 1. Deerfield River Location Map

Temperature data collection was initiated in 1958 by the company to assist in studying the effect of the then proposed Yankee reactor on the Deerfield River. This study makes no evaluation of these effects, but uses the data in order to determine whether the mathematical system is capable of modeling the river reach from a point 5 miles below the Yankee plant to a downstream location near the confluence with the Connecticut.

SUMMARY AND CONCLUSIONS

- The COL HEAT simulation system is generally adequate to represent the water temperature regime of the Deerfield River within the accuracy of the input data presented for evaluation. This case study utilizes weather data from Albany, New York as supplied by the U. S. Weather Bureau. Stream flow and dimensional data were derived from both the U. S. Geological Survey and the New England Power Company.
- Small river simulations must account for such parameters as shading of solar radiation and, to a limited extent, screening of the river from the wind. As a weak parameter in the heat budget computations, however, wind screening could be neglected in reconnaissance investigations. No serious difficulties were introduced by the existence of riffles and other indication of highly irregular bottom contour except as they relate to proper volumetric estimates. Other investigators⁽¹⁾ have previously determined that water surface disturbances are properly considered in applying heat budget methods. As a general conclusion, no problems significantly affecting the applicability of the basic concept were introduced by the size of the river.
- A hypothetical thermal discharge of 300 MW (one-half the present plant capacity) directly into the river at Five Mile Station was performed as an exercise in predictive capability of the model. The results indicate that from 10 to 30% of this

heat would remain during the summer months in the river at Bardwell Bridge, located 27 miles below the hypothetical discharge point. During the cooler months of the year, 40 to 60% of the discharged heat was indicated to remain at this point. The importance of pondage as a consideration in the planning for extensive thermal discharges into small rivers such as the Deerfield is thus illustrated and suggests that the original choice of the Yankee Atomic Power Company in discharging into Sherman Pond was a good one.

DISCUSSION

The COL HEAT simulation model has been described in previous reports and publications,⁽²⁾ and has been extensively used both on the Columbia River and other tributary systems for the operational analysis of the effects of industrial development.⁽³⁾ The computational system operates on the assumption that most streams will be turbulent or supercritical in hydraulic characteristics and, that within this assumption, the distribution of velocity within the stream is similar regardless of the stream dimensions. Based on this concept, the model sets up a series of difference equations derived from the heat budget method and iteratively computes the downstream temperatures as a function of the input parameters in the following manner:

$$T_{i+1,j+1} = (1-B) \left(T_{i,j} + \Delta T_{i,j}^{(1)} + \Delta T_{i,j}^{(2)} \right) + B \left(T_{i,j-1} + \Delta T_{i,j-1}^{(1)} \right) + \Delta T_{i,j}^{(2)}$$

where $T_{i,0}$ = average temperature of water entering the system during the i^{th} time interval, °C

$T_{i,j}$ = average water temperature of the beginning of the j^{th} flow, and flow increment at the end of the i^{th} time increment (flow day) °C

- $\Delta T_{i,j}^{(1)}$ = the temperature change during the first half of the i^{th} time interval in the j^{th} flow increment as determined from surface heat exchange plus advected energy (heat budget) in $^{\circ}\text{C}$
- $\Delta T_{i,j}^{(2)}$ = same as above except for the second half of the i^{th} time interval, in $^{\circ}\text{C}$
- $\Delta T_{i,j}^{(1)} = T_{i,j} + T_{i,j}^{(1)}$
- B = the fractional part of the water in the inner fast moving trough.

Since density currents can cause appreciable error in the heat budget calculation, the overall system heat budget must include analysis of this effect where applicable. Density currents in the rapidly flowing river are stable only when reinforced by heat input, which produces a density gradient greater than that required for maintenance of a densimetric Froude number of 0.28 or less. (4, 5) Accordingly, the existence of density currents in deep, stratifying reservoirs must be verified constantly. The thermal version of the model is verified by the process delineated in the notes of Figure 2. The additional subroutine, SMATCH, is used in the actual model to correlate and match the appropriate water masses as they pass through the reservoir or river section in question.

The following data are required for operation of the temperature model:

- Water temperature at the inlet end (time increment appropriate)
- Flow discharge at the outlet end
- Water temperature at the outlet end (optional, for statistical comparison where available)
- Meteorological parameters (wind velocity for time period, mean air temperature, dew point, sky cover in tenths, short wave radiation)
- River or reservoir dimensions reduced to equivalent non-parallel trapezoidal cross sections (volume, surface or bottom areas are derived)
- Advected heat quantities (megawatts per time incrementation)

FIGURE 2. Flow Diagram, Water Quality Simulation

Computations can be made for any incrementation time for which data are available; for instance, daily incrementation is required for use with daily average data, and hourly average data are required for hourly incrementation.

The foregoing data requirements provide a topical outline for the following discussion.

WATER TEMPERATURES

During the planning of the Yankee project, a series of stream temperature measurements was initiated by the owners in order to investigate the potential effects of the proposed project. Temperature records and locations supplied for this simulation are indicated in Figure 3. The records, taken with a maximum-minimum recording thermograph, show extensive diurnal variation. Since daily mode computations allow a single daily value only to be used in the computer code, the daily mean was selected as the mid-point of the extremes. Although selection of this approach is supported by analysis of its application to other systems, determination of the actual daily average from analog-type records would be preferable. Table I of the Appendix contains a listing of 5 station locations of the max-min values used as a basis for deriving the analog curves in the later figures.

The most significant portions of the record, between the upper and lower locations, show the smallest variation from the mean. The record for the Stillwater Bridge location does, however, show a serious anomaly with respect to the Bardwell Bridge after July 15, 1961 as an apparent result of equipment malfunction. For this reason, the Bardwell Bridge location was selected as the downstream point for comparison. Difficulty in statistically testing the actual modeling fit arose from the extreme diurnal variations shown at both the Florida Bridge and Avery Bridge locations. However, graphs of the computed values for these locations are also included to illustrate the flexibility of the analysis system. For this reason, the simulation was confined to the year of

FIGURE 3. Profiles and Location on Deerfield River

1961. Other data presented by the New England Power Company for prior years did not include measurements at the two lowest stations where the diurnality is minimal.

FLOW RECORDS

Daily average flow records for the Deerfield obtained from the U. S. Geological Survey for the Charlemont station were used as the input for the analysis. Wide diurnal variations from the daily average induced by the operation of various power products on the Deerfield would ordinarily be significant to the travel time analysis of a specific temperature front. However, since the daily mean flow of the river is frequently less than 200 cfs and rarely over 1000 cfs, the actual mean travel time of a specific water mass is on the order of two or more days. The actual total of impounded volumes and the estimate of river volume is on the order of 3,500 acre-feet for the section between Bardwell Bridge at Mile 10.3, and Number Five power station at Mile 37.3. The water levels do, however, fluctuate hourly as regulation proceeds, and the use of mean values for the hydraulic radius and width are consequently required. These variables become relatively less significant to thermal analysis after the mass balance for the system is modeled.

METEOROLOGICAL PARAMETERS

The input data required for operation of the simulation system include the five major variables involved in the heat budget computation. Of these, the input radiation and the dry bulb temperature are the strongest, the others less strong in the order of dew point, wind speed, and finally, cloud cover. The latter is involved only in the estimate of the long wave radiation exchange, since measured values of the short wave input radiation are used.

Correlations of regional weather systems for various portions of the country show distinct regional patterns over relatively wide areas. It has been determined in other studies⁽²⁾ that a single remote station can represent local weather over a radius of 75 to 100 miles.

In this case, the nearest local station providing a complete report of the needed parameters, particularly of input radiation estimates, is Albany. While an on-site instrument would be ideal, a good regional value for a station 30 to 40 miles away is more meaningful than an estimate attempted from first principles.⁽¹⁾ This conclusion is confirmed through experience gained during the licensing and operation of the Yankee plant.⁽⁶⁾ The average distance from Albany to the extreme ends of the river reach in this simulation is 53 miles. It is recognized, however, that the use of a single point weather index is not an acceptable approach to other phases of nuclear safety research.

RIVER SECTIONS

The Deerfield River offers an interesting challenge in the adaptation of a simulation system based on a stream relatively both deep and wide. While estimates of reservoir volume are available, the natural stream is, at times and places, less than one foot deep and flows in a riffle-like manner. Relatively accurate surface areas representations were available from maps and aerial photographs, and the river profile from Harriman Dam down to the Connecticut River was also available. From these two sources, computations were performed using the Manning formula, and the equivalent hydraulic radii were determined for the unsounded reaches. These computed radii were spot checked during a field trip and found to be quite representative of the actual conditions. Computed depths were extended on this basis to the entire river, exclusive of known impoundments for which good data were available. Table I below is a summary of the estimated parameters and computed volumes, and the surfaces areas resulting.

ADVECTED HEAT QUANTITIES

The original simulation plans did not provide for any additional artificial heat to the river reach between Miles 10.3 and 37.3. However, because of the readily available opportunity, a trial simulation of an

TABLE I. Summary of River Section Data Used in Deerfield Simulation

Location From Mile to Mile	W_u , ft	B_u , ft	D_u , ft	W_d , ft	B_d , ft	D_d , ft	L , ft	Area, ft^2	Vol., ft^3
7.2 to 10.3	116	58	1.5	342	171	8	16,368	3.75×10^6	1.49×10^7
10.3 to 12.8	280	93	1.5	116	58	1.5	13,200	2.61×10^6	2.71×10^6
12.8 to 14.8	248	83	1	280	93	65	10,560	2.79×10^6	6.25×10^7
14.8 to 15.8	280	93	2	248	83	40	4,224	1.11×10^6	1.53×10^7
15.8 to 16.0	124	41	20	280	93	68	2,112	4.27×10^5	1.34×10^7
16.0 to 17.2	280	93	1	124	41	20	6,336	1.28×10^6	7.90×10^6
17.2 to 18.8	342	114	4	280	93	4	8,448	2.63×10^6	7.00×10^6
18.8 to 20.4	233	77	6	342	114	24	8,448	2.43×10^6	2.52×10^7
20.4 to 24.4	93	31	4	233	77	6	21,120	3.44×10^6	1.18×10^7
24.4 to 30.1	202	67	2	93	31	4	30,096	4.44×10^6	8.51×10^6
30.1 to 31.1	109	1	2	202	67	2	5,280	8.21×10^5	1.00×10^6
31.1 to 37.3	109	1	2	109	1	2	32,736	3.57×10^6	3.60×10^6
Totals								2.93×10^7	1.74×10^8

additional plant delivering 300 MW thermal into the stream at the equivalent of Mile 37.3 was included to illustrate the comparative dissipation rate of a large heat addition. Both the trial location and size are purely hypothetical and do not represent any project under consideration. Results of the daily computations derived from this simulated heat delivery to the river are presented in Table II of the appendix.

SPECIFIC MODEL ADJUSTMENT

Only three changes in the fundamental program were made to accommodate the special conditions of this case study. They were:

- Adjustment of the solar radiation reaching the surface
- Adjustment of the wind speed
- Adjustment of the thermal conductivity of the air-water interface for high velocity reaches

The solar radiation measured at Albany includes the daily summation of short wave radiation on flat surfaces. The measuring instrument was designed to function as a near black body. Surface reflectivity of the actual river, shaded both by trees and cliffs, varies in respect to the solar altitude.⁽¹⁾ From available maps and inspections, it was determined that 33% should be used as an overall average value for the reflected or shaded short wave radiation. The actual value varies both diurnally and seasonally. For an open lake surface, a value of 5% is applicable for solar altitudes down to 30 degrees. This value increases rapidly to about 25% at 10 degrees solar altitude, the minimum from which any effective radiation quantity is produced. The primary correction for shading represents about 68% of the 33% correction total, consisting of 10% normal reflection correction for sun altitude and 23% shading correction for the Deerfield case.

The correction for wind speed was nominal. A 25% deduction from the Albany readings was taken to account for the gullies and protected nature of the river course. This correction is based entirely on judgment and observations of boundary conditions at other locations. The adjustment is of a low order of effect on the resulting computations and could have been neglected without significant result.

The correction for conduction coefficient is based on research with moving, highly turbulent western rivers. Data taken over a period of years indicate the Bowen ratio of evaporative to conducted heat for turbulent water bodies to be quite different than for lakes and impoundments. Conductive heat transfer during critical summer months may be as high as 3 to 4 times the rate for limpid surfaces. The Bowen ratio was adjusted for this study to increase the conducted heat transfer by a factor of 2.

RESULTS OF SIMULATION

Figures 4, 5, and 6 illustrate for comparative purposes the observed and computed values for three downstream locations, Florida Bridge, Avery Road, and Bardwell Bridge. Statistical "U" tests performed for each simulation run indicate that computed values for most of the time period under consideration were less than one standard deviation of the observed values, indicating a minimum of 68% confidence in the accuracy of the correlation. Figure 7 displays the superimposed value for the hypothetical heat additions discussed herein.

This study was in the nature of a reconnaissance performed with existing available information under a tight time schedule. Additional accuracy could have been obtained had hourly records of weather, water temperature, and flow been used. It was the considered judgment of the author that for the purposes of this test, the additional detail would not be worth the time and effort to acquire. It would have entailed a special program extending through the summer of 1967, and delayed the results of this demonstration into the spring of 1968. It is believed that the essential purpose of this simulation was achieved to a very successful extent and fully demonstrates the capability of the simulation system for useful employment in a wide range of environmental situations, with little or no actual field data other than that routinely available from regular private, state, and federal agency sources required.

FIGURE 4. Deerfield River Simulation, No. 5 Station to Florida Bridge

FIGURE 5. Deerfield River Simulation, No. 5 Station to Avery Road

FIGURE 6. Deerfield River Simulation, No. 5 Station to Bardwell Bridge

FIGURE 7. Deerfield River Temperatures from Hypothetical Heat Addition

The Division of Reactor Development and Technology has requested a parallel study of the simulation capability of the COL HEAT model as applied to the Illinois River. The work for this phase of the overall program is essentially complete and will be reported separately during FY 1968.

ACKNOWLEDGEMENT

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APPENDIX A

TABLE A-I. 1961 Daily Inlet Temperatures
at Five Deerfield River Stations

No. 5 Station

Day of Month	April				May			
	Max, °F	Min, °F	Mean		Max, °F	Min, °F	Mean	
			°F	°C			°F	°C
1					42	40	41	5.0
2					42	40	41	5.0
3					41	39	40	4.5
4					42	39	41	5.0
5					42	40	41	5.0
6					46	41	44	6.7
7					44	42	43	6.1
8					48	45	47	8.4
9	44	39	42	5.6	47	46	47	8.4
10	44	42	42	5.6	48	46	47	8.4
11	44	42	42	5.6	48	46	47	8.4
12	48	42	45	7.2	47	46	47	8.4
13	46	42	44	6.7	49	47	48	8.9
14	42	42	42	5.6	52	48	50	10.0
15	46	41	44	6.7	56	51	54	12.2
16	45	43	44	6.7	58	52	55	12.8
17	49	45	47	8.4	60	56	58	14.5
18	50	45	48	8.9	58	55	57	13.9
19	50	44	47	8.4	56	53	55	12.8
20	47	44	46	7.8	56	55	56	13.4
21	49	42	46	7.8	56	55	56	13.4
22	49	45	47	8.4	56	52	54	12.2
23	48	44	46	7.8	60	58	59	15.0
24	45	43	44	6.7	61	59	60	15.6
25	42	42	42	5.6	62	60	61	16.1
26	43	41	42	5.6	61	60	61	16.1
27	43	40	42	5.6	61	58	60	15.6
28	43	40	42	5.6	61	58	60	15.6
29	41	40	41	5.0	62	58	60	15.6
30	42	40	41	5.0	62	58	60	15.6
31					63	54	59	15.0

TABLE A-I. (contd)

No. 5 Station

Day of Month	June				July			
	Max, °F	Min, °F	Mean		Max, °F	Min, °F	Mean	
			°F	°C			°F	°C
1	64	62	63	17.2	71	71	71	21.7
2	65	62	64	17.8	68	68	68	20.0
3	64	64	64	17.8	70	68	69	20.6
4	64	63	64	17.8	70	68	69	20.6
5	66	65	66	18.9	74	69	72	22.2
6	68	66	67	19.5	73	71	72	22.2
7	69	67	68	20.0	72	70	71	21.7
8	69	68	69	20.6	70	70	70	21.1
9	68	67	68	20.0	70	70	70	21.1
10	64	64	64	17.8	70	70	70	21.1
11	66	64	65	18.4	70	70	70	21.1
12	70	67	69	20.6	70	70	70	21.1
13	71	69	70	21.1	70	70	70	21.1
14	70	68	69	20.6	72	70	71	21.7
15	68	67	68	20.0	72	70	71	21.7
16	66	63	65	18.4	67	66	67	19.5
17	66	63	65	18.4	68	68	68	20.0
18	66	63	65	18.4	68	67	68	20.0
19	68	64	66	18.9	69	69	69	20.6
20	68	66	67	19.5	71	71	71	21.7
21	66	66	66	18.9	71	71	71	21.7
22	66	64	65	18.4	70	70	70	21.1
23	70	66	68	20.0	72	71	72	22.2
24	70	69	70	21.1	73	71	72	22.2
25	70	69	69	20.6	72	70	71	21.7
26	67	64	66	18.9	73	70	72	22.2
27	68	64	66	18.9	74	73	74	23.4
28	68	66	67	19.5	74	74	74	23.4
29	70	66	68	20.0	73	73	73	22.8
30	70	68	69	20.6	73	73	73	22.8
31					78	74	76	24.5

TABLE A-I. (contd)

No. 5 Station

Day of Month	August				September			
	Max, °F	Min, °F	Mean		Max, °F	Min, °F	Mean	
			°F	°C			°F	°C
1	78	76	77	25.0	69	67	68	20.0
2	77	75	76	24.5	66	65	66	18.9
3	76	70	73	22.8	68	67	68	20.0
4	73	68	71	21.7	69	68	69	20.6
5	73	73	73	22.8	73	70	72	22.2
6	69	69	69	20.6	73	71	72	22.2
7	73	68	71	21.7	70	69	70	21.1
8	68	68	68	20.0	71	70	71	21.7
9	66	65	66	18.9	71	70	71	21.7
10	66	62	64	17.8	71	70	71	21.7
11	67	64	66	18.9	72	68	70	21.1
12	65	65	65	18.4	69	66	69	20.6
13	66	66	66	18.9	68	63	66	18.9
14	70	66	68	20.0	64	61	63	17.2
15	71	69	70	21.1	63	60	62	16.7
16	69	67	68	20.0	63	63	63	17.2
17	67	65	66	18.9	63	63	63	17.2
18	66	63	65	18.4	67	62	65	18.4
19	63	62	63	17.2	67	65	66	18.9
20	65	64	65	18.4	67	64	66	18.9
21	70	66	68	20.0	68	65	67	19.5
22	68	67	68	20.0	69	66	68	20.0
23	65	61	63	17.2	69	66	68	20.0
24	64	61	63	17.2	69	66	68	20.0
25	64	62	63	17.2	68	64	66	18.9
26	64	62	63	17.2	69	67	68	20.0
27	66	65	66	18.9	69	68	69	20.6
28	71	66	69	20.6	69	69	69	20.6
29	71	69	70	21.1	68	67	68	20.0
30	71	68	70	21.1	68	67	68	20.0
31	66	67	19.5					

TABLE A-I. (contd)

No. 5 Station

Day of Month	October				Max, °F	Min, °F	Mean	
	Max, °F	Min, °F	Mean				°F	°C
1	68	67	68	20.0				
2	73	66	69	20.6				
3	70	70	70	21.1				
4	70	68	69	20.6				
5	68	65	67	19.5				
6	67	64	66	18.9				
7	65	65	65	18.4				
8	65	65	65	18.4				
9	67	64	66	18.9				
10	66	63	65	18.4				
11	66	65	65	18.4				
12	65	65	65	18.4				
13	69	64	67	19.5				
14	67	65	66	18.9				
15	67	65	66	18.9				
16	66	62	64	17.8				
17	65	63	64	17.8				
18	65	62	64	17.8				
19	65	62	64	17.8				
20	66	63	65	18.4				
21	64	61	63	17.2				
22	64	61	63	17.2				
23	65	61	63	17.2				
24	64	62	63	17.2				
25	63	61	62	16.7				
26	62	61	62	16.7				
27	62	61	62	16.7				
28	62	61	62	16.7				
29	62	61	62	16.7				
30	66	59	63	17.2				
31	64	63	65	18.4				

TABLE A-I. (contd)
Florida Bridge Station

Day of Month	May				June			
	Max, °F	Min, °F	Mean		Max, °F	Min, °F	Mean	
			° F	°C			°F	°C
1					62	56	59	15.0
2					66	58	62	16.7
3					67	60	64	17.8
4					66	54	60	15.6
5					70	58	64	17.8
6					69	62	66	18.9
7					70	60	65	18.4
8					68	62	65	18.4
9					68	64	66	18.9
10					70	64	67	19.5
11					72	62	67	19.5
12					70	64	67	19.5
13					72	64	68	20.0
14					68	64	66	18.9
15					67	59	63	17.2
16					68	56	62	16.7
17					72	57	65	18.4
18					74	61	68	20.0
19					69	64	67	19.5
20					70	61	66	18.9
21	--	--	--	--	65	62	64	17.8
22	57	53	55	12.8	65	62	64	17.8
23	59	50	55	12.8	70	65	68	20.0
24	62	51	56	13.4	71	66	69	20.6
25	66	54	60	15.6	72	62	67	19.5
26	60	57	59	15.0	66	62	66	18.9
27	56	51	54	12.2	69	60	65	18.4
28	64	51	58	14.5	70	60	65	18.4
29	61	56	59	15.0	72	62	67	19.5
30	60	53	57	13.9	72	66	69	20.6
31	62	49	56	13.4				

TABLE A-I. (contd)
Florida Bridge Station

Day of Month	July				August			
	Max, °F	Min, °F	Mean		Max, °C	Min, °F	Mean	
			°F	°C			°F	°C
1	74	62	68	20.0	79	70	75	23.9
2	78	66	74	23.4	76	66	71	21.7
3	74	70	72	22.2	71	66	69	20.6
4	70	62	66	18.9	78	66	72	22.2
5	72	58	65	18.4	74	68	71	21.7
6	74	63	69	20.6	70	70	70	21.1
7	70	62	66	18.9	75	70	73	22.8
8	72	66	69	20.6	72	64	68	20.0
9	76	68	72	22.2	71	64	68	20.0
10	73	68	71	21.7	68	62	65	18.4
11	73	68	71	21.7	71	62	67	19.5
12	73	68	71	21.7	62	59	61	16.1
13	73	68	71	21.7	62	59	61	16.1
14	70	68	69	20.6	70	60	65	18.4
15	67	64	66	18.9	72	60	66	18.9
16	68	64	66	18.9	70	65	68	20.0
17	74	65	70	21.1	68	60	64	17.8
18	74	68	71	21.7	70	58	64	17.8
19	74	68	71	21.7	70	58	64	17.8
20	72	70	71	21.7	70	58	64	17.8
21	74	68	71	21.7	68	64	66	18.9
22	76	69	73	22.8	68	64	66	18.9
23	79	70	75	23.9	64	60	62	16.7
24	78	71	75	23.9	63	60	62	16.7
25	76	69	73	22.8	62	60	61	16.1
26	76	68	72	22.2	62	60	61	16.1
27	78	68	73	22.8	62	60	61	16.1
28	77	66	72	22.2	70	66	68	20.0
29	76	68	72	22.2	72	66	69	20.6
30	81	70	76	24.5	70	65	68	20.0
31	80	72	76	24.5	70	64	67	19.5

TABLE A-I. (contd)
Florida Bridge Station

Day of Month	September				Max, °C	Min, °F	Mean	
	Max, °F	Min, °F	Mean				°F	°C
			°F	°C				
1	70	65	68	20.0				
2	72	64	68	20.0				
3	78	68	73	22.8				
4	78	70	74	23.4				
5	74	70	72	22.2				
6	76	68	72	22.2				
7	69	66	68	20.0				
8	72	66	69	20.6				
9	77	68	73	22.8				
10	78	68	73	22.8				
11	76	69	73	22.8				
12	72	68	70	21.1				
13	78	76	77	25.0				
14	67	64	66	18.9				
15	64	60	62	16.7				
16	64	56	60	15.6				
17	66	57	62	16.7				
18	68	54	61	16.1				
19	66	56	61	16.1				
20	66	62	64	17.8				
21	66	63	65	18.4				
22	68	63	66	18.9				
23	64	62	63	17.2				
24								
25								
26								
27								
28								
29								
30								
31								

TABLE A-I. (contd)

Avery Road Station

Day of Month	April				May			
	Max, °F	Min, °F	Mean		Max, °C	Min, °F	Mean	
			°F	°C			°F	°C
1					47	42	45	7.2
2					44	40	42	5.6
3					46	41	44	6.7
4					49	41	45	7.2
5					50	42	46	7.8
6					52	41	47	8.4
7					50	46	48	8.9
8					56	46	51	10.6
9					52	50	51	10.6
10					52	50	51	10.6
11	43	42	43	6.1	53	47	50	10.0
12	49	40	45	7.2	50	48	49	9.5
13	46	39	44	6.7	58	49	54	12.2
14	42	40	41	5.0	63	51	57	13.9
15	50	39	45	7.2	66	54	60	15.6
16	43	40	42	5.6	60	56	58	14.5
17	47	40	44	6.7	62	54	58	14.5
18	46	41	44	6.7	60	54	57	13.9
19	45	42	44	6.7	60	52	56	13.4
20	45	42	44	6.7	60	52	56	13.4
21	52	42	47	8.4	59	51	55	12.8
22	47	44	46	7.8	58	54	56	13.4
23	49	43	46	7.8	62	52	57	13.9
24	44	43	44	6.7	64	54	59	15.0
25	45	43	44	6.7	69	56	63	17.2
26	49	44	47	8.4	65	56	61	16.1
27	47	42	45	7.2	57	55	56	13.4
28	48	42	45	7.2	64	53	60	15.6
29	44	40	42	5.6	64	57	61	16.1
30	47	40	44	6.7	63	54	59	15.0
31					62	50	56	13.4

TABLE A-I. (contd)

Avery Road Station

Day of Month	June				July			
	Max, °F	Min, °F	Mean		Max, °C	Min, °F	Mean	
			°F	°C			°F	°C
1	62	54	58	14.5	82	65	74	23.4
2	68	58	63	17.2	88	66	77	25.0
3	69	60	65	18.4	80	68	74	23.4
4	71	58	65	18.4	70	64	67	19.5
5	74	62	68	20.0	80	59	70	21.1
6	75	65	73	22.8	78	65	72	22.2
7	75	61	68	20.0	83	67	75	23.9
8	74	64	69	20.6	75	69	72	22.2
9	70	65	68	20.0	79	61	70	21.1
10	68	66	67	19.5	79	63	71	21.7
11	74	63	69	20.6	77	62	70	21.1
12	76	68	72	22.2	84	66	75	23.9
13	80	68	74	23.4	82	70	76	24.5
14	72	66	69	20.6	75	70	73	22.8
15	65	60	63	17.2	70	66	68	20.0
16	72	56	64	17.8	67	64	66	18.9
17	77	60	69	20.6	72	64	68	20.0
18	80	61	71	21.7	81	67	74	23.4
19	79	63	71	21.7	85	69	77	25.0
20	78	64	71	21.7	79	70	75	23.9
21	70	64	67	19.5	85	69	77	25.0
22	70	64	67	19.5	76	75	76	24.5
23	77	64	71	21.7	76	75	76	24.5
24	73	68	71	21.7	82	77	80	26.7
25	77	62	70	21.1	87	74	81	27.2
26	71	62	67	19.5	84	72	78	25.6
27	79	62	71	21.7	86	70	78	25.6
28	80	63	72	22.2	84	70	77	25.0
29	83	65	74	23.4	82	72	77	25.0
30	82	69	76	24.5	85	70	78	25.6
31					84	72	78	25.6

TABLE A-I. (contd)

Avery Road Station

Day of Month	August				September			
	Max, °F	Min, °F	Mean		Max, °C	Min, °F	Mean	
			°F	°C			°F	°C
1	88	72	80	26.7	85	68	76	24.5
2	74	68	71	21.7	82	70	76	24.5
3	71	66	69	20.6	84	70	77	25.0
4	80	69	75	23.9	90	68	79	26.1
5	82	70	76	24.5	88	67	78	25.6
6	86	70	78	25.6	88	67	78	25.6
7	76	71	74	23.4	75	70	73	22.8
8	82	69	76	24.5	82	69	76	24.5
9	84	68	76	24.5	84	70	77	25.0
10	86	68	77	25.0	86	69	78	25.6
11	74	65	70	21.1	78	70	74	23.4
12	84	78	81	27.2	78	72	75	23.9
13	78	64	71	21.7	70	69	70	21.1
14	77	60	69	20.6	71	62	67	19.5
15	84	62	68	20.0	64	61	63	17.2
16	81	66	74	23.4	74	66	70	21.1
17	80	64	72	22.2	78	57	68	20.0
18	82	68	75	23.9	81	53	67	19.5
19	72	68	70	21.1	86	68	77	25.0
20	70	68	69	20.6	80	76	78	25.6
21	68	66	67	19.5	68	64	66	18.9
22	68	64	66	18.9	76	65	71	21.7
23	77	64	71	21.7	69	66	68	20.0
24	73	64	69	20.6				
25	77	64	71	21.7				
26	74	66	70	21.1				
27	82	68	75	23.9				
28	82	67	75	23.9				
29	76	69	73	22.8				
30	80	68	74	23.4				
31	78	68	73	22.8				

TABLE A-I. (contd)
Bardwell Bridge Station

Day of Month	April				May			
	Max, °F	Min, °F	Mean		Max, °C	Min, °F	Mean	
			°F	°C			°F	°C
1					45	40	43	6.1
2					45	42	44	6.7
3					44	39	42	5.6
4					47	40	44	6.7
5					48	42	45	7.2
6					50	46	48	8.9
7					50	46	48	8.9
8					55	46	51	10.6
9					55	50	53	11.7
10					50	49	50	10.0
11	35	35	35	1.7	52	47	50	10.0
12	41	34	38	3.4	52	48	50	10.0
13	40	32	36	2.2	58	49	54	12.2
14	34	32	33	0.6	61	54	58	14.5
15	41	32	37	2.8	63	48	56	13.4
16	41	32	37	2.8	65	60	63	17.2
17	39	32	36	2.2	60	57	59	15.0
18	38	33	36	2.2	59	55	57	13.9
19	38	35	37	2.8	56	52	54	12.2
20	38	35	37	2.8	55	51	53	11.7
21	49	45	47	8.4	57	50	54	12.2
22	49	43	46	7.8	57	52	55	12.8
23	42	42	42	5.6	58	52	55	12.8
24	43	41	42	5.6	61	52	57	13.9
25	44	42	43	6.1	64	53	59	15.0
26	47	42	45	7.2	62	58	60	15.6
27	46	40	43	6.1	62	53	58	14.5
28	47	41	44	6.7	57	52	55	12.8
29	47	41	44	6.7	59	52	56	13.4
30	45	40	43	6.1	60	53	57	13.9
31	45	40	43	6.1	61	48	55	12.8

TABLE A-I. (contd)

Bardwell Bridge Station

Day of Month	June				July			
	Max, °F	Min, °F	Mean		Max, °C	Min, °F	Mean	
			°F	°C			°F	°C
1	60	53	57	13.9	82	65	74	23.4
2	62	56	59	15.0	82	68	75	23.9
3	66	59	63	17.2	76	71	74	23.4
4	69	54	62	16.7	75	68	72	22.2
5	83	48	66	18.9	76	66	71	21.7
6	85	54	70	21.1	73	66	70	21.1
7	82	52	67	19.5	73	66	70	21.1
8	78	64	71	21.7	75	70	73	22.8
9	79	63	71	21.7	76	69	73	22.8
10	68	64	66	18.9	80	66	73	22.8
11	70	62	66	18.9	76	67	72	22.2
12	72	66	69	20.6	80	68	74	23.4
13	78	68	73	22.8	80	70	75	23.9
14	76	70	73	22.8	80	69	75	23.9
15	71	64	68	20.0	72	70	71	21.7
16	69	58	64	17.8	72	68	70	21.1
17	71	60	66	18.9	70	68	69	20.6
18	74	60	67	19.5	73	66	70	21.1
19	72	61	67	19.5	75	66	71	21.7
20	74	64	69	20.6	76	68	72	22.2
21	72	68	70	21.1	80	69	75	23.9
22	70	66	68	20.0	80	71	76	24.5
23	74	64	69	20.6	80	70	75	23.9
24	72	66	69	20.6	80	73	77	25.0
25	74	65	70	21.1	86	77	82	27.8
26	73	64	69	20.6	84	78	81	27.2
27	73	66	70	21.1	84	75	80	26.7
28	73	64	69	20.6	83	72	78	25.6
29	80	66	73	22.8	81	75	78	25.6
30	78	70	74	23.4	85	74	80	26.7
31					82	74	78	25.6

TABLE A-I. (contd)
Bardwell Bridge Station

Day of Month	August				September			
	Max, °F	Min, °F	Mean		Max, °C	Min, °F	Mean	
			°F	°C			°F	°C
1	84	74	79	26.1	78	71	75	23.9
2	76	71	74	23.4	76	72	74	23.4
3	75	70	73	22.8	76	72	74	23.4
4	74	70	72	22.2	82	73	78	25.6
5	80	70	75	23.9	78	72	75	23.9
6	81	72	77	25.0	80	75	78	25.6
7	78	72	75	23.9	78	74	76	24.5
8	78	72	75	23.9	79	79	79	26.1
9	82	71	77	25.0	82	71	77	25.0
10	78	71	75	23.9	82	70	76	24.5
11	78	73	76	24.5	78	70	74	23.4
12	77	68	73	22.8	79	74	77	25.0
13	78	68	73	22.8	76	74	75	23.9
14	75	64	70	21.1	74	72	73	22.8
15	74	64	69	20.6	72	70	71	21.7
16	75	70	73	22.8	71	64	68	20.0
17	74	67	71	21.7	71	60	66	18.9
18	73	68	71	21.7	68	58	63	17.2
19	75	66	71	21.7	66	59	63	17.2
20	76	68	72	22.2	68	64	66	18.9
21	72	70	71	21.7	66	65	66	18.9
22	74	70	72	22.2	68	64	66	18.9
23	70	67	69	20.6	72	68	70	21.1
24	69	67	68	20.0				
25	72	66	69	20.6				
26	72	68	70	21.1				
27	78	70	74	23.4				
28	78	68	73	22.8				
29	74	70	72	22.2				
30	74	70	72	22.2				
31	75	70	73	22.8				

TABLE A-I. (contd)
Stillwater Bridge Station

Day of Month	April				May			
	Max, °F	Min, °F	Mean		Max, °C	Min, °F	Mean	
			°F	°C			°F	°C
1					45	40	43	6.1
2					44	42	43	6.1
3					43	40	42	5.6
4					45	40	43	6.1
5					47	42	45	7.2
6					47	43	45	7.2
7					49	45	47	8.4
8					53	45	49	9.5
9					53	50	52	11.1
10					50	48	49	9.5
11	39	39	39	3.9	50	46	48	8.9
12	43	39	41	5.0	50	46	48	8.9
13	43	35	39	3.9	52	46	49	9.5
14	38	36	37	2.8	56	54	55	12.8
15	41	38	40	4.5	59	56	58	14.5
16	43	37	40	4.5	61	59	60	15.6
17	42	37	40	4.5	59	58	59	15.0
18	42	39	41	5.0	58	56	57	13.9
19	41	40	41	5.0	56	53	55	12.8
20	42	39	41	5.0	54	52	53	11.7
21	48	40	44	6.7	56	52	54	12.2
22	48	42	45	7.2	57	54	56	13.4
23	45	40	43	6.1	58	54	56	13.4
24	44	40	42	5.6	59	55	57	13.9
25	43	40	42	5.6	63	56	60	15.6
26	46	42	44	6.7	60	59	60	15.6
27	45	41	43	6.1	59	52	56	13.4
28	45	41	43	6.1	56	51	54	12.2
29	46	41	44	6.7	56	53	55	12.8
30	44	40	42	5.6	59	56	58	14.5
31					60	54	57	13.9

TABLE A-I. (contd)
Stillwater Bridge Station

Day of Month	June				July			
	Max, °F	Min, °F	Mean		Max, °C	Min, °F	Mean	
			°F	°C			°F	°C
1	58	55	57	13.9	76	72	74	23.4
2	62	58	60	15.6	74	72	73	22.8
3	64	60	62	16.7	74	74	74	23.4
4	68	60	64	17.8	74	71	73	22.8
5	69	64	67	19.5	72	70	71	21.7
6	68	64	66	18.9	71	69	70	21.1
7	71	66	69	20.6	72	68	70	21.1
8	70	67	69	20.6	72	70	71	21.7
9	70	67	69	20.6	72	70	71	21.7
10	66	66	66	18.9	71	70	71	21.7
11	68	66	67	19.5	71	70	71	21.7
12	69	67	68	20.0	73	70	72	22.2
13	74	68	71	21.7	73	72	73	22.8
14	73	71	72	22.2	72	72	72	22.2
15	71	65	68	20.0	72	72	72	22.2
16	68	63	66	18.9	72	72	72	22.2
17	69	62	66	18.9	72	72	72	22.2
18	71	64	68	20.0	72	72	72	22.2
19	70	65	68	20.0	72	72	72	22.2
20	72	66	69	20.6	72	72	72	22.2
21	70	68	69	20.6	73	72	73	22.8
22	68	66	67	19.5	73	73	73	22.8
23	70	65	68	20.0	73	72	73	22.8
24	68	67	68	20.0	73	72	73	22.8
25	70	68	69	20.6	73	72	73	22.8
26	70	67	69	20.6	73	72	73	22.8
27	70	68	69	20.6	73	72	73	22.8
28	70	67	69	20.6	73	72	73	22.8
29	73	68	71	21.7	73	73	73	22.8
30	76	72	74	23.4	73	72	73	22.8
31					73	72	72	22.2

TABLE A-I. (contd)
Stillwater Bridge Station

Day of Month	August				September			
	Max, °F	Min, °F	Mean		Max, °C	Min, °F	Mean	
			°F	°C			°F	°C
1	73	73	73	22.8	72	71	72	22.2
2	73	72	73	22.8	71	71	71	21.7
3	72	72	72	22.2	72	72	72	22.2
4	72	70	71	21.7	71	71	71	21.7
5	71	70	71	21.7	72	72	72	22.2
6	71	70	71	21.7	72	72	72	22.2
7	71	70	71	21.7	72	72	72	22.2
8	71	70	71	21.7	73	72	73	22.8
9	71	70	71	21.7	73	73	73	22.8
10	71	70	71	21.7	73	73	73	22.8
11	71	71	71	21.7	73	72	73	22.8
12	71	71	71	21.7	73	73	73	22.8
13	71	70	71	21.7	73	72	73	22.8
14	70	70	70	21.1	72	72	72	22.2
15	71	70	71	21.7	73	72	73	22.8
16	71	70	71	21.7	73	72	73	22.8
17	70	70	70	21.1	72	72	72	22.2
18	71	70	71	21.7	72	72	72	22.2
19	71	71	71	21.7	72	72	72	22.2
20	71	71	71	21.7	72	72	72	22.2
21	70	70	70	21.1	72	72	72	22.2
22	71	70	71	21.7	72	72	72	22.2
23	70	70	70	21.1	72	72	72	22.2
24	70	70	70	21.1				
25	71	71	71	21.7				
26	70	70	70	21.1				
27	71	71	71	21.7				
28	72	71	72	22.2				
29	72	71	72	22.2				
30	71	71	71	21.7				
31	71	71	71	21.7				

TABLE A-II. Hypothetical 300 MW Heat Additive to the Deerfield River

April 1961	Temp. with Heat Added (°C)	Normal Temp. (°C)	Diff. Temp. (°C)	Entering Diff. Temp. (°C)	Remaining Heat (°C)
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11	4.925	3.827	1.098	1.7	0.646
12	7.016	5.353	1.663	2.4	0.693
13*					
14	9.307	7.402	1.905	3.2	0.595
15	10.919	7.560	3.359	3.7	0.908
16*					
17	9.391	8.163	1.228	1.5	0.819
18	9.494	8.227	1.267	1.6	0.792
19	8.640	7.345	1.295	1.7	0.762
20	10.540	8.745	1.795	2.4	0.748
21	11.174	9.861	1.313	1.6	0.821
22	9.077	8.184	0.893	1.0	0.893
23	6.958	6.501	0.457	0.5	0.914
24	6.782	6.036	0.746	0.8	0.933
25	7.047	6.322	0.725	0.8	0.906
26	6.763	6.140	0.623	0.7	0.890
27	6.565	6.009	0.556	0.6	0.927
28	7.246	6.617	0.629	0.7	0.899
29	5.608	5.052	0.556	0.6	0.927
30	6.328	5.691	0.637	0.7	0.910

* Missing data denotes periods where time of travel did not permit simplified comparisons

TABLE A-II. (contd)

May 1961	Temp. with Heat Added (°C)	Normal Temp. (°C)	Diff. Temp. (°C)	Entering Diff. Temp. (°C)	Remaining Heat (°C)
1	6.677	5.948	0.729	0.8	0.911
2	5.006	4.274	0.732	0.8	0.915
3	6.749	5.975	0.774	0.9	0.860
4	7.860	6.927	0.933	1.1	0.848
5	8.795	7.803	0.992	1.2	0.827
6	11.313	9.763	1.550	2.0	0.775
7	10.660	9.459	1.201	1.6	0.751
8	10.550	9.398	1.152	1.4	0.823
9	11.132	10.070	1.062	1.3	0.817
10	9.051	8.346	0.705	0.8	0.881
11	10.230	9.397	0.833	0.9	0.926
12	10.596	9.718	0.878	1.0	0.976
13	13.722	12.626	1.096	1.3	0.843
14	17.025	15.437	1.588	2.1	0.756
15	19.439	18.224	1.215	2.1	0.579
16	15.259	13.285	1.974	2.2	0.898
17	15.628	13.488	2.140	2.8	0.764
18	16.463	13.471	2.992	4.9	0.611
19	16.844	13.221	3.623	4.1	0.884
20	16.721	13.087	3.634	6.2	0.586
21	14.527	12.750	1.777	12.6	0.141
22	16.564	13.678	2.886	7.5	0.385
23	18.278	14.852	3.426	6.0	0.571
24	20.474	17.221	3.253	6.7	0.486
25	21.996	17.233	4.763	6.2	0.768
26	17.948	15.154	2.794	5.1	0.548
27	18.549	15.974	2.575	2.8	0.920
28	17.214	15.296	1.918	6.9	0.278
29	13.351	12.201	1.150	6.7	0.172
30	14.541	13.440	1.101	10.4	0.106
31	19.125	16.866	2.349	5.3	0.443

TABLE A-II. (contd)

June 1961	Temp. with Heat Added (°C)	Normal Temp. (°C)	Diff. Temp. (°C)	Entering Diff. Temp. (°C)	Remaining Heat (°C)
1	18.902	15.525	3.377	5.6	0.603
2	21.524	17.122	4.402	5.2	0.847
3	20.203	16.117	4.086	16.0	0.255
4	20.401	19.607	0.794	14.1	0.056
5	21.182	19.256	1.926	5.5	0.350
6	21.466	20.090	1.376	7.3	0.188
7	21.983	20.500	1.483	6.7	0.221
8	23.064	22.224	0.840	6.3	0.133
9	23.527	22.084	1.443	4.2	0.344
10	22.581	20.693	1.888	10.9	0.173
11	24.425	23.041	1.384	10.0	0.138
12	23.197	21.403	1.794	3.2	0.561
13	26.774	22.414	4.360	5.0	0.872
14	24.907	22.745	2.162	4.8	0.450
15	25.554	23.718	1.836	8.3	0.221
16	25.284	24.183	1.101	10.0	0.110
17	22.557	21.428	1.129	24.0	0.047
18*					
19	25.304	21.880	3.424	5.7	0.601
20	24.446	23.229	1.217	5.0	0.243
21	23.144	22.105	1.039	4.6	0.226
22	23.879	21.786	2.093	4.5	0.465
23	23.066	20.637	2.429	6.3	0.386
24	20.859	20.060	0.799	12.6	0.063
25	21.305	20.565	0.740	21.8	0.034
26	23.183	21.217	1.966	6.3	0.312
27	23.971	21.295	2.676	8.0	0.335
28	23.517	22.249	1.268	7.7	0.165
29	27.137	22.296	4.841	7.5	0.645
30	23.612	22.641	0.971	7.7	0.126

* Missing data denotes periods where time of travel did not permit simplified comparisons

TABLE A-II. (contd)

July 1961	Temp. with Heat Added (°C)	Normal Temp. (°C)	Diff. Temp. (°C)	Entering Diff. Temp. (°C)	Remaining Heat (°C)
1	24.611	22.557	2.054	20.0	0.103
2	25.627	23.171	2.456	26.7	0.092
3	24.695	23.763	0.932	12.0	0.078
4	23.844	22.992	0.852	20.0	0.043
5*					
6	22.952	22.422	0.530	6.2	0.085
7	23.881	22.414	1.467	6.5	0.226
8	25.935	22.273	3.662	17.1	0.214
9*					
10	21.973	21.745	0.228	30.0	0.008
11	23.745	22.398	1.347	30.0	0.045
12	25.904	23.708	2.196	26.7	0.082
13	23.550	23.528	0.022	21.8	0.001
14	22.600	21.197	1.403	10.0	0.140
15	22.033	21.484	0.549	18.5	0.030
16	23.399	21.918	1.481	20.0	0.074
17*					
18*					
19	27.772	25.040	2.732	12.6	0.217
20	27.188	23.256	3.932	14.1	0.279
21	26.826	25.180	1.646	14.1	0.117
22	26.755	24.141	2.614	14.1	0.185
23*					
24	26.190	23.975	2.215	9.2	0.241
25	26.626	25.244	1.382	7.5	0.184
26	28.863	26.596	2.267	6.9	0.329
27	29.327	26.390	2.937	8.0	0.367
28	29.520	27.065	2.455	9.6	0.256
29	26.287	24.638	1.649	30.0	0.055
30	29.497	27.180	2.317	21.8	0.106
31	27.702	26.651	1.051	10.0	0.105

* Missing data denotes periods where time of travel did not permit simplified comparisons

TABLE A-II. (contd)

August 1961	Temp. with Heat Added (°C)	Normal Temp. (°C)	Diff. Temp. (°C)	Entering Diff. Temp. (°C)	Remaining Heat (°C)
1	25.958	24.976	0.982	8.9	0.110
2	25.764	24.937	0.827	8.9	0.093
3*					
4	25.352	23.688	1.664	4.2	0.396
5	23.971	23.435	0.536	8.3	0.065
6	23.193	22.603	0.590	34.3	0.017
7	22.152	21.268	0.884	3.6	0.246
8	24.575	21.909	2.666	5.9	0.452
9*					
10	24.558	23.627	0.931	4.5	0.207
11	26.753	24.039	2.714	3.8	0.714
12	26.265	24.183	2.082	14.1	0.148
13	24.458	22.830	1.628	26.7	0.061
14	24.092	21.973	2.119	9.6	0.221
15	24.591	22.640	1.951	6.5	0.300
16	22.651	21.064	1.587	5.2	0.305
17	24.540	20.931	3.609	4.8	0.752
18	24.920	21.842	3.078	4.5	0.684
19	25.223	22.284	2.939	10.0	0.294
20	23.564	22.730	0.834	26.7	0.031
21	22.933	21.237	1.696	5.5	0.308
22*					
23*					
24	23.299	20.420	2.879	4.1	0.702
25	21.751	20.641	1.110	4.3	0.258
26	22.661	20.058	2.603	10.9	0.239
27	23.779	21.470	2.309	20.0	0.115
28	24.908	22.757	2.151	6.0	0.359
29*					
30*					
31	24.702	22.522	2.180	5.1	0.427

* Missing data denotes periods where time of travel did not permit simplified comparisons

FIGURE A-1. Typical View of Deerfield River in the Vicinity of the Hoosac Tunnel

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FIGURE A-2. Florida Bridge on the Deerfield River at Mile 31.1

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