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TEMPERATURE OF THE COLUMBIA RIVER
BETWEEN PRIEST RAPIDS, WASHINGTON
AND UMATILLA, OREGON

October 5, 1955

GENERAL ELECTRIC

HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

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TEMPERATURE OF THE COLUMBIA RIVER
BETWEEN PRIEST RAPIDS, WASHINGTON AND UMATILLA, OREGON

By

Royal E. Rostenbach
Radiological Engineering Section
Radiological Sciences Department

October 5, 1955

HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

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TEMPERATURE OF THE COLUMBIA RIVER
BETWEEN PRIEST RAPIDS, WASHINGTON AND UMATILLA, OREGON

I. INTRODUCTION

This report brings together certain temperature information of the Columbia River which is related to the Hanford plant of the United States Atomic Energy Commission. The information includes data from the Fish and Wildlife Service, United States Department of the Interior⁽¹⁾; Corps of Engineers, U.S. Army⁽²⁾; and data from Power Sub-Section, Reactor Section, Manufacturing Department⁽³⁾, and Biophysics Section, Radiological Sciences Department⁽⁴⁾, Hanford Atomic Products Operation, General Electric Company.

The temperature of the Columbia River is important for a number of reasons including the possible effect on aquatic life especially the habitat for salmon and the supply of cooling water for the Hanford reactors. Since the heated cooling waters from these atomic reactors are returned to the Columbia River without substantial cooling, the resulting river water temperature increase is monitored.

Climatic conditions influence greatly the temperature and flow of the river. Of these, the solar heating effects are very important. In this review the flow and temperature of both the Columbia and Snake Rivers are considered.

II. SUMMARY

Temperature data of the Columbia River between Priest Rapids, Washington and Umatilla, Oregon have been summarized from several sources for the 1944-55 period. The Snake River has a substantial influence on the temperature of the Columbia River. In general, the

temperature of the Columbia River at Umatilla, Oregon and at McNary Dam in recent years is greater during the months of March through August than in the upper reaches of the river near Coyote Rapids above Hanford operations. These higher temperatures are due primarily to the Snake River as evidenced by the June, July, and August data. The temperature differential during summer months between Priest Rapids and Pasco (above and below the heated cooling water discharge points of the Hanford reactors) is less than the temperature differential between Pasco and Umatilla (the area into which the Snake River discharges). The months of September and February appear to be transitional months. For the period of October through January the Columbia River near Coyote Rapids is warmer than it is at Umatilla and McNary Dam. The cooling conditions are believed to be due primarily to the Snake River because during the November 1954-January 1955 period the reservoir at McNary Dam cooled faster than the temperature change near Coyote Rapids. Other cooling effects include the large water surface area of the reservoir.

The temperature of the reservoir behind McNary Dam is influenced by the flow and temperature of the Snake and Columbia Rivers. From October through February the flow of the Columbia River is three to four times that of the Snake River. In the remaining portion of the year, March through September, each river has its own flow pattern for the most part depending on climatic conditions and flood control practices. The Snake usually has its peak flow one to two months earlier than that of the Columbia. It is possible for short periods in April and/or May for the flow of the Snake to equal or be greater than that of the Columbia River.

The temperatures of McNary Reservoir 3000 feet above the dam indicate that there was little temperature difference between the surface and the bottom during November 1954-February 1955. In April 1955 the surface water became slightly warmer and the warmer water extends deeper during the following summer months. With the exception of the higher temperatures in the shallow sections there is a relatively small

temperature variation across the reservoir. The average temperature of the reservoir decreased from 11.1°C on November 17, 1954 to 4.2°C on January 13, 1955, and increased gradually to 20.3°C on September 8, 1955.

Natural climatic and river conditions cause daily temperature variations in the unrestricted flow areas of the rivers. In general a maximum temperature change of 2° to 4°F is common for one or more days during a month in the Columbia and Snake rivers. Also, on one or more days during a month the minimum change is 0° to 2°F .

From the data it is not possible to determine the effect of the heated cooling waters of the Hanford reactors on the Columbia River primarily because of the effect of the Snake River and climatic and flow conditions.

III. CONCLUSION

Other temperature variations of the Columbia River are generally greater than the effect of the effluents of the Hanford reactors. These variations are due primarily to natural causes such as climatic and flow conditions. The Snake River has had a significant effect on the Columbia River and has a similar effect now on the reservoir behind McNary Dam. Additional temperature variations are expected as more of the land in the vicinity becomes irrigated, and as dams and reservoirs are established on the Columbia River and its tributaries.

IV. GEOGRAPHICAL AREA

This report deals with the Columbia River between Priest Rapids in Washington and Umatilla, Oregon. Coyote Rapids which lie within the Hanford reservation are approximately 11 miles downstream from the Priest Rapids. The Yakima River discharges into the Columbia River near Richland, Washington. Pasco, Washington and Kennewick, Washington are located downstream on each side of the river approximately four miles above the mouth of the Snake River. Approximately ten miles downstream from the Snake the Walla Walla River, a small tributary, discharges into McNary Reservoir. McNary Dam is located a few miles upstream

from Umatilla, Oregon. The backwater from McNary Dam extends approximately 60 miles to a point approximately 15 miles above Richland, Washington.

The mileage from the mouth of the Columbia River for the locations used in this report are presented in Appendix 1.

V. DATA

A. Temperature of Columbia River From Hanford Reservation Near Coyote Rapids to McNary Dam and Umatilla, Oregon

The monthly average daily temperature of the Columbia River, as it enters the Hanford reservation near Coyote Rapids, is compared in Table 1 with the monthly daily average maximum and daily average minimum temperature of the river at Umatilla, Oregon for the 1950-1954 period. Table 2 is a continuation of similar data in Table 1 except that the downstream point is McNary Dam. The dam was completed in December 1953 and is approximately 2.7 miles above the Umatilla temperature recording station.

The means by which the river temperatures are determined at each location are given in Appendix 2.

B. Temperature Differential Between Coyote Rapids and Umatilla, Oregon and McNary Dam

There are tabulated in Table 3 and Table 4 the calculated temperature differences between Coyote Rapids and Umatilla, Oregon and McNary Dam using data from Table 1 and Table 2. From these data, in general, the average river temperatures are greater at Umatilla and McNary Dam during the period of March through September and are less at these points from October through January than that reported near Coyote Rapids.

C. Summer Temperatures for the Columbia and Snake Rivers

The temperature of the Columbia River is of greater concern during the summer months. Table 5 presents data for direct

comparison of the monthly averages of daily maximum and minimum temperature of the Columbia River at Priest Rapids, above the Hanford operations; at Pasco, Washington, downstream from the Hanford operations and upstream from the mouth of the Snake River; and at Umatilla, Oregon; and of the Snake River near its mouth at Sacajawea State Park.

The 1944 data may represent the temperature of the Columbia River before the period of full operations of the Hanford reactors since operation of the first reactor began in September 1944. The data for 1952 represents the last summer of normal flow for the Columbia River prior to the establishment of McNary reservoir in 1953.

It is interesting to note that the Snake River's temperature exceeds the temperature of the Columbia River during June, July, and August. This is also true for September in the years 1947, 1949, and 1950.

Because the temperature range and especially the maximum summer temperatures are important, the monthly maximum and minimum daily temperatures at the foregoing three Columbia River and one Snake River locations are given in Table 6. The highest temperature recorded for one or more days during the month is the monthly maximum while the lowest temperature recorded for one or more days during the month is the monthly minimum. The maximum temperatures and, in most cases, the minimum temperatures recorded for the Snake River are greater than the temperatures of the Columbia River.

Climatic conditions and other factors result in daily temperature changes in the river. Table 7 summarizes daily temperature changes of the Columbia and Snake Rivers. The maximum and the minimum changes are given for one or more days during each month. For example, "6°F" is recorded for the maximum change at Umatilla, Oregon for July 1944. The highest temperature on July 18, 1944 is reported as 72°F.; the lowest temperature for this day is given as 66°F.; the difference is 6°F.; there were other days too with a difference of 6°F. At the same location in

August 1944 four days are reported in which there were no changes in daily temperature, namely 68°F. The one temperature represented both the maximum and minimum daily temperature, hence "0. °F." is recorded for August 1944 as the minimum change at Umatilla, Oregon. In general, a range of 2° to 4°F is common for one or more days during a month for the maximum temperature change of the Columbia and Snake Rivers. The data also show that on one or more days during a month the minimum change is 0° to 2°F.

The temperature recording station at Pasco, Washington is the first one below the Hanford operations hence it is interesting to note the temperature differential between Priest Rapids and Pasco. Table 8 presents the calculated differences in monthly average daily maximum and minimum temperatures from Table 5. In some months the average maximum temperature at Priest Rapids is greater than that at Pasco as indicated by negative quantities and for two months the average minimum at Priest Rapids is greater than that at Pasco. To balance these unusual data there are the positive differences of greater minimum temperatures of June 1947, August 1949, and September 1949.

In order to relate the temperature data secured at Priest Rapids above the Hanford reservation with that within the reservation near Coyote Rapids, the average river temperatures for the summer months of 1950 and 1951 are reported in Table 9. The average water temperature within the reservation is less than the average maximum and greater than the average minimum temperature at Priest Rapids. This observation is expected because the distance between the geographical points is approximately 11 miles.

D. Comparison of Temperatures of Columbia and Snake Rivers
in the Vicinity of Pasco, Washington and Umatilla, Oregon,
1947 - 1952

It has been noted heretofore that the temperature of the Snake River is greater than that of the Columbia River for the summer

months. Table 10 presents the calculated differences in the monthly average daily maximum and minimum temperatures of the Snake River and the Columbia River at Pasco, Washington four miles above the mouth of the Snake River. With exception of the minimum averages for September 1951 and 1952 the average temperatures of the Snake River are greater than the temperatures of the Columbia River.

To note further the temperature effect of the Snake River (and Walla Walla River which is only a minor tributary of the Columbia) there is presented in Table 11 the calculated differences in monthly average daily maximum and minimum temperatures of the Columbia River at Pasco, Washington and Umatilla, Oregon. For the months of June, July, and August the temperatures at Umatilla are, with a few exceptions, greater than those at Pasco. In September, however, the data indicate the river to be generally cooler at Umatilla.

E. Temperature of McNary Reservoir

The temperature of McNary Reservoir water as it passes through the power plant of McNary Dam is summarized in Table 2. In order to supplement the general information and to learn more about the McNary Reservoir, temperature measurements were observed once a month 3000 feet above the dam. The temperature data were collected at 10 to 12 locations across the reservoir by means of a Thermarine, an instrument which records temperature vs. depth. This series of measurements was started on November 17, 1954.

Tables indicating the temperature at various locations across McNary reservoir are incorporated in Appendix 3. The calculated average temperature from these tables is given in both degrees Centigrade and Fahrenheit in Table 12.

The McNary Reservoir temperature observations are discussed in a following section of this report.

F. Comparative Discharges of Columbia and Snake Rivers

Since the flows and temperatures of the Columbia and Snake Rivers directly affect the resulting temperature of the Columbia River below the mouth of the Snake River, the discharges of these rivers and the releases from the reservoir by McNary Dam are given in Table 13 for the period December 1953 through August 1955.

The future flows based on the 1960-61 level of Columbia River system development are presented in Table 14. These flows take into account long-term past averages, new or planned storage reservoirs, and usage for and return water from irrigation projects many of which have been installed in the past few years. From October through February the flow of the Columbia River is three to four times that of the Snake River. In the remaining portion of the year, March through September, each river has its own flow pattern for the most part depending on climatic conditions and flood control practices. The Snake River usually has its peak flow one or two months earlier than the Columbia River. It is possible for short periods in April and/or May for the flow of the Snake River to equal or to be greater than that of the Columbia River.

VI. DISCUSSION

Because of the limitations in making temperature measurements of large bodies of water and the temperature fluctuations of rivers which can be experienced during a day, as noted in Table 7, the data have been averaged in most of the considerations to minimize individual irregularities of the data. It is assumed for this review that the daily maximum, minimum, and average temperature data used in this report are representative of the river temperature at each specific location and are representative of the cross-section at that location. It is realized that instrument and human errors are possible. The monthly average daily maximum temperature is an arithmetical average of the daily maximum temperatures

for the calendar month. Likewise, the monthly average daily minimum temperature is an arithmetical average of the daily minimum temperatures for the month. The monthly average daily temperature is an arithmetical average of daily temperatures reported during a calendar month. In this review only complete monthly or representative monthly data are used in the summary tables, thus certain omissions have been made in the tables of this report.

The striking influence of the Snake River on the temperature of the Columbia River is significant. In general, the temperature of the Columbia River at Umatilla, Oregon before the completion of McNary Dam, and the reservoir above McNary Dam in recent years is greater during the months of March through August than in the upper reaches of the river in the Hanford reservation. During the summer months of June, July, and August the temperature difference between Priest Rapids and Pasco, points above and below the Hanford operations, is generally less than the difference between Pasco and Umatilla. In the Priest Rapids-Pasco section the river receives the warm cooling waters of the Hanford reactors, irrigation return-water from the Columbia Basin Project and the Yakima River while the Snake and Walla Walla Rivers discharge into the Columbia River below Pasco and above Umatilla. For this summer period the monthly maximum and monthly average daily maximum and minimum temperatures of the Snake River are greater than those of the Columbia River at Pasco and Umatilla. In general, for the period of October through January the Columbia River near Coyote Rapids is warmer than it is at Umatilla and McNary Dam. This is believed to be due again primarily to the influence of the Snake River. The months of September and February seem to cover transitional periods.

The temperature of the reservoir behind McNary Dam is influenced by the combined flow and temperature of the Snake River and the Columbia River. During the November 1954-March 1955 period the flow ratios of the upper Columbia River (Columbia River above the mouth

of the Snake River) and the Snake River was 3.5 to 1 (Table 12). The monthly averages of daily temperatures of the Columbia River near Coyote Rapids and at McNary Dam (Table 2) indicate that the Snake River and other factors were cooling the reservoir faster during the November 1954-January 1955 period than the temperature change near the Coyote Rapids. The other factors include the large water surface cooling effect of the reservoir. During February and March 1955 the temperature of the reservoir remained at approximately 40° F while the temperature near Coyote Rapids continued to decrease a few more degrees.

In April 1955 the ratio changed appreciably because of the higher flows of the Snake River; the ratio was 1.7 to 1 for the Columbia and Snake Rivers, respectively. In May the average flow of the Snake River exceeded the flow of the Columbia River; the ratio was 0.9 to 1. During these months and for the June-August period which followed, the temperature of the reservoir water was higher than that temperature near Coyote Rapids. These summer conditions of water temperature are similar to river conditions prior to the establishment of McNary Dam (Tables 3 and 10).

The temperature of McNary Reservoir at any one time is represented by the tables in Appendix 3. In general, for November 17 and December 16, 1955, there was no significant difference in water temperature between the surface and near the bottom at the various locations across the reservoir. No observations were made in March 1955. On April 21, 1955, noticeable changes were noted. The temperature varied from 7.3°C to 8.1°C. The maximum variation with depth at any one location was 0.8°C. The average surface water temperature was 7.6°C and the average bottom water temperature was 7.4°C. The data indicate slightly higher temperatures within the quarter section of the reservoir near the Oregon shore. By this time the flow of the Snake River had doubled and the flow ratio of the two rivers had changed as noted heretofore. On May 19, 1955, the temperature variation was

greater. The temperature near the bottom varied from 9.8°C to 10.7°C . The maximum of 15°C was observed at the surface near the Washington shore. Under these conditions an average temperature was calculated as 10.3°C . The lower temperature at the Oregon side seemed to have some relationship to the powerhouse section of the dam. However, there is only a small variation in temperature across the reservoir below the 30 foot level. This date was prior to the high water due to the upper Columbia; the flows of the Columbia and Snake Rivers were approximately equal. The surface water temperature varied from 13.3°C to 14.1°C on June 16, 1955. In the deepest section, 68 to 85-foot depth, the temperature was 13.3°C - 13.4°C ; the higher temperatures were near each shore. With the exception of the first 10 feet of the reservoir, which was slightly warmer, the condition was similar to the previous November-February situation noted above. On July 14, 1955, the average temperature had increased approximately 2.7°C since June 16, 1955. The temperature range was generally 16°C - 17°C with a high of 18°C in the shallow water near the Washington shore. On August 11, 1955, the surface water ranged from 20.2° to 20.9°C while the bottom temperature was 18.9° to 19.5°C . It is interesting to note that on August 8, 1955, three days before the temperature was determined above McNary Dam, the temperature at 12 points across the reservoir at Pasco-Kennewick area was determined by the Thermarine method. The temperature range was 17.4°C - 18.4°C and the average was calculated as 17.9°C . These data compare with the temperature range of 19.1° - 20.9°C and a calculated average of 19.5°C at McNary Dam. This is equivalent to a bulk temperature increase of 1.6°C or 2.9°F . This is a reasonable increase considering the data of higher river temperatures of the Snake River and the large reservoir surface subject to solar heating. By September 8, 1955, the surface water temperature had increased slightly to 20.4° - 21.0°C and the bottom temperature to 19.7° - 21.0°C . The average calculated temperature is 20.3°C . It is anticipated that the temperature will be lower in October as indicated in Tables 1, 2 and 6.

VII. ACKNOWLEDGEMENTS:

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- (a) Pacific Salmon Investigation, Fish and Wildlife Service, U. S. Department of the Interior, Seattle, Washington for a copy of temperature records on the Columbia and Snake Rivers;
- (b) McNary Dam, Walla Walla District, Corps of Engineers, U. S. Army for temperature and flow information;
- (c) Geological Survey, U. S. Department of Interior, Portland, Oregon for flow information;
- (d) Power Sub-Section, Reactor Section, Manufacturing Department and Biophysics Section, Radiological Sciences Department, Hanford Atomic Products Operations General Electric Company for field data and computations.

Royal E. Rostenbach

RER:dt

TABLE 1

Monthly Averages of Daily Temperatures of
Columbia River near Coyote Rapids, Washington and
Monthly Averages of Daily Maximum and Minimum Temperatures of
Columbia River at Umatilla, Oregon in Degrees Fahrenheit

		Coyote Rapids, Washington*		Umatilla Oregon**
<u>Year</u>	<u>Month</u>	<u>Average</u>	<u>Average Maximum</u>	<u>Average Minimum</u>
1950	April	-	47.7	46.4
	May	-	52.6	51.2
	June	54.0	56.2	54.9
	July	59.7	63.8	62.2
	August	64.8	68.4	66.6
	September	64.0	66.2	64.3
	October	58.1	57.9	56.8
	November	51.4	49.8	49.1
	December	45.1	44.6	43.9
1951	January	40.1	40.5	39.6
	February	37.0	39.8	39.0
	March	37.9	42.1	41.0
	April	43.3	50.1	48.9
	May	49.8	54.0	52.9
	June	54.5	59.0	57.9
	July	61.2	65.6	61.1
	August	64.4	67.8	66.4
	September	64.2	65.1	63.7
	October	59.4	58.1	56.9
	November	51.1	48.6	47.9
	December	43.9	40.3	39.5
1952	January	38.5	36.5	35.9
	February	-	38.0	37.3
	March	38.7	41.9	40.8
	April	45.5	50.2	49.1
	May	51.6	53.7	52.8
	June	56.8	59.0	57.8
	July	61.9	65.4	64.2

TABLE 1 (Continued)

<u>Year</u>	<u>Month</u>	Coyote Rapids, Washington*	Umatilla Oregon**	
		<u>Average</u>	<u>Average Maximum</u>	<u>Average Minimum</u>
1952	August	64.9	67.8	66.5
	September	64.2	65.5	64.2
	October	61.7	60.4	59.6
	November	53.1	50.0	49.1
	December	46.4	44.3	43.8
1953	January	43.3	43.2	42.6
	February	42.1	42.6	41.8
	March	42.1	44.6	43.8
	April	45.0	-	-
	May	51.1	-	-
	June	55.9	57.1	56.3
	July	60.4	63.2	62.3
	August	64.6	-	-
	September	63.3	65.5	64.2
	October	59.7	59.4	58.3
	November	52.9	51.7	50.9
	December	46.2	44.9	44.4
1954	January	41.0	39.3	38.9
	February	39.9	40.2	39.5
	March	39.6	43.4	42.3
	April	43.9	44.3	43.0
	May	50.7	-	-
	June	53.4	-	-

* Data summarized from General Electric Company information.

** Data summarized from Fish and Wildlife Service information.

TABLE 2

Monthly Averages of Daily Temperatures of Columbia River near
Coyote Rapids, Washington and McNary Dam in Degrees Fahrenheit

<u>Year</u>	<u>Month</u>	<u>Coyote Rapids Washington*</u>	<u>McNary Dam**</u>
1954	July	58.1	60.0
	August	61.7	63.7
	September	61.5	63.1
	October	56.3	56.4
	November	52.0	51.7
	December	44.8	43.6
1955	January	41.2	40.3
	February	38.5	40.0
	March	37.4	40.2
	April	41.5	46.2
	May	48.4	53.2
	June	54.2	56.7
	July	55.4	60.3
	August	62.9	66.1

* Data summarized from General Electric Company information.

** Data summarized from Corps of Engineers information.

TABLE 3

Differences in Monthly Averages of Daily Temperatures of
Columbia River near Coyote Rapids, Washington and
Umatilla, Oregon in Degrees Fahrenheit

<u>Year</u>	<u>Month</u>	<u>Maximum *</u>	<u>Minimum**</u>
1950	June	2.2	0.9
	July	4.1	2.5
	August	3.6	1.8
	September	2.2	0.3
	October	-0.2	-1.3
	November	-1.6	-2.3
	December	-0.5	-1.2
1951	January	0.4	-0.5
	February	2.8	2.0
	March	4.2	3.1
	April	6.8	5.6
	May	4.2	3.1
	June	4.5	3.4
	July	4.4	-0.1
	August	3.4	2.0
	September	0.9	-0.5
	October	-1.3	-2.5
	November	-2.5	-3.2
	December	-3.6	-4.4
1952	January	-2.0	-2.6
	February	-	-
	March	3.2	2.1
	April	4.7	3.6
	May	2.1	1.2
	June	2.2	1.0
	July	3.5	2.3
	August	2.9	1.6
	September	1.3	0.0
	October	-1.3	-2.1
	November	-3.1	-4.0
	December	-2.1	-2.6

TABLE 3 (Continued)

<u>Year</u>	<u>Month</u>	<u>Maximum*</u>	<u>Minimum**</u>
1953	January	-0.1	-0.7
	February	0.5	-0.3
	March	2.5	1.7
	April	-	-
	May	-	-
	June	1.2	0.4
	July	2.8	1.9
	August	-	-
	September	2.2	0.9
	October	-0.3	-1.4
	November	-1.2	-2.0
	December	-1.3	-1.8
1954	January	-1.7	-2.1
	February	0.3	-0.4
	March	3.8	2.7
	April	0.4	-0.9

* Monthly average of daily maximum temperatures at Umatilla, Oregon less the monthly average of daily temperatures near Coyote Rapids, Washington.

** Monthly average of daily minimum temperatures at Umatilla, Oregon less the monthly average of daily temperatures at Coyote Rapids, Washington.

TABLE 4

Differences in Monthly Averages of Daily Temperature of
Columbia River near Coyote Rapids, Washington and
McNary Dam in Degrees Fahrenheit

<u>Year</u>	<u>Month</u>	<u>Average*</u>
1954	July	1.9
	August	2.0
	September	1.6
	October	0.1
	November	-0.3
	December	-1.2
1955	January	-0.9
	February	1.5
	March	2.8
	April	4.7
	May	4.8
	June	2.5
	July	4.9
	August	3.2

* Monthly average of daily temperatures at McNary Dam less the monthly average daily temperature near Coyote Rapids, Washington.

TABLE 5

Monthly Averages of Daily Maximum and Minimum Temperatures of
Columbia and Snake Rivers in Degrees Fahrenheit**

Year	Month	Columbia River				Umatilla, Oregon		Snake River	
		Priest Rapids, Washington		Pasco, Washington		Avg. Max.	Avg. Min.	Sacajawea State Park Washington	
		Avg. Max.	Avg. Min.	Avg. Max.	Avg. Min.			Avg. Max.	Avg. Min.
1944*	July	-	-	66.0	63.3	68.7	65.3	-	-
	August	-	-	68.7	66.2	69.3	68.3	-	-
	September	65.1	63.8	65.9	64.5	-	-	-	-
1945	June	-	-	57.1	55.6	58.4	57.1	-	-
	July	-	-	64.7	62.4	65.4	64.2	-	-
	August	-	-	68.1	65.7	-	-	-	-
	September	-	-	64.5	62.9	-	-	-	-
1946	June	-	-	57.5	56.7	-	-	-	-
	July	-	-	62.9	61.1	64.4	63.2	-	-
	August	-	-	67.9	65.5	68.9	67.3	-	-
	September	65.1*	64.2*	65.1	63.3	-	-	-	-
1947	June	57.4	54.9	58.2	57.0	59.6	58.2	61.5	60.4
	July	62.9	60.7	64.1	62.4	65.7	64.3	72.4	70.0
	August	65.9	63.3	67.2	65.0	67.7	66.3	72.8	69.6
	September	64.3	62.2	65.0	63.2	65.6	63.8	66.7	64.2
1948	June	-	-	-	-	-	-	59.8	56.5
	July	63.2	60.4	-	-	-	-	70.4	68.4
	August	66.4	64.2	-	-	67.7	66.4	71.5	69.0
	September	64.8	62.7	-	-	-	-	-	-

TABLE 5 (Continued)

Year	Month	Columbia River						Snake River	
		Priest Rapids, Washington		Pasco, Washington		Umatilla, Oregon		Sacajawea State Park Washington	
		Avg. Max	Avg. Min.	Avg. Max.	Avg. Min.	Avg. Max.	Avg. Min.	Avg. Max.	Avg. Min.
1949	June	56.5	54.1	56.7	55.5	58.3	55.0	62.1	60.6
	July	62.8	60.3	-	-	-	-	72.0	66.2
	August	65.4	62.9	66.5	66.1	67.7	66.0	73.9	70.5
	September	63.4	61.5	65.7	65.1	64.6	62.7	68.2	66.0
1950	June	54.2	51.9	53.7	53.3	56.2	54.9	56.7	55.4
	July	61.0	58.3	59.4	59.0	63.8	62.2	69.2	67.6
	August	67.1	64.2	64.7	64.2	68.4	66.6	72.9	70.6
	September	66.6	63.5	65.7	65.1	66.2	64.3	67.2	65.3
1951	June	56.5	54.1	54.1	53.8	-	-	60.2	58.7
	July	66.5	60.2	61.7	61.4	-	-	72.8	70.8
	August	-	-	67.1	66.7	-	-	74.8	72.8
	September	-	-	67.3	66.9	65.1	63.7	67.5	65.5
1952	June	-	-	58.9	58.5	59.0	57.8	61.8	60.6
	July	-	-	63.0	62.5	65.4	64.2	72.6	70.6
	August	-	-	66.9	66.4	67.8	66.5	75.5	72.7
	September	-	-	67.4	66.1	65.5	64.2	68.3	66.0

* Hand thermometers; all other data from readings of continuous-recording thermometers.

** Transcribed data of Fish and Wildlife Service.

TABLE 6

Monthly Maximum and Minimum Daily Temperatures of
Columbia and Snake Rivers in Degrees Fahrenheit*

Year	Month	Columbia River						Snake River	
		Priest Rapids, Washington		Pasco, Washington		Umatilla, Oregon		Sacajawea State Park Washington	
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
1944	July	-	-	70	59	72	62	-	-
	August	70	65	70	64	70	68	-	-
	September	68	61	70	60	-	-	-	-
1945	June	-	-	60	52	62	54	-	-
	July	-	-	68	58	69	59	-	-
	August	-	-	69	64	71	66	-	-
	September	-	-	69	60	-	-	-	-
1946	June	-	-	59	56	61	57	63	60
	July	-	-	66	58	67	60	77	68
	August	-	-	70	64	72	65	78	70
	September	68	61	68	60	69	59	76	58
1947	June	60	52	61	55	62	56	64	57
	July	65	58	66	59	68	61	77	63
	August	67	62	69	63	69	63	77	65
	September	68	59	68	60	70	60	74	59
	October	64	60	-	-	-	-	-	-
1948	June	62	53	-	-	-	-	68	53
	July	66	57	-	-	-	-	75	65
	August	68	63	-	-	69	65	74	66
	September	67	58	-	-	-	-	71	59

TABLE 3 (Continued)

Year	Month	Columbia River				Snake River			
		Priest Rapids, Washington		Pasco, Washington		Umatilla, Oregon		Sacajawea State Park Washington	
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
1949	June	59	52	60	54	61	53	65	54
	July	66	57	66	63	69	59	76	63
	August	67	62	67	65	70	64	78	68
	September	67	58	68	63	70	59	75	61
1950	June	57	50	56	51	60	52	63	52
	July	66	55	62	56	67	60	75	63
	August	69	62	67	62	71	63	77	66
	September	69	60	67	62	70	58	75	58
	October	63	55	-	-	60	54	-	-
1951	June	60	51	57	52	61	54	65	53
	July	65	58	65	56	67	62	79	65
	August	-	-	68	65	70	63	79	66
	September	-	-	68	65	68	60	69	60
	October	-	-	-	-	63	51	-	-
1952	June	-	-	61	57	61	55	65	55
	July	-	-	66	60	68	60	78	64
	August	-	-	68	65	71	64	80	67
	September	-	-	69	65	67	62	71	63
	October	-	-	-	-	65	57	-	-

* Transcribed data of Fish and Wildlife Service

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TABLE 7

Maximum and Minimum Temperature Change of Columbia and Snake Rivers

On One or More Days During a Month

Degrees Fahrenheit*

Years	Month	Columbia River						Snake River	
		Priest Rapids, Washington		Pasco, Washington		Umatilla, Oregon		Sacajawea State Park Washington	
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
1944	July	-	-	4	1	6	1	-	-
	August	3	0	4	1	2	0	-	-
	September	2	0	3	0	-	-	-	-
1945	June	-	-	3	0	3	0	-	-
	July	-	-	3	1	2	0	-	-
	August	-	-	4	1	3	1	-	-
	September	-	-	3	1	-	-	-	-
1946	June	-	-	2	0	2	0	-	-
	July	-	-	3	0	2	0	-	-
	August	-	-	3	1	3	1	-	-
	September	3	0	3	0	3	1	-	-
1947	June	4	1	2	0	2	0	3	0
	July	3	1	3	0	2	0	4	1
	August	3	2	3	1	2	1	5	2
	September	4	0	3	1	3	1	5	1
1948	June	5	1	-	-	-	-	3	0
	July	4	2	-	-	-	-	4	0
	August	4	1	-	-	2	1	4	1
	September	3	0	-	-	-	-	-	-

TABLE 7 (Continued)

Years	Month	Columbia River						Snake River	
		Priest Rapids, Washington		Pasco, Washington		Umatilla, Oregon		Sacajawea State Park Washington	
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
1949	June	3	2	2	0	2	1	3	0
	July	3	1	-	-	-	-	4	2
	August	3	1	1	0	3	1	5	2
	September	4	0	1	0	3	0	4	0
1950	June	4	1	1	0	2	1	3	0
	July	5	1	2	0	2	1	3	0
	August	4	1	2	0	3	1	4	1
	September	4	1	1	0	2	1	4	1
	October	4	0	-	-	2	0	-	-
1951	June	3	1	1	0	2	0	3	0
	July	3	1	1	0	2	1	4	1
	August	-	-	1	0	2	1	3	1
	September	-	-	-	0	2	0	3	1
	October	-	-	-	-	2	0	-	-
1952	June	-	-	1	0	2	0	2	0
	July	-	-	1	0	2	0	3	1
	August	-	-	1	0	2	1	4	1
	September	-	-	2	0	2	0	3	1
	October	-	-	-	-	1	0	-	-

* Data summarized from Fish and Wildlife Service information

TABLE 8

Difference in the Monthly Averages of
Daily Maximum and Minimum Temperatures of
Columbia River at Pasco and Priest Rapids, Washington
In Degrees Fahrenheit*

<u>Month</u>	<u>Year</u>	<u>Average Maximum</u>	<u>Average Minimum</u>
June	1947	0.8	2.1
	1949	0.2	1.4
	1950	-0.5	1.4
	1951	-2.4	-0.3
July	1947	1.2	1.7
	1950	-1.6	0.7
	1951	-4.8	1.2
August	1947	1.3	1.7
	1949	1.1	3.2
	1950	-2.4	0.0
September	1944	0.8	0.7
	1946	0.0	-0.9
	1947	0.7	1.0
	1949	2.3	3.6
	1950	-0.9	1.6

* Temperature at Pasco, Washington less temperature at Priest Rapids, Washington.

TABLE 9

Monthly Averages of Daily Maximum and Minimum Temperatures
Of Columbia River at Priest Rapids, Washington and
Monthly Average of Daily Temperatures of
Columbia River near Coyote Rapids, Washington in
Degrees Fahrenheit

<u>Year</u>	<u>Month</u>	<u>Priest Rapids, Washington*</u> <u>Average Max.</u>	<u>Average Min.</u>	<u>Coyote Rapids,</u> <u>Washington</u> <u>Average**</u>
1950	June	54.2	51.9	54.0
	July	61.0	58.3	59.7
	August	67.1	64.2	64.8
	September	66.6	63.5	64.0
1951	June	56.5	54.1	54.5
	July	66.5	60.2	61.2

* Data transcribed from Fish and Wildlife Service information.

** Data summarized from General Electric Company information.

TABLE 10

Difference in the Monthly Averages of Daily Maximum and Minimum
Temperatures of Snake River at Sacajawea State Park and of
Columbia River at Pasco, Washington
In Degrees Fahrenheit*

<u>Month</u>	<u>Year</u>	<u>Average Maximum</u>	<u>Average Minimum</u>
June	1947	3.3	3.4
	1949	5.4	5.1
	1950	3.0	2.1
	1951	6.1	4.9
	1952	2.9	2.1
July	1947	8.3	7.6
	1950	9.8	8.6
	1951	11.1	9.4
	1952	9.6	8.1
August	1947	5.6	4.6
	1949	7.4	4.4
	1950	8.2	6.4
	1951	7.7	6.1
	1952	8.6	6.3
September	1947	1.7	1.0
	1949	2.5	0.9
	1950	1.5	0.2
	1951	0.2	-1.4
	1952	0.9	-0.1

* Temperature of Snake River less temperature of Columbia River at Pasco.

TABLE 11

Difference in the Monthly Averages of Daily Maximum and Minimum
Temperatures of the Columbia River at Umatilla, Oregon
And Pasco, Washington in Degrees Fahrenheit*

<u>Month</u>	<u>Year</u>	<u>Average Maximum</u>	<u>Average Minimum</u>
June	1945	1.3	1.5
	1947	1.4	1.2
	1949	1.6	-0.5
	1950	2.5	1.6
	1952	0.1	-0.7
July	1944	2.7	2.0
	1945	0.7	1.8
	1946	1.5	2.1
	1947	1.6	1.9
	1950	4.4	3.2
	1952	2.4	1.7
August	1944	0.6	2.1
	1946	1.0	1.8
	1947	0.5	1.3
	1949	1.2	-0.1
	1950	3.7	2.4
	1952	0.9	0.1
September	1947	0.6	0.6
	1949	-1.1	-2.4
	1950	0.5	-0.8
	1951	-2.2	-3.2
	1952	-1.9	-1.9

* Temperature at Umatilla, Oregon less temperature at Pasco, Washington.

TABLE 12Average Temperature of McNary Reservoir 3000 Feet Above McNary Dam*

<u>Date</u>	<u>°C.</u>	<u>°F.</u>
November 17, 1954	11.1	52.0
December 16, 1954	6.5	43.7
January 13, 1955	4.2	39.6
February 10, 1955	4.3	39.7
April 21, 1955	7.4	45.3
May 19, 1955	10.3	50.5
June 16, 1955	13.4	56.1
July 14, 1955	16.1	60.9
August 11, 1955	19.5	67.1
September 8, 1955	20.3	68.5

* Data summarized from General Electric Company information.

TABLE 13

Daily Average Discharge for Columbia River near
Coyote Rapids, Washington and Snake River near Clarkston, Washington
And Daily Average Releases from McNary Reservoir
By Months in Cubic Feet Per Second

<u>Year</u>	<u>Month</u>	<u>Columbia River at Coyote Rapids*</u>	<u>Snake River at Clarkston**</u>	<u>Release From McNary Reservoir***</u>
1953	December	75,000	26,590	98,000
1954	January	81,000	26,950	104,000
	February	75,000	37,540	113,000
	March	79,000	39,690	124,000
	April	74,000	74,100	150,000
	May	242,000	131,300	369,000
	June	386,000	103,500	485,000
	July	362,000	52,240	408,000
	August	184,000	24,330	210,000
	September	121,000	22,430	148,000
	October	79,000	24,800	105,000
	November	78,000	25,000	115,000
	December	76,000	22,100	97,000
1955	January	73,000	22,000	94,000
	February	80,000	20,800	100,000
	March	87,000	23,200	109,000
	April	86,000	51,800	132,000
	May	94,000	100,000	191,000
	June	314,000	129,000	440,000
	July	338,000	53,600	390,000
	August	152,000	22,200	173,000

* Data compiled from General Electric Company information.

** Data from USGS. October 1954-August 1955 are preliminary data.

*** Data compiled from daily records at McNary Dam, Corps of Engineers.

TABLE 14

Daily Average Discharge by Months in Cubic Feet per Second for
Columbia River at Priest Rapids and Snake River at Ice Harbor Dam Site*

<u>Month</u>	<u>Columbia River</u> ⁽⁵⁾	<u>Snake River</u> ⁽⁶⁾
January	70,520	20,880
February	71,710	24,020
March	71,360	41,250
April	84,040	62,940
May	103,770	93,390
June	263,250	73,870
July	182,270	27,570
August	107,450	16,280
September	81,330	17,360
October	69,420	17,270
November	67,260	19,590
December	70,720	22,140

* Based upon 1960-61 level of Columbia River system development.

VIII. REFERENCES

1. Letter of August 9, 1954, by C. E. Atkinson, Chief, Pacific Salmon Investigations, Fish and Wildlife Service, United States Department of the Interior, Seattle, Washington; Temperature Data.
2. Daily Temperature and Flow Data on File at McNary Dam, Walla Walla District, Corps of Engineers, U.S. Army.
3. Daily Temperature and Flow Data on File at Manufacturing Department and Biophysics Section, Radiological Sciences Department, Hanford Atomic Products Operation, General Electric Company, Richland, Washington.
4. Field Notes and Summary Reports on File at Biophysics Section, Radiological Sciences Department, Hanford Atomic Products Operation, General Electric Company, Richland, Washington.
5. Data from Bonneville Power Administration p. II-B-5 and Exhibit II-B-1, Priest Rapids Hydroelectric Development, Columbia River, Washington, Vol. II, Hydroelectric Projects Report. Public Utility District No. 2 of Grant County, Washington, June, 1955. Harza Engineering Company, Chicago, Illinois.
6. Data from "Table 6 - Mean monthly discharge in second feet, Snake River at Ice Harbor Dam site, Washington. pp. 1610-11 Vol. 4, Columbia River and Tributaries, Northwestern United States, House Document NO. 531, U.S. Government Printing Office, Washington, D.C., 1952.
7. Report of Pollution Control Subcommittee Work-Group on Columbia River and Tributaries - Mileage Index, October 20, 1952. U.S. Public Health Service, Portland, Oregon.

APPENDIX 1

Approximate Mileage from the Mouth of the Columbia River
For Locations Used in Report⁽⁷⁾

<u>Location</u>	<u>Miles from Mouth</u>
Umatilla, Oregon	289.3
McNary Dam	292.0
Mouth of Walla Walla River	313.9
Mouth of Snake River at Sacajawea State Park	342.2
Bridge at Pasco and Kennewick, Washington	328.5
Mouth of Yakima River	334.9
Richland, Washington	338.9
Coyote Rapids, Washington	382.6
Foot of Priest Rapids, Washington	393.3*

* Mileage calculated from reference and other mileage data.

APPENDIX 2COLLECTION OF DAILY RIVER TEMPERATURES

The location at which the Fish and Wildlife Service has maintained thermographs and has made temperature determinations in the geographical area covered by the report follows:

Priest Rapids, Washington; Power House of Hanford Irrigation and Power Co. at foot of Priest Rapids of Columbia River (Sec. 2, T. 13N., R. 23E., Willamette B and M.)

Pasco, Washington; Port of Pasco. (Sec. 32, T. 9N., R. 30E., Willamette B and M.)

Umatilla, Oregon; Standard Oil Company Dock (Sec. 8, T. 5N., R. 28E., Willamette B and M.)

Sacajawea State Park, Washington; Northern Pacific Railroad Bridge across Snake River (Sec. 2, T. 8N., R. 30E., Willamette B and M.)

Prior to the installation of continuous-recording thermometers river temperatures were taken by thermometer readers, who recorded the temperature at 8:00 AM and 5:00 PM for the Fish and Wildlife Service. These times were selected because information obtained from continuous-recording thermometers indicated that minimum temperatures were most frequently recorded at 8:00 AM and maximum temperatures at 5:00 PM. Continuous-recording thermometers were put into operation on the Columbia River at Pasco, Washington and Umatilla, Oregon in 1945, and at Priest Rapids, Washington in 1947; and near Sacajawea State Park, Washington on the Snake River in 1947.

Atkinson⁽¹⁾ states "The thermographs are tended by local people hired and supervised by Fish and Wildlife Service personnel, who also check the instruments once a month to insure their accuracy". Both

Taylor and Tagliabue instruments have been used. They have the following specifications: "Range; thirty-two degrees to eighty-five degrees, Fahrenheit working range with a guaranteed accuracy of 0.5% of range".

The temperature of the Columbia River near Coyote Rapids is determined by reading a stationary industrial thermometer which is installed in a large main carrying water from a river-water pumping station of the Hanford operations. The temperature is read and recorded by operators once every two hours.

The temperature of the McNary Reservoir is observed and recorded from a stationary industrial thermometer on a cooling water main taken off of the chamber directly above the turbines. The water passing through the turbines is drawn from the full depth of the reservoir immediately above the dam except for the upper 5 to 10 feet of it.

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APPENDIX 3

November 17, 1954 through September 8, 1955

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TEMPERATURE OF MCNARY RESERVOIR 3000 FEET ABOVE MCNARY DAM

November 17, 1954*

Depth in Feet	Distance from Washington Shore in Yards						Distance from Oregon Shore in Yards					
	170	350	525	700	875	1050	1225	1400	1575	1750	350	525
	1925	1750	1575	1400	1225	1050	875	700	525	350		
Temperature in Degrees Centigrade												
0-4	11.2	11.2	11.2	11.0	11.2	11.0	11.2	11.2	11.2	11.2	11.0	11.0
5-9	"	"	"	"	"	"	"	"	"	"	"	"
10-14	"	"	"	"	"	"	"	"	"	"	"	"
15-19	"	"	"	"	"	"	"	"	"	"	"	"
20-24	"	"	"	"	"	"	"	"	"	"	"	"
25-29	"	"	"	"	"	"	"	"	"	"	"	"
30-34	"	11.1	"	"	"	"	"	11.1	"	"	"	11.0
35-39	"	"	"	"	"	"	"	"	"	"	"	"
40-44	"	"	"	"	"	"	"	"	"	"	"	"
45-49	"	"	"	"	"	"	"	"	"	11.1	"	"
50-54	"	"	"	"	"	"	"	"	"	"	"	"
55-59	"	"	"	"	"	"	"	"	"	"	"	"
60-64	"	"	"	"	"	"	"	"	"	"	"	"
65-69	"	"	"	"	"	"	"	"	"	"	"	"
70-74	"	"	"	"	"	"	"	"	"	11.0	"	"
75-79	11.2	11.0	11.1	11.1	11.2	"	"	"	"	"	11.0	"
80-84						11.0	11.2					

*10:45 A. M. - 12:00 Noon

'No temperature change or a change of less than 0.1°C. from value recorded above.

December 16, 1954*

Distance from Washington Shore in Yards	700	875	1050	1225	1400
---	-----	-----	------	------	------

Distance from Oregon Shore in Yards

1575 1 750 1 970

525 350 130

Depth
in
Feet

Temperature in Degrees Centigrade

0-4
5-9
10-14
15-19
20-24
25-29
30-34
35-39
40-44
45-49
50-54
55-59
60-64
65-69
70-74
75-79
80-84

* 11:05 A.M. - 12:15 P.M.

! No temperature change or a change of less than 0.1°C . from recorded above.

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TEMPERATURE OF MCNARY RESERVOIR 3000 FEET ABOVE MCNARY DAM

January 13, 1955 *

Depth in Feet	Distance from Washington Shore in Yards									
	175	275	525	700	875	1050	1225	1400	1575	1750
	1925	1825	1575	1400	1225	1050	875	700	525	350
Distance from Oregon Shore in Yards										
Temperature in Degrees Centigrade										
0-4	4.2	4.1	4.2	4.3	4.3	4.1	4.2	4.1	4.0	4.1
5-9	"	"	"	"	"	"	"	"	"	"
10-14	"	"	"	"	"	"	"	"	"	"
15-19	"	"	"	"	"	"	"	"	"	"
20-24	"	"	"	"	"	"	"	"	"	"
25-29	"	"	"	"	"	"	"	"	"	"
30-34	"	"	"	"	"	"	"	"	"	"
35-39	"	"	"	"	"	"	"	"	"	"
40-44	"	"	4.3	"	"	"	"	"	"	"
45-49	"	"	"	"	"	"	"	"	"	"
50-54	4.2	"	"	"	"	"	"	"	"	"
55-59	"	"	"	"	"	"	"	"	"	"
60-64	"	"	"	"	"	"	"	"	"	"
65-69	"	4.2	"	"	"	"	"	"	"	"
70-74	"	"	"	"	"	"	"	"	4.0	"
75-79	"	"	"	4.4	4.3	4.2	"	4.1	"	"
80-84	"	"	4.4	"	"	"	4.2	"	"	"

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* 12:40 P. M. - 1:30 P. M.

' No temperature change or a change of less than 0.1°C. from value recorded above.

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TEMPERATURE OF MCNARY RESERVOIR 3000 FEET ABOVE MCNARY DAM

February 10, 1955*

Depth in Feet	Distance from Washington Shore in Yards						Distance from Oregon Shore in Yards					
	150	350	525	700	875	1050	1225	1400	1575	1750	1980	
	1950	1750	1575	1400	1225	1050	875	700	525	350	120	
Temperature in Degrees Centigrade												
0-4	4.3	4.2	4.3	4.4	4.4	4.4	4.4	4.5	4.4	4.3	4.4	
5-9	"	"	"	"	"	"	"	"	"	"	"	
10-14	"	"	"	"	"	"	"	"	"	"	"	
15-19	4.3	"	"	"	"	"	"	"	"	"	4.4	
20-24	"	"	"	"	"	"	"	"	"	"	"	
25-29	"	"	"	"	"	4.4	"	"	"	"	"	
30-34	"	"	"	"	"	"	"	"	"	"	"	
35-39	"	"	"	"	"	"	"	"	"	"	"	
40-44	"	"	"	"	"	"	"	"	"	"	"	
45-49	"	"	"	"	"	"	"	"	"	4.3	"	
50-54	"	"	4.3	"	"	"	"	"	4.4	"	"	
55-59	4.2	"	"	"	"	4.3	4.4	"	"	"	"	
60-64	"	"	"	"	"	"	"	"	"	"	"	
65-69	"	"	4.4	4.4	4.5	"	4.3	4.5	"	"	"	
70-74	"	"	"	4.3	"	"	"	"	"	"	"	
75-79	"	"	"	"	"	"	"	"	"	"	"	
80-84	"	"	4.3	"	"	"	"	"	"	"	"	

* 12:15 P. M. - 12:45 P. M.

" No change in temperature or less than 0.1°C. of value reported above and below.

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TEMPERATURE OF MCNARY RESERVOIR 3000 FEET ABOVE MCNARY DAM

April 21, 1955*

Depth in Feet	Distance from Washington Shore in Yards										Distance from Oregon Shore in Yards										1930				
	165	320	485	645	800	965	1125	1285	1450	1600	1765	1930	165	320	485	645	800	965	1125	1285		1450	1600	1765	1930
	Temperature in Degrees Centigrade																								
0-4	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3
5-9	7.5	7.4	7.6	7.7	7.6																				
10-14	7.3	7.3	7.3	7.3	7.3																				
15-19																									
20-24																									
25-29																									
30-34	7.3																								
35-39																									
40-44		7.3																							
45-49																									
50-54																									
55-59			7.3																						
60-64																									
65-69																									
70-74																									
75-79																									
80-84																									
85-89																									

* 9:40 A. M. - 10:45 A. M.

, No temperature change or one of less than 0.1°C. from value recorded above.

TEMPERATURE OF MCNARY RESERVOIR 3000 FEET ABOVE MCNARY DAM

May 19, 1955*

Depth in Feet	Distance from Washington Shore in Yards															
	135	350	525	735	945	1135	1375	1575	1775	1910						
	1965	1750	1575	1365	1155	965	725	525	325	190						
Temperature in Degrees Centigrade																
0-4	14.0	14.5	12.0	12.5	12.5	10.5	10.0	11.0	10.0	10.5	10.5					
5-9	15.0		12.5	14.0	13.0	10.7			10.3							
	12.2	11.5	11.0	11.0	10.5	10.0	'	9.9	9.9	9.9	9.9					
10-14	13.6	12.5	11.6	12.5	11.0			10.3								
	11.6	11.0	10.6	10.5	10.4	'	'	9.9	'	'	'					
15-19	12.5		11.0	11.3												
	11.3	10.8	10.1	10.3	10.2	'	'	'	'	'	'					
20-24	11.6		11.0													
	10.7	10.8	10.1	10.2	10.0	'	'	'	'	'	'					
25-29			10.4													
		10.6	10.2	10.2	'	'	'	'	'	'	'					
30-34		10.5	10.1	'	'	'	'	'	'	'	'					
35-39		'	10.1	'	'	'	'	'	'	'	'					
40-44		'	'	'	'	'	'	'	'	'	9.9					
45-49		'	'	'	'	'	'	9.9								
50-54		'	'	'	'	'	'									
55-59		10.4	'	'	'	'	'									
60-64		'	'	'	'	'	'									
65-69		'	'	'	'	'	'									
70-74		'	'	'	'	'	'	9.9								
75-79		'	'	'	'	'	'									
80-84		10.3	10.0	10.1	10.0	'										
85-89			10.1							9.9						

Temperature in Degrees Centigrade

* 12:00 Noon - 1:05 P. M.

, No temperature change or a change of less than 0.1°C. from values recorded above.

TEMPERATURE OF MCNARY RESERVOIR 3000 FEET ABOVE MCNARY DAM

June 16, 1955*

Depth in Feet	Distance from Washington Shore in Yards										Distance from Oregon Shore in Yards			
	75	270	525	665	875	1050	1250	1450	1650	2000	450	250	100	
	2025	1830	1575	1435	1225	1050	850	650						
Temperature in Degrees Centigrade														
0-4	13.9	13.5	13.5	13.4	13.6	13.4	13.3	13.5	13.6	13.4	13.6	13.4	14.0	
	14.1			13.5		13.6	13.6	13.7				13.7		
5-9	13.7			13.4	13.4	13.4	13.4	13.5	13.5	13.4	13.5	13.4	13.7	
	13.8							13.7				13.8		
10-14				13.3				13.4	13.2		13.2	13.3		
15-19					13.3								13.6	
20-24														
25-29														
30-34													13.2	
35-39														
40-44														
45-49														
50-54														
55-59														
60-64														
65-69														
70-74	13.4													
75-79														
80-84			13.4	13.3	13.3	13.3	13.4							

* 10:35 A.M. - 11:05 A.M.

' No temperature change or a change of less than 0.1°C. from value recorded above.

TEMPERATURE OF MCNARY RESERVOIR 3000 FEET ABOVE MCNARY DAM

July 14, 1955*

Depth in Feet	Distance from Washington Shore in Yards										Distance from Oregon Shore in Yards									
	185	385	585	785	985	1185	1385	1585	1785	1985	1915	1715	1515	1315	1115	915	715	515	315	115
	18.0	17.1	16.5	16.4	16.5	16.4	16.2	16.3	16.2	16.1	16.0	16.1	16.0	16.0	16.0	16.0	16.0	16.0	16.1	17.0
0-4	17.0	16.5	16.2	16.2	16.2	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	15.9
5-9	17.0	16.1	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	15.9
10-14	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	15.9
15-19	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	15.9
20-24	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	15.9
25-29	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	15.9
30-34	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	15.9
35-39	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	15.9
40-44	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	15.9
45-49	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	15.9
50-54	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	15.9
55-59	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	15.9
60-64	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	15.9
65-69	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	15.9
70-74	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	15.9
75-79	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	15.9
80-84	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	15.9

Temperature in Degrees Centigrade

* 8:35 A. M. - 9:42 A. M.

, No temperature change or a change of less than 0.1 °C. from value recorded above.

TEMPERATURE OF MCNARY RESERVOIR 3000 FEET ABOVE MCNARY DAM

August 11, 1955*

Depth in Feet	Distance from Washington Shore in Yards											
	235	385	585	735	885	1035	1185	1335	1485	1635	1785	1935
	Distance from Oregon Shore in Yards											
	1865	1715	1515	1365	1215	1065	915	765	615	465	315	165
Temperature in Degrees Centigrade												
0-4	20.3	20.2	20.5	20.6	20.4	20.6	20.5	20.6	20.6	20.6	20.9	20.8
5-9	19.7	19.6	20.5	20.1	20.0	20.5	20.4	20.5	20.6	20.5	20.6	20.5
10-14	19.5	19.5	19.9	19.8	19.7	20.0	20.1	20.1	20.1	19.7	19.5	19.8
15-19	'	'	19.7	19.7	19.6	19.9	20.0	19.7	19.3	19.1	19.4	19.2
20-24	'	19.4	19.6	19.6	19.6	19.8	19.5	19.3	'	'	19.1	19.1
25-29	'	'	19.5	19.5	19.5	19.6	19.3	'	'	'	'	18.9
30-34	'	'	'	19.4	19.3	19.4	'	'	'	'	'	18.9
35-39	19.5	'	'	'	'	'	'	'	19.2	'	19.0	
40-44		'	'	'	'	'	'	'	'	'	19.0	
45-49		'	'	'	'	'	'	'	'	'	19.0	
50-54		'	'	'	'	19.3	'	'	'	'		
55-59		'	'	'	'	'	'	19.3	19.1	19.1		
60-64		'	'	'	'	'	19.3	'	'			
65-69		19.3	'	'	'	'	'	'	'			
70-74			'	'	'	'	'	19.2	19.0			
75-79			'	'	19.3	'	'	'				
80-84			'	19.3		19.3	'	19.1				
85-90			19.5				19.2					

* A. M.

' No temperature change or a change of less than 0.1°C. from value recorded above.

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HW-39347

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TEMPERATURE OF MCNARY RESERVOIR 3000 FEET ABOVE MCNARY DAM
September 8, 1955*

Depth in Feet	Distance from Washington Shore in Yards									
	185	385	585	785	985	1185	1385	1585	1785	1985
	Distance from Oregon Shore in Yards									
	1915	1715	1515	1315	1115	915	715	515	315	115
Temperature in Degrees Centigrade										
0-4	20.6	20.4	20.7	20.7	20.6	20.6	21.0	21.1	21.1	21.0
5-9	20.5	20.4	20.6	20.6	20.5	20.5	20.9	21.1	20.9	'
10-14	20.4	20.3	20.6	20.5	20.4	'	20.8	21.0	'	'
15-19		20.3	20.5	20.4	'	20.4	20.7	20.9	'	'
20-24		'	20.5	'	'	'	20.7	20.8	'	'
25-29		'	20.4	'	'	20.3	20.6	20.8	'	21.0
30-34		20.2	20.4	'	'	'	20.5	20.6	20.6	
35-39		'	20.4	'	'	20.2	20.5	20.4	20.4	
40-44		'	20.3	20.3	'	'	20.4	20.0	20.3	
45-49		'	20.3	20.2	20.3	'	20.0	19.8		
50-54		20.2	20.2	20.2	20.1	20.1	19.9	19.6		
55-59			'	20.1	20.0	20.0	19.8	19.6		
60-64			'	'	19.9	19.9	19.8			
65-69			'	'	'	19.9	19.8			
70-74			20.2	'	19.9	19.8				
75-79				20.1		19.7				
80-84						19.7				

* 11
A.M.

1235-1315

' No temperature change or a change of less than 0.1°C. from value recorded above.

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HW-39347

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ABSTRACT

Columbia River temperature data for the 1944-55 period have been collected from several sources and summarized. The temperature of the river between Priest Rapids in Washington and Umatilla, Oregon is considered both before and after the establishment of the reservoir behind McNary Dam in 1953. The Snake River has a substantial influence on the temperature of the Columbia River especially during the critical summer months of higher temperatures. The surface water of McNary Reservoir immediately above the dam did not become generally warmer than the bulk of the reservoir until May 1955 in the November 1954-September 1955 period. Flow relationships of the Columbia and Snake rivers are noted. Natural climatic and river conditions cause greater temperature variations in the Columbia River for the 1944-55 period than do the effluents of the Hanford reactors.

DATE

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END