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DISPERSION OF DISSOLVED MATERIAL IN THE COLUMBIA RIVER

March 12, 1957

By

J. F. Honstead

HANFORD LABORATORIES OPERATION

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HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

PRELIMINARY REPORT

LEGAL NOTICE

DISPERSION OF DISSOLVED MATERIAL IN THE COLUMBIA RIVER

By

J. F. Honstead

Introduction

Data were obtained downstream from a reactor cooling water discharge structure to permit application to semi-empirical diffusion equations. Ten traverses of the river were made at different distances from the discharge point to collect samples of water and make velocity readings. The cooling water was discharged essentially at a single point in the bottom of the river about 300 feet from the Plant shore. Approximately 38% of the river flowed between the point of discharge and the Plant shore.

Experimental

The ten traverses sampled were selected to be as nearly normal to the direction of flow of the main current of the river as could be judged visually. They were selected at distances of 950; 1,750; 2,850; 3,590; 6,230; 8,870; 14,150; 14,430; 24,710, and 29,990 feet from the point of discharge. The river makes a very gradual s-curve in the reach encompassed by these traverses. The cross-sectional shape and measured velocity pattern of each traverse are shown in Figures 1 through 10. The figures are numbered consecutively according to their distance from the discharge point. Velocities were measured with a Gurley, cup-type velocity meter.

The mixture of short-lived radioisotopes in the reactor effluent was used as a tracer of the dispersion pattern in the river. While this material is an ideal tracer from the standpoint of low-level detection in river water, it introduces the serious complication of decay corrections from one traverse to the next. In view of the non-uniform velocity across the traverse, the "age" of the radioisotopic mixture in a given sample is uncertain. The analytical results of samples taken from various positions across each traverse are also plotted in Figures 1 through 10. The data shown are relative concentrations based on a value of 100 ascribed to the concentration of the reactor effluent at the time of discharge to the river. These data have all been corrected for decay. The samples were all collected from a uniform depth of three feet below the surface of the river, it having been previously determined that vertical concentration variations are negligible on the scales used for plotting.

The data shown in the attached figures were obtained in a two-day period during which the river flow, and the flow and concentration of discharged effluent remained essentially constant. The flow rate of the river as reported by an adjacent U.S.G.S. gauging station during the course of the test was 62,000 second feet. The test was performed near the middle of the annual low-water period on the Columbia, no major changes in flow rate having occurred during the preceding three months.

Evaluation

Several factors limit the precision of the data reported here. One major complication encountered was the scope of the survey required. The river is large and relatively swift, making it difficult to locate sampling points on the river traverse with exactitude. This factor was of particular importance at locations near the discharge point where the width of the plume is little more than the uncertainties in the sampling positions. At these locations the lateral concentration changes are very pronounced and the probability of sampling the point of maximum concentration is small.

Other factors affecting the reliability of the data include: (1) Uncertainties in the sample analyses, including the decay corrections previously mentioned; (2) variations of short periods in the effluent concentration (a standard deviation of 10% was noted in hourly samples); (3) initial thermal effects caused by the marked temperature difference between the effluent and the river water; and (4) possible reduction in the concentration of certain isotopes in the river by such phenomena as surface adsorption on suspended silts and biological assimilation by aquatic organisms.

The traverse taken at 6,230 feet below the discharge point was located a few feet upstream from a small rapids in the river. These rapids probably affected the continuity of the dispersion rate function through this stretch of the river, although the rapids are not a very pronounced feature and occur at essentially one location. The river does not become shallow enough at the rapids to impede navigation of boats up to 40 inches draft.

An effort was made to evaluate the data obtained in this survey by means of integrated material balances at each of the traverses. The velocity pattern was integrated to determine the total river flow for comparison with U.S.G.S. reports, and the concentration data was weighted with point velocities and integrated to calculate the total radioactivity flowing through the traverse in unit time.

The results of the attempt to integrate the river velocity data are shown in Table I.

TABLE I

Traverse (feet below Discharge)	Integrated Flow Rate (Second Feet)	Variation from Reported Flow (Percent)	Variation from Average Integrated Flow Rate (Percent)
950	40,400	-35	-9.2
1,750	43,300	-31	-3.4
2,850	45,900	-26	+2.5
3,590	45,30	-27	+1.1
6,230	49,900	-19	+11.4
8,870	55,000	-11	+22.8
14,150	44,800	-27	0.0
19,430	43,500	-31	-2.9
24,710	41,400	-34	-7.6
29,990	38,500	-37	-14.0

The significant difference between the flow rates obtained by integration of the velocity profiles and that reported by the U.S.G.S. is ascribed to the method used in the graphical integration and probably does not represent a real inaccuracy in individual velocity measurements.

Results of the attempt to integrate the radioactive material flowing across each traverse are shown in Table II.

TABLE II

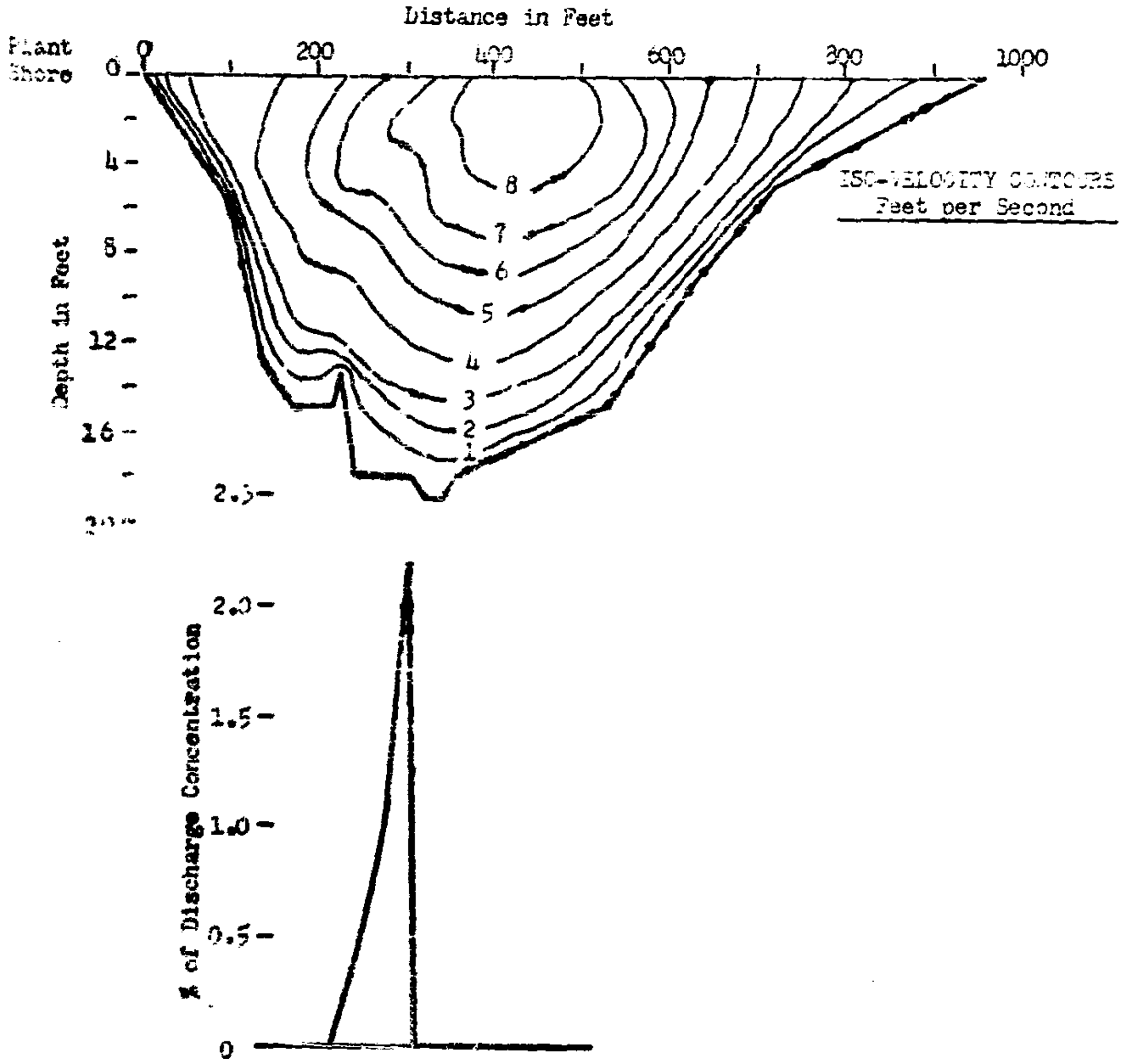
Traverse (feet below Discharge)	Variation between Integrated Rate of Flow of Material and actual Discharge Rate (Percent)
950	-49.0
1,750	+44.0
2,850	+1.6
3,590	+6.7
6,230	+0.7
8,870	+43.0
14,150	+9.4
19,430	+11.0
24,710	+1.6
29,990	+9.9

To obtain the data of Table II, the point concentration data were weighted by the average velocity of the river at the point sampled and adjusted to the actual flow rate of the river reported by the U.S.G.S. The summation of these results was then compared with the actual rate of discharge of radioactive material in the reactor effluent to obtain the percent variation shown in the table. Individual analytical results are ascribed a 95% confidence limit of about ± 50%. The data were, of course, corrected for radioactive decay before making the above comparisons.

References

This report was abstracted from Document No. HW-32506 (SECRET).

FIGURE 1.
COLUMBIA RIVER



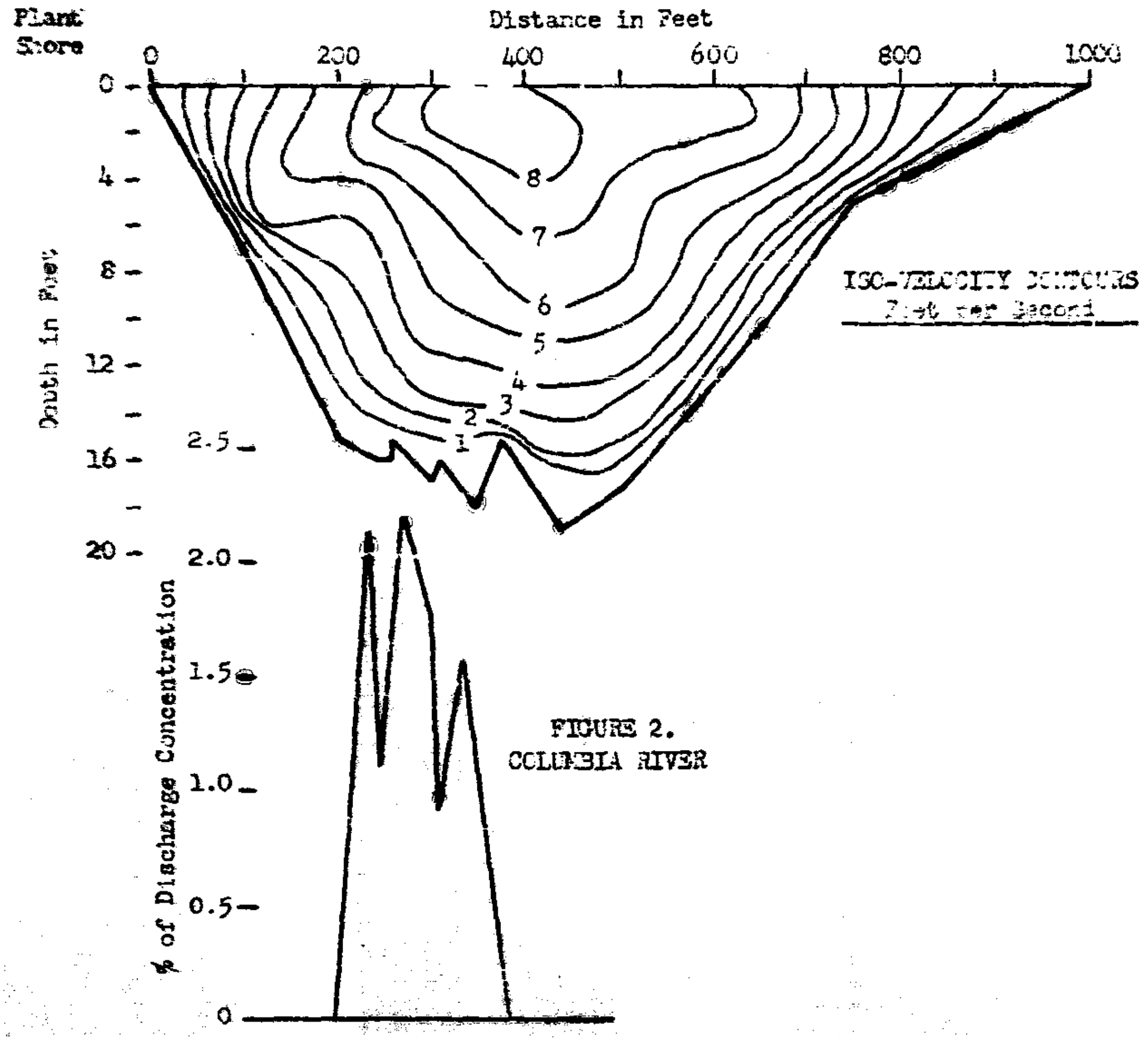


FIGURE 2.
COLUMBIA RIVER

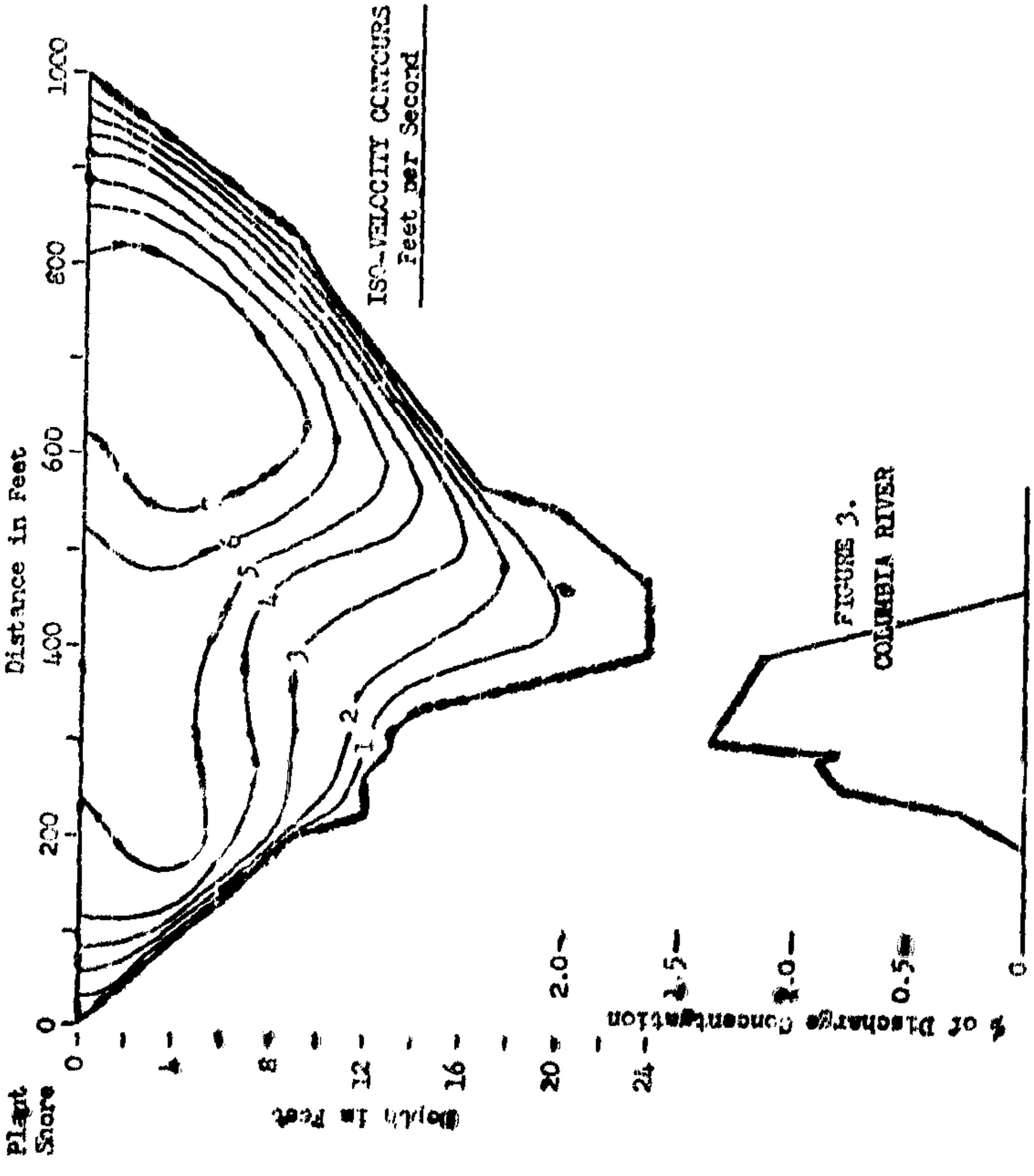


FIGURE 3.
COLUMBIA RIVER

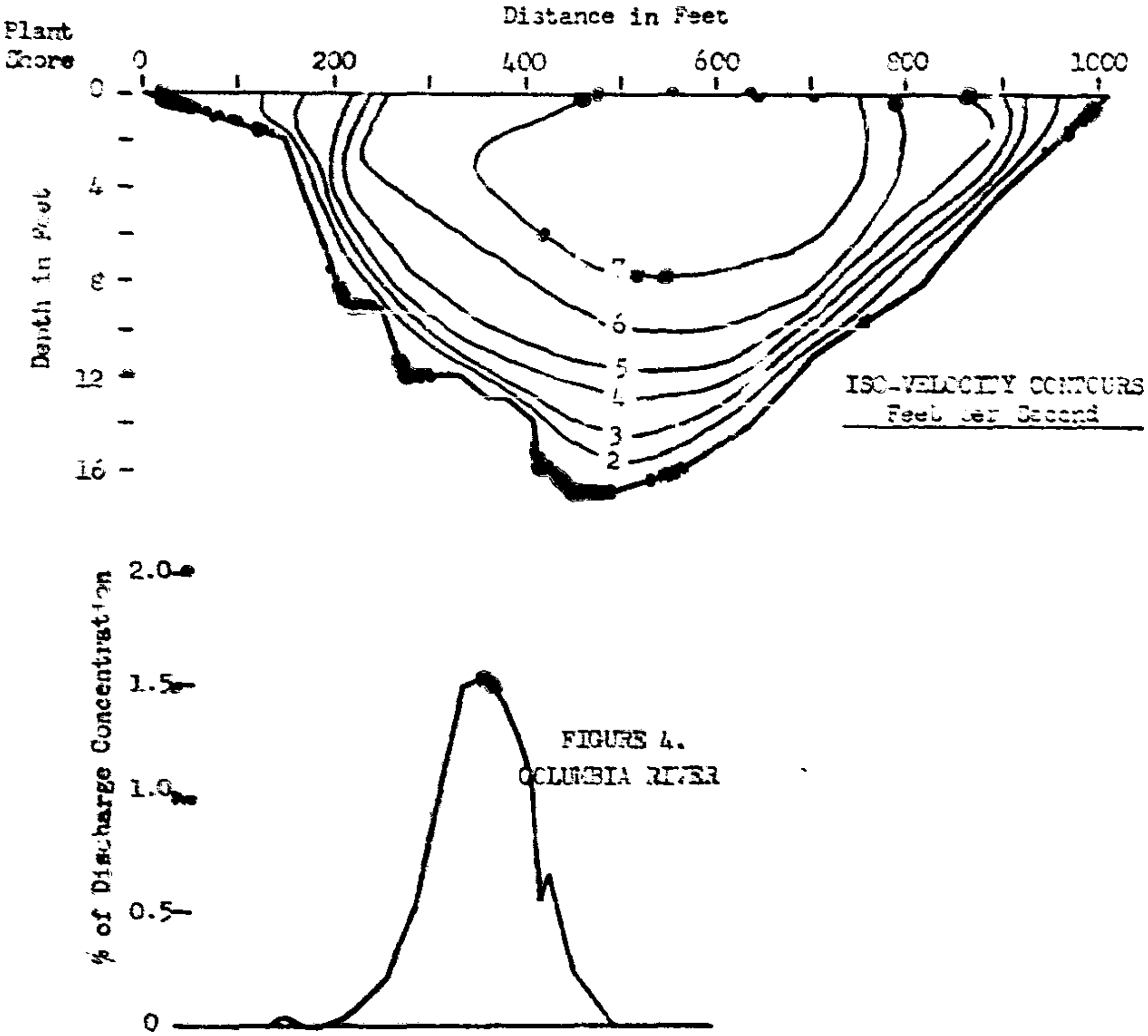


FIGURE 4.
COLUMBIA RIVER

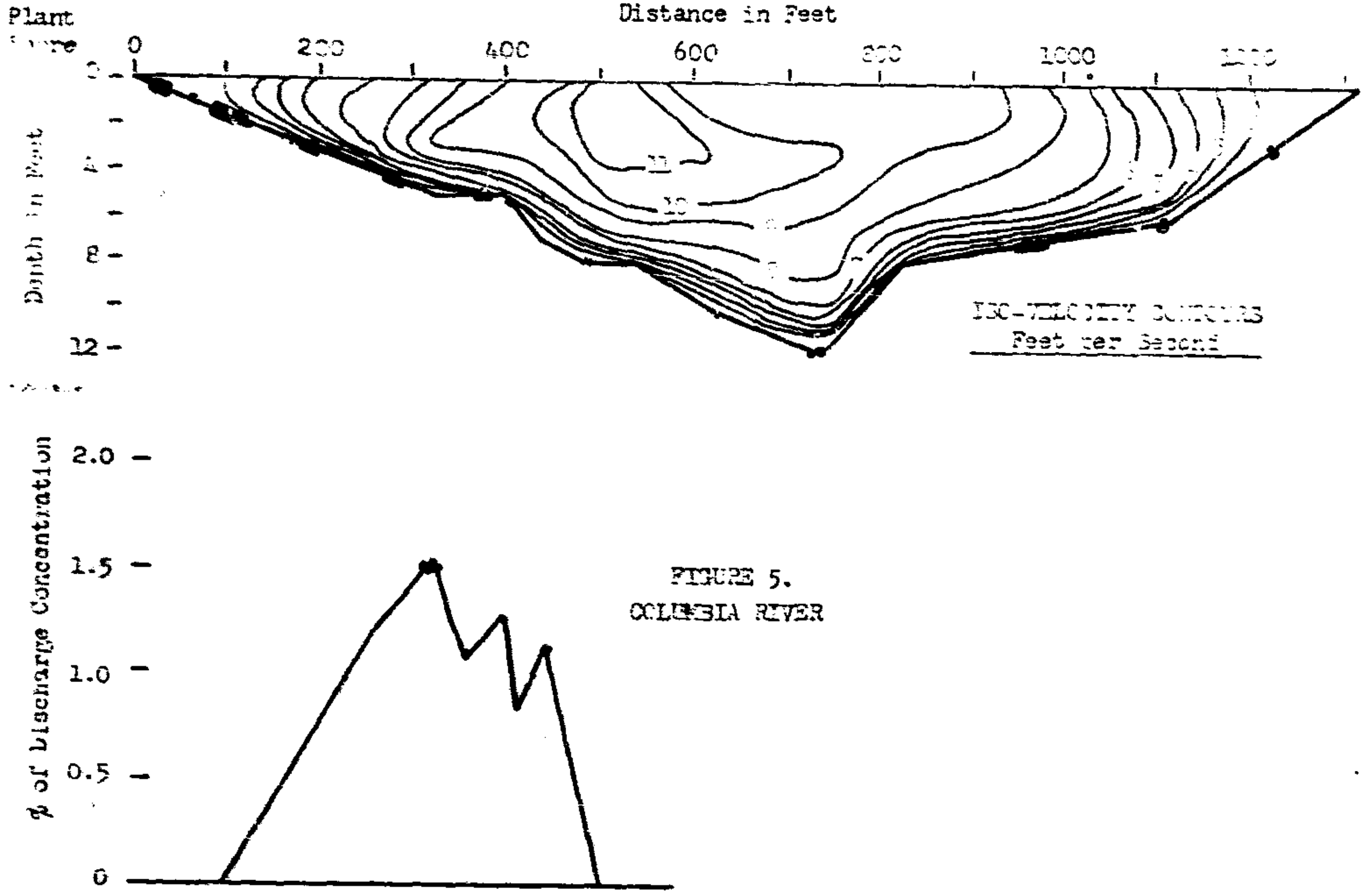


FIGURE 5.
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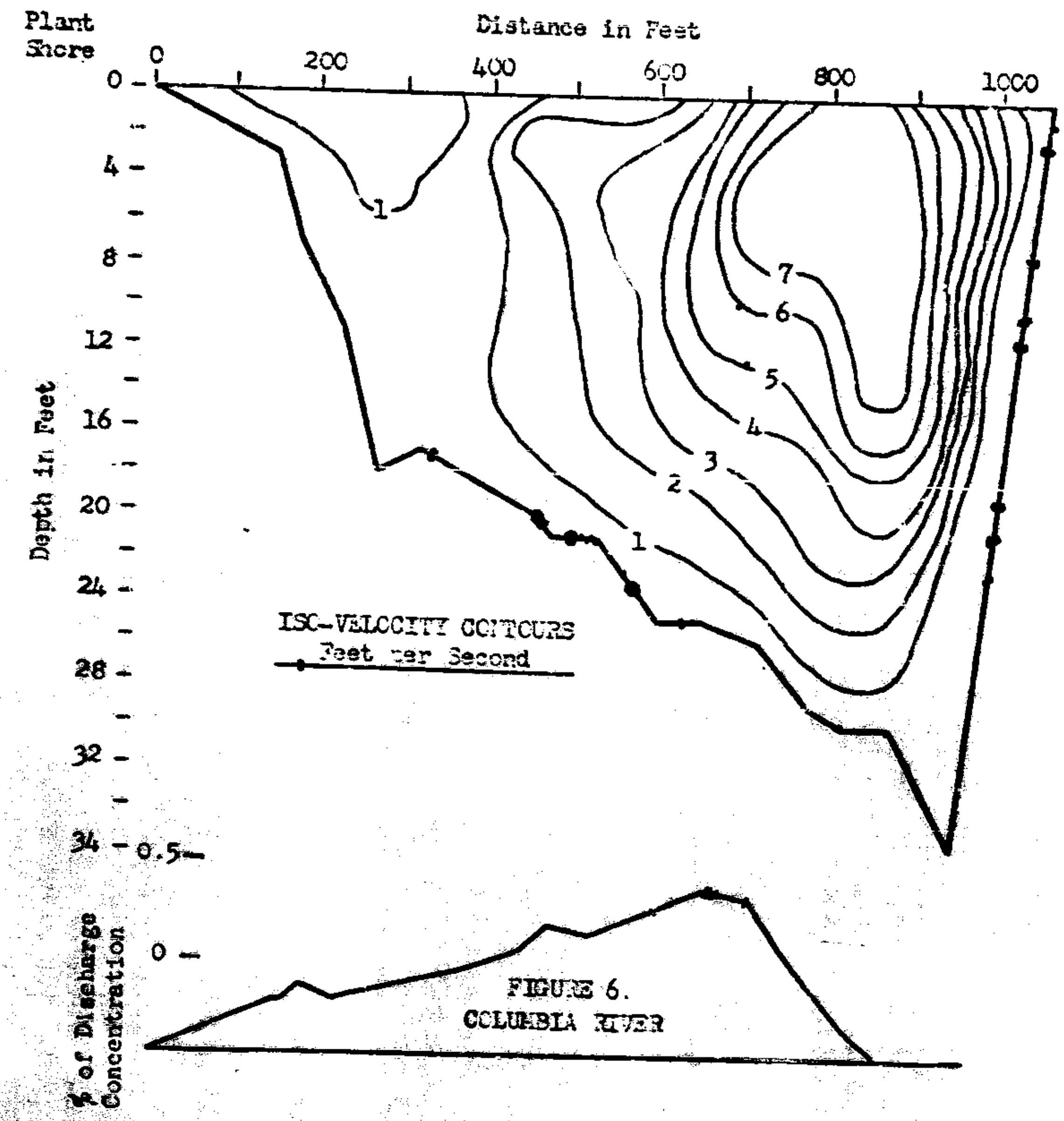
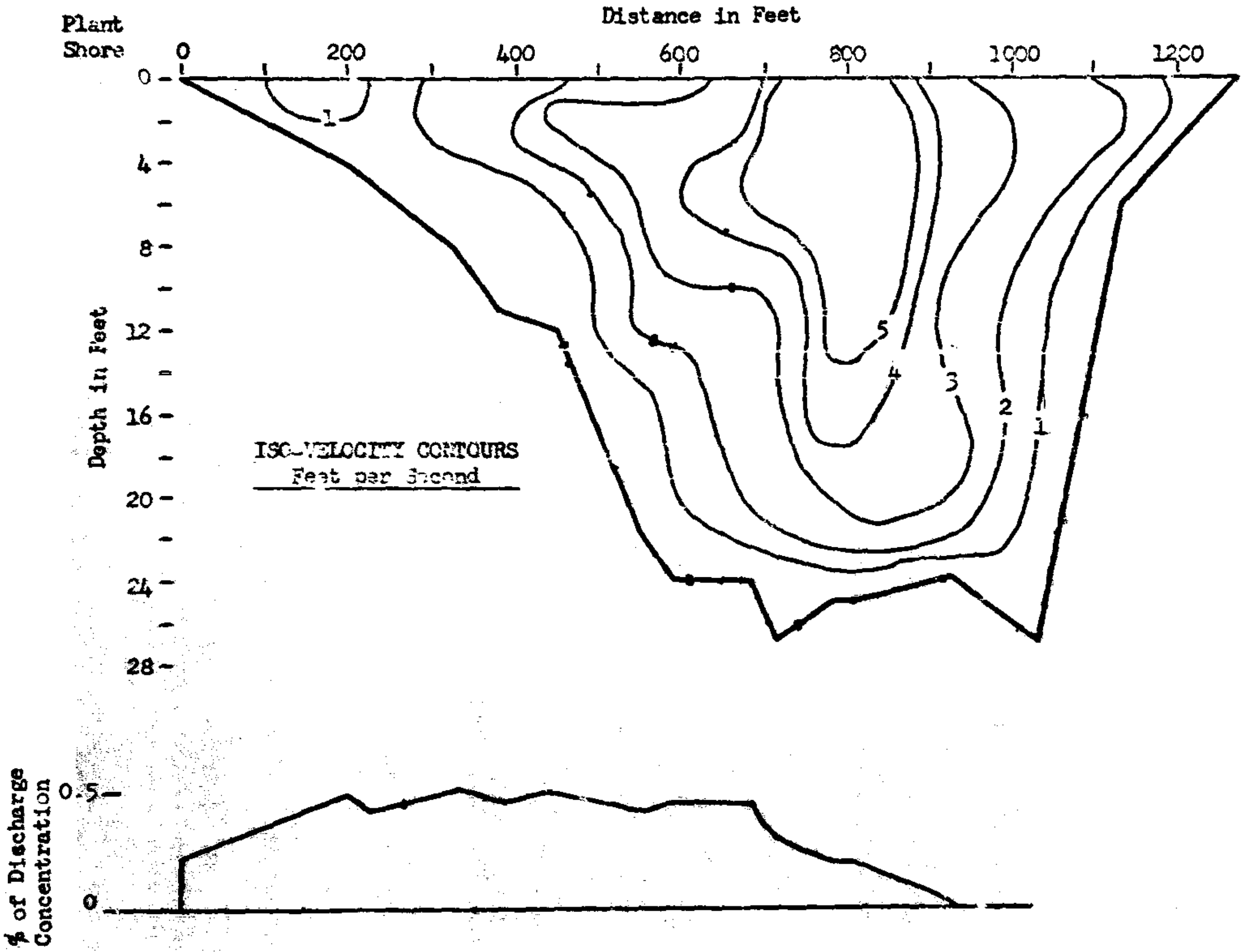


FIGURE 6.
COLUMBIA RIVER

FIGURE 7
COLUMBIA RIVER



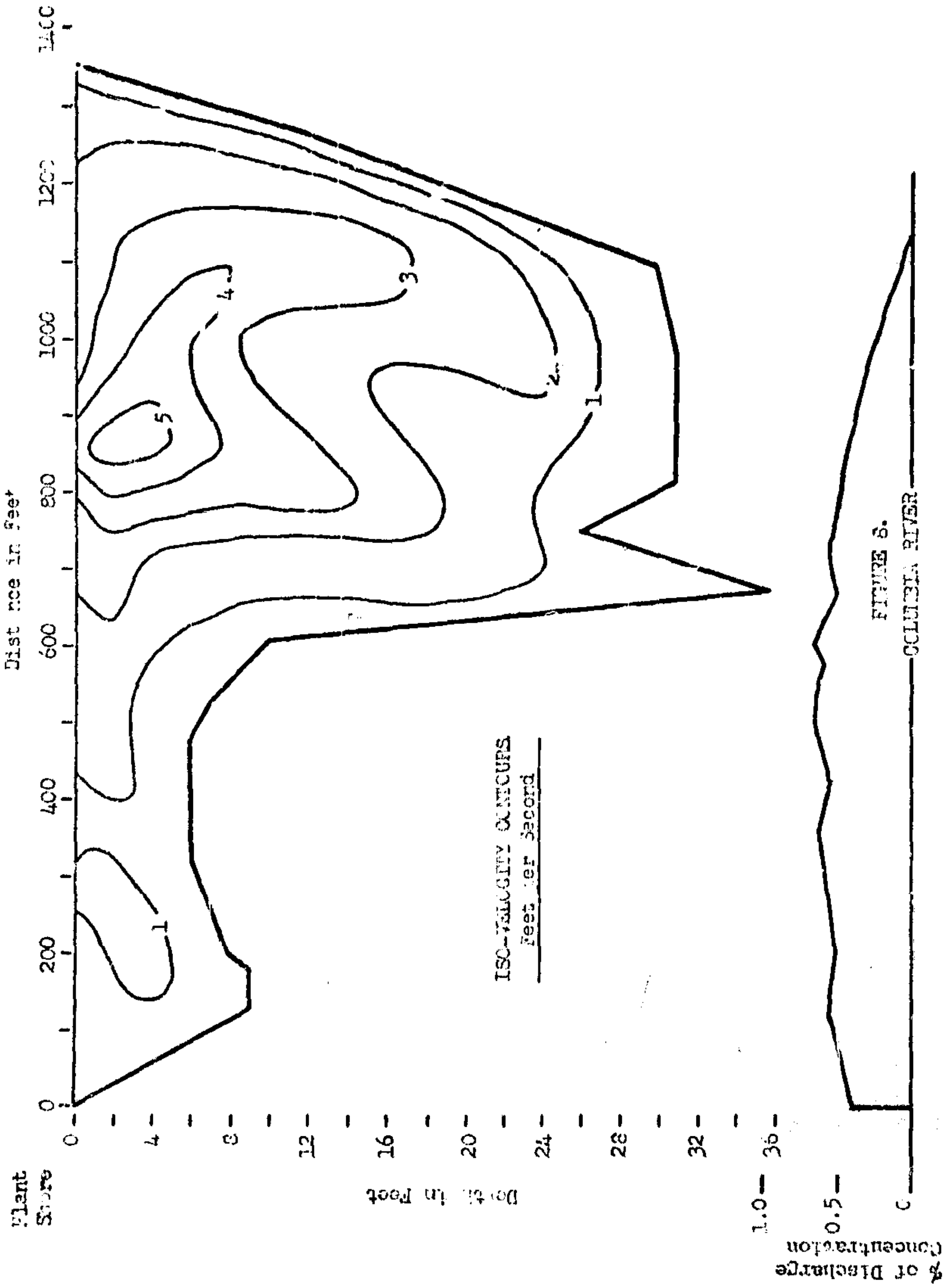


FIGURE 8.
COLUMBIA RIVER

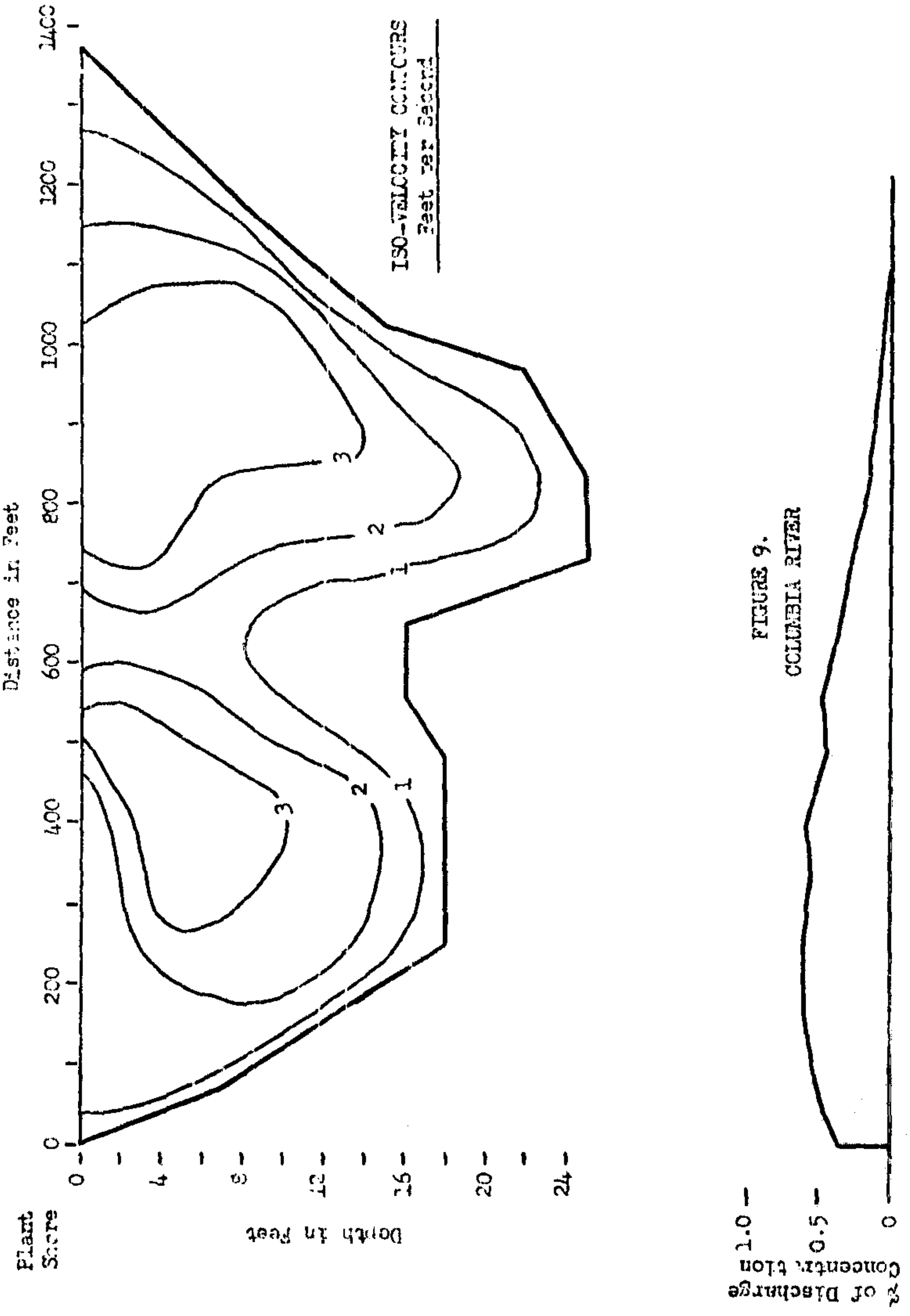


FIGURE 9.
COLUMBIA RIVER

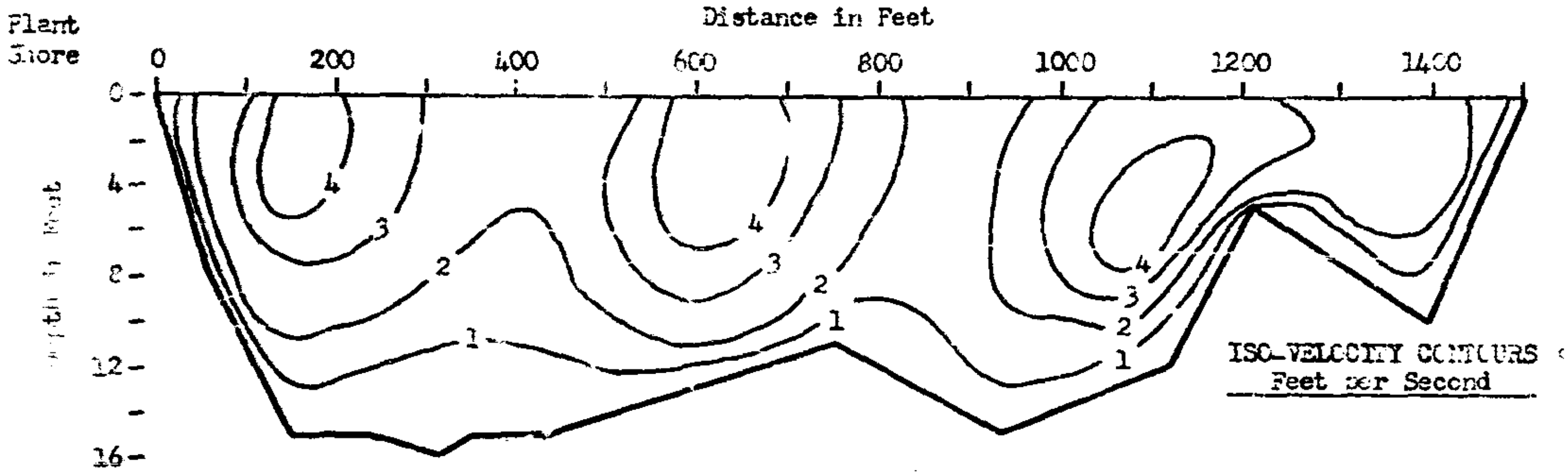


FIGURE 10.
COLUMBIA RIVER