J. M. STUART STATION

316(a) Demonstration

FINAL

WAPORA Inc. Research & Consulting in Pollution Control

Project No. 160

September 28, 1976

J. M. STUART STATION

316(a) Demonstration

FINAL

Submitted to:

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TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

LIST OF TABLES

LIST OF TABLES (continued)

LIST OF TABLES (continued)

LIST OF FIGURES

LIST OF FIGURES (continued)

(continued)

LIST OF FIGURES (continued)

LIST OF FIGURES (continued)

WAPORA

LIST OF FIGURES (continued)

SUMMARY AND CONCLUSIONS

I. SUMMARY AND CONCLUSIONS

A. Background

The J. M. Stuart Station is located near Aberdeen, Ohio on the mainstem Ohio River; thermal discharges from the station enter the Ohio River via the lower portion of Little Three Mile Creek (LTMC). The J. M. Stuart Station has four similar coal-fired steam electric generating units with a total nameplate rating of 2,441 MW. Units 1, 2, and 3 utilize once-through cooling water from the Ohio River and were declared commercial on May 17, 1971, October 11, 1970 and May 10, 1972, respectively. Unit 4 operates with a closed cycle natural-draft cooling tower and was declared commercial June 21, 1974. Units 1, 2 and 3 have a combined maximum circulating water flow of 1,458 cfs with both circulating pumps in operation for each of the three units.

The J. M. Stuart Station has been operating with the three once-through units since May 1972, and water quality is such in this section of the Ohio River as not to preclude the selection of a Type I (Absence of Prior Appreciable Harm) 316(a) demonstration. Studies designed to evaluate the possible detrimental impact of the thermal effluent on the receiving waters were initiated in 1970 prior to plant operation and have continued to date.

B. Thermal Plume Configuration

The J. M. Stuart Station utilizes the lower dredged and straightened portion (approximately 1.57 kilometers) of LTMC as a discharge canal. A concrete and steel weir is located at the mouth of LTMC to increase the water velocity at the point of entry into the Ohio River. Under normal plant operating conditions, the cooling water is raised (ΔT) 10-17°C (18-30.6°F) above ambient river temperature.

The configuration of the thermal plume at the J. M. Stuart Station is dependent on several factors including plant generating load, effluent discharge volume, river flow and velocity, and meterological conditions. During periods of high river flow and velocity, and normal plant operation, the thermal plume remains near the Ohio side of the river. During lower river flows and normal plant operation, the thermal plume, after leaving the discharge canal, crosses the river diagonally to the far shore. Following initial partial mixing with ambient waters the plume, under normal conditions, has a tendency to remain near the surface and is undercut by the cooler river water, resulting in a vertical temperature gradient downstream.

C. Biological Impact Assessment

Biological impact assessment studies were initiated in 1970 and have continued to date. Relevant studies and publications include: Miller, 1970-1971; Miller, Kallendorf, and Reed, 1971-1972; Miller and Kallendorf, 1972-1973; Reed *et al.*, 1974; Smiddy, 1974; Hater, 1975; Miller *et al.*, 1975; Gammon and Norris, 1970; Norris and Gammon, no date;

Hatch and Gammon, 1973; Lesniak and Gammon, 1974; Yoder and Gammon, 1975; and Yoder and Gammon, 1976. These reports are appended to this document, each under separate cover.

1. Phytoplankton

A summary of four years of data on primary productivity revealed that small temperature increases ($\Delta T<5°C$) stimulate primary productivity over a range of ambient temperatures up to 20 to 25°C (68 to 77°F) and large ΔT's are stimulatory only at cold ambient temperatures (<5°C). In general, any absolute temperature (ambient temperature + ΔT) less than 25°C caused stimulation of primary production. At ambient temperatures greater than 25°C (77°F), however, all temperature increases (ΔT's) on the average caused inhibition of plankton production.

The overwhelming conclusion from these studies is that the thermal discharge from the J. M. Stuart Station has decreased primary productivity from approximately April to November in LTMC, but has not caused appreciable harm to the photosynthetic capacity of the Ohio River. Studies further indicate that natural phenomena such as heavy rains, increased river discharge, and increased silt load caused far greater variation in the year-to-year total primary production in the Ohio River than the thermal load from the J. M. Stuart Station. The slight temperature increases of the plume in the Ohio River were actually stimulatory of algal production even though there was marked inhibition in LTMC.

2. Periphyton

Periphyton primary production on artificial substrates (glass slides) was measured at the J. M. Stuart Station from 1970 to 1972. The maximum biomass in the Ohio River occurred during the summer and fall when Ohio River flow was lowest, whereas it occurred during the winter in February and March in the heated areas of LTMC. The minimum in LTMC occurred during the summer.

Although decreases in periphyton production and biomass on artificial substrates occurred in LTMC during the summer, the impact on the naturally-occurring periphyton community is difficult to assess. The Ohio River offers very limited natural surface area for periphyton growth where light penetration is suitable for photosynthesis. This fact reduces the consideration of appreciable harm on this community component.

3. Zooplankton

Zooplankton mortality, measured during the summer of 1974, was significantly increased by retention at high temperatures during the transit time (approximately 1 hour) in LTMC. Stations sampled in LTMC had an average ΔT of 7 to 8°C (12.6 to 14.4°F) over the study dates, with a maximum ΔT of 10°C (18°F). At the outfall point (discharge into LTMC) mortality was 5.1 percent higher than in the Ohio River; at the weir, 21.7 percent higher, on the average. Apparently, increased numbers of zooplankters were dying in the discharge channel (LTMC) and their sensitivity was greatest in mid-summer when the absolute temperature was highest.

Even if 100 percent mortality occurred during summer months, at a flow of 11,500 cfs, for example, the plant would remove less than 13 percent of the population, based on a three-unit intake of 1,458 cfs and assuming even distribution of zooplankters. Realistic mortality figures reduce this percentage considerably. It is therefore reasonable to conclude that the J. M. Stuart Station operation will not appreciably harm this component of the aquatic community.

4. Macroinvertebrates

Investigations of the impact of the J. M. Stuart Station thermal effluent on the macroinvertebrates of LTMC and the Ohio River have been conducted by Gammon and Norris, 1970; Norris and Gammon, no date; Reed et al., 1974; and Miller et al., 1975. Analyses have included general substrate identification (Norris and Gammon, no date), use of artificial substrates such as Hester-Dendy multiple-plate samplers and rock basket samplers (Gammon and Norris, 1970; Norris and Gammon, no date; Reed et al., 1974; Miller et al., 1975) and sampling of natural substrates (Norris and Gammon, no date; Reed et al., 1974).

During the period 1970-1974, benthic macroinvertebrates and macroinvertebrates colonizing artificial substrate samplers were virtually eliminated from the thermally affected reach of LTMC by the summer of 1973. During the summer of 1974, macroinvertebrates were able to recolonize the artificial substrate samplers implaced in LTMC. No really detectable change occurred in the Ohio River samples downstream of the entry of LTMC. The effects on the macroinvertebrates in LTMC is primarily an entrainment phenomenon since very few invertebrates occur there "naturally" in the present situation.

5. Fishes

Studies of the fishes of lower LTMC, the adjacent Ohio River, and a control backwater area, Kennedy Creek, have been conducted since July 1970. Reports attached to this document as appendices are: Gammon and Norris, 1970; Norris and Gammon, no date; Hatch and Gammon, 1973; Lesniak and Gammon, 1974; Yoder and Gammon, 1975; and Yoder and Gammon, 1976.

Yoder and Gammon (1976) note the following about seasonal trends as revealed by electrofishing and D-net collections from June 1974 through October 1975:

- Indices were near zero in the discharge canal and highest in the ambient river zones during both summer seasons.
- Indices were lower in the ambient river zones and highest in LTMC during the winter.

- Species attracted to the discharge canal during winter included longnose gar, white bass, smallmouth buffalo, river carpsucker, quillback carpsucker, and carp.

- Species occurring in relative abundance over the gradient of thermal conditions encountered during the summer and transitional periods were, in order of decreasing thermal preference: longnose gar, carp, quillback carpsucker, white bass, river carpsucker, largemouth bass, spotted bass, skipjack herring, gizzard shad, and sauger.

- Spotted sucker, bluegill, and white crappie preferred the backwater during all seasons.

In addition to the electrofishing and D-net results, Yoder and Gammon (1976) also present seining data from the Ohio River for sampling locations above and below the J. M. Stuart Station. The authors determined from the seining data that:

- There were no significant differences between the locations for all months as well as for numbers/haul, grams/haul, and number of species. The data were subjected to a nested two-way analysis of variance at the 95 percent level.

- Community density (as measured by seining) and biomass peaked during the late summer months of August through October in the shallow areas of the Ohio River. This was most likely due to the recruitment of young-of-the-year individuals into the catch rates.

- Gizzard shad and emerald shiner catches made up nearly 90 percent of the total catch by number and 75 percent by weight.

- Young-of-the-year and juvenile gizzard shad were most abundant above the J. M. Stuart Station.

- Young-of-the-year and juvenile river carpsucker and river shiner were generally more common below the J. M. Stuart Station.

Based on comparisons of yearly mean numbers/km, kg/km, Shannon-Weiner diversity indices, based on numbers and weights, and number of species for electrofishing catches for the years 1970 through 1975, Yoder and Gammon, 1976 observed the following trends:

- Relative density and biomass (as reflected in electrofishing catch rates) decreased from 1970 to 1972 and then increased gradually from 1973 through 1975, probably reflecting a normal trend in the Ohio River.
- Community diversity indices were fairly uniform throughout the study period.
- Community indices in LTMC decreased to zero in 1972 and 1973 but then increased to 1970 and 1971 levels in 1974 and 1975.
- The two thermally-influenced Ohio River zones exhibited a similar, but less extreme, pattern of change.
- Indices in the control (upstream ambient) Ohio River zone gradually decreased during the six-year period.

Based on the available data we have further addressed the following questions which reflect potential concerns:

- Has the thermal effluent reduced a significant portion of usable habitat in the Ohio River proper for important species?
- Has the thermal effluent altered available habitat in LTMC for important species? During which periods of the year?
- How has the thermal effluent altered the expected backwater fisheries composition in LTMC?
- Has the thermal effluent adversely affected spawning migrations into the upper portion of LTMC?
- Has the thermal effluent altered expected spawning activity in lower LTMC?
- Has the thermal effluent altered the expected overwintering activity in LTMC? Are fish successfully able to survive the winters in LTMC?

- How has the thermal effluent affected recreational fishing in LTMC and the adjacent Ohio River?

- Has the operation of the J. M. Stuart Station caused any significant fish mortalities? What is the significance of the fish kills to the fisheries complex of LTMC and the Ohio River? What is the likelihood of future fish kills?

- Are any endangered or threatened fish species being adversely affected by the thermal effluent?

- What is the overall impact of the thermal effluent on the fisheries of the LTMC-Ohio River complex?

The answers to these questions have been carefully considered and more fully developed in Section V-F of this document; the conclusions we have drawn are as follows:

- On balance, it is concluded that a significant portion of the Ohio River has not been eliminated for important fish species.

- We conclude from a careful evaluation of the appended reports that when temperatures in the canal exceed 34°C (93.2°F) the canal portion of LTMC is temporarily removed as habitat for many important fish species.

- We conclude that the combination of higher temperatures and higher flows in the present-day LTMC allows for a considerably different fish species composition than might be expected in a more natural LTMC.

- We have carefully examined the physical habitat available, and in our professional judgment, conclude that it would be very unlikely that riverine species utilized or would be likely to utilize upper LTMC for major spawning activities with or without the presence of a thermal effluent.

- Except for the extreme lower portions near the mouth of the effluent canal during Ohio River backflooding, LTMC does not provide appropriate habitats for many of the apparent backwater spawners.

- We conclude that the thermal effluent does alter the expected overwintering activity in LTMC, but several species of fish do inhabit the canal in the winter. We do not believe that the removal of this one creek from the available overwintering habitat constitutes more than a local change. It also appears, from limited data, that some species which would normally overwinter in the pits on the bottom of the Ohio River do successfully inhabit LTMC in the winter.

- We conclude that recreational fishing has been altered by the thermal effluent, and that overall recreational usage may now be greater than prior to start-up. Summer fishing in LTMC has been degraded, but winter fishing has been greatly enhanced. We believe that, on balance, the trade-off is acceptable.

- A fish kill numbering 7,540 fish (95% gizzard shad) occurred in January, 1971 due to reverse thermal shock. The possibility of another large reverse thermal shock kill appears to be very remote. The present multi-unit operation at J. M. Stuart should normally preclude simultaneous shutdown of all units.

- The State of Kentucky owns the waters of the Ohio River in that area of the Ohio River bordering Kentucky (includes the Ohio River adjacent to the J. M. Stuart Station). None of the fish species on the Kentucky Endangered Species List or the United States Endangered and Threatened List have appeared in any of the collections at the J. M. Stuart Station. The State of Ohio Endangered Species List, developed for Ohio waters, includes the following species collected at the J. M. Stuart

Station: shortnose gar (Lepisosteus platostomus), ghost shiner (Notropis buchanani), silver chub (Hybopsis storeriana), and river redhorse (Moxostoma carinatum). Neither the Ohio or the Kentucky lists specifically address any Ohio River endangered species, nor does ORSANCO, the interstate agency most directly responsible for coordinating the bordering states concerned with such matters.

Based on a consideration of the habitat, occurrence, and abundance, in the Ohio River of the four species listed above, we have made the following determinations:

- The river redhorse is apparently limited in numbers in the Ohio River due to its reported intolerance to siltation, "industrial pollution," and because of its migratory spawning habit. Since only one specimen was taken, and because of the lack of temperature tolerance information, it is not possible to determine the effect of the J. M. Stuart thermal effluent on the river redhorse.

The silver chub has been reported in sufficient numbers in the Ohio River such that it should probably not be considered endangered in the Ohio River.

Given the low frequency of occurrence of the shortnose gar in collections and the lack of temperature tolerance information, it is not possible to say if the thermal effluent from the J. M. Stuart Station has had an adverse effect on its distribution and abundance. Its reported low tolerance to turbid and silt-laden rivers may well override any considerations of thermal effects in the Ohio River population.

If the ghost shiner is "rare" in the Ohio River, it is probably due to its intolerance to turbidity and current velocity.

- Very subtle and complex changes are occurring over time as fish species interact with the thermal effluent. Current knowledge of the effects of such changes on large river fish complexes is far from complete. However, we submit that the observed changes are most likely local and limited, and that measurable changes in the Ohio River fisheries are not likely to occur as a result of the operation of the J. M. Stuart Station. Therefore, we conclude that the overall impact of the thermal effluent of the J. M. Stuart Station on the fisheries of the LTMC-Ohio River complex does not constitute significant, adverse harm.

6. Nuisance Species

Of the species of aquatic organisms collected at the J. M. Stuart Station, none were considered to be nuisance organisms as defined by the EPA's guidelines for 316(a) demonstrations (Section V-G).

D. Synergistic Effects

Review of the available water quality data in the vicinity of the J. M. Stuart Station indicates little probability that synergistic effects between temperature and existing pollutants would occur.

Dissolved oxygen concentrations, in both the heated and unheated water at the J. M. Stuart Station, are adequate for the support of aquatic life. No incidence or symptoms of "gas bubble disease" have been reported by personnel conducting biological studies in this section of the river.

INTRODUCTION

II. INTRODUCTION

A. Background

Under the 1972 Amendments to the Federal Water Pollution Control Act (the Act), operators of steam electric power generating units must comply with applicable technology based on effluent limitations promulgated by the Administrator of the EPA. These limitations are published in 40 C.F.R. Part 423. In addition, compliance with effluent limitations calculated to achieve water quality standards is required under Section 301 (b) (1) (C) of the Act.

With respect to the discharge of heat, an exemption from any of those limitations is available, if the operator can make a successful demonstration under Section 316(a) of the Act. Whenever the operator can successfully demonstrate that the effluent limitation proposed for the control of the thermal component of any discharge is more stringent than necessary to assure the protection and propagation of a balanced, indigenous community of shellfish, fish, and wildlife in and on the receiving waters, the appropriate regulatory body may impose an alternative effluent limitation.

The Dayton Power and Light Company (DP&L) contracted WAPORA, Inc. to prepare a 316(a) demonstration for the J. M. Stuart Generating Station. This document presents data evaluating the effects of the J. M. Stuart Station thermal effluent on a balanced, indigenous community of shellfish, fish, and wildlife in and on the receiving waters. The "receiving waters" as outlined in a letter from N. E. Williams, Director, Ohio EPA to Mr. Howard R. Palmer, The Dayton Power and Light Company, dated August 23, 1976 are described as follows: "It is our intent to assess the affect of the thermal discharge on the entire area affected - the Ohio River and Little Three Mile Creek."

B. Nature of Demonstration

On September 30, 1974, the Water Planning Division, Office of Water and Hazardous Materials, U.S. Environmental Protection Agency, issued a Draft 316(a) Technical Guidance Manual for thermal dischargers. The manual has undergone several revisions, but the basic guidance contained in the document remains essentially unchanged.

The document provides for several different basic types of demonstrations depending on plant size and age, water body size and habitat condition. Based on WAPORA's recommendation, and EPA Region V and Ohio EPA concurrence, DP&L has chosen to provide a Type I Demonstration: Absence of Prior Appreciable Harm (Existing Sources). The J. M. Stuart Station has been on line discharging heated effluents into Little Three Mile Creek and the Ohio River since 1970, and the water quality of the Ohio River at the plant site supports a varied and typical large river biota. No other known factors are present at this site that complicate an assessment of the effects of the thermal discharge on the biota of the receiving waters. This Type I Demonstration evaluates the effects of thermal effluents from the J. M. Stuart Station on the interrelationship of the biotic components of the lower portion of Little Three Mile Creek and the Ohio River.

C. Site Description

The J. M. Stuart Station is located on the mainstem Ohio River (River Mile 405.6) about five miles east of Aberdeen, Ohio on the north shore of the Ohio River (Figure II-1). The site occupies an area of approximately 1,276 acres, most of which is located between U.S. Route 52 and the Ohio River in Adams County, Ohio. Thermal discharges from the station enter the Ohio River via the lower portion of Little Three Mile Creek.

The Dayton Power and Light Company has provided the following account of the history of this portion of Little Three Mile Creek:

"Previous to the installation and operation of Meldahl Dam, the level of the Ohio River at the location of Little Three Mile Creek (LTMC) was established by Dam 34 at River Mile 434.1, near Chilo. Corps of Engineers records show the pool elevation above Dam 34 to be 461.0 feet at normal river stage.

Topographic data obtained for The Dayton Power and Light Company by Ebasco Services in November 1957 shows that with a normal pool stage of 461.0 feet there would be backwater in Little Three Mile Creek for a distance of approximately 40 feet from the Ohio River shore line.

With the construction and subsequent operation of Meldahl Dam, the normal pool stage was raised to 485.0 feet. (Figure II-2 shows the extent of backwater at 485.0 feet MSL). The change to this higher elevation occurred in stages on certain dates and caused a change in the amount of backwater in Little Three Mile Creek. This information is shown by the following tabulation:

Date[1]	Normal Pool[1]	LTMC Backwater
--	461.0 ft	40 ft
June 13, 1964	468.0 ft	1400 ft
July 14, 1964	475.5 ft	4000 ft
August 18, 1964	483.0 ft	6300 ft
March 28, 1965	485.0 ft	7000 ft

[1]Corps of Engineers, Huntington District, Russ Patterson, Engineering Technician, Navigation Section, February 4, 1975.

The design of the first circulating water outfall structure to be located in the area of LTMC (5400 feet from the Ohio River) was completed in November 1966. Construction of this structure was started on June 21, 1968. The layout and clearing of the discharge channel started in December 1968. During March 1969, clearing and grubbing was completed and excavation for the channel change was underway." (Figure II-3 shows the plans for excavation superimposed on the original contour of LTMC.)

In early 1970 The Dayton Power and Light Company, in conjunction with the Ohio Department of Health, constructed a weir at the mouth of Little Three Mile Creek (Figure III-2). In late 1973 or early 1974 (exact date not known) the weir opening was widened from 19.5 feet to 58.5 feet. Public access to LTMC is presently limited to negotiating the weir (approximate water velocity = 3.5 fps) by boat since the land adjacent to the discharge portion of the Creek is owned by The Dayton Power and Light Company.

In this area, the Ohio River is about 550 yards wide and ranges up to 50 feet deep at mid-channel. The water can fluctuate dramatically as determined by rainfall and regulation of flow at the Greenup and Meldahl Dams.

The U.S. Geological Survey maintains a gaging station on the Ohio River at Maysville, Kentucky. This station is located a short distance downstream of the Maysville-Aberdeen highway bridge (see Figure IV-11).

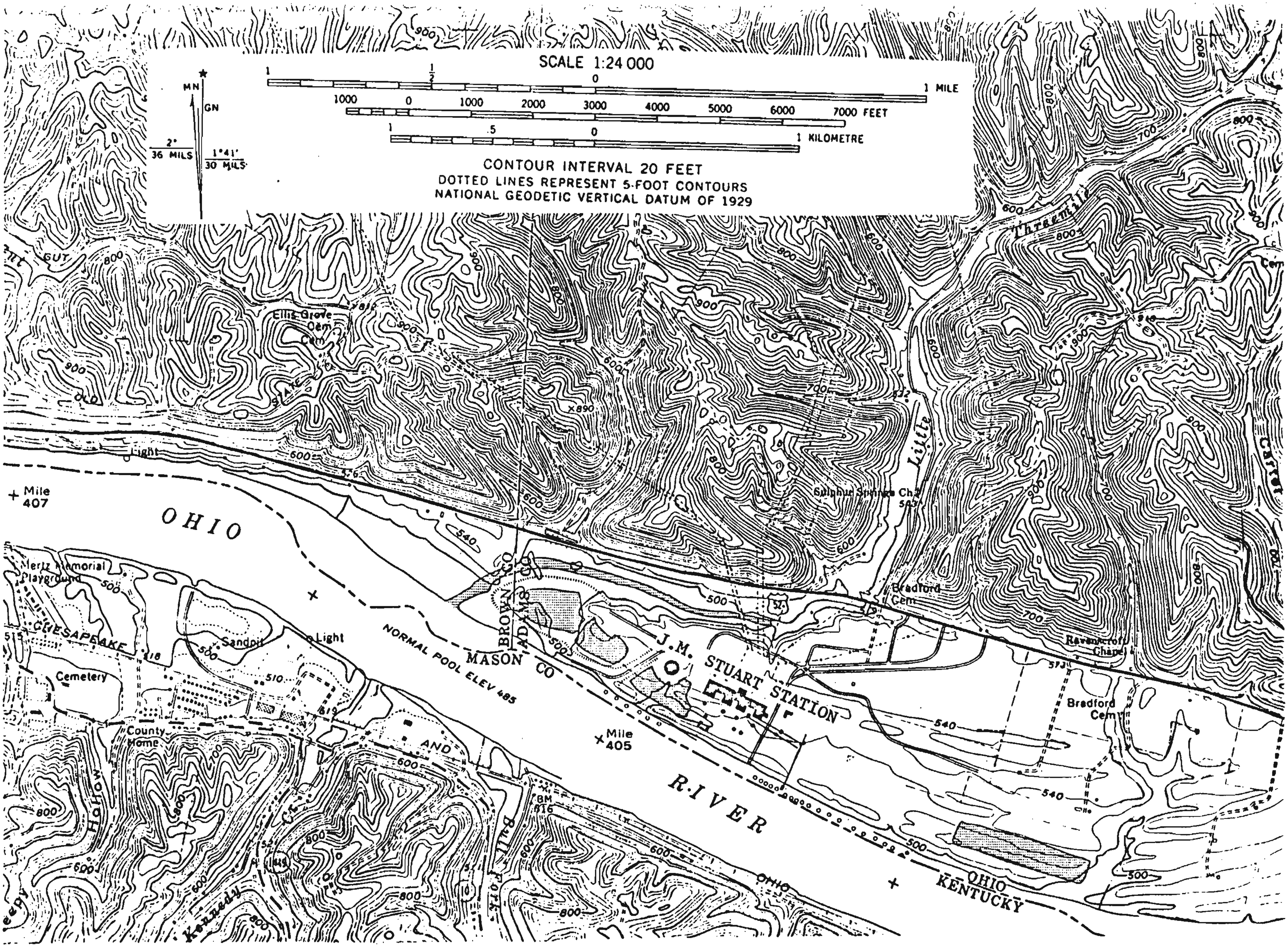


FIGURE II-1 Location of the J. M. Stuart Station on the Ohio River.

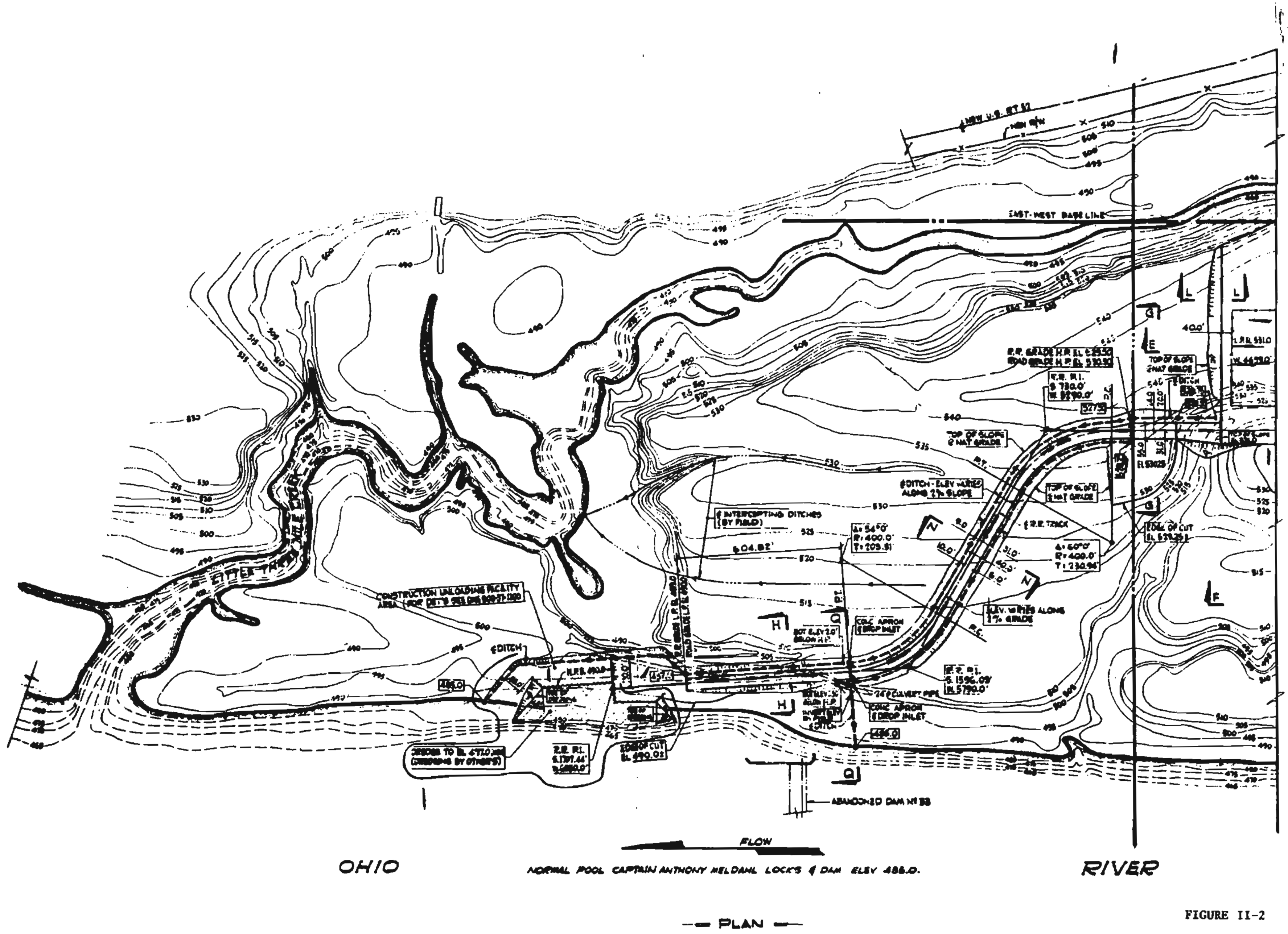

EAST-WEST BASE LINE
FLOW
OHIO
RIVER
NORMAL POOL CAPTAIN ANTHONY MELDAHL LOCKS & DAM ELEV 485.0.
ABANDONED DAM No 33
— PLAN —

FIGURE II-2

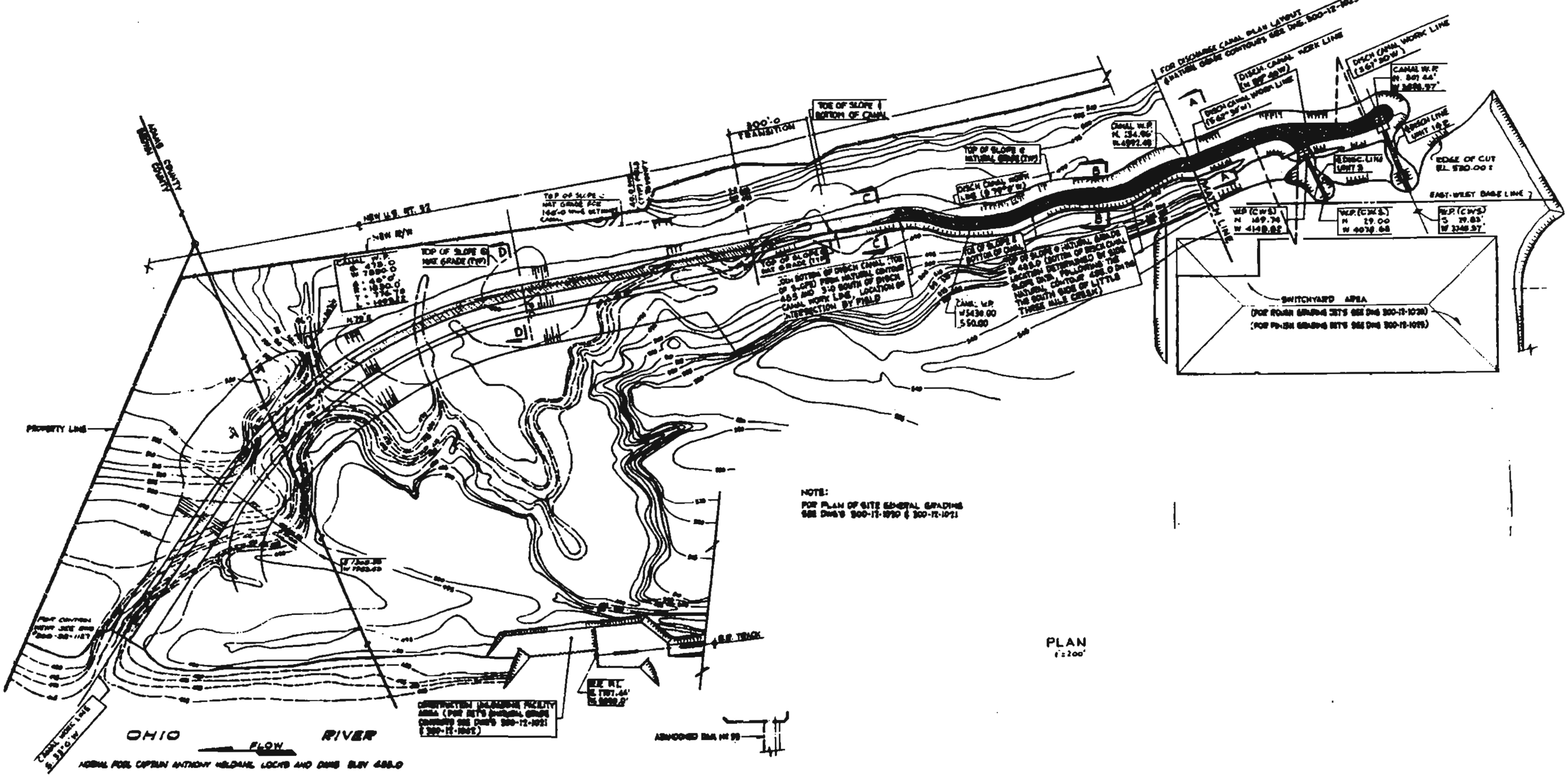

SWITCHYARD AREA
EDGE OF CUT
EAST-WEST BASE LINE
MATCH LINE
PROPERTY LINE
OHIO
FLOW
RIVER
NOTE:
PLAN

FIGURE II-3

ENGINEERING AND HYDROLOGY

III. ENGINEERING AND HYDROLOGY

A. Engineering

1. Unit Operating Characteristics

The J. M. Stuart Station currently consists of four steam electric generating units with a total nameplate rating of 2,441 MW. The four steam turbine generators are supplied by four pulverized coal-fired boilers, each of which supplies 4,400,000 lbs. of steam per hour, at 3,500 psig, 1,000°F main steam temperature and 1,000°F reheat temperature. Units 1, 2, and 3 operate with once-through cooling water from the Ohio River. Unit 4 operates with cooling water circulating through a closed cycle, natural-draft cooling tower. The dates of initial operation of each unit and the dates when each unit was declared commercial are as follows:

Unit No.	First Operation (testing)	Commercial Operation
1	April 12, 1971	May 17, 1971
2	August 31, 1970	October 11, 1970
3	March 20, 1972	May 10, 1972
4	May 8, 1974	June 21, 1974

Units 1, 2, and 3 have a combined maximum circulating water flow of 1,458 cfs (942 mgd) with both circulating pumps in operation (normal operation) for each of the three units (Flow = 285 cfs/unit with one circulating pump/unit in operation). Unit 4 make-up water flow is 15.47 cfs.

2. Cooling Water Characteristics

Cooling water characteristics for the J. M. Stuart Station once-through units (Units 1, 2, and 3) are presented in Table III-1. The calculated rise in water temperature through the condensers of the three once-through systems is 23.7°F at 100 percent load. Actual temperature rises (ΔT) as high as 30-34°F have been measured at the condenser outlet on occasion (see Section IV). The calculated ΔT's in Table III-1 apply during winter and summer operations.

3. Time-Temperature Profile

Figure III-1 presents calculated time-temperature profiles from the intake to the discharge canal under maximum and 75 percent load conditions for Units 1, 2, and 3. Temperature decay with passage down Little Three Mile Creek has been recorded as high as 3°C (Miller et al., 1975).

4. Record of Station Shutdowns and Recorded Effects

Complete plant shutdowns at the J. M. Stuart Station have been infrequent following the initiation of operation of Unit 3 in May 1972. During the early period of construction and testing, the plant was shut down many times (Table III-2). However, after May 1972, when Unit 3 was declared commercial, there were only four periods of complete shutdown, only one of which occurred during the winter (December 1972). Other partial shutdowns are apparent from an examination of the average daily condenser inlet and outlet temperatures presented in Figures III-29 through III-33 (e.g., 5/3-4/1972, 5/25/1972, 8/4/1974, 7/2/1973 and 11/4/1973).

The following excerpts from EPA-DP&L correspondence serve to document the occurrence of known effects on the aquatic biota during these shutdowns.

1) Letter dated May 23, 1972: Valdas V. Adamkus, Region V EPA to Howard R. Palmer, The Dayton Power and Light Company - "The present condition of Little Three Mile Creek and the numerous fish kills which have occurred in the past, readily qualify as substantial environmental impact."

2) Letter dated June 2, 1972: Howard R. Palmer, The Dayton Power and Light Company to Valdas V. Adamkus, Region V EPA - "In your letter you refer to the numerous fish kills which have occurred in the past at the Station site. As I indicated to you on the phone, we have knowledge of only one fish kill associated with the condenser cooling water discharge into Little Three Mile Creek. This occurred on January 21, 1971 as a result of the unexpected sudden trip out of Unit No. 2 (the only unit in operation at the time) and caused a decrease in the temperature of the condenser flow to Little Three Mile Creek. This was reported to the State by the Company. Cooling water flow was maintained to supply other vital services. The reverse thermal situation has a low probability of occurrence with multiple units in service. If you should have other information as to other reported fish kills, we would appreciate such information."

3) Letter dated June 22, 1972: Valdas V. Adamkus, Region V EPA to Howard R. Palmer, The Dayton Power and Light Company - "The enforcement section of the Ohio Department of Natural Resources has records of at least five fish kills occurring in the discharge channel. A list of these kills and numbers of fish involved is attached as you requested."

Date	Number of fish Killed	Reason
March 26, 1970	15	Cutting oil in stream
September 23, 1970	51	Thermal
October 23, 1970	36	Thermal
January 21 or 22, 1971	7,540	Thermal
(Company fined $602 for game fish kills)		
February 6, 1971	1,006	Thermal

The January 21 or 22, 1971 fish kill is documented in a special report by Dr. James R. Gammon, DePauw University entitled "The Effects of the Heated Water Effluent on the Aquatic Biota of Little Three Mile Creek" dated February 2, 1971. Gammon reported that the fish kill probably occurred between January 21 and 22 when temperatures in the Little Three Mile Creek dropped from a relatively stable 81°F to 49°F, a change of 32°F. Table III-3 lists the species and numbers of fish counted approximately one week following the shutdown occurrence. Although some fish may have been flushed out of the canal before the count was made, the data does provide information on the relative abundance and species of fish attracted to the heated water during the winter months. Approximately 95 percent were gizzard shad.

Of the five incidents listed in the third letter cited above, The Dayton Power and Light Company has direct knowledge of only one; the kill occurring in January, 1971. The reported fish kill on February 6, 1971 may have been a result of the January shutdown since no shutdown occurred in February.

No complete shutdowns have occurred since May 28, 1974. Moreover, with all units now on-line, the probability of such an occurrence will be quite low.

5. Heat Rejection

The fluctuation in heat rejection rate due to variations in power generation is shown in Table III-4 which represents the operating loads for a typical day, and the integrated monthly heat rejection rates within the recent experience of the J. M. Stuart Station.

6. Outfall Configuration

The thermal outfalls presently discharging into Little Three Mile Creek are shown on Figure II-3. Units 1 and 2 presently discharge to a common outfall port; Unit 3 discharges into a separate outfall port. The two ports direct the discharge into Little Three Mile Creek. Pertinent dimensions are shown in Table III-5.

In order to ensure that the thermal plume remained within the confines of the then established mixing zone for the Ohio River, The Dayton Power and Light Company, in conjunction with the Ohio Department of Health, constructed a weir at the mouth of Little Three Mile Creek (Figure III-2) in early 1970. The weir was designed such that it could readily be widened to accommodate additional units and increased circulating water flows thereby maintaining a minimum velocity at the point of discharge (into the Ohio River) of at least 2.5 fps. In December 1973 or January or February 1974 (exact date not known) the weir opening was widened from 19.5 feet to 58.5 feet.

7. Deicing Line Operation

When the Ohio River ambient temperature approaches 38°F recirculation is initiated to prevent flash freezing across the circulating water pumps. If possible, a temperature of 45°F is maintained.

B. Hydrology

1. Flow (Discharge)

Tables III-6 through III-11 present USGS flow data measured at the Maysville, Kentucky gaging station located on the Ohio River at Maysville, Kentucky for the water years 1970 through 1975. Low flow records for periods when flow was less than 70,000 to 100,000 cfs are generally not given, since reliable and accurate means for measurement are not available (personal communication, Mr. Howard Beaver, USGS, Louisville, Ky., August 1976).

Presently, up-to-date calculations for seven day, once-in-ten-year low-flow at Maysville, Kentucky are not available from the USGS. Seven day, once-in-ten-year low-flow values have been calculated by USGS District Offices for this and other Ohio River locations but are subject to the approval of the Director, USGS prior to official release (personal communication, Mr. Howard Beaver, USGS, Louisville, Kentucky August, 1976).

In 1970 the U. S. Corps of Engineers calculated the seven day, once-in-ten-year low-flow at Maysville, Kentucky at 11,150 cfs based on a 1968 list of existing reservoirs, those under construction and those in the planning stage. This analysis included Rowlesburg Lake planned for the Monongahela River system. In 1976 the Corps of Engineers up-dated their calculations but eliminated all reservoirs except existing ones and those under construction. While there are some reservoirs on the 1968 list which are not on the 1976 list, the large majority of the effects on low flows are attributable to Rowlesburg Lake. The seven day, once-in-ten-year low-flow less Rowlesburg was recalculated to be 9,750 cfs.

As a point of reference, Figures III-3 through III-7 are presented based on flow data at Cincinnati, Ohio (ORSANCO, 1976). Figure III-3 illustrates the duration of various flows occurring at Cincinnati, Ohio from 1946 through 1975 versus the period July 1975 through June 1976. Figures III-4 through III-6 present the seven-day running average flow at Cincinnati, Ohio based on various periods of record. These figures serve to show that lowest flows typically occur during September and October on the Ohio River. An analysis of average monthly flow at Cincinnati, Ohio (Figure III-7) shows this same trend over a long period of record as well as that which occurred from July 1975 through June 1976.

The Ohio River flow at the J. M. Stuart Station (three miles upstream from Maysville gage) is subject to rapid day-to-day fluctuation depending primarily upon the various combinations of control and release patterns at Greenup Dam (upstream) and Meldahl Dam (downstream). USGS flow data at Greenup Dam, Kentucky (river mile 341.0) for water years 1970 through 1975 are presented in Tables III-12 through III-17. No records are available at Meldahl Dam (river mile 436.2).

2. Currents (Velocity)

Very limited data are available on water velocity in the vicinity of the J. M. Stuart Station. Velocities measured on a transect immediately upstream of the Station on July 22, 1976 (WAPORA) ranged from 0.10 to 0.93 fps near shore and from 0.97 to 1.38 fps at mid-river. At this time river flow was calculated to be approximately 54,000 cfs (based on an average velocity of .984 fps and approximate cross-section of 55,000 sq. ft).

3. Depth Contours

Figures III-8 through III-25 present the results of a series of depth profiles taken by WAPORA on October 10 and 11, 1974 in the vicinity of the J. M. Stuart Station. River stage was 33.8 feet (484.70 feet MSL). Transects are identified by river mile; the Stuart Station intake is located at River Mile 405.2 and the discharge (LTMC) enters at River Mile 405.6 (Figure III-26).

4. Ambient and Discharge Temperatures

A ten year record of water temperatures for the Ohio River is presented in Tables III-18 through III-28. The early data was obtained from ORSANCO stations at Huntington, West Virginia and Cincinnati, Ohio. The data after October 25, 1970 were recorded at the Stuart Station intake monitor. Figure III-27 presents a composite of the temperature data showing the ten year extremes on a weekly basis and the range of the weekly averages over the ten year period. Figure III-28 shows the seasonal trend in temperature variation of the Ohio River based on average monthly temperature at Cincinnati, Ohio for the period 1964 through 1974.

Figures III-29 through III-33 illustrate the daily average condenser inlet and outlet temperatures and corresponding ΔT at the J. M. Stuart Station for the period May 1972 through August 1976. The data upon which these graphs are based (maximum, minimum, and daily average inlet and outlet temperatures) are appended under separate cover.

TABLE III-1 Cooling water characteristics calculated for J. M. Stuart Station, Units 1, 2 and 3 (from The Dayton Power and Light Company).

% Unit Load	Unit Loading % Time	Intake[1] Velocity (fps)	Rate of Cooling[2] Water Flow (MGD/cfs)	Condenser[3] ΔT (°F)	Discharge ΔT (°F)	Rate of Total[2] Water Discharge (MGD/cfs)
40	-		-	-	-	-
50	100	.97	627/970	18	18	627/970
60	65	.97	627/970	21	21	627/970
70	47	1.46	942/1458	17	17	942/1458
80	35	1.46	942/1458	19	19	942/1458
90	28	1.46	942/1458	21	21	942/1458
100	25	1.46	942/1458	24	24	942/1458

[1]Based on an adjusted intake area (due to present siltation and clogging of bottom cells) of approximately 1001.4 square feet at trash bars.

[2]cfs = 1.54723 x·MGD

[3]Applys to both summer and winter operation.

TABLE III-2 J. M. Stuart Station complete shutdowns, 1970-1976 (from The Dayton Power and Light Company).

Shutdown Date		Duration Hours	Duration Minutes
Aug 31, 1970	(Unit 2 began testing August 31, 1970)	11	55
Sep 2, 1970		17	57
3		27	00
5		22	42
6		69	49
9		1	59
10		53	31
13		5	42
16		22	32
18		55	03
21		0	20
21		0	09
27		259	40
Oct 8, 1970		3	33
10		7	07
11	(Unit 2, Commercial - October 11, 1970)	195	20
28		16	21
31		21	30
Nov 19, 1970		5	55
24		102	03
Dec 6, 1970		101	58
11		4	46
17		96	01
21		2	35
Jan 21, 1971		13	24
22		1	26
22		5	01
23		5	33
Feb 7, 1971		37	2
Mar 2, 1971		177	27
Apr 5, 1971		62	18
26		90	22
	(Unit 1, Commercial - May 17, 1971)		
May 18, 1971		13	25

TABLE III-2 (continued)

Shutdown Date	Duration Hours	Duration Minutes
Sep 18, 1971	15	23
24	241	3
Oct 11, 1971	17	27
(Unit 3, Commercial - May 10, 1972)		
Nov 6, 1972	14	70
Dec 17, 1972	15	18
May 23, 1974	8	92
28	68	86
(Unit 4, Commercial - June 21, 1974)		

(No shutdowns occurred after May 28, 1974)

TABLE III-3 Numbers and species of dead fish counted in the effluent canal (locations designated in a downstream direction) following a shutdown occurrence on January 21 or 22, 1971 (from Gammon, 1971).

Species	Right Bank	Left Bank	Total
Golden redhorse	5	-	5
River carpsucker	110	-	110
Carp	44	19	63
Channel catfish	39	38	77
Flathead catfish	1	2	3
Bluegill sunfish	28	28	56
White crappie	14	-	14
White bass	3	5	8
Spotted bass	3	6	9
Freshwater drum	3	2	5
Gizzard shad	5,000	2,190	7,190
TOTAL	5,250	2,290	7,540

TABLE III-4 Heat rejection rate at the J. M. Stuart Station for a typical day and year of operation (from The Dayton Power and Light Company).

Hour	Typical Day[1] Heat Rejected (BTU/hr x 10^6)	Month	Typical Recent Year Heat Rejected (BTU/month x 10^9)
1 AM	4700	January	4275
2 AM	4700	February	3880
3 AM	4700	March	4040
4 AM	4700	April	3705
5 AM	4700	May	3785
6 AM	4700	June	4090
7 AM	4700	July	4355
8 AM	6300	August	4375
9 AM	6300	September	4080
10 AM	6300	October	4030
11 AM	6300	November	4075
12 Noon	6300	December	4645
1 PM	6300		
2 PM	6300		
3 PM	6300		
4 PM	6300		
5 PM	6300		
6 PM	6300		
7 PM	6300		
8 PM	4700		
9 PM	4700		
10 PM	4700		
11 PM	4700		
12 Midnight	4700		

[1]Calculations based on an annual average load factor of 71 percent with a daily loading of 12 hours at 81 percent load and 12 hours at 60 percent load (100 percent load heat rejection = 7800 x 10^6 BTU/hr).

TABLE III-5 Outfall configuration for the J. M. Stuart Generating Station discharge system to Little Three Mile Creek (from The Dayton Power and Light Company).

	Unit 1	Unit 2	Unit 3
1. Length of discharge pipe or canal:			
Pipe	1000 feet	885 feet	885 feet
Outfall	290 feet[1]		160 feet
Structure	25 feet[1]		25 feet
2. Area and dimensions of discharge port:			
16 feet x 44 feet	704 square feet[1]		---
12 feet x 40 feet	---	---	480 square feet
3. Number of ports:	1[1]		1
4. Spacing of ports:	300 feet between Units 1 & 2 and Unit 3		
5. Depth:			
Mean		Not Applicable	
Extreme		Not Applicable	
6. Angle of discharge:			
Horizontal axis	90°[1]		90°
Vertical axis	0°[1]		0°
Current direction	90°[1]		90°
7. Velocity:			
Maximum	1.4 fps[1]		1.0 fps
Most usual	1.1 fps[1]		0.8 fps

[1]Data for combined discharge of Units 1 and 2

TABLE III-6 USGS Ohio River flow data at Maysville, Kentucky.

03238000 Ohio River at Maysville, Ky.

LOCATION.--Lat 38°38'55", long 83°45'49", Mason County, on left bank at foot of Market Street, at Maysville, 850 ft downstream from Aberdeen-Maysville bridge, 0.2 mile downstream from Limestone Creek, and at mile 408.6.

DRAINAGE AREA.--70,130 sq mi, approximately.

PERIOD OF RECORD.--January 1939 to current year (fragmentary prior ~~to~~ October 1940, high-water records only after May 1964). Prior to October 1965, published as "near Maysville."

GAGE.--Water-stage recorder. Datum of gage is 450.90 ft above mean sea level, datum of 1929 or 451.50 ft above mean sea level, Ohio River datum. Prior to Oct. 1, 1964, nonrecording gage at site 3.5 miles upstream at datum 1.07 ft higher. Auxiliary water-stage recorder at upper gage at Capt. Anthony Meldahl Locks and Dam at mile 436. Prior to Oct. 1, 1964, nonrecording auxiliary gage at abandoned lock and dam 34 at mile 434.1.

AVERAGE DISCHARGE.--23 years (1940-63), 91,010 cfs (17.62 inches per year).

EXTREMES.--Current year: Maximum discharge during year, 399,000 cfs Apr. 5 (gage height, 47.86 ft); minimum not determined.
Period of record: Maximum discharge, 635,000 cfs Apr. 17, 1948; maximum gage height, 66.6 ft Mar. 9, 1945 (present datum at site 3.5 miles upstream); minimum discharge not determined.
Maximum stage known, 76.4 ft Jan. 27, 1937 (present datum at site 3.5 miles upstream, discharge, 820,000 cfs, estimated).

REMARKS.--Records fair above 70,000 cfs and poor below.

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1969 TO SEPTEMBER 1970

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1			33,000	284,000	247,000	75,000	196,000	238,000				
2			28,000	304,000	246,000	72,000	255,000	209,000				
3			33,000	287,000	229,000	68,000	305,000	167,000				
4			28,000	226,000	225,000	81,700	365,000	129,000				
5			32,000	175,000	231,000	141,000	394,000	110,000				
6			35,000	140,000	229,000	194,000	393,000	99,400				
7			38,000	110,000	190,000	222,000	356,000	80,000				
8			35,000	90,000	185,000	226,000	294,000	70,000				
9			50,000	73,100	205,000	205,000	243,000	60,000				
10			60,000	55,000	223,000	175,000	213,000	50,000				
11			84,100	40,000	235,000	150,000	190,000	50,000				
12			125,000	40,000	225,000	130,000	170,000	60,000				
13			165,000	45,000	190,000	135,000	155,000	107,000				
14			170,000	40,000	160,000	160,000	140,000	125,000				
15			139,000	45,000	155,000	160,000	130,000	112,000				
16			110,000	48,000	185,000	130,000	124,000	101,000				
17			107,000	48,000	264,000	105,000	117,000	117,000				
18			90,000	50,000	268,000	90,000	136,000	109,000				
19			82,800	54,000	236,000	100,000	120,000	107,000				
20			80,000	60,000	195,000	120,000	110,000	111,000				
21			70,000	56,000	170,000	130,000	105,000	88,700				
22			62,000	60,000	145,000	125,000	110,000	70,000				
23			58,000	58,000	110,000	125,000	110,000	70,000				
24			40,000	56,000	89,600	135,000	210,000	70,000				
25			40,000	55,000	82,600	130,000	247,000	55,000				
26			43,000	55,000	82,000	130,000	266,000	65,000				
27			37,000	65,000	78,000	130,000	273,000	70,000				
28			37,000	87,600	80,000	125,000	266,000	75,000				
29			40,000	124,000	------	125,000	250,000	70,000				
30			75,000	170,000	------	135,000	247,000	65,000				
31			204,000	222,000	------	150,000	------	55,000				
TOTAL			2,230.9M	3,222.7M	5,160.2M	4,179.7M	6,490.0M	2,965.1M				
MEAN			71,960	104,000	184,300	134,800	216,300	95,650				
MAX			204,000	304,000	268,000	226,000	394,000	238,000				
MIN			28,000	40,000	78,000	68,000	105,000	50,000				
CFSM			1.03	1.48	2.63	1.92	3.08	1.36				
IN.			1.18	1.71	2.74	2.22	3.44	1.57				

CAL YR 1969 MAX 260,000
WTR YR 1970 MAX 394,000

M Expressed in thousands.

TABLE III-7 USGS Ohio River flow data at Maysville, Kentucky.

03238000 Ohio River at Maysville, Ky.

LOCATION.--Lat 38°38'55", long 83°45'49", Mason County, on left bank at foot of Market Street, at Maysville, 850 ft downstream from Aberdeen-Maysville bridge, 0.2 mile downstream from Limestone Creek, and at mile 408.6.

DRAINAGE AREA.--70,130 sq mi, approximately.

PERIOD OF RECORD.--January 1939 to current year (fragmentary prior to October 1940, high-water records only after May 1964). Prior to October 1965, published as "near Maysville."

GAGE.--Water-stage recorder. Datum of gage is 450.90 ft above mean sea level, datum of 1929 or 451.50 ft above mean sea level, Ohio River datum. Prior to Oct. 1, 1964, nonrecording gage at site 3.5 miles upstream at datum 1.07 ft higher. Auxiliary water-stage recorder at upper gage at Capt. Anthony Meldahl Locks and Dam at mile 436. Prior to Oct. 1, 1964, nonrecording auxiliary gage at abandoned lock and dam 34 at mile 434.1.

AVERAGE DISCHARGE.--23 years (1940-63), 91,010 cfs (17.62 inches per year).

EXTREMES.--Current year: Maximum discharge during year, 352,000 cfs Feb. 25; maximum gage height, 44.32 ft Feb. 25; minimum not determined.
Period of record: Maximum discharge, 635,000 cfs Apr. 17, 1948; maximum gage height, 66.6 ft Mar. 9, 1945 (present datum at site 3.5 miles upstream); minimum discharge not determined.
Maximum stage since at least 1772, 76.4 ft Jan. 27, 1937 (present datum at site 3.5 miles upstream, discharge, 820,000 cfs, estimated).

REMARKS.--Records fair above 100,000 cfs and poor below. Discharge less than about 70,000 cfs on days for which no discharge is shown.

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1970 TO SEPTEMBER 1971

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1		145,000	85,000	98,000	88,300	257,000		60,000				
2		156,000	90,000	90,000	84,100	245,000		60,000				
3		140,000	95,000	80,000	70,000	231,000		60,000				
4		144,000	99,300	80,000	70,000	216,000		60,000				
5		148,000	95,000	170,000	169,000	213,000		60,000			124,000	
6		140,000	95,000	234,000	249,000	218,000		80,700			99,800	
7		140,000	105,000	267,000	287,000	240,000		164,000				
8		126,000	105,000	258,000	269,000	271,000		246,000				
9		113,000	90,000	210,000	216,000	287,000		305,000				
10		96,900	80,000	161,000	171,000	271,000		321,000				
11		95,000	75,000	138,000	153,000	238,000		283,000				
12		95,000	75,000	112,000	139,000	211,000		230,000				
13		95,000	115,000	103,000	163,000	199,000		213,000				
14		95,000	146,000	115,000	185,000	190,000		248,000				
15		100,000	154,000	145,000	222,000	191,000		273,000				148,000
16		108,000	143,000	158,000	224,000	198,000		256,000				134,000
17		106,000	129,000	161,000	203,000	199,000		219,000				125,000
18		120,000	121,000	150,000	177,000	197,000		184,000				
19		120,000	124,000	130,000	179,000	190,000		151,000				
20		120,000	122,000	95,000	198,000	177,000		115,000				
21		110,000	120,000	75,000	222,000	162,000		85,000				
22		99,900	164,000	70,000	261,000	162,000		70,000				
23		110,000	242,000	65,000	290,000	160,000		60,000				
24		86,900	291,000	70,000	328,000	150,000		55,000				
25		85,000	305,000	92,700	350,000	145,000		50,000				
26		75,000	298,000	119,000	341,000	147,000		50,000				
27		70,000	248,000	112,000	314,000	137,000		50,000				
28		75,000	184,000	89,200	277,000	125,000		45,000				
29		70,000	152,000	80,000	------	116,000		45,000				
30		75,000	118,000	74,500	------	103,000		45,000				
31	92,400	------	109,000	81,600	------	95,000	------	75,000	------			------
TOTAL	-	3,259.7M	4,374.3M	3,884.0M	5,900.4M	5,940.0M		4,218.7M			-	-
MEAN	-	108,700	141,100	125,300	210,700	191,600		136,100			-	-
MAX	92,400	156,000	305,000	267,000	350,000	287,000		321,000			124,000	148,000
MIN	-	70,000	75,000	65,000	70,000	95,000		45,000			-	-

CAL YR 1970 MAX 394,000
WTR YR 1971 MAX 350,000

M Expressed in thousands.

TABLE III-8 USGS Ohio River flow data at Maysville, Kentucky.

03238000 Ohio River at Maysville, Ky.

LOCATION.--Lat 38°38'55", long 83°45'49", Mason County, on left bank at foot of Market Street, at Maysville, 850 ft downstream from Aberdeen-Maysville bridge, 0.2 mile downstream from Limestone Creek, and at mile 408.6.

DRAINAGE AREA.--70,130 sq mi, approximately.

PERIOD OF RECORD.--January 1939 to current year (fragmentary prior to October 1940, high-water records only after May 1964). Prior to October 1965, published as "near Maysville."

GAGE.--Water-stage recorder. Datum of gage is 450.90 ft above mean sea level, datum of 1929 or 451.50 ft above mean sea level, Ohio River datum. Prior to Oct. 1, 1964, nonrecording gage at site 3.5 miles upstream at datum 1.07 ft higher. Auxiliary water-stage recorder at upper gage at Capt. Anthony Meldahl Locks and Dam at mile 436. Prior to Oct. 1, 1964, nonrecording auxiliary gage at abandoned lock and dam 34 at mile 434.1.

AVERAGE DISCHARGE.--23 years (1940-63), 91,010 cfs (17.62 inches per year).

EXTREMES.--Current year: Maximum discharge during year, 418,000 cfs Apr. 24; maximum gage height, 48.25 ft Apr. 24; minimum not determined.

Period of record: Maximum discharge, 635,000 cfs Apr. 17, 1948; maximum gage height, 66.6 ft Mar. 9, 1945 (present datum at site 3.5 miles upstream); minimum discharge not determined.

Maximum stage since at least 1772, 76.4 ft Jan. 27, 1937 (present datum at site 3.5 miles upstream, discharge, 820,000 cfs, estimated).

REMARKS.--Records fair. Discharge less than about 100,000 cfs on days for which no discharge is shown.

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1971 TO SEPTEMBER 1972

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1				97.300	150.000	310.000	136.000	124.000		261.000		
2				136.000	107.000	263.000	117.000	101.000		227.000		
3				154.000	102.000	293.000	82.000	115.000		215.000		
4				164.000	110.000	335.000	97.300	134.000		202.000		
5				192.000	120.000	371.000	119.000	150.000		196.000		
6				228.000	115.000	375.000	134.000	174.000		191.000		
7			111.000	247.000	105.000	344.000	148.000	171.000		212.000		
8			168.000	229.000	90.000	304.000	209.000	155.000		216.000		
9			214.000	197.000	85.000	256.000	266.000	136.000		194.000		
10			220.000	184.000	75.000	237.000	276.000	125.000		167.000		
11			204.000	200.000	70.000	229.000	246.000	164.000		138.000		
12			176.000	196.000	65.000	210.000	206.000	181.000		103.000		
13			153.000	190.000	105.000	196.000	192.000	181.000		95.000		
14			124.000	180.000	200.000	180.000	230.000	167.000		93.200		
15			110.000	160.000	226.000	188.000	288.000	155.000				
16			100.000	140.000	227.000	211.000	336.000	157.000				
17			116.000	110.000	204.000	223.000	380.000	167.000				
18			110.000	95.000	189.000	234.000	394.000	168.000				
19			101.000	85.000	184.000	241.000	379.000	160.000				
20				85.000	176.000	240.000	352.000	139.000				
21				123.000	156.000	224.000	318.000	110.000				
22				170.000	122.000	210.000	338.000	105.000				
23				200.000	113.000	209.000	396.000	89.700	149.000			
24				188.000	179.000	214.000	414.000		196.000			
25				170.000	234.000	219.000	380.000		247.000			
26				160.000	302.000	213.000	329.000		302.000			
27				160.000	357.000	197.000	286.000		363.000			
28				160.000	388.000	180.000	235.000		360.000			
29				150.000	364.000	164.000	192.000		343.000			
30				160.000	------	155.000	169.000		309.000			
31		------		160.000	------	147.000	------		------			------
TOTAL			-	5.070.3M	4.921.0M	7.372.0M	7.644.3M	-	-	-		
MEAN			-	163.600	169.700	237.800	254.800	-	-	-		
MAX			220,000	247.000	388.000	375.000	414.000	181,000	363,000	261,000		
MIN			-	85.000	65.000	147.000	82.000	-	-	-		

CAL YR 1971 MAX 350,000
WTR YR 1972 MAX 414,000

M Expressed in thousands.

TABLE III-9 USGS Ohio River flow data at Maysville, Kentucky.

03238000 Ohio River at Maysville, Ky.

LOCATION.--Lat 38°38'55", long 83°45'49", Mason County, on left bank at foot of Market Street, at Maysville, 850 ft (259 m) downstream from Aberdeen-Maysville bridge, 0.2 mile (0.3 km) downstream from Limestone Creek, and at mile 408.6 (657.4 km).

DRAINAGE AREA.--70,130 sq mi (181,640 sq km), approximately.

PERIOD OF RECORD.--January 1939 to current year (fragmentary prior to October 1940, high-water records only after May 1964). Prior to October 1965, published as "near Maysville."

GAGE.--Water-stage recorder. Datum of gage is 450.90 ft (137.434 m) above mean sea level, datum of 1929 or 451.50 ft (137.617 m) above mean sea level, Ohio River datum. Prior to Oct. 1, 1964, nonrecording gage at site 3.5 miles (5.6 km) upstream at datum 1.07 ft (0.326 m) higher. Auxiliary water-stage recorder at upper gage at Capt. Anthony Meldahl Locks and Dam at mile 436 (702 km). Prior to Oct. 1, 1964, nonrecording auxiliary gage at abandoned lock and dam 34 at mile 434.1 (698.5 km).

AVERAGE DISCHARGE.--23 years (1940-63), 91, 010 cfs (2,577 cu m/s), 17.62 in/yr (448 mm/yr).

EXTREMES.--Current year: Maximum discharge during year, 475,000 cfs (13,500 cu m/s) Dec. 12; maximum gage height, 52.06 ft (15.868 m) Dec. 12; minimum not determined.
Period of record: Maximum discharge, 635,000 cfs (18,000 cu m/s) Apr. 17, 1948; maximum gage height, 66.6 ft (20.30 m) Mar. 9, 1945 (present datum at site 3.5 miles or 5.6 km upstream); minimum discharge not determined.
Maximum stage since at least 1772, 76.4 ft (23.29 m) Jan. 27, 1937 (present datum at site 3.5 miles or 5.6 km upstream, discharge, 820,000 cfs or 23,200 cu m/s, estimated).

REMARKS.--Records fair. Discharge less than about 100,000 cfs (2,830 cu m/s) on days for which no discharge is shown.

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1972 TO SEPTEMBER 1973

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1			150,000	143,000		72,000	159,000	413,000	179,000			
2			135,000	125,000		76,000	147,000	362,000	162,000			
3			120,000	118,000		82,000	146,000	291,000	124,000			
4			110,000	140,000		87,000	162,000	242,000	90,200			
5			110,000	164,000		117,000	190,000	218,000				
6			125,000	176,000		136,000	213,000	196,000				
7			165,000	178,000		148,000	215,000	169,000				
8			210,000	165,000		165,000	221,000	144,000				
9			275,000	146,000		170,000	233,000	143,000				
10			392,000	115,000		160,000	253,000	178,000				
11			460,000			151,000	264,000	202,000				
12			470,000			141,000	261,000	203,000				
13			450,000			130,000	250,000	192,000				
14			394,000			118,000	230,000	179,000				
15			349,000			118,000	214,000	163,000				
16			325,000			124,000	192,000	146,000				
17			319,000		182,000	195,000	178,000	128,000				
18			306,000		170,000	280,000	153,000	109,000				
19			275,000		137,000	340,000	162,000	92,000				
20			240,000		101,000	366,000	175,000	84,000				
21			225,000			353,000	171,000	78,000				
22			231,000			325,000	146,000	73,000				
23			267,000			297,000	137,000	73,000				
24			321,000			253,000	141,000	82,000				
25			338,000			228,000	184,000	132,000				
26			315,000			212,000	191,000	164,000				
27			263,000			210,000	207,000	167,000				
28			225,000			209,000	283,000	147,000				
29			205,000		------	205,000	383,000	137,000				
30			185,000		------	201,000	424,000	167,000				
31		------	163,000		------	174,000	------	182,000	------			------
TOTAL			8,118.0M	-	-	5,843.0M	6,285.0M	5,256.0M	-			
MEAN			261,900	-	-	188,500	209,500	169,500	-			
MAX			470,000	-	-	366,000	424,000	413,000	179,000			
MIN			110,000	-	-	72,000	137,000	73,000	-			

CAL YR 1972 MAX 470,000
WTR YR 1973 MAX 470,000

M Expressed in thousands.

TABLE III-10 USGS Ohio River flow data at Maysville, Kentucky.

03238000 Ohio River at Maysville, Ky.

LOCATION.--Lat 38°38'55", long 83°45'49", Mason County, on left bank at foot of Market Street, at Maysville, 850 ft (259 m) downstream from Aberdeen-Maysville bridge, 0.2 mile (0.3 km) downstream from Limestone Creek, and at mile 408.6 (657.4 km).

DRAINAGE AREA.--70,130 sq mi (181,640 sq km), approximately.

PERIOD OF RECORD.--January 1939 to current year (fragmentary prior to October 1940, high-water records only after May 1964). Prior to October 1965, published as "near Maysville."

GAGE.--Water-stage recorder. Datum of gage is 450.90 ft (137.434 m) above mean sea level, datum of 1929 or 451.50 ft (137.617 m) above mean sea level, Ohio River datum. Prior to Oct. 1, 1964, nonrecording gage at site 3.5 miles (5.6 km) upstream at datum 1.07 ft (0.326 m) higher. Auxiliary water-stage recorder at upper gage at Capt. Anthony Meldahl Locks and Dam at mile 436 (702 km). Prior to Oct. 1, 1964, nonrecording auxiliary gage at abandoned lock and dam 34 at mile 434.1 (698.5 km).

AVERAGE DISCHARGE.--23 years (1940-63), 91,010 cfs (2,577 cu m/s), 17.62 in/yr (448 mm/yr).

EXTREMES.--Current year: Maximum discharge during year, 488,000 cfs (13,800 cu m/s) Jan. 12; maximum gage height, 52.15 ft (15.895 m) Jan. 13; minimum not determined.
Period of record: Maximum discharge, 635,000 cfs (18,000 cu m/s) Apr. 17, 1948; maximum gage height, 66.6 ft (20.30 m) Mar. 9, 1945 (present datum at site 3.5 miles or 5.6 km upstream); minimum discharge not determined.
Maximum stage since at least 1772, 76.4 ft (23.29 m) Jan. 27, 1937 (present datum at site 3.5 miles or 5.6 km upstream, discharge, 820,000 cfs or 23,200 cu m/s, estimated).

REMARKS.--Records fair. Discharge less than about 100,000 cfs (2,830 cu m/s) on days for which no discharge is shown.

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1973 TO SEPTEMBER 1974

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1		106,000	340,000	285,000	215,000	108,000	165,000	55,000	198,000	101,000		102,000
2		115,000	263,000	269,000	190,000	108,000	195,000	60,000	244,000	102,000		90,000
3		110,000	182,000	242,000	166,000	131,000	213,000	92,000	279,000	118,000		127,000
4		99,300	140,000	245,000	152,000	156,000	238,000	95,000	296,000	115,000		136,000
5			126,000	272,000	137,000	153,000	282,000	88,400	260,000	98,200		145,000
6			106,000	268,000	130,000	151,000	319,000	81,900	203,000			131,000
7			85,000	236,000	130,000	177,000	323,000	70,000	134,000			102,000
8			75,000	186,000	135,000	187,000	296,000	71,500	84,900			
9			65,000	150,000	148,000	190,000	263,000	65,000				
10			65,000	170,000	142,000	187,000	263,000	65,000				
11			70,000	293,000	133,000	191,000	264,000	70,000				
12			70,000	424,000	109,000	238,000	245,000	97,500				
13			65,000	480,000	109,000	283,000	221,000	186,000				
14			80,000	473,000	108,000	315,000	203,000	253,000				
15			103,000	408,000	117,000	312,000	180,000	286,000				
16			135,000	281,000	133,000	268,000	160,000	252,000				
17			141,000	209,000	136,000	223,000	150,000	195,000				
18			117,000	188,000	126,000	204,000	135,000	148,000				
19			80,000	199,000	107,000	198,000	120,000	156,000				
20			80,000	213,000	106,000	189,000	110,000	166,000				
21			95,000	233,000	110,000	196,000	100,000	142,000				
22			118,000	250,000	117,000	233,000	91,100	115,000	93,100			
23			166,000	237,000	126,000	267,000	80,000	114,000	132,000			
24			175,000	226,000	135,000	266,000	95,800	109,000	210,000			
25			161,000	221,000	158,000	227,000	105,000	114,000	246,000			
26			148,000	222,000	157,000	178,000	89,100	106,000	222,000			
27		143,000	183,000	237,000	144,000	149,000	70,000	85,000	173,000			
28		248,000	254,000	245,000	125,000	128,000	65,000	65,000	128,000			
29		335,000	292,000	257,000	------	125,000	65,000	70,000	106,000			
30		375,000	295,000	253,000	------	137,000	60,000	95,500	115,000			
31		------	291,000	235,000	------	156,000	------	157,000	------			------
TOTAL		-	4,566.0M	8,107.0M	3,801.0M	6,031.0M	5,166.0M	3,735.8M	-	-		-
MEAN		-	147,300	261,500	135,800	194,500	172,200	120,500	-	-		-
MAX		375,000	340,000	480,000	215,000	315,000	323,000	286,000	296,000	118,000		145,000
MIN		-	65,000	150,000	106,000	108,000	60,000	55,000	-	-		-

CAL YR 1973 MAX 424,000
WTR YR 1974 MAX 480,000

M Expressed in thousands.

TABLE III-11 USGS Ohio River flow data at Maysville, Kentucky.

03238000 Ohio River at Maysville, Ky.

LOCATION.--Lat 38°38'53", long 83°45'49", Mason County, on left bank at foot of Market Street, at Maysville, 850 ft (259 m) downstream from Aberdeen-Maysville bridge, 0.2 mi (0.3 km) downstream from Limestone Creek, and at mile 408.6 (657.4 km).

DRAINAGE AREA.--70,130 sq mi (181,640 sq km), approximately.

PERIOD OF RECORD.--January 1939 to September 1975 (discontinued). Fragmentary prior to October 1940, high-water records only after May 1964. Prior to October 1965, published as "near Maysville."

GAGE.--Water-stage recorder. Datum of gage is 450.90 ft (137.434 m) above mean sea level, datum of 1929 or 451.50 ft (137.617 m) above mean sea level, Ohio River datum. Prior to Oct. 1, 1964, nonrecording gage at site 3.5 mi (5.6 km) upstream at datum 1.07 ft (0.326 m) higher. Auxiliary water-stage recorder at upper gage at Capt. Anthony Meldahl Locks and Dam at mile 436 (702 km). Prior to Oct. 1, 1964, nonrecording auxiliary gage at abandoned lock and dam 34 at mile 434.1 (698.5 km).

AVERAGE DISCHARGE.--23 years (1940-63), 91,010 cfs (2,577 cu m/s), 17.62 in/yr (448 mm/yr).

EXTREMES.--Current year: Maximum discharge during year, 402,000 cfs (11,400 cu m/s) Mar. 16; maximum gage height, 47.36 ft (14.435 m) Mar. 16; minimum discharge not determined.
Period of record: Maximum discharge, 635,000 cfs (18,000 cu m/s) Apr. 17, 1948; maximum gage height, 66.6 ft (20.30 m) Mar. 9, 1945 (present datum at site 3.5 miles or 5.6 km upstream); minimum discharge not determined.
Maximum stage since at least 1772, 76.4 ft (23.29 m) Jan. 27, 1937 (present datum at site 3.5 miles or 5.6 km upstream, discharge, 820,000 cfs or 23,200 cu m/s, estimated).

REMARKS.--Records fair. Discharge less than about 100,000 cfs (2,830 cu m/s) on days for which no discharge is shown.

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1			137.000	194.000	257.000	354.000	356.000	305.000	97.000			
2			167.000	219.000	282.000	282.000	331.000	274.000	103.000			116.000
3			166.000	241.000	294.000	224.000	273.000	252.000	122.000			111.000
4			161.000	239.000	294.000	195.000	221.000	234.000	130.000			
5			152.000	222.000	271.000	180.000	202.000	232.000	110.000			
6			128.000	190.000	262.000	169.000	187.000	237.000	100.000			
7			117.000	170.000	282.000	156.000	174.000	227.000	123.000			
8			125.000	149.000	293.000	156.000	145.000	193.000	142.000			
9			165.000	136.000	277.000	171.000	121.000	160.000	135.000			
10			208.000	134.000	240.000	193.000	118.000	147.000	110.000			
11			221.000	159.000	195.000	198.000	102.000	136.000	95.000			
12			202.000	173.000	178.000	204.000	85.000	126.000	90.000			
13			174.000	176.000	212.000	278.000	80.000	110.000	95.000			
14			155.000	174.000	242.000	336.000	75.000	95.000	105.000			
15			150.000	176.000	232.000	380.000	65.000	95.000	106.000			
16			150.000	164.000	201.000	399.000	60.000	108.000	100.000			
17			162.000	146.000	162.000	390.000	65.000	118.000	95.000			
18			177.000	136.000	149.000	352.000	60.000	132.000	100.000			
19			192.000	156.000	158.000	307.000	65.000	145.000	95.000			
20			171.000	190.000	176.000	294.000	70.000	135.000				
21		96.500	155.000	221.000	184.000	324.000	75.000	128.000				
22		104.000	142.000	228.000	181.000	367.000	75.000	110.000				
23		112.000	127.000	203.000	191.000	375.000	75.000	95.000				
24		108.000	119.000	164.000	253.000	379.000	110.000	97.600				138.000
25		112.000	121.000	151.000	295.000	377.000	221.000	110.000				200.000
26		108.000	144.000	177.000	341.000	376.000	294.000	111.000				232.000
27		118.000	181.000	223.000	378.000	355.000	345.000	100.000				169.000
28		128.000	208.000	246.000	388.000	306.000	371.000	99.100				110.000
29		123.000	215.000	233.000	------	292.000	361.000	95.000				95.500
30		113.000	213.000	208.000	------	334.000	326.000	90.000				
31		------	205.000	221.000	------	355.000	------	100.000	------			------
TOTAL			5.100.0M	5.819.0M	6.868.0M	9.057.0M	5.108.0M	4.596.7M				
MEAN			164.500	187.700	245.300	292.200	170.300	148.300				
MAX			221.000	246.000	388.000	399.000	371.000	305.000				
MIN			117.000	134.000	149.000	156.000	60.000	90.000				

CAL YR MAX 480,000
WTR YR MAX 399,000

M Expressed in thousands.

TABLE III-12 USGS Ohio River flow data at Greenup Dam, Kentucky.

03216600 Ohio River at Greenup Dam, Ky.

LOCATION.--Lat 38°38'48", long 82°51'38", Greenup County, at left end of Greenup Dam on Ohio River, 1.1 miles upstream from Grays Branch, 4.7 miles downstream from Little Sandy River, 5.0 miles north of Greenup, and at mile 341.0.

DRAINAGE AREA.--62,000 sq mi, approximately.

PERIOD OF RECORD.--October 1968 to current year.

GAGE.--Gate-opening and water-stage recorders. Headwater gage 0.4 mile upstream at datum 503.06 ft above mean sea level, Ohio River datum and 502.51 ft above mean sea level, datum of 1929. Tailwater gage 0.4 mile downstream at datum 30.12 ft lower.

EXTREMES.--Current year: Maximum daily discharge, 335,000 cfs Apr. 5; maximum headwater gage height, 20.32 ft Apr. 5; maximum tailwater gage height, 49.58 ft Apr. 5; minimum daily discharge, 10,400 cfs Oct. 14, 16.
Period of record: Maximum daily discharge, 335,000 cfs Apr. 5, 1970; maximum headwater gage height, 20.32 ft Apr. 5, 1970; maximum tailwater gage height, 49.58 ft Apr. 5, 1970; minimum daily discharge, 9,300 cfs Oct. 17, 1968.

REMARKS.--Records good. Daily discharge computed from head, gate openings, and lockages. Flow regulated by Ohio River system of locks, dams, and reservoirs

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1969 TO SEPTEMBER 1970

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	11,600	19,600	28,900	279,000	240,000	72,700	170,000	215,000	43,900	26,800	50,300	21,400
2	21,200	33,400	24,000	275,000	206,000	64,700	230,000	159,000	28,000	44,700	56,700	20,400
3	18,600	25,500	31,000	206,000	207,000	62,500	273,000	116,000	32,300	34,100	48,100	32,700
4	21,700	35,700	24,500	192,000	220,000	61,300	320,000	104,000	33,900	33,200	39,400	27,200
5	24,700	41,200	29,600	163,000	231,000	123,000	335,000	91,100	27,800	30,900	32,300	15,100
6	27,500	29,000	33,300	124,000	201,000	197,000	319,000	83,900	32,600	34,600	29,500	24,400
7	19,100	32,800	35,100	94,400	172,000	227,000	274,000	74,600	47,900	36,800	22,700	20,300
8	19,700	23,000	30,900	81,800	173,000	211,000	215,000	67,900	48,000	18,900	21,500	21,400
9	23,800	22,500	52,200	60,900	193,000	187,000	205,000	55,100	36,600	39,400	27,700	27,700
10	15,100	26,400	59,300	46,900	200,000	152,000	178,000	45,700	32,700	54,800	30,400	28,000
11	16,800	27,400	91,000	25,800	190,000	124,000	169,000	47,400	26,700	55,700	33,200	34,800
12	21,200	24,700	132,000	45,300	180,000	114,000	153,000	44,900	39,300	55,600	38,600	25,900
13	19,500	25,400	183,000	33,900	160,000	157,000	138,000	75,500	32,900	35,700	38,300	22,500
14	10,400	24,200	156,000	41,100	135,000	165,000	120,000	86,600	28,000	32,700	29,700	28,500
15	20,100	18,100	122,000	42,200	170,000	142,000	110,000	84,300	35,400	24,100	22,400	21,200
16	10,400	23,100	112,000	41,600	200,000	104,000	105,000	83,200	42,500	40,900	20,800	19,000
17	11,900	30,800	103,000	41,400	214,000	78,300	104,000	84,700	49,200	49,800	22,900	22,800
18	16,600	26,400	88,700	44,900	200,000	79,400	107,000	87,000	43,900	55,800	16,200	33,200
19	18,000	34,700	79,700	56,900	180,000	97,400	99,700	98,400	53,400	47,900	16,700	32,100
20	14,900	47,800	75,900	48,700	160,000	110,000	95,900	91,500	70,200	38,600	16,200	32,100
21	16,700	65,200	66,400	57,400	140,000	106,000	88,400	85,000	76,300	38,400	22,200	31,200
22	17,200	73,500	55,500	51,800	122,000	108,000	97,000	65,500	66,800	33,100	20,000	29,800
23	18,500	64,500	53,700	51,300	91,600	111,000	99,600	72,900	36,700	31,200	41,600	33,500
24	22,900	55,500	34,700	45,200	81,300	119,000	196,000	64,700	47,600	32,300	44,100	28,500
25	12,500	50,400	41,300	45,200	81,300	113,000	230,000	46,900	31,900	26,700	47,500	20,500
26	19,700	51,000	38,200	60,500	81,600	108,000	240,000	56,800	29,900	23,200	26,400	27,700
27	17,500	51,200	31,800	61,900	72,600	108,000	240,000	65,800	37,200	26,600	30,800	33,200
28	15,600	51,200	36,900	85,600	75,600	106,000	222,000	69,300	48,300	27,400	26,900	32,600
29	12,800	43,300	38,900	97,600	------	109,000	224,000	65,800	31,400	24,600	21,500	33,300
30	19,700	32,600	96,100	174,000	------	119,000	209,000	61,400	35,600	30,600	21,900	34,700
31	10,900	------	279,000	220,000	------	152,000	------	47,200	------	41,300	16,000	------
TOTAL	546,800	1,110.1M	2,264.6M	2,895.3M	4,578.0M	3,788.3M	5,566.6M	2,497.1M	1,231.9M	1,126.4M	930,500	815,700
MEAN	17,640	37,000	73,050	93,400	163,500	122,200	185,600	80,550	41,060	36,340	30,020	27,190
MAX	27,500	73,500	279,000	279,000	240,000	227,000	335,000	215,000	76,300	55,800	56,700	34,800
MIN	10,400	18,100	24,000	25,800	72,600	61,300	88,400	44,900	26,700	18,900	16,000	15,100

CAL YR 1969 TOTAL 22,225,200 MEAN 60,890 MAX 279,000 MIN 10,400
WTR YR 1970 TOTAL 27,351,300 MEAN 74,940 MAX 335,000 MIN 10,400

M Expressed in thousands.

TABLE III-13 USGS Ohio River flow data at Greenup Dam, Kentucky.

03216600 Ohio River at Greenup Dam, Ky.

LOCATION.--Lat 38°38'48", long 82°51'38", Greenup County, at left end of Greenup Dam on Ohio River, 1.1 miles upstream from Grays Branch, 4.7 miles downstream from Little Sandy River, 5.0 miles north of Greenup, and at mile 341.0 (measured downstream from Pittsburg, Pa.).

DRAINAGE AREA.--62,000 sq mi, approximately.

PERIOD OF RECORD.--October 1968 to current year.

GAGE.--Gate-opening and water-stage recorders. Headwater gage 0.4 mile upstream at datum 503.06 ft above mean sea level, Ohio River datum and 502.51 ft above mean sea level, datum of 1929. Tailwater gage 0.4 mile downstream at datum 30.12 ft lower.

EXTREMES.--Current year: Maximum daily discharge, 330,000 cfs Feb. 24; maximum headwater gage height, 16.55 ft Feb. 25; maximum tailwater gage height, 45.80 ft Feb. 25; minimum daily discharge, 11,500 cfs Sept. 2.
Period of record: Maximum daily discharge, 335,000 cfs Apr. 5, 1970; maximum headwater gage height, 20.32 ft Apr. 5, 1970; maximum tailwater gage height, 49.58 ft Apr. 5, 1970; minimum daily discharge, 9,300 cfs Oct. 17, 1968.

REMARKS.--Records good. Daily discharge computed from head, gate openings, and lockages. Flow regulated by Ohio River system of locks, dams, and reservoirs upstream from station.

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1970 TO SEPTEMBER 1971

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	30,800	186,000	80,000	88,000	74,000	240,000	89,300	50,700	59,000	33,100	52,300	18,600
2	25,300	164,000	92,000	80,700	69,000	220,000	87,000	54,100	80,000	34,200	36,000	11,500
3	27,700	148,000	100,000	68,500	62,000	200,000	66,900	51,600	61,000	31,700	51,000	15,800
4	29,300	157,000	92,000	78,000	65,000	190,000	76,600	52,600	47,000	26,100	84,000	16,400
5	21,500	146,000	88,000	180,000	180,000	210,000	74,400	60,500	41,000	21,200	126,000	16,300
6	14,100	149,000	100,000	240,000	230,000	220,000	68,500	79,900	54,000	16,000	94,000	18,600
7	23,600	138,000	110,000	260,000	233,000	240,000	64,500	188,000	65,000	20,500	68,000	12,900
8	24,200	123,000	100,000	230,000	202,000	260,000	74,900	250,000	57,000	14,400	44,000	16,300
9	25,000	111,000	82,000	181,000	174,000	250,000	91,800	290,000	54,000	17,200	35,000	19,600
10	27,000	93,300	72,000	136,000	148,000	220,000	89,600	280,000	53,000	34,000	25,000	20,000
11	21,100	93,000	73,000	117,000	126,000	180,000	81,300	240,000	43,000	37,500	29,000	17,900
12	34,200	89,600	78,000	99,700	108,000	170,000	77,100	180,000	41,000	64,000	23,200	24,800
13	30,200	84,000	115,000	86,000	137,000	160,000	66,800	180,000	40,000	32,000	26,200	49,900
14	61,900	100,000	158,000	90,000	199,000	161,000	69,500	230,000	52,000	30,100	21,400	151,000
15	73,500	110,000	164,000	131,000	239,000	173,000	72,100	240,000	62,000	21,200	23,900	171,000
16	73,900	110,000	135,000	146,000	225,000	174,000	66,400	220,000	64,000	22,700	20,500	140,000
17	56,600	110,000	124,000	147,000	165,000	180,000	68,200	190,000	62,000	13,100	11,900	133,000
18	54,600	115,000	120,000	129,000	149,000	175,000	63,800	160,000	54,000	24,800	15,000	103,000
19	49,900	95,200	122,000	102,000	172,000	155,000	60,900	140,000	43,100	51,400	15,100	95,500
20	46,900	89,600	120,000	78,000	189,000	140,000	46,100	95,000	38,500	79,000	13,000	81,600
21	47,800	89,500	118,000	66,000	226,000	137,000	42,300	74,000	34,000	48,400	13,600	75,400
22	63,100	91,800	184,000	61,000	268,000	138,000	50,400	60,900	33,900	32,000	26,000	64,100
23	67,100	87,100	270,000	55,000	310,000	125,000	53,800	53,800	38,100	30,600	20,900	66,600
24	65,100	80,900	300,000	62,000	330,000	119,000	59,700	47,400	32,200	29,500	13,100	60,700
25	56,800	74,600	300,000	69,000	320,000	122,000	45,600	36,200	41,800	29,000	25,300	42,300
26	49,600	61,200	260,000	81,000	290,000	116,000	40,600	45,100	33,700	22,100	22,000	54,300
27	43,400	68,800	196,000	90,000	250,000	104,000	35,500	38,400	35,500	25,300	24,700	63,900
28	43,400	57,700	147,000	82,000	230,000	95,000	39,000	41,100	21,600	26,900	21,100	56,000
29	36,000	67,100	120,000	69,000	------	89,600	48,600	32,100	33,800	33,100	28,700	59,200
30	70,200	64,500	98,400	62,000	------	58,800	58,700	40,500	22,000	43,300	25,900	44,500
31	139,000	------	92,200	69,000	------	84,700	------	74,700	------	53,100	24,800	-----
TOTAL	1,432.8M	3,154.9M	4,210.6M	3,433.9M	5,370.0M	5,107.1M	1,929.9M	3,776.6M	1,427.2M	997,500	1,060.6M	1,720.7M
MEAN	46,220	105,200	135,800	110,800	191,800	164,700	64,330	121,800	47,570	32,180	34,210	57,360
MAX	139,000	186,000	300,000	260,000	330,000	260,000	91,800	290,000	89,000	79,000	126,000	171,000
MIN	14,100	57,700	72,000	55,000	62,000	58,800	35,500	32,100	21,600	13,100	11,900	11,500

CAL YR 1970 TOTAL 32,228,100 MEAN 88,300 MAX 335,000 MIN 14,100
WTR YR 1971 TOTAL 33,621,800 MEAN 92,110 MAX 330,000 MIN 11,500

M Expressed in thousands.

TABLE III-14 USGS Ohio River flow data at Greenup Dam, Kentucky.

03216600 Ohio River at Greenup Dam, Ky.

LOCATION.--Lat 38°38'48", long 82°51'38", Greenup County, at left end of Greenup Dam on Ohio River, 1.1 miles upstream from Grays Branch, 4.7 miles downstream from Little Sandy River, 5.0 miles north of Greenup, and at mile 341.0.

DRAINAGE AREA.--62,000 sq mi, approximately.

PERIOD OF RECORD.--October 1968 to current year.

GAGE.--Gate-opening and water-stage recorders. Headwater gage 0.4 mile upstream at datum 503.06 ft above mean sea level, Ohio River datum and 502.51 ft above mean sea level, datum of 1929. Tailwater gage 0.4 mile downstream at datum 30.12 ft lower.

EXTREMES.--Current year: Maximum daily discharge, 419,000 cfs Feb. 27; maximum headwater gage height, 21.24 ft Feb. 28; maximum tailwater gage height, 50.16 ft Feb. 28; minimum daily discharge, 14,200 cfs Sept. 10.
Period of record: Maximum daily discharge, 419,000 cfs Feb. 27, 1972; maximum headwater gage height, 21.24 ft Feb. 28, 1972; maximum tailwater gage height, 50.16 ft Feb. 28, 1972; minimum daily discharge, 9,300 cfs Oct. 17, 1968.

REMARKS.--Records good. Daily discharge computed from head, gate openings, and lockages. Flow regulated by Ohio River system of locks, dams, and reservoirs.

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1971 TO SEPTEMBER 1972

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	42,300	26,400	107,000	97,400	112,000	230,000	96,400	78,000	31,100	215,000	77,200	20,500
2	31,600	37,100	113,000	130,000	95,000	229,000	80,000	86,000	42,100	195,000	65,100	16,000
3	28,000	44,100	104,000	138,000	85,000	310,000	60,300	92,000	39,100	181,000	53,900	15,200
4	31,000	59,600	91,000	149,000	95,000	364,000	75,500	119,000	41,100	172,000	74,300	23,300
5	32,500	55,800	65,000	184,000	112,000	381,000	95,700	141,000	35,000	161,000	83,200	19,200
6	29,600	48,100	57,000	228,000	110,000	350,000	112,000	159,000	25,000	195,000	70,200	17,000
7	26,500	42,600	96,400	214,000	90,000	292,000	127,000	144,000	31,200	231,000	42,300	15,500
8	27,400	36,800	194,000	190,000	75,000	243,000	207,000	122,000	30,100	201,000	42,300	20,000
9	27,100	35,100	230,000	155,000	70,000	219,000	250,000	102,000	21,100	161,000	30,100	21,600
10	26,700	31,300	220,000	156,000	70,000	214,000	225,000	114,000	29,600	140,000	28,100	14,200
11	20,500	33,300	190,000	168,000	60,000	202,000	188,000	144,000	24,600	112,000	36,300	21,400
12	19,300	21,900	168,000	172,000	56,000	171,000	155,000	150,000	24,000	99,000	36,700	14,600
13	25,300	27,800	136,000	169,000	110,000	148,000	151,000	138,000	23,700	102,000	35,700	29,700
14	20,900	21,700	113,000	158,000	185,000	143,000	210,000	124,000	37,100	88,000	18,100	33,300
15	18,000	27,400	105,000	144,000	205,000	178,000	305,000	112,000	38,600	79,000	27,100	38,700
16	21,800	23,200	95,000	122,000	185,000	201,000	310,000	124,000	44,700	74,000	22,200	23,300
17	18,700	24,400	95,000	89,900	160,000	208,000	369,000	125,000	49,400	67,000	27,700	40,400
18	17,800	25,900	101,000	80,000	150,000	214,000	394,000	127,000	56,800	65,000	57,900	32,100
19	17,300	21,200	94,000	80,000	145,000	221,000	384,000	119,000	51,800	66,000	90,500	38,900
20	18,600	23,100	78,000	95,000	140,000	209,000	291,000	100,000	51,700	60,000	105,000	31,700
21	22,900	22,300	76,000	116,000	110,000	182,000	250,000	95,000	74,200	62,000	94,100	23,400
22	17,900	29,600	79,000	158,000	85,000	168,000	322,000	83,000	110,000	50,000	56,300	24,200
23	16,600	17,000	77,000	150,000	95,000	172,000	361,000	83,000	154,000	42,000	41,700	22,300
24	26,400	28,800	81,000	140,000	140,000	182,000	415,000	76,100	227,000	38,000	33,200	29,000
25	51,600	34,700	74,000	145,000	210,000	191,000	392,000	71,000	300,000	27,000	33,800	14,400
26	70,200	30,100	63,000	162,000	362,000	176,000	293,000	51,200	350,000	35,000	25,200	17,900
27	77,800	33,800	53,000	155,000	419,000	155,000	200,000	46,800	380,000	28,000	35,800	21,500
28	61,300	40,700	59,000	139,000	395,000	139,000	165,000	41,600	370,000	25,000	21,400	30,000
29	52,700	59,700	64,000	149,000	327,000	125,000	138,000	33,700	320,000	39,000	25,900	31,900
30	38,900	71,600	72,000	167,000	------	121,000	120,000	30,100	250,000	45,600	26,600	46,700
31	34,900	------	80,000	143,000	------	116,000	------	35,800	------	67,600	17,300	------
TOTAL	972,100	1,035.1M	3,230.4M	4,543.3M	4,453.0M	6,454.0M	6,741.9M	3,067.3M	3,263.0M	3,123.2M	1,438.1M	747,900
MEAN	31,360	34,500	104,200	146,600	153,600	208,200	224,700	98,950	108,800	100,700	46,390	24,930
MAX	77,800	71,600	230,000	228,000	419,000	381,000	415,000	159,000	380,000	231,000	108,000	46,700
MIN	16,600	17,000	53,000	80,000	56,000	116,000	60,300	30,100	21,100	25,000	17,300	14,200

CAL YR 1971 TOTAL 30,061,100 MEAN 82,360 MAX 330,000 MIN 11,500 CFSM 1.33 IN. 18.03
WTR YR 1972 TOTAL 39,069,300 MEAN 106,700 MAX 419,000 MIN 14,200 CFSM 1.72 IN. 23.44

M Expressed in thousands.

TABLE III-15 USGS Ohio River flow data at Greenup Dam, Kentucky.

03216600 Ohio River at Greenup Dam, Ky.

LOCATION.--Lat 38°38'48", long 82°51'38", Greenup County, at left end of Greenup Dam on Ohio River, 1.1 mi (1.8 km) upstream from Grays Branch, 4.7 mi (7.6 km) downstream from Little Sandy River, 5.0 mi (8.0 km) north of Greenup, and at mile 341.0 (548.7 km), measured downstream from Pittsburgh, Pa.

DRAINAGE AREA.--62,000 mi² (161,000 km²), approximately.

PERIOD OF RECORD.--October 1968 to current year.

GAGE.--Gate-opening and water-stage recorders. Headwater gage 0.4 mi (0.6 km) upstream at datum 503.06 ft (153.333 m) above mean sea level, Ohio River datum and 502.51 ft (153.165 m) above mean sea level, datum of 1929. Tailwater gage 0.4 mi (0.6 km) downstream at datum 30.12 ft (9.181 m) lower.

AVERAGE DISCHARGE.--5 years, 89,520 ft³/s (2,535 m³/s), 19.61 in/yr (498 mm/yr).

EXTREMES.--Current year: Maximum daily discharge, 475,000 ft³/s (13,500 m³/s) Dec. 11; maximum headwater gage height, 25.45 ft (7.757 m) Dec. 12; maximum tailwater gage height, 54.41 ft (16.584 m) Dec. 12; minimum daily discharge, 8,100 ft³/s (229 m³/s) Sept. 3.
Period of record: Maximum daily discharge, 475,000 ft³/s (13,500 m³/s) Dec. 11, 1972; maximum headwater gage height, 25.45 ft (7.757 m) Dec. 12, 1972; maximum tailwater gage height, 54.41 ft (16.584 m) Dec. 12, 1972; minimum daily discharge, 8,100 ft³/s (229 m³/s) Sept. 3, 1973.

REMARKS.--Records poor. Daily discharge computed from head, gage openings, and lockages. Flow regulated by Ohio River system of locks, dams, and reservoirs upstream from station.

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1972 TO SEPTEMBER 1973

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	49,200	64,000	134,000	118,000	121,000	71,400	126,000	360,000	176,000	50,100	29,300	16,200
2	76,800	126,000	122,000	102,000	117,000	74,100	119,000	260,000	145,000	32,300	21,500	9,800
3	68,600	131,000	114,000	95,600	161,000	76,000	119,000	230,000	112,000	38,500	31,900	8,100
4	45,700	141,000	103,000	116,000	227,000	87,600	140,000	200,000	82,600	31,200	18,800	10,800
5	42,300	130,000	108,000	144,000	250,000	119,000	184,000	190,000	80,000	27,800	27,000	11,200
6	41,500	120,000	126,000	152,000	230,000	127,000	199,000	181,000	103,000	35,000	12,800	16,600
7	78,100	88,000	182,000	148,000	210,000	147,000	207,000	148,000	111,000	34,100	17,300	16,300
8	84,200	98,100	245,000	137,000	183,000	159,000	210,000	125,000	111,000	28,000	17,400	14,200
9	73,100	131,000	345,000	110,000	201,000	146,000	240,000	136,000	88,500	27,300	16,200	11,600
10	51,100	163,000	440,000	79,500	208,000	143,000	250,000	183,000	83,100	27,300	16,100	18,000
11	47,900	168,000	475,000	72,100	190,000	132,000	250,000	203,000	72,800	16,800	17,300	9,700
12	46,500	152,000	455,000	64,500	155,000	117,000	230,000	196,000	52,100	33,500	14,000	13,900
13	45,600	126,000	390,000	51,600	120,000	112,000	220,000	184,000	63,600	27,300	23,000	14,400
14	38,300	107,000	350,000	51,200	115,000	106,000	200,000	167,000	69,000	16,100	20,600	18,000
15	38,200	117,000	310,000	51,800	143,000	94,800	190,000	146,000	66,000	21,600	28,200	16,100
16	34,400	173,000	290,000	55,700	171,000	124,000	164,000	130,000	44,900	21,300	42,300	15,000
17	29,200	194,000	300,000	53,100	165,000	225,000	140,000	114,000	53,800	23,000	32,300	21,600
18	25,700	174,000	280,000	57,000	123,000	330,000	133,000	101,000	66,200	20,200	39,700	15,400
19	32,700	148,000	230,000	57,500	86,400	370,000	140,000	87,200	85,800	24,600	34,100	18,100
20	25,500	157,000	220,000	65,500	88,400	350,000	147,000	86,200	84,000	18,300	21,300	18,700
21	29,000	170,000	210,000	68,900	80,900	315,000	140,000	79,300	73,900	25,500	47,400	19,800
22	34,000	180,000	240,000	77,900	83,900	280,000	115,000	77,200	66,900	38,800	40,100	14,100
23	31,700	165,000	320,000	83,600	79,300	250,000	95,600	77,400	62,600	32,000	43,800	30,200
24	29,000	147,000	355,000	90,200	75,500	225,000	142,000	80,000	67,000	32,900	38.700	14,800
25	30,100	119,000	325,000	90,200	75,300	210,000	157,000	120,000	49,900	31,800	37,000	15,100
26	38,500	112,000	270,000	85,700	68,000	190,000	174,000	145,000	35,600	48,500	25,300	17,200
27	32,200	129,000	220,000	51,600	66,400	190,000	204,000	150,000	38,800	50,500	15,400	21,100
28	29,400	151,000	200,000	102,000	67,200	200,000	310,000	123,000	35,200	39,400	15,000	11,200
29	32,300	162,000	180,000	126,000	------	197,000	360,000	135,000	37,000	32,100	14,900	22,300
30	35,700	152,000	160,000	131,000	------	165,000	380,000	170,000	32,600	33,600	21,800	41,900
31	34,900	------	134,000	136,000	------	137,000	------	186,000	------	16,500	18,700	------
TOTAL	1,331.4M	4,195.1M	7,833.0M	2,855.2M	3,861.3M	5,469.9M	5,685.6M	4,770.3M	2,249.9M	915,900	799,200	501,400
MEAN	42,950	139,800	252,700	92,100	137,900	176,400	189,500	153,900	75,000	29,550	25,780	16,710
MAX	84,200	194,000	475,000	152,000	250,000	370,000	380,000	360,000	176,000	50,500	47,400	41,900
MIN	25,500	64,000	103,000	51,200	66,400	71,400	95,600	77,200	32,600	16,100	12,800	8,100

CAL YR 1972 TOTAL 47,191,200 MEAN 128,900 MAX 475,000 MIN 14,200 CFSM 2.08 IN 28.31
WTR YR 1973 TOTAL 40,468,200 MEAN 110,900 MAX 475,000 MIN 8,100 CFSM 1.79 IN 24.27

TABLE III-16 USGS Ohio River flow data at Greenup Dam, Kentucky.

03216600 Ohio River at Greenup Dam, Ky.

LOCATION.--Lat 38°38'48", long 82°51'38", Greenup County, at left end of Greenup Dam on Ohio River, 1.1 mi (1.8 km) upstream from Grays Branch, 4.7 mi (7.6 km) downstream from Little Sandy River, 5.0 mi (8.0 km) north of Greenup, and at mile 341.0 (548.7 km), measured downstream from Pittsburgh, Pa.

DRAINAGE AREA.--62,000 mi^2 (161,000 km^2), approximately.

PERIOD OF RECORD.--October 1968 to current year.

GAGE.--Gate-opening and water-stage recorders. Headwater gage 0.4 mi (0.6 km) upstream at datum 503.06 ft (153.333 m) above mean sea level, Ohio River datum and 502.51 ft (153.165 m) above mean sea level, datum of 1929. Tailwater gage 0.4 mi (0.6 km) downstream at datum 30.12 ft (9.181 m) lower.

AVERAGE DISCHARGE.--6 years, 92,050 ft^3/s (2,607 m^3/s), 20.16 in/yr (512 mm/yr).

EXTREMES.--Current year: Maximum daily discharge, 540,000 ft^3/s (15,300 m^3/s) Jan. 12; maximum headwater gage height, not determined; maximum tailwater gage height, 55.11 ft (16.798 m) Jan. 13; minimum daily discharge, 11,200 ft^3/s (317 m^3/s) Aug. 27.
Period of record: Maximum daily discharge, 540,000 ft^3/s (15,300 m^3/s) Jan. 12, 1974; maximum headwater gage height, not determined; maximum tailwater gage height, 55.11 ft (16.798 m) Jan. 13, 1974; minimum daily discharge, 8,100 ft^3/s (229 m^3/s) Sept. 3, 1973.

REMARKS.--Records poor. Daily discharge computed from head, gage openings, and lockages. Flow regulated by Ohio River system of locks, dams, and reservoirs upstream from station.

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1973 TO SEPTEMBER 1974

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	32,500	105,000	268,000	250,000	170,000	82,100	131,000	49,000	105,000	73,400	31,400	86,100
2	45,000	114,000	169,000	235,000	145,000	90,200	151,000	54,200	242,000	92,000	17,000	93,000
3	27,400	106,000	135,000	220,000	130,000	108,000	181,000	65,800	200,000	100,000	16,800	107,000
4	41,400	100,000	116,000	260,000	120,000	124,000	228,000	71,000	270,000	84,600	26,400	125,000
5	41,200	78,000	99,500	290,000	115,000	124,000	270,000	76,300	199,000	63,200	27,900	140,000
6	40,600	58,000	63,800	250,000	105,000	126,000	280,000	72,000	150,000	53,600	25,600	117,000
7	40,000	70,000	64,400	190,000	100,000	162,000	270,000	67,000	109,000	41,000	16,400	85,900
8	29,200	61,500	55,200	140,000	110,000	166,000	242,000	58,000	72,200	40,100	36,500	65,600
9	30,000	60,000	59,900	120,000	115,000	166,000	231,000	58,000	83,300	33,900	27,200	68,700
10	27,400	49,300	63,600	180,000	110,000	161,000	251,000	62,000	51,600	32,600	38,800	53,500
11	29,000	49,300	63,100	400,000	90,000	187,000	240,000	69,000	41,900	39,200	24,300	38,200
12	27,200	39,200	64,400	540,000	88,000	262,000	207,000	110,000	31,700	33,800	25,500	39,600
13	28,300	40,300	60,300	520,000	83,200	270,000	183,000	240,000	38,100	21,000	30,100	47,000
14	21,700	39,700	69,400	430,000	85,800	280,000	169,000	285,000	30,900	18,200	26,200	55,900
15	22,400	33,800	111,000	330,000	95,100	249,000	156,000	265,000	25,400	18,400	21,600	73,800
16	14,900	55,200	129,000	190,000	110,000	199,000	144,000	197,000	51,200	23,500	16,900	46,800
17	23,300	53,700	117,000	165,000	103,000	180,000	132,000	149,000	40,300	22,300	22,200	46,800
18	18,700	54,100	89,500	165,000	93,000	175,000	122,000	133,000	45,500	22,800	23,500	38,600
19	20,100	53,000	68,700	175,000	73,900	171,000	113,000	145,000	52,800	12,300	22,600	31,700
20	15,200	50,800	65,800	190,000	77,800	163,000	99,100	147,000	42,700	18,600	19,300	31,000
21	17,600	55,300	65,800	225,000	82,000	190,000	89,100	121,000	57,900	12,600	19,100	40,100
22	16,600	54,000	123,900	215,000	82,200	258,000	74,300	98,800	106,000	12,500	18,000	72,100
23	13,300	43,600	170,000	190,000	93,100	299,000	64,700	93,000	139,000	16,100	19,400	64,100
24	15,000	45,500	159,000	185,000	115,000	237,000	83,300	92,700	214,000	11,900	18,100	39,900
25	14,000	58,700	134,000	190,000	131,000	178,000	87,300	104,000	201,000	17,300	15,800	39,200
26	17,000	86,400	130,000	200,000	125,000	139,000	73,100	87,400	174,000	16,600	16,900	31,400
27	18,000	155,000	231,000	215,000	106,000	115,000	67,500	64,400	139,000	24,800	11,200	34,300
28	17,000	290,000	287,000	225,000	92,400	107,000	55,000	56,600	91,400	22,200	17,900	28,700
29	30,000	312,000	232,000	235,000	------	98,500	59,000	49,500	84,800	35,100	44,600	28,200
30	75,000	317,000	229,000	215,000	------	103,000	51,400	98,200	86,800	33,900	67,900	23,900
31	115,000	------	250,000	190,000	------	120,000	------	140,000	------	13,700	104,000	------
TOTAL	924,000	2,688.4M	3,962.4M	7,525.0M	2,946.5M	5,289.8M	4,504.8M	3,378.9M	3,296.5M	1,061.2M	849,300	1,793.1M
MEAN	29,810	89,610	127,800	242,700	105,200	170,600	150,200	109,000	109,900	34,230	27,400	59,770
MAX	115,000	317,000	287,000	540,000	170,000	299,000	280,000	285,000	270,000	100,000	104,000	140,000
MIN	13,300	33,800	55,200	120,000	73,900	82,100	51,400	49,000	25,400	11,900	11,200	23,900

CAL YR 1973 TOTAL 34,683,500 MEAN 95,020 MAX 390,000 MIN 8,100 CFSM 1.53 IN 20.80
WTR YR 1974 TOTAL 38,219,900 MEAN 104,700 MAX 540,000 MIN 11,200 CFSM 1.69 IN 22.93

TABLE III-17 USGS Ohio River flow data at Greenup Dam, Kentucky.

03216600 Ohio River at Greenup Dam, Ky.

LOCATION.--Lat 38°38'48", long 82°51'38", Greenup County, at left end of Greenup Dam, 1.1 mi (1.8 km) upstream from Grays Branch, 4.7 mi (7.6 km) downstream from Little Sandy River, 5.0 mi (8.0 km) north of Greenup, and at mile 341.0 (548.7 km).

DRAINAGE AREA.--62,000 sq mi (161,000 sq km), approximately.

PERIOD OF RECORD.--October 1968 to current year.

GAGE.--Gate-opening and water-stage recorders. Headwater gage 0.4 mi (0.6 km) upstream at datum 502.51 ft (153.165 m) above mean sea level, datum of 1929 or 503.06 ft (503.06 ft (153.333 m) above mean sea level, Ohio River datum. Tailwater gage 0.4 mi (0.6 km) downstream at datum 30.12 ft (9.181 m) lower.

AVERAGE DISCHARGE.--7 years, 95,100 cfs (2,693 cu m/s), 20.83 in/yr (529 mm/yr).

EXTREMES.--Current year: Maximum daily discharge, 400,000 cfs (11,300 cu m/s) Mar. 16; maximum observed headwater gage height, 19.80 ft (6.035 m) Mar. 16; maximum tailwater gage height, 48.78 ft (14.868 m) Mar. 16; minimum daily discharge, 10,700 cfs (303 cu m/s) Aug. 3.
Period of record: Maximum daily discharge, 540,000 cfs (15,300 cu m/s) Jan. 12, 1974; maximum observed headwater gage height, 26.2 ft (7.99 m) Jan. 13, 1974; maximum tailwater gage height, 55.11 ft (16.798 m) Jan. 13, 1974; minimum daily discharge, 8,100 cfs (229 cu m/s) Sept. 3, 1973.

REMARKS.--Records good. Daily discharge computed from head, gage openings, and lockages. Flow regulated by Ohio River system of locks, dams, and reservoirs upstream from station.

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1974 TO SEPTEMBER 1975

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	27,400	26,600	134,000	177,000	255,000	274,000	305,000	259,000	93,200	50,700	24,200	113,000
2	21,100	30,000	154,000	221,000	292,000	169,000	257,000	235,000	101,000	37,000	14,600	131,000
3	30,300	23,400	149,000	221,000	283,000	161,000	200,000	210,000	125,000	30,600	10,700	95,600
4	31,000	23,300	150,000	203,000	276,000	151,000	180,000	205,000	118,000	16,300	19,600	70,100
5	25,900	32,200	132,000	175,000	211,000	141,000	173,000	220,000	81,800	37,400	12,900	48,900
6	31,400	47,400	108,000	158,000	235,000	126,000	158,000	215,000	100,000	27,400	23,500	46,700
7	19,800	52,500	92,800	137,000	280,000	118,000	133,000	182,000	129,000	27,400	23,600	50,700
8	23,100	50,800	97,300	117,000	265,000	129,000	113,000	147,000	134,000	26,300	29,600	45,600
9	23,400	44,500	163,000	111,000	236,000	159,000	99,200	137,000	120,000	28,900	20,500	33,100
10	23,300	41,000	209,000	113,000	184,000	177,000	95,400	126,000	93,400	40,200	17,300	36,700
11	22,800	39,200	200,000	127,000	147,000	165,000	79,200	121,000	78,400	37,400	18,700	27,000
12	20,100	44,800	167,000	138,000	156,000	204,000	68,800	105,000	80,400	29,400	17,900	42,700
13	21,200	55,200	144,000	134,000	220,000	286,000	76,400	87,300	90,900	24,100	23,000	72,800
14	17,700	55,500	135,000	136,000	219,000	334,000	57,400	83,900	98,400	25,300	31,800	70,100
15	25,000	66,000	128,000	140,000	181,000	393,000	55,200	84,500	101,000	21,500	36,800	54,000
16	24,100	60,800	126,000	125,000	145,000	400,000	58,900	106,000	85,500	31,200	68,600	33,000
17	45,800	62,400	143,000	114,000	126,000	332,000	53,300	109,000	79,700	21,900	97,800	36,600
18	54,300	57,800	159,000	108,000	125,000	277,000	55,000	127,000	85,500	24,400	88,100	42,700
19	54,000	50,000	156,000	141,000	141,000	251,000	46,500	132,000	76,400	26,500	39,100	49,700
20	32,000	54,300	139,000	195,000	163,000	260,000	63,400	119,000	68,600	24,100	30,500	69,100
21	33,800	85,900	122,000	219,000	159,000	338,000	67,200	117,000	54,600	25,100	19,900	78,100
22	25,400	107,000	111,000	201,000	144,000	365,000	67,300	79,700	55,100	27,700	25,100	69,600
23	26,900	109,000	104,000	154,000	148,000	355,000	61,400	84,900	46,200	22,900	20,300	67,300
24	34,000	106,000	93,900	130,000	211,000	304,000	81,700	103,000	38,700	17,600	18,100	132,000
25	29,400	103,000	97,600	131,000	282,000	310,000	246,000	116,000	34,600	38,400	23,500	225,000
26	30,800	102,000	140,000	186,000	317,000	325,000	330,000	94,000	43,400	12,800	17,700	211,000
27	28,500	118,000	178,000	225,000	340,000	281,000	354,000	92,200	78,600	28,300	20,000	136,000
28	23,200	125,000	201,000	216,000	324,000	204,000	319,000	91,000	72,200	26,800	18,300	107,000
29	29,700	119,000	199,000	182,000	------	239,000	275,000	74,200	79,200	14,400	24,200	93,600
30	24,200	104,000	195,000	183,000	------	287,000	270,000	79,200	74,900	13,100	22,600	76,300
31	31,900	------	177,000	215,000	------	314,000	------	109,000	------	11,500	56,700	------
TOTAL	891,500	1,996.6M	4,504.6M	5,033.0M	6,065.0M	7,829.0M	4,399.3M	4,050.9M	2,517.7M	826,600	915,200	2,365.0M
MEAN	28,760	66,550	145,300	162,400	216,600	252,500	146,600	130,700	83,920	26,660	29,520	78,830
MAX	54,300	125,000	209,000	225,000	340,000	400,000	354,000	259,000	134,000	50,700	97,800	225,000
MIN	17,700	23,300	92,800	108,000	125,000	118,000	46,500	74,200	34,600	11,500	10,700	27,000

CAL YR 1974 TOTAL 38,037,800 MEAN 104,200 MAX 540,000 MIN 11,200 CFSM 1.68 IN. 22.82
WTR YR 1975 TOTAL 41,394,400 MEAN 113,400 MAX 400,000 MIN 10,700 CFSM 1.83 IN. 24.84

M Expressed in thousands.

TABLE III-18 Ambient Ohio River temperatures (°F) in the vicinity of the J. M. Stuart Station, 1964.

Month	Week of	Mean	Maximum	Minimum
January	5	39	42	39
	12	39	40	38
	19	39	41	38
	26	41	44	40
February	2	40	40	39
	9	41	41	40
	16	40	41	39
	23	40	41	40
March	1	43	46	41
	8	48	52	45
	15	48	51	45
	22	49	50	47
	29	49	51	47
April	5	48	50	48
	12[1]	53	56	50
	19	57	59	53
	26	61	64	60
May	3	69	74	64
	10	66	69	63
	17	71	73	69
	24	73	74	73
	31	73	73	72
June	7	75	76	73
	14	78	79	78
	21	79	81	79
	28	80	81	80
July	5	80	81	80
	12	80	81	80
	19	82	84	81
	26	84	85	84
August	2	84	84	84
	9	81	83	81
	16	78	79	78
	23	78	79	78
	30	79	79	79
September	6	80	82	78
	13	77	80	76
	20	76	78	74
	27	73	74	72
October	4	68	71	66
	11	64	65	64
	18	63	65	61
	25	61	62	60
November	1	61	61	61
	8	60	60	59
	15	59	60	57
	22	54	55	53
	29	50	52	49
December	6	48	49	47
	13	47	48	46
	20	44	47	42
	27	45	46	45

YEARLY MAXIMUM: 85, WEEK OF: 7-26

YEARLY MINIMUM: 38, WEEK OF: 1-12, 19

[1]Indicates only Huntington data used.

TABLE III-19 Ambient Ohio River temperatures (°F) in the vicinity of the J. M. Stuart Station, 1965.

Month	Week of	Mean	Maximum	Minimum
January	3	44	44	43
	10	42	43	40
	17	38	38	37
	24	39	41	38
	31	37	40	35
February	7	37	41	34
	14	43	45	42
	21	40	41	39
	28	42	46	39
March	7	44	47	41
	14	44	46	42
	21	46	47	45
	28	48	49	46
April	4	53	55	50
	11	56	58	54
	18	58	61	57
	25	59	61	58
May	2	64	66	60
	9	71	71	70
	16	73	75	73
	23	76	77	76
	30	77	78	76
June	6	78	79	77
	13	79	80	78
	20	79	80	78
	27	80	81	79
July	4	81	82	81
	11	82	83	81
	18	83	84	82
	25	83	84	82
August	1	80	83	79
	8	79	82	79
	15	80	84	80
	22	80	83	80
	29	77	80	77
September	5	78	78	77
	12	78	78	76
	19	78	78	74
	26	75	75	73
October	3	70	73	67
	10	65	67	63
	17	65	66	64
	24	61	63	59
	31	57	59	57
November	7	58	58	58
	14	55	57	54
	21	52	52	52
	28	47	50	46
December	5	45	45	44
	12	45	46	45
	19	44	45	44
	26	45	46	44

YEARLY MAXIMUM: 84, WEEK OF: 7-18, 25; 8-15

YEARLY MINIMUM: 34, WEEK OF: 2-7

TABLE III-20 Ambient Ohio River temperatures (°F) in the vicinity of the J. M. Stuart Station, 1966.

Month	Week of	Mean	Maximum	Minimum
January	2	45	46	44
	9	39	42	38
	16	38	39	33
	23	36	37	33
	30	34	39	33
February	6	34	36	33
	13	40	40	38
	20	39	40	38
	27	43	50	38
March	6	48	52	46
	13	49	51	48
	20	52	54	51
	27	53	54	53
April	3	49	50	49
	10	50	55	48
	17	53	56	49
	24	61	62	57
May	1	60	64	57
	8	60	60	59
	15	63	64	60
	22	70	68	65
	29	71	72	71
June	5	75	75	73
	12	77	77	75
	19	80	81	78
	26	83	85	81

Month	Week of	Mean	Maximum	Minimum
July	3	84	85	84
	10	83	84	83
	17	84	86	83
	24	84	85	83
	31	83	84	82
August	7	82	82	82
	14	81	81	81
	21	81	82	80
	28[1]	81	82	80
September	4[1]	80	83	78
	11	78	78	76
	18	75	77	73
	25	72	73	69
October	2	65	67	64
	9	64	66	63
	16	62	63	60
	23	61	62	59
	30[1]	56	57	55
November	6[1]	54	54	53
	13[1]	53	54	52
	20	55	55	55
	27	54	55	52
December	4	49	49	48
	11[1]	45	47	42
	18[1]	42	43	40
	25	40	41	39

YEARLY MAXIMUM: 86, WEEK OF: 7-17

YEARLY MINIMUM: 33, WEEK OF: 1-23, 30; 2-6

[1]Indicates only Cincinnati data used.

TABLE III-21 Ambient Ohio River temperatures (°F) in the vicinity of the J. M. Stuart Station, 1967.

Month	Week of	Mean	Maximum	Minimum
January	1	39	40	38
	8	40	40	39
	15	38	40	35
	22	41	43	39
	29	42	43	41
February	5	41	42	40
	12	38	40	38
	19	39	40	37
	26	36	36	36
March	5[1]			
	12[1]			
	19[1]			
	26[1]			
April	2[1]			
	9[1]			
	16[1]			
	23[1]			
	30[2]	56	59	54
May	7[2]	56	57	55
	14[2]	56	58	54
	21[2]	61	65	58
	28[2]	69	70	68
June	4[2]	70	73	68
	11[2]	78	80	75
	18	80	82	80
	25	81	83	79
July	2	80	81	79
	9	80	81	80
	16	80	81	79
	23	81	81	80
	30	82	83	81
August	6	80	81	80
	13	79	79	79
	20	78	79	78
	27	77	78	77
September	3	76	77	73
	10	75	76	72
	17	75	76	72
	24	72	74	68
October	1	69	70	67
	8	66	69	64
	15	64	65	62
	22	61	62	58
	29	57	58	55
November	5	54	54	53
	12	50	51	48
	19	47	48	47
	26	45	47	43
December	3	43	43	42
	10	45	45	44
	17	45	46	44
	24	43	45	41
	31	39	40	37

YEARLY MAXIMUM: 83, WEEK OF: 6-25; 7-30

YEARLY MINIMUM: 35, WEEK OF: 1-15

[1]Indicates no data available.
[2]Indicates only Huntington data used.

TABLE III-22 Ambient Ohio River temperatures (°F) in the vicinity of the J. M. Stuart Station, 1968.

Month	Week of	Mean	Maximum	Minimum
January	7	34	36	33
	14	35	37	33
	21	37	38	37
	28	40	42	37
February	4	40	41	39
	11	36	38	35
	18	35	36	35
	25	37	37	36
March	3	41	44	38
	10	46	48	43
	17	48	50	45
	24	49	51	47
	31	57	58	55
April	7	57	60	56
	14	62	63	60
	21	64	65	63
	28	65	67	64
May	5	67	68	65
	12	68	70	67
	19	66	69	64
	26	62	63	62
June	2	68	69	68
	9	75	77	73
	16	77	78	76
	23	79	79	78
	30	80	81	79
July	7	82	83	81
	14	83	84	82
	21	85	85	84
	28	83	84	83
August	4	84	84	83
	11	81	82	80
	18	82	83	81
	25	80	82	80
September	1	79	81	77
	8	76	79	74
	15	75	77	73
	22	77	78	74
	29	73	76	70
October	6	69	70	69
	13	70	70	68
	20	67	68	63
	27	61	62	60
November	3	60	61	59
	10	55	57	54
	17	51	54	49
	24	48	49	46
December	1	47	48	45
	8	43	44	41
	15	40	41	39
	22	38	40	38
	29	36	38	34

YEARLY MAXIMUM: 85, WEEK OF: 7-21

YEARLY MINIMUM: 33, WEEK OF: 1-7, 14

TABLE III-23 Ambient Ohio River temperatures (°F) in the vicinity of the J. M. Stuart Station, 1969.

Month	Week of	Mean	Maximum	Minimum
January	5	32	33	32
	12	34	35	33
	19	37	40	35
	26	41	41	40
February	2	41	41	40
	9	40	41	39
	16	39	41	38
	23	40	41	39
March	2	43	44	41
	9	43	44	42
	16	46	46	45
	23	47	50	43
	30	48	51	45
April	6	51	54	49
	13	58	60	57
	20	58	60	57
	27	58	60	58
May	4	64	66	62
	11	66	66	64
	18	63	65	61
	25	72	74	70
June	1	75	77	74
	8	78	80	76
	15	78	80	78
	22	80	82	78
	29	85	86	83
July	6	84	85	83
	13	82	83	81
	20	82	83	82
	27	82	83	82
August	3	81	82	81
	10	81	82	81
	17	79	80	79
	24	79	80	78
	31	80	80	80
September	7	77	80	75
	14	76	78	73
	21	74	75	72
	28	72	74	70
October	5	71	72	70
	12	70	72	67
	19	66	68	63
	26	61	63	59
November	2	57	61	55
	9	53	54	52
	16	50	51	48
	23	47	48	47
	30	44	45	42
December	7	43	44	42
	14	42	43	40
	21	39	41	37
	28	38	40	37

YEARLY MAXIMUM: 86, WEEK OF: 6-29

YEARLY MINIMUM: 32, WEEK OF: 1-5

TABLE III-24 Ambient Ohio River temperatures (°F) in the vicinity of the J. M. Stuart Station, 1970.

Month	Week of	Mean	Maximum	Minimum
January	4	36	39	33
	11	33	33	33
	18	34	34	33
	25	36	39	34
February	1	37	38	37
	8	38	39	37
	15	39	40	38
	22	41	41	40
March	1	44	45	41
	8	45	45	42
	15	43	43	42
	22	44	44	41
	29	46	49	41
April	5	50	52	48
	12	53	56	50
	19	59	61	57
	26	63	65	61
May	3	66	67	66
	10	69	70	68
	17	72	74	71
	24	74	77	70
	31	76	77	71
June	7	78	80	77
	14	80	81	79
	21	80	82	79
	28	81	83	80
July	5	81	82	80
	12	81	83	80
	19	81	83	80
	26	83	84	82
August	2	83	84	83
	9	81	82	81
	16	81	82	81
	23	82	83	81
	30	82	83	82
September	6	82	84	80
	13	81	83	80
	20	82	84	80
	27	79	81	78
October	4	72	73	71
	11[1]	71	72	69
	18	68	69	67
	25	66	67	65
November	1	61	63	59
	8	58	58	57
	15	54	56	53
	22	51	54	49
	29	51	52	49
December	6	49	51	48
	13	47	50	47
	20[2]	48	49	46
	27[2]	46	47	45

YEARLY MAXIMUM: 84, WEEK OF: 7-26; 8-2; 9-6, 20

YEARLY MINIMUM: 33, WEEK OF: 1-4, 11, 18

[1]Indicates only Cincinnati data used.

[2]Indicates possible recirculation influence.

TABLE III-25 Ambient Ohio River temperatures (°F) in the vicinity of the J. M. Stuart Station, 1971.

Month	Week of	Mean	Maximum	Minimum
January	3[1]	45	46	44
	10[1]	46	47	44
	17[1]	44	46	40
	24[1]	43	44	42
	31[1]	41	43	39
February	7[1]	40	44	38
	14[1]	42	42	41
	21[1]	43	44	42
	28[1]	50	57	44
March	7	43	51	41
	14	46	47	43
	21	46	47	46
	28	49	50	47
April	4	52	54	50
	11	57	58	55
	18	60	61	59
	25	60	60	60
May	2	61	61	60
	9	60	61	59
	16	64	68	60
	23	68	69	68
	30	73	75	70
June	6	74	77	73
	13	78	79	77
	20	80	81	78
	27	82	85	80
July	4	84	85	83
	11	84	85	83
	18	79	81	77
	25	78	79	77
August	1	77	78	76
	8	77	77	77
	15	78	80	78
	22	78	79	76
	29	78	79	77
September	5	78	80	72
	12	77	79	72
	19	74	79	71
	26	75	77	72
October	3	72	73	70
	10	68	69	67
	17	67	68	65
	24	68	69	67
	31	66	67	63
November	7	58	61	57
	14	58	58	57
	21	52	55	50
	28	48	50	46
December	5	46	47	45
	12	48	49	47
	19	46	47	45
	26	47	48	46

YEARLY MAXIMUM: 85, DATE: 7-1, 9, 15

YEARLY MINIMUM: 38, DATE: 2-8, 9

[1]Indicates possible recirculation influence.

TABLE III-26 Ambient Ohio River temperatures (°F) in the vicinity of the J. M. Stuart Station, 1972.

Month	Week of	Mean	Maximum	Minimum
January	2	45	48	42
	9[1]	42	44	41
	16[1]	43	44	41
	23[1]	43	44	42
	30[1]	42	44	41
February	6[1]	41	41	41
	13[1]	40	41	38
	20[1]	40	42	39
	27	43	44	41
March	5	41	43	39
	12	44	46	40
	19	45	46	43
	26	44	45	43
April	2	47	49	45
	9	49	53	47
	16	57	58	55
	23	56	57	55
	30	59	61	56
May	7	61	62	60
	14	62	63	61
	21	66	68	64
	28	68	69	68
June	4	72	73	70
	11	74	75	73
	18	75	77	72
	25	64	69	61
July	2	66	68	64
	9	70	73	68
	16	76	79	73
	23	81	81	80
	30	80	81	77
August	6	75	76	74
	13	77	79	76
	20	78	79	77
	27	78	78	77
September	3	77	78	76
	10	77	77	76
	17	77	77	74
	24	75	76	74
October	1	71	73	69
	8	67	69	65
	15	62	65	60
	22	59	61	56
	29	56	57	56
November	5	53	55	52
	12	50	51	48
	19	45	47	43
	26	42	43	41
December	3	43	44	42
	10	43	44	42
	17	40	41	39
	24	42	42	41
	31	42	43	42

YEARLY MAXIMUM: 81, DATE: 7-24, 25, 26, 27, 28; 8-1

YEARLY MINIMUM: 38, DATE: 2-16

[1]Indicates possible recirculation influence.

TABLE III-27 Ambient Ohio River temperatures (°F) in the vicinity of the J. M. Stuart Station, 1973.

Month	Week of	Mean	Maximum	Minimum
January	7	39	41	38
	14	38	39	38
	21	39	41	38
	28	41	42	41
February	4	42	43	40
	11	40	40	39
	18[1]	40	40	39
	25[1]	41	43	39
March	4	47	50	44
	11	53	54	51
	18	49	53	45
	25	48	50	46
April	1	51	51	50
	8	49	51	47
	15	51	55	48
	22	57	57	56
	29	55	56	54
May	6	58	60	56
	13	61	62	60
	20	63	64	61
	27	65	66	64
June	3	70	73	67
	10	75	77	73
	17	79	80	77
	24	79	80	78
July	1	79	80	78
	8	81	82	80
	15	81	82	81
	22	81	82	81
	29	81	81	80
August	5	81	82	81
	12	81	82	80
	19	80	81	80
	26	81	82	80
September	2	83	83	82
	9	80	81	78
	16	76	77	75
	23	76	77	75
	30	76	77	75
October	7	73	74	73
	14	71	73	69
	21	67	68	66
	28	63	66	60
November	4	56	58	53
	11	51	52	50
	18	50	51	50
	25	52	53	51
December	2	49	50	48
	9	45	47	44
	16	42	44	40
	23	41	43	41
	30	42	43	41

YEARLY MAXIMUM: 83, DATE: 9-3, 4, 5, 6

YEARLY MINIMUM: 38, DATE: 1-12, 13, 14, 15, 16, 17, 21

[1]Indicates possible recirculation influence.

TABLE III-28 Ambient Ohio River temperatures (°F) in the vicinity of the J. M. Stuart Station, 1974.

Month	Week of	Mean	Maximum	Minimum	Month	Week of	Mean	Maximum	Minimum
January	6	41	42	41	February	3	44	46	42
	13	42	43	41		10	40	41	40
	20	45	46	44		17	43	44	41
	27	46	47	46		24	44	44	43
March	3	48	55	44	April	7	51	52	50
	10	50	51	47		14	53	54	52
	17	46	46	46		21	56	58	55
	24	46	47	46		28	61	62	59
	31	50	52	47					
May	5	62	63	62	June	2	68	69	66
	12	63	64	62		9	72	73	70
	19	67	65	69		16	74	75	72
	26	69	70	69		23	70	74	68

MAXIMUM: 75, WEEK OF: 6-16 MINIMUM: 40, WEEK OF: 2-10

NOTE: Some temperatures may have been influenced by recirculation.

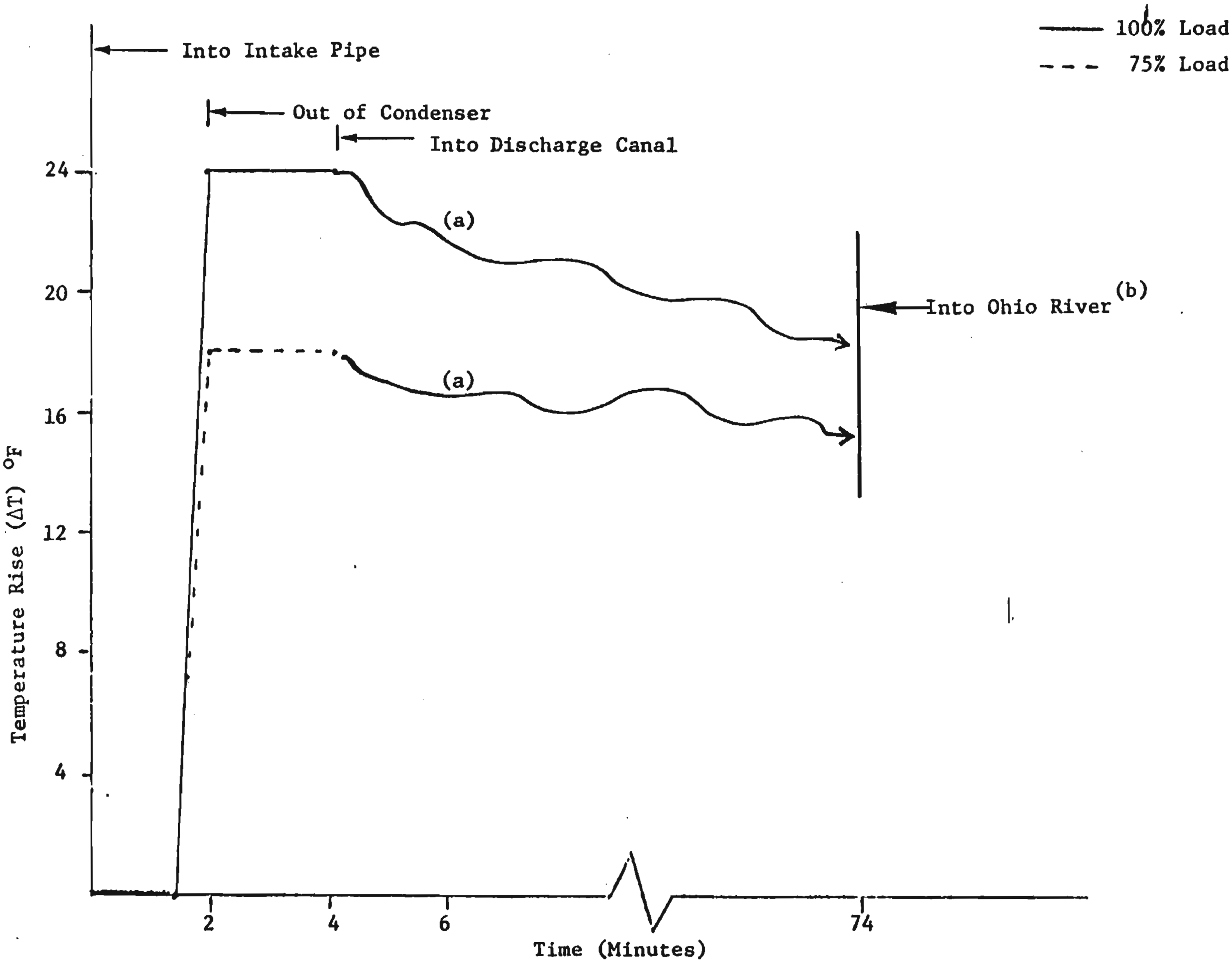
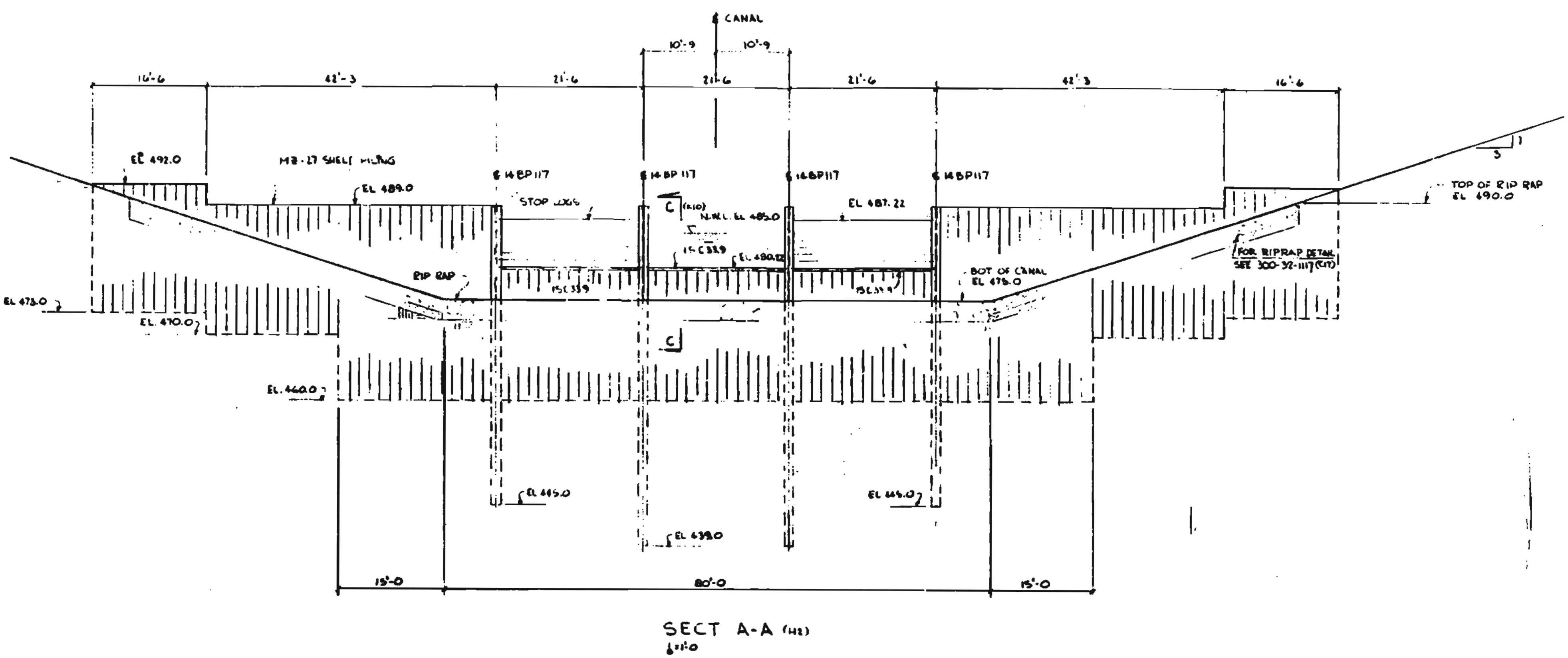


FIGURE III-1 J. M. Stuart Station Units 1, 2 and 3, Time-Temperature Profile (from the Dayton Power and Light Company).

(a) Temperature decay varies with flow and atmospheric conditions (no field tests conducted).

(b) Calculated time of travel to the Ohio River (from the Dayton Power and Light Company).

FIGURE III-2 Control weir structure located at the mouth of Little Three Mile Creek (from The Dayton Power and Light Company).



SECT A-A

FIGURE III-2

FIGURE III-3

DURATION CURVE OF FLOWS FOR CINCINNATI, OHIO

(from ORSANCO, 1976)

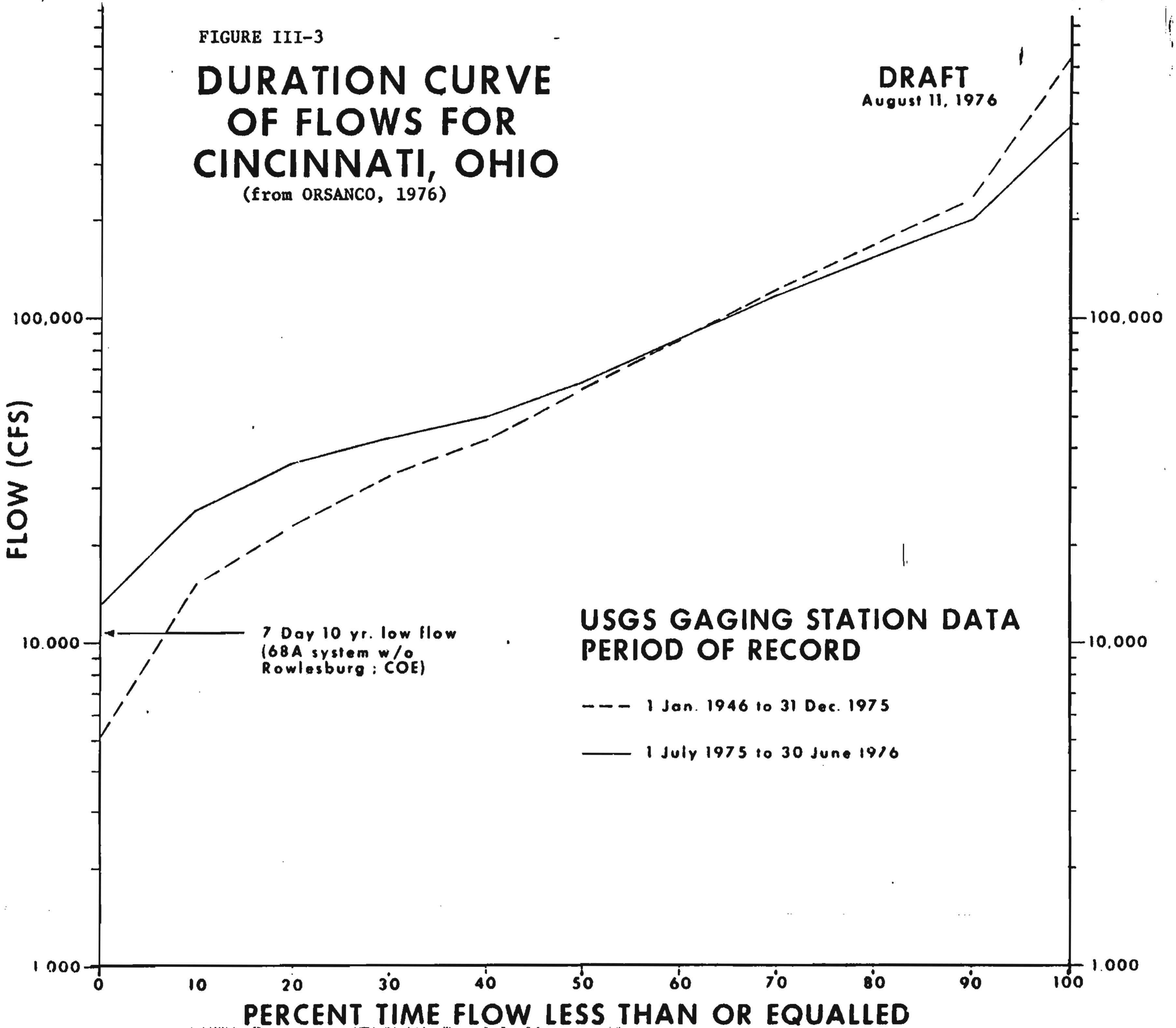
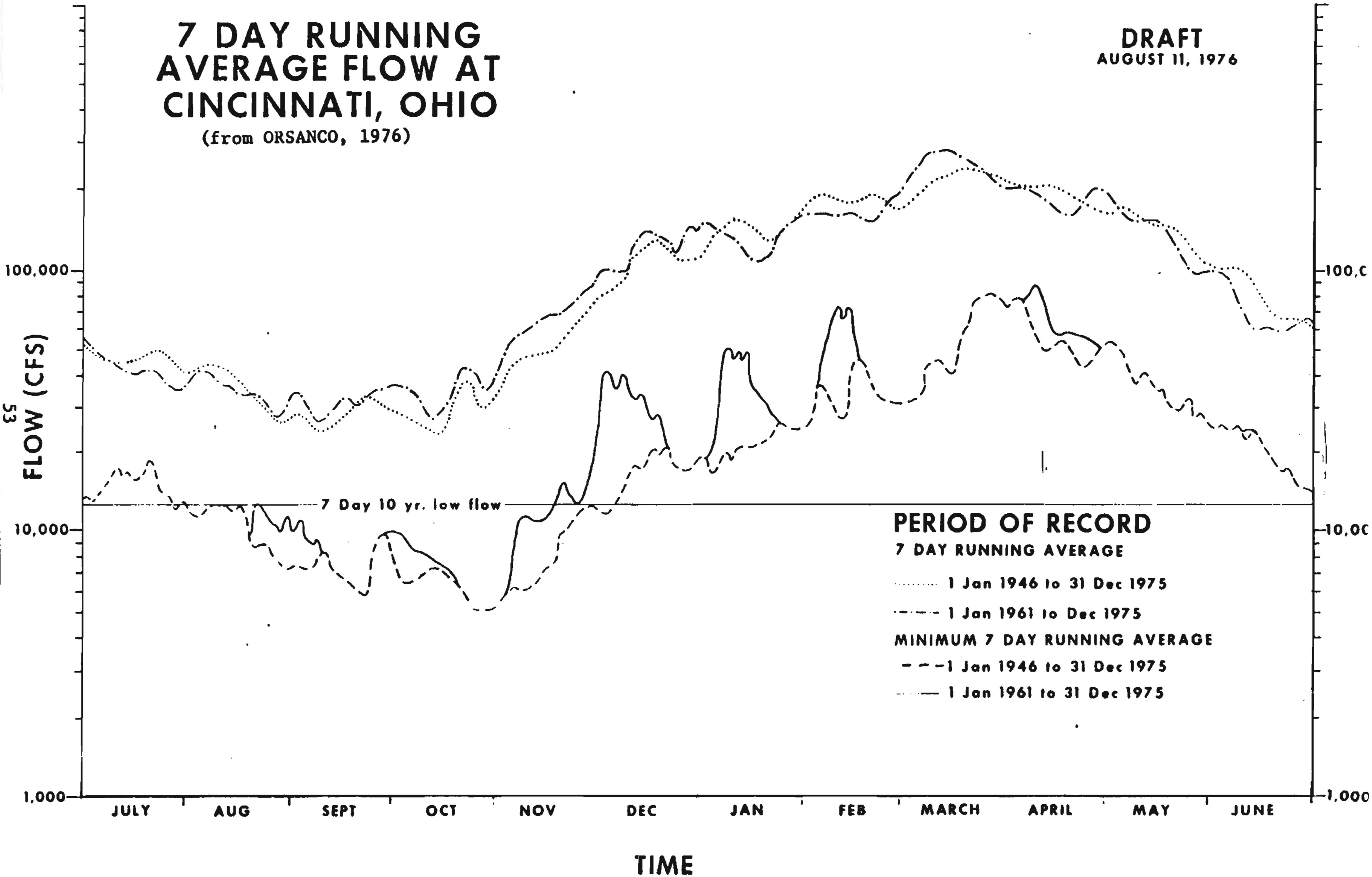


FIGURE III-4



7 DAY RUNNING AVERAGE FLOW AT CINCINNATI, OHIO
(from ORSANCO, 1976)
DRAFT
AUGUST 11, 1976
FLOW (CFS)
100,000
10,000
1,000
7 Day 10 yr. low flow
PERIOD OF RECORD
7 DAY RUNNING AVERAGE
1 Jan 1946 to 31 Dec 1975
1 Jan 1961 to Dec 1975
MINIMUM 7 DAY RUNNING AVERAGE
1 Jan 1946 to 31 Dec 1975
1 Jan 1961 to 31 Dec 1975
JULY
AUG
SEPT
OCT
NOV
DEC
JAN
FEB
MARCH
APRIL
MAY
JUNE
TIME

FIGURE III-5

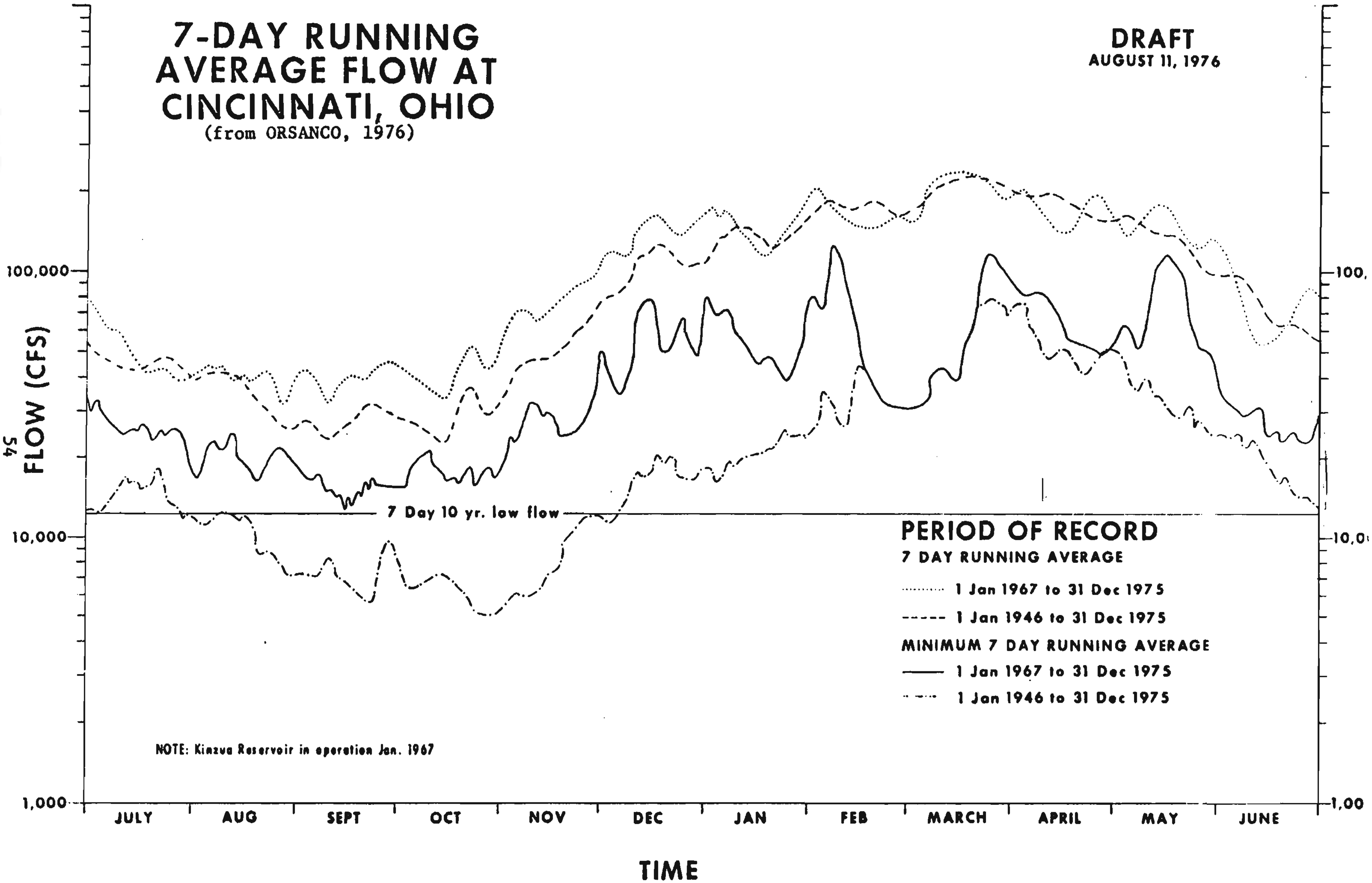

7-DAY RUNNING
AVERAGE FLOW AT
CINCINNATI, OHIO
(from ORSANCO, 1976)
DRAFT
AUGUST 11, 1976
FLOW (CFS)
100,000
10,000
1,000
7 Day 10 yr. low flow
PERIOD OF RECORD
7 DAY RUNNING AVERAGE
1 Jan 1967 to 31 Dec 1975
1 Jan 1946 to 31 Dec 1975
MINIMUM 7 DAY RUNNING AVERAGE
1 Jan 1967 to 31 Dec 1975
1 Jan 1946 to 31 Dec 1975
NOTE: Kinzua Reservoir in operation Jan. 1967
JULY
AUG
SEPT
OCT
NOV
DEC
JAN
FEB
MARCH
APRIL
MAY
JUNE
TIME

FIGURE III-6

7-DAY RUNNING AVERAGE FLOW AT CINCINNATI, OHIO
(from ORSANCO, 1976)

DRAFT
AUGUST 11, 1976

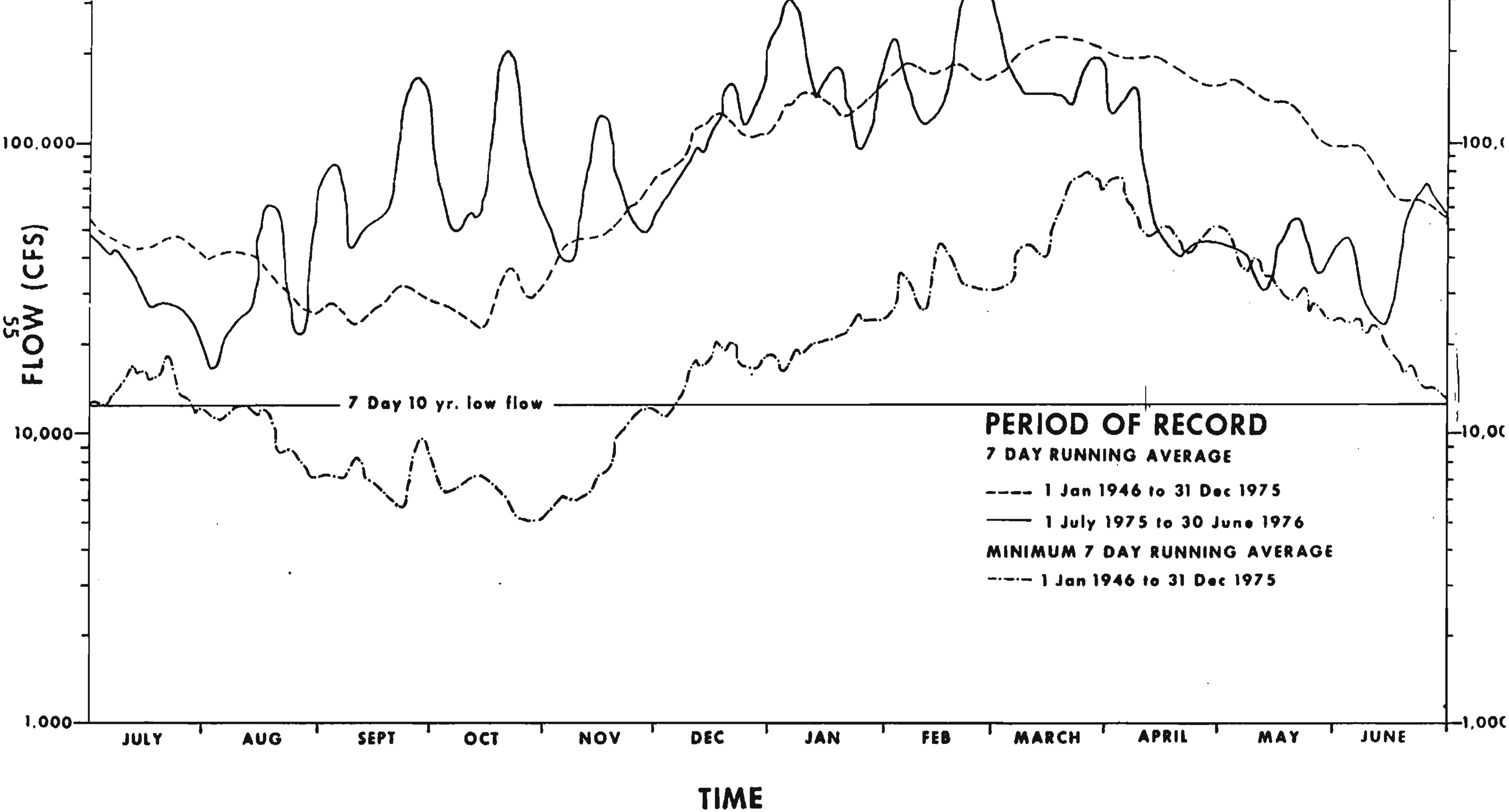
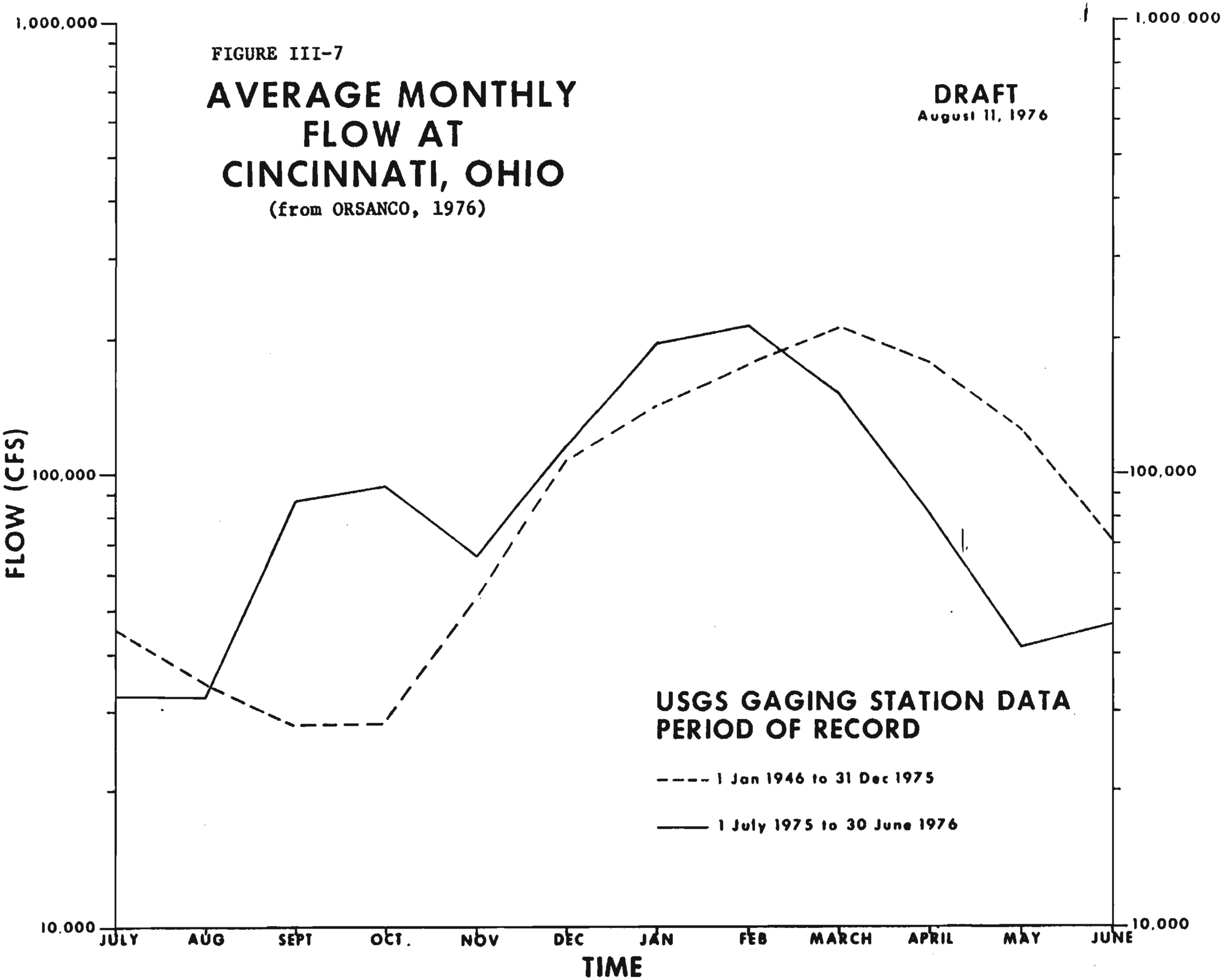


FIGURE III-7


AVERAGE MONTHLY FLOW AT CINCINNATI, OHIO
(from ORSANCO, 1976)
DRAFT
August 11, 1976
1,000,000
100,000
10,000
FLOW (CFS)
JULY
AUG
SEPT
OCT.
NOV
DEC
JAN
FEB
MARCH
APRIL
MAY
JUNE
TIME
USGS GAGING STATION DATA
PERIOD OF RECORD
1 Jan 1946 to 31 Dec 1975
1 July 1975 to 30 June 1976

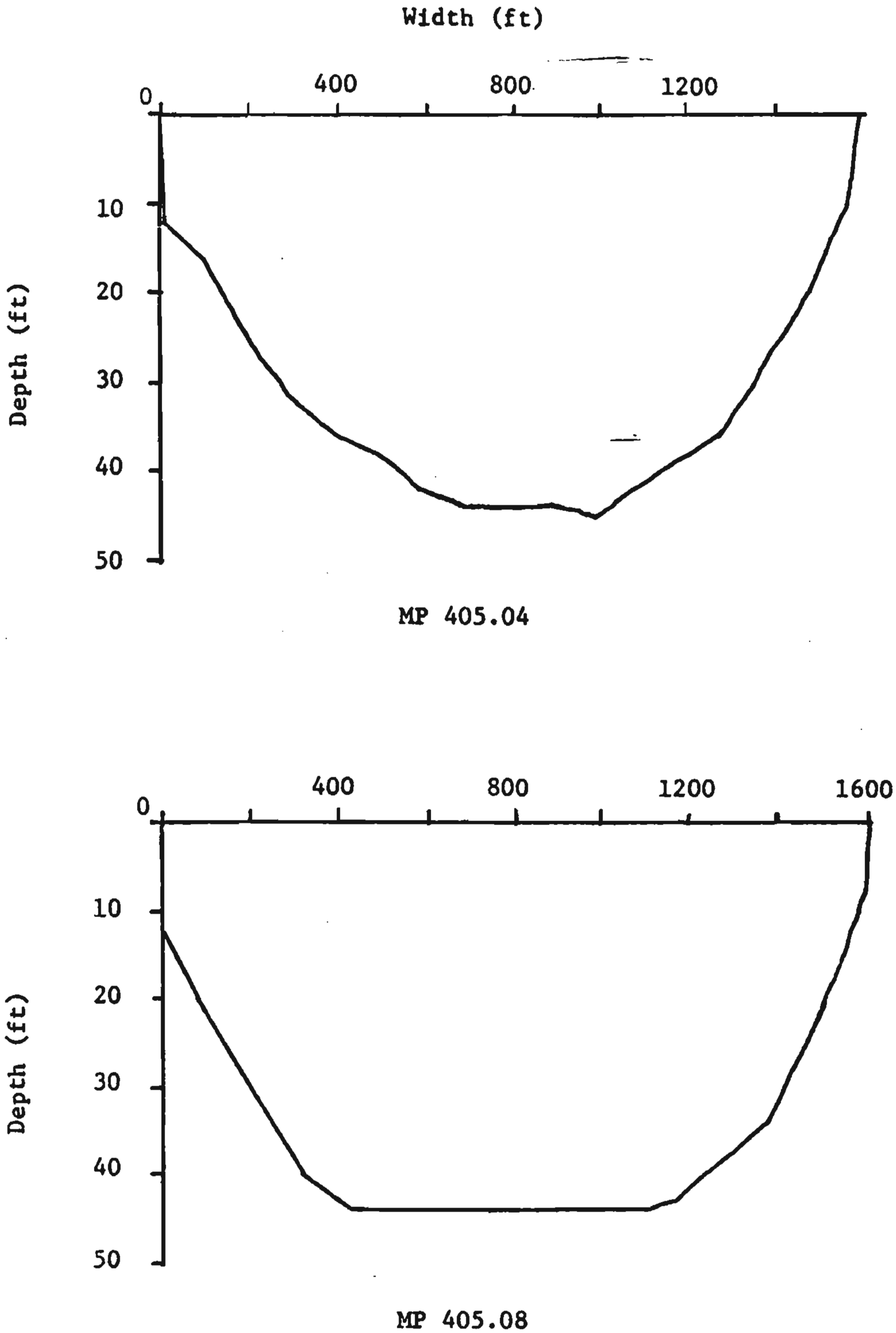
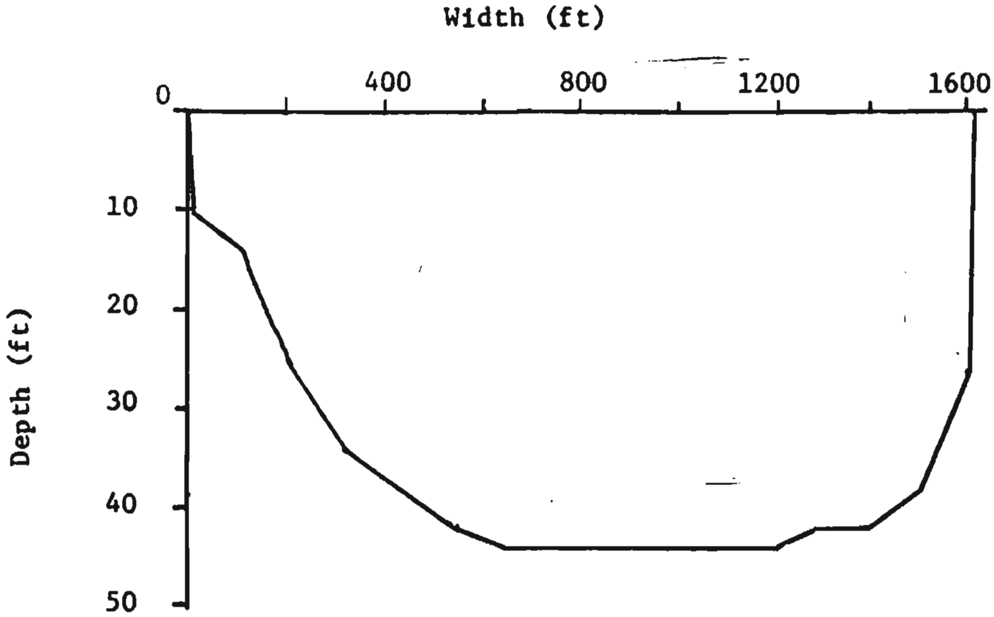
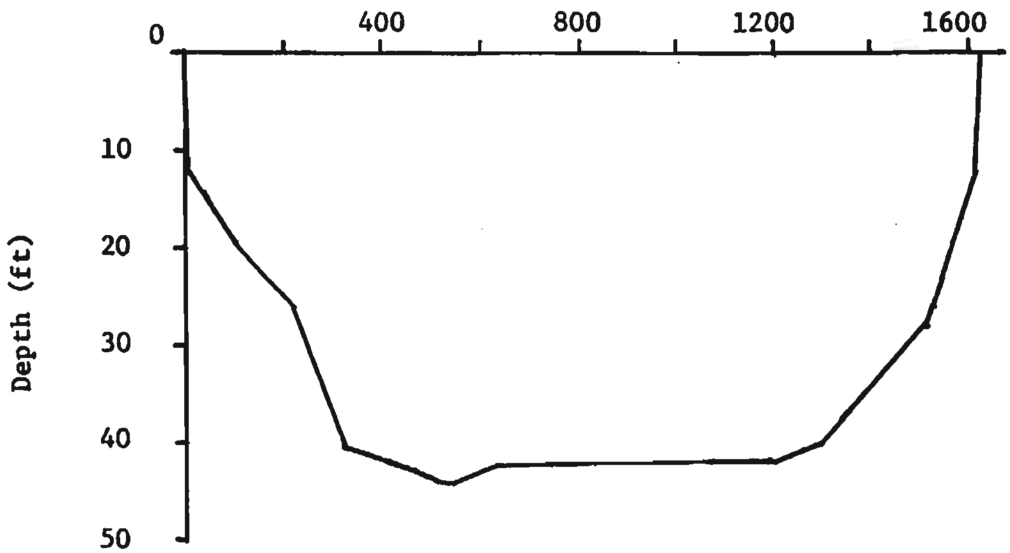


FIGURE III-8 Depth profile at designated mile points (MP) on the Ohio River.



MP 405.12



MP 405.16

FIGURE III-9 Depth profile at designated mile points (MP) on the Ohio River.

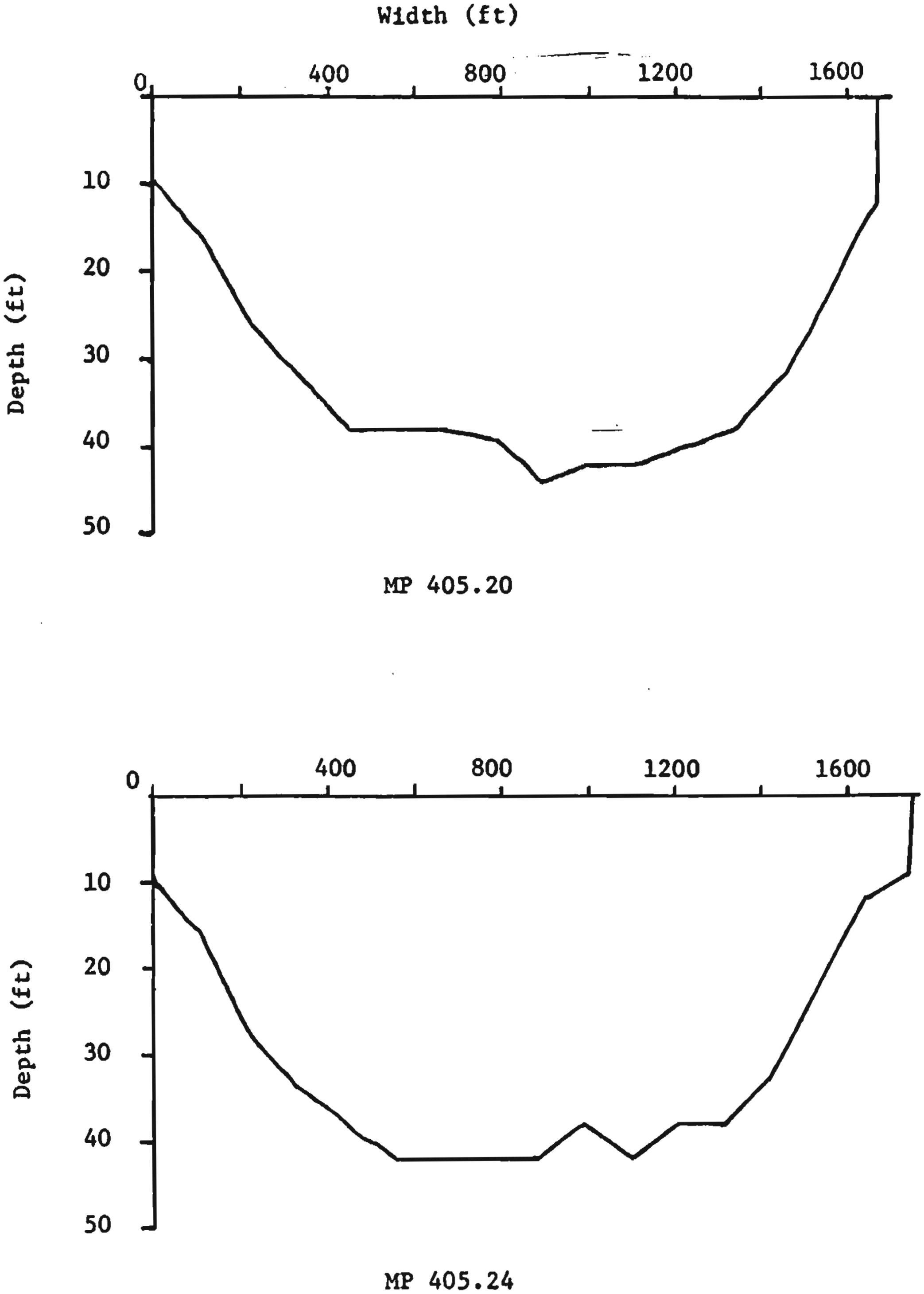
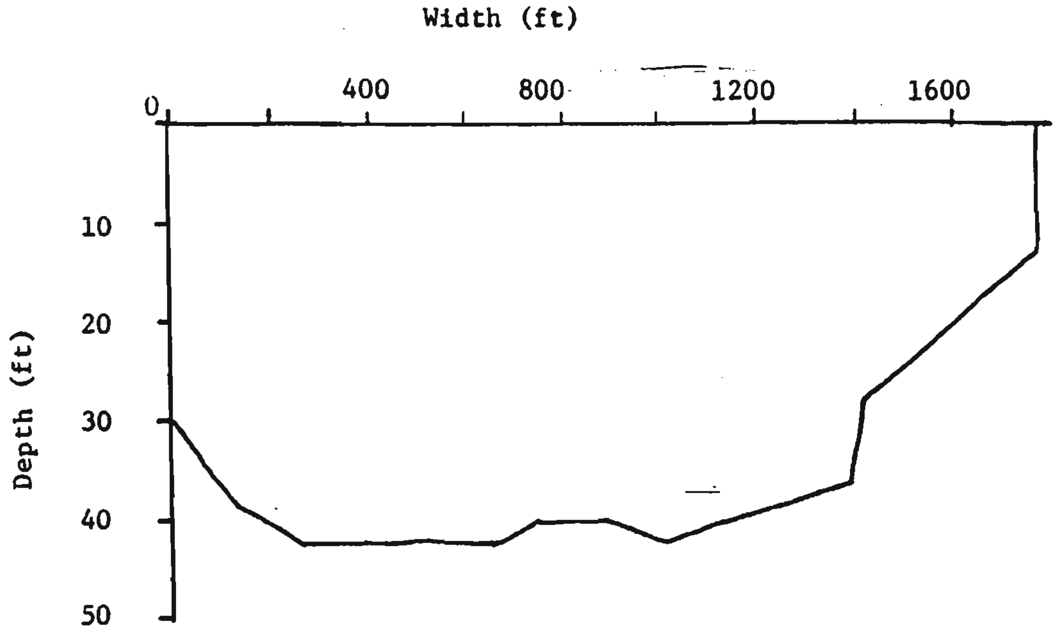
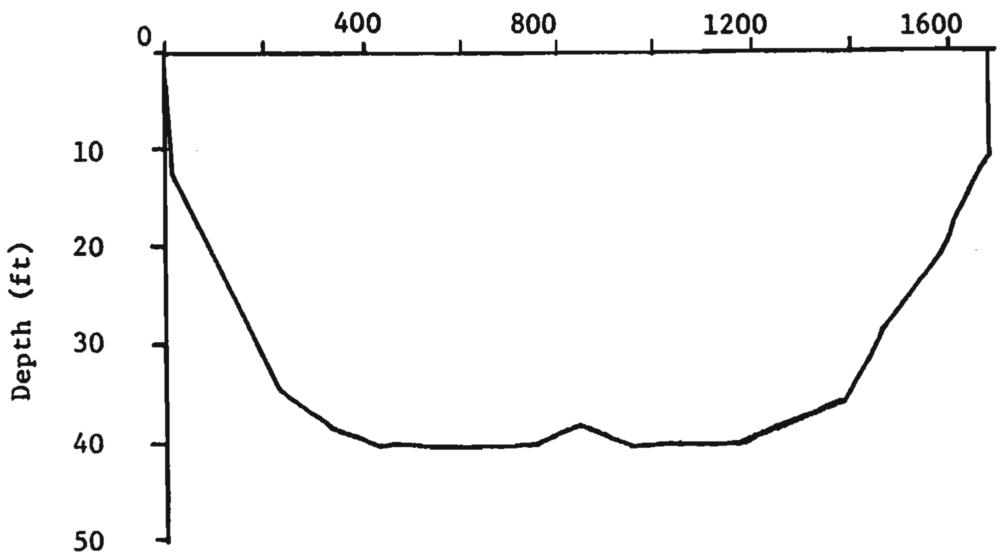


FIGURE III-10 Depth profile at designated mile points (MP) on the Ohio River.

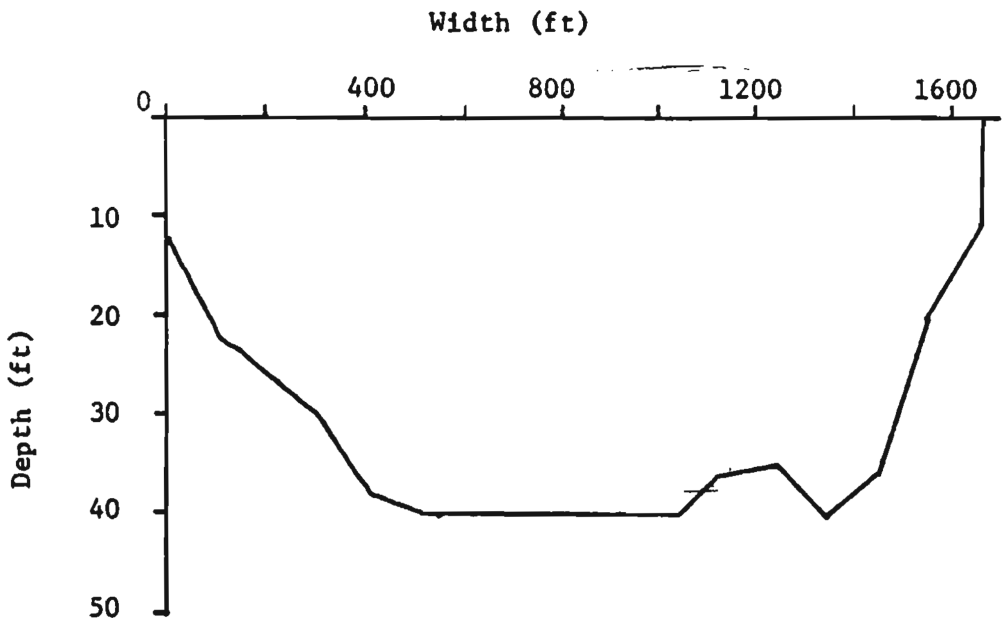


MP 405.28

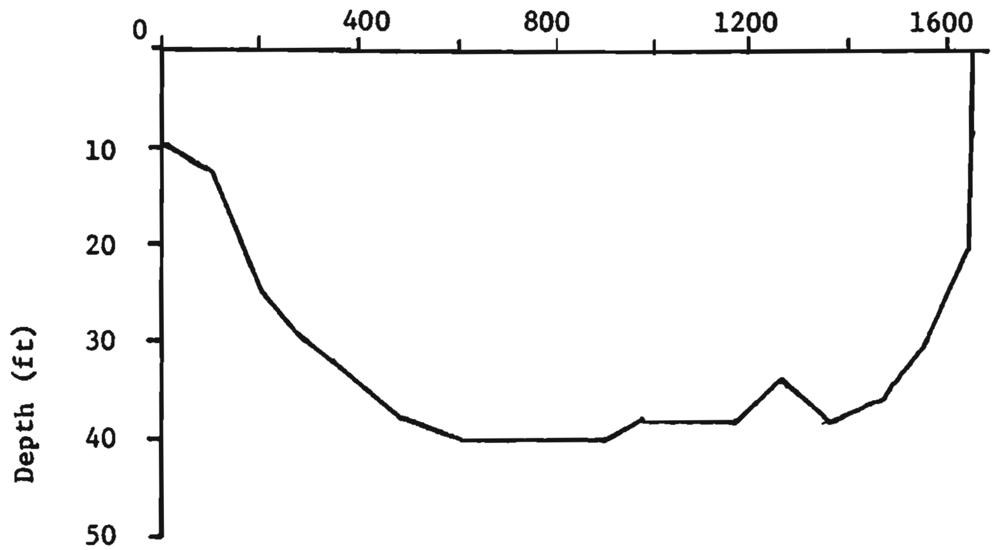


MP 405.32

FIGURE III-11 Depth profile at designated mile points (MP) on the Ohio River.



MP 405.36



MP 405.40

FIGURE III-12 Depth profile at designated mile points (MP) on the Ohio River.

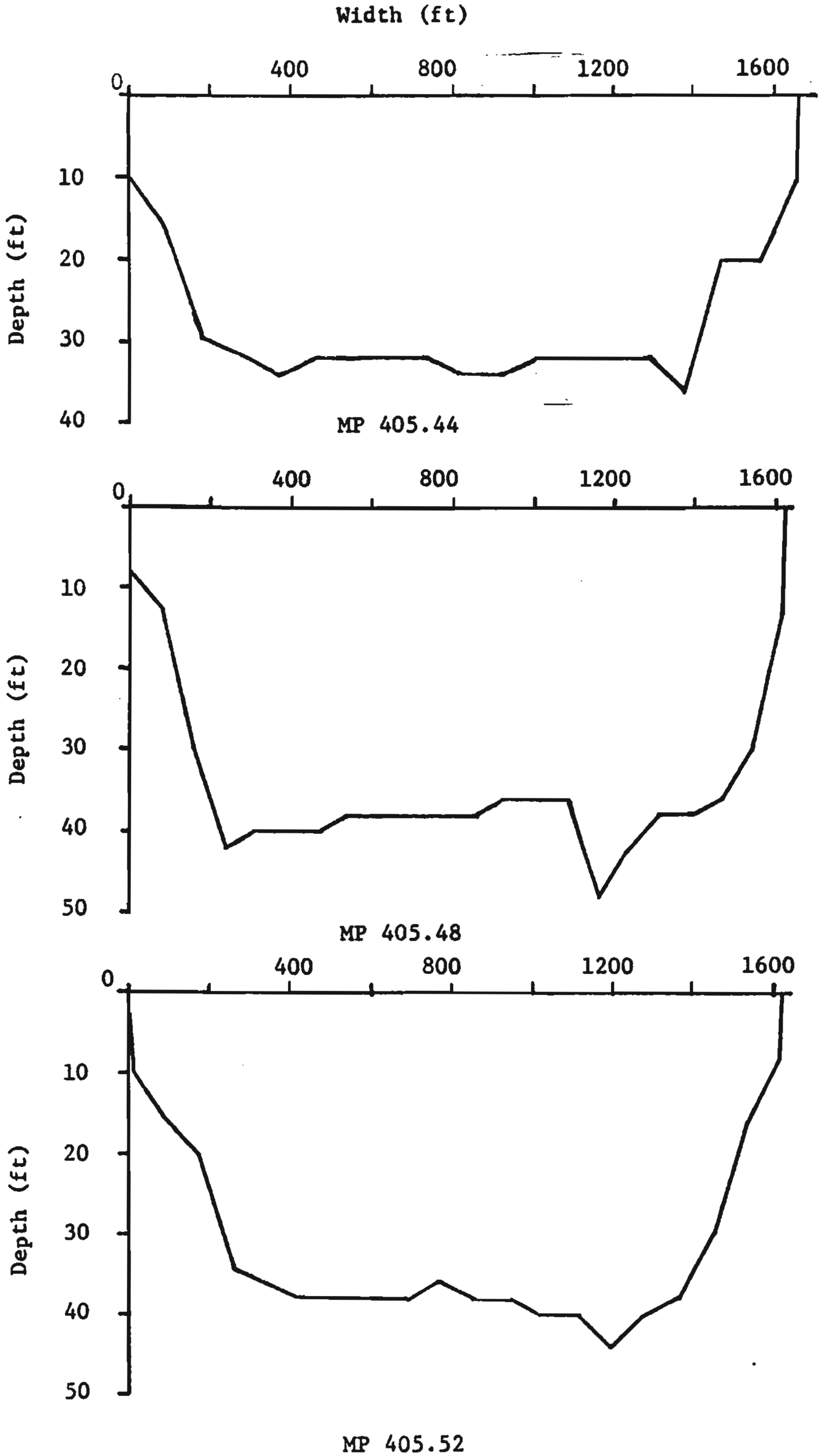
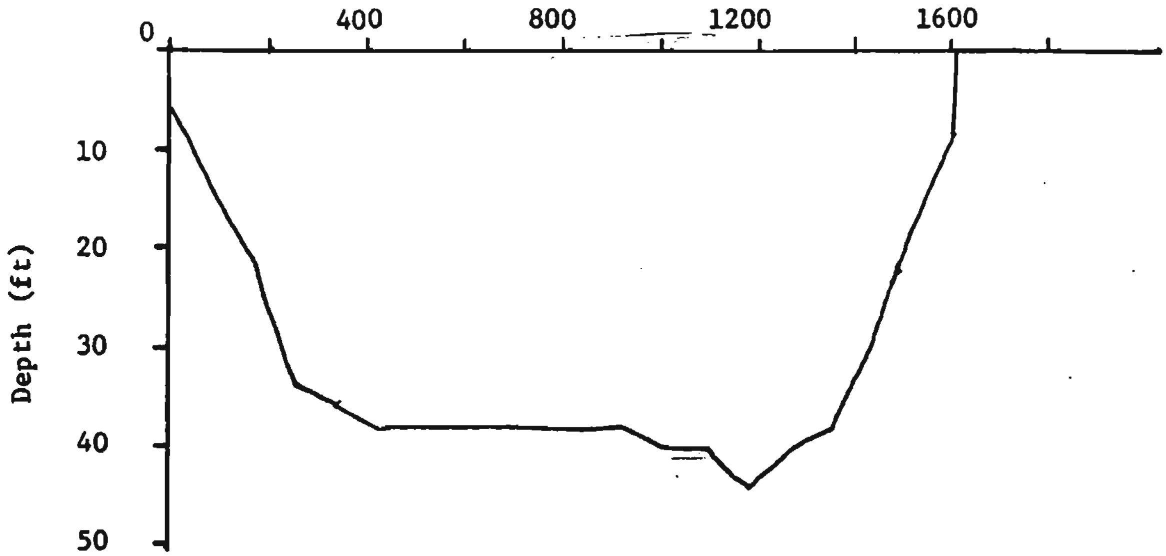
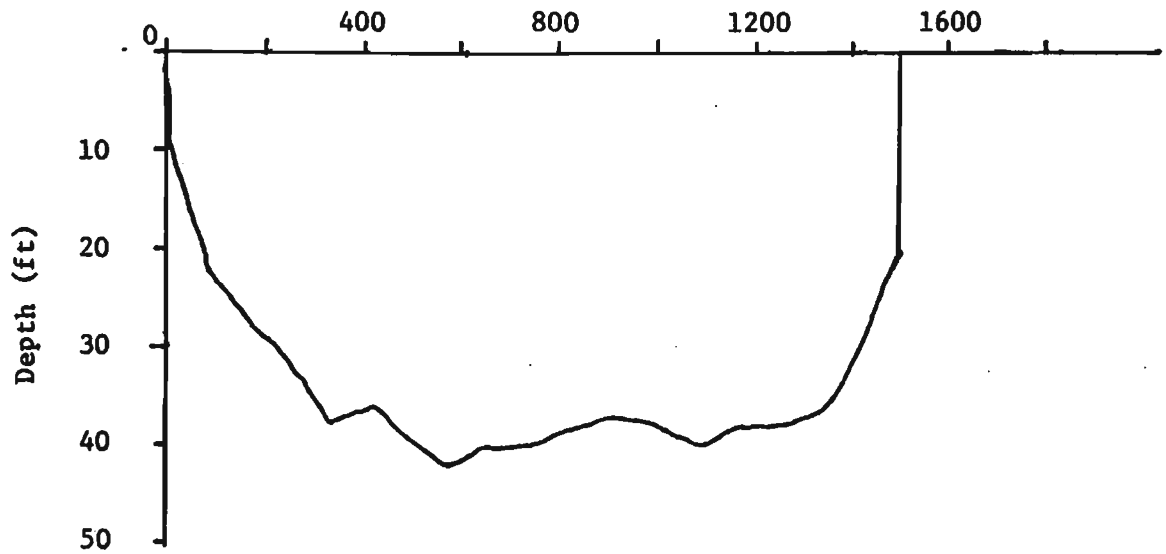


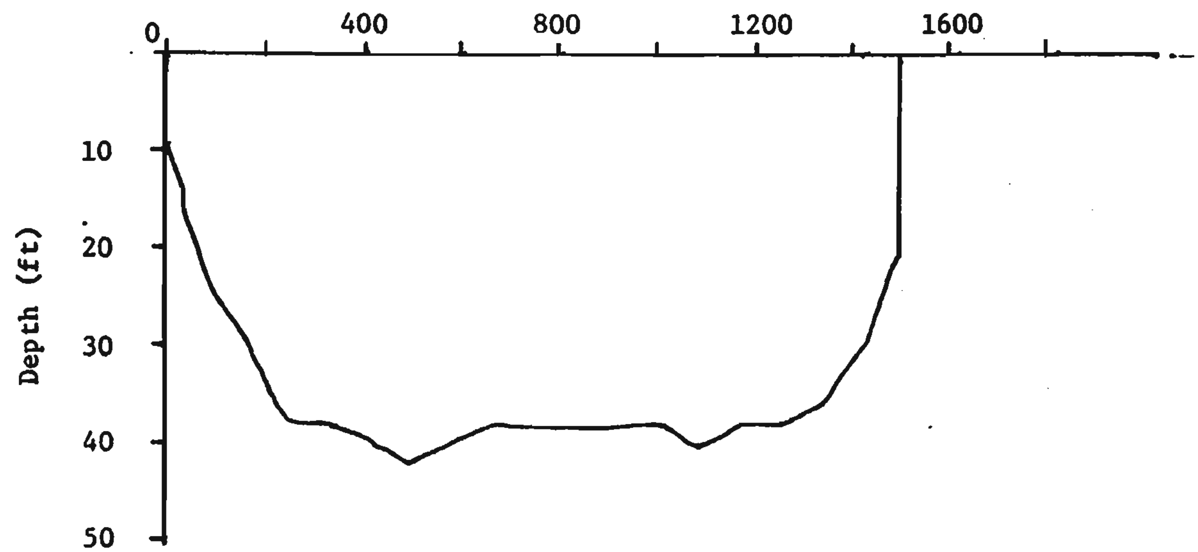
FIGURE III-13 Depth profile at designated mile points (MP) on the Ohio River.



MP 405.56

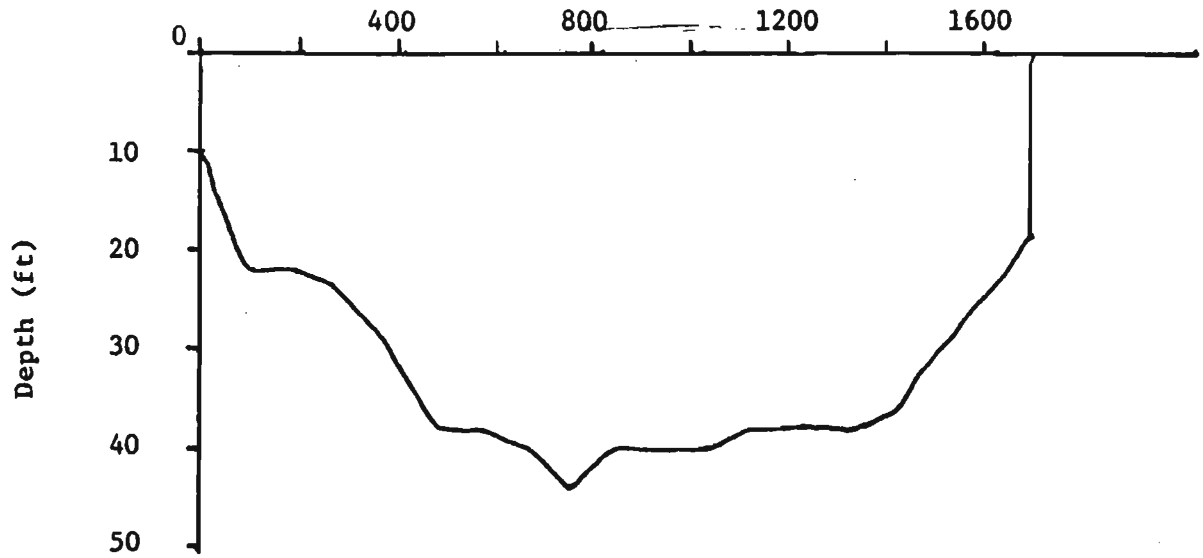


MP 405.60

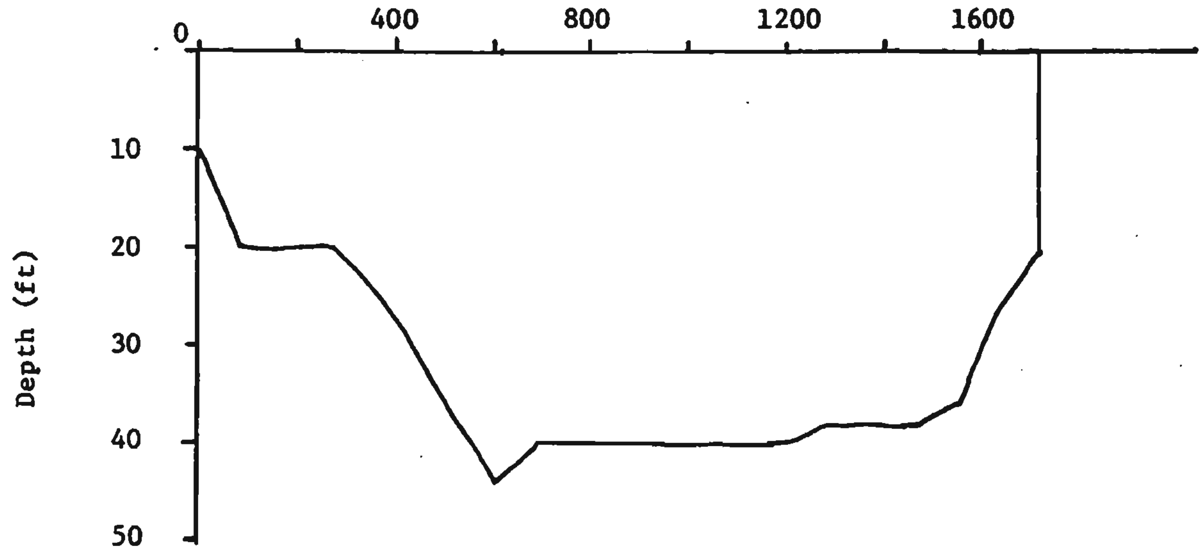


MP 405.64

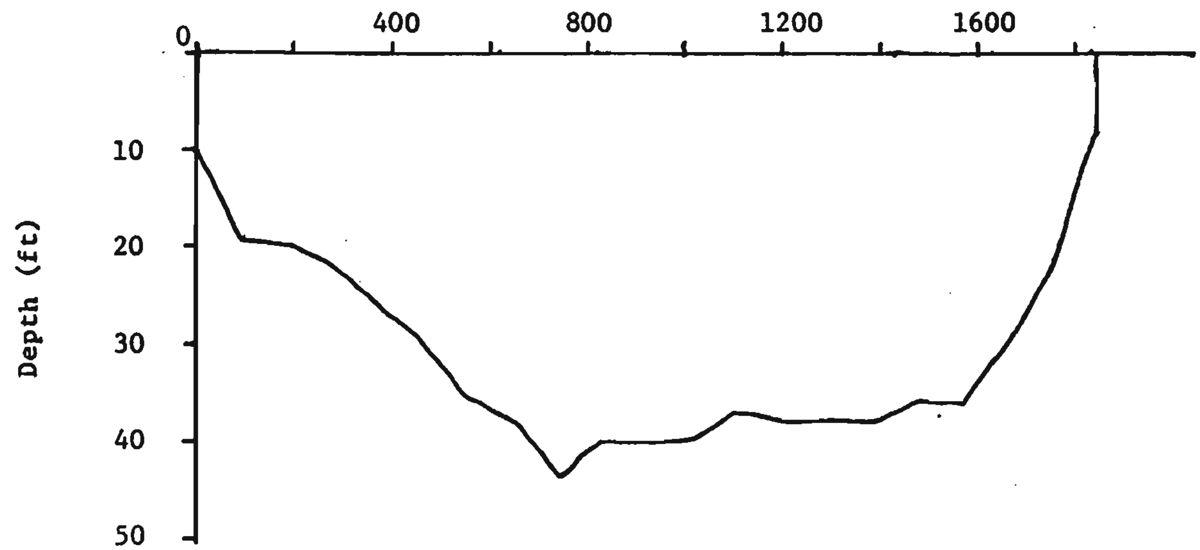
FIGURE III-14 Depth profile at designated mile points (MP) on the Ohio River.



MP 405.68



MP 405.72



MP 405.76

FIGURE III-15 Depth profile at designated mile points (MP) on the Ohio River.

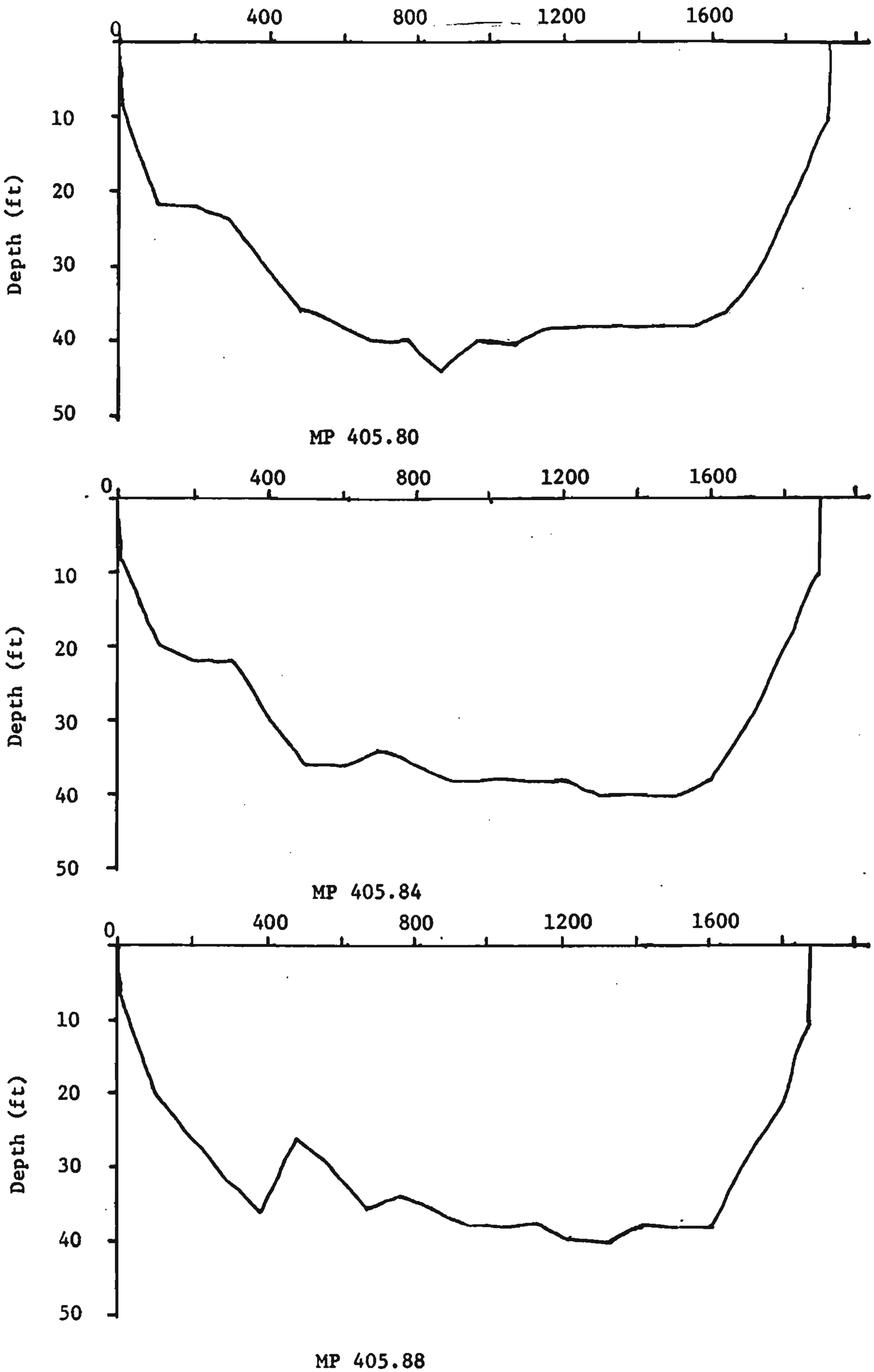
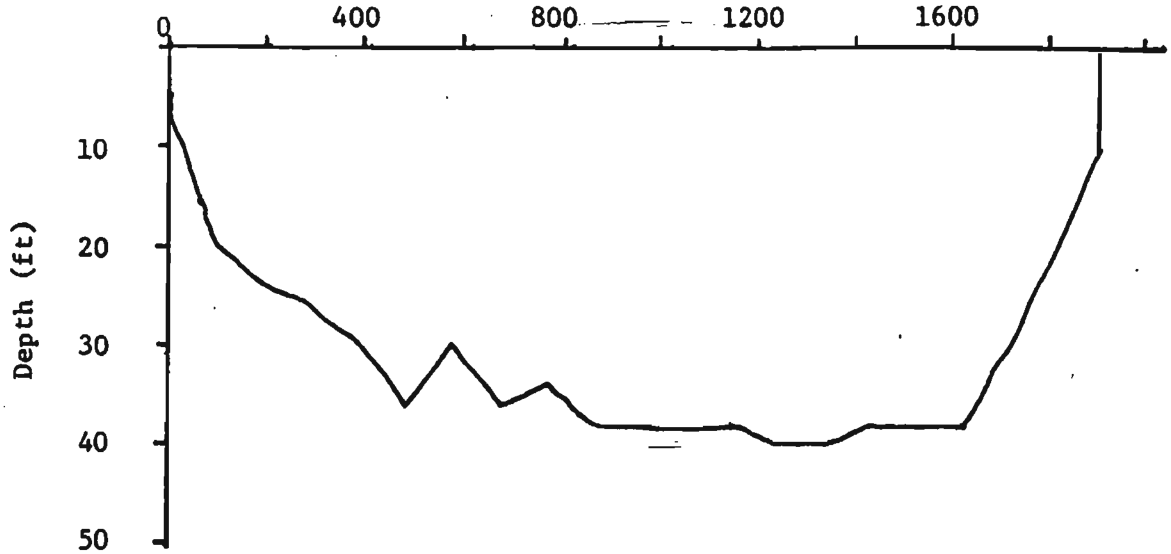
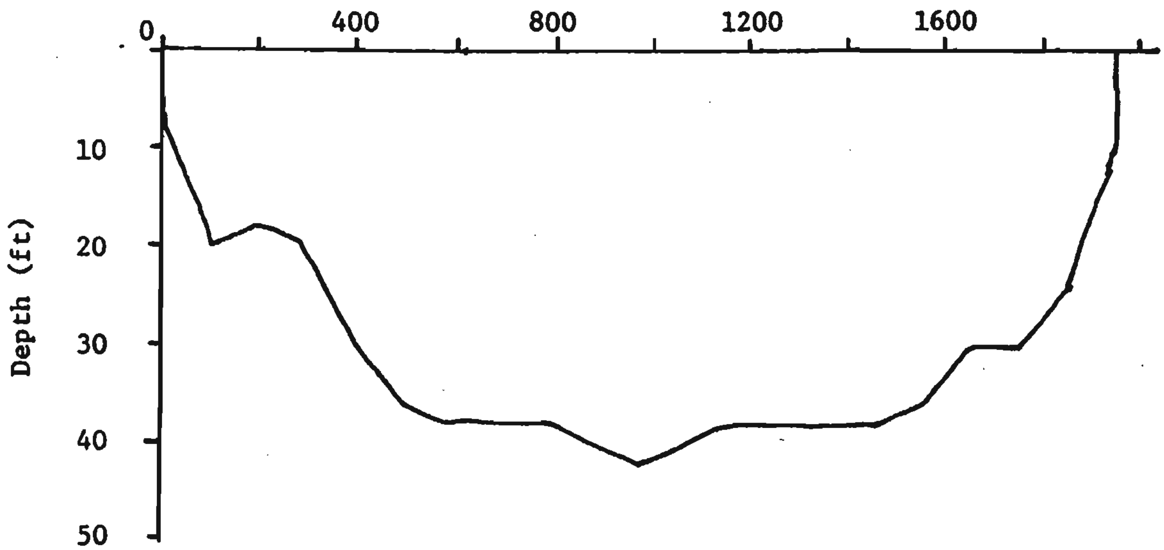


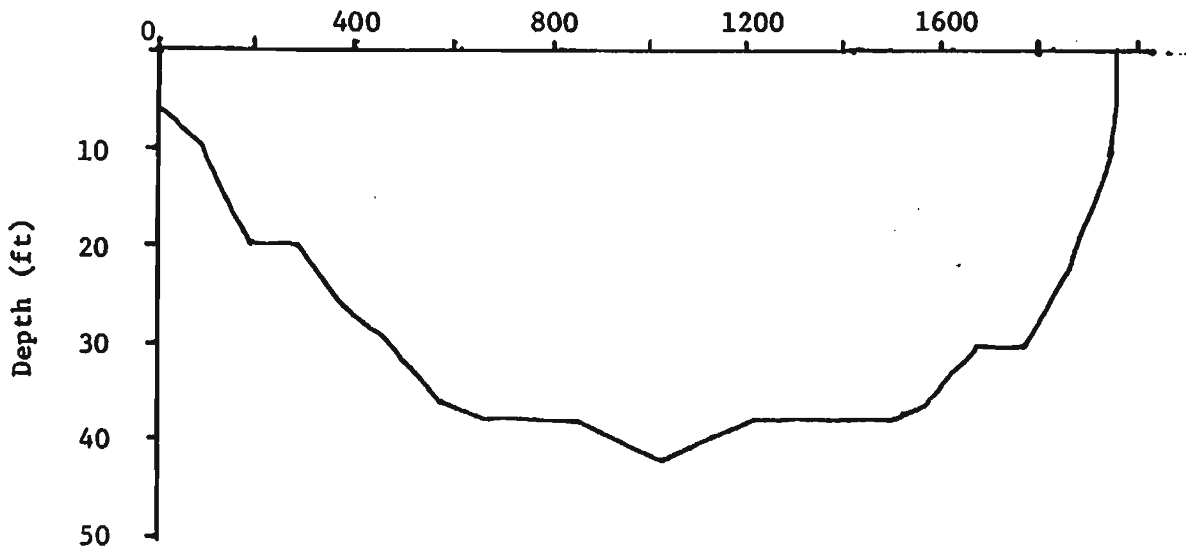
FIGURE III-16 Depth profile at designated mile points (MP) on the Ohio River.



MP 405.92



MP 405.96



MP 406.00

FIGURE III-17 Depth profile at designated mile points (MP) on the Ohio River.

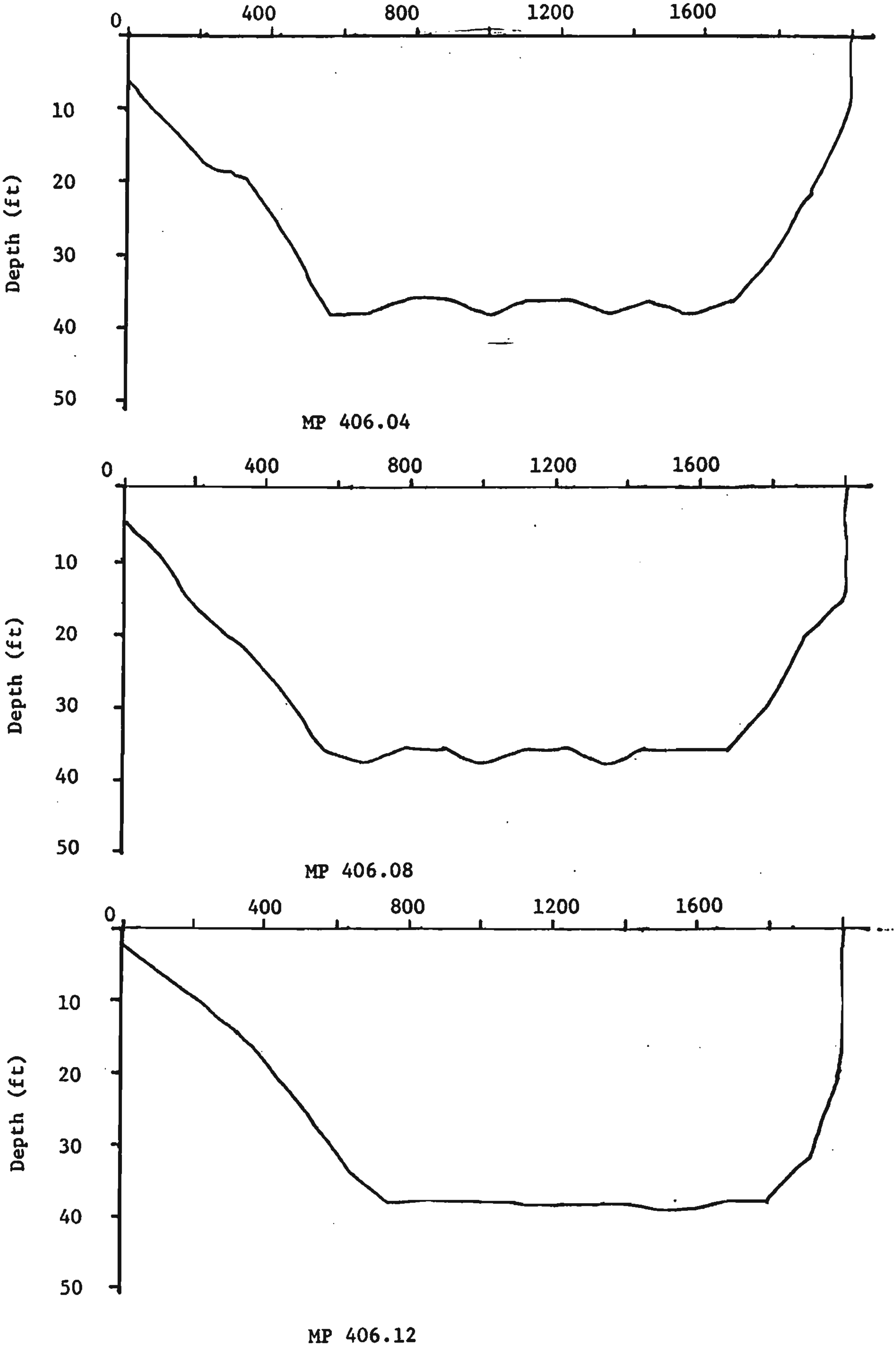


FIGURE III-18 Depth profile at designated mile points (MP) on the Ohio River.

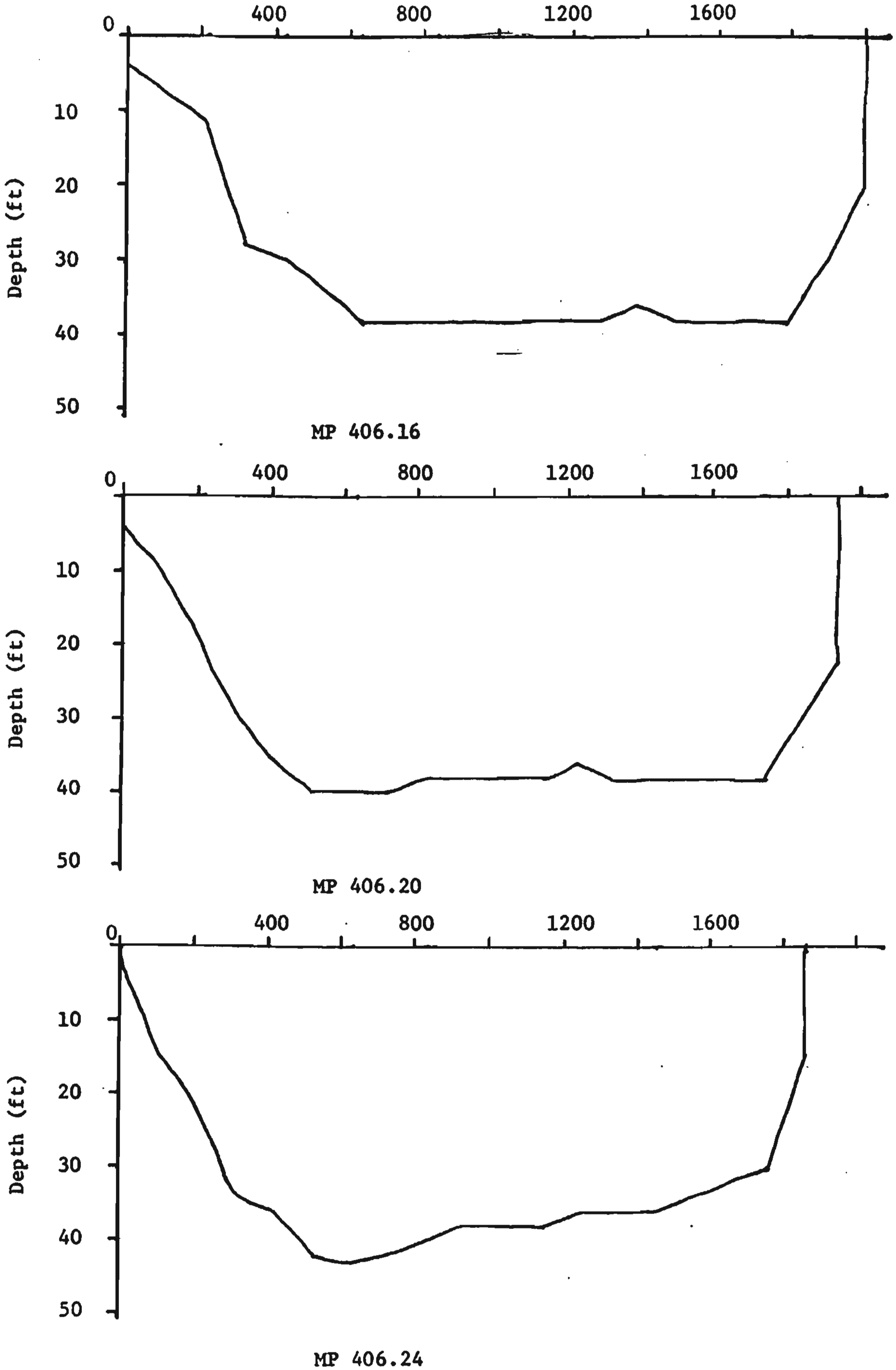
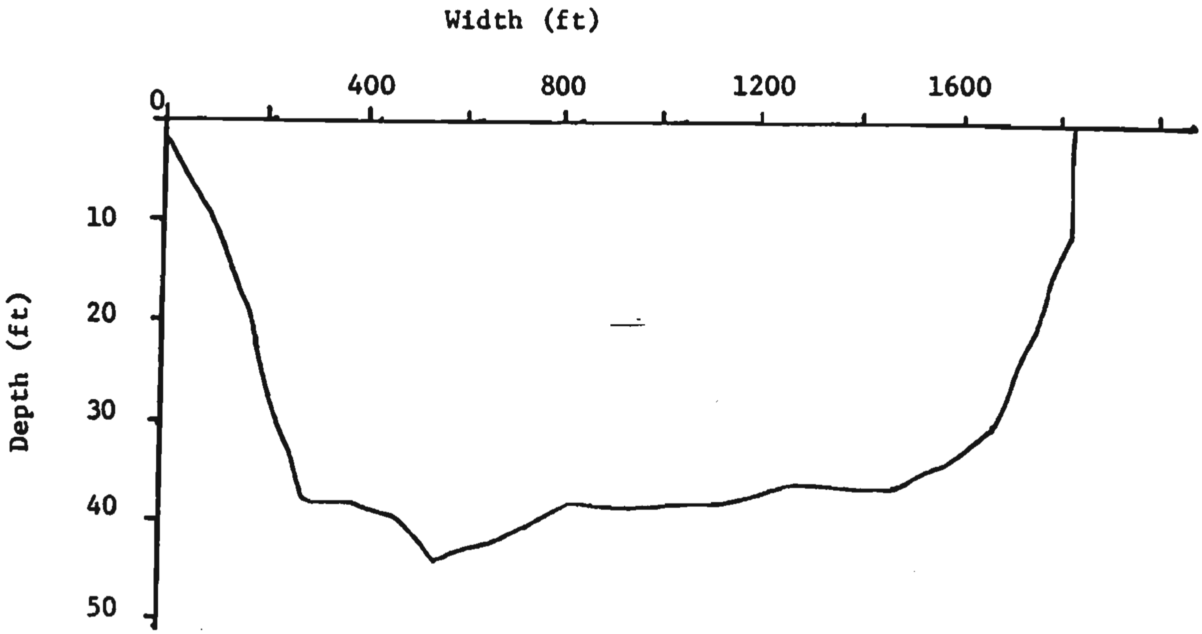
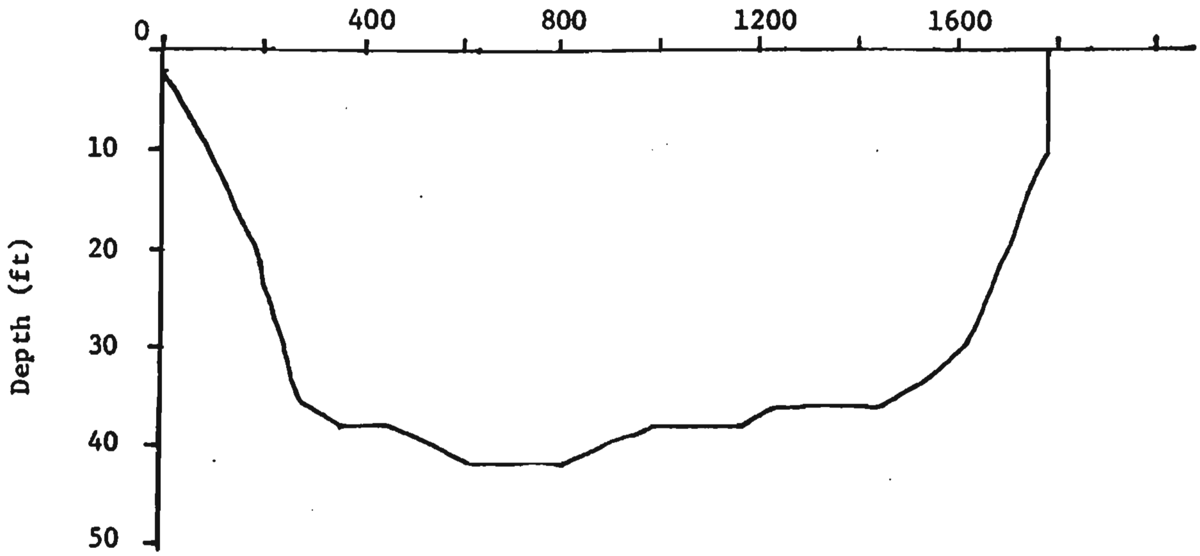


FIGURE III-19 Depth profile at designated mile points (MP) on the Ohio River.

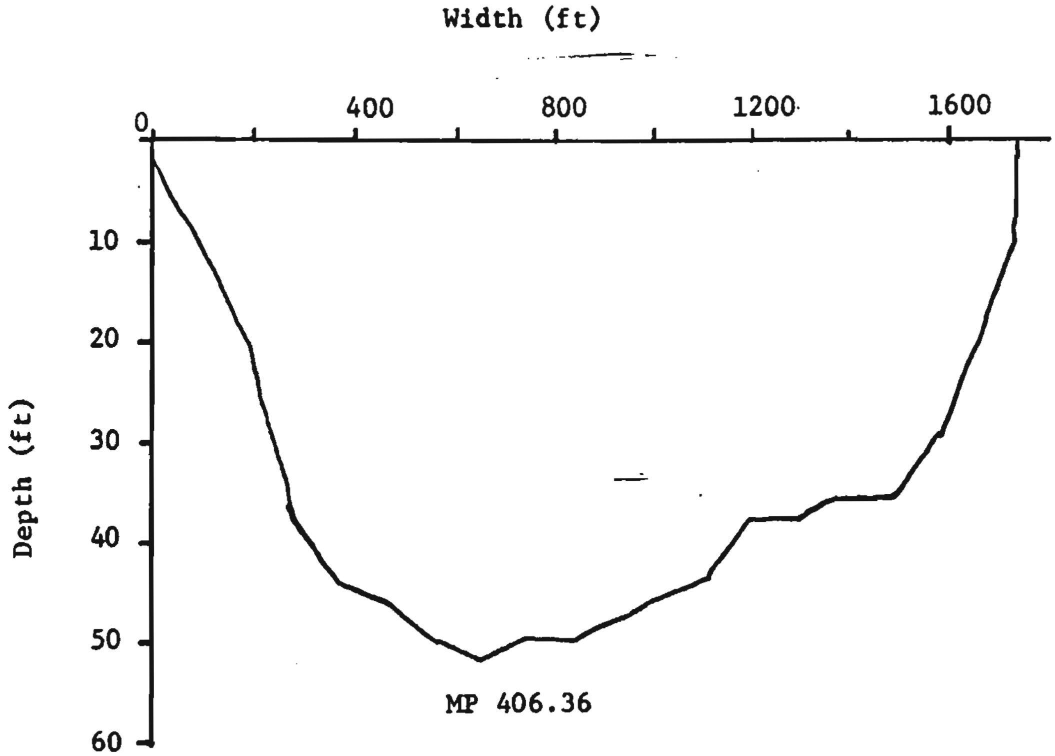


MP 406.28

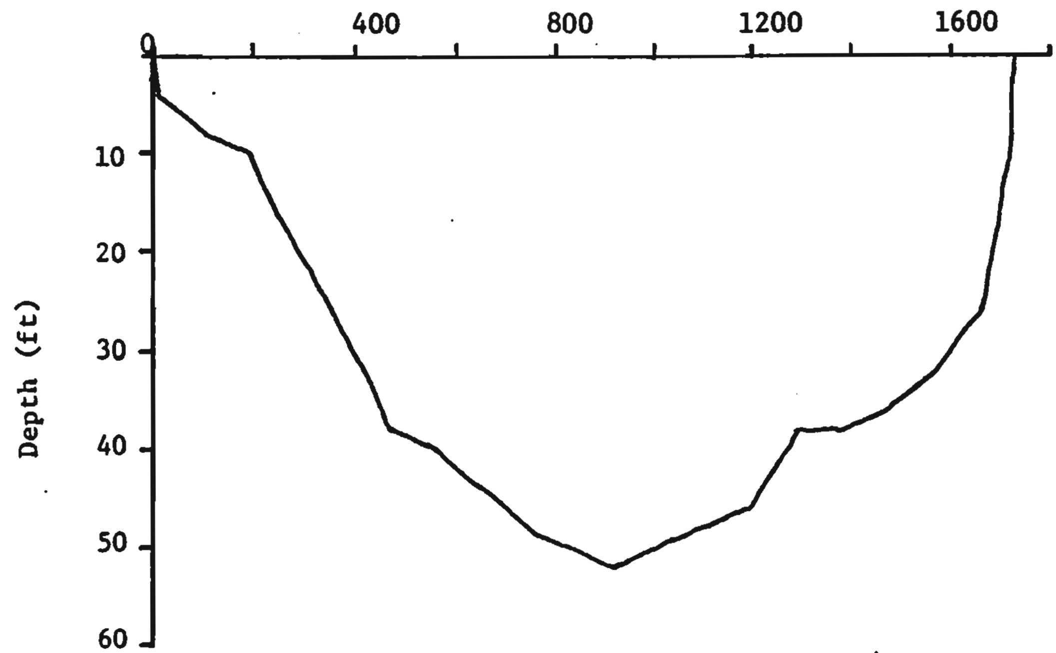


MP 406.32

FIGURE III-20 Depth profile at designated mile points (MP) on the Ohio River.

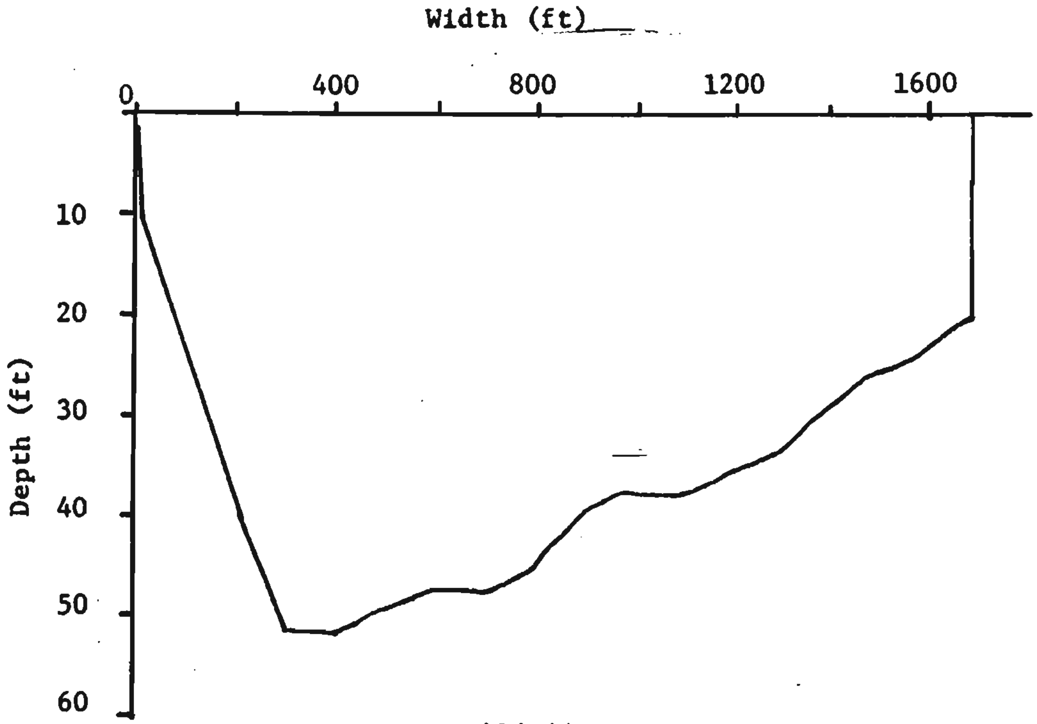


MP 406.36

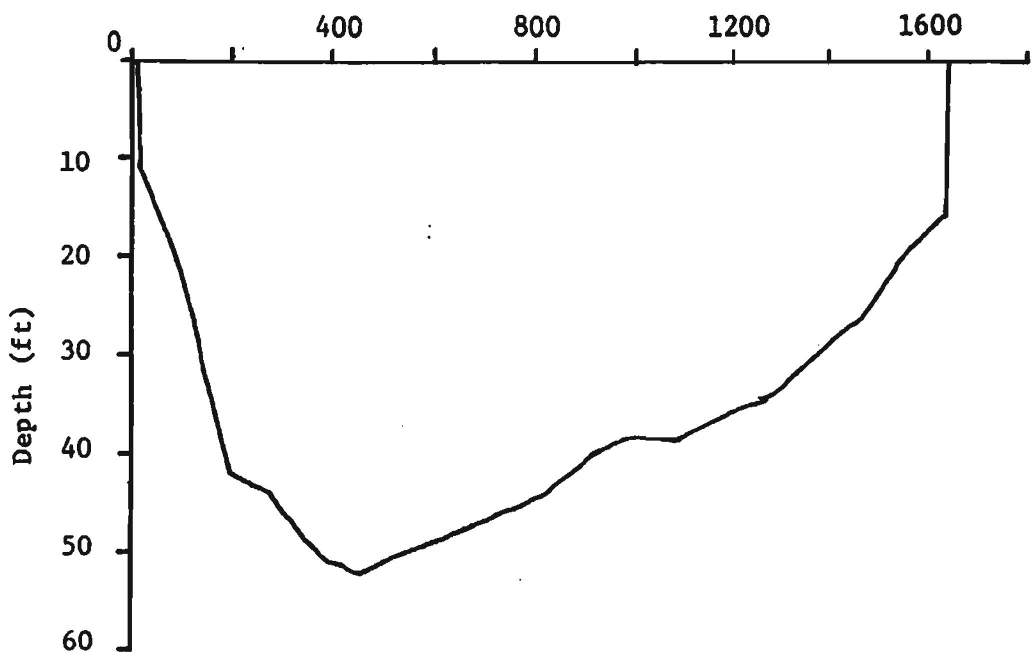


MP 406.40

FIGURE III-21 Depth profile at designated mile points (MP) on the Ohio River.

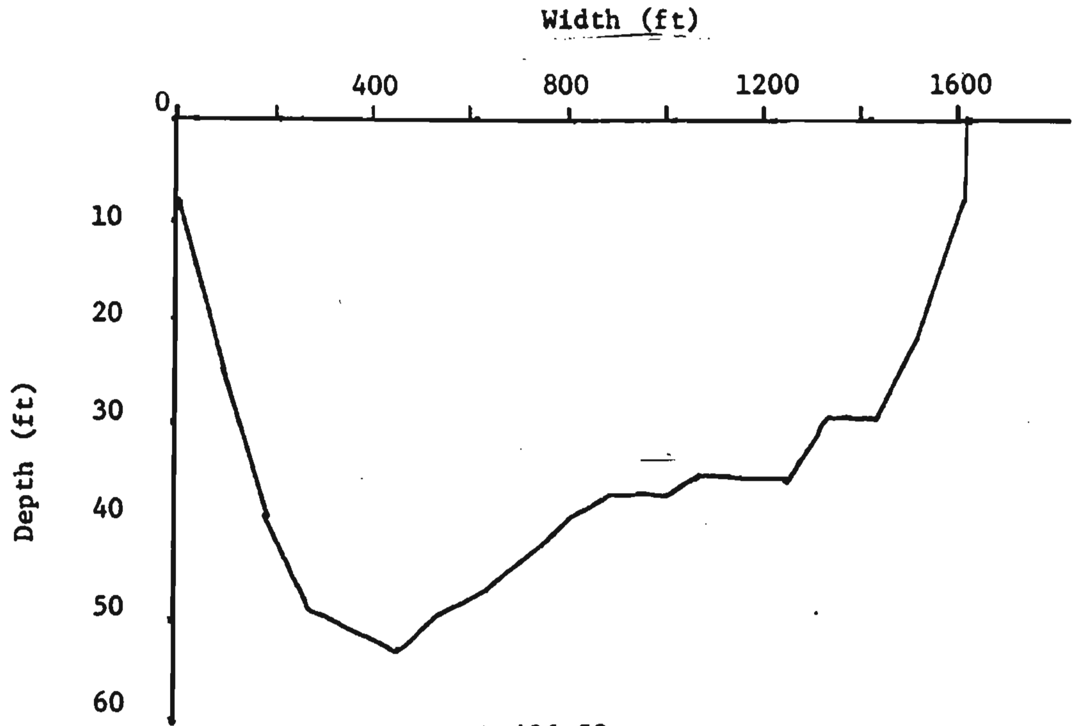


MP 406.44



MP 406.48

FIGURE III-22 Depth profile at designated mile points (MP) on the Ohio River.



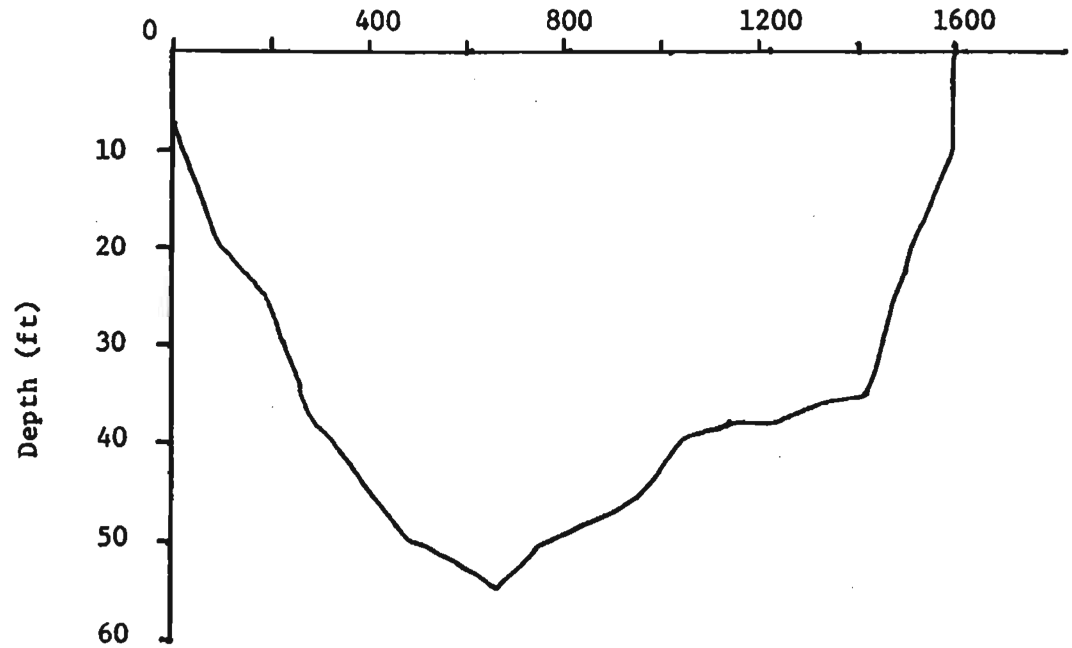


FIGURE III-23 Depth profile at designated mile points (MP) on the Ohio River.

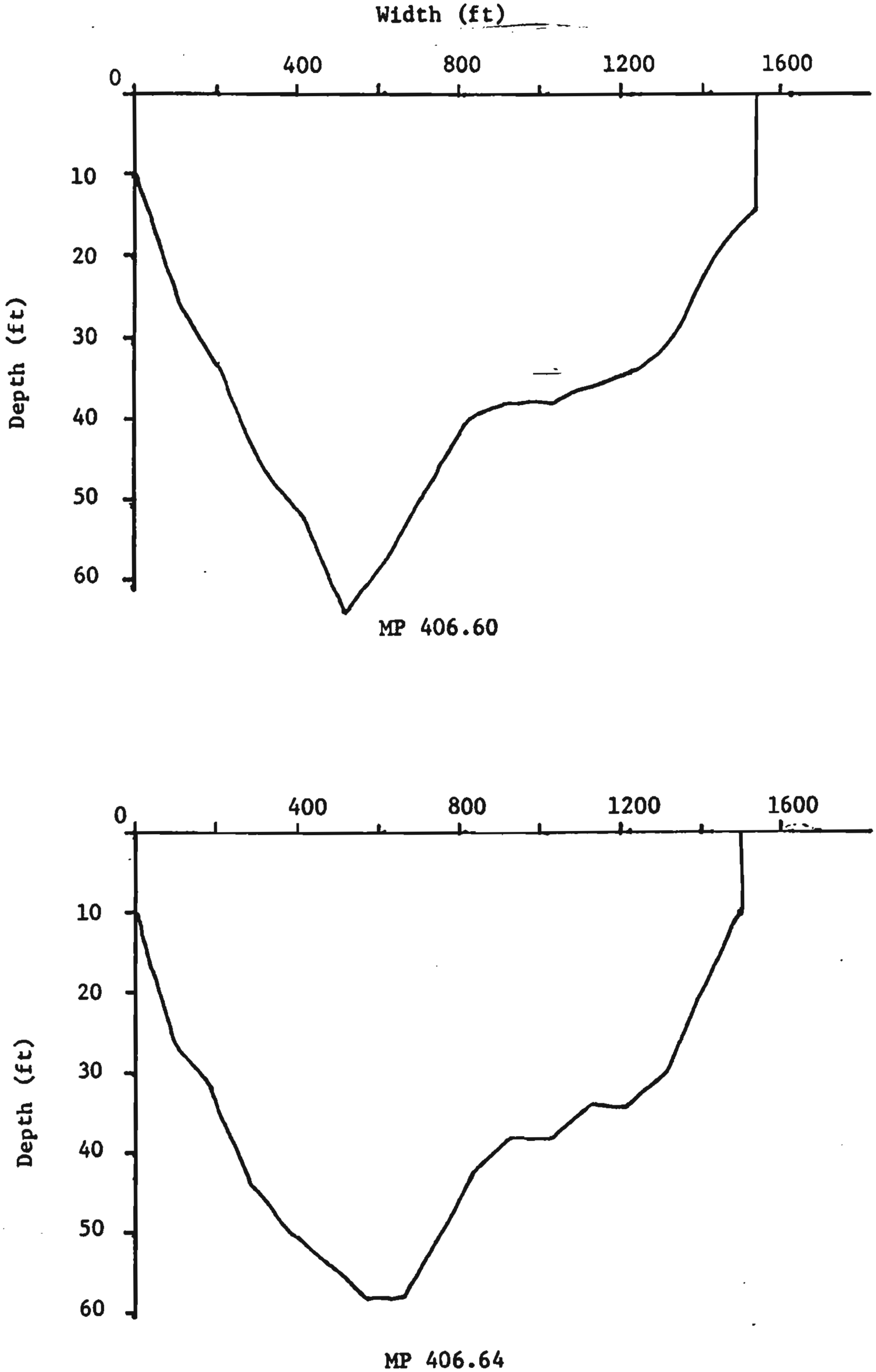


FIGURE III-24 Depth profile at designated mile points (MP) on the Ohio River.

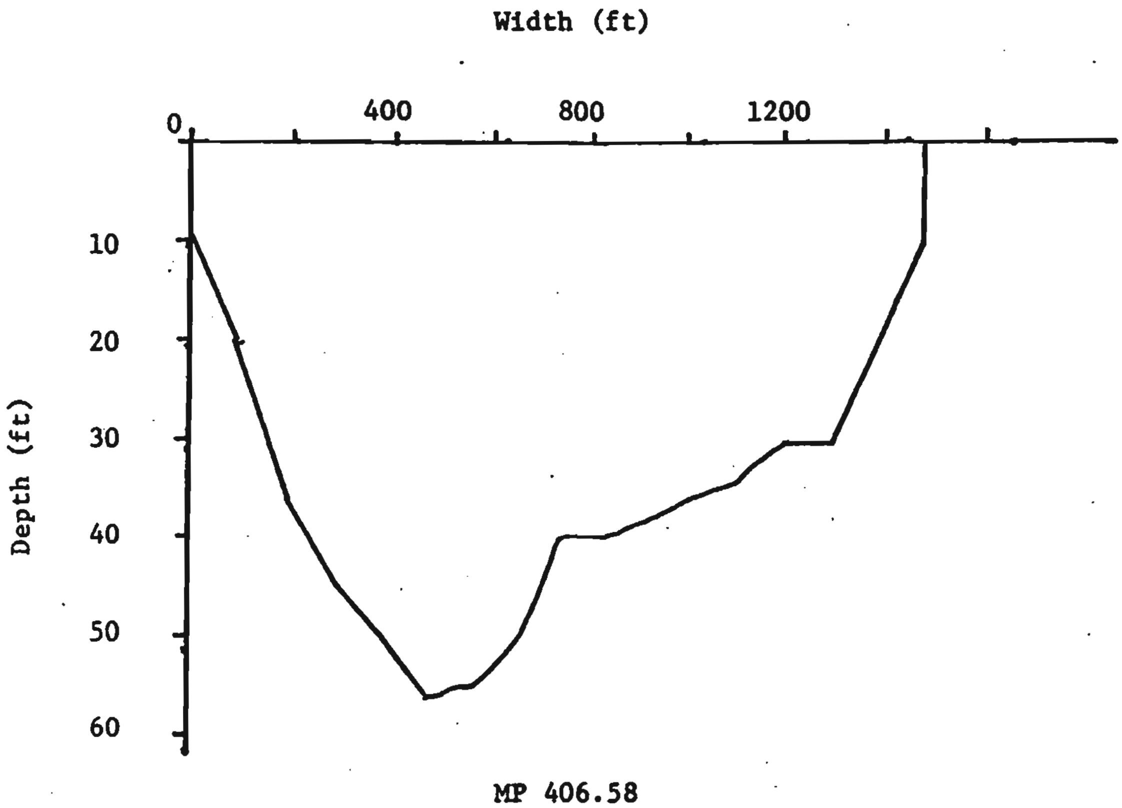


FIGURE III-25 Depth profile at designated mile points (MP) on the Ohio River.

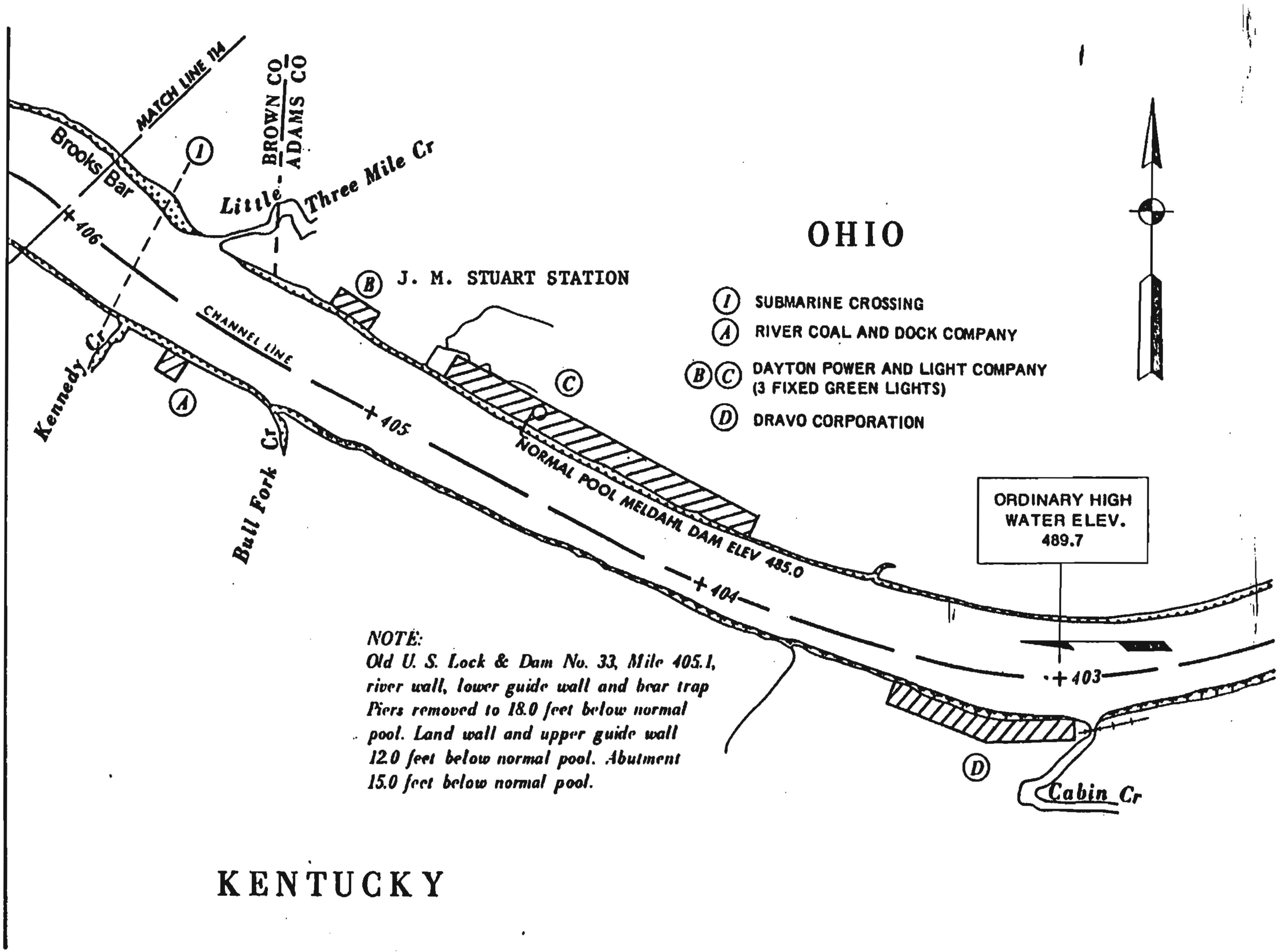


FIGURE III-26 Location of the J. M. Stuart Station and River Mile designations on the Ohio River (from Corps of Engineers, Huntington, West Virginia, January 1975).

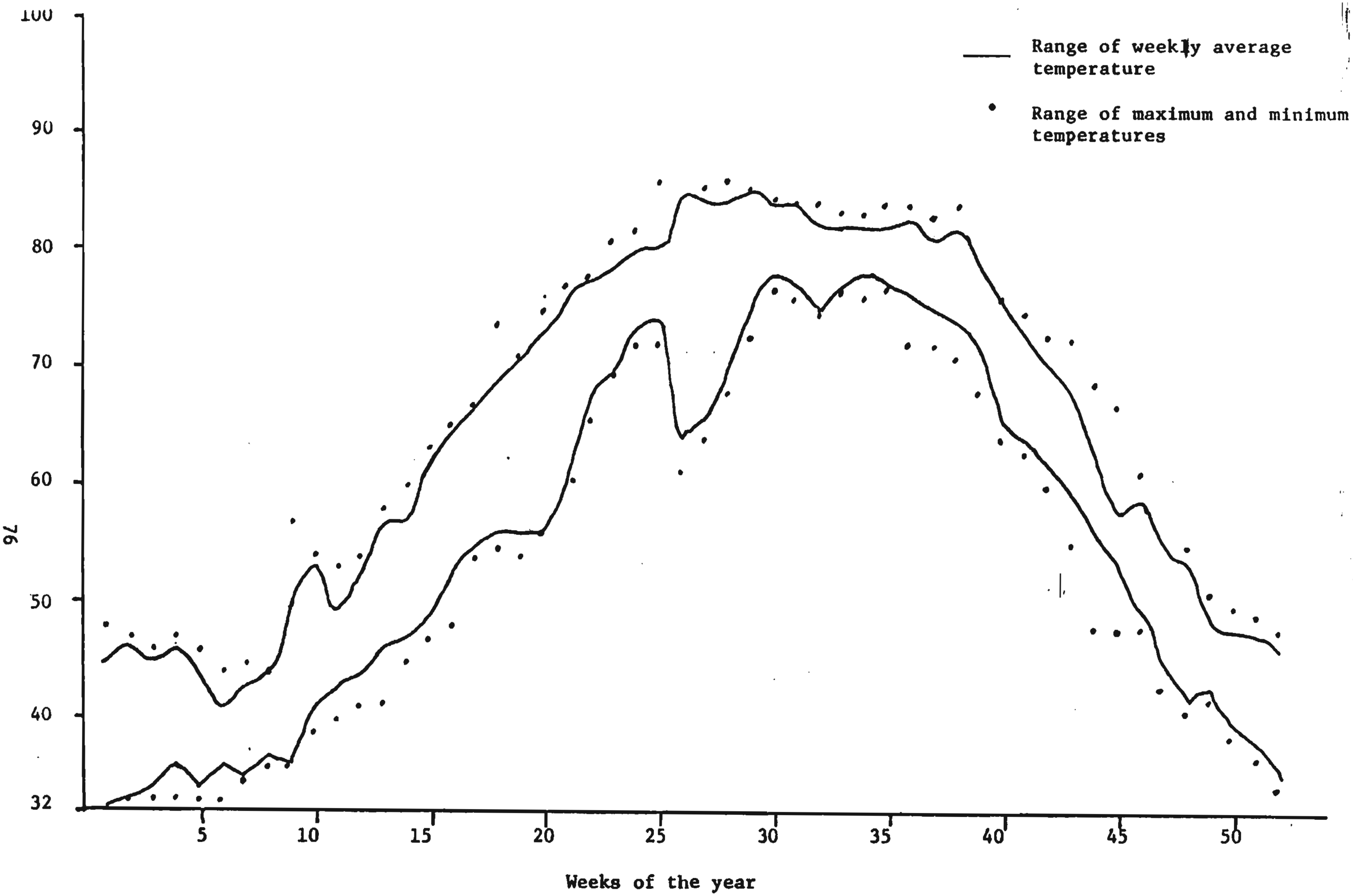


FIGURE III-27 Ten year record of water temperature of the Ohio River in the vicinity of the J. M. Stuart Station (1964-1973).

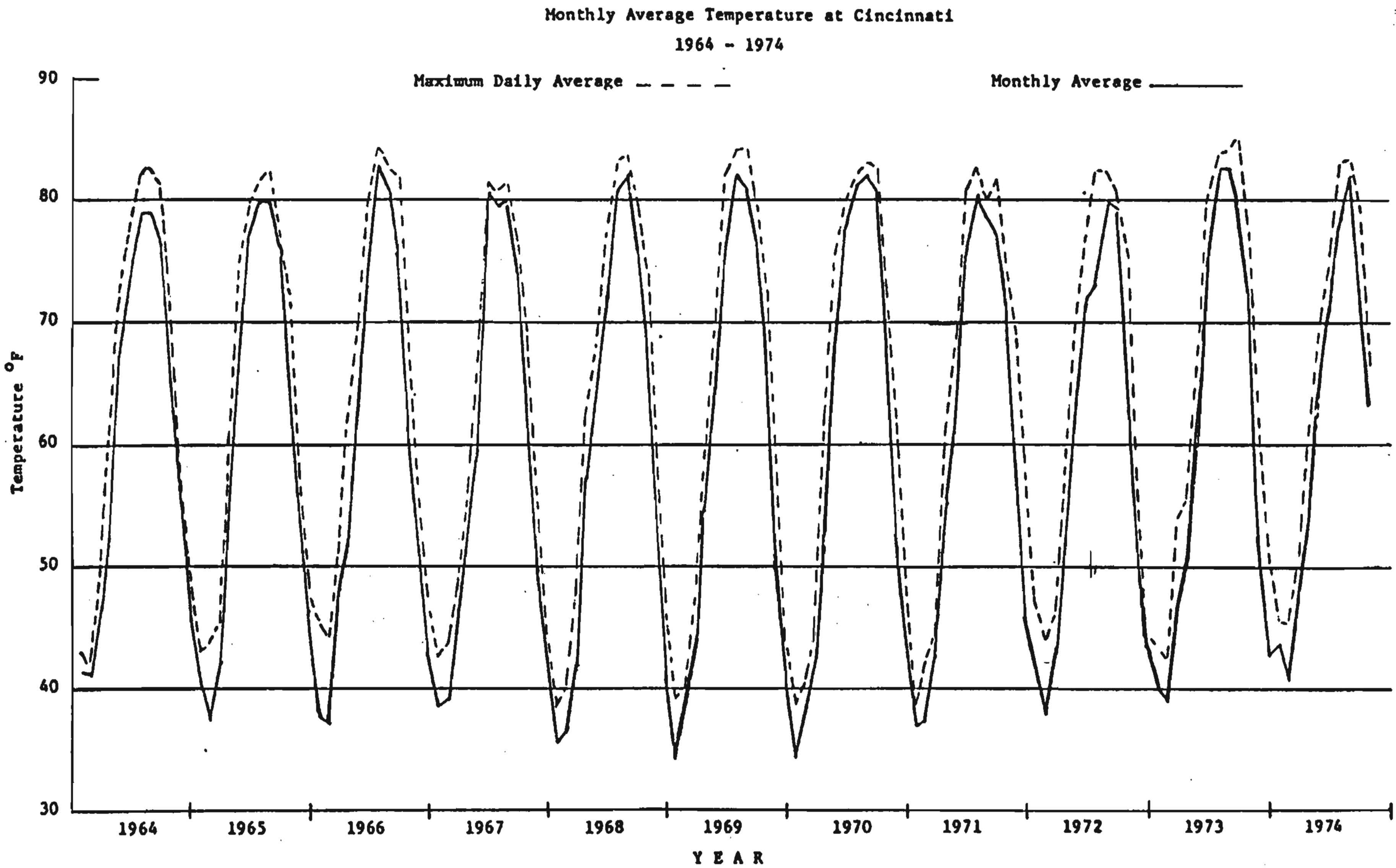


FIGURE III-28 Seasonal temperature variation of the Ohio River based on the average monthly temperature at Cincinnati, Ohio, 1964-1974 (from ORSANCO, 1974).

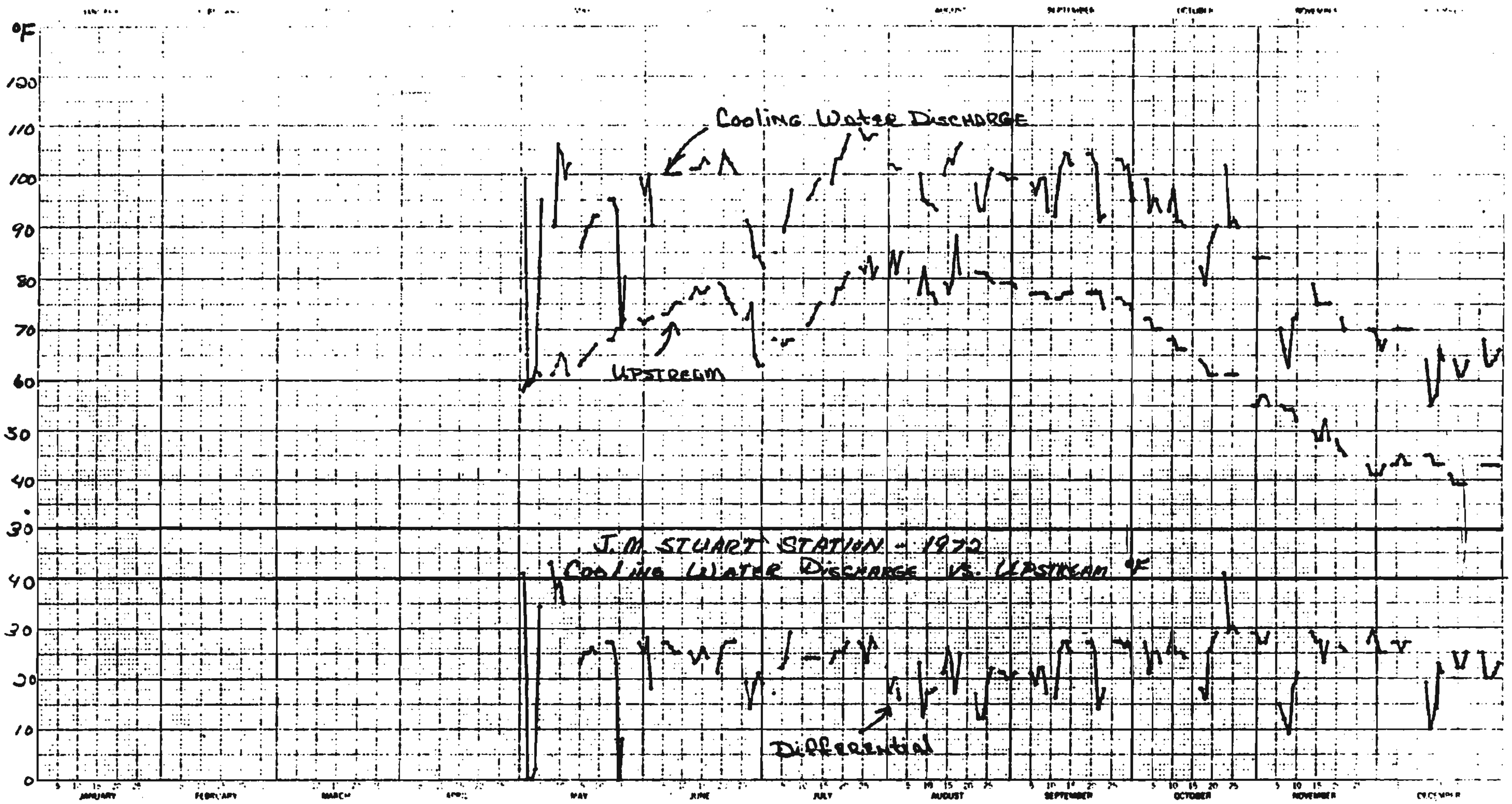


FIGURE III-29 Daily average condenser inlet (upstream) and outlet (cooling water discharge) temperatures (°F) and ΔT (°F) at the J. M. Stuart Station, 1972 (from The Dayton Power and Light Company).

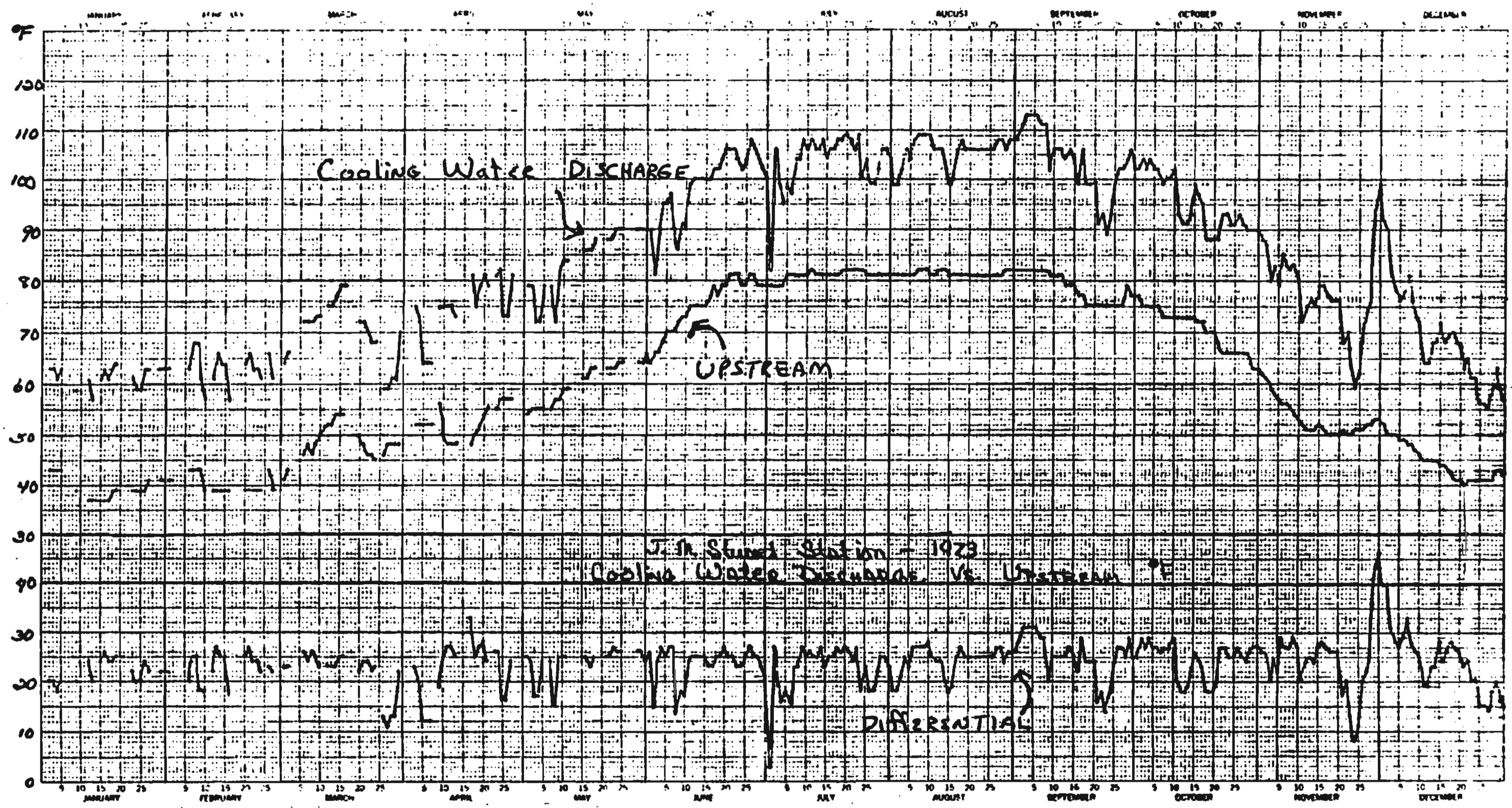


FIGURE III-30 Daily average condenser inlet (upstream) and outlet (cooling water discharge) temperatures (°F) and ΔT (°F) at the J. M. Stuart Station, 1973 (from The Dayton Power and Light Company).

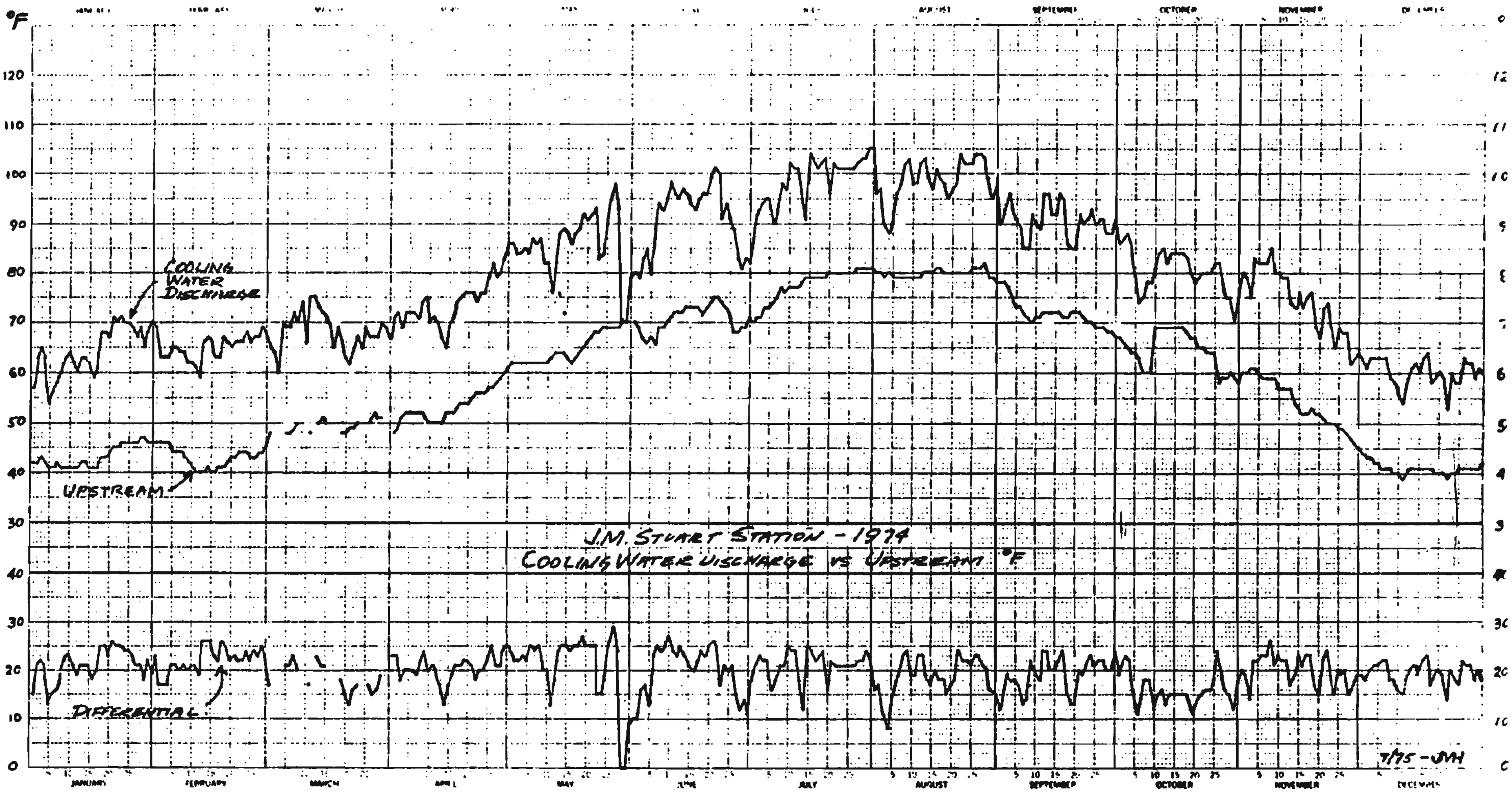


FIGURE III-31 Daily average condenser inlet (upstream) and outlet (cooling water discharge) temperatures (°F) and ΔT (°F) at the J. M. Stuart Station, 1974 (from The Dayton Power and Light Company).

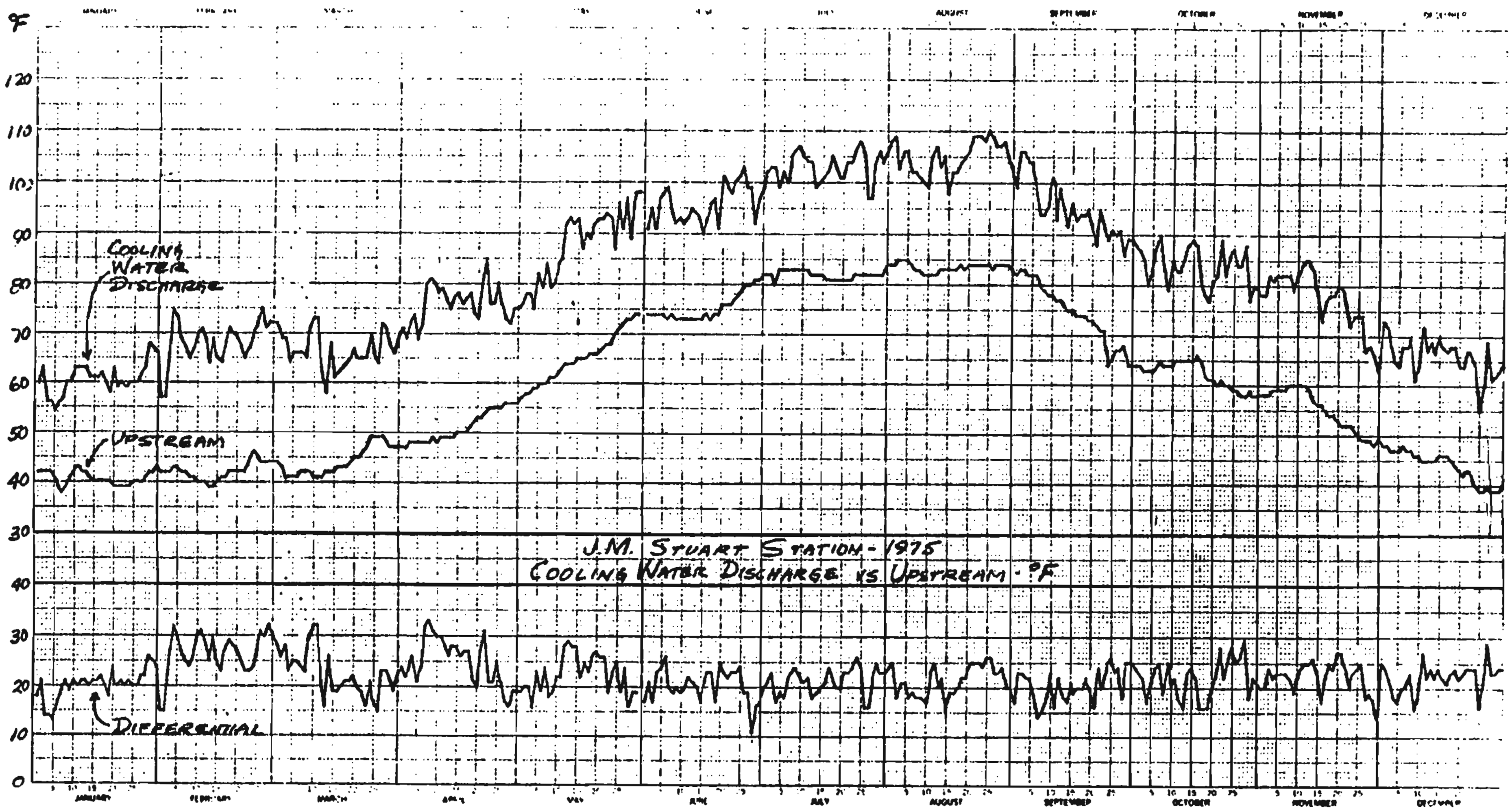
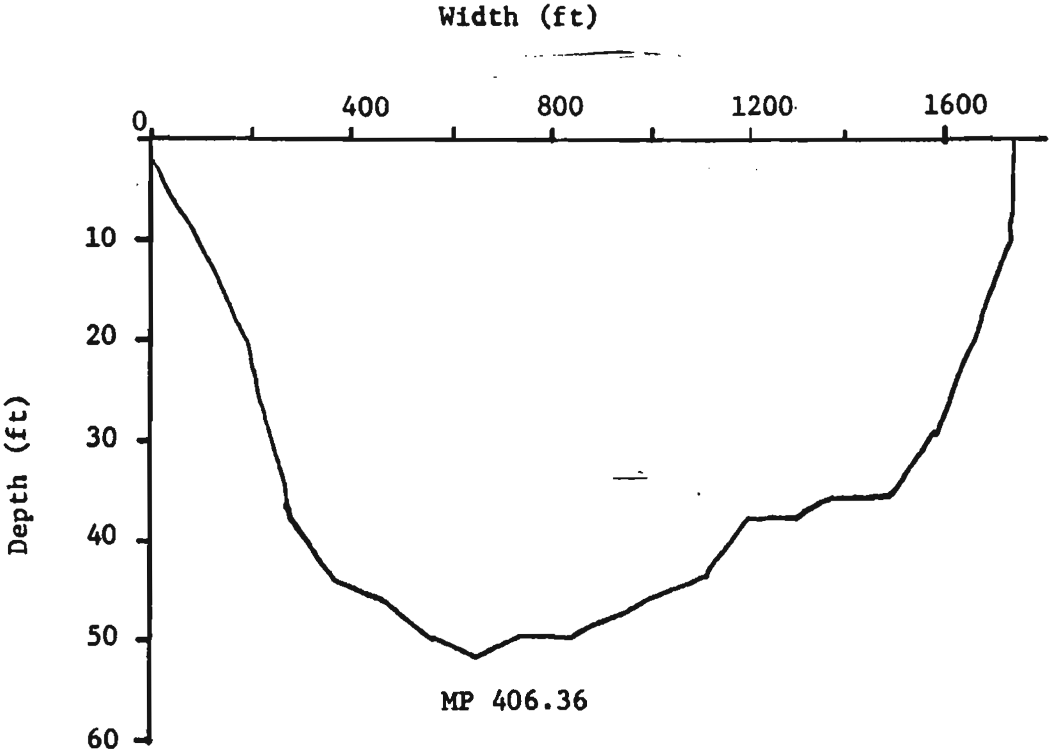


FIGURE III-32 Daily average condenser inlet (upstream) and outlet (cooling water discharge) temperatures (°F) and ΔT (°F) at the J. M. Stuart Station, 1975 (from The Dayton Power and Light Company).



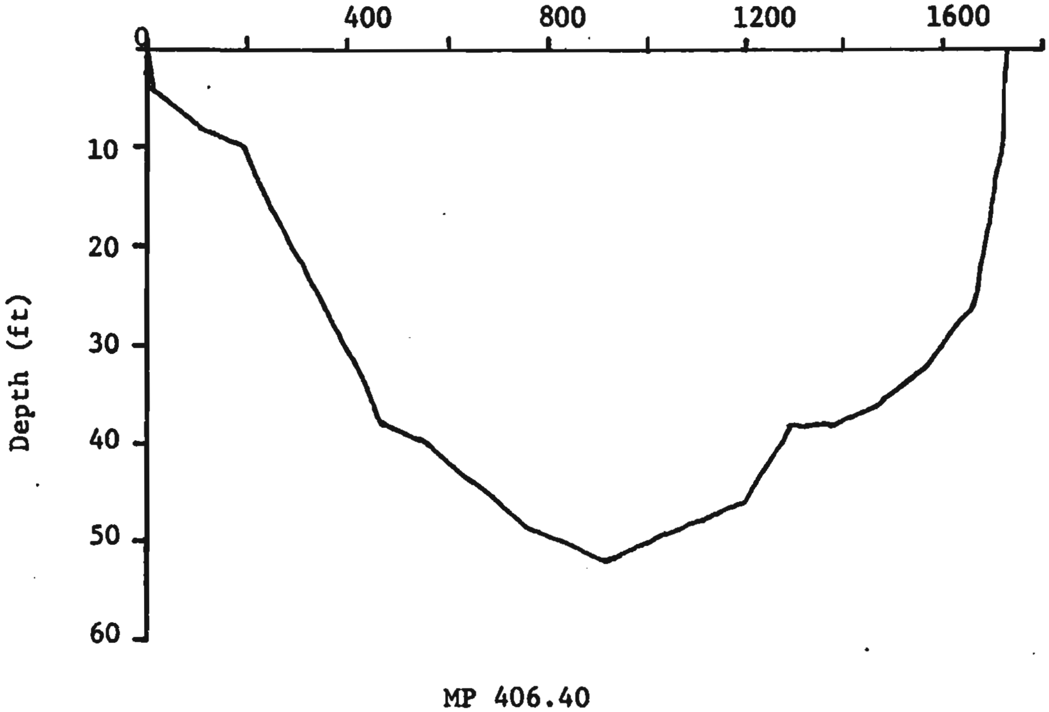
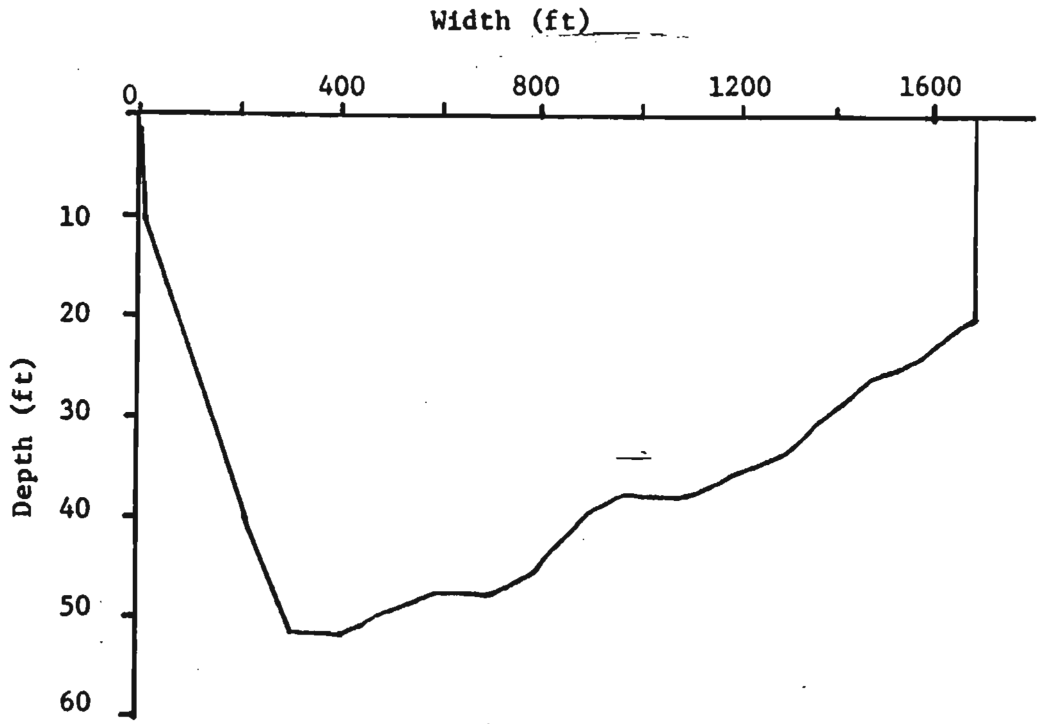
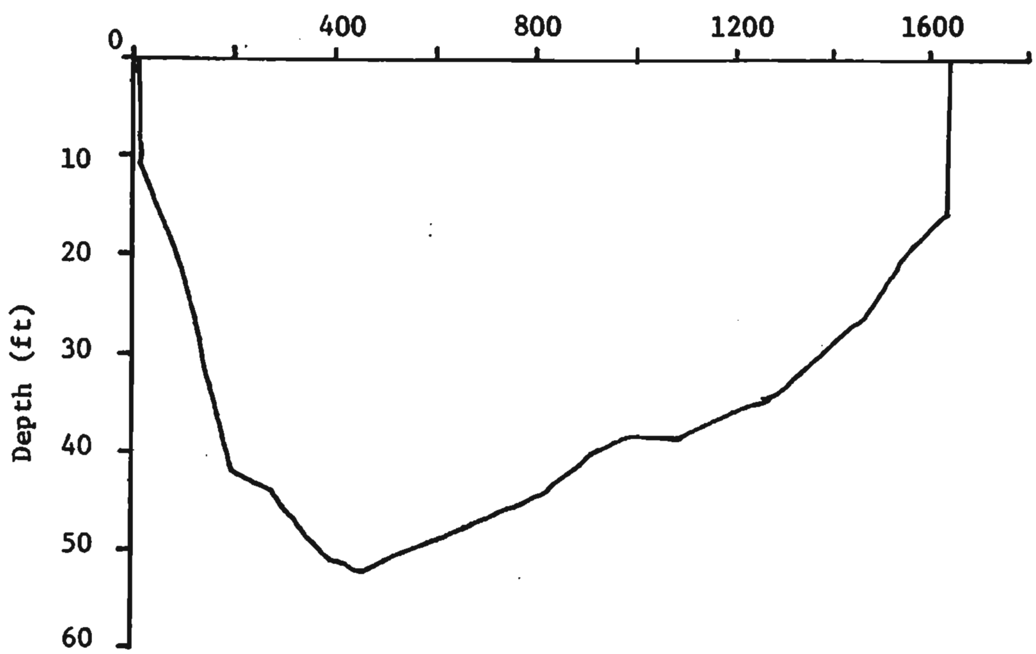


FIGURE III-21 Depth profile at designated mile points (MP) on the Ohio River.

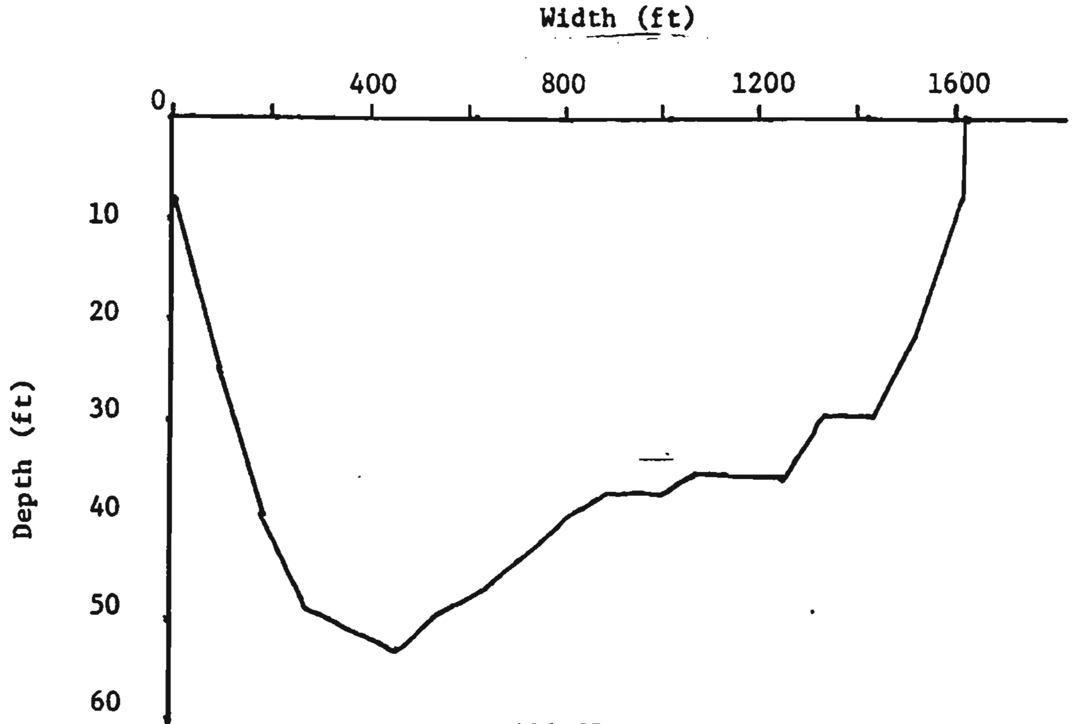


MP 406.44

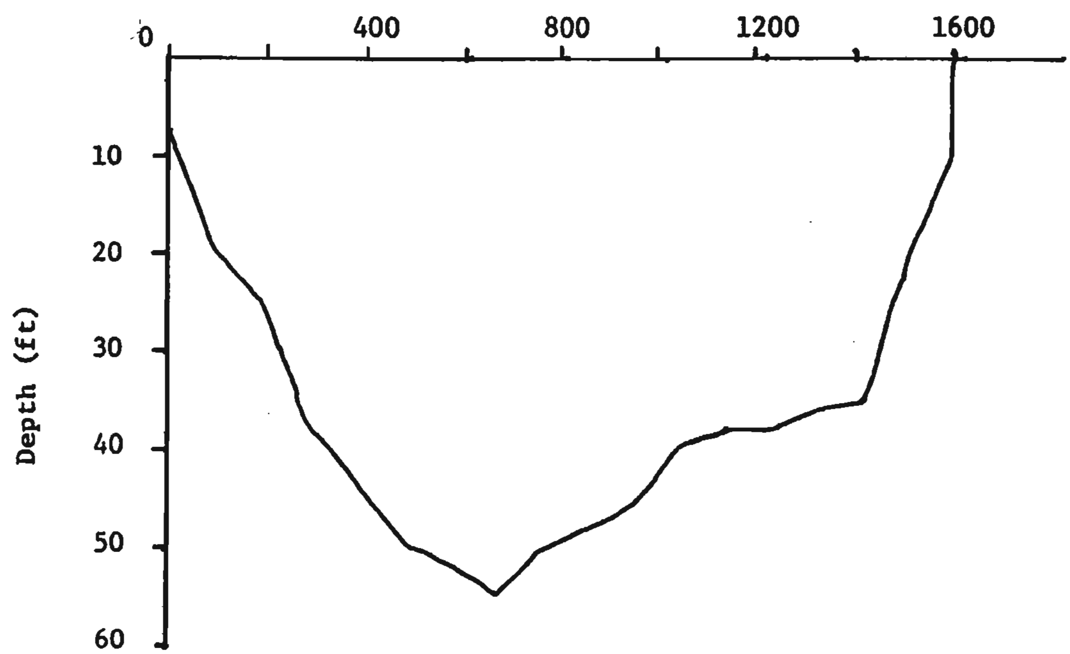


MP 406.48

FIGURE III-22 Depth profile at designated mile points (MP) on the Ohio River.

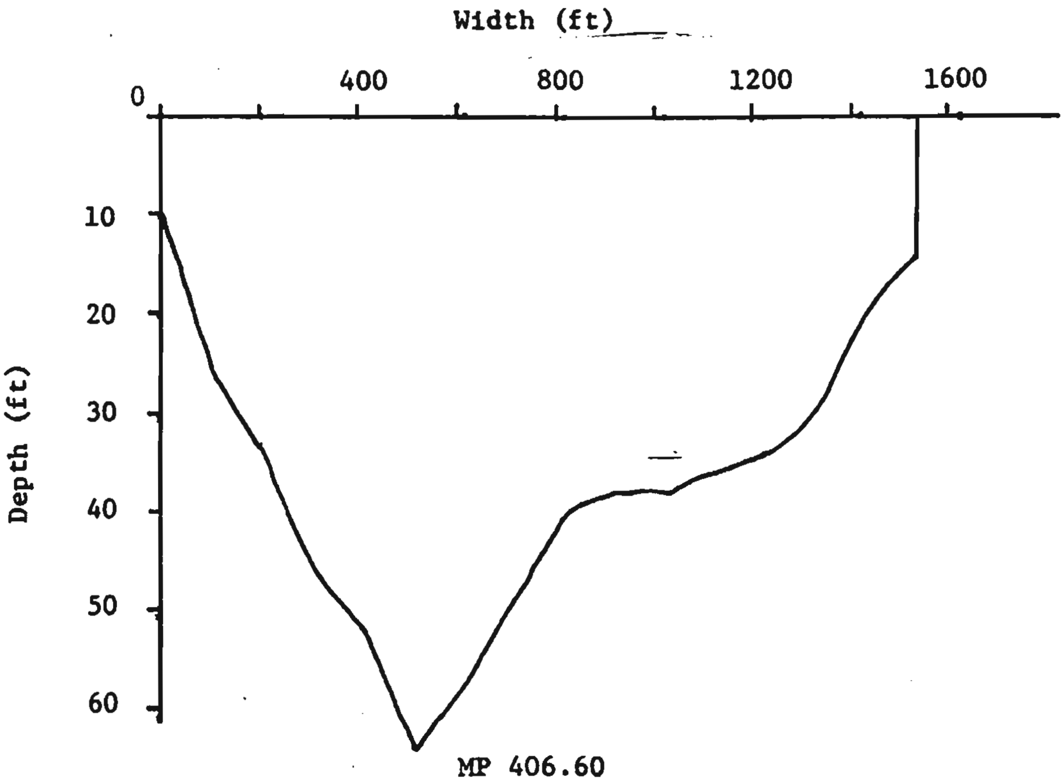


MP 406.52



MP 406.56

FIGURE III-23 Depth profile at designated mile points (MP) on the Ohio River.



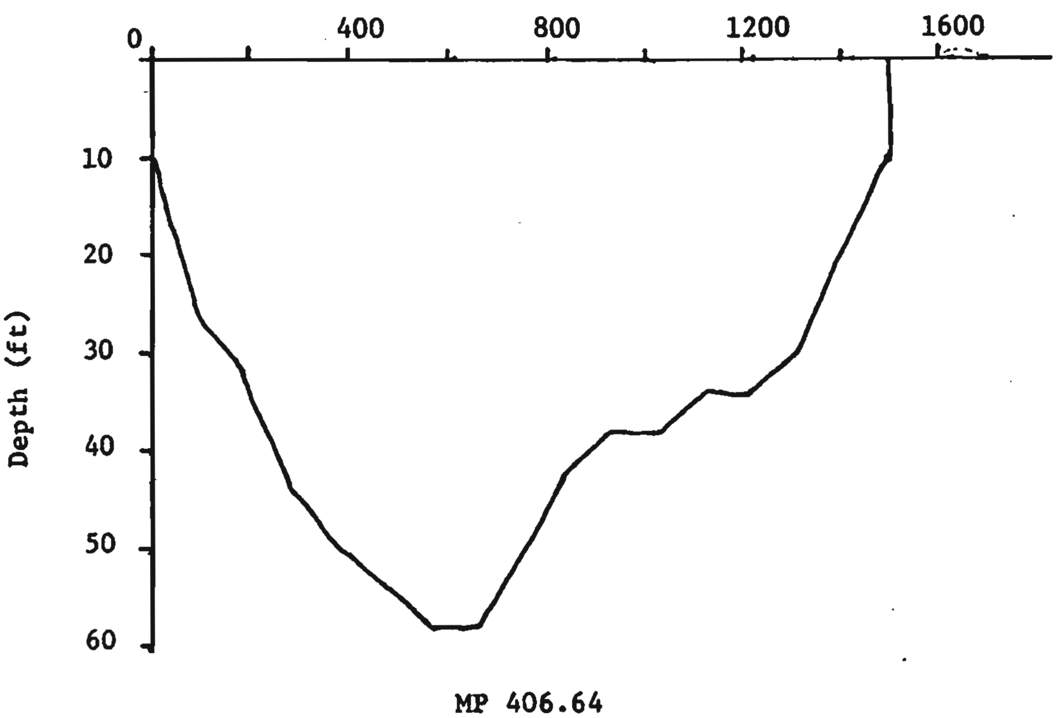


FIGURE III-24 Depth profile at designated mile points (MP) on the Ohio River.

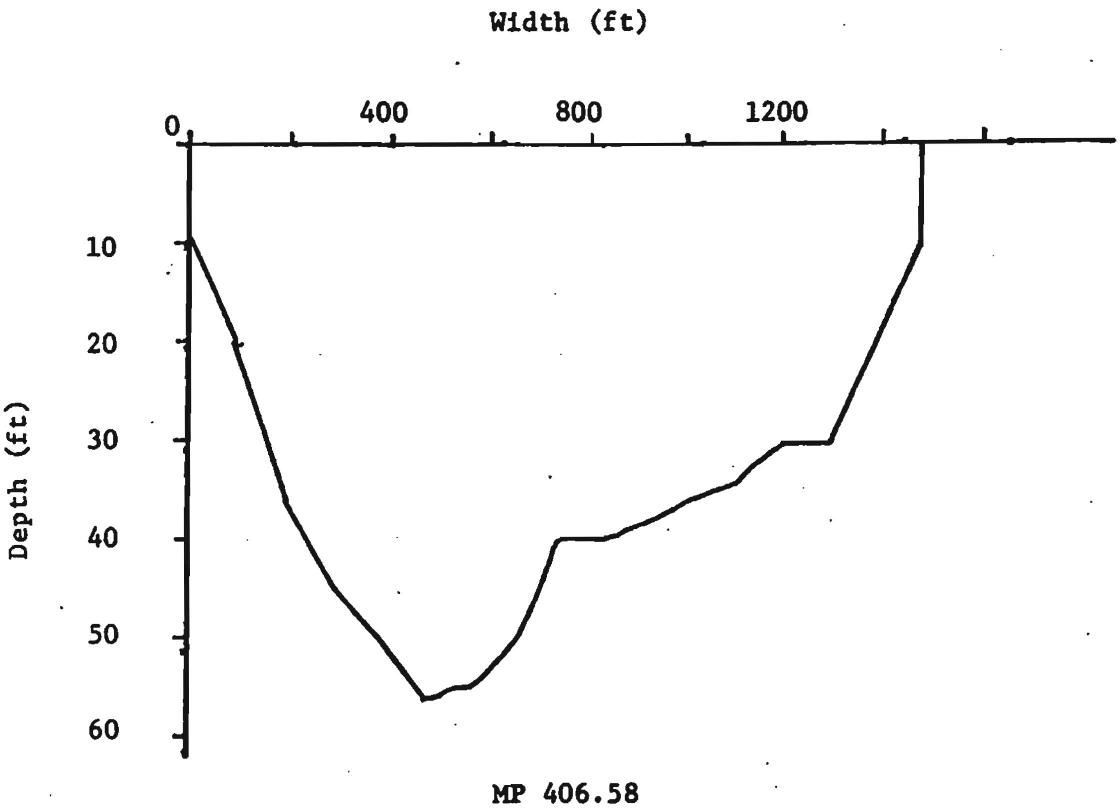


FIGURE III-25 Depth profile at designated mile points (MP) on the Ohio River.

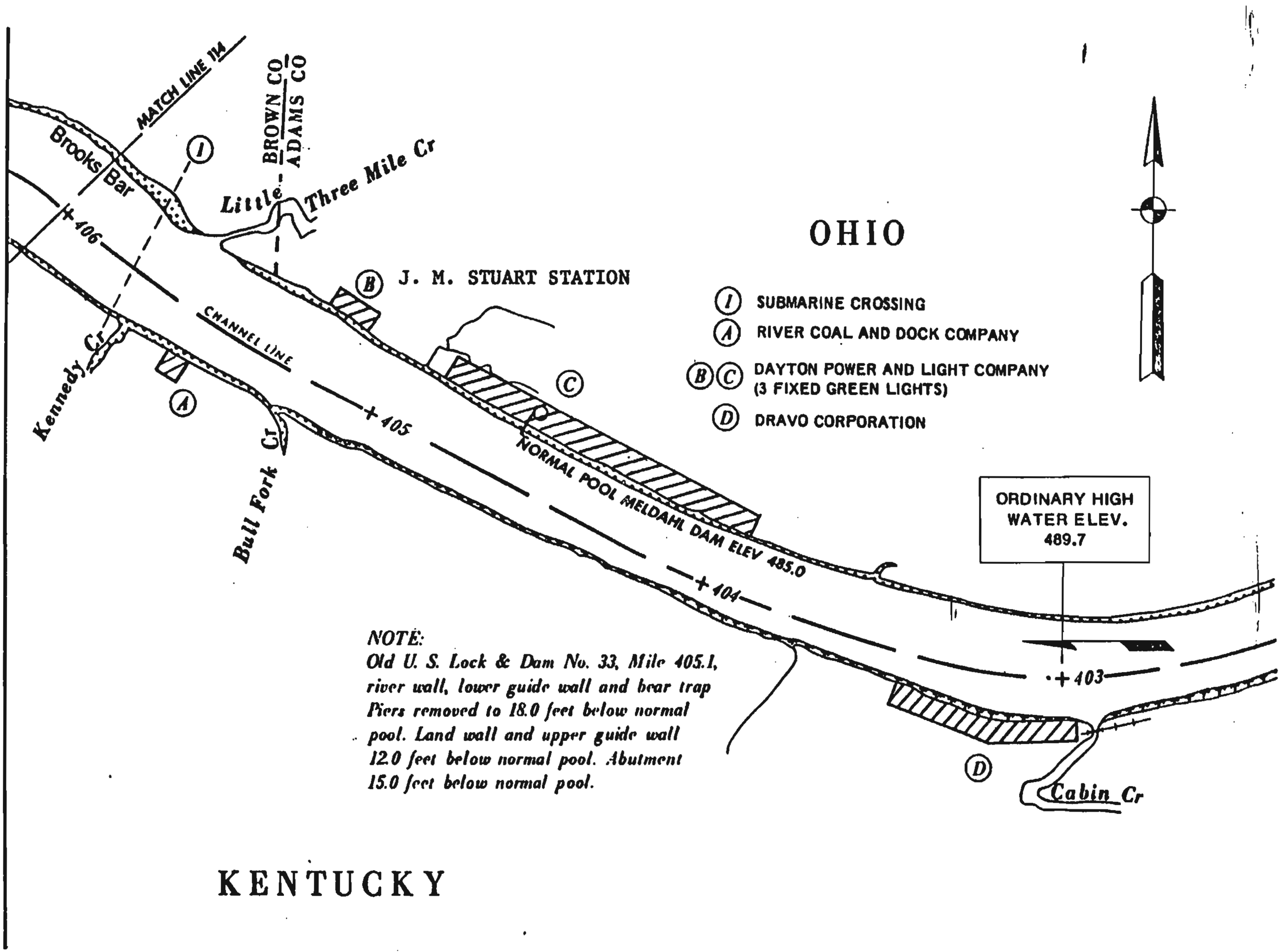


FIGURE III-26 Location of the J. M. Stuart Station and River Mile designations on the Ohio River (from Corps of Engineers, Huntington, West Virginia, January 1975).

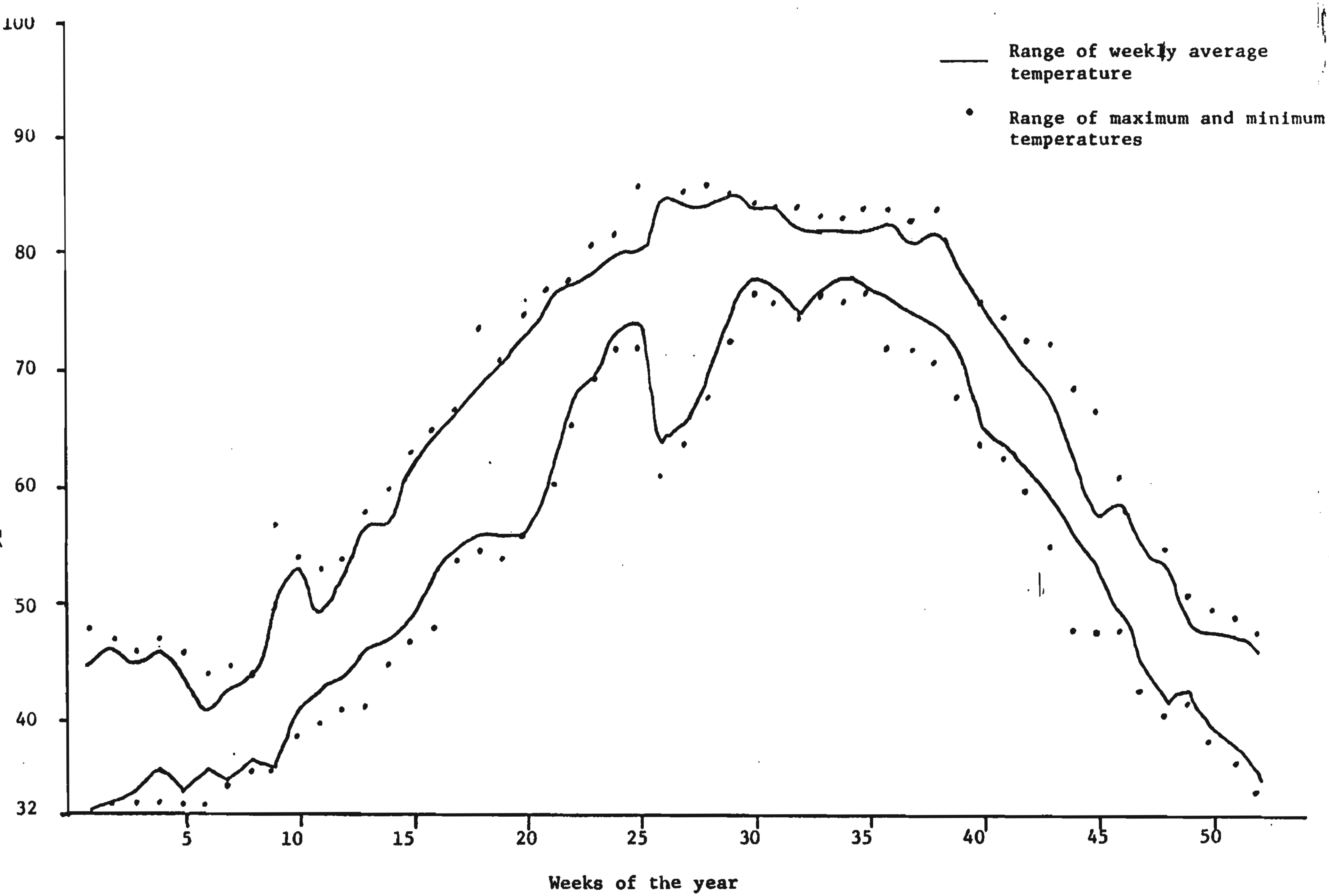


FIGURE III-27 Ten year record of water temperature of the Ohio River in the vicinity of the J. M. Stuart Station (1964-1973).

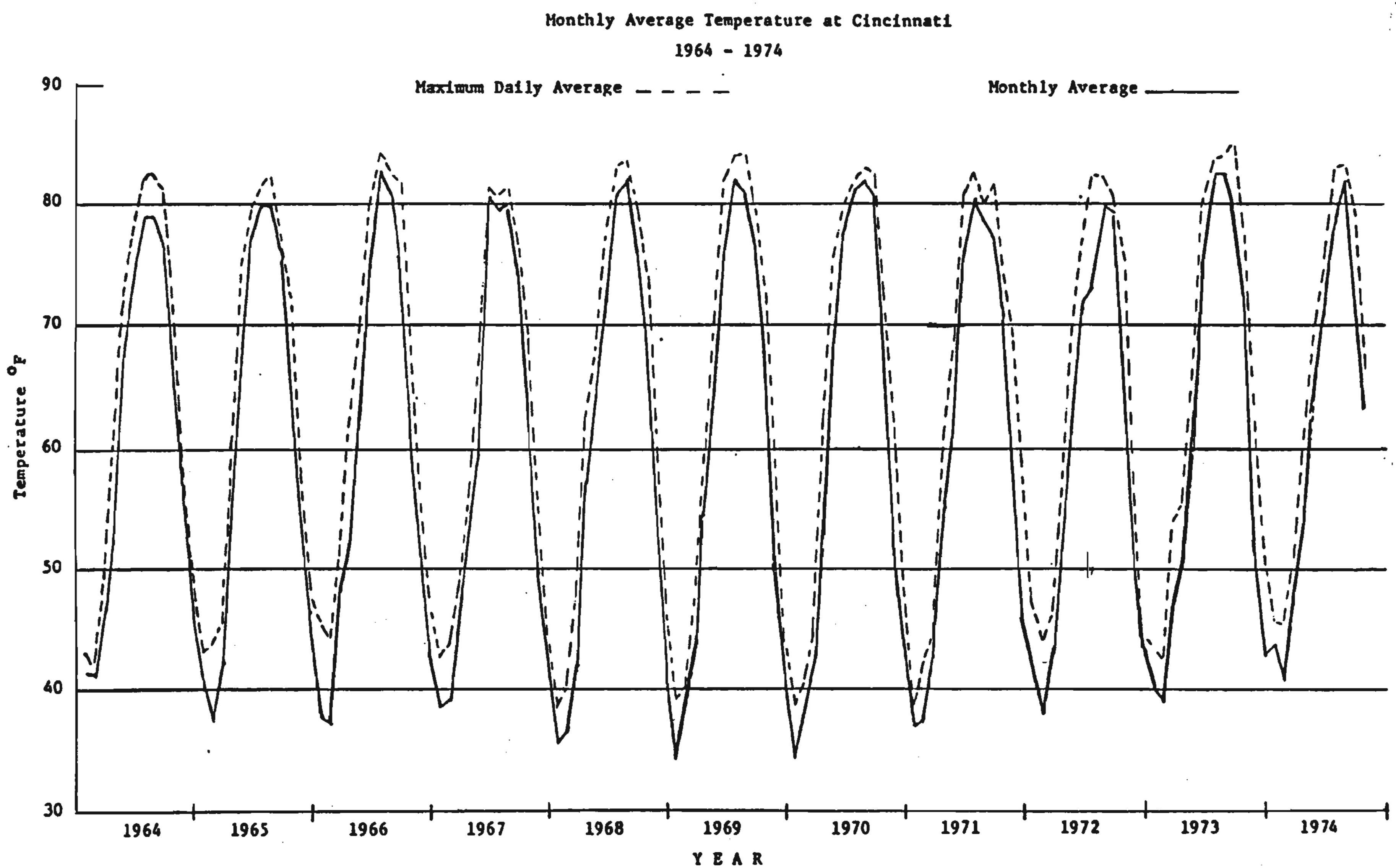


FIGURE III-28 Seasonal temperature variation of the Ohio River based on the average monthly temperature at Cincinnati, Ohio, 1964-1974 (from ORSANCO, 1974).

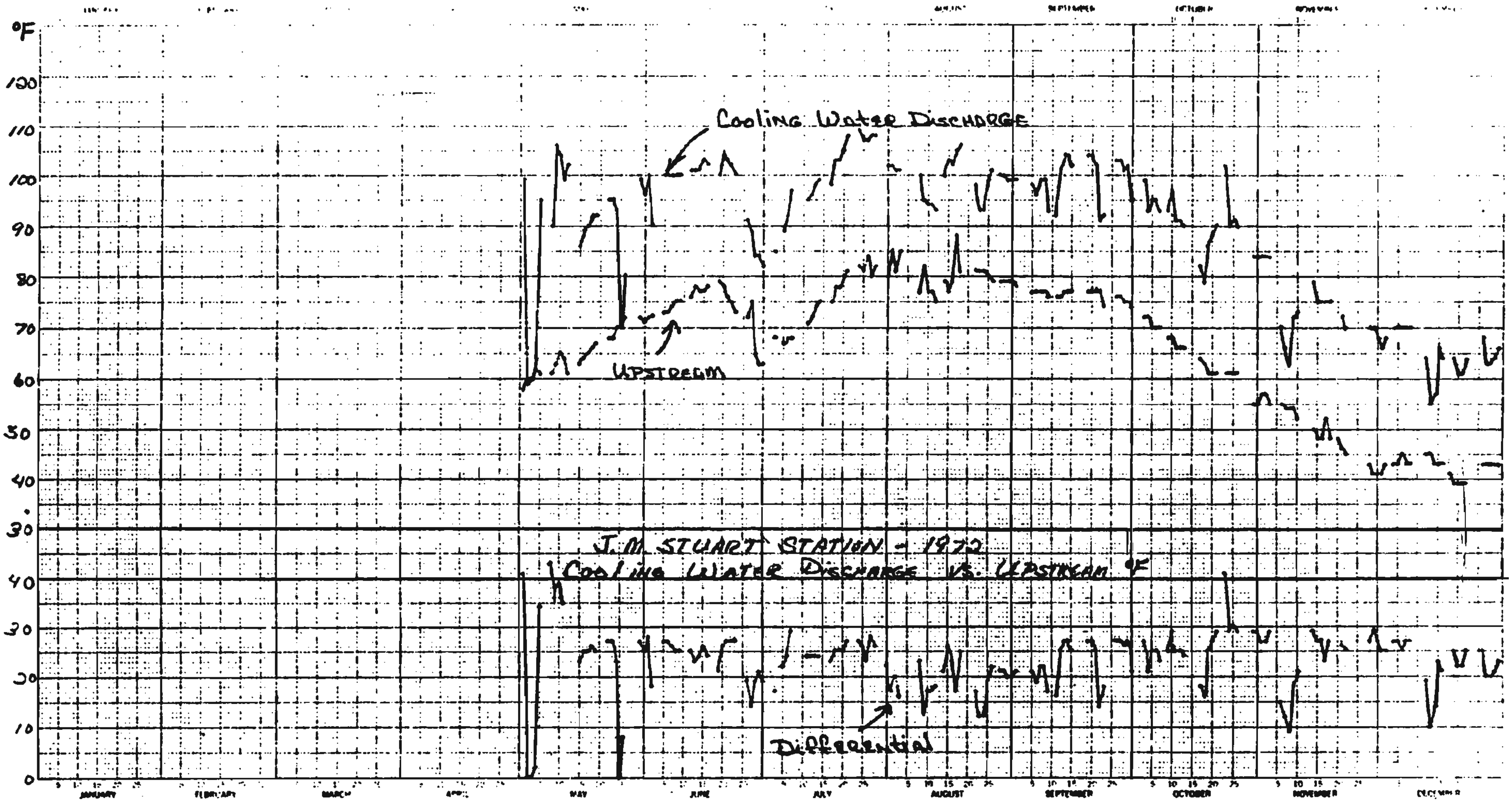


FIGURE III-29 Daily average condenser inlet (upstream) and outlet (cooling water discharge) temperatures (°F) and ΔT (°F) at the J. M. Stuart Station, 1972 (from The Dayton Power and Light Company).

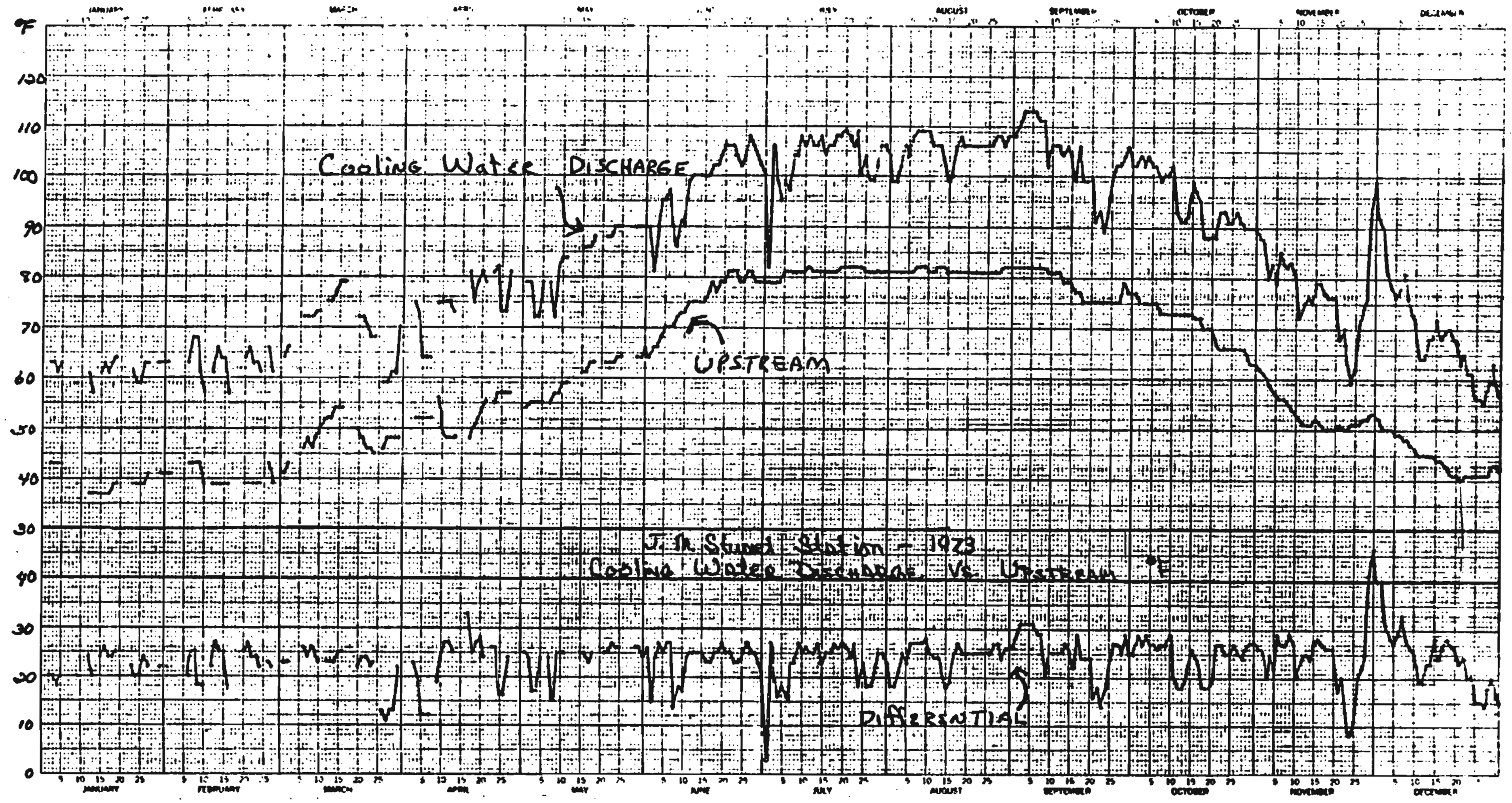


FIGURE III-30 Daily average condenser inlet (upstream) and outlet (cooling water discharge) temperatures (°F) and ΔT (°F) at the J. M. Stuart Station, 1973 (from The Dayton Power and Light Company).

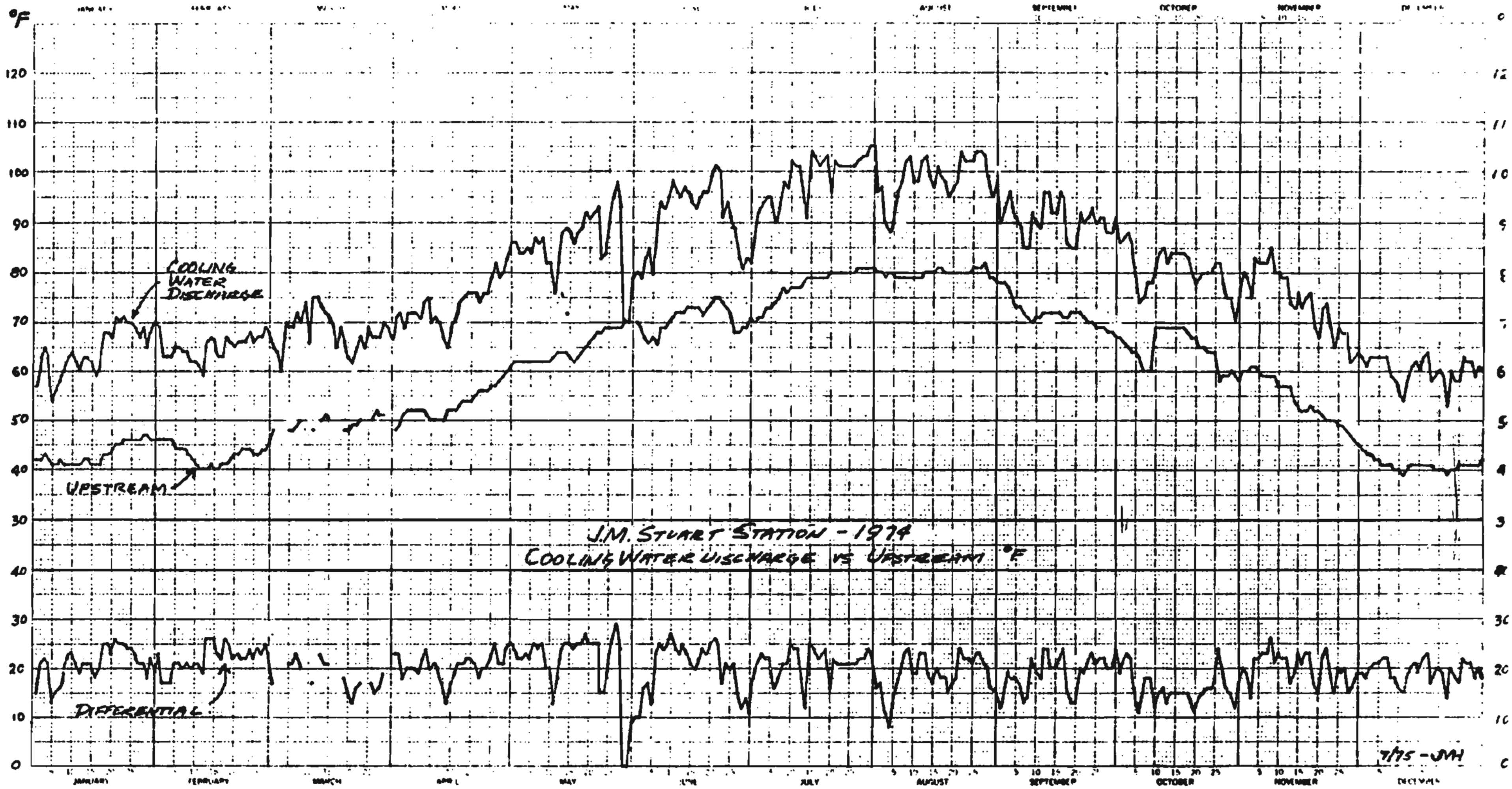


FIGURE III-31 Daily average condenser inlet (upstream) and outlet (cooling water discharge) temperatures (°F) and ΔT (°F) at the J. M. Stuart Station, 1974 (from The Dayton Power and Light Company).

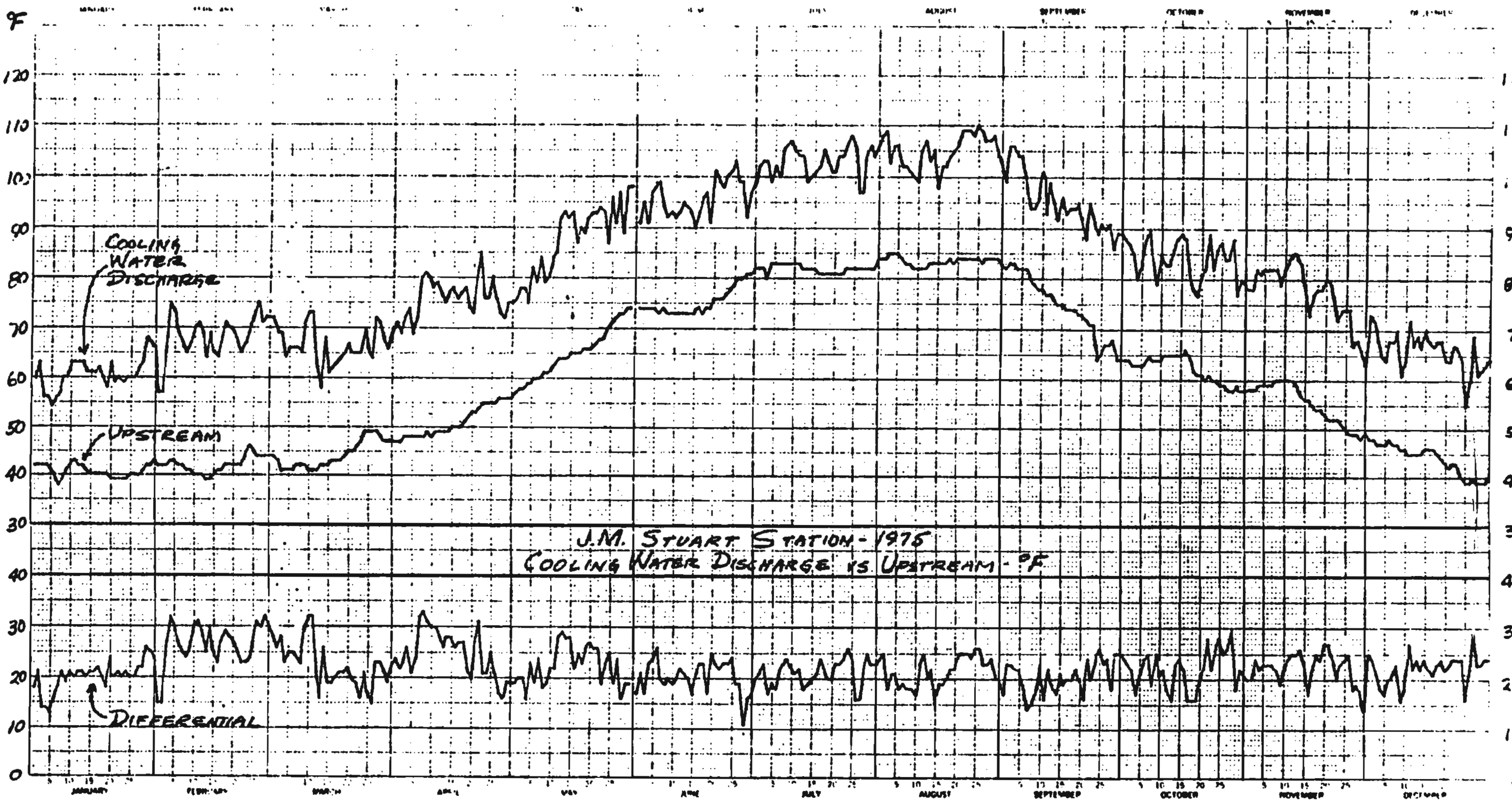


FIGURE III-32 Daily average condenser inlet (upstream) and outlet (cooling water discharge) temperatures (°F) and ΔT (°F) at the J. M. Stuart Station, 1975 (from The Dayton Power and Light Company).

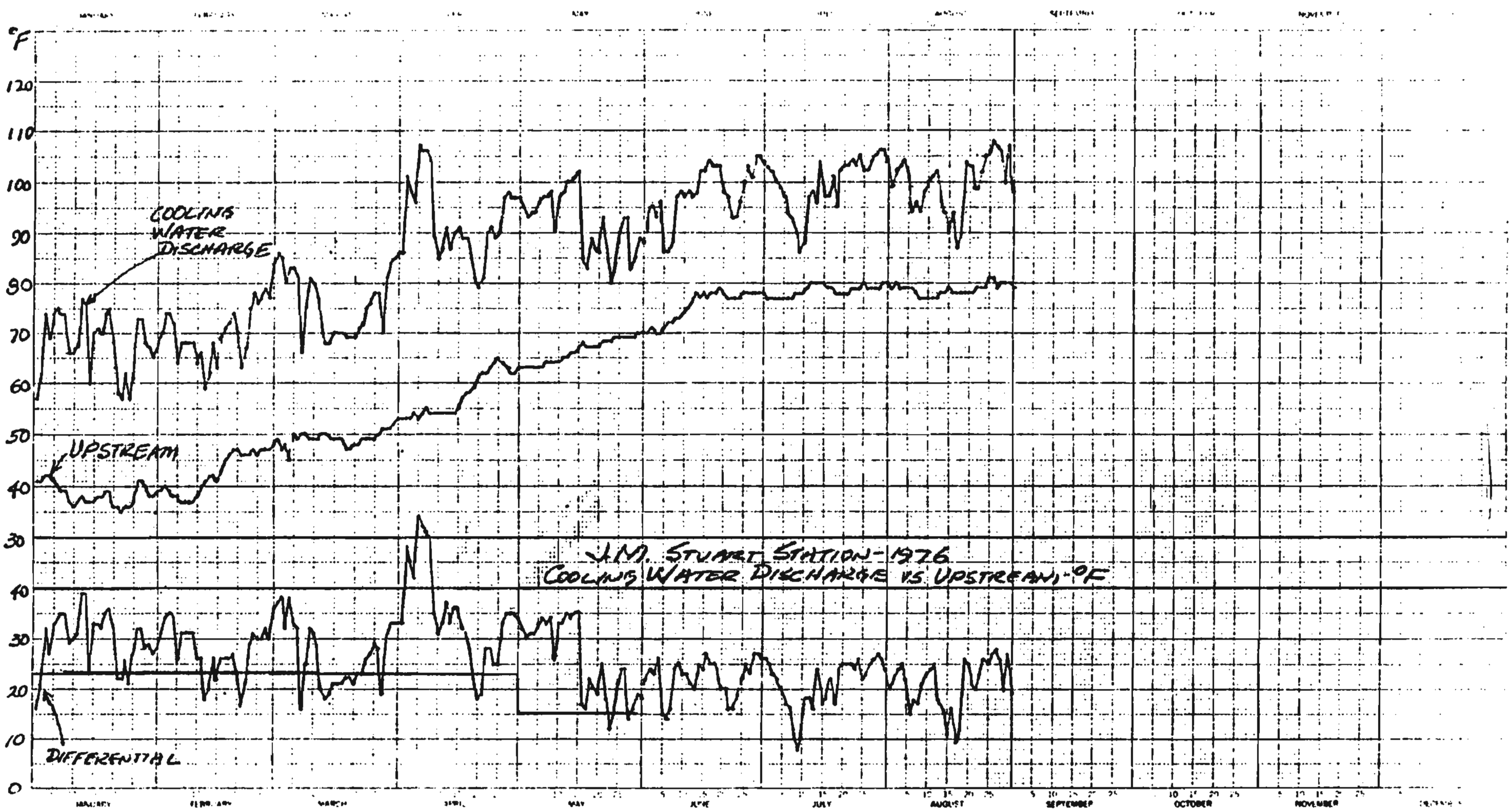


FIGURE III-33 Daily average condenser inlet (upstream) and outlet (cooling water discharge) temperatures (°F) and ΔT (°F) at the J. M. Stuart Station, 1976 (from the Dayton Power and Light Company.

THERMAL PLUME ANALYSIS

IV. THERMAL PLUME ANALYSIS

A. Field Observations

The configuration of the thermal plume at the J. M. Stuart Station is dependent on a number of factors, including plant generating load, thermal discharge volume, river flow (discharge), and meteorological conditions. The difficulty in obtaining reliable low flow (discharge) data for this section of the Ohio River is discussed in Section III-B-1. An approximation of flow can be found by referring to flow data from Greenup Dam, approximately 64 miles upstream of the J. M. Stuart Station. No records are available for Meldahl Dam, 31 miles downstream (personal communication, Mr. Howard Beaver, U.S.G.S., Louisville, Kentucky).

The first of the four J. M. Stuart Station units (Unit No. 2) was declared commercial on October 11, 1970. The initial thermal discharge regime (Figure IV-1) was somewhat erratic until May 17, 1971 when the second unit (Unit No. 1) was declared commercial and plant operation became more uniform.

Figures IV-2 through IV-4 show the configuration of the thermal plume in Little Three Mile Creek and the Ohio River during August and November 1970 and June 1971 (Norris and Gammon, no date). Each figure depicts the temperature at the surface, two foot and four-foot depths. The thermal plume measured on August 18, 1970 (prior to commercial declaration, when Unit 2 was being tested) is shown in Figure IV-2. On November 12 1970 when average plant load was 580 MW and river flow was 95,000 cfs, the thermal plume (Figure IV-3) remained near the Ohio shore and dissipated rapidly.

With two units (Units 1 and 2) in operation on June 16, 1971 (Average load = 1180 MW), the thermal plume configuration (Figure IV-4) extended farther out from the Ohio shore. However, river flows were apparently less than in November 1970 as no record is available from the Maysville gage and the discharge recorded at Greenup Dam on June 14, 15, and 16, 1971 was 52,000, 62,000, and 64,000 cfs, respectively. Thus, with lower flow the thermal plume predictably extends farther out in the Ohio River.

The Dayton Power and Light Company conducted thermal plume tests on June 22, 1972 (Average load = 1700 MW) and October 11, 1972 (average load = 1745 MW) when all three once-through cooling units were in commercial operation (Figures IV-5 through IV-10). Again, although no flow records are available from the Maysville gage, the records from Greenup Dam (51,700, 74,200, and 110,000 cfs on June 20, 21, and 22, 1972, respectively; 73,100, 51,100, and 47,900 cfs on October 9, 10, and 11, 1972, respectively) indicate that flow was considerably lower during the October period when the plume reached the Kentucky shore (Figures IV-8 to IV-10). This becomes more likely considering that lower ambient temperatures during October (67°F on October 11, 1972 versus 75°F on June 22, 1972) should have helped dissipate the plume more rapidly under similar plant loadings.

WAPORA conducted thermal plume measurements at the J. M. Stuart Station on September 12, 1974. Transects were established as depicted in Figures IV-11 and IV-12; the cross sectional temperature profiles are presented in Figures IV-13 through IV-21. The total generation by Units 1, 2, and 3 for the day of the test (September 12, 1974) and the previous day (September 11, 1974) was as follows:

Hour	September 11	September 12
8 AM	1142 MW	906[1] MW
9	1162	927[1]
10	1164	1028[1]
11	1167	1044[1]
12 Noon	1177	1042[1]
1 PM	1182	1045[1]
2	1144	1071[1]
3	1134	1056[1]
4	1023[1]	1054[1]
5	1024[1]	1055[1]
6	1019[1]	1039[1]
7	1021[1]	1022[1]
8	970[1]	1019[1]

[1]Unit 2 out of service.

Ambient river temperature was 22.0°C (71.6°F) on September 12, 1974. Even though Unit 2 was forced out of service during the actual test, all circulating water pumps remained in service, and the flow out of LTMC was maintained at approximately 640,000 gallons per minute (1427 cfs). Ohio River flow at Greenup Dam was 53,500, 38,200, and 39,600 cfs on September 10, 11, and 12, 1974, respectively. No records are available from the Maysville, Kentucky gage during this low flow period.

The plume reached the opposite shore approximately one mile downstream (Figure IV-11 through IV-16) but had dissipated to within 1°C of ambient and remained within 5 to 10 feet of the surface the entire width. The 1°C ΔT isotherm was followed downstream to River Mile 412.3 (Figure IV-21), the location of Transect J (Figure IV-12).

The surface configuration of the thermal plume measured on July 22, 1976 is shown in Figure IV-22. The longitudinal depth profile of the plume is shown on Figure IV-23. Ohio River flow was calculated to be approximately 54,000 cfs on this date and the circulating water flow approximately 640,000 gpm (1,427 cfs). Table IV-1 shows the generating loads of Units 1, 2, and 3 at the time of plume measurement.

On September 20, 1976, a third survey of the river was made by WAPORA. This survey was triggered by the fact that at that time, the flow in the river was expected to be approximately 15,000 cfs. Since this was very near the predicted 7 day, 10 year low flow value, an opportunity was present to observe the actual performance of the plume under low flow conditions. The plume, as measured, is shown in Figure IV-24. At the time of the field study, the ambient temperature was 23°C (73.4°F). There were high winds blowing from the West, the sky was completely overcast, and the air temperature was between 22 and 25°C (71 and 77°F). Only two once-through cooling units were operating; however, all of the circulating pumps were in operation.

As the figure shows, the configuration of the plume is quite complex. This complexity is increased by the fact that there are apparently thermal plumes from thermal discharges upstream from LTMC, on the Kentucky side. The resulting plume, which is approximately 4°C (7.2°F) ΔT above the ambient temperature, lies along the Kentucky shore above the power plant discharge. In addition, there are small discharges of warm water from the power plant itself, which form a small plume, about 1°C (1.8°F) ΔT along the Ohio bank, above the discharge.

The plot of temperature cross-sections measured during the field study (Figures IV-25 to IV-27) clearly show that there is a separate and distinct plume on the Kentucky side which is not a part of the J. M. Stuart Station plume. Note particularly the cross-sections at River Mile (RM) 405.2 and 405.4.

Measurements of the effluent from the operating units indicated that the water was being discharged at 38°C (100.4°F) at the upstream end of LTMC. This was mixed with discharges from the circulating pump on the non-operating unit which was being discharged at 25°C (77°F). The two flows mixed thoroughly in LTMC and had a resulting temperature of 36°C (96.8°F). In traveling down LTMC, the temperature of the outflow decreased until it was 34°C (93.2°F) at the mouth of the creek.

Measurements of the plume inside the 5°F isotherm (2.8°C) ΔT indicated a surface plume of approximately 265 acres. This area extended all the way across the river; however, it remained at all times less than seven feet deep. Since the average depth of the river is 35 feet, the plume covered less than 20 percent of the transverse area of the river at all times. The 5°F plume extended on the surface, from the mouth of LTMC (RM 405.5), to approximately RM 406.3, thus yielding a total length of 0.8 miles.

B. Water Quality Compliance

Copies of all water quality related communications (which indicate possible harmful effects) between the applicant (The Dayton Power and Light Company) and any agency other than EPA during the last five years are presented separately as an appendix to this document. The 316 (a) guidelines (U.S. EPA, September 30, 1974, p. 28) further state:

"The applicant should submit copies of all such communications or show why he is unable to do so, except that in the case of State administration of the permit program, communications with the State need not be submitted but communications with EPA should be included."

Ohio EPA regulation EP-1-03 "Mixing Zones" establishes in Section (B) (1) that:

"Except as subsequent provisions of this paragraph provide different limits, no mixing zone shall:

(a) constitute more than one-half of the width of the receiving watercourse nor constitute more than one-third of the area of any cross-section of the receiving watercourse,

(b) extend downstream at any time a distance more than five times the width of the receiving watercourse at the point of discharge,

(c) exceed twenty-three acres of horizontal area of the Ohio River or twelve acres of horizontal area of any other receiving watercourse,

(d) include spawning or nursery areas of any indigenous aquatic species, or

(e) interdict the migratory routes of any indigenous aquatic species, or

(f) include a drinking water supply intake."

Section (C) (1) provides that:

"Except as subsequent provisions of this paragraph establish different standards, the water quality standards in mixing zones shall be as follows:

(a) All pollutants or combinations of pollutants shall not exceed at any time the 96-hour median tolerance limit for any indigenous aquatic species, determined by static or dynamic bioassays in accordance with standard methods described in "Standard Methods for the Examination of Water and Wastewater", 13th Edition, 1971, published by the American Public Health Association, and Water Pollution Control Federation.

(b) Water temperature shall not exceed the temperature of the receiving watercourse upstream of the mixing zone by more than 15 degrees Fahrenheit (8.3 degrees centigrade) during the months of May, June, July, August, September and October or by more than 23 degrees Fahrenheit (12.8 degrees centigrade) during the months of November, December, January, February, March and April."

Section EP-1-02 (G) provides that outside of the established mixing zone, the maximum stream temperature rise "shall not exceed by more than five degrees fahrenheit (2.8 degrees centigrade) the water temperature which would occur if there were no temperature change of such waters attributable to human activities. In addition, at no time shall water temperature exceed the maximum temperatures indicated in the following table:"

Water		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
All Waters Except Ohio River	C°	10.0	10.0	15.6	21.1	26.7	32.2	32.2	32.2	32.2	25.6	21.1	13.9
	F°	50	50	60	70	80	90	90	90	90	78	70	57
Main Stem Ohio River	C°	10.0	10.0	15.6	21.1	26.7	30.6	31.7	31.7	30.6	25.6	21.1	13.9
	F°	50	50	60	70	80	87	89	89	87	78	70	57

Finally, it should be noted that EP-1-01 declares that:

"(A) Except as specified in subsection (B) below, all surface waters of the state are hereby classified as appropriate for warm water fisheries, for primary contact recreation, for processing by conventional treatment into public, industrial, and agricultural water supplies, and for such other uses as are identified for specific waters in subsequent sections of this Chapter, EP-1, of the Regulations of the Ohio EPA.

(B) The water quality standards set forth in this Chapter, EP-1, of the Regulations of the Ohio EPA, shall not apply in any of the following circumstances:

(1) whenever the flow falls below the annual minimum seven-day average flow that has a recurrence period of once-in-ten-years taking into account hydraulically altered flow regimes, calculated by the methods described in H. C. Riggs, Techniques of Water-Resources Investigation of the United States Geological Survey, Chapter B 1, Low-Flow Investigations (Washington, D. C., 1972).

(2) where a portion of a watercourse is determined to be a low-flow stream. The term "low-flow stream" means that portion of a watercourse where: (a) the total upstream drainage area is less than five square miles, and (b) less than 50 percent of the flow would be present if there were no point-source waste-water discharges for 15 percent

of any two consecutive year periods during the ten years preceding July 1, 1974.

Discharges to low-flow streams as described by this subsection, EP-1-01 (B)(2), commenced on or before July 1, 1974, will be required to either meet water quality standards or be treated by "the best available control technology economically achieveable" as defined by the Director of the Ohio Environmental Protection Agency or the Administrator of the United States Environmental Protection Agency under the Federal Water Pollution Control Act Amendments of 1972, whichever is less stringent; and water discharge permits for such discharges will contain effluent levels that would be reached by such treatment. The standards set forth in this Chapter, EP-1, of the Regulations of the Ohio EPA, shall apply to low-flow streams for discharges commenced after July 1, 1974. Such discharges shall not interfere with the attainment or maintenance of the water quality standards set forth in this Chapter."

Evaluation of the biological impact of the thermal effluent will be presented in Section V of this document.

C. Low Flow Model

Several attempts were made to model the near-field plume in the Ohio River resulting from the J. M. Stuart Station discharge. Two methods were used. The first was a graphical method based on techniques developed by Shirazi and Davis (1974). The second was based on a computer program developed by Motz & Benedict (1971). Neither model gave entirely satisfactory results. The lack of success is attributable to the limitations of current thermal modeling coupled with the complexity of the discharge conditions at the J. M. Stuart Station. Complete descriptions of the modeling efforts are included as an appendix to this report (WAPORA, 1976b).

The reasons why the various near-field modeling techniques were not entirely successful are several. First, current technology in near-field plume modeling is far from complete. Most existing plume models assume a discharge into an infinite receiving water. The J. M. Stuart Station discharges a relatively high velocity jet (3.54 feet per second) almost straight across a body of water about 2,000 feet wide. This means that the plume almost certainly would strike the opposite bank and be reflected back causing a pattern of interference with existing near-field models. This effect is most severe at low flow when the movement of the ambient water is not fast enough to deflect the plume in the downstream. The net effect of the boundary interference is to cause the plume to spread more rapidly than expected and to cause the velocity of the jet to decrease more rapidly than expected. This conclusion is borne out by the field studies conducted by WAPORA. Figure IV-24 shows the plume on September 20, 1976 curving downstream very sharply. In view of the fact that the cross current on that day was approximately 0.25 feet per second compared with a jet velocity over 3 feet per second, the sharp curvature can only be attributed to interference from the bank opposite the discharge. Note also on Figure IV-24 how the 25°C isotherm spreads sharply upstream. A second observable effect which occurred on September 20, 1976 is that the plume quickly mixes with the river water and forms a well mixed surface layer. This is observed ~~on~~ Figure IV-26. Notice especially on Figure IV-26 that the deepest part of the plume oscillates from side to side. This is also attributable to bank effects.

A second major limitation of plume models is that they assume a discharge into a relatively quiescent body of water. The water may be assumed to be flowing but it must be assumed that existing turbulence is slight compared to the turbulence along the edges of the plume due to the movement in the jet. On September 20, 1976 there was a high wind blowing almost straight up the centerline of the river causing one- to two-foot waves. This would tend to cause the plume to mix with the river water much more quickly than would be predicted with a plume model. Therefore, on a very windy day, such as occurred during the field study, the plume would be expected to spread quicker than predicted. For the above reasons the near-field modeling of the discharge is not reliable.

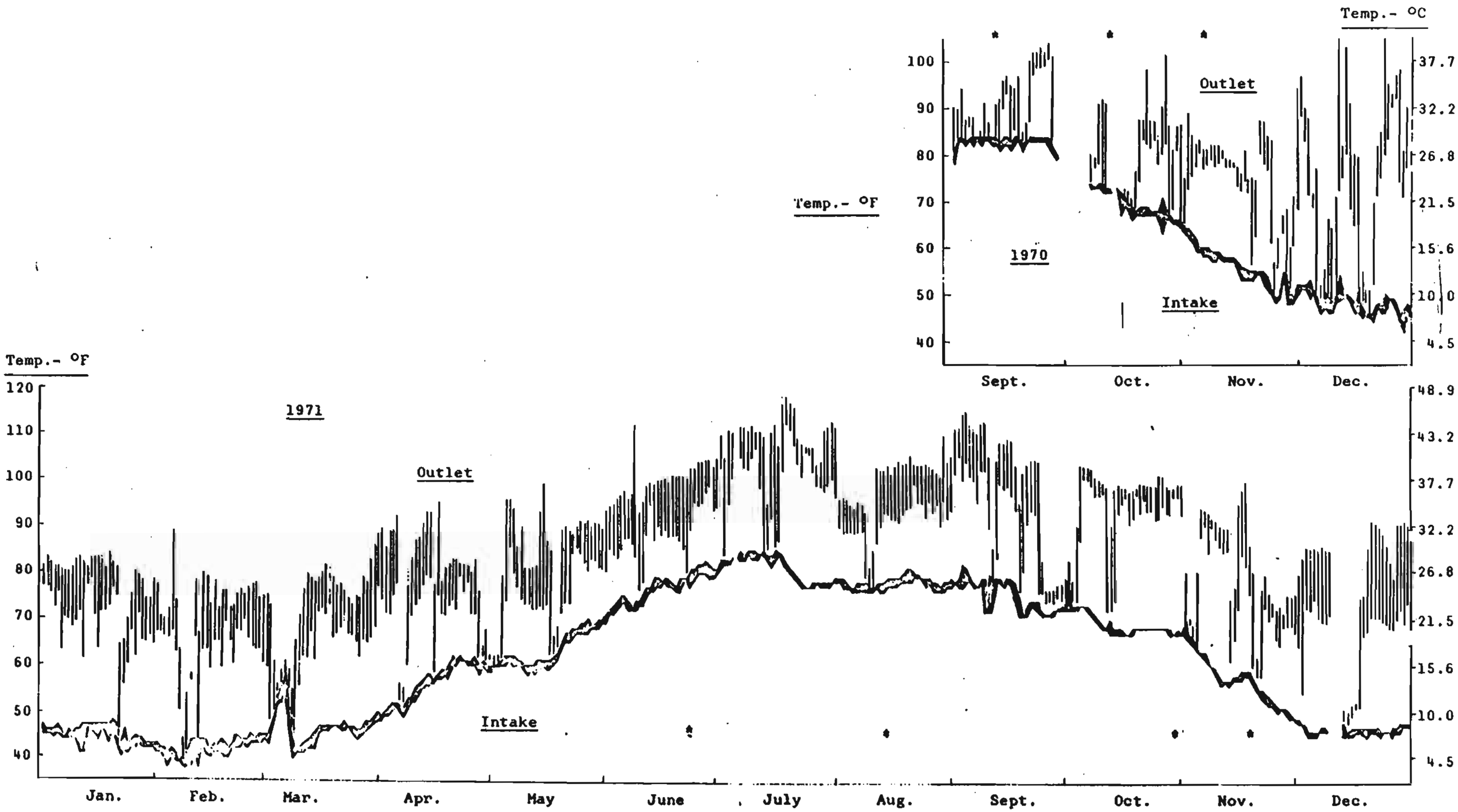
In view of the fact that the flow conditions on September 20, 1976 were very nearly 7-day, 10-year low flows, it would seem reasonable to assume that the plume at actual low flow would be very similar to that measured in the field. On September 20, 1976 a surface plume greater than 5°F ΔT was observed over an area of about 265 acres. This plume extended approximately 0.8 miles below the J. M. Stuart Station. The temperature rise through the station was about 19.8°F (11°C). Had all three units been operating the temperature rise would have been at least 23°F (12.8°C). Assuming that the plume area is roughly proportional to the ΔT, a plume area of approximately 308 acres would be expected. This plume would probably extend no deeper than the observed plume or seven feet deep. All of the surveys to date have shown that the heated water from the J. M. Stuart Station tends to remain within the top seven feet of the river once mixing has occurred (see Figures IV-13 to 21 and IV-25 to 27).

The far-field analysis of the J. M. Stuart Station discharge (WAPORA, 1976b) indicates that assuming extreme meteorological and hydrological conditions the maximum expected temperature rise would be 1.6°F thirty miles downstream at Mehldahl Dam. This assumes the concurrence of the 7-day, 10-year low flow in the river with a set of meteorological conditions having a frequency of occurrence greater than 10 years. This result would therefore be considered to be extremely conservative, as the field studies indicated the river is not usually heated more than 1°C (1.8°F) for more than three miles downstream.

TABLE IV-1 Gross generating load (MWH) for Units 1, 2, and 3 at the J. M. Stuart Station during thermal plume measurements July 22, 1976 (from The Dayton Power and Light Company).

	Unit		
Time	1	2	3
0800	402	367	400
0900	551	421	511
1000	596	433	598
1100	599	429	598
1200	570	428	599
1300	540	427	599
1400	563	425	-
1500	578	425	344
1600	577	426	559
1700	581	425	577
1800	581	411	577

FIGURE IV-1 Daily range in condenser inlet and outlet temperatures at the J. M. Stuart Station, 1970 and 1971 (* = fish collection period) (from Norris and Gammon, no date).



Temp.- °C
Temp.- °F
Outlet
1970
Intake
100
90
80
70
60
50
40
37.7
32.2
26.8
21.5
15.6
10.0
4.5
Sept.
Oct.
Nov.
Dec.
Temp.- °F
1971
Outlet
Intake
120
110
100
90
80
70
60
50
40
48.9
43.2
37.7
32.2
26.8
21.5
15.6
10.0
4.5
Jan.
Feb.
Mar.
Apr.
May
June
July
Aug.
Sept.
Oct.
Nov.
Dec.

FIGURE IV-1

FIGURE IV-2 Thermal plume isotherms (ΔT : °F) observed at the J. M. Stuart Station, August 18, 1970 (from Norris and Gammon, no date).

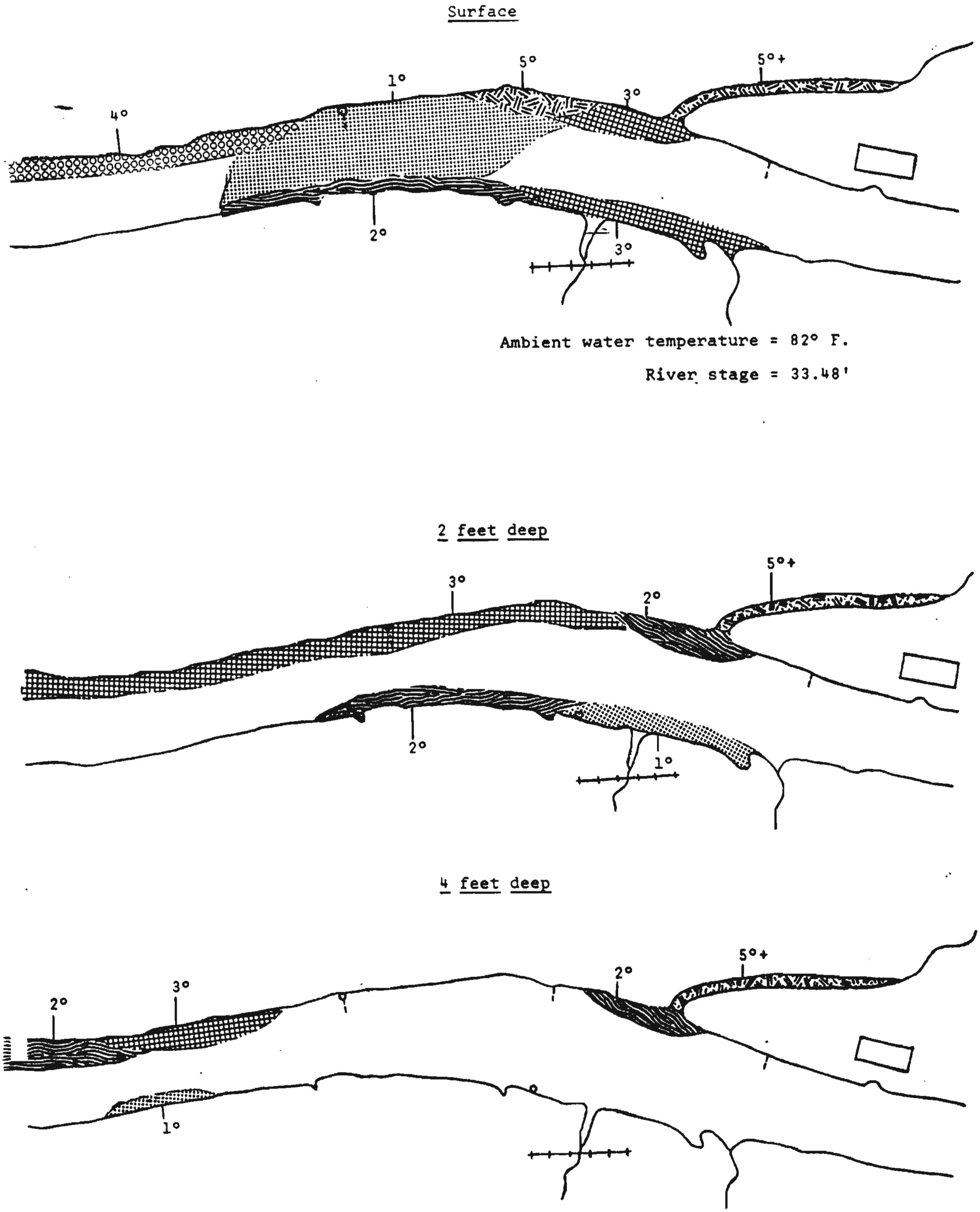
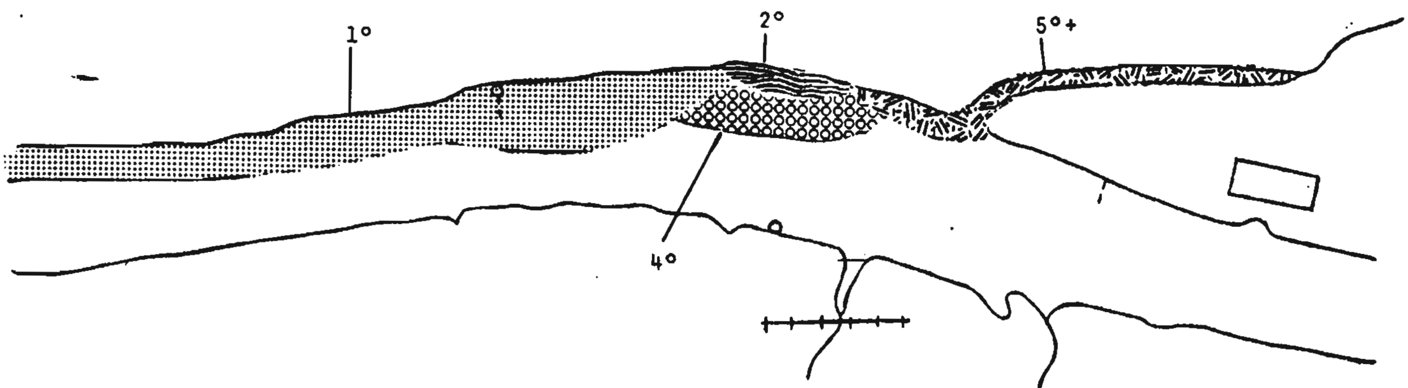

Surface
5°
5°+
1°
3°
4°
2°
3°
Ambient water temperature = 82° F.
River stage = 33.48'
2 feet deep
5°+
3°
2°
2°
1°
4 feet deep
5°+
2°
3°
2°
1°

FIGURE IV-2

FIGURE IV-3 Thermal plume isotherms (ΔT : °F) observed at the J. M. Stuart Station, November 12, 1970 (Ave. Load = 580 MW; Ohio River flow = 95,000 cfs) (from Norris and Gammon, no date).

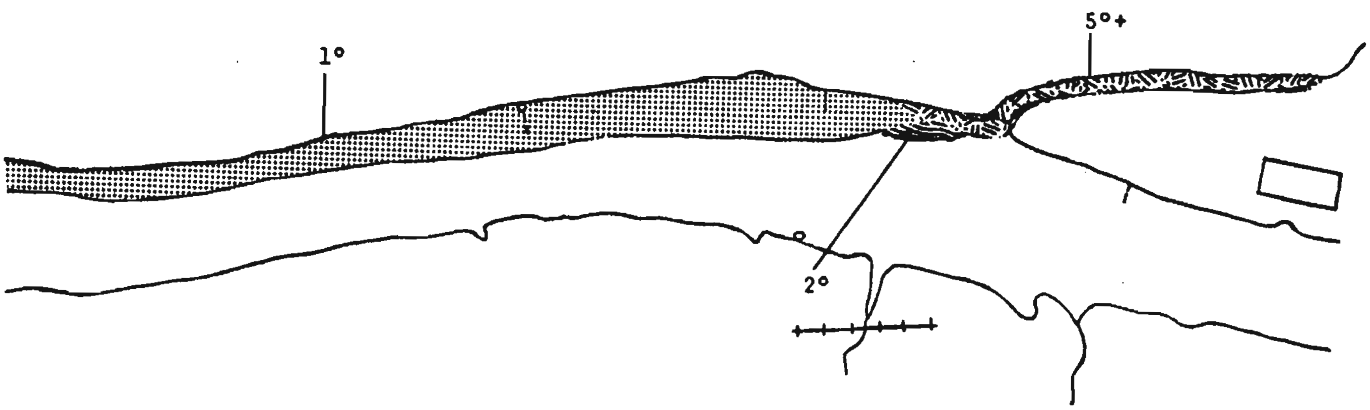
Surface



Ambient water temperature = 55° F.

River stage = 34.07'

2 feet deep



4 feet deep

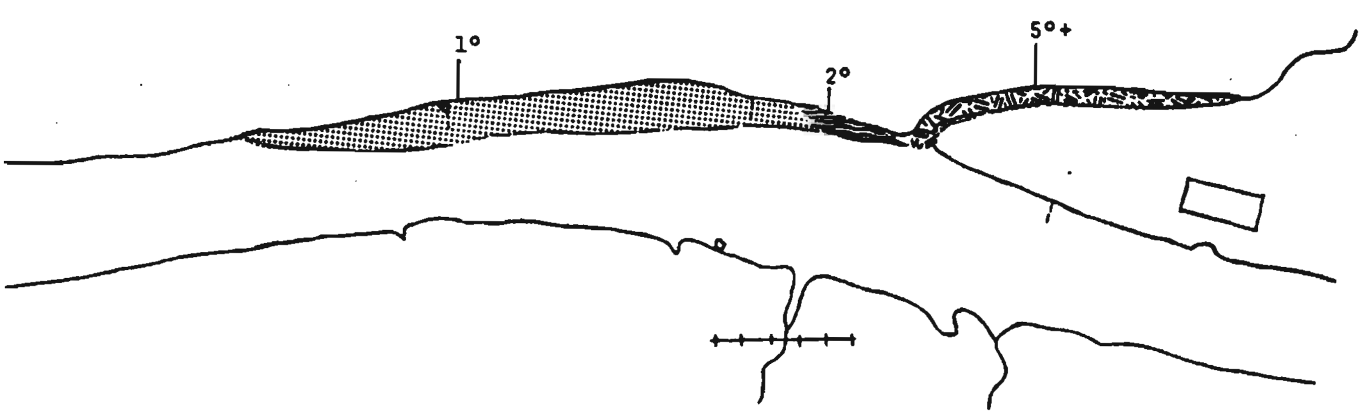


FIGURE IV-3

FIGURE IV-4 Thermal plume isotherms (ΔT : °F) observed at the J. M. Stuart Station, June 16, 1971 (Average Load = 1180 MW; see text for consideration of Ohio River flow) (from Norris and Gammon, no date).

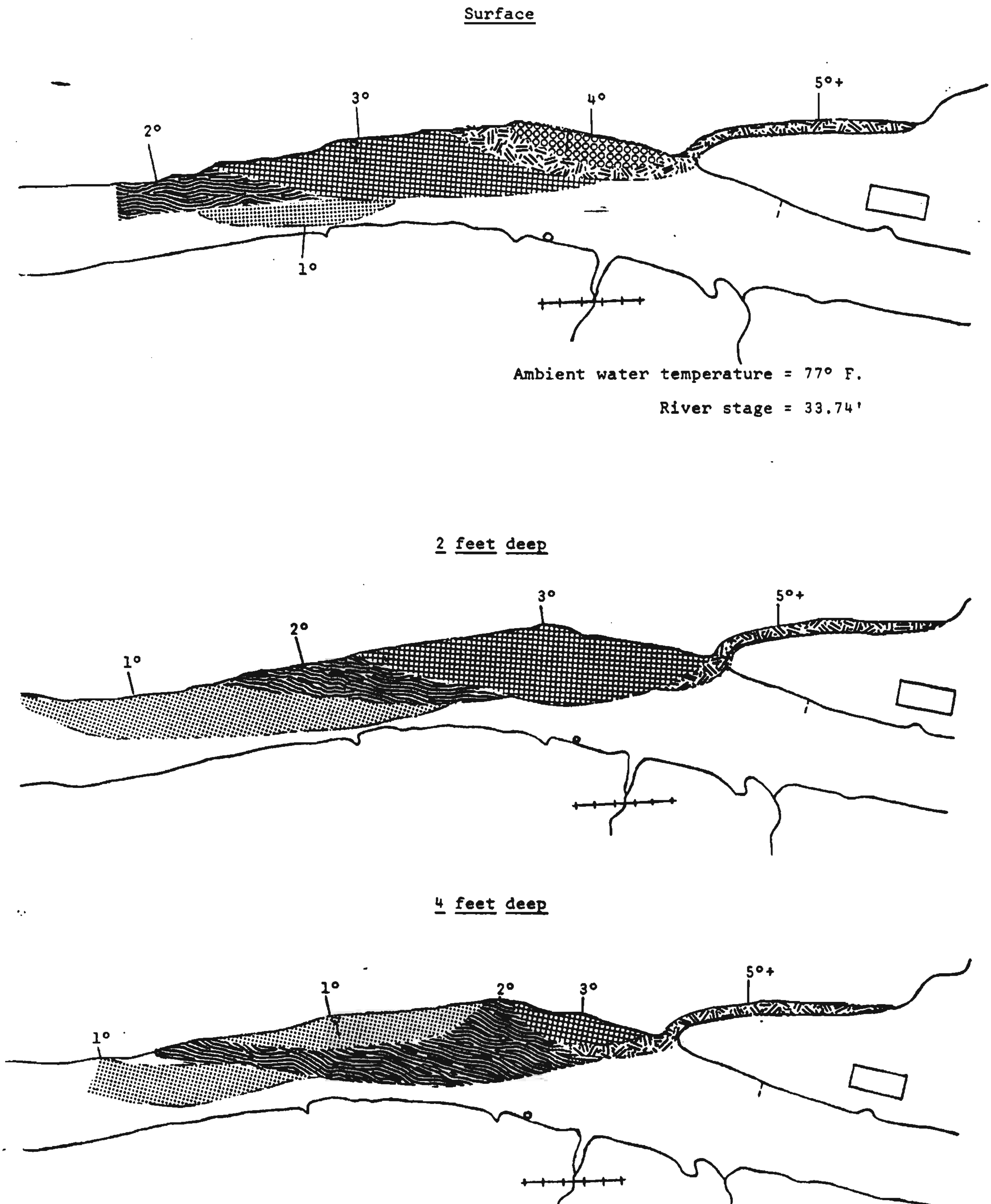

Surface
2°
3°
4°
5°+
1°
Ambient water temperature = 77° F.
River stage = 33.74'
2 feet deep
1°
2°
3°
5°+
4 feet deep
1°
1°
2°
3°
5°+

FIGURE IV-4

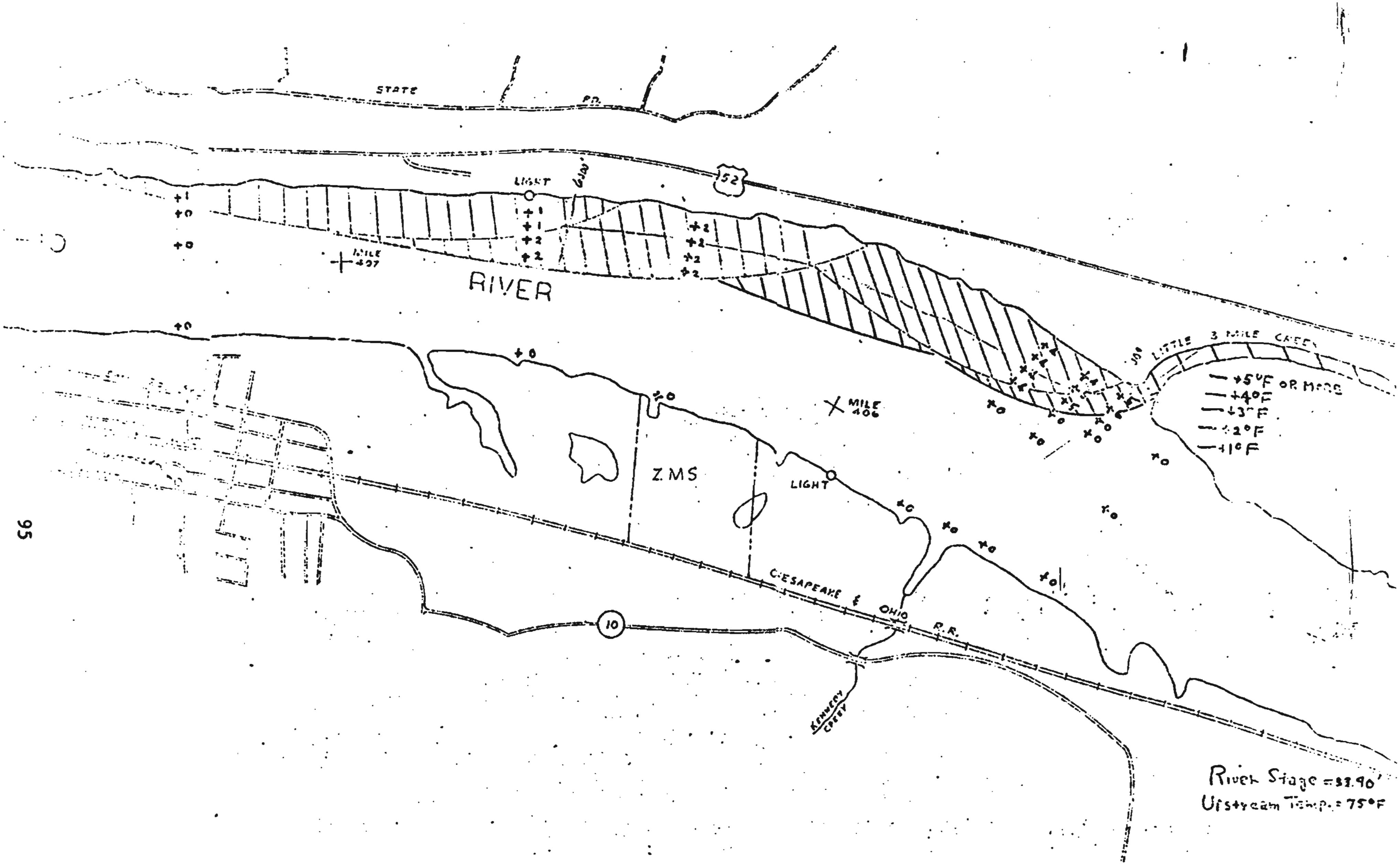


FIGURE IV-5 Surface isotherms (ΔT : °F) in the Ohio River at the J. M. Stuart Station, June 22, 1972 (from The Dayton Power and Light Company).

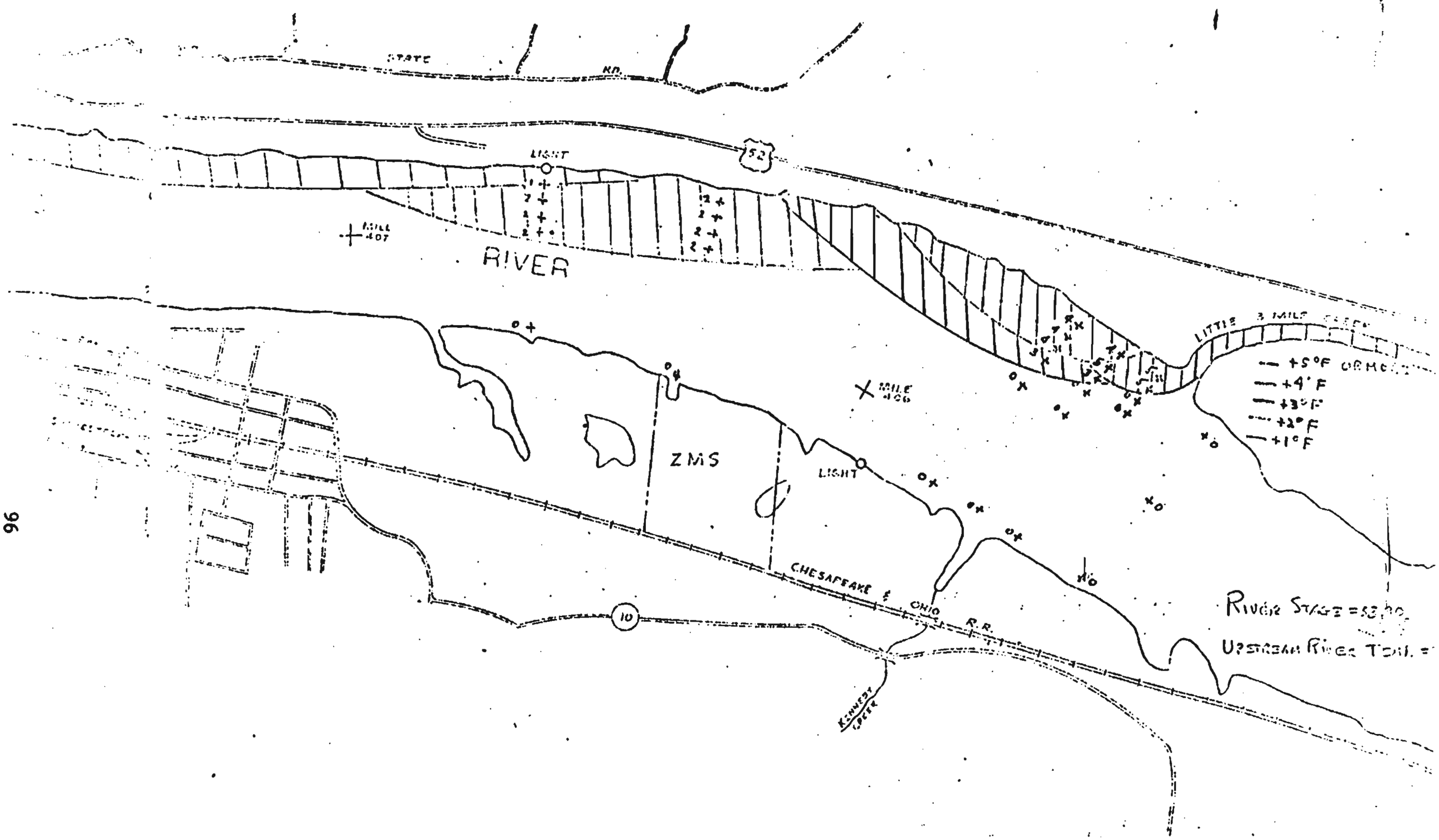


FIGURE IV-6 Two foot depth isotherms (ΔT : °F) in the Ohio River at the J. M. Stuart Station, June 22, 1972 (from The Dayton Power and Light Company).

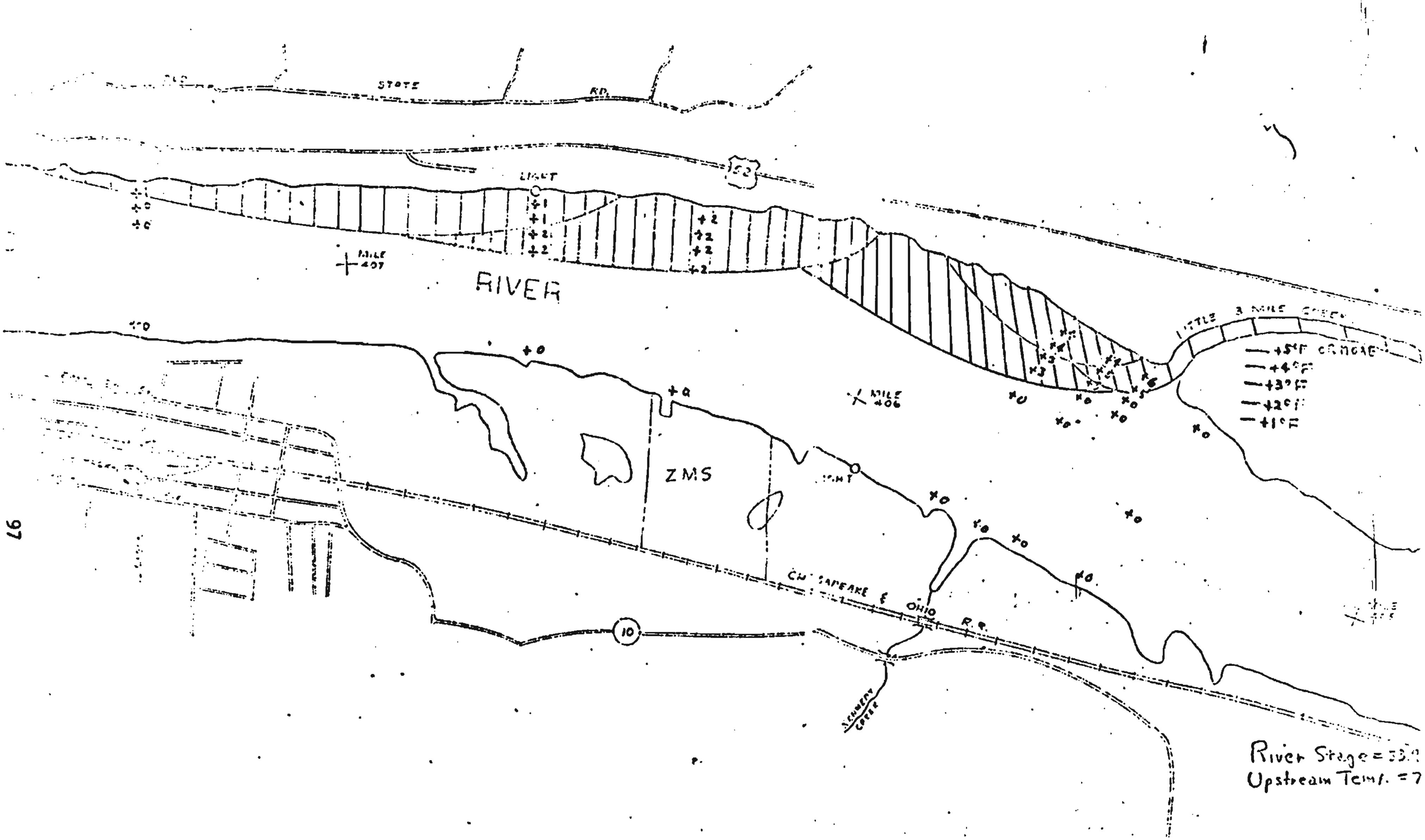


FIGURE IV-7 Four foot depth isotherms (ΔT : °F) in the Ohio River at the J. M. Stuart Station, June 22, 1976 (from The Dayton Power and Light Company).

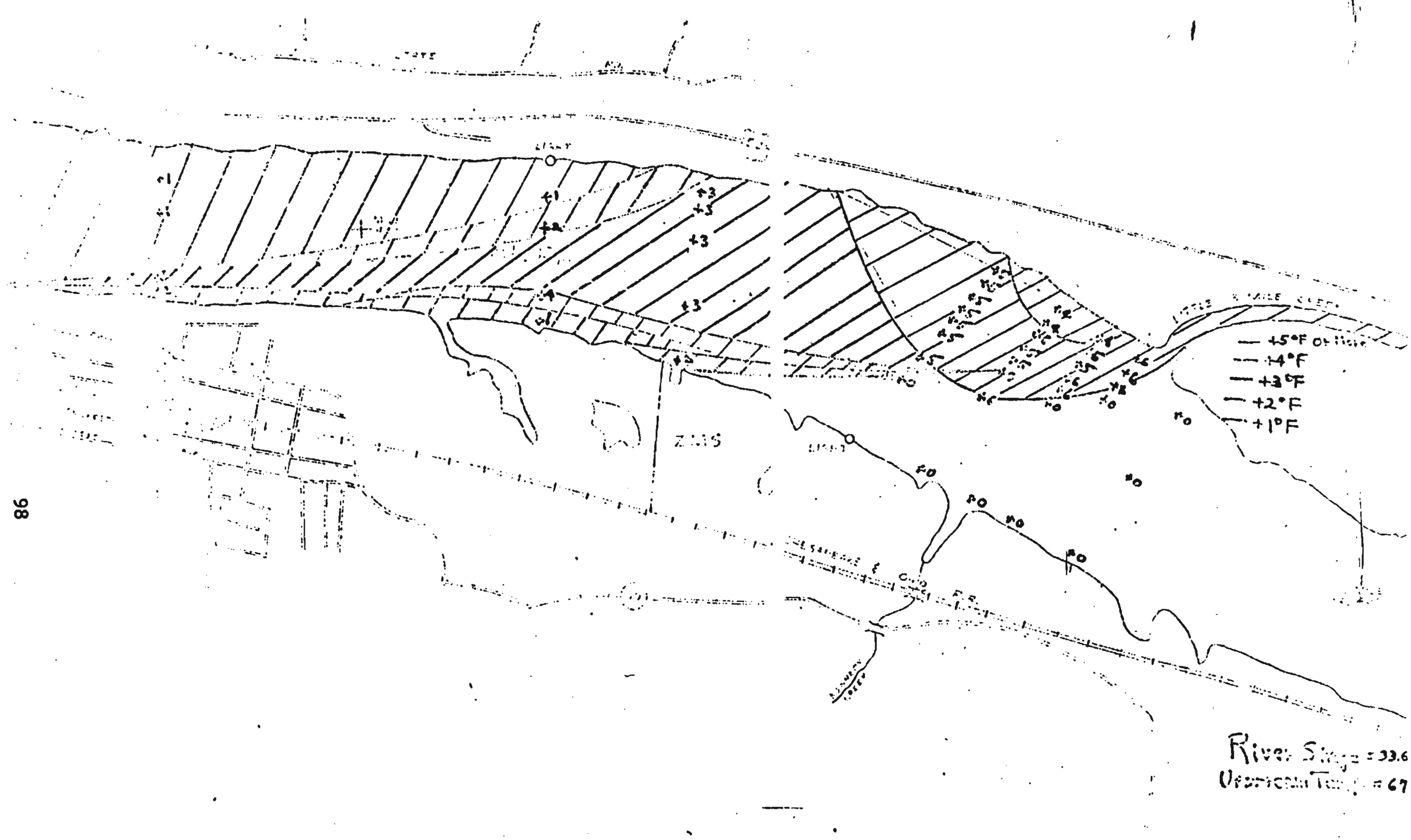


FIGURE IV-8 Surface isotherms (ΔT : °F) in the Ohio River at the J. M. Stuart Station, October 11, 1972 (from The Dayton Power and Light Company).

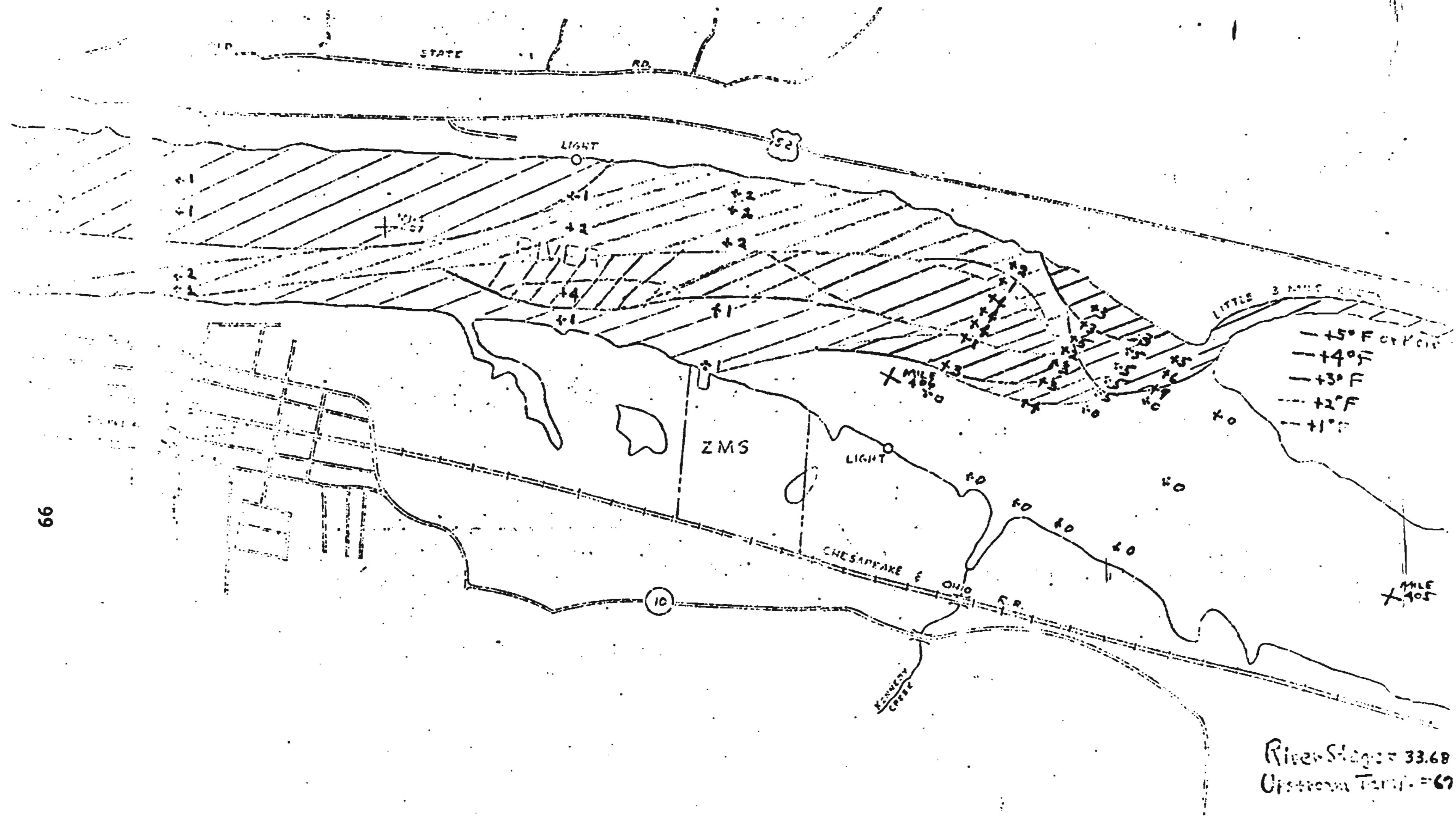


FIGURE IV-9 Two foot isotherms (ΔT : °F) in the Ohio River at the J. M. Stuart Station, October 11, 1972 (from The Dayton Power and Light Company).

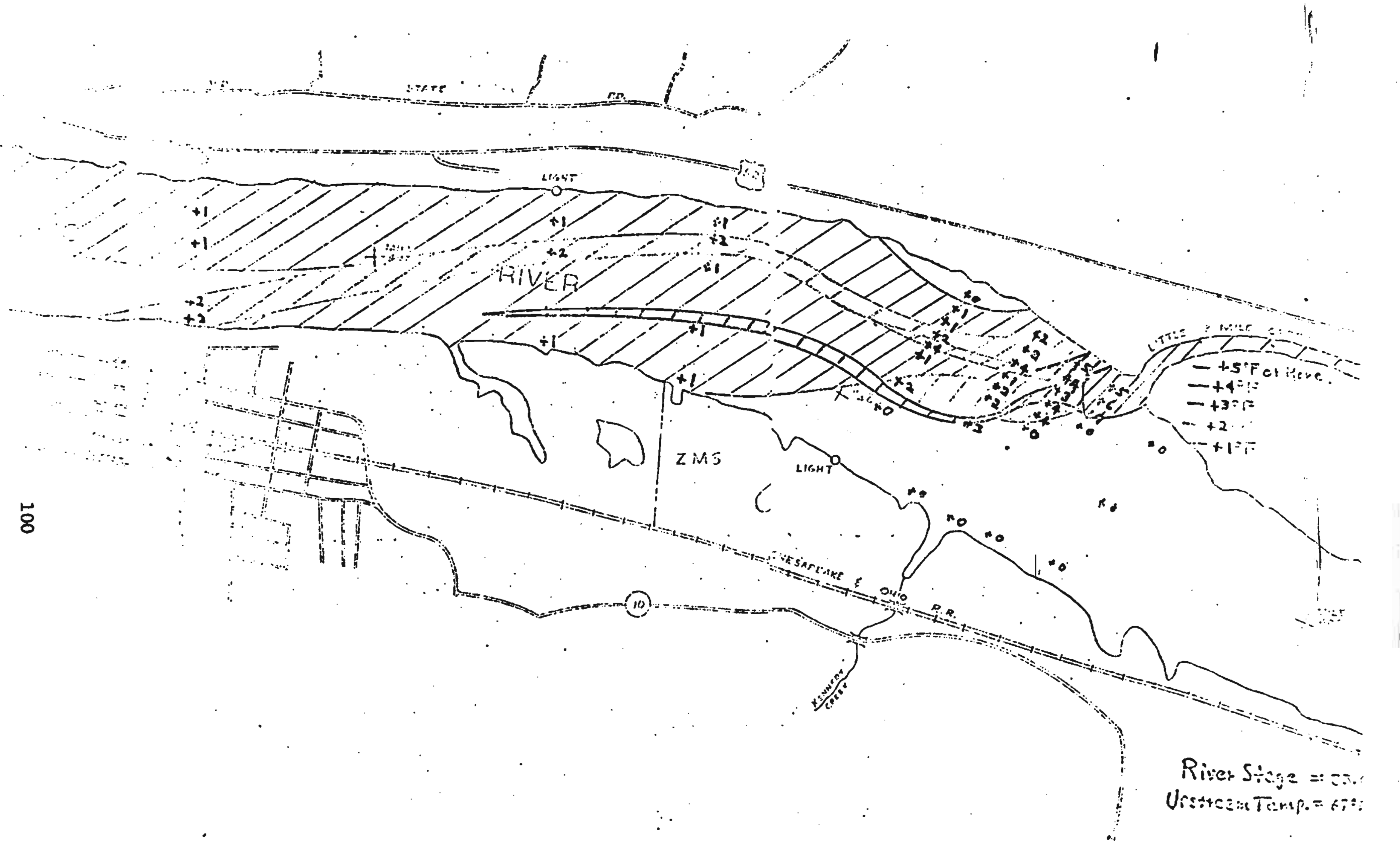


FIGURE IV-10 Four foot depth isotherms (ΔT : °F) in the Ohio River at the J. M. Stuart Station, October 11, 1972 (from The Dayton Power and Light Company).

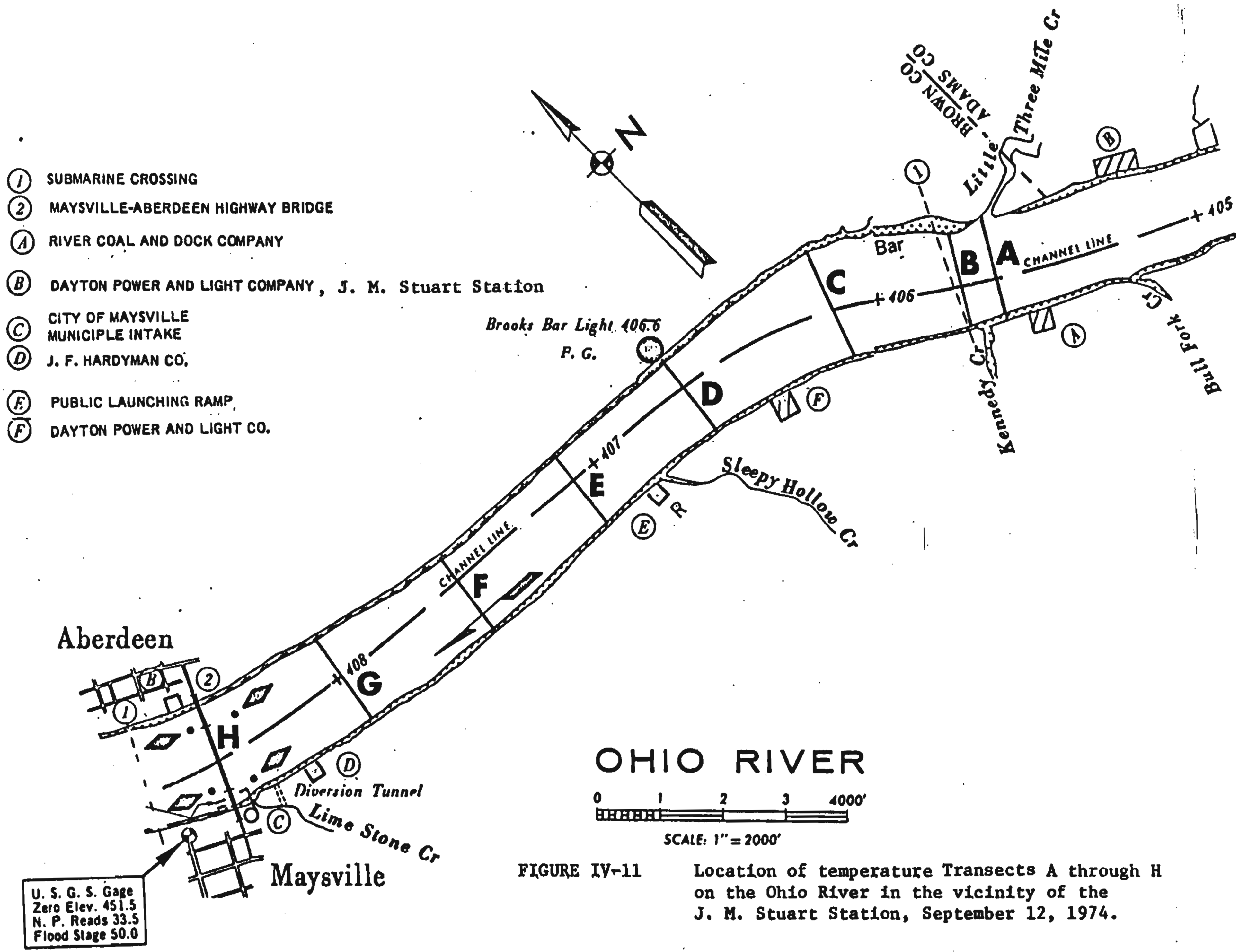


FIGURE IV-11 Location of temperature Transects A through H on the Ohio River in the vicinity of the J. M. Stuart Station, September 12, 1974.

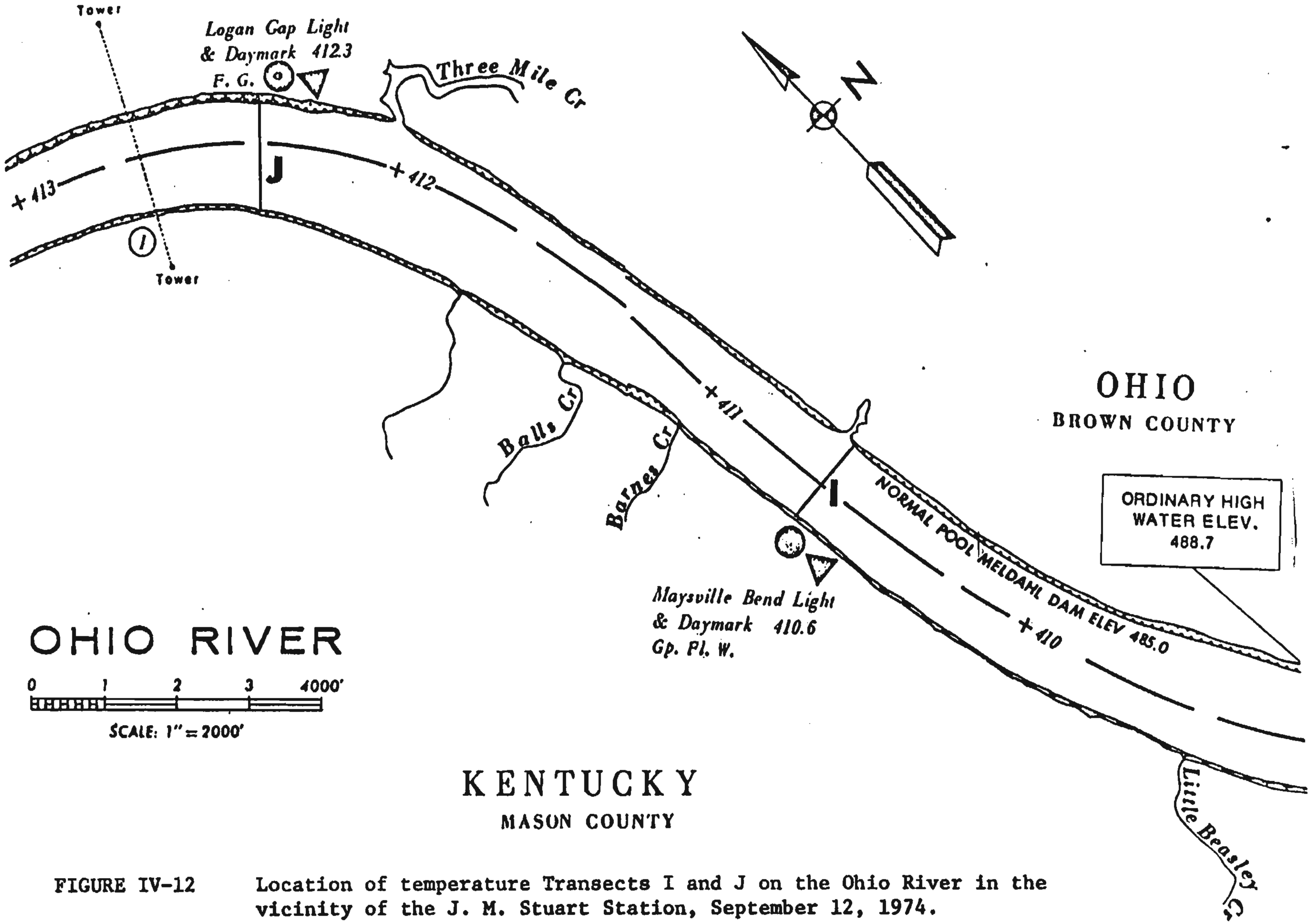


FIGURE IV-12 Location of temperature Transects I and J on the Ohio River in the vicinity of the J. M. Stuart Station, September 12, 1974.

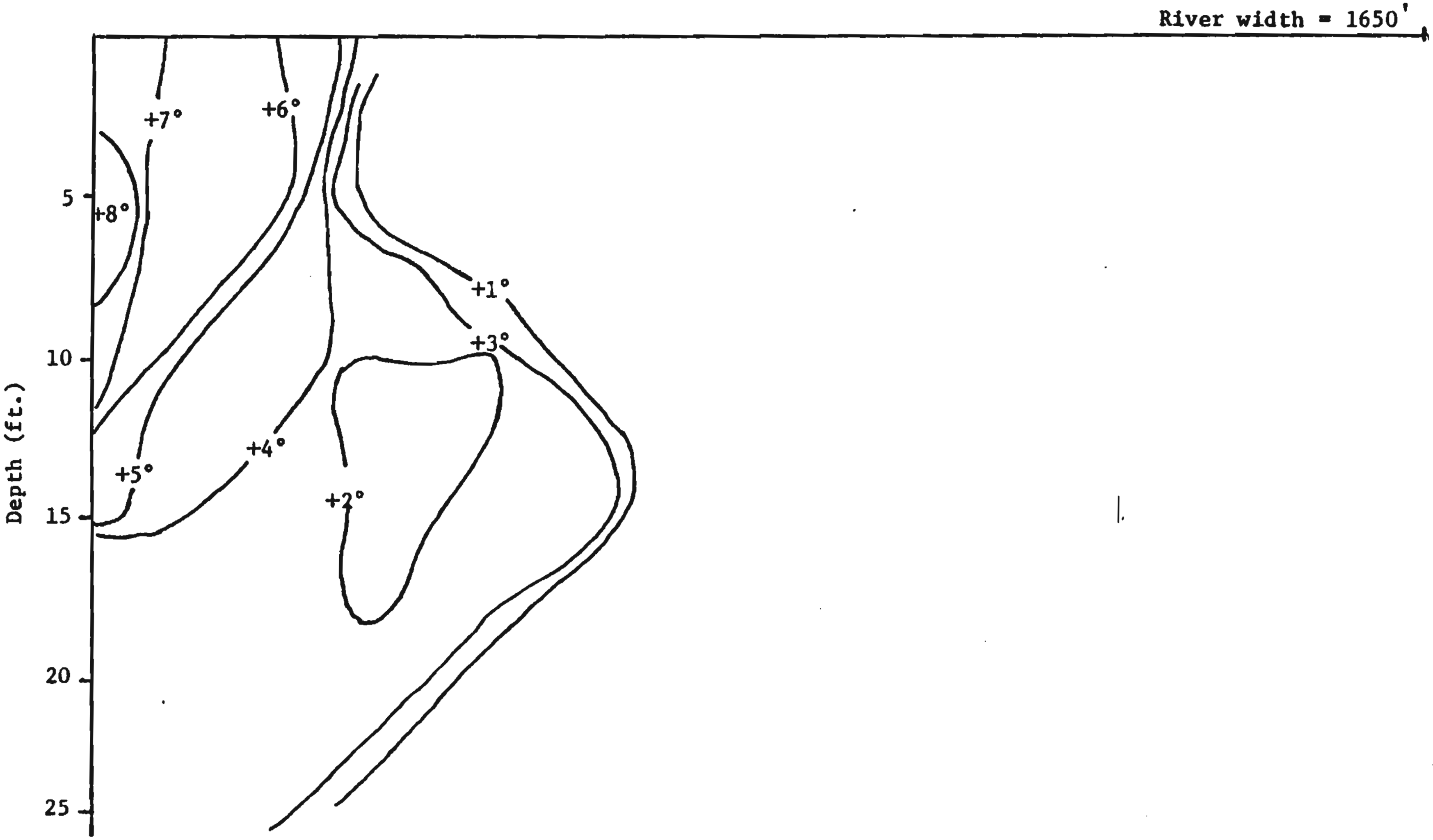


FIGURE IV-13 Cross section of Transect A, ΔT (°C) isotherms, September 12, 1974.

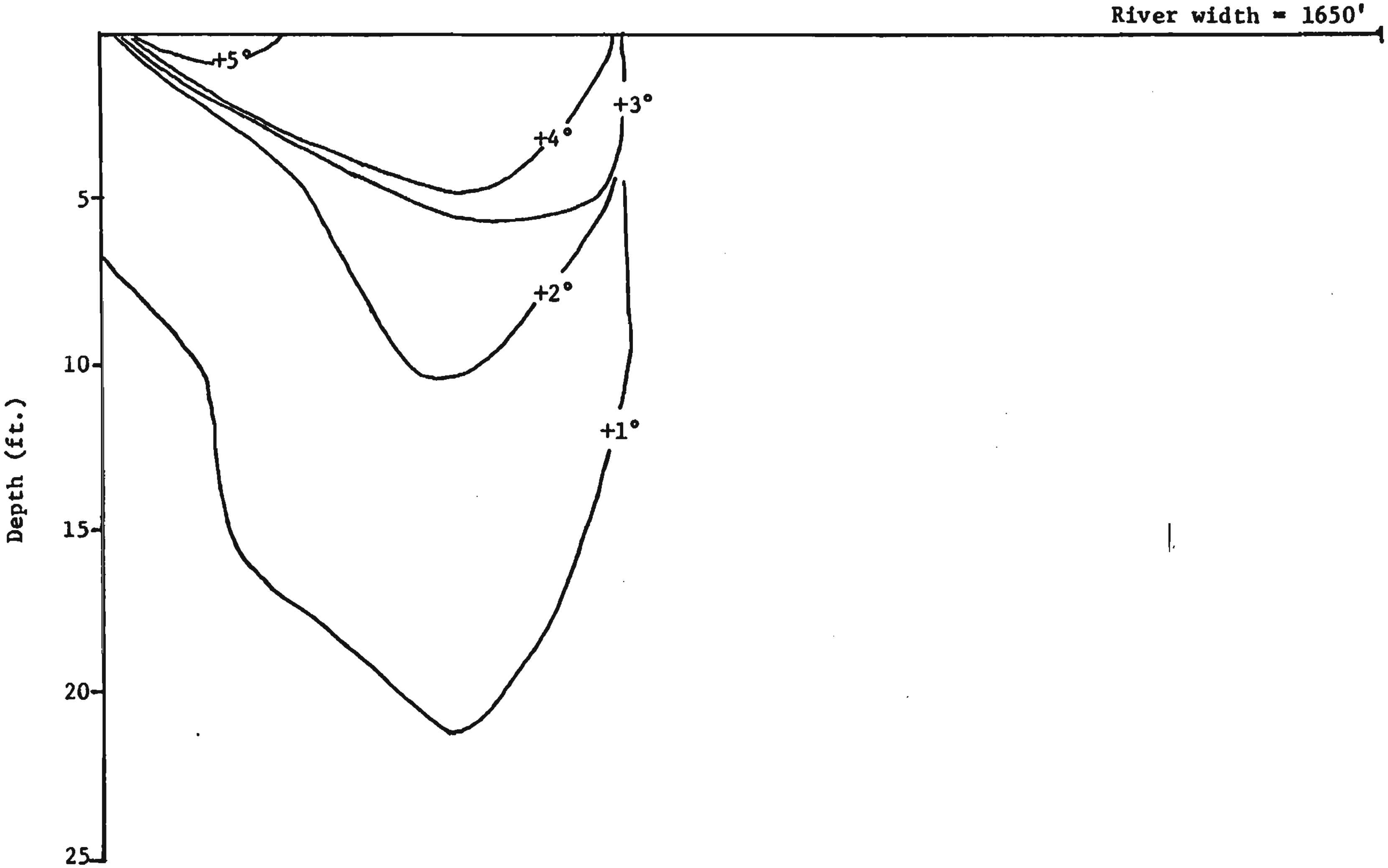


FIGURE IV-14 Cross section of Transect B, ΔT (°C) isotherms, September 12, 1974.

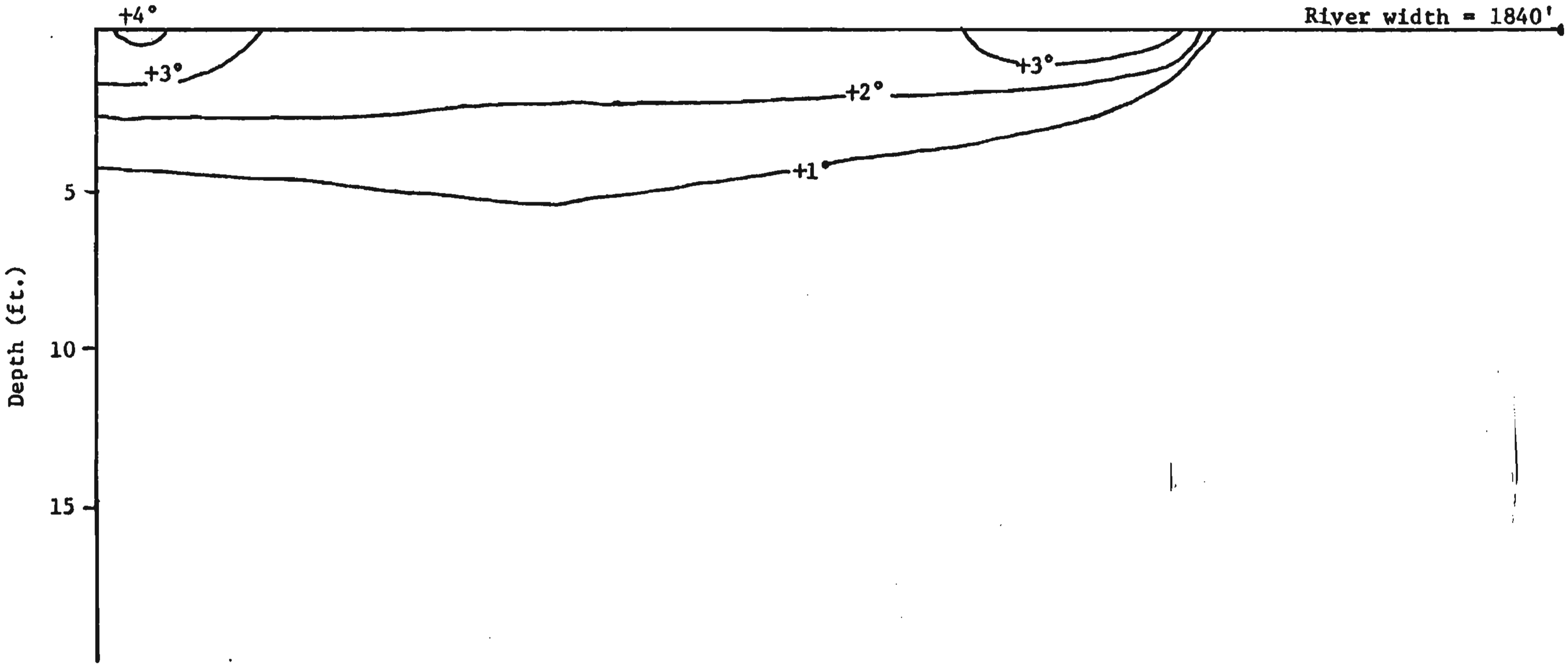


FIGURE IV-15 Cross section of Transect C, ΔT (°C) isotherms, September 12, 1974.

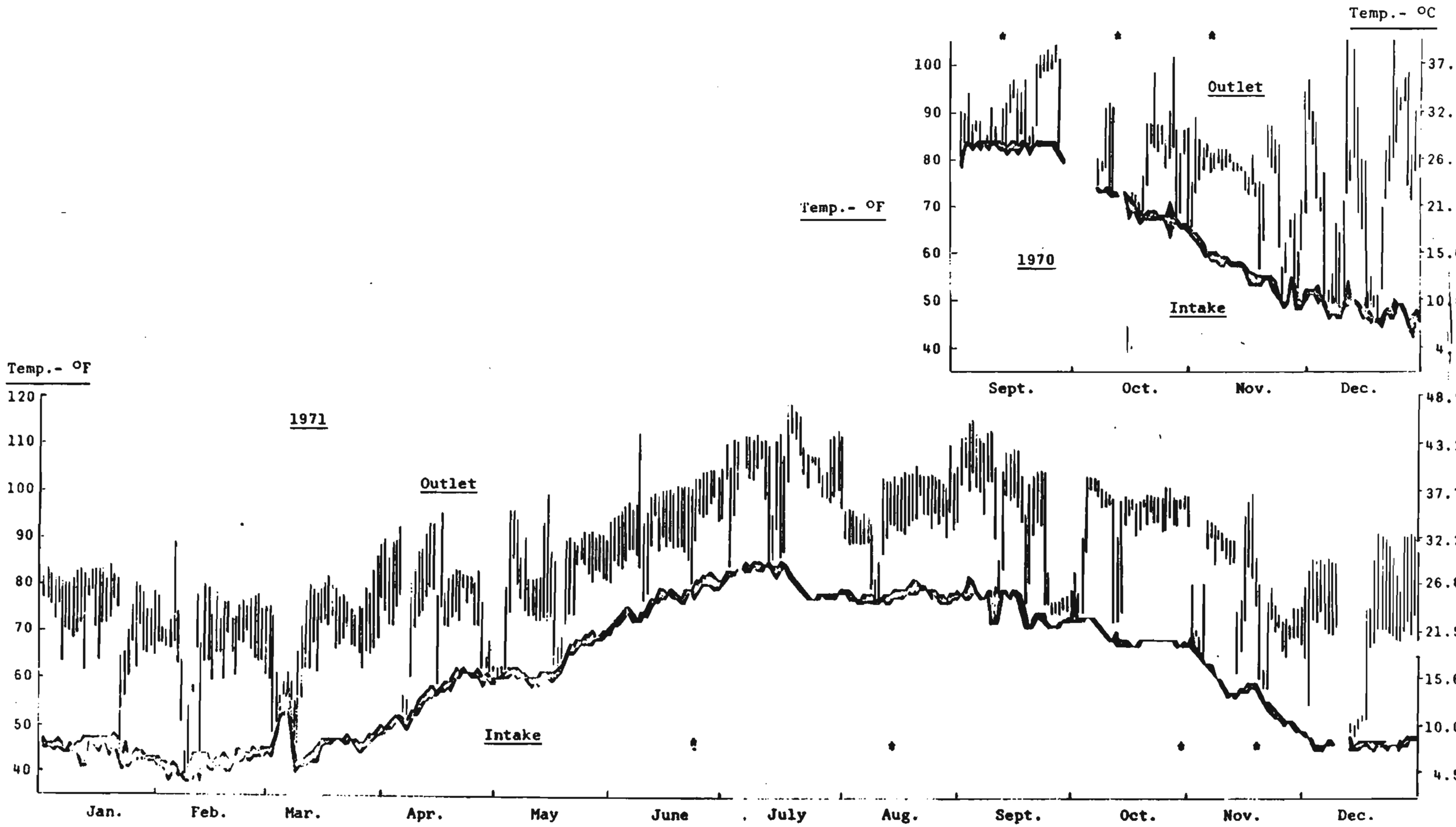

Temp.- °C
100
90
80
70
60
50
40
37.7
32.2
26.8
21.5
15.6
10.0
4.5
Outlet
Temp.- °F
1970
Intake
Sept.
Oct.
Nov.
Dec.
Temp.- °F
120
110
100
90
80
70
60
50
40
1971
Outlet
Intake
48.9
43.2
37.7
32.2
26.8
21.5
15.6
10.0
4.5
Jan.
Feb.
Mar.
Apr.
May
June
July
Aug.
Sept.
Oct.
Nov.
Dec.

FIGURE IV-1

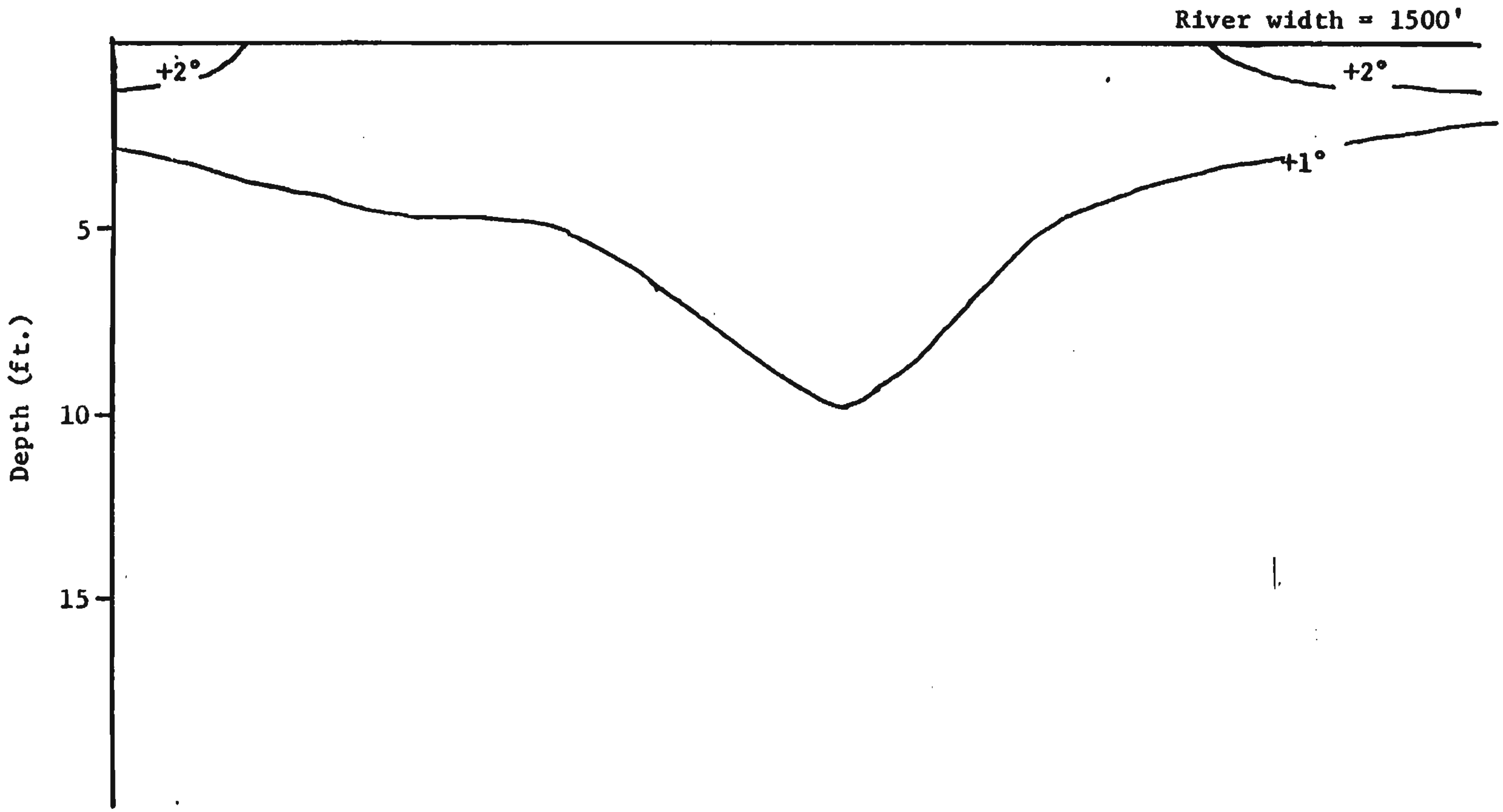


FIGURE IV-16   Cross section of Transect D, ΔT (°C) isotherms, September 12, 1976.

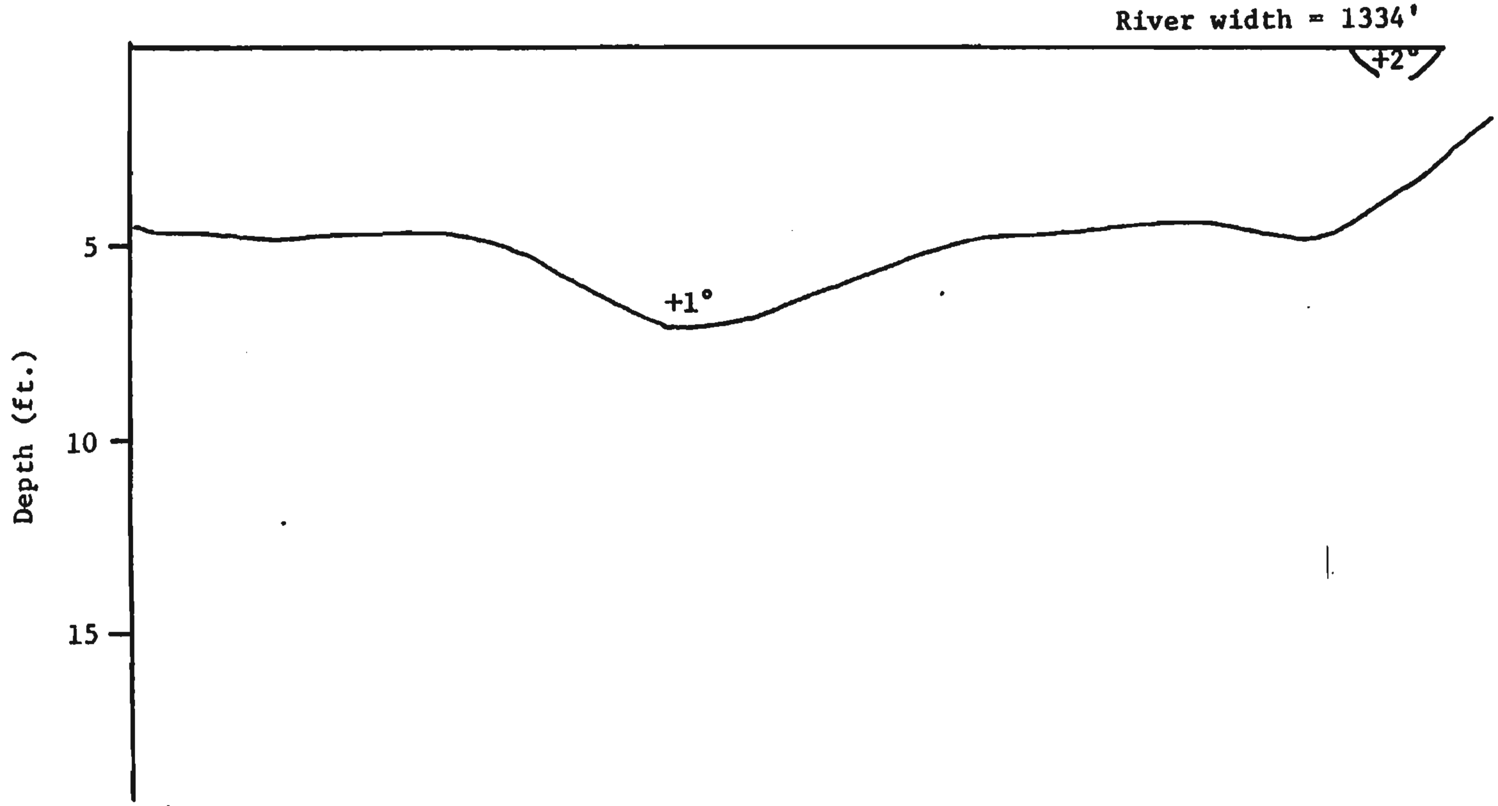


FIGURE IV-17 Cross section of Transect E, ΔT (°C) isotherms, September 12. 1974.

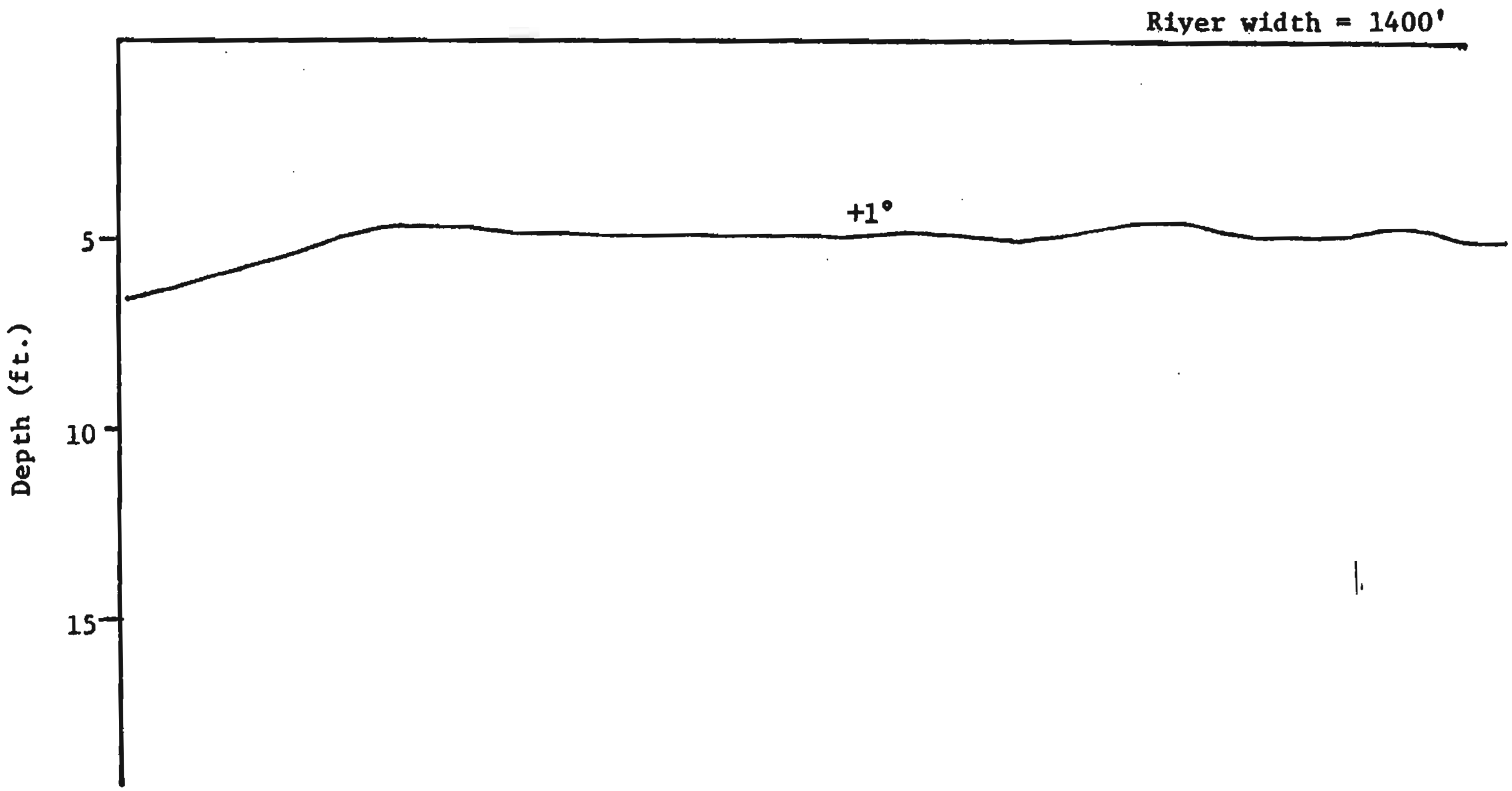


FIGURE IV-18 Cross section of Transect F, ΔT (°C) isotherms, September 12, 1974.

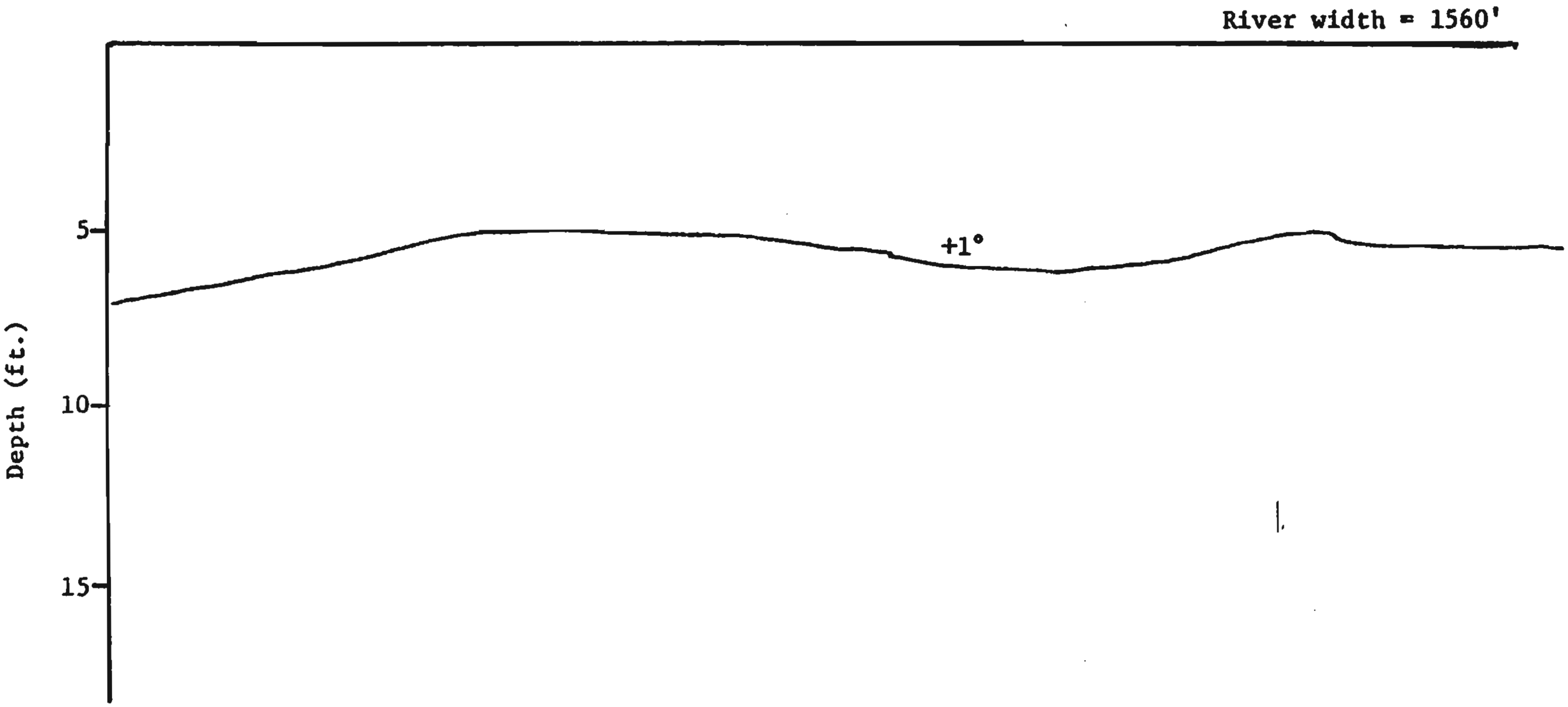


FIGURE IV-19 Cross section of Transect G, ΔT (°C) isotherms, September 12, 1974.

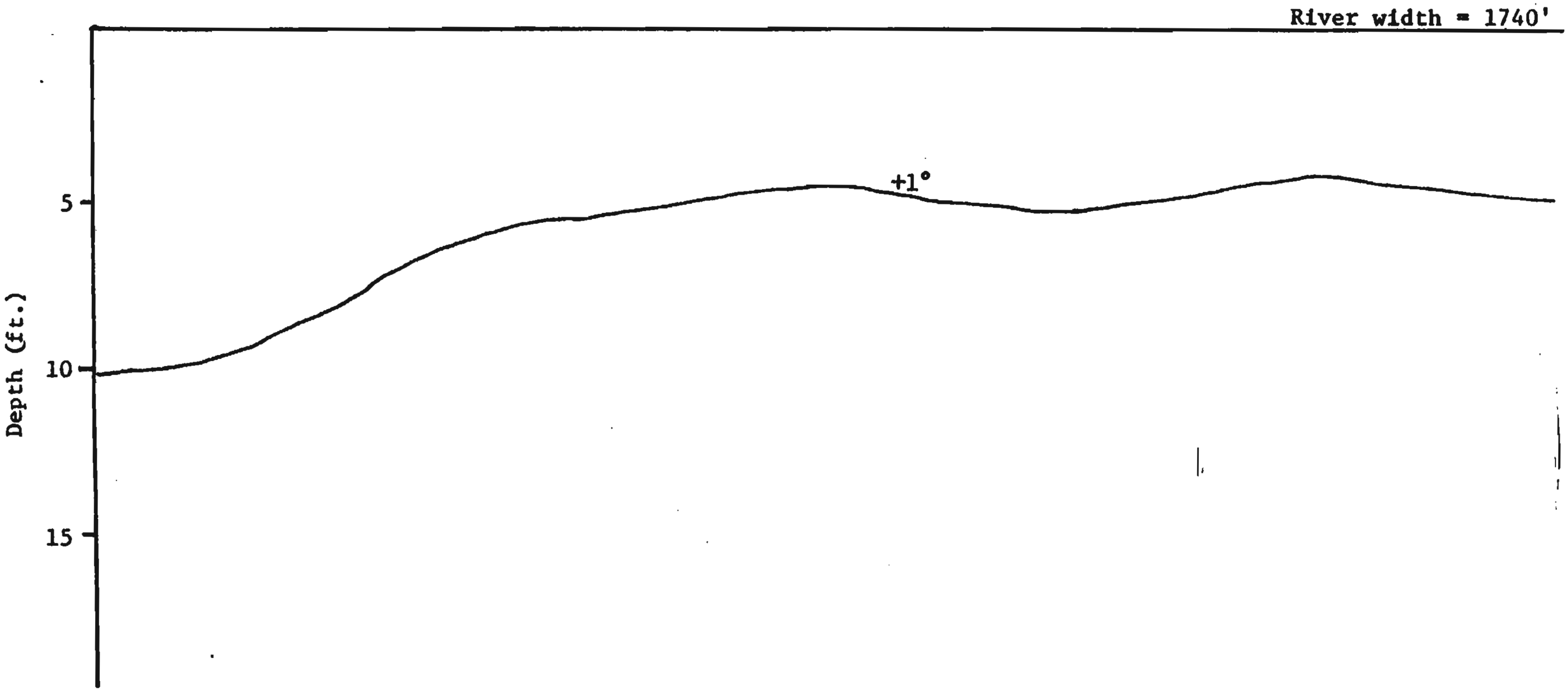


FIGURE IV-20 Cross section of Transect H, ΔT (°C) isotherms, September 12, 1974.

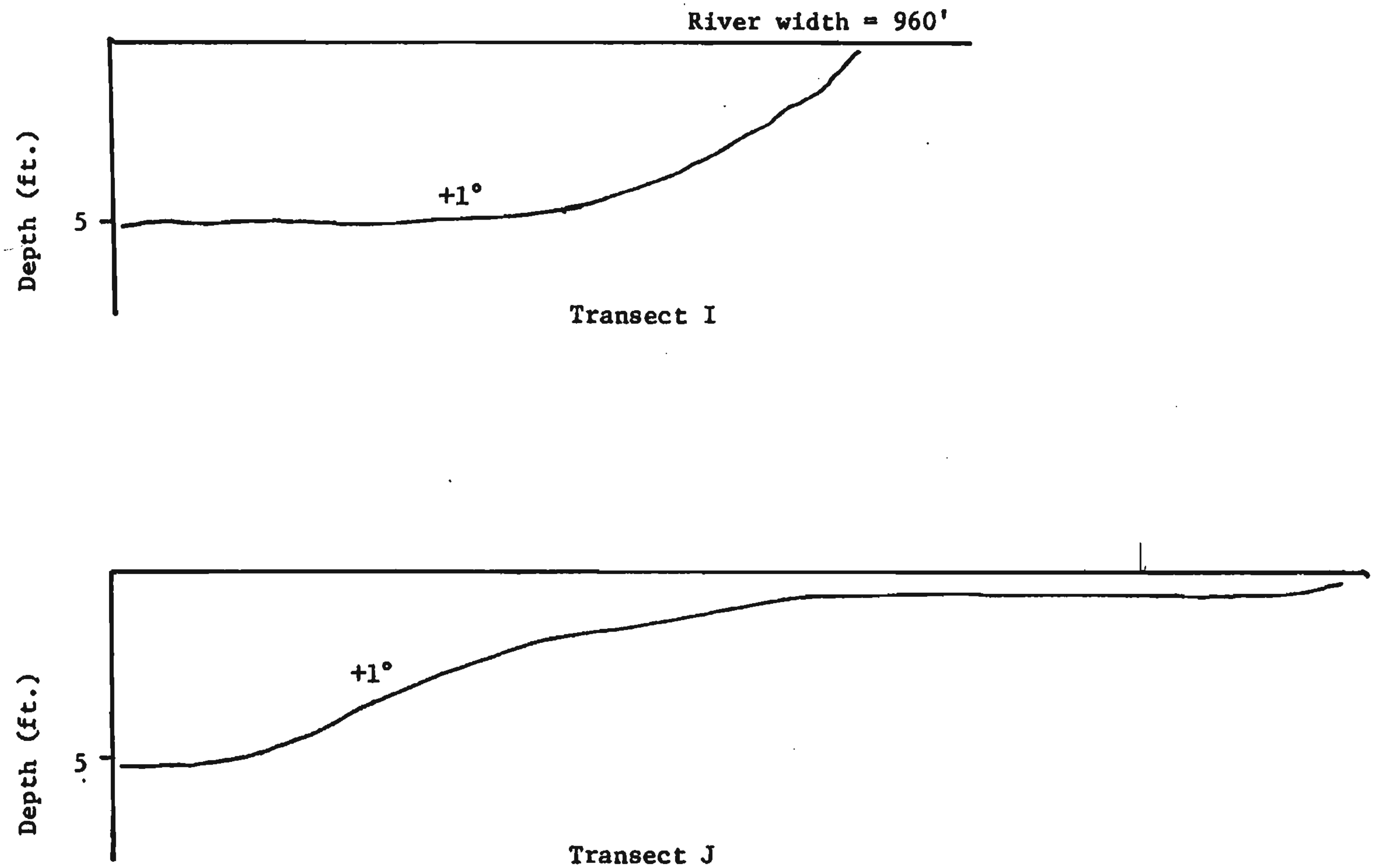


FIGURE IV-21 Cross sections of Transects I and J, ΔT (°C) isotherms, September 12, 1974.

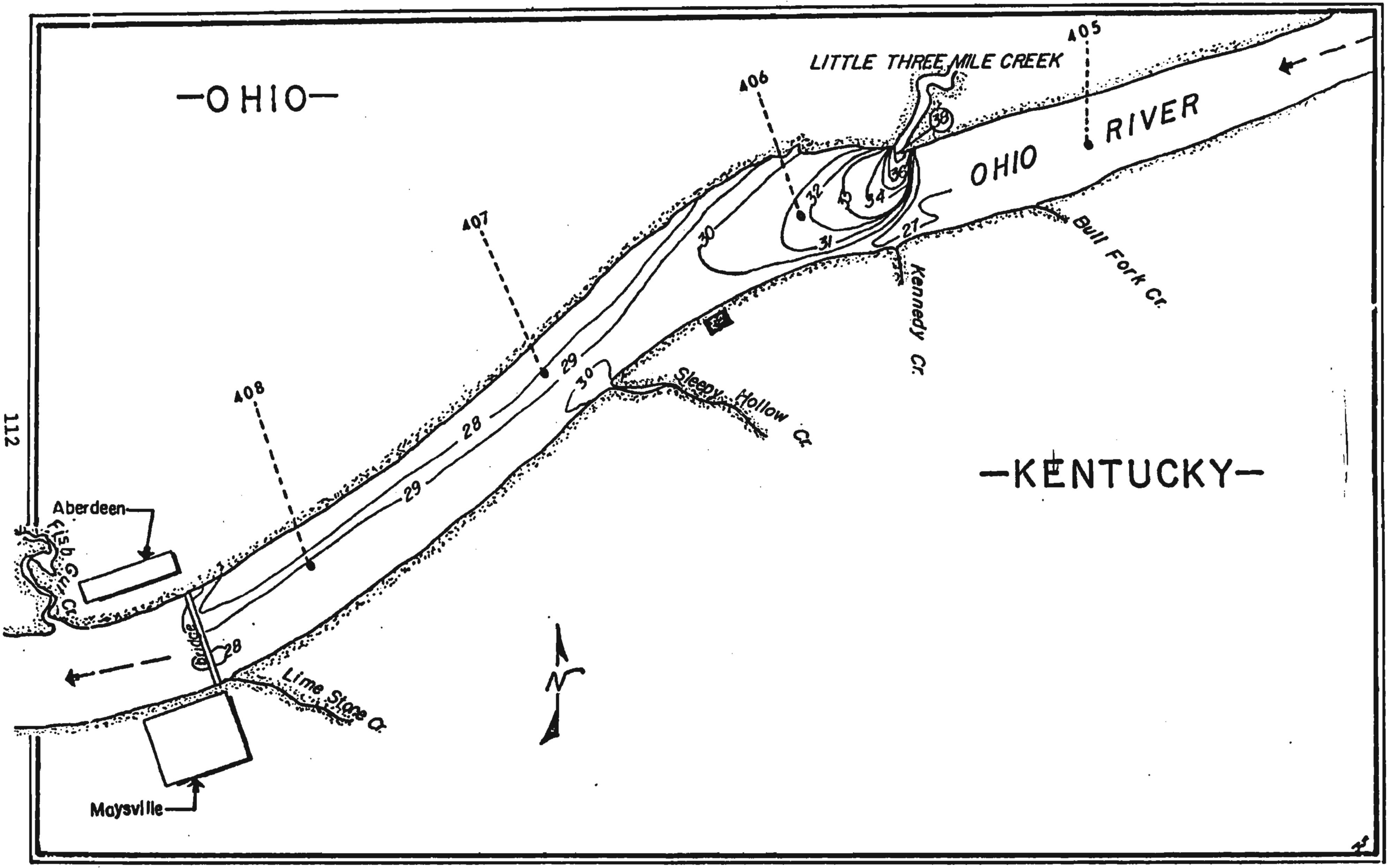


FIGURE IV-22 Surface temperatures (°C) of the thermal plume at the J. M. Stuart Station, July 22, 1976.

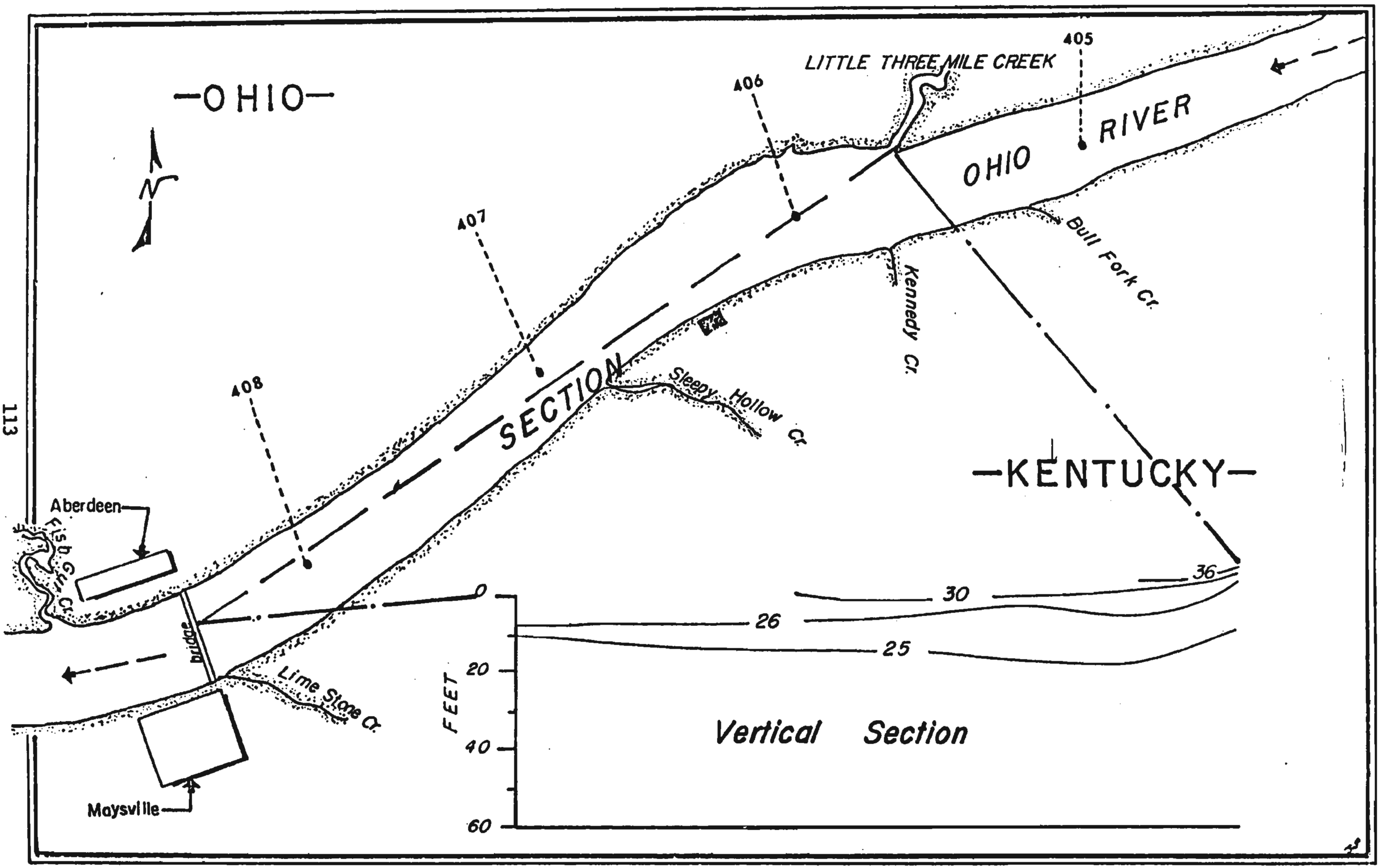


FIGURE IV-23 Longitudinal profile of thermal plume (°C) at the J. M. Stuart Station, July 22, 1976.

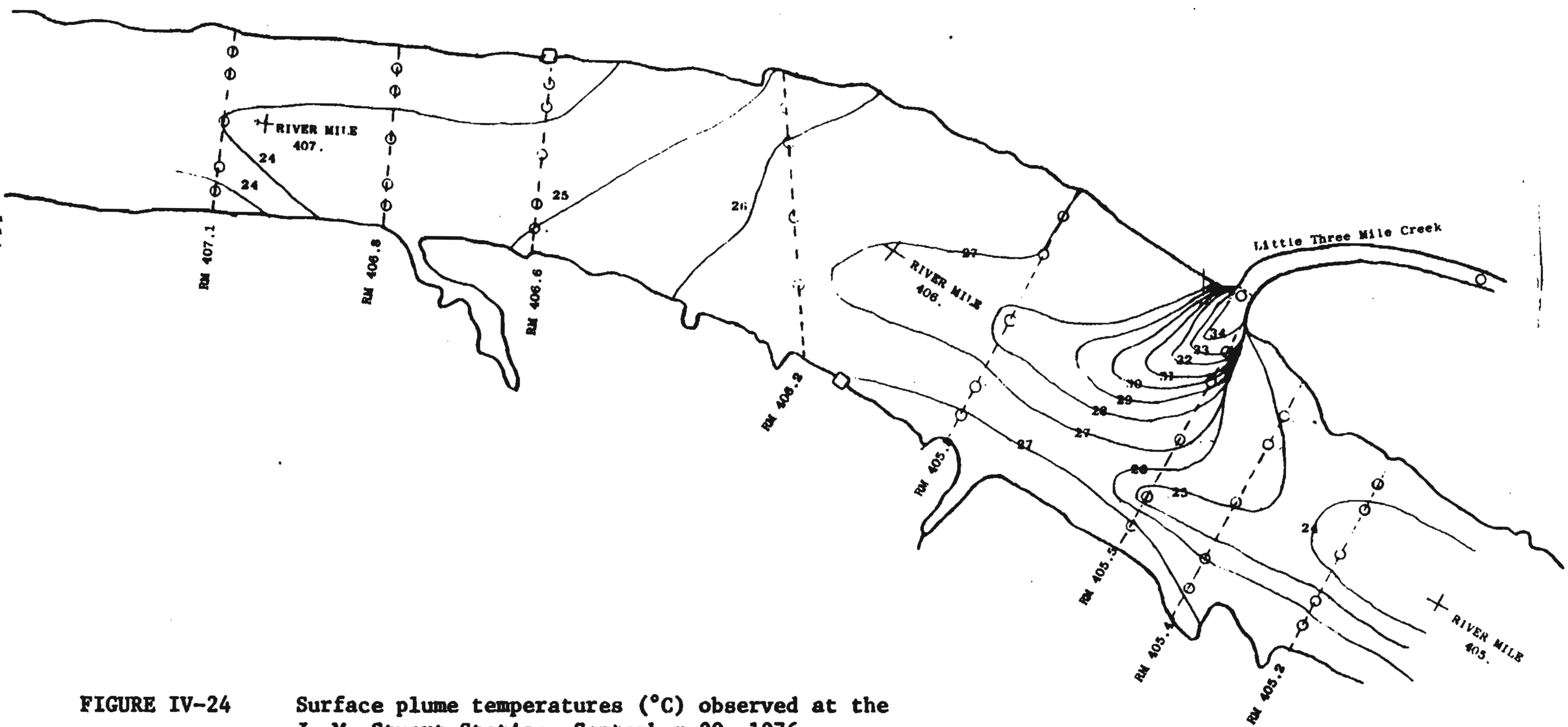


FIGURE IV-24 Surface plume temperatures (°C) observed at the J. M. Stuart Station, September 20, 1976 (0 = stations where measurements were taken).

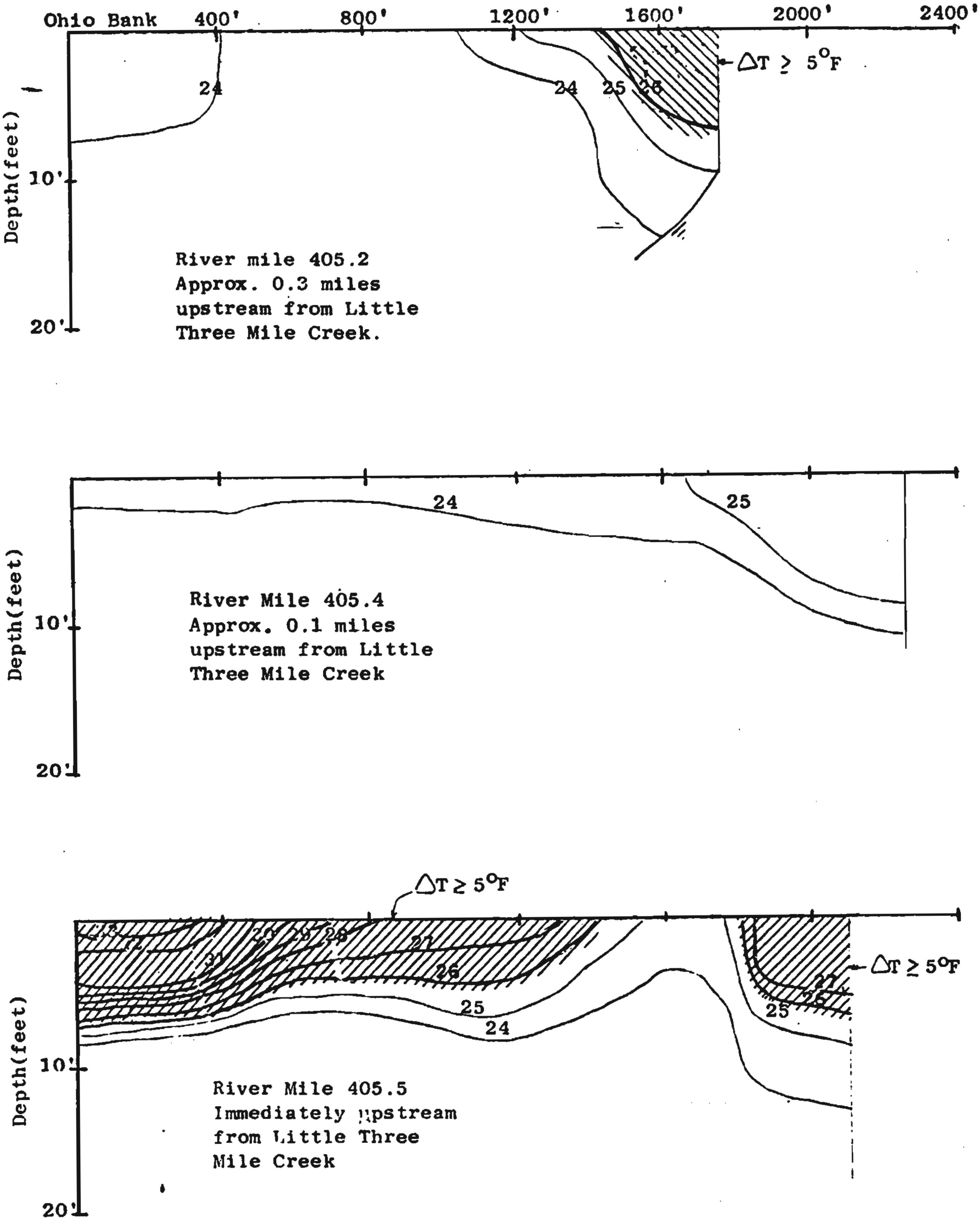


FIGURE IV-25 Temperature (°C) cross sections observed at designated mile points on the Ohio River at the J. M. Stuart Station, September 20, 1976.

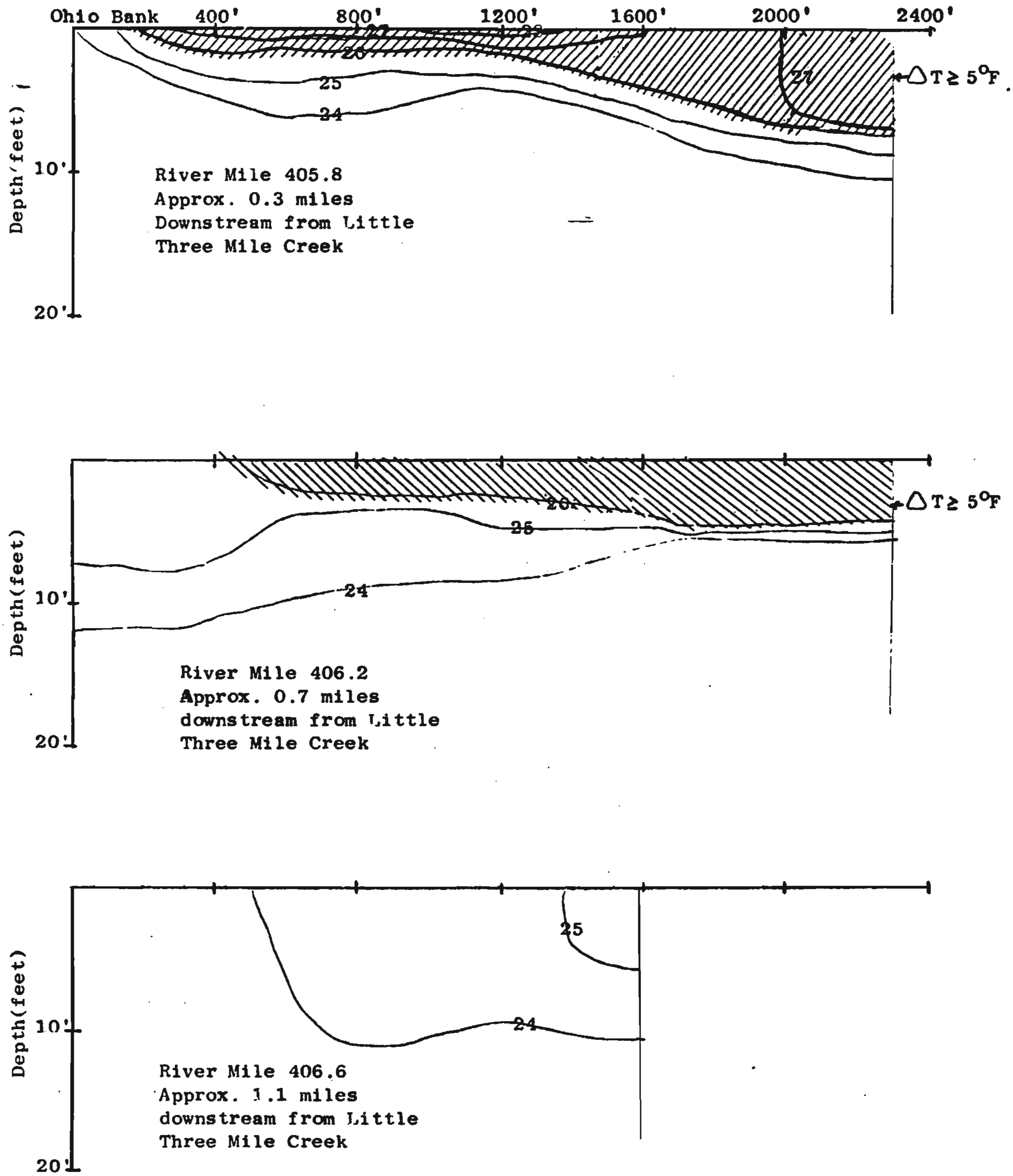


FIGURE IV-26 Temperature (°C) cross sections observed at designated mile points on the Ohio River at the J. M. Stuart Station, September 20, 1976.

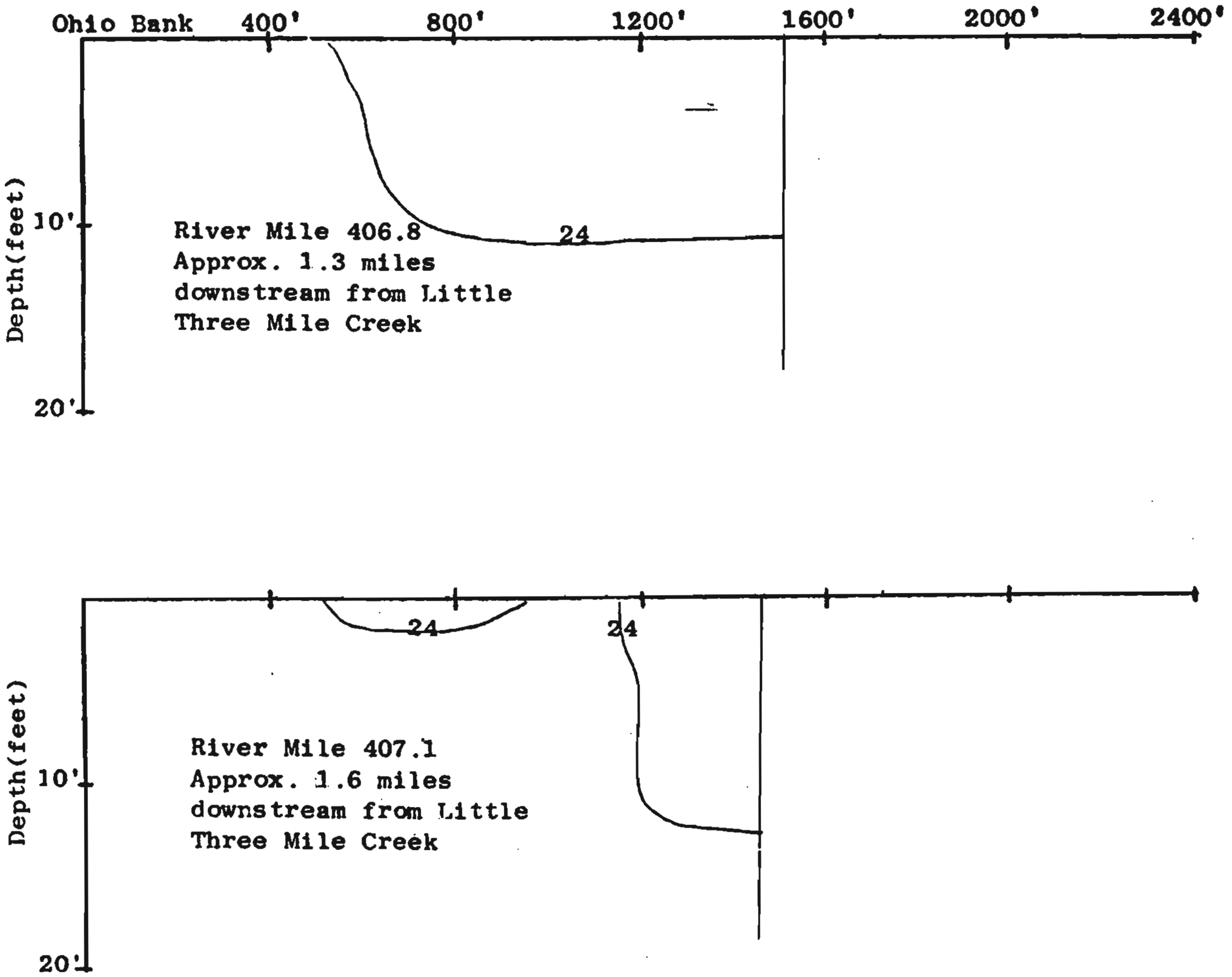


FIGURE IV-27 Temperature (°C) cross sections observed at designated mile points on the Ohio River at the J. M. Stuart Station, September 20, 1976.