# Hydraulic, Geotechnical, Geomorphic, and Biologic Data for the Cache River/ Heron Pond Area in Southern Illinois

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## CONVERSION FACTORS AND VERTICAL DATUM

| Multiply | By | To obtain |
|---|---|---|
| inch (in.) | 25.4 | millimeter |
| foot (ft) | 0.3048 | meter |
| mile (mi) | 1.609 | kilometer |
| cubic foot per second ($ft^3/s$) | 0.02832 | cubic meter per second |
| foot per second (ft/s) | 30.48 | centimeter per second |
| gallon per day per square foot [$(gal/d)/ft^2$] | 40.743 | liter per day per square meter |
| gallon per day (gal/d) | 3.785 | liter per day |
| pound per cubic foot ($lb/ft^3$) | 16.017 | kilogram per cubic meter |
| ton per square foot ($ton/ft^2$) | 9.772 | metric ton per square meter |

**Sea level:** In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)—a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

# Hydraulic, Geotechnical, Geomorphic, and Biologic Data for the Cache River/ Heron Pond Area in Southern Illinois

*By* Robert R. Holmes, Jr.

## Abstract

Heron Pond, located in extreme southern Illinois, lies immediately adjacent to the upper Cache River. The upper Cache River is encroaching on Heron Pond, which has raised the issue of the possibility of a failure of the Heron Pond wall, the area between Heron Pond and the upper Cache River. Hydraulic, geotechnical, geomorphic, and biologic data were collected by the U.S. Geological Survey (USGS) in cooperation with the Illinois Department of Natural Resources, Office of Water Resources (IDNR/OWR) for use in designing a mitigation plan by the IDNR/OWR to prevent the failure of the Heron Pond wall. The river is sluggish during floods with velocities generally 1–2 feet per second. Biologic activity in the area have increased bank instability, which already is a problem because of saturated soils in the Heron Pond wall. In the area adjacent to the Heron Pond, the right descending bank of the upper Cache River receded 0.5 foot between September 21, 1995 and June 25, 1996. Comparisons between two surveys, 1958 and 1995, indicate that the channel near the discontinued USGS streamflow-gaging station near the Burlington Northern Railroad crossing has widened by more than 10 feet with less than 0.5 foot of incision.

## INTRODUCTION

The Federally protected natural area at Heron Pond, located adjacent to the upper Cache River in southern Illinois (fig. 1), is a part of a cypress/tupolo wetland rich in biodiversity. This area of the State, sometimes called "Illinois' hidden bayou," has been called a scenic treasure and most recently given the title of "Wetland of International Importance" (Smith, 1996). The Cache River, with nearly vertical banks, appears to be encroaching on Heron Pond. At one location, the river is within 35 ft of the pond. The elevation difference between Heron Pond and the bottom of the Cache River channel is approximately 13 ft. Heron Pond is approximately 4 mi upstream from the beginning of the Forman Floodway/Post Creek Cutoff area and less than 0.25 mi upstream from the inflow of Dutchman Creek (fig. 1). The apparent lateral progression of the nearly vertical banks of the upper Cache River and its proximity to Heron Pond has raised the issue of the possibility of a failure of the Heron Pond wall, the area between Heron Pond and the upper Cache River. This failure probably would be detrimental to the ecosystem of Heron Pond.

Any effort to prevent failure of the wall and subsequent collapse of the pond requires knowledge of factors such as the hydraulics of the Cache River, the properties of the soils in the area, the biologic effects on streambank stability, and the hydrology of the area. As part of a study (September 1995 until July 1996) to gain this knowledge, the U.S. Geological Survey (USGS) in cooperation with the Illinois Department of Natural Resources, Office of Water Resources (IDNR/OWR) collected information on the Cache River channel velocities, ground-water elevations in the area, channel geometry, water-surface profiles, soil-structural characteristics, biologic effects on streambank stability, streambank-progression rates, and stream channel changes. Soil-structural characteristics

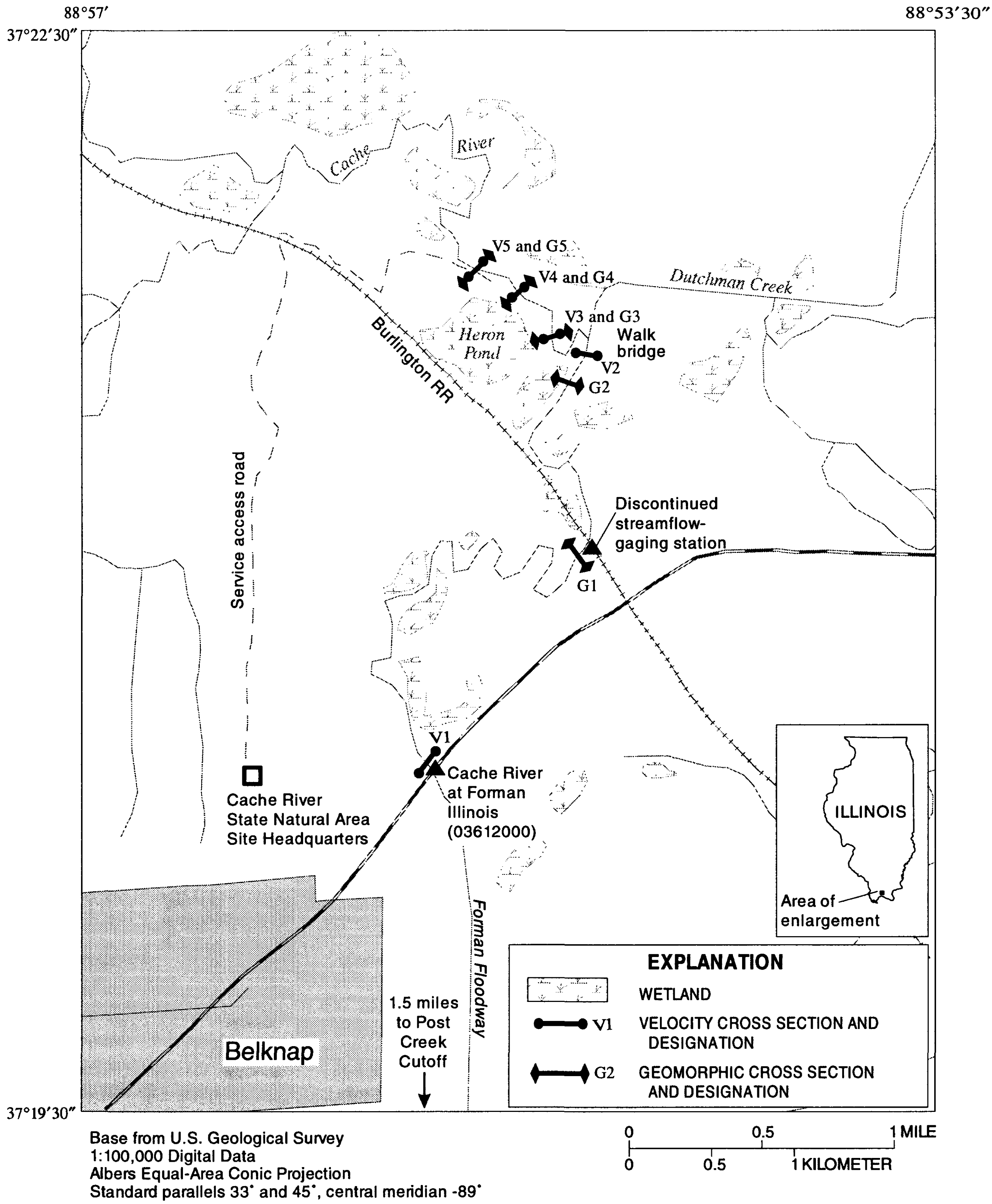



**Figure 1.** Cache River/Heron Pond area in southern Illinois, and velocity and geomorphic cross sections.

and an inventory of biologic effects in the study area were determined at the start of the study. A range of hydraulic flows were targeted for measurement of flow velocities. Ground-water elevations were collected approximately every 2 months, whereas streambank-progression rates and stream channel changes were determined after two large flood periods. The purpose of this report is to present these data.

## HYDRAULIC DATA

The range in expected water velocities in the Cache River, the ground-water elevations, and ground-water discharges were considered important factors in formulating a design to mitigate the potential failure of the Heron Pond wall. The water velocity was measured during six flow conditions in the Cache River, whereas ground-water elevations were measured on six site visits during various flow conditions.

Velocities were collected for five runoff periods. For the largest runoff period, April 30–May 2, 1996, velocities were collected on the ascending and descending limbs of the hydrograph. At the beginning of the study, five cross sections (fig. 1) were designated for collection of stream velocities on the Cache River. Velocities at cross sections V1 and V2 were measured from bridges, whereas velocities at cross sections V3, V4, and V5 were collected from a boat tethered to a steel cable strung across the stream. Velocities were collected in the main channel with a Price AA current meter, while in the overbank, velocities were measured with a pygmy meter (Buchanan and Somers, 1969). Overbank velocities were collected on April 30 and May 2, 1996, during the highest runoff period experienced during the study. The velocities and water-surface elevations measured in the main channel of the Cache River at each cross section are shown in table 1. The highest velocity of the main channel measured in the immediate vicinity of Heron Pond (upstream from Dutchman Creek at cross sections V3, V4, and V5) was 2.68 ft/s on January 24, 1996. Downstream from the confluence of the Dutchman Creek and the Cache River, the highest velocity was 5.95 ft/s, measured on April 30, 1996. During the April 30–May 2, 1996 flood period, the main channel velocities were lower in the vicinity of Heron Pond than in previous smaller runoff periods when velocity data were collected (table 1). Overbank velocities measured on April 30, 1996, are shown in figure 2. The flow-duration curve for the Cache River at Forman, Ill., USGS streamflow-gaging station (03612000), is shown in figure 3. The April 30 and May 2, 1996, velocity data were collected for discharges at the Forman station that were exceeded less than 5 percent of the time. The discharge hydrograph for the study period at the Forman streamflow-gaging station (03612000) is shown in figure 4.

Three groupings (nests) of ground-water piezometers were installed at the beginning of the study to obtain information to estimate the ground-water flow between Heron Pond and the upper Cache River (fig. 5). Ground-water elevations were measured periodically and are listed in table 2. Based on laboratory tests of soil boreholes (discussed in the "Geotechnical Data" section), the coefficient of permeability was determined at $3.609 \times 10^{-8}$ ft/s. Based on this value and the measured ground-water elevations, the ground-water discharge in the immediate area between Cache River and Heron Pond was estimated to range from $2.5 \times 10^{-4}$ to 0.25 (gal/d)/ft$^2$. This discharge is of the soil matrix, which does not include the ground-water discharge along the preferential flow paths. Flow is along a preferential flow path, which are old animal burrows and remnant tree-root passages that sometimes have been enlarged by soil piping. The discharge along these preferential flow paths was determined to be 4,360 gal/d on September 21, 1995, and 3,280 gal/d on September 22, 1995. These values were determined by volumetrically sampling the water cascading from the nearly vertical face of the Cache River, in the vicinity of Heron Pond. The high volume of ground-water flow in this area keeps the right descending bank of the Cache River adjacent to Heron Pond saturated. This increases the instability of the banks.

## GEOTECHNICAL DATA

Soil samples from three soil boreholes (S1, S2, and S3 (fig. 5)), drilled on September 22, 1995, were collected to characterize the physical and structural characteristics of the soil in the Heron Pond wall. Water content, plastic limit, and liquid limit were determined in the USGS laboratory in Urbana, Ill., and are shown in table 3. Samples collected from soil borehole S2 were sent to private geotechnical testing laboratories to determine coefficient of permeability, grain size, angle of shearing resistance, cohesion, saturation, void ratio, dry density, and bulk density. The results from these tests are given in table 4.

**Table 1.** Water-surface elevation, discharge, and velocity data collected in the Cache River/Heron Pond area in southern Illinois
[USGS, U.S. Geological Survey; $ft^3/s$, cubic feet per second; ft/s, feet per second; --, no data]

Cross-section number:
V1, at current USGS gage on Belknap Road
V2, at foot bridge from Heron Pond parking lot
V3, at the downstream end of the reach adjacent to Heron Pond
V4, at the middle of the reach adjacent to Heron Pond
V5, at the upstream end of the reach adjacent to Heron Pond

| Cross-section number | Date of measurement | Time of measurement | Distance upstream from cross section (feet) | Water-surface elevation (feet above sea level) | Discharge ($ft^3/s$) | Maximum velocity (ft/s) | Velocity near right bank (ft/s) | Velocity near left bank (ft/s) |
|---|---|---|---|---|---|---|---|---|
| V1 | 1/16/96 | 1100 | 0 | 320.15 | 98.90 | 2.61 | 1.24 | 1.23 |
| V2 | 1/16/96 | 1325 | 20,580 | 334.60 | -- | 2.76 | 2.67 | 2.00 |
| V3 | 1/16/96 | 1352 | 22,920 | 334.89 | -- | 1.02 | .50 | 1.02 |
| V4 | 1/16/96 | 1423 | 23,720 | 336.20 | -- | 1.58 | 1.16 | .73 |
| V5 | 1/16/96 | -- | 25,120 | -- | -- | -- | -- | -- |
| V1 | 1/24/96 | 0815 | 0 | 324.12 | 585 | 3.87 | 1.38 | 2.98 |
| V2 | 1/24/96 | 1140 | 20,580 | 337.07 | 601 | 4.27 | 2.72 | .95 |
| V3 | 1/24/96 | 1649 | 22,920 | 338.82 | 362 | 2.00 | 1.29 | 1.80 |
| V4 | 1/24/96 | 1607 | 23,720 | 339.06 | 361 | 2.68 | 1.01 | 1.58 |
| V5 | 1/24/96 | 1447 | 25,120 | 339.60 | 317 | 1.80 | 1.62 | 1.44 |
| V1 | 2/28/96 | 0951 | 0 | 327.08 | 1,180 | 4.83 | 1.52 | 3.97 |
| V2 | 2/28/96 | 1118 | 20,580 | 339.45 | 1,164 | 4.44 | 2.42 | 2.78 |
| V3 | 2/28/96 | 1618 | 22,920 | 339.67 | 362 | 1.62 | .86 | 1.66 |
| V4 | 2/28/96 | 1538 | 23,720 | 339.96 | 340 | 2.33 | 1.25 | 1.17 |
| V5 | 2/28/96 | 1445 | 25,120 | 340.43 | 246 | 1.70 | 1.37 | .91 |
| V1 | 4/23/96 | 1020 | 0 | 330.53 | 2,140 | 5.88 | 3.63 | 2.46 |
| V2 | 4/23/96 | 1200 | 20,580 | 343.17 | 2,510 | 5.35 | 3.45 | .93 |
| V3 | 4/24/96 | 1040 | 22,920 | 343.80 | 779 | 2.08 | 1.32 | 1.28 |
| V4 | 4/23/96 | 1520 | 23,720 | 344.38 | 696 | 1.70 | 1.10 | .89 |
| V5 | 4/23/96 | 1827 | 25,120 | 344.41 | 567 | 1.98 | 1.98 | 1.26 |
| Heron Pond | 4/24/96 | 1000 | -- | 345.60 | -- | -- | -- | -- |
| V1 | 4/30/96 | 1000 | 0 | 333.88 | 2,960 | 5.95 | 2.03 | 1.76 |
| V2 | 4/30/96 | 1320 | 20,580 | 346.42 | [1]3,047 | 3.62 | 2.91 | 3.16 |
| V3 | 4/30/96 | 1920 | 22,920 | 347.76 | [1]668 | 1.60 | .96 | 1.37 |
| V4 | 4/30/96 | 1835 | 23,720 | -- | [1]777 | 1.61 | 1.47 | .64 |
| V5 | 4/30/96 | 1725 | 25,120 | 347.86 | [1]740 | 1.57 | .99 | .70 |
| Heron Pond | 4/30/96 | 1730 | -- | 347.65 | -- | -- | -- | -- |
| V1 | 5/2/96 | 0750 | 0 | 335.42 | 3,380 | 5.89 | 1.68 | 1.99 |
| V2 | 5/2/96 | 1055 | 20,580 | 346.33 | [1]2,295 | 3.60 | 1.59 | 2.59 |
| V3 | 5/2/96 | 1035 | 22,920 | 347.35 | [1]1,128 | 1.67 | 1.01 | 1.47 |
| V4 | 5/2/96 | 1009 | 23,720 | -- | [1]949 | 1.91 | 1.91 | .85 |
| V5 | 5/2/96 | 0934 | 25,120 | 347.70 | [1]1,171 | 1.75 | 1.60 | 1.44 |
| Heron Pond | 5/2/96 | 1107 | -- | 347.41 | -- | -- | -- | -- |

[1] Main channel discharge only.

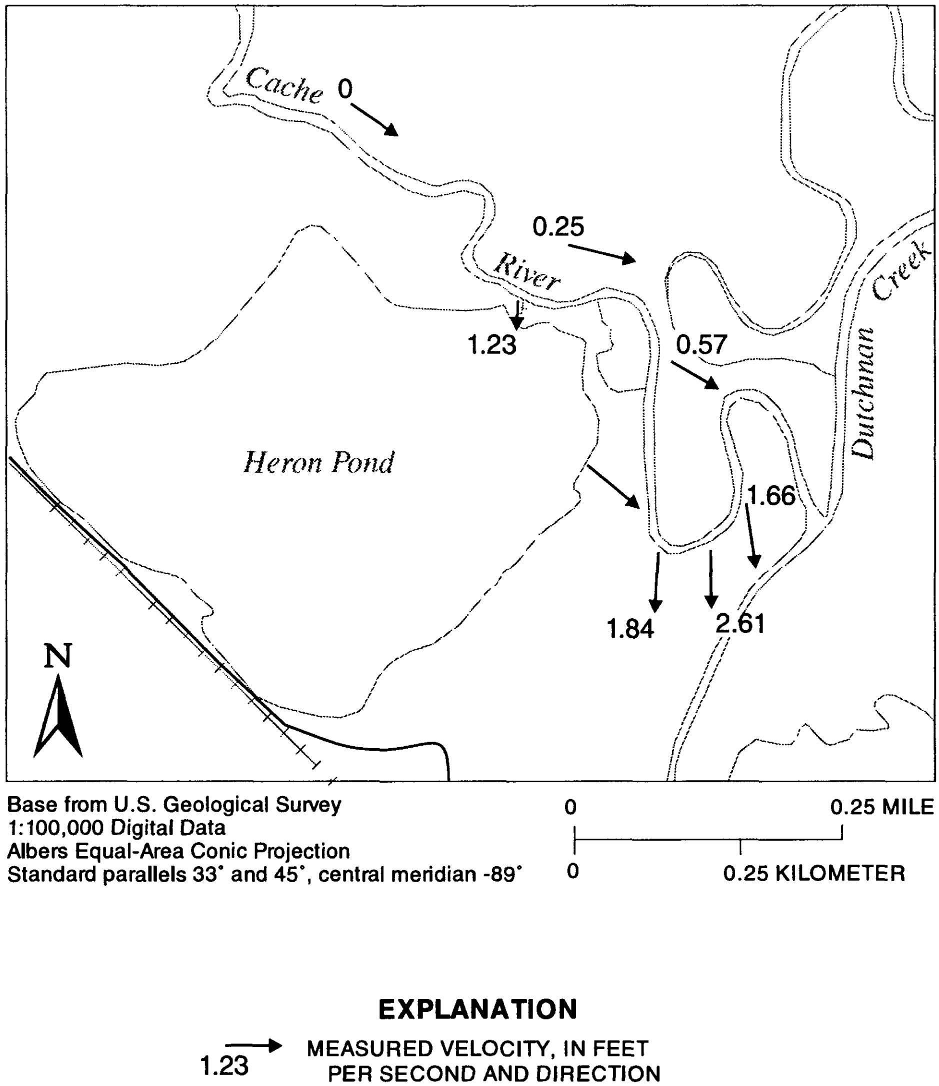



**Figure 2.** Measured overbank-flow velocities and observed velocity direction in the Cache River/Heron Pond area in southern Illinois on April 30, 1996.

## GEOMORPHIC DATA

Knowledge of the geomorphic character and evolution of the upper Cache River channel is important in addressing the design of any mitigation efforts and the assessment of long-term effects of mitigation on the Cache River. Assessment of the geomorphic character and evolution of the upper Cache River involved the installing and monitoring of horizontal bank rods and the monument, surveying, and resurveying of channel cross-section geometry. These efforts undertaken during the study give a snapshot in time of the rates of channel movement. These rates may be larger or smaller than the overall long-term rates of channel movement. An attempt was made to establish the monumented cross sections permanently to determine future rates of channel change.

The bank rods, installed in September 1995, are 4-ft long rebars driven horizontally into the streambank at selected locations (fig. 6, at end of report). Initially, only 3–4 in. of rebar was exposed from the bank, and a saw cut was made to mark the location of the surface of the streambank. Bank-rod readings, taken on March 14, and June 25, 1996, are shown in table 5 (at end of report). These readings were used to estimate the movement of the streambank during this period. Attempts were made to visit the sites soon after the May 2, 1996, flood period, but high water in the channel prevented access to the bank rods until late

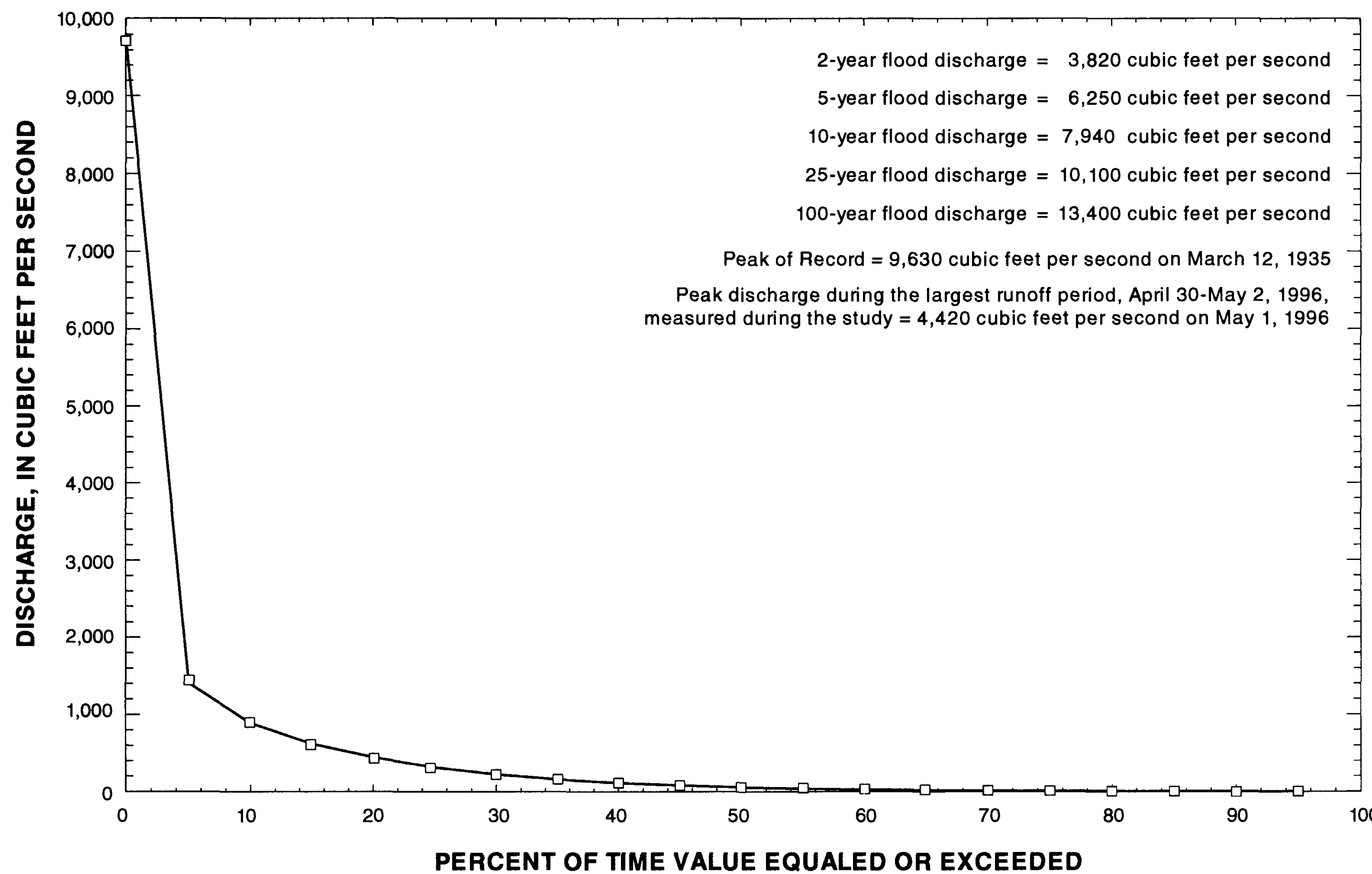



**Figure 3.** Flow-duration curve for the Cache River at Forman, Ill. (03612000).

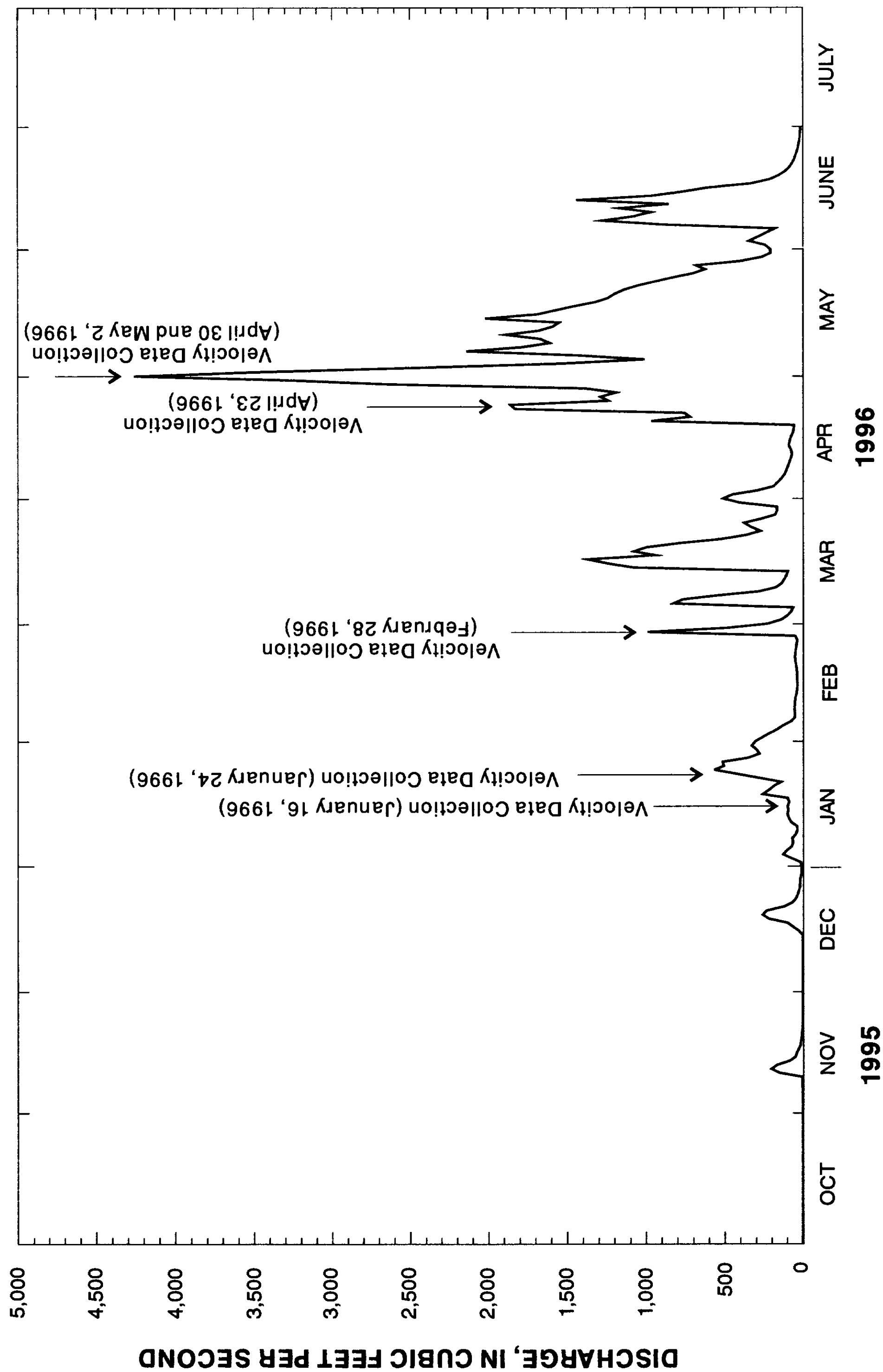
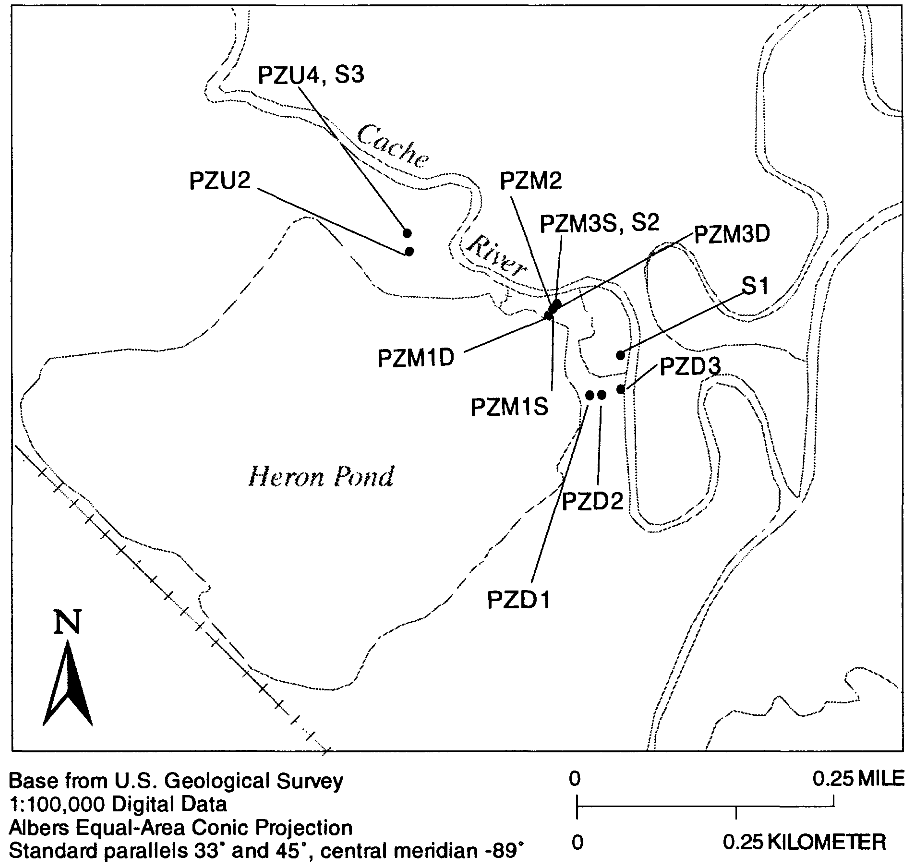



**Figure 4.** Discharge hydrograph for the Cache River at Forman, Ill. (03612000).




**EXPLANATION**

| | |
|---|---|
| PZU | MEMBER OF UPPER PIEZOMETER NEST |
| PZM | MEMBER OF MIDDLE PIEZOMETER NEST |
| PZD | MEMBER OF LOWER PIEZOMETER NEST |
| S1 | SOIL BOREHOLE |

**Figure 5.** Location of soil boreholes and ground-water piezometers in the Cache River/Heron Pond area in southern Illinois.

June 1996. For the period September 21, 1995–June 25, 1996, the largest amount of bank loss was 1.49 ft on the outer bend of the upper Cache River approximately 2,000 ft downstream from Heron Pond and approximately 1,200 ft upstream from cross section 2. In the reach of the upper Cache River adjacent to Heron Pond (fig 6.), the right descending bank had a maximum loss of 0.62 ft.

Five monumented cross sections (G1–G5, (fig. 1)), were established and surveyed in late September, 1995, by IDNR/OWR surveyors. These monumented cross sections were resurveyed on June 25, 1996. Geomorphic cross sections (G1–G5), based on the September 1995 and June 1996 data, are shown in figures 7–11 (at the end of the report). Channel widening is noted in the geomorphic cross sections in the reach upstream from the confluence of Dutchman Creek and the Cache River (G3–G5). Aggradation of the channel appears in cross section G3, whereas part of the bed was lowered 0.5 ft at cross section G4. Downstream from the confluence of the Cache River and Dutchman Creek, approximately 0.3 ft of channel

**Table 2.** Ground-water elevations in the Cache River /Heron Pond area in southern Illinois
[All elevations in feet above sea level; --, not measured]

| Date of | Piezometer (fig. 5) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| measurement | PZD1 | PZD2 | PZD3 | PZM1S | PZM1D | PZM2 | PZM3S | PZM3D | PZU1 | PZU4 | Heron Pond |
| 9/28/95 | 343.92 | 342.74 | -- | 344.25 | 344.19 | 342.34 | 341.02 | 340.64 | 344.62 | Dry | -- |
| 11/7/95 | 344.20 | 342.43 | 342.05 | 344.48 | 344.47 | 343.16 | 341.22 | 338.74 | 344.87 | 333.19 | -- |
| 1/9/96 | 344.63 | 343.90 | 340.89 | 344.88 | 344.80 | 343.60 | 341.47 | 339.71 | 346.29 | 333.86 | -- |
| 1/24/96 | 344.85 | 344.27 | 341.98 | 345.28 | 345.31 | 344.29 | 342.40 | 340.02 | 345.43 | 333.43 | 345.31 |
| 2/28/96 | 344.55 | 343.96 | 341.56 | 345.10 | 345.09 | 344.25 | 342.16 | 340.92 | 345.36 | 334.24 | 345.33 |
| 3/14/96 | 344.75 | 344.14 | 341.65 | 346.40 | 345.45 | 344.24 | 341.76 | 340.60 | 345.62 | 336.68 | 345.44 |

incision is noted in cross-section G2, which is understandable because the velocities in cross section V2 (which is 200 ft upstream from G2) generally were 2 ft/s higher than the velocities in the main channel near Heron Pond.

In addition to the five monumented cross sections, the cross-section geometry was determined by a survey just upstream from a dilapidated concrete weir at the site of a discontinued USGS streamflow-gaging station, upstream from the Burlington Railroad bridge (fig. 1). Surveyed cross-section data, collected by the USGS in 1958 and that collected in September 1995 as part of this study, are shown in figure 12 (at end of report). It appears that very little channel incision has occurred (less than 0.5 ft) but the channel width has increased by approximately 10 ft or more from 1958 to 1995.

## BIOLOGIC DATA

Biologic factors were thought to appreciably affect and increase the ground-water discharge along preferential flow paths and the overall instability of the channel banks. Knowledge of the types of animals present in the area and their burrowing abilities is necessary when considering mitigation efforts to prevent the failure of the Heron Pond wall. In the upper Cache River/Heron Pond area, several species of crayfish are known to actively burrow into the streambanks, in addition burrowing mammals, such as muskrat and beaver, which can greatly affect bank stability.

On September 20–21, 1995, crayfish were collected by seining, dip netting, trapping, and digging into burrows. Thirty crayfish traps were placed over burrows on the evening of September 20, and then checked the following morning. Several burrows were excavated to document the extent of the burrows and to find additional crayfish species. Of the seven crayfish species known to inhabit the area (Chris Taylor, Illinois Natural History Survey, written commun., 1995), two species of crayfish were identified, *Orconectes illinoiensis* and *Cambarus diogenes. Orconectes illinoiensis* was found abundantly in the Cache River by seining. *Cambarus diogenes* was found in crayfish traps and excavated burrows. No crayfish were recovered from seining in Heron Pond. This was not unexpected because thick vegetation made seining difficult. *Cambarus diogenes* is known to dig deep burrows (Page, 1985). *Fallicambarus fodiens*, which was not found during the September 20–21, 1995 collection,

**Table 3.** Results of geotechnical tests for soil boreholes in the Cache River/Heron Pond area in southern Illinois
[CL, inorganic clay of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays; --, no data]

| Soil borehole (fig. 5) | Sample depth (feet below land surface) | Water content (percent) | Plastic limit (percent) | Liquid limit (percent) | Unified soils classification |
|---|---|---|---|---|---|
| S1 | 2.2 | 15.8 | 20 | 46 | CL |
| S1 | 5.9 | 27.1 | 20 | 38 | CL |
| S1 | 7.8 | 26.2 | 19 | 35 | CL |
| S1 | 7.8 | 26.2 | 17 | 39 | CL |
| S2 | 1 | 20.8 | 18 | 43 | CL |
| S2 | 2 | 8.7 | 19 | 34 | CL |
| S2 | 3 | 11.3 | 21 | 33 | CL |
| S2 | 5 | 25.7 | 17 | 34 | CL |
| S2 | 7.2 | 34.6 | 17 | 36 | CL |
| S2 | 8 | 22.9 | 14 | 34 | CL |
| S2 | 10 | 41.8 | -- | -- | -- |
| S2 | 11 | 24.9 | 15 | 32 | CL |
| S3 | 1.5 | 22.5 | 21 | 40 | CL |
| S3 | 3.6 | 22.0 | 21 | 35 | CL |
| S3 | 5.6 | 25.8 | 20 | 34 | CL |
| S3 | 7.6 | 27.3 | 19 | 34 | CL |
| S3 | 10.4 | 30.3 | 19 | 33 | CL |

also are deep burrowers. The depth of the burrows of these two species is often related to ground-water elevations. Although it is not possible to place an upper limit on the depth of their burrows, there are records of *Fallicambarus fodiens'* burrows that are nearly 7 ft deep. Burrows were excavated on the shoreline of the Cache River and in the wet mud in the streambanks. Several *Cambarus diogenes* were recovered from these burrows. These burrows consisted of a series of branching tubes and chambers, and often had several entrances. Maximum horizontal extent of the excavated burrows was approximately 1.6 ft, and the maximum depth found was about 2 ft. A deeper burrow was found on the upland between Heron Pond and the Cache River. A minimum depth of 2.5 ft for this burrow was estimated by pushing a metal measuring tape down the crayfish hole, but the burrow was not excavated.

During subsequent wading along the banks of the Cache River in mid-March 1996, many beaver dens were noted along the streambanks. Many beaver den burrows seem to be along the river bank. Beaver also were seen numerous times swimming in the Cache River during the course of this study. Abundant deer trails were noticed traversing the nearly vertical banks of the Cache River in the immediate area of Heron Pond. One trail was noted to have eroded a narrow path into the bank by about 3 ft.

The exposed root systems of several trees along the Cache River, in the vicinity of Heron Pond, were noted. The continued increased exposure of the root system enhances the chance of tree failure. The failure of the larger trees carries several feet of bank, lateral and longitudinal, into the river. This allows more rapid lateral progression of the upper Cache River. One prominent fallen tree was noted to have taken approximately 15 ft, longitudinally, of the streambank just prior to the start of the project.

## SUMMARY

Hydraulic, geotechnical, geomorphic, and biologic data were collected in the reach of the upper Cache River near the Heron Pond in southern Illinois. During this study (September 1995–July 1996), in the reach upstream from the confluence of Dutchman Creek, the highest measured velocity in the main channel was 2.68 ft/s, whereas downstream from the confluence of Dutchman Creek the highest velocity of the Cache River was 5.95 ft/s. Ground-water flow was determined in the soil matrix and along preferential flow paths. The soil matrix flow, in the Heron Pond wall, ranged from $2.5 \times 10^{-4}$ to 0.25 (gal/d)/ft$^2$, whereas the discharge along preferential flow paths was 4,360 gal/d on September 21, 1995, and 3,280 gal/d on September 22, 1995. Geotechnical laboratory tests were conducted on soil borings collected from the area between the Cache River and

**Table 4.** Results of detailed geotechnical tests at soil borehole S2 in the Cache River/Heron Pond area in southern Illinois

[ft/s, feet per second; mm, millimeters; ton/ft$^2$, tons per square foot; lb/ft$^3$, pounds per cubic foot; <, less than; --, no data]

Grain size: $D_{10}$, grain size where 10 percent of material is finer;
$D_{50}$, grain size where 50 percent of material is finer;
$D_{90}$, grain size where 90 percent of material is finer

| | Characteristic | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Depth (feet below land surface) | Coefficient of permeability (ft/s) | Grain size $D_{10}$ (mm) | Grain size $D_{50}$ (mm) | Grain size $D_{90}$ (mm) | Angle of shearing resistance (degrees) | Cohesion (ton/ft$^2$) | Saturation (percent) | Void ratio (percent) | Dry density (lb/ft$^3$) | Bulk density (lb/ft$^3$) |
| 6.5 | $3.609 \times 10^{-8}$ | <0.001 | 0.02 | 0.11 | -- | -- | -- | -- | -- | -- |
| 9 | -- | -- | -- | -- | 33.3 | 0.125 | 90 | 60 | 104.4 | 125.5 |

Heron Pond. A coefficient of permeability of $3.609 \times 10^{-8}$ ft/s was determined for soils in this area. Monitoring of bank rods driven horizontally into the streambank indicated a lateral streambank progression of the upper Cache River towards Heron Pond of around 0.62 ft. Comparison of channel geometry between September 1995 and July 1996, indicated some channel widening in the reach near Heron Pond and around 0.3 ft of channel incision in the Cache River downstream from the confluence of Dutchman Creek. Comparison of channel-geometry data, obtained in 1958 and 1995, at the site of the discontinued U.S. Geological Survey (USGS) streamflow-gaging station indicated less than 0.5 ft of channel incision and more than 10 ft of channel widening. A biologic characterization of the study area was completed and indicated that crayfish, beaver, muskrat, and deer activities along with falling trees affected bank stability.

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Smith, Wes, 1996, World-class Illinois swamp rises above the muck: Chicago Tribune, June 13, 1996, p. 1.



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TABLE 5

FIGURES 6–12

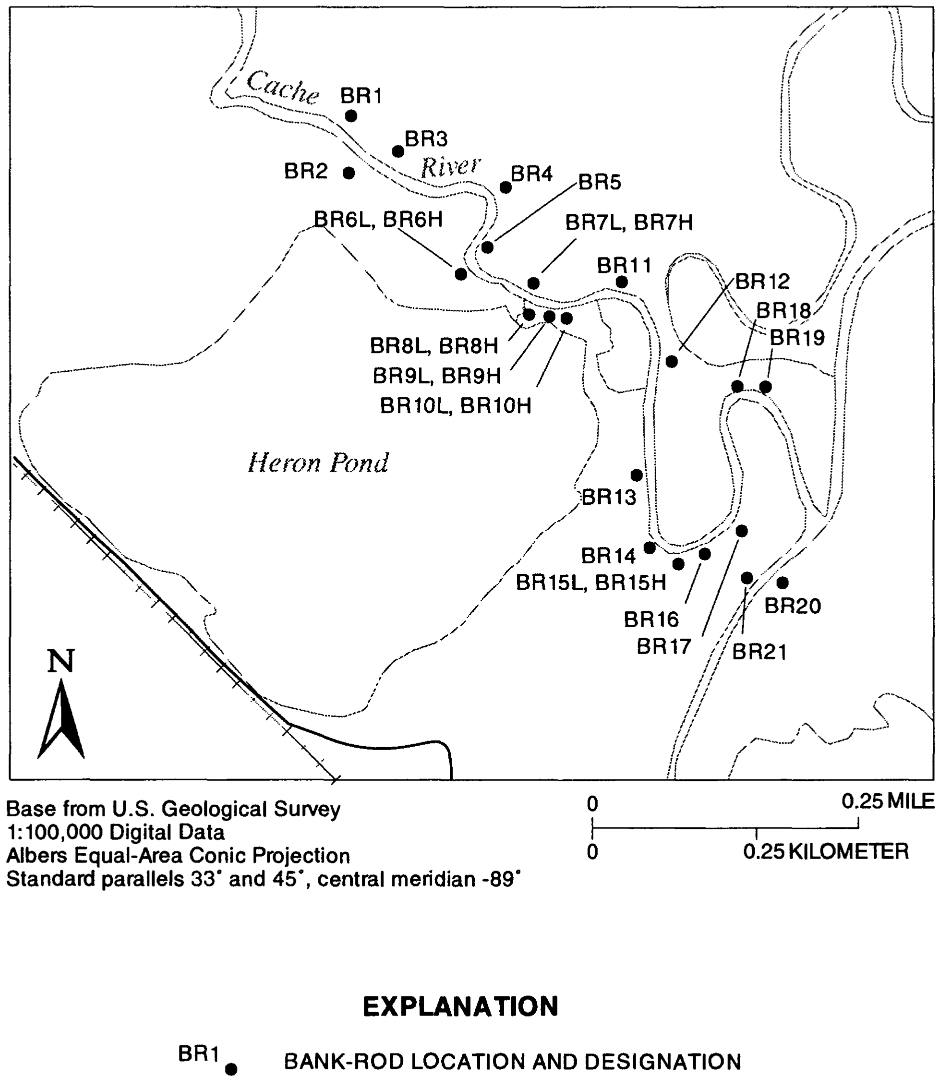


**Figure 6.** Locations of bank rods in the Cache River/Heron Pond area in southern Illinois.

**Table 5.** Bank loss as determined from bank rods at the Cache River/Heron Pond area in southern Illinois
[--, no data]

| Bank rod (fig. 5) | Bank loss from5 September 1995 to March 14, 1996 (feet) | Bank loss from September 1995to June 15, 1996 (feet) |
|---|---|---|
| BR1 | -- | 0.14 |
| BR2 | 0 | 0 |
| BR3 | -- | -- |
| BR4 | -- | .49 |
| BR5 | .34 | .58 |
| BR6H | 0 | 0 |
| BR6L | 0 | .24 |
| BR7H | 0 | .47 |
| BR7L | .46 | .25 |
| BR8H | 0 | .15 |
| BR8L | 0 | .54 |
| BR9H | 0 | .1 |
| BR9L | 0 | 0 |
| BR10H | -- | .62 |
| BR10L | -- | 0 |
| BR11 | -- | -- |
| BR12 | .46 | .72 |
| BR13 | 0 | -- |
| BR14 | .4 | .77 |
| BR15H | 0 | .38 |
| BR15L | .2 | .55 |
| BR16 | 0 | .58 |
| BR17 | .43 | 1.49 |
| BR18 | -- | .41 |
| BR19 | -- | .5 |
| BR20 | 0 | .25 |
| BR21 | 0 | .18 |

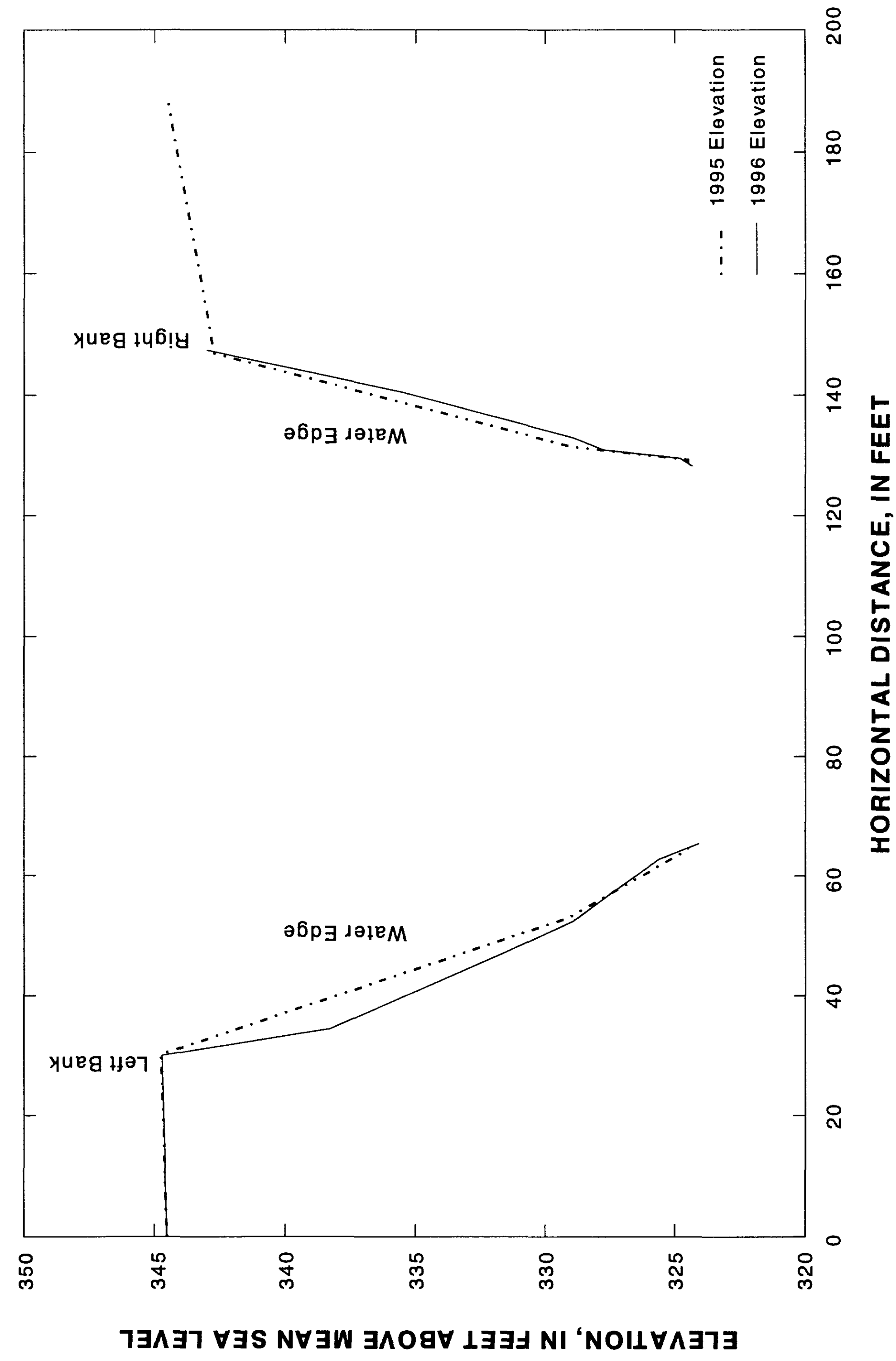


**Figure 7.** Geomorphic cross section G1 in the Cache River/Heron Pond area in southern Illinois.

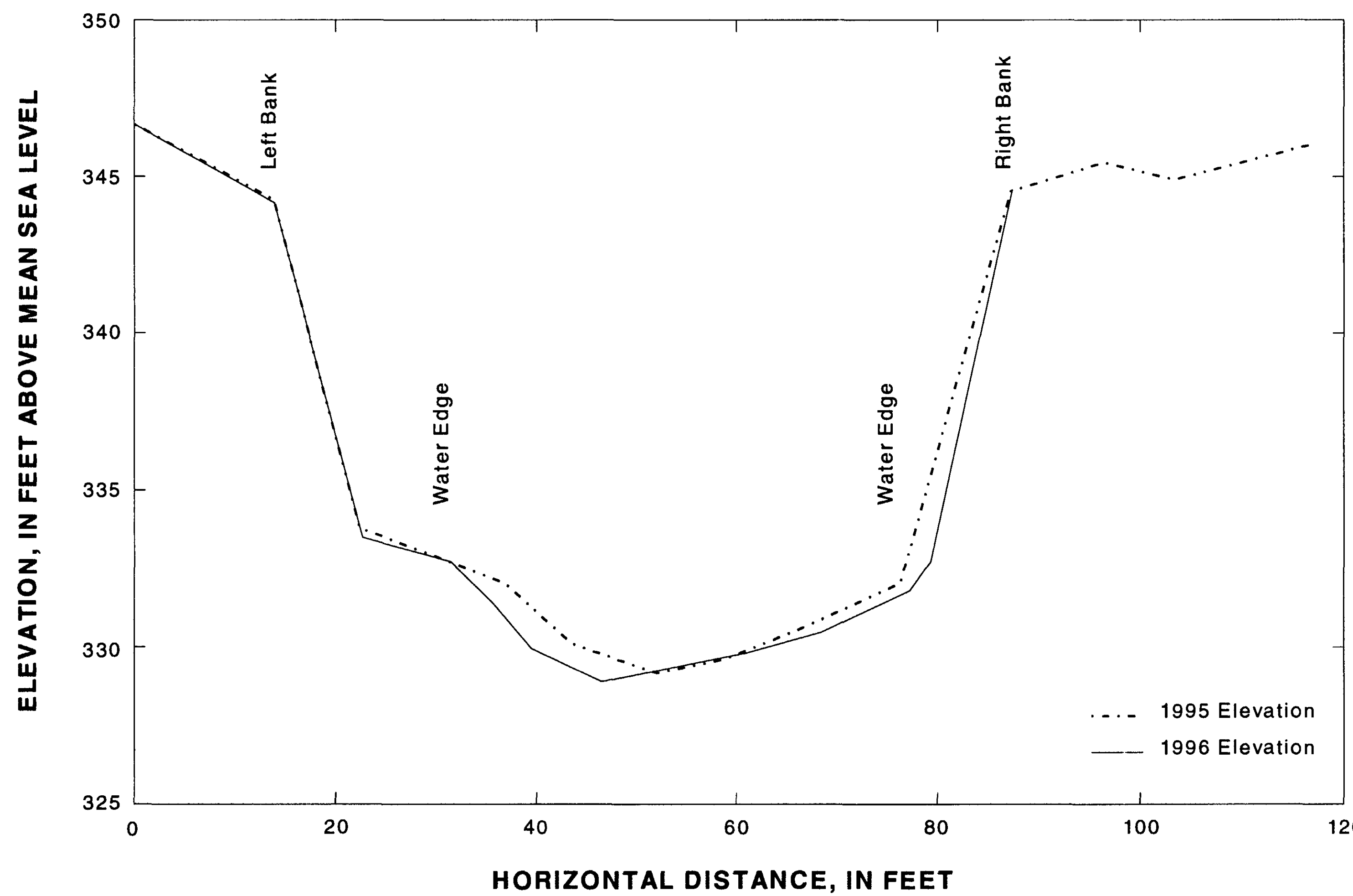


**Figure 8.** Geomorphic cross section G2 in the Cache River/Heron Pond area in southern Illinois.

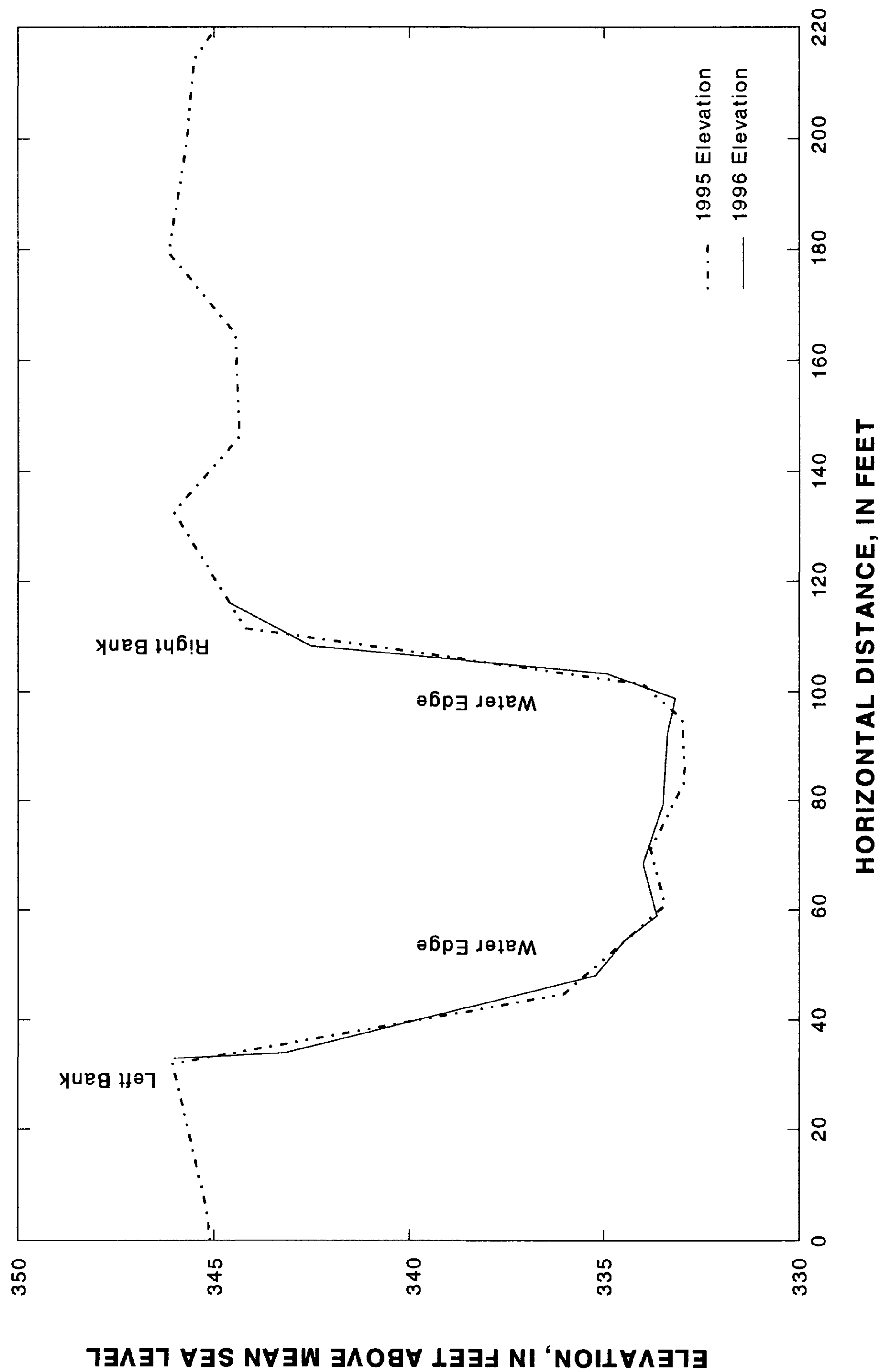


**Figure 9.** Geomorphic cross section G3 in the Cache River/Heron Pond area in southern Illinois.

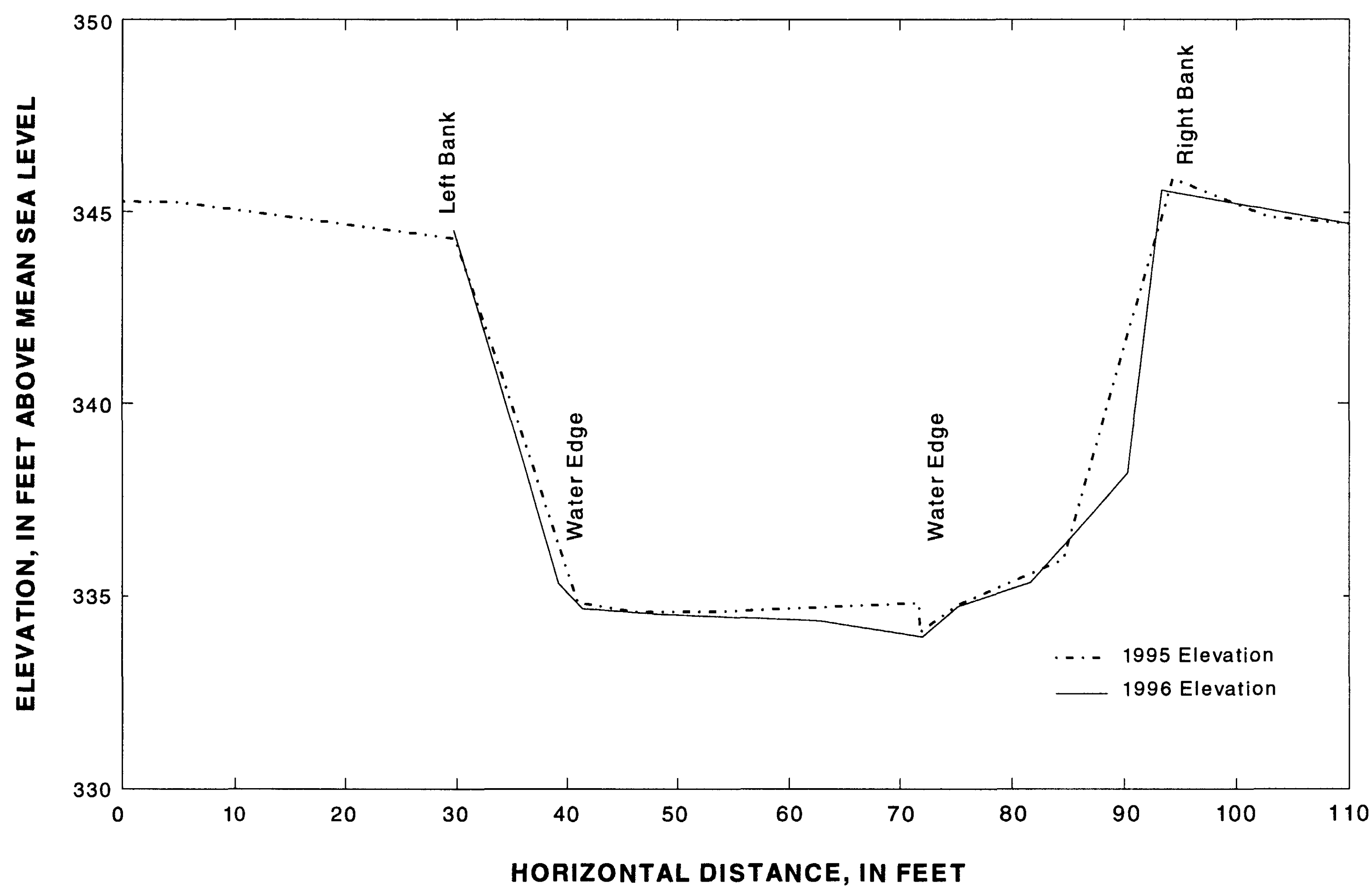


**Figure 10.** Geomorphic cross section G4 in the Cache River/Heron Pond area in southern Illinois.

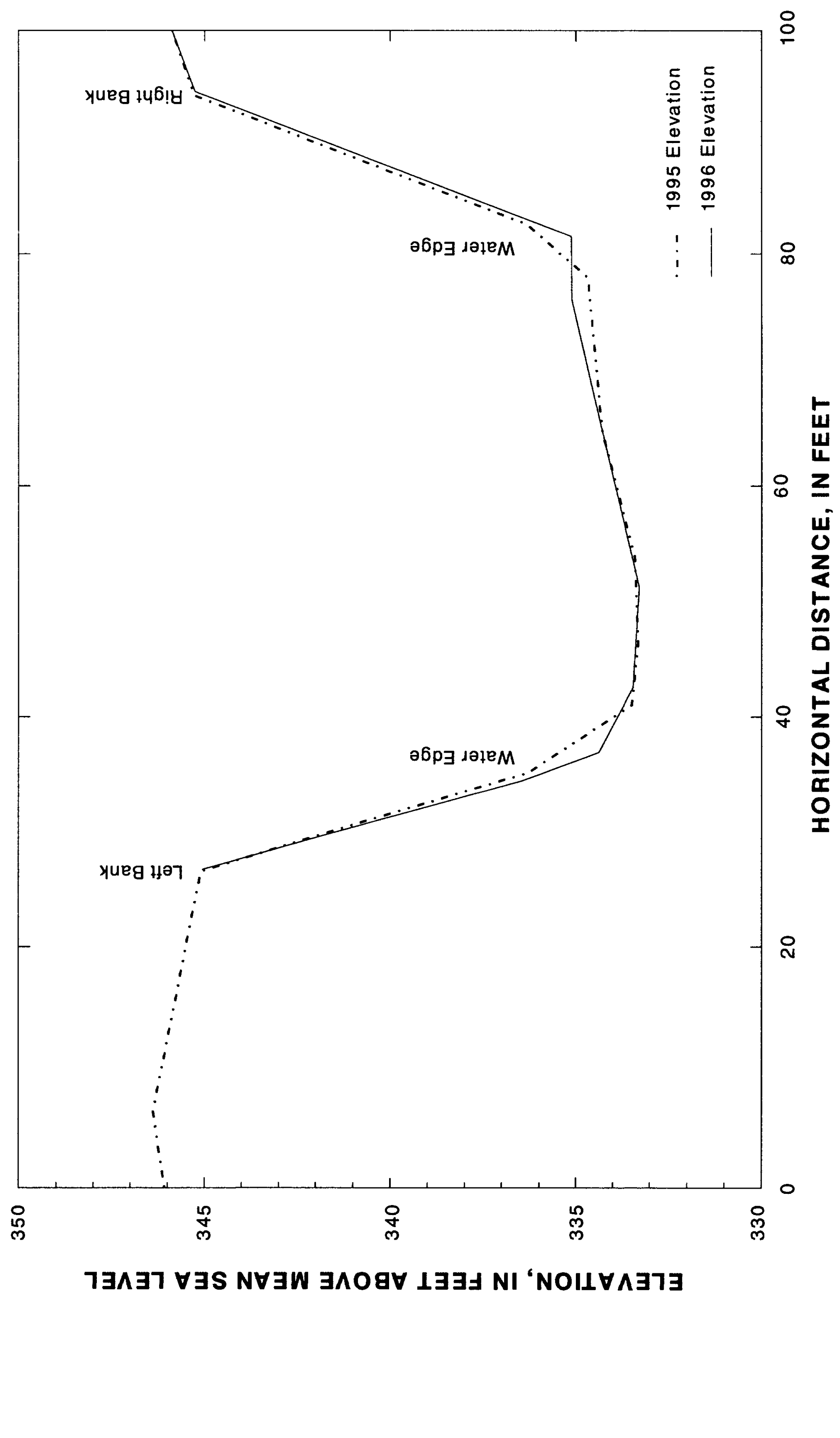


**Figure 11.** Geomorphic cross section G5 in the Cache River/Heron Pond area in southern Illinois.

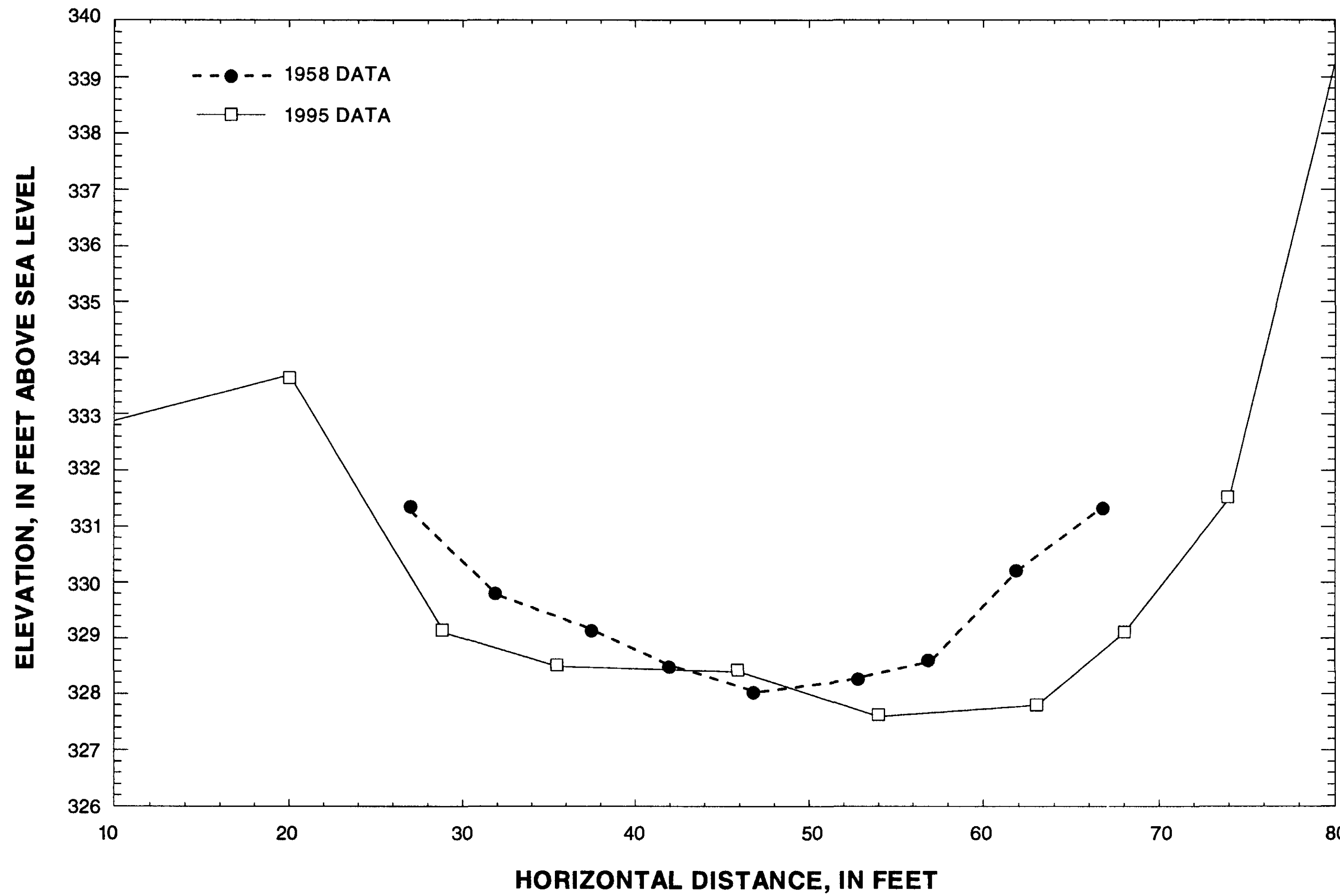


**Figure 12.** Cross section at the discontinued U.S. Geological Survey streamflow-gaging station in the Cache River/Heron Ponds area in southern Illinois.