FLOATING SAMPLE-COLLECTION PLATFORM WITH STAGE-ACTIVATED AUTOMATIC WATER SAMPLER FOR STREAMS WITH LARGE VARIATION IN STAGE

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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
gallon per minute (gal/min)	0.06309	liter per second
cubic foot per second (ft^3/s)	0.02832	cubic meter per second
pound, avoirdupois (lb)	0.4536	kilogram
gallon (gal)	3.785	liter

National Geodetic Vertical Datum of 1929--a geodetic datum derived from a general adjustment of the first-order level nets of the United States and Canada, formerly called Sea Level Datum of 1929.

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ABSTRACT

A floating sample-collection platform is described for stream sites where the vertical or horizontal distance between the stream-sampling point and a safe location for the sampler exceed the suction head of the sampler. The platform allows continuous water sampling over the entire storm-runoff hydrograph. The platform was developed for a site in southern Illinois.

INTRODUCTION

The U.S. Geological Survey (USGS) and Illinois Environmental Protection Agency (IEPA) monitored the concentrations of triazine herbicides during storm runoff following application of herbicides to agricultural fields at three sites in Illinois. The use of automatic samplers was necessary to collect samples over the entire storm-runoff hydrograph. One of the monitoring sites, a USGS streamflow-gaging station Silver Creek near Freeburg, Ill. (05594800) (fig. 1), is in an area where the position of the gage house relative to the flood-plain profile would not allow a simple installation because of the large variation in stream stage. A floating sample-collection platform was developed to address three related problems at this site: (1) The suction head of the sampler was not great enough to collect a sample if the sampler was installed in the gage house, (2) the sampler could be submerged during high streamflow, and (3) the sampler could be vandalized if placed within the flood plain.

Background

The flood history of Silver Creek near Freeburg shows that the stage frequently rises above bankful stage during high streamflows; thus, the automatic sampler could not be installed within the flood plain near the stream. A cross section of Silver Creek at the gage shows the maximum stage resulting from four storms during 1979-90 (fig. 2). The mean water-surface elevation in the spring is approximately 3.5 ft above a gage datum of 381.40 ft above National Geodetic Vertical Datum of 1929 (NGVD of 1929).

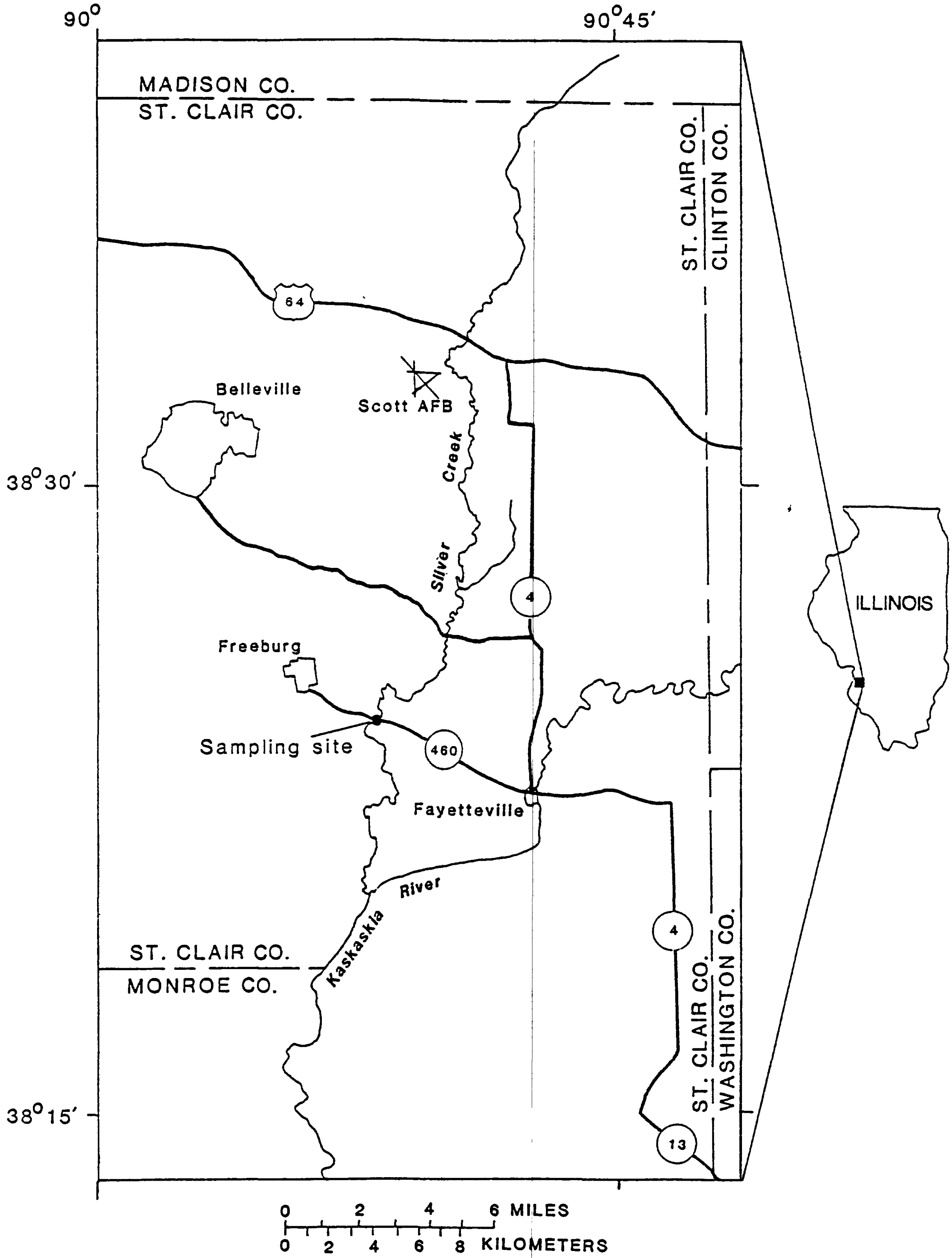

Figure 1.--Location of study area.

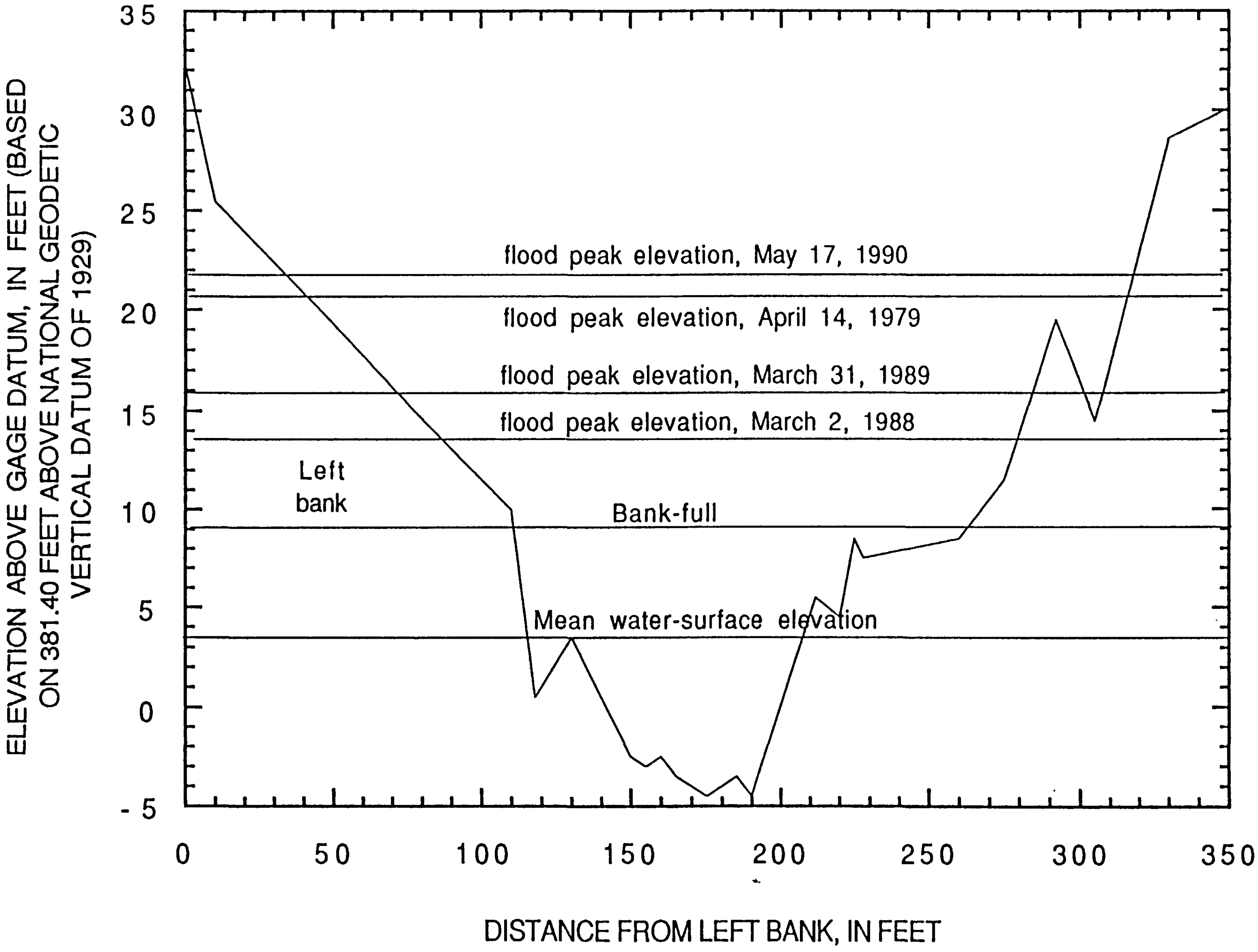

Figure 2.--Channel cross section, Silver Creek near Freeburg, Illinois.

The maximum suction head of the sampler used is 26 ft. The pumping rate of this sampler is 0.8 gal/min (0.00178 ft^3/s). With the 3/8-in. inside-diameter (i.d.) Teflon tubing[1] used, friction loss is 0.092 ft per foot of tubing. Figure 3 shows the maximum distance the pump can be located from the intake for different vertical pumping distances if all other losses in suction, such as those due to friction, are negligible. A sampler located in the gage house at the Freeburg site would require approximately 130 ft of tubing and a vertical lift of approximately 25 ft above the mean water surface; this combination of vertical lift and friction loss is well beyond the sampler's pumping capacity (fig. 3).

The gage is about 2.2 mi from Freeburg, and the gage house is easily seen from the road. An additional concern, therefore, is the possibility of vandalism.

Purpose and Scope

The purpose of this report is to describe and illustrate the design and application of a floating sample-collection platform and to show the wiring and operation for the stage-activated sampler. The report describes tests of the sample-collection platform at one streamflow-gaging station in south-western Illinois from March through August 1990.

PLATFORM CONSTRUCTION, INSTALLATION, AND OPERATION

Three steps are involved in making the floating sample-collection platform operational: (1) construction and installation of the floating platform, (2) installation of the stage-activated sampler, and (3) programming the data logger to initiate sample collection. Each of these steps are described in the sections below.

Construction and Installation of Floating Collection Platform

The floating collection platform consisted of two 55-gal drums, flotation foam, two 2-in. steel pipes, and miscellaneous hardware. One of the barrels was completely filled with flotation foam, and the other barrel was filled to a depth of 16 in. A hole was cut in the foam of the full barrel, and a deep cycle battery was placed inside. The total minimum buoyancy of the two barrels attached was about 560 lb and the weight of the barrels, sampler, and battery was about 70 lb with full samples. Thus, about the upper 7/8 of the barrels are above the water surface when floating (figs. 4a and 4b). The foam inside the barrel also may function as a waterproof protectant for the electronic equipment. The two barrels were bolted together, and a hole was cut near the top of both drums to connect the battery cables to the sampler.

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[1]In this report, dimensions of pipes are nominal inside diameters. Use of brand and firm names in this report is for descriptive purposes only and does not constitute endorsement by the U.S. Geological Survey.

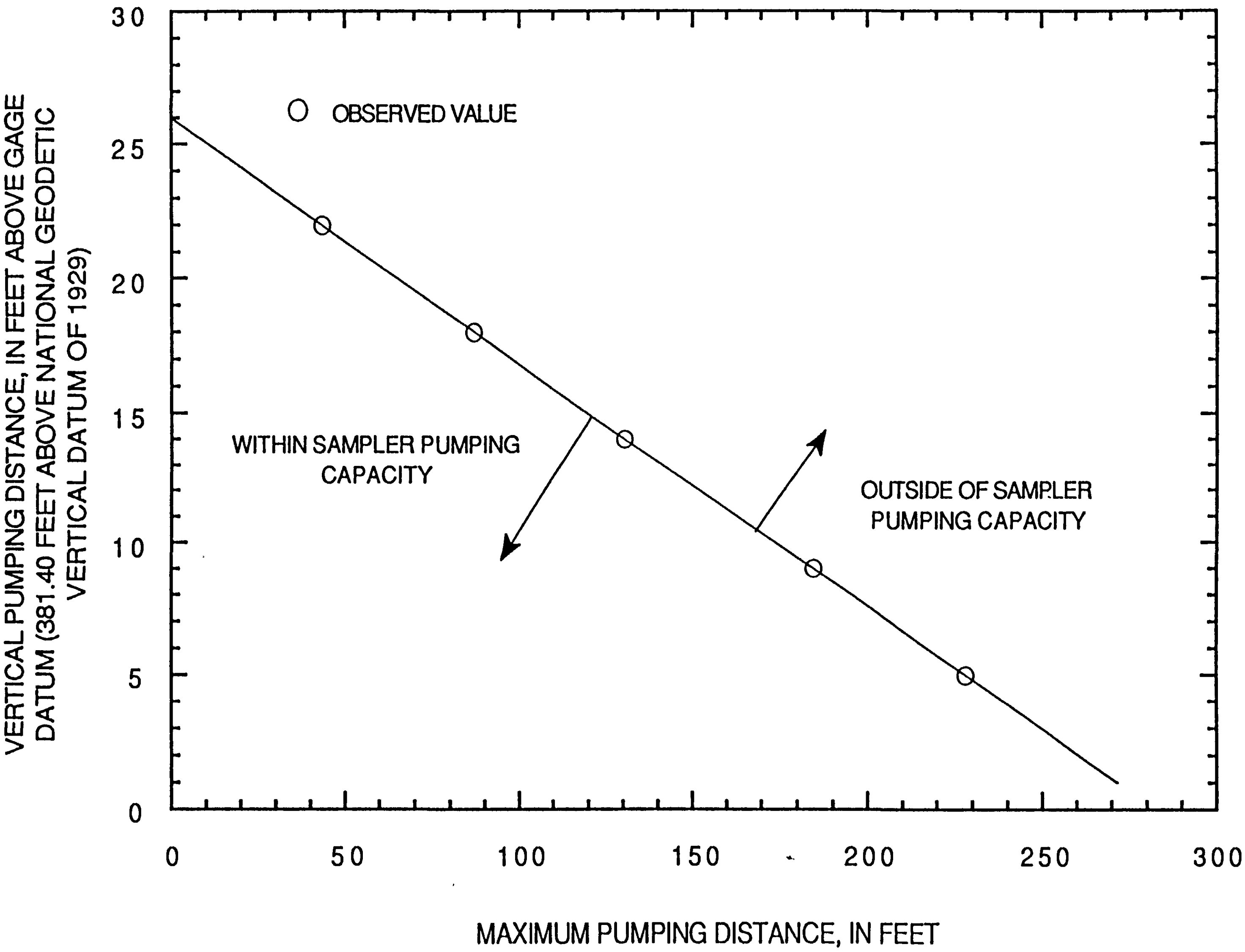


Figure 3.--Maximum horizontal and vertical pumping distance.

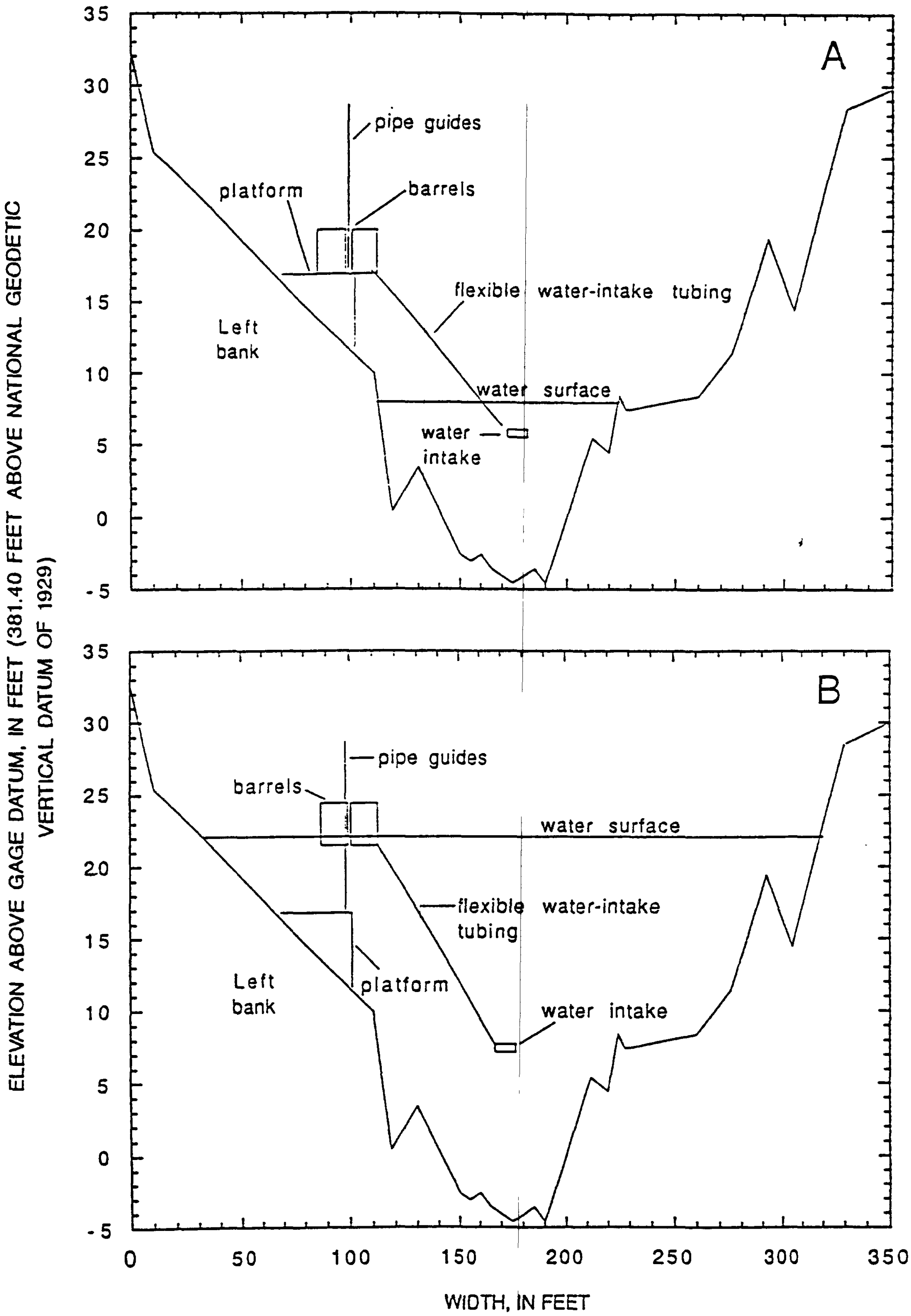


Figure 4.--Floating sample-collection platform at (A) normal stage and (B) flood stage.

Two 2-in. steel pipes were attached to the downstream side of the bridge to provide some protection from flood debris and to connect the platform to the bridge. U-clamps were attached in a vertical position at the top and bottom ends of one of the barrels (fig. 5) to secure the platform to the two 2-in. steel pipes that served as guides for the platform and as deterrents to vandalism. Control wires to connect the sampler on the platform to a data logger in the gage house were run through one of the 2-in. steel pipes, and eye bolts along the bridge were used to guide and hold the wire to the bridge.

In areas where vandalism could be a problem, the wires should be run through conduit. Flexible conduit should be used to shield the wires that are exposed for the vertical travel of the platform. The intake, if possible, should be run through flexible conduit from the platform to the water's edge. The conduit should protect the intake, and the intake should be affixed to the bottom of the stream by means of an angle iron to prevent the intake from floating to the bank.

Installation of Stage-Activated Sampler

After construction of the platform, it was necessary to install the sampling equipment itself--in this case, a battery, a Campbell Scientific CR-21 data-logger, an ISCO automatic water sampler, and the water intake line. The sampler was placed in the barrel half-filled with flotation foam. A hole was cut between the barrels, and the wiring was connected to the battery, data-logger control, and water-intake tubing. The sampler controls were adjusted for the site conditions as described in the sampler manual (ISCO, 1982). The data logger was placed in the gage house to protect it from weather, to facilitate connection to the stage measuring device, and to provide a good working area. A potentiometer was wired to the data logger and connected to the manometer--the stage measuring instrument--by chains and gears with a gear ratio that allowed the full range of stages to be covered in less than 10 turns of the potentiometer. The potentiometer was wired to the data logger to induce a voltage of 5 volts direct current (dc), relative to a common ground, across the potentiometer. The data logger would measure the output voltage from the potentiometer, relative to the same ground. The wiring configuration for the stage-activated sampler at Silver Creek near Freeburg is shown in figure 6. The data logger was calibrated to calculate the water stage according to the output voltage from the potentiometer by means of a linear relation between voltage and stage. An example calibration curve for this relation is shown in figure 7.

The data logger activates the sampler by emitting 5 volts for 10 seconds. The sampler requires a 12-volt pulse for a duration of at least 25 milliseconds to activate the sampler. The circuit shown in figure 8 converts the 5-volt triggering pulse into the required 12-volt pulse to activate the sampler.

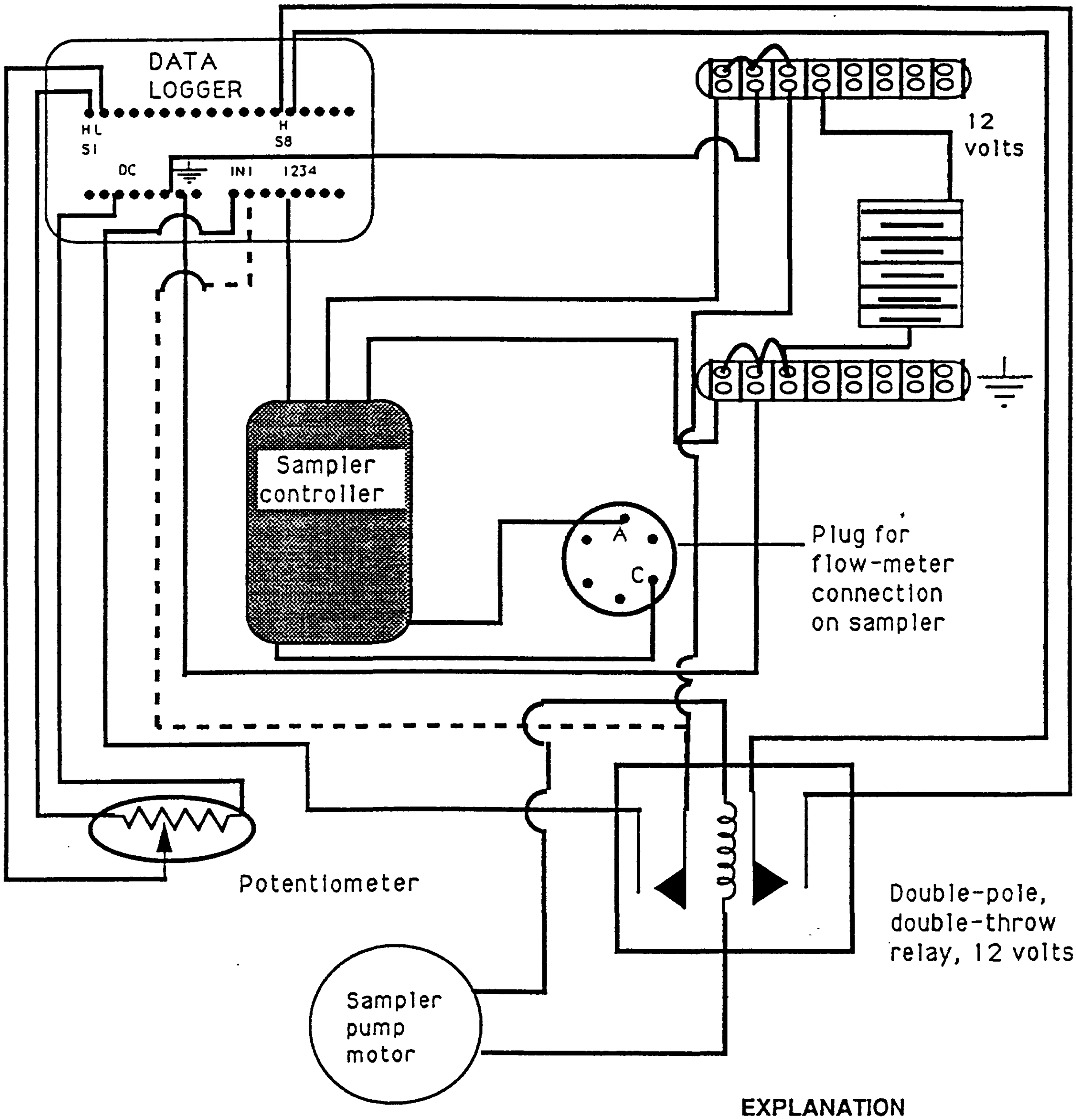
Stage-Activated Sampler Program Specifications

The data logger was programmed to collect samples at two different intervals (frequencies) according to the water stage. The data logger has a base-sampling time interval, or hydrologic time interval (HTI), that can be set from 0 to 60 minutes. Four threshold stages, H_1, H_2, H_3, and H_4, initiate

Top view looking down from deck of bridge (approximately 25 feet)

View at ground level

Figure 5.--Floating sample-collection platform.



EXPLANATION

DC	DIRECT CURRENT
HL,S1,H,S8, IN1,1234	LOCATION OF PORTS ON CR-21 DATA LOGGER

Figure 6.--Wiring diagram of CR-21 data logger.

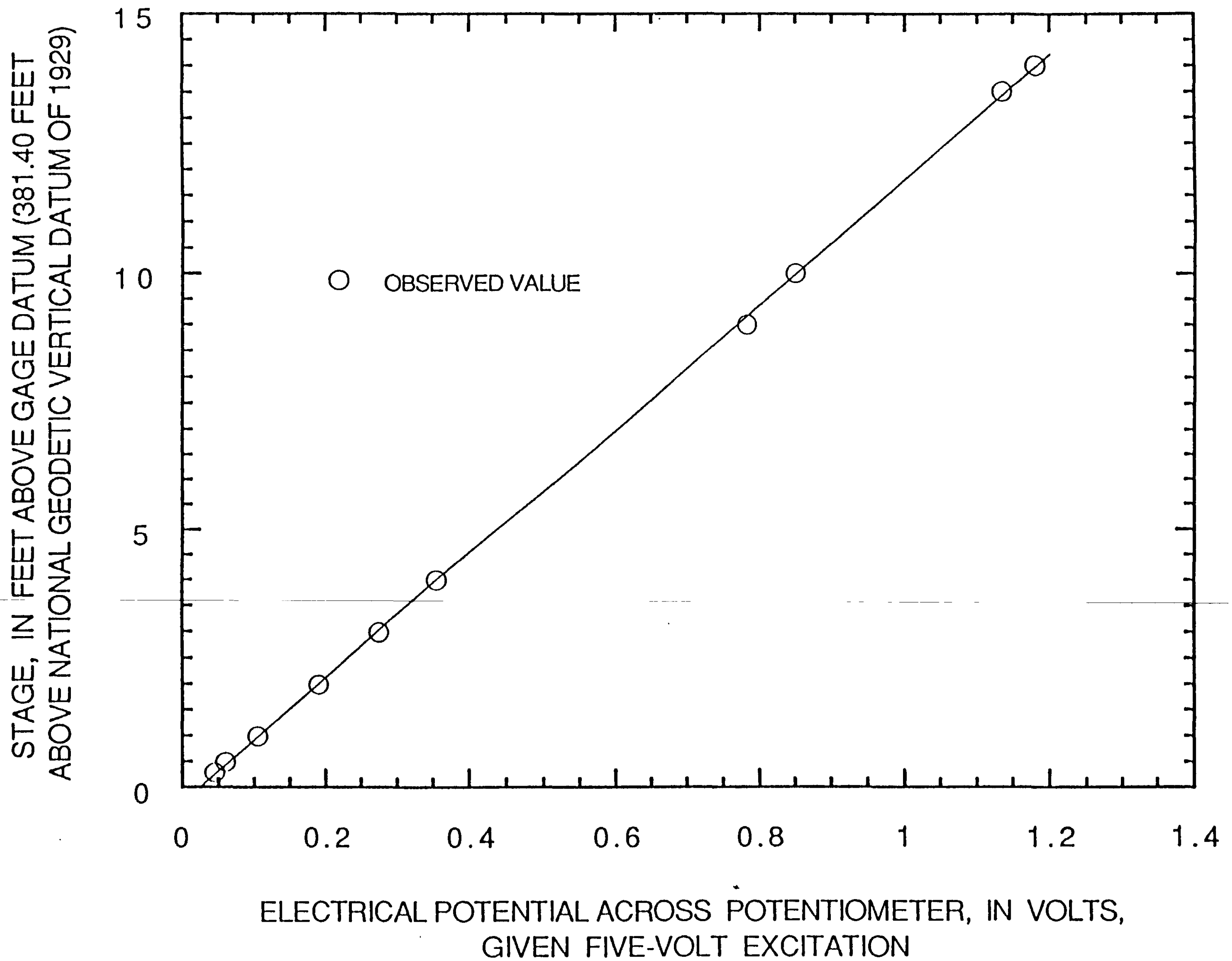


Figure 7.--Relation between river stage and voltage.

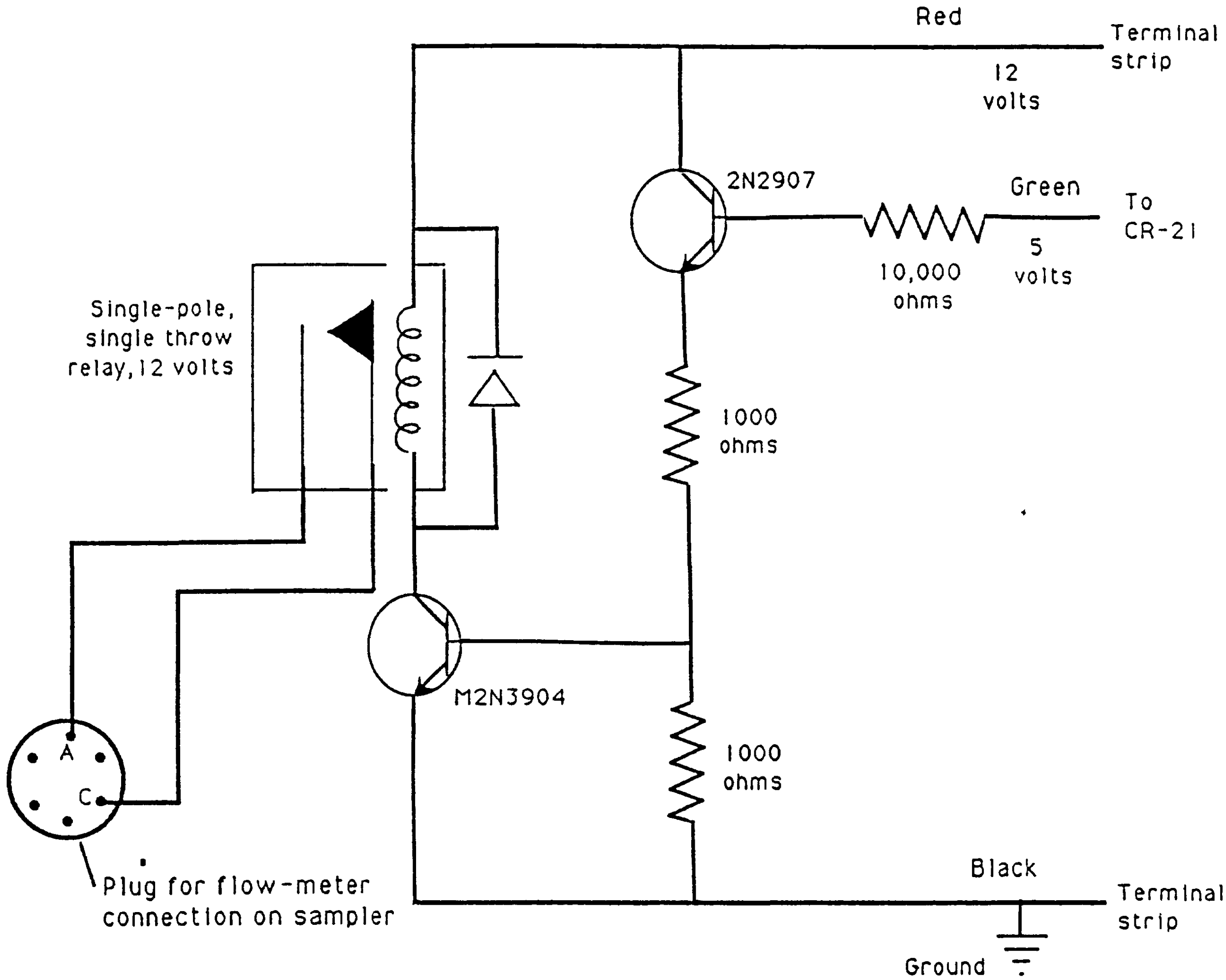


Figure 8.--Wiring diagram for sample-trigger circuit.

and determine time intervals between sampling. When the stage has risen above H_1 but is below H_2, or has fallen below H_3 but is still above H_4 (fig. 9), samples are collected at intervals of T_1 x HTI minutes, where T_1 is a multiplier of HTI for this stage range. When the stage has risen above H_2 but has not fallen below H_3, samples are collected at intervals of T_2 x HTI minutes, where T_2 is a multiplier for this stage range. Background concentrations at the site at Silver Creek near Freeburg were determined by setting HTI to 60 minutes, setting H_1 and H_4 to 0 ft, and setting T_1 to 48, which caused one sample to be collected every 48 hours. Threshold stages H_2 and H_3 were reprogrammed whenever the gage was inspected to increase the sampling frequency after a stage increase of 0.5 ft above the gage height at the time of inspection. The multiplier T_2 was set to 6, which caused a sample to be collected every 6 hours at stages greater than H_2 until either (1) the maximum number of samples were collected, or (2) the stage dropped below H_3, at which time the sampling frequency returned to once every 48 hours until the stage dropped below H_4, at which time sampling ceased and (or) the sampler was serviced.

The power line to the sampler pump motor was connected to a relay, which activated a pulse counter in the data logger, to determine the time each sample was collected. The pulse counts and time intervals between pulses enabled personnel to calculate when each sample was collected. The wiring diagram for the entire system is shown in figure 6.

APPLICATION AND TEST OF SAMPLER PERFORMANCE

Figures 4a and 4b illustrate the channel cross section at the station. The channel is fairly wide at this point, and the low right bank overflows frequently. Locating the sampler at a high elevation near the gage house to prevent flooding of the sampler would increase the horizontal distance needed to pump water at low stages; under these conditions, the pump's capacity would be exceeded. The left bank is steep and difficult to reach. Therefore, the floating sampler was designed to improve consistency of pump head and to prevent submergence of the sampler.

The streamflow-gaging station at Silver Creek near Freeburg was used to provide the discharge record for the sampling of pesticides during periods of storm runoff. The floating sample-collection platform was tested during a storm on May 17, 1990. The stream stage crested at 21.8 ft above gage datum of 381.40 ft NGVD of 1929 (fig. 3) and resulted in a flood that exceeded the 100-year recurrence interval for Silver Creek near Freeburg. The floating platform worked well and rose with the rising stage until it became lodged under the bridge deck. The sampler collected samples successfully until the limit of vertical travel was reached. If adequate vertical travel had been allowed, the platform would have kept the sampler above water. The water flooded the battery, which then shorted out, inactivating the sampler. As the stage fell below the bridge deck, the sampler platform emerged from the water and continued to float.

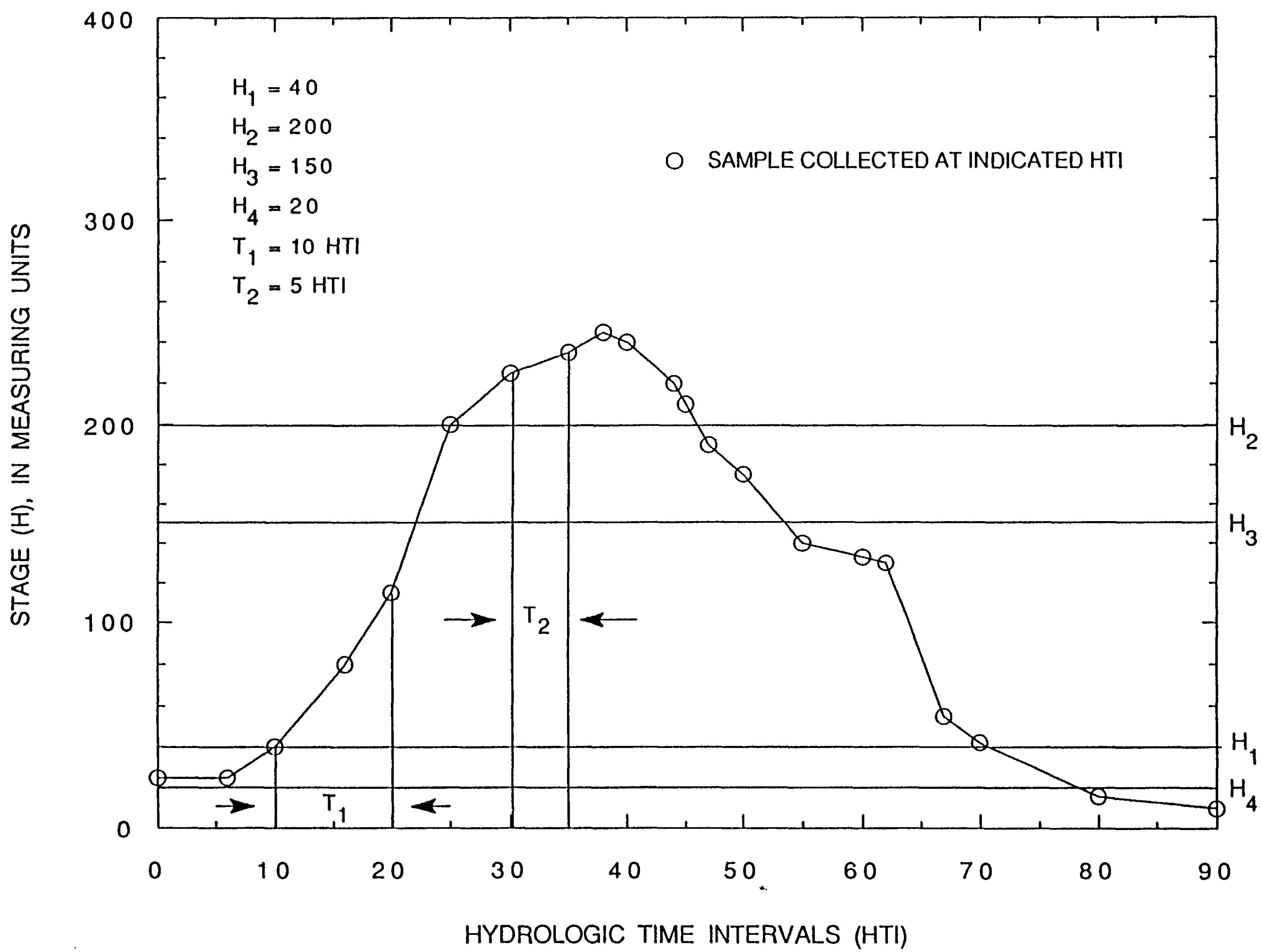


Figure 9.--Sampler-trigger depths and sampling frequency.

SUMMARY

Automatic samplers were used to monitor concentrations of triazine herbicides after high streamflows at three sites in Illinois. Three operational problems were encountered at the Freeburg site: (1) The suction head of the sampler was not great enough to collect a sample if the sampler was installed in the gage house, (2) the sampler could be submerged during a high streamflow, and (3) the sampler could be vandalized if placed within the flood plain.

The problems were successfully overcome by means of a floating sample-collection platform. The problems created when horizontal or vertical distance from the water exceeded the suction head were overcome. An automatic water-quality sampler and battery were installed in two 55-gallon barrels. The barrels were attached to 2-in. steel pipe that was attached to the side of a bridge. As long as the installation allows for adequate vertical travel, the rise or fall in stage will not affect the sampler's ability to collect samples. The chances of vandalism are minimal because the equipment is locked in the barrels and the platform is bolted to the 2-in. steel pipe. The floating sample-collection platform can be used in many applications and is not limited to streams subject to large and rapid changes of stage. The platform could be used at a site where vandalism is a problem or where the stream is large and servicing from a boat would be easy.

REFERENCE CITED

ISCO, Inc., 1982, Instruction manual, model 2100 wastewater sampler: Lincoln, Nebr., ISCO, Inc., 84 p.