ORSANCO

Quality Control Assurance Program

1981

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ORSANCO

QUALITY CONTROL ASSURANCE PROGRAM

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INTRODUCTION

The following procedures outline a program for quality control assurance for the ORSANCO regional river monitoring program. Essentially, the procedures are in conformance with those previously published in the Federal Register as proposed guidelines for monitoring (Appendix A, Section 106 and the forthcoming guideline to regions and states under the so-called Model States Program). Elements of the program are: representative sampling, sampling devices and preservation of samples, shipment of samples, chain of custody, analytical procedures, quality control of data, and data reporting.

Representative Sampling

Initially, each sampling point is selected by making measurements with field instruments for temperature, pH, conductivity and dissolved oxygen (DO) at various points and depths across the river. Following the initial survey, representative points are chosen. This multipoint examination is performed periodically to ensure continued validity of the selected point.

Sampling Devices and Preservation of Samples

The conventional "Ohio River" sampler, sometimes called the Sargent sampler, is used for sample collection. This sampler has a volume of about 3-4 liters and can accommodate two DO bottles when such samples are required. The sampler is made of cast aluminum with stainless steel fittings and weighted from the outside so that it may be used for metals sampling.

A set of bottles, either of plastic or glass, sterile or nonsterile as required, and of appropriate volume, is supplied for each sampling location. Sample bottles are spiked with the appropriate preservative by laboratory personnel before the bottles are sent into the field, or by the sample collector at the time of collection using prepackaged ampules of preservative. Reagents used for preservatives are checked for acceptable quality and freedom from contamination by a quality control officer. Methods of preservation for all samples adhere to guidelines suggested in the EPA Manual of Methods for the Chemical Analysis of Waters and Wastes, 1974. All samples requiring preservation are iced ($4^{\circ}C.$) and shipped to the appropriate contract lab the same day collected. All samples requiring field filtration (i.e., dissolved trace metals) are filtered immediately after collection in the field through a membrane filter (0.45). In cases where recommended holding times cannot be met, the laboratory quality control officer determines whether samples are to be analyzed or discarded.

Shipment of Samples

Shipping containers are coolers with impact-resistant outer coverings and fitted lids to maintain cooling efficiency. Ice needed for cooling is obtained locally. A standardized protocol for shipping the sample cartons to the laboratory in minimum time has been established.

Measurements which can be performed efficiently and accurately in the field are performed at the time of collection to reduce the number of shipping containers required. For such measurements, field instruments are calibrated

by approved techniques as specified by the manufacturer on each day of use. Such calibration data are permanently recorded in field notebooks. (Section II).

Arrangements have been made with local laboratories to perform those measurements requiring minimal holding times, i.e., coliform, 5-day BOD.

Chain of Custody

Using waterproof ink, the sample collector labels sample bottles with all information pertinent to the sample in an approved log form. The sample collector attests by signature on the bottle and in the log form to the validity of the sample.

All samples, having been duly recorded, are delivered by the sample collector to the authorized carrier for shipment to the receiving laboratory. At the receiving laboratory, all samples are delivered to the authorized laboratory personnel.

In special cases, such as enforcement cases where it is legally imperative that sample integrity be maintained, special chain of custody procedures will be followed as required to satisfy the parties involved.

Analytical Procedures

Analytical methods used for analysis of all samples conform to those methods cited in Federal Register, Vol. 33, No. 199, Part II, "Guidelines for Establishing Test Procedures for Analysis of Pollutants."

In the event that an analytical variance is required, the request for the variance is made by the ORSANCO Executive Director following the protocol prescribed in the Federal Register cited above.

The choice of methods for certain biological and microbiological examinations for which no official guidelines have been promulgated is made following advice from qualified authorities.

Quality Control of Data

Quality control of analytical data is achieved by: a)routine calibration and maintenance of laboratory instruments and equipment; b) routine verification of working standard curves; c) determination of individual method precision and accuracy; d) use of reference samples and blind samples to verify daily results; e) use of reference samples and standards, as knowns or unknowns, as additional checks. (See Section IV.)

Reporting of Data

All data are reported using the accepted reporting levels (Section III) and in a form suitable for computerized storage and retrieval. Sample data, along with the quality control data, are sent by the analytical laboratory to the ORSANCO office for review before computer entry and before samples are discarded. For storage and retrieval of data, the most recently distributed STORET parameter codes are used. (See Section III.)

Samples are not held longer than seven days after the data have been reported to ORSANCO, except for those samples involving chain-of-custody and enforcement actions.

Calibration and Quality Control of Data for Automatic Monitor

In general, the calibration of the instrument is performed according to the manufacturer's recommendations by a duly qualified representative of the manufacturer

or commission representative. (See Section V for a detailed description of procedures.) All instruments are inspected, repaired as necessary, calibrated and restandardized on a fixed schedule every two weeks.

The procedures used are as follows:

pH - Clean electrodes as necessary; calibrate using standard buffers at 4 and 7 to ensure linearity. When practical, a separate pH check may be run with a precalibrated field meter against a stream sample.

Temperature - Clean sensor; calibrate with a standard NBS-certified thermometer.

Dissolved oxygen - Clean sensor; standardize against a DO measurement using the Winkler method. When practical, a separate check may be made against an air-calibrated sensor.

Conductivity - Calibrate with standard conductivity solution at or near stream conductivity and at $\pm$ 100 micromhos. When practical, a check may be made against an actual stream sample using a precalibrated field meter.

A record of maintenance for each monitor is kept in a permanent record book showing the date of maintenance and standardization with readings before and after calibration. Accumulated data are discarded (or flagged) if the maintenance update shows sensor drift of $\pm$5 percent from the true reading.

Specific instructions to the field personnel concerning safety, sample collection, preservation and shipment techniques and the use and protection of field equipment are contained in "Quality Control in Field Sampling and Analysis" (Section II).

I

RIVER CROSS-SECTION
FOR
ORSANCO MONITORING PROGRAM

The ORSANCO river cross-sectioning program is conducted to fulfill the following specific objectives at all of the monitoring stations covered by the monitoring strategy:

1. To determine the variation in dissolved oxygen, pH, conductivity and temperature in the river at each station;
2. To determine the adequacy of the robot and manual sampling locations, if they are representative of the dissolved oxygen, pH, conductivity and temperature of the river;
3. To compare the robot data with the observed river values at the time of cross-sectioning.

Procedure

The cross-sectioning of each of the 36 stations consists of performing dissolved oxygen, pH, conductivity and temperature measurements at three or more points across the river, depending upon the width of the river and other hydrologic factors. The depth measurements are made at five-foot intervals starting about two feet from the bottom and ending at one-and-a-half feet from the surface.

Measurements are made at the same location as each specific manual and automatic sampling point.

Measurements are also made on the water samples from intake lines to the robot monitor, to determine if there are any changes in water quality, especially in the dissolved oxygen concentration, as the water flows through the intake line.

Water quality monitors manufactured by Martek (Model Mark III) and NERA (Model 4) have been used for the river measurements. Accuracy specifications for the instruments are as follows:

Martek III Monitor:

DO probe	$= \pm$ 0.1 mg/l
pH probe	$= \pm$ 0.05 pH units
Conductivity probe	$= \pm$ 2 percent
Temperature probe	$= \pm$ 0.1°C from -2°C to 45°C
Depth probe	$= \pm$ 1.0 percent

NERA Water Quality Monitor:

DO probe = $\pm$ 0.1 to 0.2 mg/l

pH probe = $\pm$ 0.2 pH units

Conductivity probe = $\pm$ 0.2 percent

Temperature probe = $\pm$ 0.1^{o}C

All meters are reported by the manufacturers to have an accuracy of approximately $\pm$ 1.0 percent.

Robot monitors and the instruments are calibrated before cross-sectioning and the DO probes are checked against Winkler titration.

Data Analysis

The cross-sectional data are analyzed by plotting the cross-sectional profile and performing a statistical analysis to find the variation of DO, pH, conductivity and temperature within the river and to compare the robot data with the observed values in the river.

Cross-sectional Profile

Two dimensional charts are prepared which represent the cross-section of the river at all stations along the Ohio River and lower reaches of major tributaries. The profiles show the difference between the actual observed values and the overall average for DO, pH, conductivity and temperature.

Statistical Analysis

A. Discrepancies across the river

The coefficient of variation, or relative variation, is calculated in the following manner to determine the actual variation of DO, pH, conductivity and temperature in the river at all stations, because it is a measure of the dispersion of the average value of these parameters across the river:

$$CV = \frac{SD}{M} \times 100$$

where:

CV = coefficient of variation

SD = standard deviation

M = average value of a parameter

The CV value is a relative value which can be used for the purpose of comparing parameters.

B. Adequacy of the robot and manual sampling locations

For the point where each manual sample is collected and the intake for each electronic monitor, the mean of the samples collected at that vertical section is compared with the range revealed by the 95 percent confidence interval.

Ninety-five percent confidence intervals are calculated as:

$$C\,I_{95} = M_R \pm 1.96 \sqrt{R}$$

Where:

M_R = overall averages of a parameter in the river

1.96 = confidence factor for 5 percent level of significance

$\sqrt{R}$ = standard deviation of a parameter in the river

C. Comparison of robot data and observed river value

The 95 percent confidence intervals calculated above are used to determine if the robot data are within these limits.

II

QUALITY CONTROL IN FIELD SAMPLING AND FIELD ANALYSIS

This section of the ORSANCO Quality Control Assurance Program for the Primary In-stream Monitoring Network is divided into five elements:

1. Safety in the Field
2. Sampling, Sample Handling and Preservation
3. Sample Shipment
4. Analysis Techniques with Field Instruments
5. Special Samples

Safety in the Field

There are a number of situations that each surveillance specialist will encounter at different locations, and each of these situations must be given full consideration and attention. At any sampling site, safety is a prime consideration. There is no short cut to safety. No water sample is worth the life of a field person.

If the sampling operation is conducted from a bridge and the vehicle must be parked either on the bridge or at the bridge approach, every precaution must be taken to minimize traffic hazards. Park the vehicle in the least hazardous place with safety flashers operating. Set out warning flags as appropriate. Take the sample as quickly as possible and perform the necessary operations as promptly as possible. Do not linger in the area. Be especially cautious in bad weather and during early morning or twilight hours. If special or unusual conditions exist that the supervisor-in-charge does not know about, report them.

If the sampling operation is conducted from a restricted area (power plant, dam, etc.), check in as appropriate. Do not assume that the guard knows that you are in the area. Register upon entering premises. If hard hats or life jackets are required, use them. Operate your vehicle with special care on the company grounds and park it where it will not be an inconvenience to company personnel or violate company rules.

Since many of the monitors are installed in remote, isolated areas of power plants and water treatment plants, it is a good practice to let local personnel know that you are in the area and should return within a specified period of time. Similarly, let the same persons know when you are leaving the area. By all means, police the area carefully after you have serviced the

automatic monitor and have completed the required field analyses. If you observe any unsafe conditions such as electrical hazards, greasy catwalks, etc., report them to the local man in charge.

Sampling, Sample Handling and Preservation

The ORSANCO Monitoring Network consists of 36 stations, of which 22 are located on the Ohio River and 14 on lower reaches of the major tributaries. This network represents a nucleus of key locations above and below major population centers and industrial areas, and in critical sections of the relatively new higher level pools on the Ohio River. The stations were selected by the Monitoring Strategy Study Team from a compendium of potential sites recommended by the participating agencies for satisfying their need with regard to statutory requirements.

The analytical parameters selected and the frequency of sample (Table 1) are designed to provide sufficient information to appraise water quality conditions at each location and to provide for comparisons of quality with other sections of the river. Data reviews in the future may indicate that frequency of sampling should be altered, sampling sites moved, additional analyses added to the existing list, or that some analyses should be omitted. Meanwhile, it is the basic function of the surveillance specialist to visit the sampling station at the scheduled time and secure the samples in the prescribed manner.

Sampling Schedules

The sampling schedule for the ORSANCO river monitoring network has been planned so that it should be possible to sample each of the selected sites once every month or more frequently using three full-time field representatives. Each field person is responsible for approximately one-third of the river, but the number of sites assigned to each person is not the same because of varying distances between sites. The sampling stations are shown in Table 2, which also indicates designated CORE stations in the National Basic Water Monitoring Network.

Samples are always taken at the official site. If access to the site is not available for one reason or another (locked gate, high water, icy walkways, etc.), the sample may be taken at the nearest convenient point, which is duly noted on the sampling report form.

Locations of Sampling Sites

Each sampling site in the ORSANCO monitoring network is located and briefly described on a page of the navigation charts included in Appendix A. For example, the location of the South Pittsburgh station on the Monongahela River at mile point 5 is described on the navigation chart as "intake to Western Pennsylvania Water Co. . . . collected from platform above intake structure."

Securing the Sample

The basic sampling instrument used by the ORSANCO monitoring team is the so-called Ohio River sampler. The original material used to construct the sampler was copper, because of ease of construction. At the time (mid-1930's) there was little concern about trace metals in surface waters. The bucket is currently made of aluminum with exterior weight in the form of lead plates, so that samples may be taken with no detectable metals contamination. The sampler is designed to accommodate collection of samples for dissolved oxygen measurement and/or bacteriological samples. The sampler also provides for a three-fold displacement of water in the DO bottles without aeration. Additional sample volume is secured at the same time to allow for other analyses.

TABLE 1

Analytical Schedule for ORSANCO

Primary Monitoring Network Stations[1]

Group 01 (Semimonthly[2])	Group 11 (Monthly)	Group 21 (Quarterly)
Cyanide	Coliform, fecal[3], BOD_5	All of Group 11
Phenolics	Suspended Solids	plus:
Tot. Kjeldahl Nitrogen	Tot. Kjeldahl Nitrogen	Arsenic
Nitrite+Nitrate as N	Nitrite+Nitrate as N	Selenium
Ammonia as N	Ammonia as N[4]	Silver
Tot. Phosphorus	Tot. Phosphorus	Manganese
	Sulfate	Magnesium
	Alkalinity[5]	Nickel
	Cyanide	Chromium
	Phenolics	Barium[7]
	Total Hardness	Sodium[7]
	Copper	
	Iron	
	Zinc	
	Mercury	
	Lead	
	COD[6]	

In addition to the laboratory analyses, each sample is analyzed in the field for temperature, dissolved oxygen, conductivity and pH.

1 As prescribed by the commission, September 14, 1978

2 At electronic monitor stations only--May through October

3 Fecal coliform will be analyzed at all stations May through October and at CORE stations only the remainder of the year.

4 Nutrients will be collected on non-CORE stations from May through October only but at CORE stations all year.

5 All stations in Pennsylvania and at East Liverpool, OH

6 CORE stations--those monitored as part of the National Basic Water Quality Monitoring Network (see Table 2)

7 Mainstem stations only

TABLE 2

ORSANCO Primary Monitoring Network Stations

Station Name	River	Core	Approximate Mile Points	Type Station+
Oakmont	Allegheny	*(Pa)	13	A
South Pittsburgh	Monongahela	*(Pa)	5	A
South Heights	Ohio	*(Pa)	15	A
Beaver Falls	Beaver	*(Pa)	5	A
East Liverpool	Ohio	*(Pa, WV)	40	A
Pike Island	Ohio	*(WV)	84	B
Shadyside	Ohio		102	A
Hannibal	Ohio	*(WV)	126	B
Willow Island	Ohio	*(WV)	162	B
Lock & Dam #2	Muskingum		6	B
Belleville	Ohio	*(WV)	204	B
Addison	Ohio	*(WV)	260	A
Winfield	Kanawha		31	A
Gallipolis	Ohio	*(WV)	279	A
Huntington	Ohio	*(WV)	307	A
Kenova	Ohio		316	B
Louisa	Big Sandy	*(Ky)	20	A
Greenup	Ohio	*(Ky)	341	B
Lucasville	Scioto		15	B
Meldahl	Ohio		436	B
Cincinnati	Ohio		463	A
Little Miami	Little Miami		8	B
Kenton County	Licking	*(Ky)	5	A
North Bend	Ohio		490	A
Great Miami	Great Miami		6	A
Markland	Ohio		532	A
Louisville	Ohio	*(Ky)	601	A
West Point	Ohio	*(Ky)	626	A
Cannelton	Ohio		721	A
Sebree	Green	*(Ky)	41	B
Evansville	Ohio	*(Ky)	792	A
Uniontown	Ohio		846	B
New Harmony	Wabash		52	A
Barkley Dam	Cumberland		31	B
Paducah	Tennessee	*(Ky)	6	B
Joppa	Ohio	*(Ky)	952	A

\+ A - Combined monitor and manual
B - Manual only

* Pa, WV, KY = National Basic Water Quality Monitoring Network CORE stations as designated by state. None designated by OH, IND, ILL, VA, NY.

In use, the sampler should have sufficient exterior weight attached to the outside of the bottom to submerge it promptly. In flowing water, an inadequately weighted sampler will float some distance with the current before sinking. Sufficient weight decreases the angle between the line and the vertical so that the depth accuracy is improved. To ensure that the sample is taken at the desired depth, the sample line should be marked or knotted at regular intervals so that the sample collector can read the depth of the sampler below the surface.

The interior of the bucket must be kept scrupulously clean. After each sample, the bucket should be emptied and visually inspected for residual debris or oil films that may contaminate the next sample. If it is contaminated with oil or grease, clean with detergent and rinse thoroughly with water. Good field practice requires that the bucket is rinsed first with the sample being taken, in order to avoid sample-to-sample contamination by abrupt changes in concentrations. In the case of ORSANCO samples, however, where there are no dramatic changes in sample-to-sample concentrations because all samples are taken from the same surface waters, it is sufficient to use the previous sample taken as rinse for the next sample. If the bucket is kept reasonably clean and emptied after each sample, it should not be necessary to obtain a preliminary rinse sample. In the unlikely event, however, that an unusual condition is encountered when a sample is taken, i.e., a heavy oil slick or similar condition, the bucket must then be thoroughly cleaned with detergent and rinsed with water before taking the next sample.

Securing the Sample with the Use of the Ohio River Sampler

Place two clean, dry DO bottles in the spring clips mounted in the bottom of the bucket. Position the lid on the bucket so that the dip tubes on the underside of the lid are inserted into the open necks of the DO bottles. Fasten the lid securely in place with the pivoting wing nuts mounted on the flange of the bucket. Lower the bucket into the water to the depth of five to six feet, and wait a sufficient length of time (until bubbling ceases) to ensure that the bucket is full. Retrieve the bucket, remove the lid and carefully remove the DO bottles. Promptly stopper the bottles and place in the sample cooler. If a large volume of sample is needed, pour the water remaining in the sample bucket (after removal of the DO bottles) into a larger container and repeat the sampling operation without the DO bottles. The auxiliary sample container should be a plastic container of about two-gallon capacity, fitted with a lid to retard spillage. The auxiliary container must also be kept scrupulously clean and rinsed in the same manner as the sample bucket.

Protection of Samples, Dilute Solutions and Field Instruments from Freezing

In the spring, summer and fall months when weather temperatures are normal, no special temperature precautions for protection of the samples, various dilute solutions and instruments are required. In the winter months, however, when air temperatures are below freezing for extended periods of time, there is always the danger of sample and solution loss or instrument damage due to icing and freezing.

During freezing weather, remember that the following events may occur:

1. DO bottles, filled with water at the freezing temperature and exposed at sub-freezing ambient air temperatures, will freeze and crack.
2. Buffer solutions used for pH standardization will freeze.
3. Standard solutions used for conductivity standards will freeze.

4. Ampouled preservatives may freeze and crack the container.
5. pH electrodes may freeze and crack.
6. Miscellaneous phenomena.

Take whatever sensible precautions are required to forestall the freezing and icing events. Store such equipment in insulated chests, in the heated rear of the van or in the heated cab of the pick-up truck. Particularly use special care to protect the pH electrode, since any damage to this item is a costly one.

It is suggested that the field work required after securing the sample (field measurements, sample preparation, etc.) may be performed under roof at the various sampling sites. While this may not always be possible, it does offer an alternative in some cases.

Preservation of Samples

After returning to the vehicle, mix the sample in the auxiliary container, either by stirring or inversion and aliquot the sample to the inversion, pre-washed bottles of the proper size according to the determinations to be performed (Table 3). Any stirring device used to agitate the sample prior to aliquoting should be constructed of an inert plastic material.

Add the proper preservative to each portion as indicated in Table 3, but do not open the ampoules containing the preservative solutions until immediately prior to use. Note that the constricted neck of the opened ampoule restricts the flow and tapping the inverted ampoule against the neck of the sample bottle may be necessary. Avoid scattering of the preserving solutions; if any of these fluids touch the skin or clothing, flush the area with water. An acid burn of any significance should have medical attention.

Shipment of Samples

All samples are to be shipped by a ground express carrier to ensure delivery to the lab within 24 hours. Any bus shipment, in which a transfer or similar problem is anticipated, is to be shipped by Greyhound's "Next Bus Out" service, where expedited shipment is guaranteed. All samples are to be shipped in insulated coolers packed with ice. Delivery arrangements have been made with local delivery services under contract to provide expedient delivery of samples to the laboratory. Shipments arriving during the night are transferred to the laboratories at the start of business on the following day. The sample report form which accompanies each sample is the log-in document which the lab uses to indicate time of arrival at the lab.

Chain of Custody

Normally, the samples and analytical data obtained by the ORSANCO Monitoring Network do not possess the legal significance requiring a chain of custody protocol. In the event that a situation should arise in which such a formal procedure will be required, the chain of custody procedure recommended by the EPA Regional Office in which the situation arises will be used.

The surveillance specialists should note, however, that proper identification of all samples is a vital necessity. Misidenitified samples result in confusing data production. Unidentified samples or samples

TABLE 3

Sampling and Analytical Requirements

LABORATORY TESTS

Parameter	Treatment	Sample Volume (ml)
01 Analyses		
Cyanide	Raw, NaOH	500
Phenolics	Raw, $CuSO_4$ + H_3PO_4	500
11 Analyses		
Residue, TKN, T. Phosphorus, Sulfate, Ammonia, Nitrite + Nitrate, Alkalinity[1]	Raw, mixed	1000
Cyanide	Raw, NaOH	500
Phenolics	Raw, $CuSO_4$ + H_3PO_4	500
Hardness, Copper Iron, Zinc, Mercury, Lead, Cadmium	Raw, HNO_3	1000
BOD_5,	Raw, mixed	1000
Coliform, Fecal[2]	Raw, mixed	250
COD[3]		
21 Analyses		
All as in 11 Group Analyses Plus:		Same as for Group Analyses
Arsenic, Selenium, Silver Manganese, Magnesium, Nickel, Chromium, Barium[4], Sodium[4]	Raw, HNO_3	

FIELD TESTS

Temperature, ^{o}C
Dissolved Oxygen
pH
Conductivity
Total Diss. Solids (calculated from conductivity)

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1 All stations in Pennsylvania plus East Liverpool, OH.

2 Fecal coliform will be analyzed at all stations May through October and at CORE stations only the remainder of the year

3 CORE stations only

4 Ohio River mainstem stations only

illegibly labeled are simply discarded in the laboratory, resulting in useless field work.

Analysis Techniques with Field Instruments

Four parameters must be measured as soon as possible after the sample is taken because of their instability. These are conductivity, pH, dissolved oxygen and temperature. Temperature and dissolved oxygen should be run as soon as possible after the sample is taken; pH and conductivity are not as critical but also require measurement in the field. Each of these measurements is affected by ambient air temperature and the necessary precautions and corrections for each must be observed.

The instruments supplied to the field representatives for these determinations have been selected by the ORSANCO staff as being the best suited for the measurements required. However, the best evidence of suitability is performance under the varying and often adverse conditions of actual field use. The surveillance specialists are urged to view these instruments critically for signs of fragility, instability, corrosion, chronic maintenance problems and other impediments to efficient field use.

Comments and observations regarding instrument malfunctions or desirable improvements are encouraged.

Temperature

The Fahrenheit thermometer should be used for calibration of the automatic monitors; the Centigrade thermometer should be used for reporting temperature of the grab samples at the time of collection.

For measurement of temperature of the grab sample, remove the DO bottle from the sampling bucket as soon as it is retrieved. Then, with the sample still in the bucket, immerse the stem of the thermometer at least three inches below the surface of the sample and wait about one minute for the temperature to equilibrate. Read the thermometer with the thermometer immersed in the sample. Do not remove the thermometer from the sample in order to read it more conveniently.

Report the temperature on the report form to the nearest 0.1°C.

Dissolved Oxygen

The instrument supplied by ORSANCO for this measurement is the Weston and Stack Model 330 Dissolved Oxygen Analyzer, equipped with a Model 33 Lab Probe. The lab probe is designed with a built-in agitator to provide the necessary sample flow. Each surveillance specialist must be familiar with the details of operation and routine maintenance prescribed in the instruction manual supplied with the instrument.

The DO meter should be standardized daily, or in the case of intermittent operation, before use. Use the standardization procedure outlined in the Weston and Stack Manual, employing the Winkler method. The "wet bottle" standardization, which is not outlined in the Weston and Stack instruction manual, may also be used as follows:

1. Place about 100 ml of distilled water in a standard DO bottle; stopper and shake vigorously;
2. Remove the stopper and insert the probe, taking care not to wet the tip of the probe;

3. Note the temperature of the air phase in the bottle, as indicated on the Model 330 meter. Switch the meter to the high DO range and adjust the reading according to the following table:

Temperature (°C)	Oxygen (mg/l)
20	9.2
21	9.0
22	8.8
23	8.7
24	8.5
25	8.4
26	8.2
27	8.1
28	7.9

The probe is now standardized for future readings, but should be calibrated daily. An occasional check of the wet bottle against the Winkler calibration is recommended.

To obtain a DO reading on the sample, remove the DO bottles containing a fresh sample from the sampling bucket as soon as it is retrieved. Stopper the bottles and return to the vehicle. Insert the probe into the bottle and note the DO reading, using the high range scale, and reading the result to the nearest 0.1 mg/l. Also, note the sample temperature as indicated by the meter to check the sample temperature as observed with the glass-stemmed mercury thermometer. Record the result on the report form.

If the sample on which the DO measurement was obtained is to be used for a BOD measurement, and if the DO is less than 9.2 mg/l, dribble a few drops of distilled water from a squirt bottle into the neck of the DO bottle to replace the small loss caused by probe displacement. Re-stopper the bottle and place it in the cooler for shipment to the laboratory.

pH

The instrument used for the ORSANCO pH measurement is the Leeds and Northup Model No. 7417 Portable pH meter. As with the other ORSANCO field instruments, it is the responsibility of the surveillance specialists to be familiar with the manufacturer's directions for use and maintenance of the meter.

Follow the manufacturer's instructions for standardization of the meter; however, to improve accuracy of readings, standardize the meter at two levels using both the pH 4.0 and pH 7.0 buffers. Discard the buffer solutions used for the standardizations; use fresh solutions each time the meter is standardized.

Abnormal instrument behavior, such as a wildly twitching needle, slow drift or erratic response, may be indicative of various instrument failures, such as a cracked electrode, weak battery, loss of KCl in the reference electrode, faulty electrical connection, etc. The battery check position of this instrument does not check all batteries. Such behaviors are most likely to be observed during the standardization operation. Refer to the manual for troubleshooting or return the meter to the ORSANCO office for repairs.

Note the temperature of the sample and adjust the temperature °C compensator to the measured temperature. Pour an aliquot of the fresh grab sample into the vessel reserved for pH measurement, and with the meter on standby, rinse the electrode by gently raising and lowering the container several times. Discard that portion of the sample and pour a fresh aliquot into the vessel. With the meter on pH, immerse the electrode into the sample and read the pH to the nearest 0.1 unit. Record the result on the report form. Rinse the electrode with distilled water and store until the next sample.

Conductivity

The instrument used for the conductivity measurement is the Solu Bridge RRB-3 portable battery-operated meter, equipped with a CEL-VS 2 dip cell. Details of operation, maintenance and troubleshooting are contained in the manual supplied with the instrument.

The conductivity cell supplied with the instrument has a stated cell constant of 2.0. The cell is very stable, barring accident or sample damage, and does not require standardization. However, the cell should be checked daily with the two standard conductivity solutions supplied by the ORSANCO office. These solutions have conductivities of 200 and 1200 umhos/cm.

Pour the standard solution into the container reserved for conductivity readings. Place the cell in the solution and move it up and down vigorously under the liquid to ensure removal of air bubbles from the cell casing. Discard the solution, place fresh solution in the container and repeat the operation. Take the conductivity measurement with the cell immersed in the solution to a point at least 0.5 inches above the uppermost air vent and no closer than 0.5 inches to the sides and bottom of the container. Apply the necessary temperature conversion for adjusting the reading to 25°C. Temperature compensation is necessary because the stated conductivity of the standard solutions implies reading at 25°C. The cell readings, with the 200 and 1200 umhos/cm standards should agree within ± 3 percent.

If the cell constant appears to have changed, a new constant may be calculated following the procedure outlined in Standard Methods, 14th Edition, pages 72 and 73. A damaged cell should be replaced with a new one.

Using an aliquot of fresh grab sample, rinse the cell with one or more portions, as described in the previous paragraph. Measure the resistance of the sample using the proper temperature compensation as outlined in the manufacturer's manual. Record the result on the report form.

Special Samples

The sampling requirements for pesticides, radioactivity and organics in water are listed in Table 4. No listing has been made for sediment sampling, pending further discussion concerning available methods.

The analytical procedures to be used will be those recommended by the U.S. EPA when and if a special sample program is initiated.

TABLE 4

Sampling Requirements for Special Samples

Parameter	Treatment	Sample Volume, (ml)
Radioactivity	Raw, mixed	1000 ml
Pesticides	Raw, mixed	1000 ml cleaned glass bottle
Purgeable organics	Raw, mixed	2 oz bottle[1]
Organics	Raw, mixed	1000[1]
Solvent extractable organics	Raw, mixed	1 gallon[1]

[1] See Section VI, "Glassware Cleaning and Handling," for special instructions.

Use of Water Quality Report Form

The ORSANCO Water Quality Report Form (Figure 1) is used to record field data, to provide instructions for laboratory analysis and to record laboratory data. Instructions for completing the form follow.

Station Name

The station name should be entered on all forms used. Names for regular stations with I D numbers assigned should remain uniform.

Station I D Code

The station I D Code (Table 5) is the four-digit code used at ORSANCO to identify stations to the computer. The first digit is the station type code. 1 is used for routine grab samples. The second digit is a state code. The third and fourth digits are station identifiers. Forms and samples from locations where routine samples have not been collected will not use this column, but will have the stream and mile point identified. The code designations are as follows:

First Digit

0 indicates water users data, pre-1972 U.S.G.S. data, or special reports from discharges data received during the Demo Project (1969-71).

1 indicates manual sample collected in accordance with the ORSANCO Monitoring Strategy.

Second Digit

This digit is a state code for sampling location.

1	- New York
2	- Pennsylvania
3	- Virginia
4	- West Virginia
5	- Ohio
6	- Kentucky
7	- Indiana
8	- Illinois

Third Digit

Sampling point identification code relating to sampling location.

00-29 - Mainstem Ohio River location

30-99 - Tributary location

Stream and Mile Point

This information may be omitted when station I D code is used.

Collection Data and Time

Numbers only should be used for the date; such as, 7-01-76. For the time, military time, time zone, and daylight or standard time should be entered; for example, 1415 CDT.

Analysis Code

A two-digit code is to be used.

ORSANCO WATER QUALITY
SAMPLE REPORT

Station Name _____ Station I.D. Code _____

Stream _____ Mile Point _____ Collection Date _____ Time _____

Analyses Code _____ Analysis Exceptions _____

Type Sample ☐ Routine Grab ☐ Other _____ Field Technician _____

Comments: _____

_____

_____

FIELD DATA

River Conditions _____

Weather _____

Water Temperature (C°)	1A	
Conductivity (μmhos/cm)	1B	
pH (su)	1C	
Dissolved Oxygen(mg/l)	1D	

LAB USE ONLY

Lab Number _____

Date Received at Lab _____ Time _____

Date Completed _____ Supervising Chemist _____

GENERAL

Flow(CFS)x 1000	2A	
Turbidity(JU)	2B	
Suspended Solids (mg/l)	2C	
Dissolved Solids (mg/l)	2D	
Acidity (mg/l)	2E	
Alkalinity(mg/l)	2F	
Sulfate(mg/l)	2G	
Chloride(mg/l)	2H	
Fluoride(mg/l)	2J	
Total Hardness (mg/l)	2K	
Calcium (mg/l)	2L	
Magnesium(mg/l)	2M	
Sodium(mg/l)	2N	
Potassium(mg/l)	2P	
Silica(mg/l)	2Q	
Phenolics(μg/l)	2R	
Cyanide(μg/l)	2S	
TOC (mg/l)	2T	
_____	__	

NUTRIENTS (mg/l)

Total Phosphorous(P)	3A	
TKN	3B	
Ammonia	3C	
Nitrate/Nitrite	3D	
Dissolved Phosphorous	3E	

BACTERIOLOGICAL

Total Coliform (#/100ml)	5A	
Fecal Coliform (#/100ml)	5B	
BOD_5 (mg/l)	5C	
COD (mg/l)	5D	
_____	__	
_____	__	
_____	__	
_____	__	
_____	__	
_____	__	
_____	__	
_____	__	

TOTAL METALS (μg/l)

Arsenic	4A	
Barium	4B	
Cadmium	4C	
Chromium	4D	
Copper	4E	
Iron	4F	
Lead	4G	
Manganese	4H	
Mercury	4J	
Nickel	4K	
Selenium	4L	
Silver	4M	
Zinc	4N	
_____	__	
_____	__	
_____	__	
_____	__	
_____	__	
_____	__	

Figure 1: ORSANCO Water Quality Report Form

TABLE 5

Station Codes for ORSANCO[1] Manual Monitoring Stations

Upper Ohio Region	
Allegheny River at Oakmont, Pa.	1233
Monongahela River at South Pittsburgh, Pa.	1237
Ohio River at South Heights, Pa.	1201
Beaver River at Beaver Falls, Pa.	1242
Ohio River at East Liverpool, Oh.	1500
Ohio River at Wheeling, W. Va. (Pike Island Dam)	1405
Ohio River at Shadyside, Oh.	1521
Ohio River at Willow Island, W. Va.	1408
Ohio River at Hannibal Dam, Oh.	1423
Muskingum River near Marietta, Oh.	1531
Ohio River at Belleville Dam, W. Va.	1421
Ohio River at Addison (Kyger Creek), Oh.	1510
Ohio River at Gallipolis Dam, W. Va.	1422
Middle Ohio Region	
Kanawha River at Winfield, W. Va.	1450
Ohio River at Huntington, W. Va.	1412
Ohio River at Kenova, W. Va. (South Point, Oh.)	1523
Big Sandy River near Louisa, Ky.	1630
Ohio River at Greenup Dam, Ky.	1621
Scioto River at Lucasville, Oh.	1538
Ohio River at Meldahl Dam, Oh.	1511
Ohio River at Cincinnati, Oh.	1504
Little Miami River at Cincinnati, Oh.	1571
Licking River at Covington, Ky.	1634
Ohio River at North Bend, Oh.	1508
Great Miami River at Cleves, Oh.	1551
Ohio River at Markland Dam, Ky.	1600
Lower Ohio Region	
Ohio River at Louisville, Ky.	1601
Ohio River at West Point, Ky.	1622
Ohio River at Cannelton Dam, Ind.	1721
Green River at Sebree, Ky.	1656
Ohio River at Evansville, Ind.	1703
Ohio River at Uniontown Dam, Ind.	1722
Wabash River at New Harmony, Ind.	1741
Cumberland River at Barkley Dam, Ky.	1645
Tennessee River at Paducah, Ky.	1650
Ohio River at Joppa, Ill.	1821

[1] Maps showing exact location of each of these monitoring stations are in Appendix A

Analysis Exceptions

Any exceptions to the standard analyses should be noted (identified by their codes) by marking add to the two-digit alpha numeric parameter code(s) and/or delete and the parameter code(s).

Type Sample

Either routine grab or other box should be checked and type sample specified in blank provided.

Field Technician

Form should be signed by person responsible for the collection and preservation of the sample.

Comments

This column is reserved for any comments or unusual conditions noted by sampler or special instructions to the lab.

River Conditions

Flow and general river conditions should be noted, as well as unusual conditions.

Weather

Weather conditions and approximate air temperature at time of sample collection should be noted.

Field Data

Field readings are recorded here on sheet.

Three copies of this form should accompany sample to lab. Lab will complete the form and forward it to ORSANCO. One copy should be forwarded to the ORSANCO office by the field technician.

III

ANALYTICAL METHODS: STORET PARAMETER CODES, REFERENCES AND REPORTING LEVELS

At the time of this writing (September, 1980) the U.S. EPA Methods Manual, ASTM Part 31 and the USGS Manual have each been revised and republished. References to analytical method cited in the following tables are now being revised by EPA and will be published in the Federal Register sometime in 1981. When the new references are available the references cited in these tables will be replaced by similarly revised material.

Table 6
Analytical Methods: Storet Parameter Codes, References and Reporting Levels

PARAMETER AND REPORTING UNITS	STORET AND PARAMETER CODE	ANALYTICAL METHOD	REFERENCE AND PAGE NUMBER				REPORTING LEVEL
			U.S. EPA 1974	ST. METHODS 14th EDITION	ASTM PART 31 1975	USGS	
BASIC PHYSICAL AND CHEMICAL							
Temperature, °C	00010	Calibrated Glass or Electric Thermometer	286	125		31	.x
pH, Units	00400	Electrometric Measurement	239	460	178	129	.x
Dissolved Oxygen, mg/1	00300	Winkler (Azide Mod.) or Electrode Method	51	443	368	126	x.x
Conductivity, micromhos	00095	Wheatstone Bridge	275	71	120	148	x.
Turbidity, NTU	00070	Nephelometric	295	132	223	156	x.
Flow, CFS	00060	USGS Gauge					
GENERAL CHEMICAL							
Acidity, mg/1 as $CaCO_3$	00435	Elec. End Point (pH 8.2) or Phenol-Phthalein	1	273(4d)	116	40	x.
Alkalinity, mg/1 as $CaCO_3$	00410	Elec. End Point (pH 4.5) Manual Or Automated or Equiv. Auto. Methods	3/5	278	111	41	x.
BOD, 5 day, mg/1	00310	Winkler (Azide Mod.) or Electrode Method		543			x.
Cyanide, mg/1	00720	Distillation, Followed by Colorimetric Barbituric Acid or Pyridine Pyrazalone	40	361	503	85	.xx
Fluoride, mg/1	00950	Distillation, Followed By Electrode, SPADNS or Automated Complexone	65 59 61	389 391 393 614	307 305	93	.xx

Table 6 (continued)

PARAMETER AND REPORTING UNITS	STORET AND PARAMETER CODE	ANALYTICAL METHOD	REFERENCE AND PAGE NUMBER				REPORTING LEVEL
			U.S. EPA 1974	ST. METHODS 14th EDITION	ASTM PART 31 1975	USGS	
GENERAL CHEMICAL (cont.)							
Total hardness, mg/l as $CaCO_3$	00900	EDTA Titration, Auto. Colorimetric or Atomic Absorption (Ca + Mg)	68 70	202	161	94	x.
Ammonia, mg/l	00610	Distillation at pH 9.5 Followed by Nesslers, Titration, Electrode or Auto.	159/165 168	412; 616 410	237	116	.xx
Nitrate/Nitrite, mg/l	00620	Cadmium Reduction; Brucine Sulfate or Automated Method	201;197 207	423; 427 620	358	119	.xx
Total Kjeldahl/N, mg/l	00625	Digestion, distillation, Nessler, Titration, Electrode or Auto. Phenolate	175,182 165	437		122	.x
Phenolics, mg/l	32730	4AAP, Colorimetric	241	582	545		.xxx
Total dissolved phosphorus, mg/l	00666	0.45μ Filtration FBRP for total Phosphorus	249,256	476,481, 624	384	133	.xx
Total phosphorous, mg/l	00665	Digestion, Colorimetric, Manual or Auto.	249,256	476,481, 624	384	133	.xx
Solids, dissolved, mg/l	70300	Glass Fiber Filtration, 160° C	266	92			x.
Solids, suspended, mg/l	70299	Glass Fiber Filtration, 103 to 105° C	268	94			x.
Sulfate, mg/l	00945	Gravimetetric; turbidimetric or Auto.	277, 279	493, 496	424, 425		x.
Sodium, mg/l	00930	AA or Flame Photometric	147	250	403	143	.x

Table 6 (continued)

PARAMETER AND REPORTING UNITS	STORET AND PARAMETER CODE	ANALYTICAL METHOD	REFERENCE AND PAGE NUMBER				REPORTING LEVEL
			U.S. EPA 1974	ST. METHODS 14th EDITION	ASTM PART 31 1975	USGS	
GENERAL CHEMICAL (cont.)							
Potassium, mg/1	00935	AA or Flame Photometric	143	235,234	403	134	.x
Silica, Dissolved, mg/1 as SiO_2	00955	0.45μ Filtration, Colorimetric	274	487	398	139	.x
Calcium, Dissolved mg/1	00915	0.45μ Filtration, AA	103	148, 189	345	66	.x
Magnesium, Dissolved, mg/1	00925	0.45μ Filtration, AA	114	148, 221	345	109	.x
Total Organic Carbon, mg/1	00680	Combustion-Infrared Method	236	532	467	4	.x
TRACE METALS							
Arsenic,Total, mg/1	01002	Digestion, SDDC Colorimetric; or AA	995	285,283 159			.xxx
Arsenic, Dissolved, mg/1	01000	0.45μ Filtration, FBRM+					.xxx
Barium, Total, mg/1	01007	Digestion, AA	97	152		52	.xxx
Barium, Dissolved, mg/1	01005	0.45μ Filtration, FBRM+					.xxx
Cadmium, Total, mg/1	01027	Digestion, AA or Colorimetric	101	148,182	345	62	.xxx
Cadium, Dissolved, mg/1	01025	0.45μ Filtration, FBRM+					.xxx
Chromium, Total, mg/1	01034	Digestion, AA or Colorimetric	105	148,192	345,286	78,77	.xxx
Chromium, Dissolved, mg/1	01030	0.45μ Filtration, FBRM+					.xxx
Copper, Total, mg/1	01042	Digestion, AA or Colorimetric	108	148,196	345,293	83	.xxx
Copper, Dissolved, mg/1	01040	0.45μ Filtration, FBRM+					.xxx

FBRM = followed by referenced method

Table 6 (continued)

PARAMETER AND REPORTING UNITS	STORET AND PARAMETER CODE	ANALYTICAL METHOD	REFERENCE AND PAGE NUMBER				REPORTING LEVEL
			U.S. EPA 1974	ST. METHODS 14th EDITION	ASTM PART 31 1975	USGS	
TRACE METALS (cont.)							
Iron, Total, mg/1	01045	Digestion, AA or Colorimetric	110	148,208	345,326	102	.xxx
Iron, Dissolved, mg/1	01046	0.45 μ Filtration, FBRM+					.xxx
Manganese, Total, mg/1	01055	Digestion, AA, or Colorimetric	116	148,225 227	345	111	.xxx
Manganese, Dissolved, mg/1	01056	0.45 μ Filtration, FBRM+					.xxx
Mercury, Total, mg/1	71900	Digestion, Flameless AA	118	156	338		.xxxx
Mercury, Dissolved, mg/1	71890	0.45 μ Filtration, FBRM+					.xxxx
Lead, Total, mg/1	01051	Digestion, AA or Colorimetric	112	148,215	354	105	.xxx
Lead, Dissolved, mg/1	01049	0.45 μ Filtration, FBRM+					.xxx
Nickel, Total, mg/1	01067	Digestion, AA or Colorimetric	141	148,232	345	115	.xxx
Nickel, Dissolved, mg/1	01065	0.45 μ Filtration, FBRM+					.xxx
Selenium, Total, mg/1	01147	Digestion, AA	145	159			.xxx
Selenium, Dissolved, mg/1	01145	0.45 μ Filtration, FBRM+					.xxx
Silver, Total, mg/1	01077	Digestion, AA or Colorimetric	146	148,243		142	.xxx
Silver, Dissolved, mg/1	01075	0.45 μ Filtration, FBRM+					.xxx
Zinc, Total, mg/1	01092	Digestion, AA or Colorimetric	155	148,265	345	159	.xxx
Zinc, Dissolved, mg/1	01090	0.45 μ Filtration, FBRM+					.xxx

Table 6 (continued)

PARAMETER AND REPORTING UNITS	STORET AND PARAMETER CODE	ANALYTICAL METHOD	REFERENCE AND PAGE NUMBER				REPORTING LEVEL
			U.S. EPA 1974	ST. METHODS 14th EDITION	ASTM PART 31 1975	USGS	
TRACE METALS (cont.)							
Trace Metals Not Listed		Follow recommended procedure	*				
RADIOLOGICAL							
Alpha, Total, pc/l	01501	Proportional or Scintillation Counter		648	591		.x
Alpha, Dissolved, pc/l	01503	0.45μ Filtration, Proportional or Scintillation Counter		648			.x
Alpha, Counting Error, pc/l	01502	Proportional or Scintillation Counter		648	594		
Beta, Total, pc/l	03501	Proportional Counter		648	601		.x
Beta, Dissolved, pc/l	03503	0.45μ Filtration, Proportional Counter					.x
Beta, Counting Error, pc/l	03502	Proportional Counter		648	606		
Radium, Total, pc/l	09501	Proportional or Scintillation Counter		661	661		.x
Radium, Total, Counting Error, pc/l	09502	Proportional or Scintillation Counter		661			
ORGANICS							
Pesticides, ug/l and other Organics		Extraction, GC Method	* *	555	529	24	.xx
BACTERIA		* Procedure as specified by EPA					
Coliform, Fecal, No/100 ml	31616/31615	MPN; MF		922, 937		45	

Table 6 (continued)

PARAMETER AND REPORTING UNITS	STORET AND PARAMETER CODE	ANALYTICAL METHOD	REFERENCE AND PAGE NUMBER				REPORTING LEVEL
			U.S. EPA 1974	ST. METHODS 14th EDITION	ASTM PART 31 1975	USGS	
BACTERIA (cont.)							
Coliform Fecal in Presence of Chlorine, No/100 ml		MPN; MF		922,928, 937			
Coliform, Total, No/100 ml	31501/31506	MPN; MF		916,928		35	
Coliform, Total, in Presence of Chlorine, No/100 ml		MPN; MF with Enrichment		916,933			
Fecal Strep., No/100 ml	31671/31675 31672	MPN; MF; Plate Count		943,944 947		50	

IV

PROTOCOL FOR QUALITY CONTROL OF DATA IN ORSANCO CONTRACT LABORATORIES

U.S.G.S. Laboratories

In the past, analytical services have been provided to the ORSANCO monitoring network by the laboratories of the U.S. Geological Survey, particularly the Albany and Atlanta Regional Laboratories. The quality control procedures in these laboratories are well defined.

On a daily basis, a blind reference sample is added by the quality control officer to each batch of incoming samples. The resulting analytical data are reviewed. When a variance is observed, samples are either rerun or the data are discarded. Also on a daily basis, a known standard for each parameter is run at the beginning and end of each set of samples or with a frequency of one standard to every 15 samples to ensure replication.

The U.S. EPA-EMSL reference samples for nutrient elements, COD, etc., are used as supplements to the U.S.G.S. reference samples daily or periodically as required. Once a week, or more often if the sample load is unusually heavy, a trace metals reference sample is used as a blind. The same corrective measures are applied with the mineral reference samples.

The mineral samples routinely used as reference samples contain the conventional mineral constituents and are prepared by the U.S.G.S.-WRD Laboratory in Denver Laboratory; a smaller number of special reference samples (mercury, nutrients, BOD, COD, etc.) are available from EPA-EMSL.

Other quality control techniques include interchange of samples between district and project laboratories, and analysis of reference samples submitted by the Water Resources District laboratories to all U.S.G.S. labs. The use of an appointed quality control officer in each laboratory is emphasized.

State and Other Laboratories

Analytical services furnished by contract to ORSANCO, either by private consulting laboratories or by state laboratories, require the following procedures as a part of the laboratory's quality control effort:

I. Minimum Daily Quality Control

   A. After a standard reagent curve composed of a reagent blank and at least three standards has been prepared, a daily check of the standard curve is to be run using at least a reagent blank and one standard at mid-range of the working curve. Daily checks must be within ± 10 percent of the original curve.

   B. If 20 or more samples per day are analyzed, the working standard curve is verified by running an additional standard at mid-range every 20 samples. Checks must be within ± 10 percent of the original curve.

C. At least one duplicate sample and one spike is run every 10 to 20 samples or with each set of samples to verify the precision of the samples. Checks must be within ± 2 standard deviations.

2. Routine, Non-daily Quality Control

   A. The laboratory must perform on a known reference sample (when available) once per quarter for the parameters measured. The measured value should be within ± 2 standard deviations of the known value as based upon the precision given in the approved method.

   B. The laboratory must perform on an unknown performance sample (when available) once per year for the parameters measured. Results must be within ± 2 standard deviations for precision in the approved methods. If problems do occur, appropriate technical consultation will be provided and a follow-up performance sample will be analyzed.

   C. Standard deviation (σ) should be calculated and documented for all measurements being conducted.

3. If more than five persons are employed in the laboratory (other than the supervisor), one person will be appointed as the quality control officer, who will be responsible for quality control techniques and programs.

4. The quality control officer will keep a complete log of all quality control samples and data. All such information will be available for inspection.

5. Other items that will be strongly recommended to the contract laboratories will be: a) the use of service contracts on analytical balances; b) use of class S weights for periodic checks on balances; c) use of an NBS-standardized thermometer to check thermometers in ovens, water baths, etc.; d) color standards for spectrophotometer checks and e) use of quality control charts.

V

MAINTENANCE AND SERVICE OF AUTOMATIC QUALITY MONITOR*

Introduction

A disciplined and rigorous maintenance program is the key to obtaining valid and useful data from the operation of automatic field instrumentation. For the robot monitor, this program must be carried out with diligence to assure that:

1) An adequate flow of sample water is obtained through the flow system at all times (about 7 gallons per minute);

2) Sensors are free of dirt and contaminants which may decrease their sensitivity or accuracy;

3) The electronic circuitry is functioning properly and with good stability;

4) The calibrations of the parametric systems and the recording equipment are maintained;

5) Functional failures of electromechanical and mechanical phases of the system are averted by preventive maintenance procedures.

Maintenance Schedules

Monitor station service calls for cleaning and operation checking will be required at a frequency determined by local stream conditions and influenced by seasonal variations in flow. Experience is essential to decide the exact need for attention at each monitor location in each season. However, optimum performance may require a 7- to 10-day schedule.

Service Log

Field personnel will maintain a service log for each monitor. This record consists of an assembly of individual service call reports (Figure 2) containing pertinent comments relating to stream conditions and instrumentation problems. The log should also include records of repair work and basic calibration that may be done away from the monitor site.

The complete log is useful (a) in evaluation of unusual or questionable data, (b) for more accurate determination of cleaning requirements on a seasonal and location basis, (c) for anticipation of the need for sensor replacement, (d) as a troubleshooting tool, and (e) as a record of what has been done and what may have been neglected. The log is a means for better system performance and an aid in evaluation system data output.

*Procedures outlined for maintenance and service of the automatic monitors are based on instructions furnished by Schneider Instrument Company, 8115 Camargo Road, Cincinnati, Ohio 45243.

Serv. by _____

MONITOR SERVICE CALL REPORT

Station # _____ Location _____ Date _____ Time _____ to _____

TEMPERATURE

Reading: Initial _____ After cleaning _____ After service _____

Calibration check: 0 adjust _____ FS Adjust _____

Water temperature measured with standard thermometer _____

Calibration (circle adjustments): R1 R2 R3a R3b R4 R5 R6 R7

CONDUCTIVITY

Reading: Initial _____ After cleaning _____ After service _____

Calibration check: 1/6 adjust _____ FS Adjust _____

Conductivity SS check 200 read _____ 1200 read _____

Calibration (circle adjustments): R1 R2 R3a R3b R4 R5 R6 R7

DISSOLVED OXYGEN

Reading: Initial _____ After cleaning _____ After service _____

Calibration check: 1/6 read _____ FS adjust _____

DO determined by Winkler titration _____

Calibration (circle adjustments): R1 R2 R3a R3b R4 R5 R6 R7

pH

Reading: Initial _____ After cleaning _____ After service _____

Calibration check: 7 adjust _____ FS adjust _____

7 buffer _____ 4 buffer _____

Calibration (circle adjustments): R1 R2 R3a R3b R4 R5 R6 R7

SRI

Reading: Initial _____ After cleaning _____ After service _____

Time: _____

Telemeter check:	Test	ORP	Temp	Cond	pH	SRI	DO	DCL	DCL
Reading at monitor									
Reading at Central Station									

Figure 2: Monitor Service Call Report

Procedure for Routine Service

The procedure is subdivided into four headings for reference; however, there is no exact dividing line between areas of activity. The individual steps are arranged to permit the most orderly progression through the work and to minimize the elapsed time required.

Initial Observation

1) Before disturbing the monitor in any manner, read and record the panel meter indication for each parameter. Be certain to interpret the meter scale divisions properly.

2) Read and record the telemeter line current.

3) Open the telemeter cubicle and switch the test signal to the 0100 level. Do not leave the door open. (The telemeter output signal will automatically revert to the 1000 level upon the next recording of data by the microprocessor.)

4) Observe the flows through the effluent line. Make a record of any abnormal flow conditions.

5) Open the flow cell drawer; try to avoid causing any change in flow. Observe the flow through each cell and make a record of any abnormal flow conditions in particular flow cells.

Cleaning

1) Remove the temperature/dissolved oxygen sensor assembly; the temperature sensor shares a flow cell with the dissolved oxygen sensor assembly. Observe the condition of the membrane and of the DO electrode. If unusual slime build-up or algae growth exists, note the condition on the service call report. The sensor systems are expected to get dirty and it will take some field experience to recognize the difference between normal and unusual conditions.

2) Gently wipe the DO electrode membrane with wet soft tissue; do not clean with any abrasive material or use any tool which may injure the membrane. Wipe and rinse the membrane repeatedly as required until it is entirely clean. A squirt bottle of distilled water (or tap water) may be useful in this operation.

3) Use wet tissue to clean thoroughly the entire body of the DO electrode, the temperature compensator, the temperature sensor, and the underside of the neoprene stopper. Clean the top of the sensor assembly with moist tissue and dry carefully with clean dry tissue.

4) Clean the temperature/dissolved oxygen flow cell using the plastic-handled sponge mop provided for this use. Use the tubing brush provided to clean the outlet line from the flow cell.

5) Return the temperature/dissolved oxygen sensor assembly to its flow cell.

6) Remove the conductivity sensor assembly. Observe the condition of the vertical and horizontal bores in the conductivity cell. If unusual slime build-up or algae growth exists, note this condition on the service call report.

7) Clean the vertical and horizontal bores of the conductivity cell using wet 8mm tubing cleaner. For the low-range cell (K=1, black body), use a double strand, running the folded end into the cell. This cell has a platinum black surface which can be damaged by the sharp end of the wire on the tubing cleaner. Moving it slowly and

gently, pass it into or through each bore several times. A squirt bottle of distilled water (or tap water) will be useful in this operation. Vigorous manipulation of the cleaner is not required and may cause damage to the cell. Under no circumstances in the field should the conductivity cell be cleaned chemically, under power, or with any mechanical abrasive device.

8) Use wet tissue to clean thoroughly the entire body of the conductivity cell, the temperature compensator, and the underside of the neoprene stopper. Clean the top of the sensor assembly with moist tissue and dry with dry tissue.

9) Clean the conductivity flow cell and flow cell outlet line.

10) Return the conductivity sensor assembly to its flow cell.

11) Remove the pH sensor assembly. Observe the condition of the sensitive tip of the glass electrode and the orifice end of the reference electrode. If unusual slime build-up or algae growth exists, note conditions on the service call report.

12) Gentle wipe the tips of the glass electrode and the reference electrode with wet soft tissue. Use extreme care when handling the glass electrode and avoid a twisting action during wiping; the glass ball tip can be twisted off very easily. A squirt bottle of distilled water (or tap water) may be useful in this operation.

13) Use wet tissue to clean thoroughly the entire bodies of the glass and the reference electrodes, the temperature compensator, the ground rod, and the underside of the neoprene stopper. Clean the top of the sensor assembly with moist tissue and dry carefully with clean dry tissue.

14) Check the electrolyte level in the reference electrode. If it is within 3/4 inch above the bottom of the reservoir, then refill to within 1/2 inch of the filler hole with Beckman #4787 reference electrode filler solution.
CAUTION: Use no other solution in the reference electrode.

15) Clean the pH flow cell and flow cell outlet line.

16) Return the pH sensor assembly to its flow cell.

17) Wait at least five minutes after the replacement of the last sensor assembly for transients to subside, then read and record the panel meter indication for each parameter. These readings are "after cleaning" and will provide some indication of the effect of sensor cleaning. However, it must be considered quite possible that some parameter values may have changed during the time between the initial reading and the completion of the sensor cleaning.

18) Turn the flow control valve in the flow cell drawer to the off position. Place the plastic basin on the flow at one side of the drawer to catch wastewater. Remove the cleanout plugs from the flow cells on that side one at a time and run the tubing brush through each line and into the inlet reservoir. The flow control valve can be opened briefly after each line is cleaned to flush it out. Replace the plug after each line is cleaned, tightening it only enough to prevent leaks. This can be done by hand. Repeat for the flow cells on the other side.

19) Open the flow control valve and adjust the flow to the proper rate.

20) After five minutes, review the parameter readings, comparing them to the "after cleaning" readings already recorded. Give special attention

to the DO reading, since an increase may be an indication of inadequate flow before adjustment. If there is a change, record it on the service call report. The monitor sample flow must not drop to a borderline level between weekly cleanings. If such a situation should arise, the reason for flow decrease must be corrected.

Operation Checking

1) For each analyzer the following steps should be performed:

a) Open the control access door on the front panel of the analyzer.

b) Press the push-button switch (left side of the sub-panel).

c) Put the toggle switch (right side of the sub-panel) in the down position.

d) Read the panel meter; it should indicate the reading of the low-scale calibration reference. Record this reading on the service call report. NOTE: The low-scale calibration reference point and the high-scale calibration reference point are marked on the front sub-panel of each analyzer as the labels for the front panel controls, R1 and R2, e.g., "Zero Adj" and "FS Adj."

e) Put the toggle switch in the up position with the push button switch pressed.

f) The panel meter should indicate the reading of the high-scale calibration reference. Record this reading.

g) If both references are checked perfectly, the operation and stability of the analyzer are verified.

h) If either or both of the reference checks are off by less than 1/2 percent of full scale (1/64 inch on the meter scale), no adjustment is required, but it may be performed if it is desired to trim up the calibration. This is accomplished by adjusting the front panel calibration controls, R1 and R2, to cause the analyzer to read the references exactly, as follows in (i), (j), and (k).

i) With the push button pressed and the toggle switch down to read low-scale reference, adjust R1 until the panel meter indicates the low-scale reference exactly. Always adjust R1 first since it will affect both the low-scale and the high-scale readings equally. R2 will usually have a very small effect on the low-scale reading.

j) With the push button pressed and the toggle switch up to read the high-scale reference, adjust R2 until the panel meter indicates the high-scale reference exactly.

k) Repeat (i) and (j) as required until both references can be read exactly without further adjustment of either control.

l) If the error noted in (h) is greater than 1/2 percent but less than three percent, follow the same adjustment procedure, but make a special note on the call report to watch the check of the analyzer on the next service call to see if a further shift of calibration occurs in the same direction.

m) If the error noted (h) is greater than three percent of full scale, a troubleshooting check of the analyzer is needed.

2) Perform the steps a-m to check the Temperature Analyzer.

   The low-scale calibration reference is zero and the high-scale calibration reference is full scale.

3) Perform the steps a-m to check the Conductivity Analyzer.

   The low-scale calibration reference is 1/6 of full scale and the high-scale calibration reference is full scale.

4) Perform the steps a-m to check the Dissolved Oxygen Analyzer.

   a) The low-scale calibration reference is 1/6 of full scale and the high-scale calibration reference is full scale.

   b) There is no RI control on the dissolved oxygen analyzer.

5) Check the pH Analyzer as follows:

   a) Open the lower analyzer cubicle drawer.

   b) Remove the pH analyzer input coax cable from the connector on the rear left of the pH analyzer chassis deck. Replace it with the coax jumper and plug the pin on the jumper into the white test jack. This removes the pH glass electrode from the analyzer input and grounds the electrometer input without running the high-impedance circuit through the front panel switches.

   c) Perform the steps a-m.

   d) The low-scale calibration reference is 7 and the high-scale calibration reference is full scale.

   e) After check, or check and adjustment, remove the coax jumper and replace the input coax cable on the connector.

   f) Close and fasten the lower analyzer cubicle drawer.

6) Perform the steps a-m to check the Solar Radiation Intensity Analyzer.

   a) The low-scale calibration reference is zero and the high-scale calibration reference is full scale.

   b) There is no RI control on the solar radiation intensity analyzer.

7) Check the functioning of the telemeter transmitter by observing the transmission of a complete "line of data" in response to a call from the central station. This call may be a regularly scheduled station call, or may be a manually initiated call requested by telephone.

   Make a record on the service call report of the reading of each parameter as that parameter is being transmitted. Include the time of transmission, so that later this line of data can be compared to the line logged at the central station to confirm satisfactory transmission.

Verification of the Dissolved Oxygen Reading

The importance of dissolved oxygen as a water quality parameter and the vulnerable nature of the dissolved oxygen electrode make it advisable to give this parametric system special attention during every service call. Care and patience are required to provide a validly calibrated and clean parametric system, but the extra care will be reflected in the data obtained.

1) After completion of the operation check for the dissolved oxygen analyzer and at least five minutes after the return of the dissolved oxygen sensor assembly to its flow cell, draw two water samples from that flow cell for Winkler titration.

2) Read and record the dissolved oxygen panel meter indication during the time that the BOD bottles are being filled. If there are slight fluctuations, try to record an average value. If any significant excursion in the reading (over 0.25 mg/l) occurs during this time, discard the samples and start over.

3) Prepare the samples and follow the Winkler titration procedure.

4) The average of the two titrations will be used as the titrated dissolved oxygen value for comparison with the analyzer reading recorded in step 2 above.

5) If this comparison is within one percent of full scale (approximately 0.25 mg/l), the system should be considered properly calibrated and no adjustments should be made.

6) If the titrated dissolved oxygen value is higher or lower than the analyzer reading by more than 0.25 mg/l, but not more than 1.0 mg/l, merely adjust R2, the full scale adjust control on the front sub-panel of the analyzer by an amount which will cause the analyzer reading to agree with the titrated value. Note that this adjustment should not make the present reading agree with the titrated value; the dissolved oxygen level in the water may have changed in the time elapsed during the titration. The amount of the adjustment should be determined by noting the percentage difference in values and adjusting the present analyzer reading by that percentage.
For example:

DO indication when sample was drawn	= 7.0 mg/l
DO concentration determined by titration	= 7.7 mg/l
Present DO indication	= 8.0 mg/l
Required adjustment of indication = 10% of 8.0	= +0.8 mg/l

7) If the difference between the titrated value and the analyzer reading is greater than 1.0 mg/l, additional factors should be considered before making the decision either to adjust the analyzer or to replace the electrode. These factors are length of service, record of recent performance, and physical condition. Refer to the service log to determine the date of installation of the electrode and note the comparison between the titrated value of dissolved oxygen and the analyzer reading for the last two service calls. If the period of use is less than ten weeks, but the recent service record indicates that the present discrepancy in reading is part of a developing trend (difference in the same direction and growing larger each week), the electrode should be replaced. There are other factors, some of which will be noticeable in a visual inspection, which will be cause for replacement of the electrode regardless of the past record.

8) If the electrode is not replaced, adjust R2 in the manner described in step 6.

9) If the electrode is replaced, it will be necessary to allow at least one hour of operation of the replacement electrode before attempting adjustment of the dissolved oxygen parametric system. Then steps 1-4 above should be repeated. After the titration is completed, R2 should

be adjusted to cause the analyzer reading to agree with the titrated dissolved oxygen value as outlined in step 6.

10) After any adjustment of R2 (whether or not the electrode has been replaced), it will be necessary to reset the calibration references by adjusting R4 and R5. Press the push button switch, put the toggle switch in an up position, and adjust R5 to cause the analyzer meter to read full scale.

Check Out

Close all drawers and doors and fasten them securely. All fasteners should be tightened; their purpose is to provide a compression of the gasket to seal the cubicles containing electronic equipment from dirt and moisture. Time saved by leaving the fasteners loose will be negligible, compared to the time used working on the extra service problems which this practice may cause.

Procedure for Monthly Calibration Checking and Preventive Maintenance

This procedure calls for all the work performed in the routine cleaning and operation checking plus some additional cleaning of all parametric systems, and cleaning and lubrication of some of the system hardware.

Preliminary Steps

1) Perform steps 1-6 of "Initial Observation."

2) Open the upper drawer of the analyzer cubicle and estimate the inside temperature; it should be about 105°F. Heaters located on subpanels at the two sides of the cubicle are thermostatically controlled to maintain this temperature. If it is noticeably higher or lower, check the setting of the adjustable thermostat near the top on the right side.

3) A service light in the cubicle is switched by limit switches operated by the analyzer drawers. It should go on whenever an analyzer drawer is opened. Replace the bulb if it does not. CAUTION: Do not use a bulb of higher power rating than 40 watts; it may create a hot-spot problem for the nearest amplifier.

4) Inspect all analyzer to see that all plug-in components are seated properly in their sockets.

5) Check the analyzer cubicle front panels to see that each analyzer is securely fastened in its plug-in position to assure good contact at the blue-ribbon connector.

6) Perform steps 1-20 of "Cleaning."

7) Clean the solar radiation sensor by wiping the pyrheliometer bulb with a clean dry rag. Inspect for moisture condensation on the inside of the bulb.

8) Perform steps 17 and 18 of "Cleaning."

9) Remove the end plug from the inlet reservoir, using the adapter plate provided for this purpose. This is a steel plate, approximately 2" x 3" x 1/8", which fits in the slot on the plug to permit removal of the plug with a small adjustable wrench. Use the plastic basin to catch any water that comes out of the reservoirs.

10) Clean the reservoir with the sponge mop. Open the flow valve briefly to flush the dirt into the basin. Replace the end plug.

11) Repeat steps 11 and 12 for the outlet header.

12) Inspect the effluent line and, if necessary, clean it with the pipe auger, using a rag wrapped around the tip of the auger.

13) Shut off the water flow at the service valve. Disconnect the inlet line from the monitor and run the pipe auger through the line. Open the service valve briefly to flush the line. Reconnect the line to the monitor and open the service valve. Experience may indicate that this cleaning operation need not be performed monthly; however, it must not be overlooked continually.

14) Open the flow control valve and adjust the flow to the proper rate.

15) After five minutes, review the parameter readings, comparing them with the "after cleaning" readings previously recorded. Give special attention to the DO reading, since an increase may be an indication of inadequate initial flow. If there is a change, record it on the service call report as the DO reading "after flow adjustment." However, consider that some change in parameters of the water sample may have occurred in the stream during the time required for the cleaning.

16) If the initial observation of the flow conditions or the change in DO reading after flow adjustment give cause to suspect a decrease in the incoming water supply since the last station visit, it may be advisable to check the supply line. In some cases, pebbles or small pieces of wood will accumulate in the line behind the service valve. Use of a mud-leg will alleviate, but not completely eliminate, this condition. Occasionally, it may be necessary to back flush the line or to remove the service valve for cleaning. A low flow situation must always be corrected promptly, since it will create other problems if ignored.

17) Inspect the tops of the sensor assemblies and the flow cell terminal board to see that all leads are securely fastened.

18) If the flow cell terminal board is not entirely clean, it should be brushed carefully with a stiff-bristled brush (such as a toothbrush) to remove all dirt or salt. Wipe, as required, with a clean dry rag. Wipe the steatite standoff insulators with clean dry tissue.

19) Perform steps 1-7 of "Operating Checking."

20) At this stage the parametric systems should be in good operational condition and ready for a calibration check.

Calibration Checking

This procedure is for a simple calibration check of the complete parametric systems (sensors and analyzers) while they are in operation in the field. The primary purpose is to check the sensors, since the stability of the analyzers has already been certified by the operation check against the built-in references. The procedure is not as comprehensive as the initial or basic calibration, but is adequate to assure that system accuracy has been maintained.

The itemized procedure provides a guideline to accomplishing the work in a minimum elapsed time by checking all parametric systems simultaneously. It is presented for monitors having analyzers for temperature, conductivity, dissolved oxygen, pH, and solar radiation intensity.

1) All cleaning and operation checking has been completed in the steps outlined in "Preliminary Steps."

2) The temperature parametric system will be checked at one point only, the present stream temperature.

3) Place the standard thermometer in the temperature/dissolved oxygen flow cell. CAUTION: Remember to remove the thermometer to avoid breaking it, if the flow cell drawer is to be closed at any time.

4) The conductivity parametric system will be checked at a low-scale point approximately 1/6 of full scale, at mid-scale, and at full scale. This initial check, including a mid-scale point, will prevent the possibility of calibrating with badly contaminated standards or an unclean conductivity cell. If the initial check is satisfactory, calibration adjustments will be made using the low standard and the full-scale standard only.

   For this procedure, it will be assumed that a 2400 micromho range is being checked, and that standard solutions of 2400, 1200, and 400 micromhos are available. NOTE: In the calibration of the conductivity parametric system, two portions of the same standard are employed. One is labeled a wash solution; the other, the primary standard. When a clean sensor is immersed into a wash, then into the primary standard of the same value, the droplets of solution remaining inside the sensor are of approximately the same conductivity as the primary standard and, therefore, will not contaminate it. Wash solutions should be discarded and replaced when they deviate by more than ten percent from the standard solutions.

5) Remove the conductivity sensor assembly from its flow cell, shake it briskly to remove water from the vertical and horizontal bores, and dry it with tissue. Immerse the cell in the 400 micromho wash solution and swirl it to flush out the cell bores. Remove the assembly, shake it, dry it carefully, and insert it in the jar of 400 micromho standard solution. Put this test setup aside for at least five minutes, to allow transients to subside, and proceed with the next step. NOTE: A low stool, bench, or table that can be placed beside the flow cell drawer will be convenient for location of standard solution jars during their test use.

6) The pH parametric system will be checked at a pH of 7 and a pH of 4 only. Calibration adjustments will be made using only these two buffers. The Fischer pH 7 buffer solution varies in pH from 7.0 at 100°F and 77°F to 7.1 at 35°F. The Fischer pH 4 buffer can be considered to have a pH of 4.0 over the full temperature range.

   Optionally a high pH buffer (9 or 10) may be used for an additional check after calibration adjustment; however, these high pH buffers are of questionable value for field service. Each has a high temperature coefficient and the variation of pH with temperature is not linear. The pH 10 buffer is much less stable than the 7 and 4 buffers. NOTE: Wash solutions are not required with the pH buffer solutions since the pH electrode assembly can be completely dried before being put into the buffer.

7) Remove the pH sensor assembly from its flow cell, dry it carefully, and insert it in the jar of pH 7 buffer solution. Put this test setup aside for at least five minutes and proceed with the next step.

8) Draw two water samples from the dissolved oxygen flow cell for Winkler titration. Read and record the dissolved oxygen panel meter indication during the time that the BOD bottles are being filled. If there are slight fluctuations, try to read an average value. If any significant excursion in the reading (over 0.25 mg/l) occurs during this time, discard the samples and start over. Add reagents and prepare the samples as instructed in Winkler procedure.

9) In the following steps all transfers of sensor assemblies from one solution to another must follow the procedures outlined in the preceding steps.

10) Read and record on the service call report the conductivity analyzer panel meter indication for the 400 micromho standard solution.

11) Transfer the conductivity sensor assembly through the 1200 micromho wash solution to the 1200 micromho standard solution. Put this test setup aside for at least five minutes.

12) Read and record on the service call report the pH analyzer panel meter indication for the pH 7 buffer solution. It is unusually helpful to stir the buffer solution slightly with the electrode assembly about 30 seconds before taking the reading.

13) Remove the pH electrode assembly from the pH 7 buffer solution, dry it carefully with clean dry tissue, and insert it in the jar of pH 4 buffer solution. Put this test setup aside for at least five minutes.

14) Add acid to the two Winkler samples.

15) Read and record the conductivity analyzer reading for the 1200 micromho standard solution.

16) Transfer the conductivity sensor assembly through the 2400 micromho wash solution to the 2400 micromho standard solution. Put this test setup aside for at least five minutes.

17) Titrate the two Winkler samples following procedure. If the results of the two titrations are within 0.25 mg/l of agreement, use the average of the two as the titrated dissolved oxygen concentration. If the results of the two titrations do not agree, it will be necessary to start over by drawing two new samples. Record the results of the titrations on the service call report.

18) Read and record the pH analyzer reading for the pH 4 buffer solution.

19) Read and record the temperature indications of the standard thermometer and the temperature analyzer.

20) Read and record the conductivity analyzer reading for the 2400 micromho standard solution.

At this stage, a set of data will have been acquired covering the existing calibration of all of the parametric systems measuring water parameters. The calibration information will be useful in evaluating the stream data obtained by the monitor since the last calibration check.

The calibration information can be summarized as follows:

Parameter	Standard	Monitor
Temperature	Standard thermometer reading of sample water	Analyzer reading of sample water
Conductivity	400 micromho standard solution	Analyzer reading
	1200 micromho standard solution	Analyzer reading
	2400 micromho standard solution	Analyzer reading
pH	pH 4 buffer solution	Analyzer reading
	pH 7 buffer soiution	Analyzer reading

This comparison will determine if any parametric systems require calibration adjustment. A few general guidelines can be set up:

a) Do not adjust calibration of a parametric system for which the analyzer readings are within 1/2 percent of agreement with the standards.

b) If there is a difference of between 1/2 and three percent, adjust the calibration, note the adjustment on the service call report, and watch future calibration checks of the parametric system to see if a trend develops. Slow deterioration of a sensor may be detected in this manner.

c) If a difference of three to ten percent exists, look for the reason before changing calibration as a last resort.

d) If a difference of more than ten percent exists, the cause must be determined and the fault corrected.

For conditions (c) or (d), the best aids for locating the trouble are: (a) the analyzer built-in reference check facility, (b) the service log, and (c) spare electrodes.

By referring to the service log, it can be determined whether any abnormal adjustments of the analyzer calibration controls, R1 and R2, have been made during the weekly operation checks since the last monthly calibration check. If not, and if the analyzer now checks the built-in calibration references (which were set immediately after the last calibration adjustment last month), then the analyzer must be in good order and is not a factor.

This means the "shift in calibration" is sensor oriented; that is, it is probably due to a change in the electrode, a defect in the temperature compensator, a poor connection in the sensor assembly wiring, or contaminated standard solutions or reagents. IMPORTANT: There is always the possibility that the previous calibration adjustment (last month) was bad because of poor standard solutions. A review of the service log will indicate whether any large changes were made in the other direction at that time.

The substitution of a spare electrode, known to be good, should always be one of the first measures used to isolate the trouble further. In most cases it will provide the solution.

Assuming that one or more parametric systems will require a calibration change for one reason or another, the adjustment procedures in steps 21-8 below should be followed. The precautions relating to drying of sensors, using wash solutions, allowing five minutes response time, etc., will always apply but will not be repeated in the instructions for the individual steps.

21) To adjust the calibration of the temperature parametric system:

a) Read the present indication of the standard thermometer in the temperature/dissolved oxygen flow cell, and simultaneously read the temperature analyzer panel meter.

b) If the water temperature is below 60°F, use R1 to adjust the analyzer reading to agree with the standard thermometer reading. If the water temperature is above 60°F, use R2 for the adjustment.

22) To adjust the calibration of the dissolved oxygen parametric system use the data already recorded as the basis for an adjustment of R2 as described in step 6 of "Verification of the Dissolved Oxygen Reading."

23) To adjust the calibration of the conductivity or turbidity parametric systems:

a) Transfer the sensor assembly to the low-scale standard solution.

b) Adjust R1 until the analyzer panel meter is correctly reading the low-scale standard solution.

c) Transfer the sensor assembly to the full-scale standard solution.

d) Adjust R2 until the analyzer panel meter is correctly reading the full-scale standard and the calibration adjustment is completed. If not, then repeat steps (b), (d) and (a) in sequence, until both standard solutions can be measured correctly without further adjustment.

24) To adjust the calibration of the pH parametric system:

a) Transfer the pH sensor assembly to the pH 7 buffer solution.

b) Adjust R1 until the pH analyzer panel meter reads 7.0.

c) Transfer the pH sensor assembly to the pH 4 buffer solution.

d) Adjust R2 until the pH analyzer panel meter reads 4.0.

e) Return the sensor assembly to the pH 7 buffer solution. If the pH analyzer panel meter reading is 7.0, the calibration adjustment is completed. If not, then repeat steps (b), (c) (d), and (a) in sequence until both buffer solutions can be measured correctly without further adjustment.

25) To adjust the calibration of the solar radiation intensity parametric system:

a) The solar radiation intensity sensor is an Eppley Pyranometer, which is a primary standard for this measurement; that is, it can only be checked against a second Pyranometer kept for that purpose and protected from damage and weather except when used for calibration checking.

b) There is no reason to question the Pyranometer output unless the solar radiation intensity readings have been abnormally low over a long period of time despite sensor cleaning, or unless the visual inspection of step 9 of "Preliminary Steps," has revealed condensed moisture inside the glass bulb. If either condition occurs, and a replacement is not available, the Pyranometer may be returned to Eppley laboratories for test.

c) The calibration adjustment of the solar radiation intensity analyzer may be checked by measuring the potential at the gray jack at the top center of the analyzer chassis deck. This calibration reference potential should be 2.4 times the Pyranometer sensitivity in MV/calorie/cm^2/minute (marked for each Pyranometer on a metal tag on the base). The reference potential is usually 17 to 19 MV; the exact value for a particular sensor will be stamped on the chassis deck next to the gray jack. IMPORTANT: Pyranometers have different sensitivities and are not interchangeable in the parametric system without an adjustment of this reference potential. The potential at the gray jack is set by R5, the full-scale calibration reference control.

In the solar radiation intensity analyzer only, setting this reference R5 sets up the calibration, also.

d) After adjustment of R5 to give the correct potential at the gray jack, press the push button switch, put the toggle switch in the up position, and adjust R2 (front sub-panel) to cause the analyzer panel meter to read full scale. NOTE: There are no R1 or R4 controls on this analyzer.

26) After calibration adjustment, if the settings of R1 and/or R2 have been changed for any analyzer, the references, R4 and R5, for that analyzer must be reset to correspond to the new calibration. NOTE: There are no R1 or R4 controls on this analyzer.

Perform the following procedure for the temperature, conductivity, dissolved oxygen, and turbidity analyzers (not required for the solar radiation intensity analyzer):

a) Press the push-button switch, put the toggle switch in the down position, and adjust R4 (top rear left on the chassis deck) to cause the analyzer panel meter to read the low-scale reference marked on the front sub-panel (over control R1).

b) Press the push-button switch, put the toggle switch in the up position, and adjust R5 (top rear left on the chassis deck) to cause the analyzer panel meter to read full scale.

27) For the pH analyzer, follow the same procedure after removing the input coax from the connector at top rear on the analyzer chassis deck and replacing it with the coax jumper to ground (coax connector to white pin jack). Do not remove the jumper at this time.

28) Check each analyzer telemeter output by measuring between the orange jack and the white jack at the front on the analyzer chassis deck. Use a digital voltmeter or MV potentiometer. With the push-button switch pressed and the toggle switch up (panel meter reading an accurate full scale), the voltage should be 1000 MV; if it is not, adjust by turning R38 (top front center on the chassis deck).

Preventive Maintenance

Wipe the flow-cell-drawer slides with a clean dry rag to remove dirt and dirty lubricant. Lubricate with light oil applied in moderation to all segments of the slide assembly.

There are obvious benefits to be derived from keeping the insides of the cubicles clean and dry. Dust left in the cubicle will circulate and moisture can be harmful. The advantages of keeping the outside of the cabinet clean are

largely aesthetic; but it is recommended that it be given enough attention to present an orderly appearance. A sloppy exterior appearance of instrumentation is often closely related to carelessness in other phases of its operation and maintenance.

There may be other service needs which will be noticed during work with the robot monitor. An effort should be made to take care of these requirements as they arise.

Checkout

1) Perform checkout procedure. This procedure is subject to streamlining and some rearrangement may be desired based on experience; however, any short cuts devised must still accomplish the end results intended for the above routines, all parts of which are considered essential to attaining good performance.

VI

QUALITY ASSURANCE PROGRAM FOR THE ORGANICS DETECTION SYSTEM

The monitoring of the Ohio River and its tributaries for priority pollutants at the microgram per liter level also requires a stringent quality assurance program. This program has been developed from the Federal Register, Vol. 44, No. 233, Method 601, and from experience in operating the system. Additions based on operational experience with the Organics Detection System (ODS) have been incorporated into the EPA method to improve the quality of data produced. The resulting ORSANCO quality assurance program includes glassware cleaning and handling, sample collection, sample analysis, and contract laboratory procedures for both purgeable and base-neutral extractable samples.

Glassware Cleaning and Handling

At the sampling sites, three different sizes of sample containers are used for organics sampling. Initially, the contract laboratory supplies all the bottles in the sterile useable condition required by the water laboratory.

The three sizes of bottles are two-ounce, one-liter and one-gallon. The two-ounce bottles are equipped with Teflon-faced silicone septa sealed in place with a plastic screw cap. The one-gallon and one-liter glass bottles are supplied with Teflon-faced silicone septa sealed in place with a plastic screw cap.

The sample containers must be carefully cleaned following a prescribed protocol, as follows:

> Wash all sample bottles, seals and caps in detergent and rinse thoroughly with finished tap water. Rinse again with organic-free blank water and allow to air dry in an area free of organic vapors. The two-ounce bottles may be dried in a 150°C oven for one hour, then allowed to cool in air free of organic vapors. When cool, seal the bottles with the Teflon septa and caps. However, the one-gallon and one-liter containers will crack if placed in the oven; merely drain, air dry and seal them.

Each site is supplied with a minimum of one 5-10 µl syringe, one 25-50 µl syringe and one 20 ml syringe. These must be kept scrupulously clean to avoid contamination of the standards and samples. Before using the standard µl syringes, flush them several times with acetone or methyl alcohol. The remaining traces of solvent may be removed by

pulling clean air through the syringe using a vacuum flask and a small-holed rubber stopper. The syringe may also be dried in an oven at 70°C. Higher temperatures will crack the syringe because of the glass-metal expansion coefficient difference. The sample syringe should also be cleaned before and between sample analyses. Rinse the syringe twice with organic-free water, then with methanol. Heat in a 70°C oven for several minutes to drive off the methanol. Again, do not use higher temperatures or the syringe will crack.

To reduce the likelihood of cross-contamination between subsequently analyzed samples, the purging vessel should also be rinsed twice with organic-free water. In the event of samples containing large amounts of water-soluble materials, suspended solids, high boiling compounds or high halocarbons levels, it may be necessary to wash the purge vessel with detergent, rinse it with distilled water and dry it in a 105°C oven between analyses. If solids accumulate on the frit of the vessel and cannot be removed by the above methods, the vessel may be soaked in a dilute chromic acid solution.

Sample Collection

The daily sample is drawn from the raw water intake tap. Turn on the water and allow the system to flush. When the temperature of the water has stabilized, adjust the flow to minimize bubbling and collect duplicate samples in the two-ounce bottles. Immediately place the samples on a solid level surface, position the Teflon sides of the septa on the convex sample meniscus, and seal the bottle by tightening the cap. Invert the bottle to check for entrapped air. If there is no air or only a small bubble, the seal is successful. If a bubble larger than an upper case "O" is present, add a few additional drops of sample and reseal. Simultaneously, fill the one-gallon container with raw water. It is not necessary that this container be headspace free. When it is full, seal the bottle with the Teflon-lined cap. Collect duplicate organic-free water blanks in the two-ounce bottles and the one-liter bottle by following the procedure above. If analysis of the sample does not occur immediately after collection, store all samples and blanks together. Stored samples should be refrigerated at 10°C or lower. Identify the sample by labeling with site code, date, time and sampler's name.

If it is not necessary to ship any of the samples to the contract laboratory, as is usually the case, empty the sample containers and clean according to the procedure described under "Glassware Cleaning and Handling."

Analysis of the Sample

Daily Analyses

Remove the plunger from the clean 20-ml syringe and attach a closed valve. Open one of the two-ounce bottles of organic-free blank water and carefully pour into the syringe barrel until it overflows. Replace the plunger and compress the sample. Open the syringe valve and vent any residual air while adjusting the volume to 10 ml. Add 2 µl of the internal standard solution with the 5-10 µl microsyringe, taking care not to introduce air into the sample. Close the valve and attach the 6" luer lock needle.

Open the Mininert valve cap on the purge vessel and insert the syringe

needle through the septum. Open the syringe valve and inject the blank sample into the purging chamber. Withdraw the syringe and close the Mininert valve cap. The blank sample is now ready for analysis.

After the analysis of the organic-free water blank, the analyst should check the chromatogram for extraneous peaks, internal standard retention time and area response. If the system is found to be free of interference, proceed with analysis of the raw water sample. Follow the steps above, exchanging the two-ounce bottle of raw water for the organic-free water.

Bi-weekly Analyses

A purgeable standard solution is analyzed a minimum of twice a week to ensure proper peak identification, identify problems such as column deterioration, and ensure analysis reproductibility. The 20-ml syringe is filled with organic-free water using the technique described before. Add 2 µl of internal standard with the 5-10 µl syringe and 20 µl of the purgeable standard with the 25-50 µl syringe through the syringe valve. Inject the sample into the purge vessel and analyze.

To avoid cross-contamination of subsequently analyzed samples, follow proper cleaning procedures and analyze in this order:

1) Organic-free water blank plus 2 µl internal standard
2) Raw water plus 2 µl internal standard
3) Organic-free water plus 20 µl purge standard and 2 µl internal standard

Raw water analyses are terminated if interferences occur which cannot be explained and eliminated. This will necessitate a service call from ORSANCO surveillance specialists, ODS staff members and/or chromatographic equipment service personnel.

If analysis of the raw water sample shows a higher than normal amount of purgeable organics, another raw water sample should be drawn and analyzed to verify the initial findings. These chromatograms should be sent via facsimile telecopier to the ORSANCO office for inspection by ODS staff. An alert may be declared if a significant amount of organics in raw water is noted. During an alert situation, the remaining two-ounce samples of raw water and organic-free water, the one-liter organic-free water sample and the one-gallon solvent-extractable sample are shipped by site personnel to the contract analytical laboratory for GC-MS confirmation. In an alert situation, the site personnel may be asked to analyze additional samples throughout the alert period. In non-alert situations, the extra samples are discarded and the bottles cleaned for the next day's sampling.

Monthly Analyses

Once a month, surveillance specialists draw duplicate samples, in accordance with proper sampling techniques, to be analyzed on site and at the contract analytical laboratory. The site analyzes the two-ounce raw water sample, labels it as a quality control sample and sends the chromatogram to the ORSANCO ODS staff. The surveillance specialist ships two (2) two-ounce raw water samples, a one-liter organic-free water sample and the one-gallon solvent-extractable sample to the contract laboratory by 24-hour Purolator service. A heavy duty insulated plastic container with a tightly fitted lid is used to ship samples to the contract laboratory. Frozen blue ice packs are placed in the container with sample bottles and polyurethane shock insulation. Contract laboratory

results are compared with on-site analysis by ODS staff members to assure the validity of the results. If results do not compare favorably, ORSANCO personnel may be dispatched to the site to correct discrepancies.

Quarterly Analyses

Round-robin performance evaluation analyses are conducted quarterly (or when samples are available). The samples are provided by U.S. EPA in sealed ampoules in two concentrations. Both the sites and the contract analytical laboratory analyze these samples for examination by ODS staff members. These samples help identify any problems with equipment, personnel or procedures.

Surveillance Specialist Maintenance

The surveillance specialists visit each site at least twice per month. On each visit, the field people examine the equipment by following a checklist produced for that purpose (Figure 3). The surveillance specialist is responsible for: (1) assuring adequate pressure in the gas tanks; (b) regenerating molecular sieve and moisture filters; (c) assuring adequate supplies of fresh standards, microprocessor recording paper, organic-free water (if necessary), columns and column-packing material and ion exchange resin; and (d) general troubleshooting.

Contract Laboratory Quality Control Procedures

At submicrogram and microgram per liter (µg/l) levels of analysis for organic compounds, a stringent quality assurance program is necessary to ensure the validity of the data. The program is necessary for two reasons: (a) reports of an organic compound should be the result of its presence in the water at the time it was sampled and (b) the significance of the data must be known before interpretation.

The contract laboratory must follow extensive laboratory quality control practices to ensure that interferences are at a definable and acceptably low level. These practices should include the following: (a) cleaning, preparation and handling of sample bottles and laboratory glassware; (b) preparation and storage of organic-free water for blank analyses and glassware rinses; (c) identification and control of interferences from such materials as gases and solvents; and (d) storage of samples to maintain integrity prior to analysis. When system blanks are shown to contain unacceptable interferences, analyses should be discontinued until the interference is identified and controlled.

Daily Quality Assurance for Purgeable Organics

The daily quality control routine should follow this sequence:

1) Blank water analysis
2) Analysis of calibration standard
3) Analysis of U.S. EPA reference standard
4) Analysis of current field samples
5) Analysis of an aliquot of a previously analyzed field sample
6) Blank water analysis
7) Analysis of a duplicate sample from a randomly chosen field site
8) Analysis of calibration standard

ODS SERVICE REPORT FORM

Name:_____ Station:_____ Date:_____

GAS	Delivery Pressure(psi)	Tank Pressure(psi)	Spare Tank	Moisture Trap	Date Trap Change
Helium					
Hydrogen					
Air					

CDS (ORSANCO No.)	Flow Controller (cc/min)		Valve Temp. (°C)	Operation (✓ if OK)		
	Top	Bottom		Purge	Trap A	Rotation

GC (ORSANCO No.)	Injector Temp. (°C)	Oven Temp. (°C)		Column Flow (cc/min)		Memory Words	
		Initial	Final	Carbowax	n-Octane	Before	After
SIGMA							
HP*							
VARIAN (SP)							

GC	Spare Printer Paper	Observations (✓ if OK)				Remarks
		Printer Head	Door Opening	Fan		
SIGMA						
HP*						
VARIAN (SP)						

CCD (ORSANCO No.)	Temp. (°C)		Observations		Electrolyte Conductivity	Date Resin Replacement
	Valve	Furnace	Glass Trombone	Clips		

* None

Figure 3. ODS Service Report Form

The precision of analysis will vary with the concentration of the sample. From the data collected by ODS personnel, the following limits of precision have been established.

When Concentration is:	Mean Value ($\bar{X}$) should be:
0.1 to 1.0 µg/l	± 50% of true value
1.0 to 10 µg/l	± 30% of true value
10 to 100 µg/l	± 20% of true value
100 µg/l and greater	± 10% of true value

When analyses of the U.S. EPA standard do not fall within these limits, analyses should be terminated until the cause is identified and eliminated.

Periodic Equipment Controls

Because the integrator assumes linearity of the detector (Hall or Coulson) response when quantifying, the linear relationship between amount purged and amount detected must be checked periodically. By using concentrations of the compounds in all expected ranges, a standard curve can be plotted. Studies have shown that the above detectors can be expected to detect the compounds in a linear fashion between the concentrations of 0.1 µg/l and 200 µg/l.

Daily Quality Assurance for Base-Neutral Extractable Organics

The daily quality control routine for base-neutral extractables is based on a group analysis concept. One bottle of methylene chloride contains sufficient volume for six extractions--four samples and two control blanks per bottle of solvent. Samples are extracted, concentrated, stored and analyzed in groups with the associated solvent blanks. Daily analysis includes the following components per group: four field samples, direct injection calibration standards, two solvent blanks, and a previously analyzed field extract. In addition, one of the monthly samples should be randomly chosen and analyzed in replicate.

The quality control procedure should be in the following sequence:

1) Analysis of calibration standard
2) Solvent blank analysis
3) Field sample analysis
4) Field sample analysis
5) Standard sample analysis
6) Field sample analysis
7) Solvent blank analysis
8) Reanalysis of sample from previous day
9) Field sample analysis
10) Analysis of calibration standard as an unknown to determine stability of the system.

After it has been firmly established that all problems relating to quality control are eliminated and veracity of the data is assured, the laboratory may then consider elimination of steps 5, 7 and 9 in the above sequence.

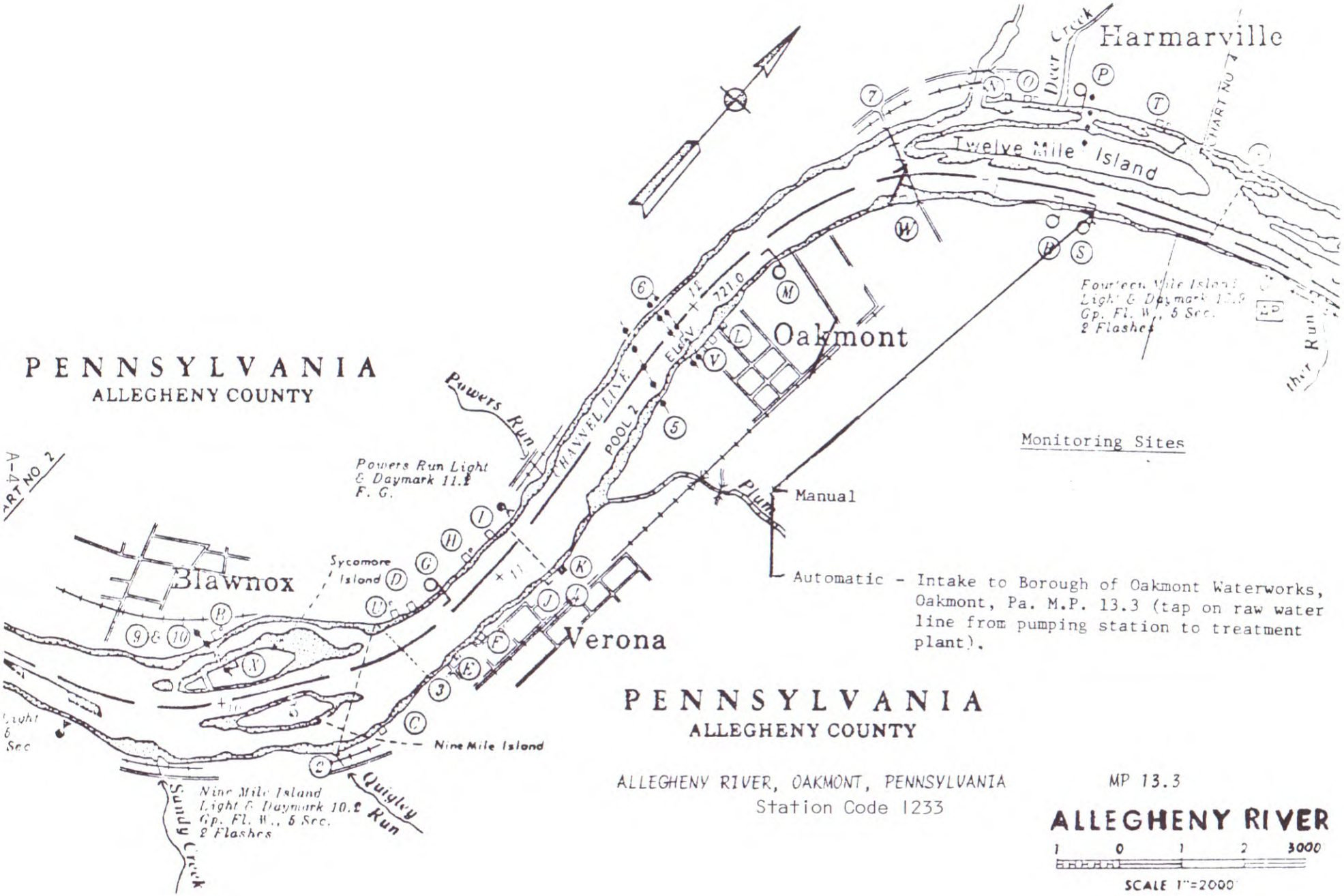
Periodically, extraction recoveries of the base-neutral extractable compounds at several concentrations should be determined by spiking the calibration standard compounds into organic-free water. Extraction can then be evaluated by averaging the recoveries of triplicate extraction and concentration tests.

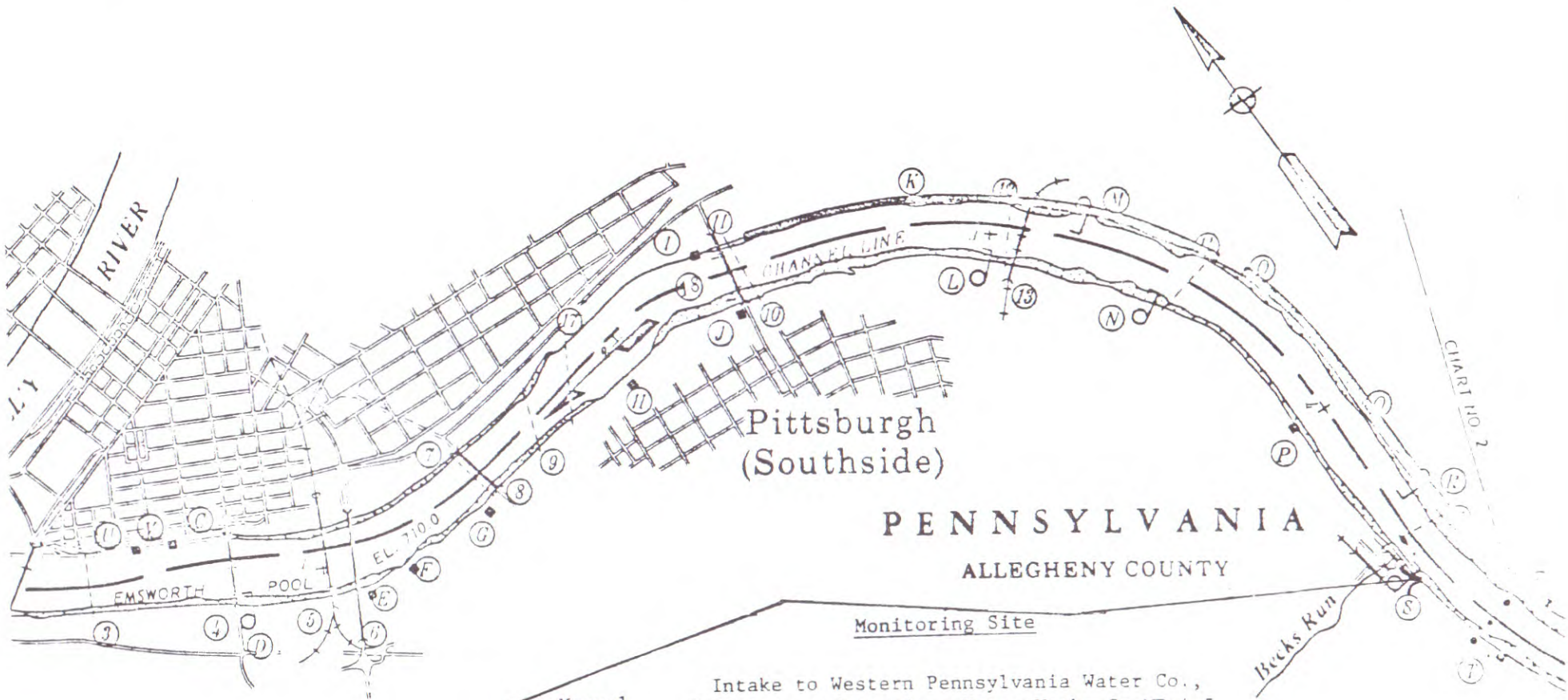
APPENDIX A

MONITORING SITES

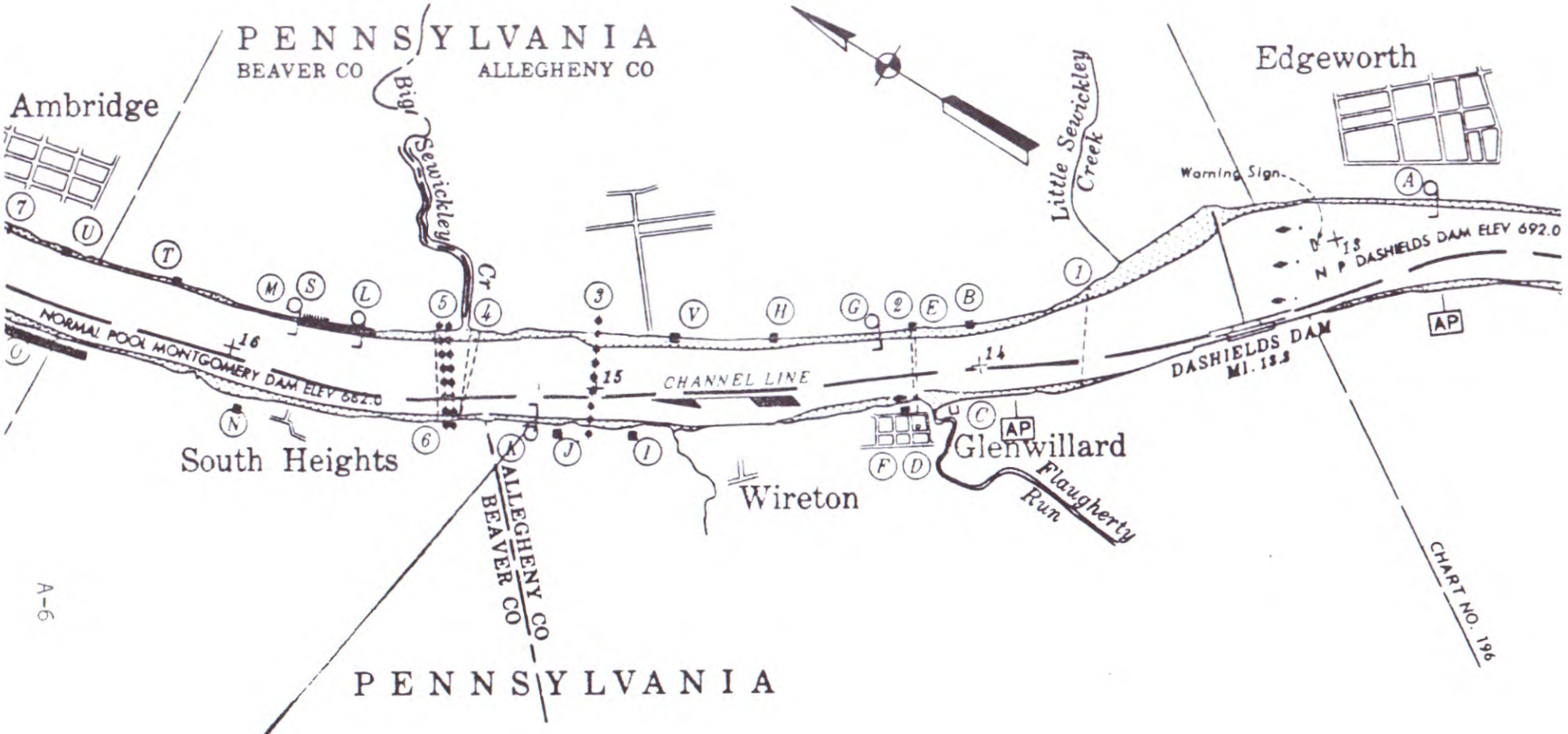
STATION CODES FOR UPPER OHIO REGION
MANUAL MONITORING STATIONS

Allegheny River at Oakmont, Pa.	1233
Monongahela River at South Pittsburgh, Pa.	1237
Ohio River at South Heights, Pa.	1201
Beaver River at Beaver Falls, Pa.	1242
Ohio River at East Liverpool, Oh.	1500
Ohio River at Wheeling, W.Va. (Pike Island Dam)	1405
Ohio River at Shadyside, Oh.	1521
Ohio River at Willow Island, W.Va.	1408
Ohio River at Hannibal Dam, Oh.	1423
Muskingum River near Marietta, Oh.	1531
Ohio River at Belleville Dam, W.Va.	1421
Ohio River at Addison (Kyger Creek), Oh.	1510
Ohio River at Gallipolis Dam, W.Va.	1422


PENNSYLVANIA
ALLEGHENY COUNTY
Harmarville
Deer Creek
Twelve Mile Island
Oakmont
Powers Run
POOL 2
Powers Run Light
& Daymark 11.2
F. G.
Plum
Manual
Monitoring Sites
Automatic - Intake to Borough of Oakmont Waterworks, Oakmont, Pa. M.P. 13.3 (tap on raw water line from pumping station to treatment plant).
Blawnox
Sycamore Island
Verona
Nine Mile Island
Nine Mile Island
Light & Daymark 10.2
Gp. Fl. W., 5 Sec.
2 Flashes
Quigley Run
Spring Creek
PENNSYLVANIA
ALLEGHENY COUNTY
ALLEGHENY RIVER, OAKMONT, PENNSYLVANIA
Station Code 1233
MP 13.3
ALLEGHENY RIVER
1 0 1 2 3000
SCALE 1"=2000'



MONONGAHELA RIVER, PITTSBURGH, PENNSYLVANIA MP 4.5
Station Code 1237



A-6

Monitoring Site

Manual - South Heights, Pennsylvania, Duquesne Power Generating Plant (Phillips Station) M.P. 15.2 (Sample collected from platform above river intake).

Automatic - South Heights, Pennsylvania, Duquesne Power Generating Plant (Phillips Station) M.P. 15.2 (tap in raw water line in pump house).

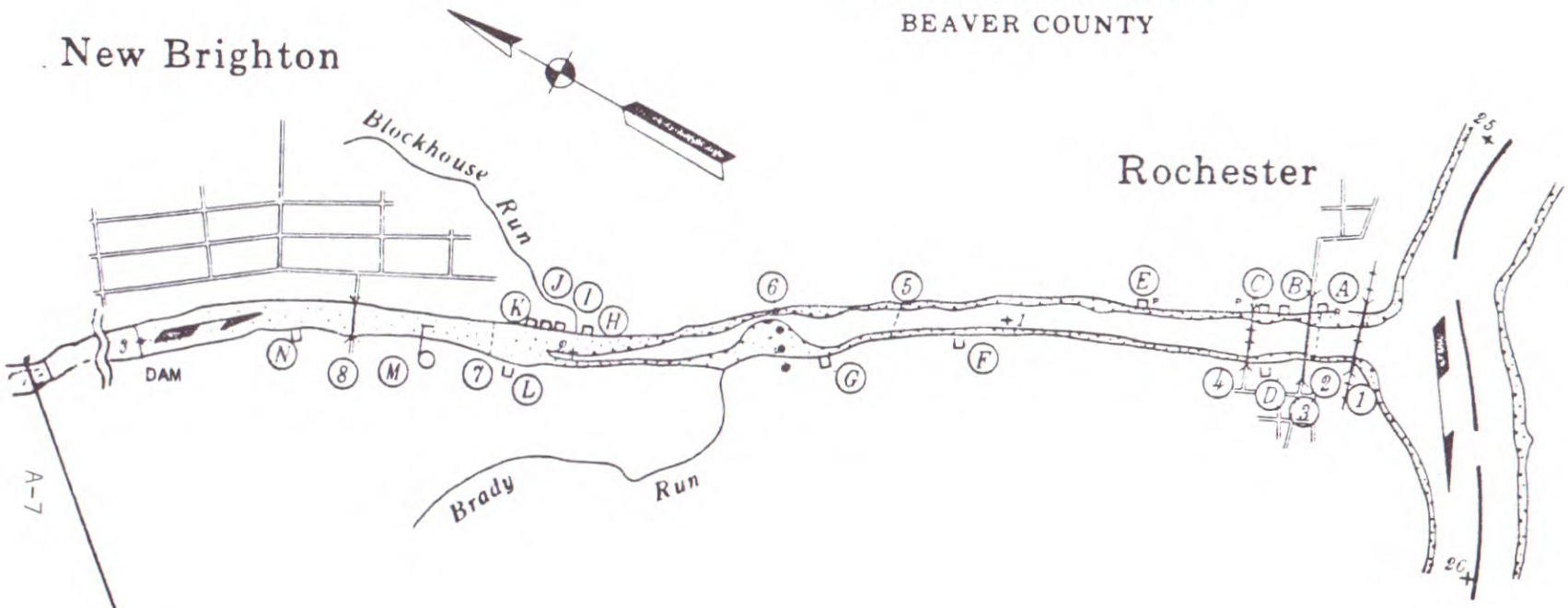
OHIO RIVER, SOUTH HEIGHTS, PENNSYLVANIA MP 15.2
Station Code 1201

OHIO RIVER

1 0 1 2 3000

SCALE 1"=2000'

PENNSYLVANIA
BEAVER COUNTY



Monitoring Site

Manual - Intake of Beaver Falls, Pennsylvania Waterworks located in Beaver Falls, Pennsylvania M.P. 5.3. (Sample collected from the intake line in pumping station.)

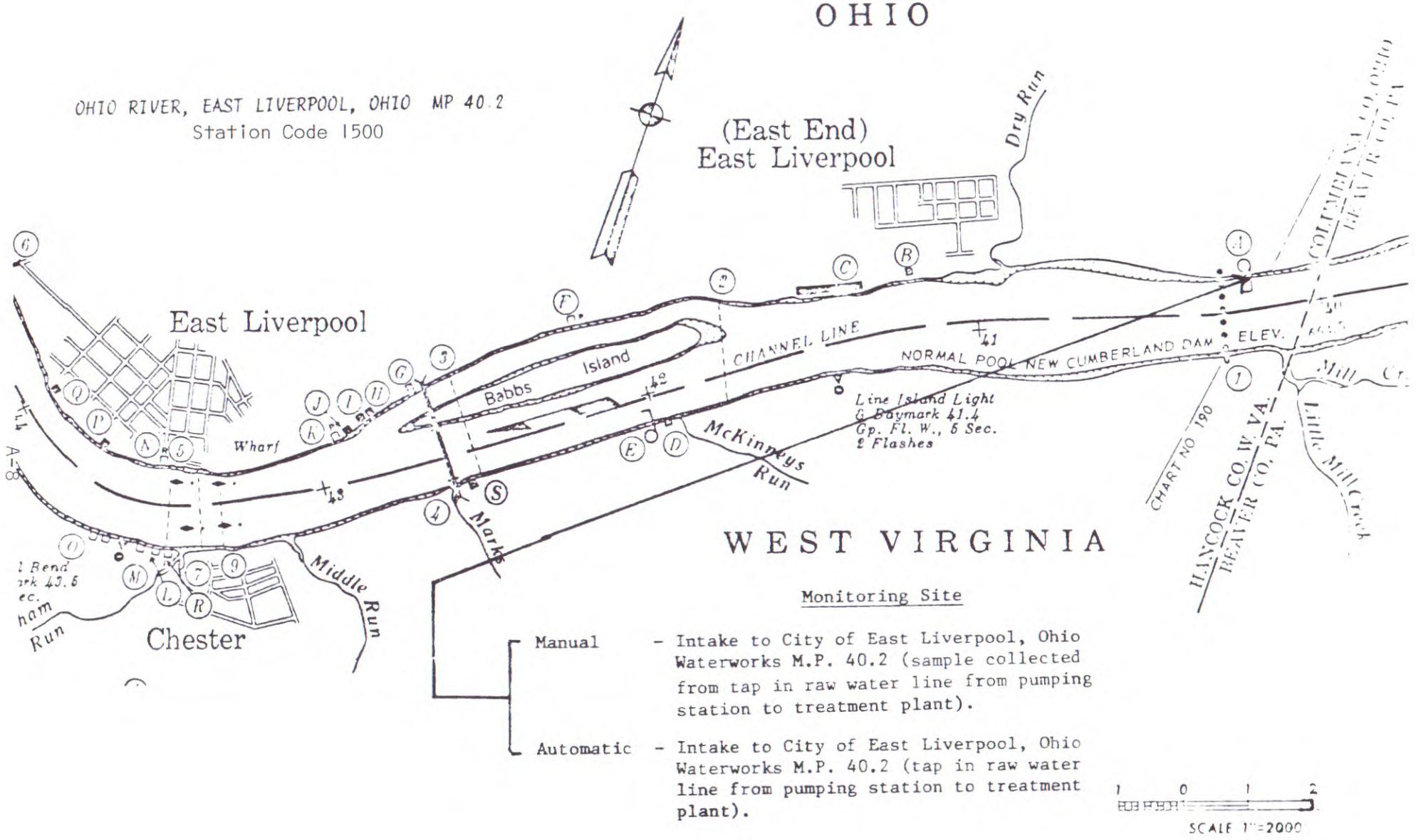
Automatic - Intake of Beaver Falls, Pennsylvania Waterworks located in Beaver Falls, Pennsylvania M.P. 5.3. (Sample collected from the intake line in pumping station.)

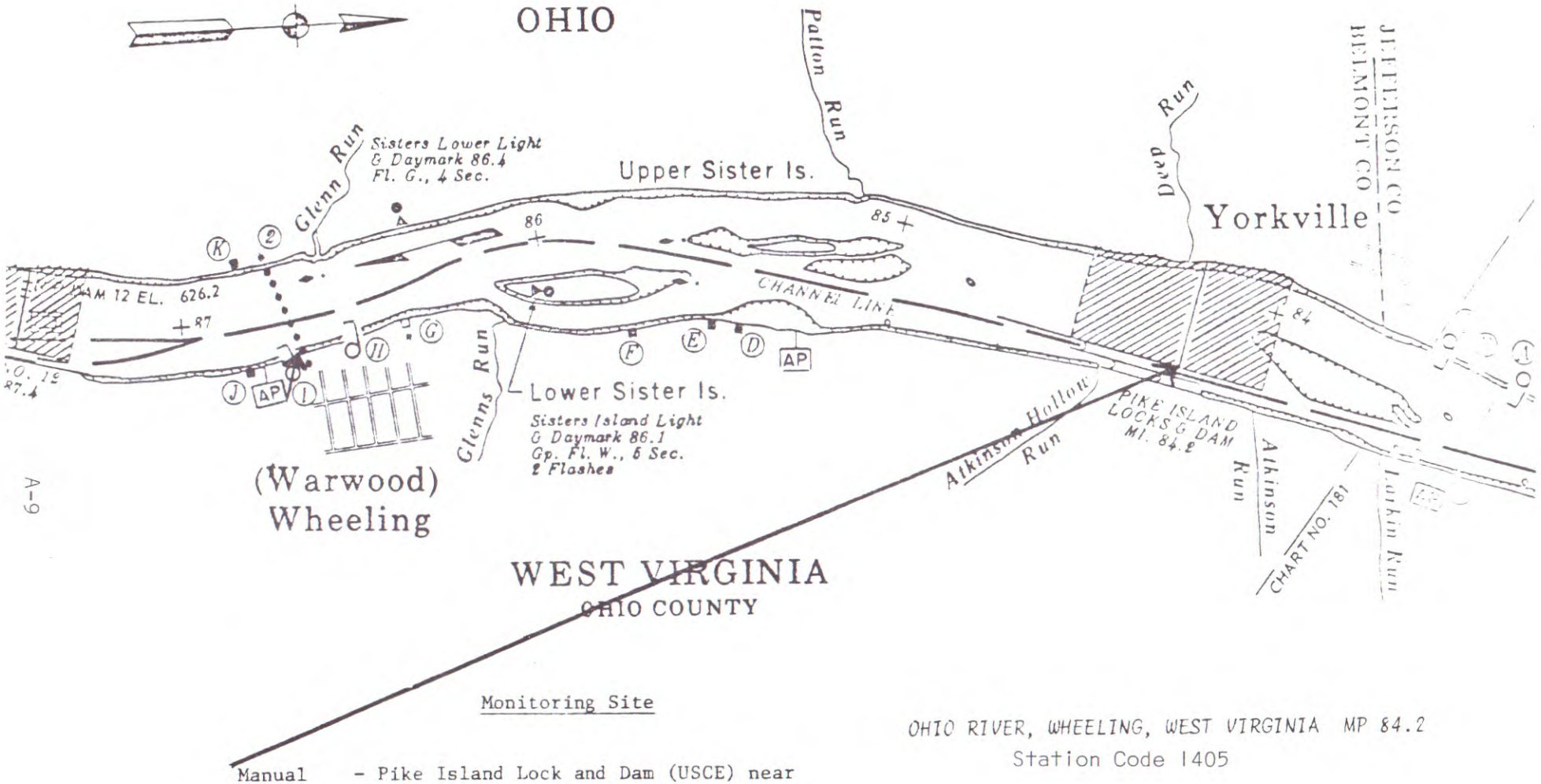
BEAVER RIVER, BEAVER FALLS, PENNSYLVANIA MP 5.3
Station Code 1242

(BEAVER RIVER)
OHIO RIVER

0 1 2 3 4000
SCALE 1" = 2000'

OHIO RIVER, EAST LIVERPOOL, OHIO MP 40.2
Station Code 1500





Monitoring Site

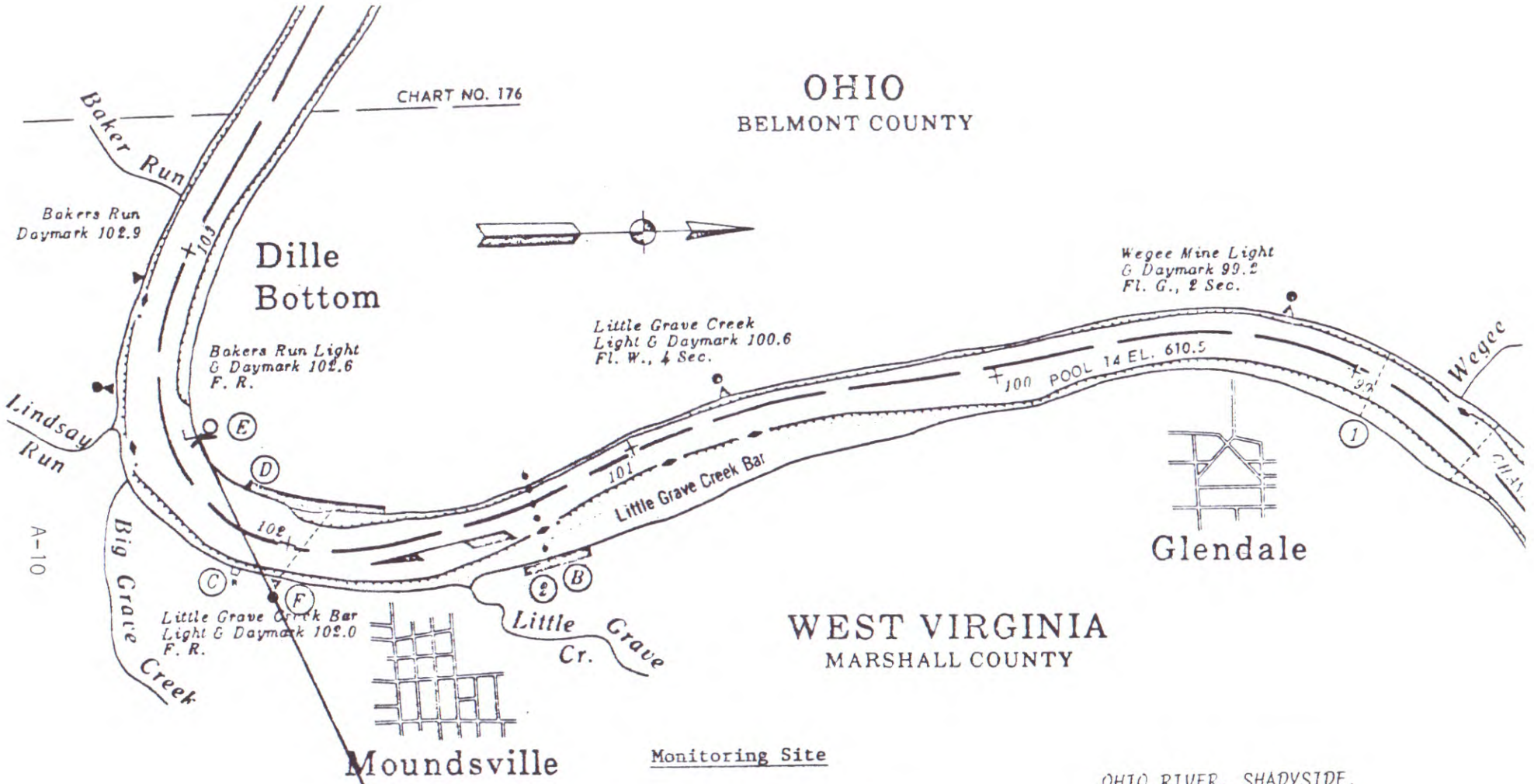
Manual - Pike Island Lock and Dam (USCE) near Wheeling, W. Va. - M.P. 84.2 (sample collected from upstream end of guide-wall to lock).

OHIO RIVER, WHEELING, WEST VIRGINIA MP 84.2
Station Code 1405

OHIO RIVER

0 1 2 3

SCALE 1" = 2000



A-10

Monitoring Site

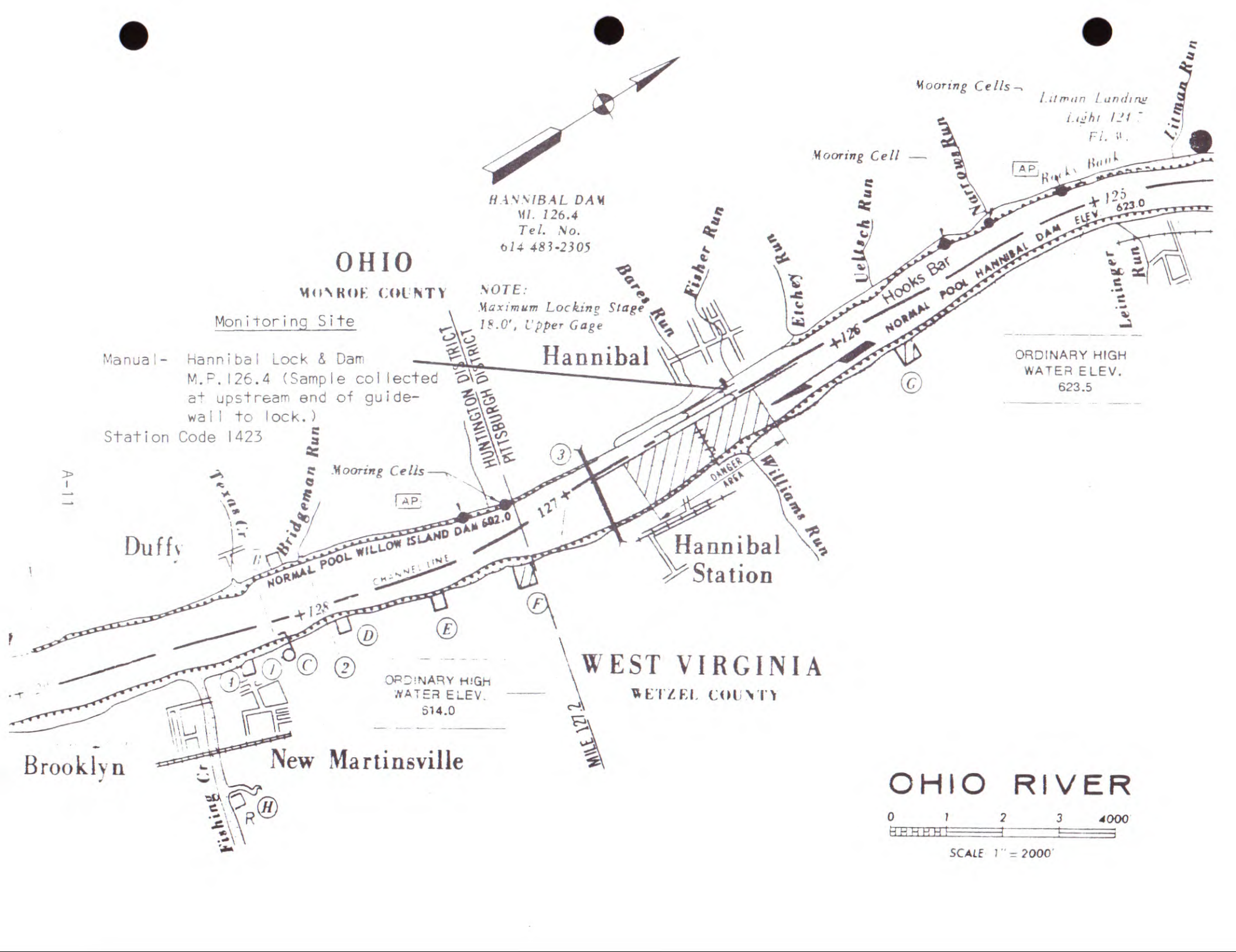
OHIO RIVER, SHADYSIDE, OHIO MP 102.4
Station Code 1521

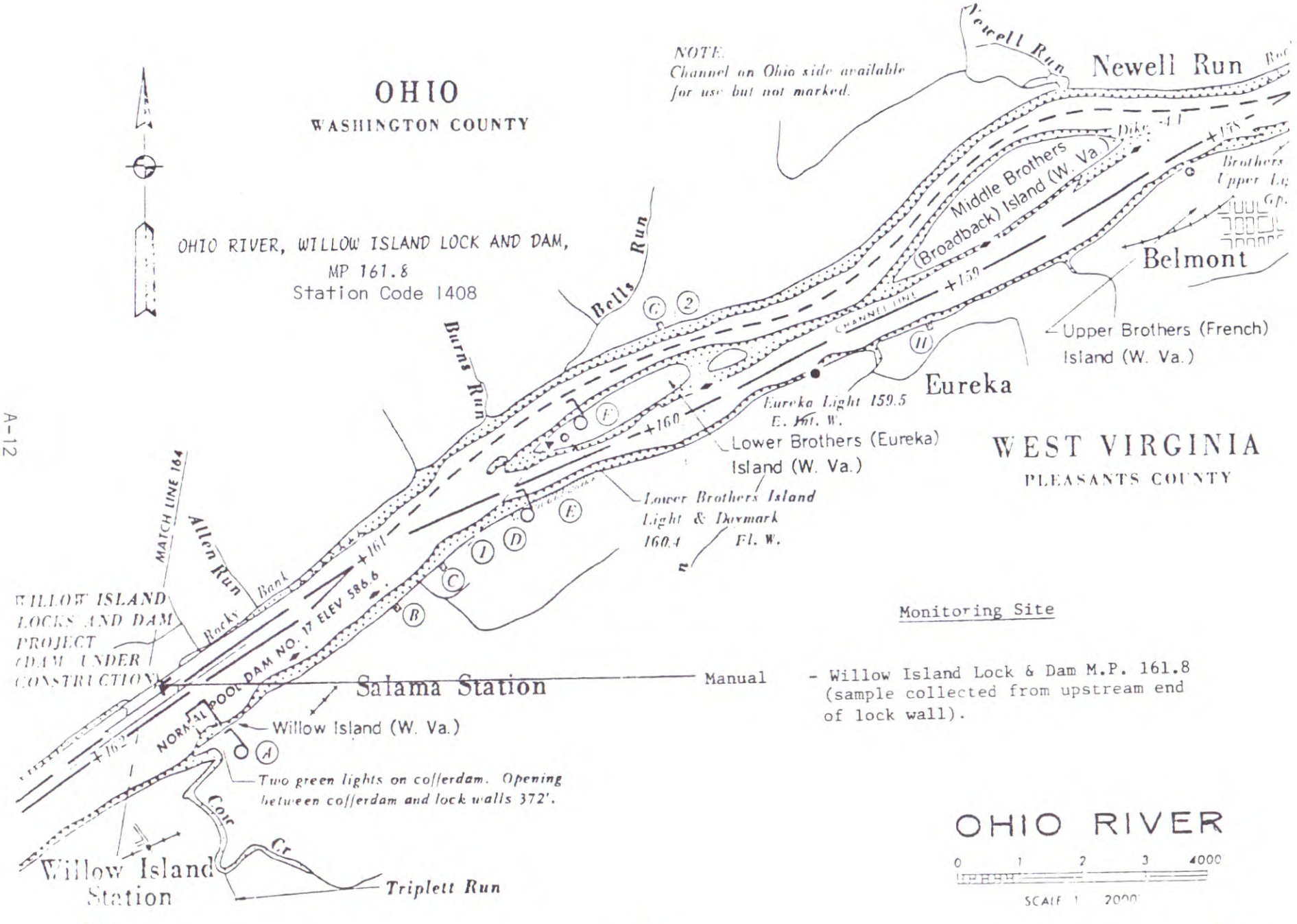
Manual - Burger Power Generating Plant of Ohio Edison Co. near Shadyside, Ohio M.P. 102.4 (sample collected from walkway over intake structure).

Automatic -Intake to Burger Power Generating Plant of Ohio Edison Co. near Shadyside, Ohio M.P. 102.4 (tap in raw water line near pumps to generating facility).

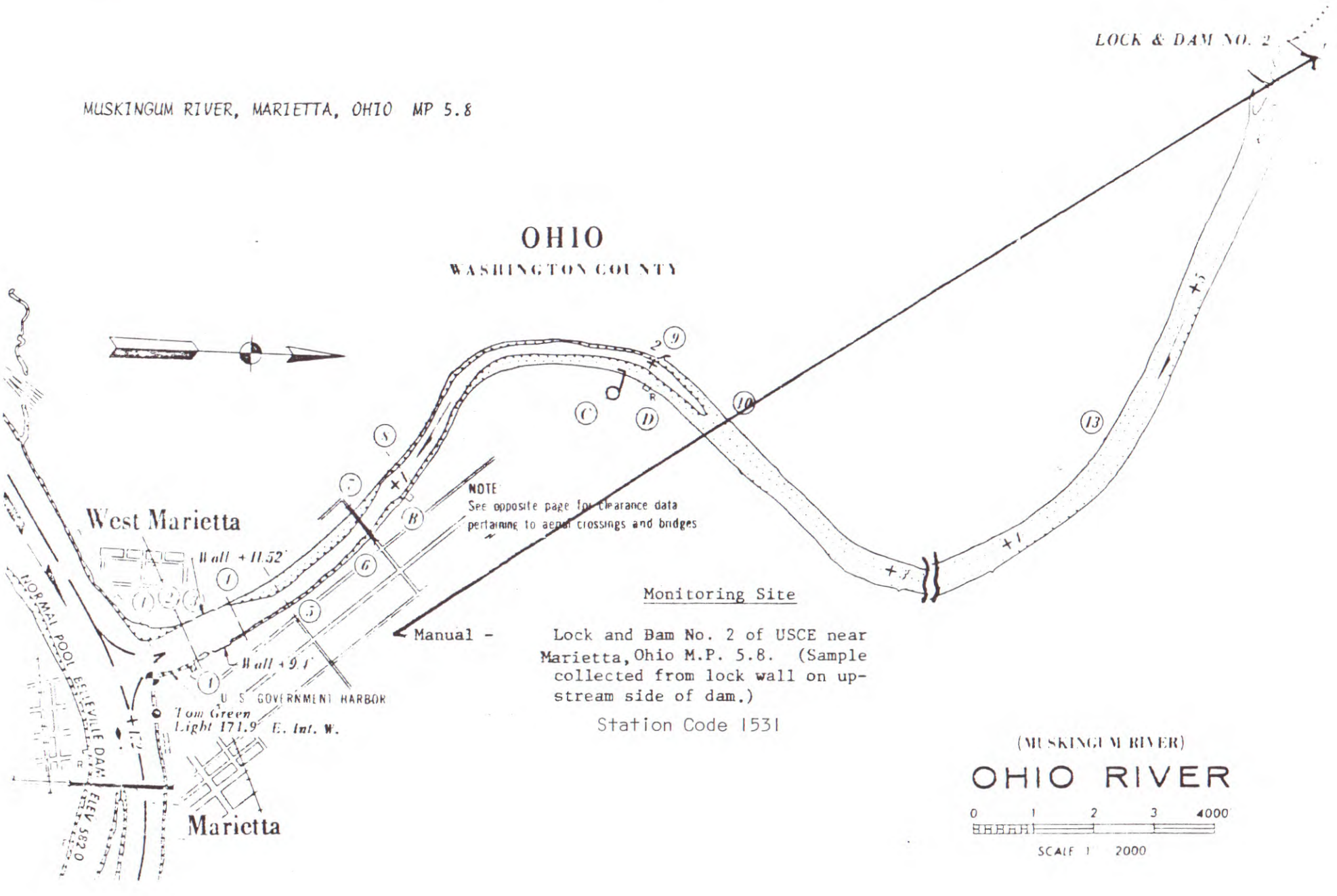
1 0 1 2

SCALE 1"=2000


HANNIBAL DAM
Mi. 126.4
Tel. No.
614 483-2305
OHIO
MONROE COUNTY
NOTE:
Maximum Locking Stage
18.0', Upper Gage
Monitoring Site
Manual- Hannibal Lock & Dam
M.P. 126.4 (Sample collected
at upstream end of guide-
wall to lock.)
Station Code 1423
A-11
Hannibal
Duffy
Brooklyn
New Martinsville
Hannibal
Station
WEST VIRGINIA
WETZEL COUNTY
Mooring Cells
Litman Landing
Light 124.7
Fl. W.
Litman Run
Mooring Cell
Narrows Run
AP
Rocky Bank
+125
623.0
Uellech Run
Eichey Run
Fisher Run
Bares Run
Hooks Bar
+126
NORMAL POOL HANNIBAL DAM ELEV
Leininger Run
ORDINARY HIGH
WATER ELEV.
623.5
HUNTINGTON DISTRICT
PITTSBURGH DISTRICT
Mooring Cells
AP
Bridgeman Run
Taxes Cr
127 +
DANGER
AREA
Williams Run
NORMAL POOL WILLOW ISLAND DAM 602.0
CHANNEL LINE
+128
ORDINARY HIGH
WATER ELEV.
614.0
MILE 127.2
Fishing Cr
OHIO RIVER
0 1 2 3 4000
SCALE 1" = 2000'


OHIO
WASHINGTON COUNTY
OHIO RIVER, WILLOW ISLAND LOCK AND DAM,
MP 161.8
Station Code 1408
NOTE:
Channel on Ohio side available for use but not marked.
Newell Run
Newell Run
Middle Brothers (Broadback) Island (W. Va.)
Belmont
Upper Brothers (French) Island (W. Va.)
Bells Run
Burns Run
Eureka
Eureka Light 159.5
E. Int. W.
Lower Brothers (Eureka) Island (W. Va.)
Lower Brothers Island Light & Daymark 160.4 Fl. W.
WEST VIRGINIA
PLEASANTS COUNTY
MATCH LINE 164
Allen Run
WILLOW ISLAND LOCKS AND DAM PROJECT (DAM UNDER CONSTRUCTION)
Rocky Bank
NORMAL POOL DAM NO. 17 ELEV 586.6
Salama Station
Willow Island (W. Va.)
Two green lights on cofferdam. Opening between cofferdam and lock walls 372'.
Willow Island Station
Triplett Run
Manual
Monitoring Site
- Willow Island Lock & Dam M.P. 161.8 (sample collected from upstream end of lock wall).
OHIO RIVER
0 1 2 3 4000
SCALE 1 2000'

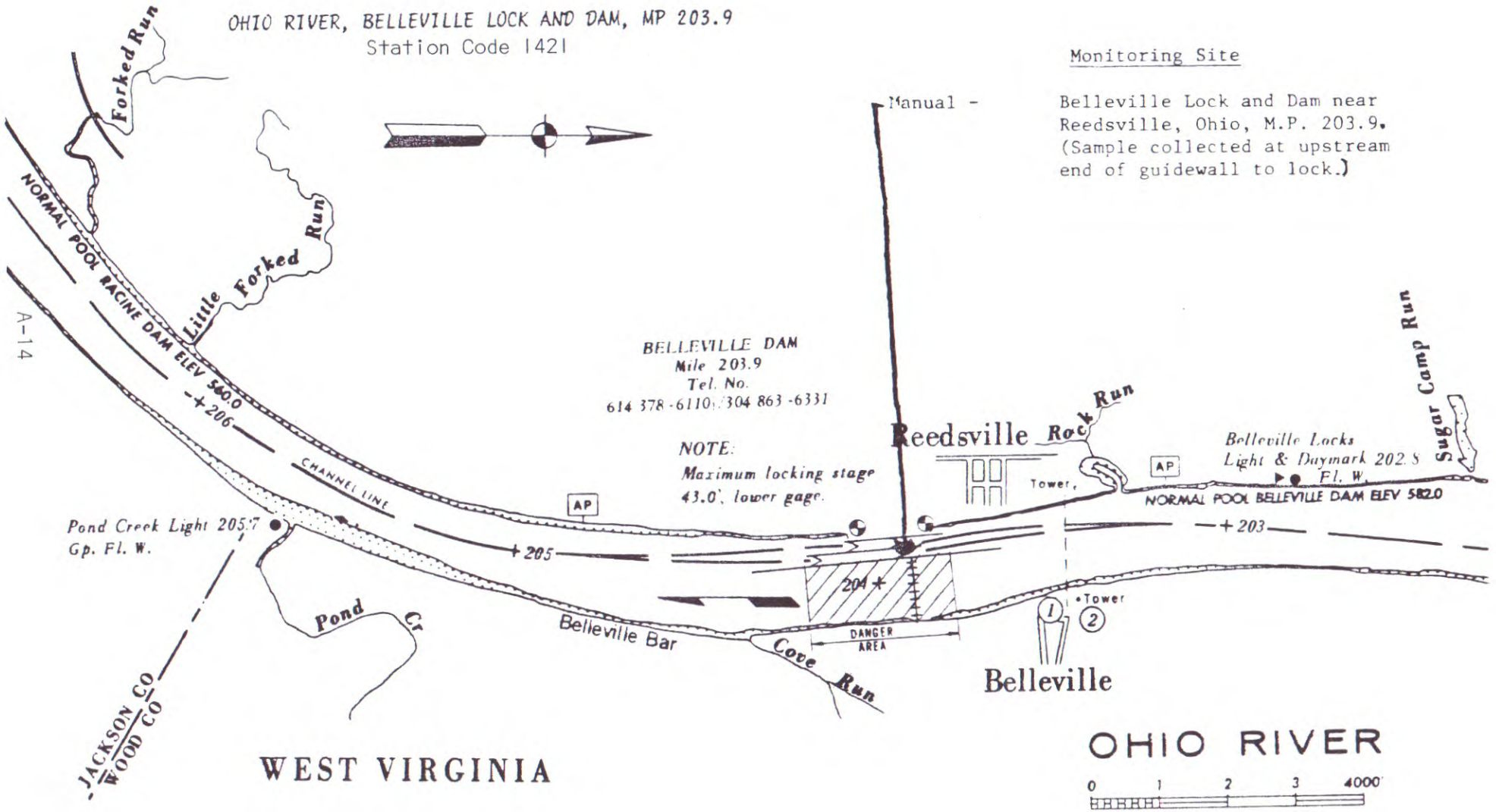
MUSKINGUM RIVER, MARIETTA, OHIO MP 5.8



OHIO

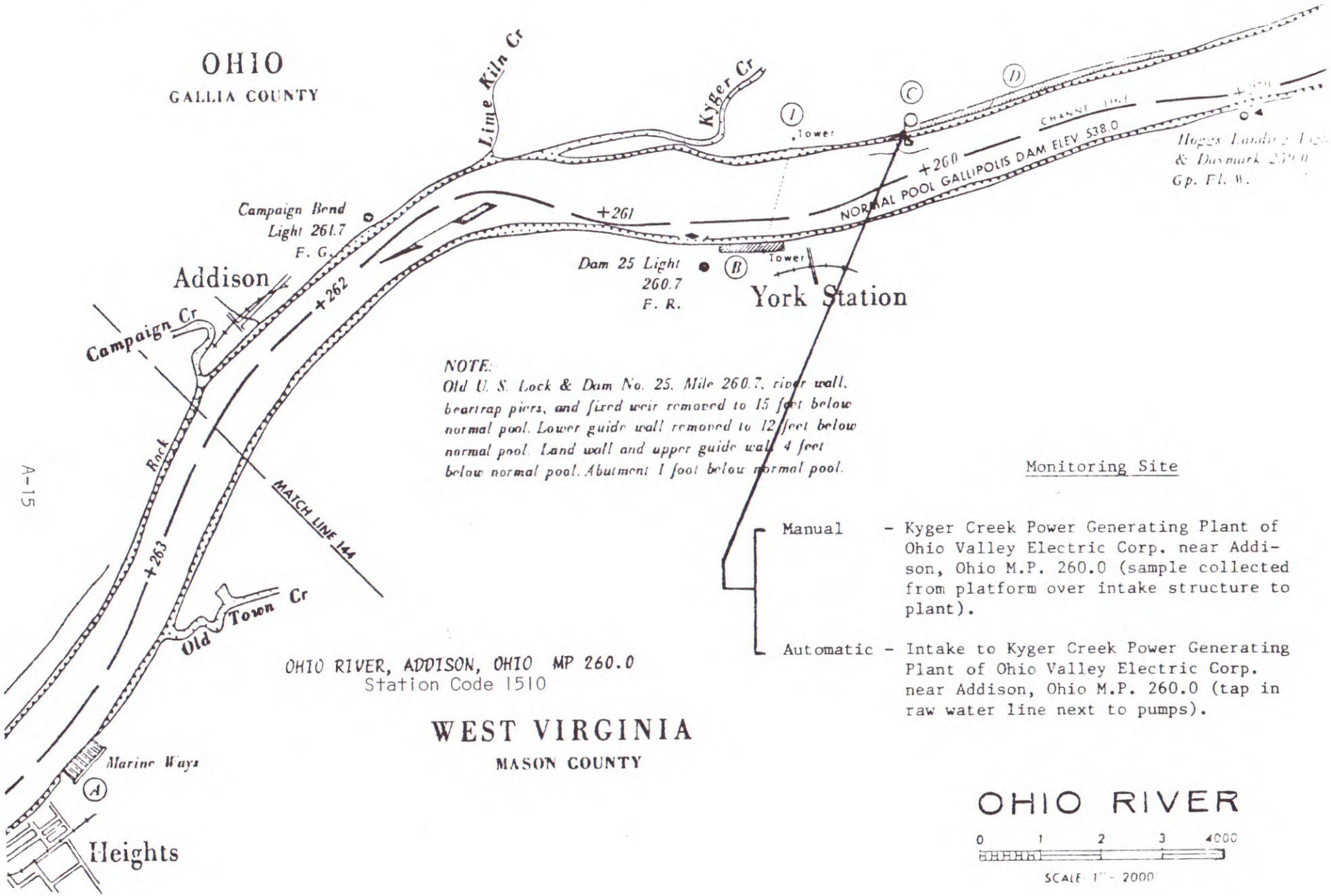
MEIGS COUNTY

OHIO RIVER, BELLEVILLE LOCK AND DAM, MP 203.9
Station Code 1421



Monitoring Site

Belleville Lock and Dam near Reedsville, Ohio, M.P. 203.9. (Sample collected at upstream end of guidewall to lock.)



NOTE:
Old U. S. Lock & Dam No. 25. Mile 260.7, river wall, beartrap piers, and fixed weir removed to 15 feet below normal pool. Lower guide wall removed to 12 feet below normal pool. Land wall and upper guide wall 4 feet below normal pool. Abutment 1 foot below normal pool.

OHIO RIVER, ADDISON, OHIO MP 260.0
Station Code 1510

Monitoring Site

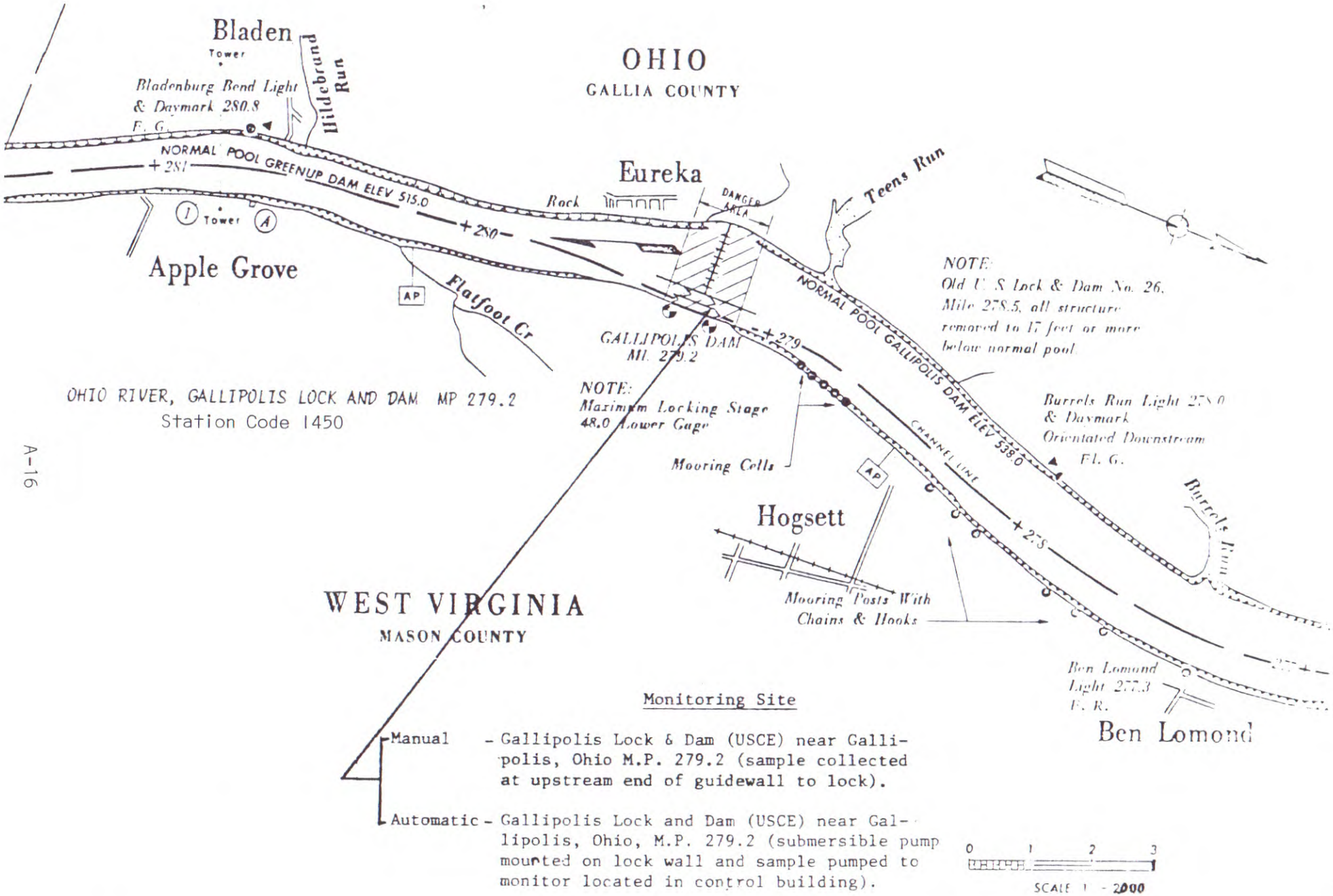
Manual - Kyger Creek Power Generating Plant of Ohio Valley Electric Corp. near Addison, Ohio M.P. 260.0 (sample collected from platform over intake structure to plant).

Automatic - Intake to Kyger Creek Power Generating Plant of Ohio Valley Electric Corp. near Addison, Ohio M.P. 260.0 (tap in raw water line next to pumps).

OHIO RIVER

0 1 2 3 4000

SCALE 1" = 2000'


Bladen
Tower
Bladenburg Bend Light
& Daymark 280.8
F. G.
Hildebrand Run
OHIO
GALLIA COUNTY
NORMAL POOL GREENUP DAM ELEV 515.0
+281
Eureka
Rock
DANGER AREA
Teens Run
+280
Tower
1
A
Apple Grove
AP
Flatfoot Cr
GALLIPOLIS DAM
MI. 279.2
+279
NOTE:
Old U. S. Lock & Dam No. 26,
Mile 278.5, all structure
removed to 17 feet or more
below normal pool
NORMAL POOL GALLIPOLIS DAM ELEV 538.0
OHIO RIVER, GALLIPOLIS LOCK AND DAM MP 279.2
Station Code 1450
NOTE:
Maximum Locking Stage
48.0 Lower Gage
Mooring Cells
Burrels Run Light 278.0
& Daymark
Orientated Downstream
F. L. G.
CHANNEL LINE
AP
Hogsett
+278
Burrels Run
Mooring Posts With
Chains & Hooks
WEST VIRGINIA
MASON COUNTY
Ben Lomond
Light 277.3
F. R.
Ben Lomond
Monitoring Site
Manual - Gallipolis Lock & Dam (USCE) near Gallipolis, Ohio M.P. 279.2 (sample collected at upstream end of guidewall to lock).
Automatic - Gallipolis Lock and Dam (USCE) near Gallipolis, Ohio, M.P. 279.2 (submersible pump mounted on lock wall and sample pumped to monitor located in control building).
0 1 2 3
SCALE 1 - 2000

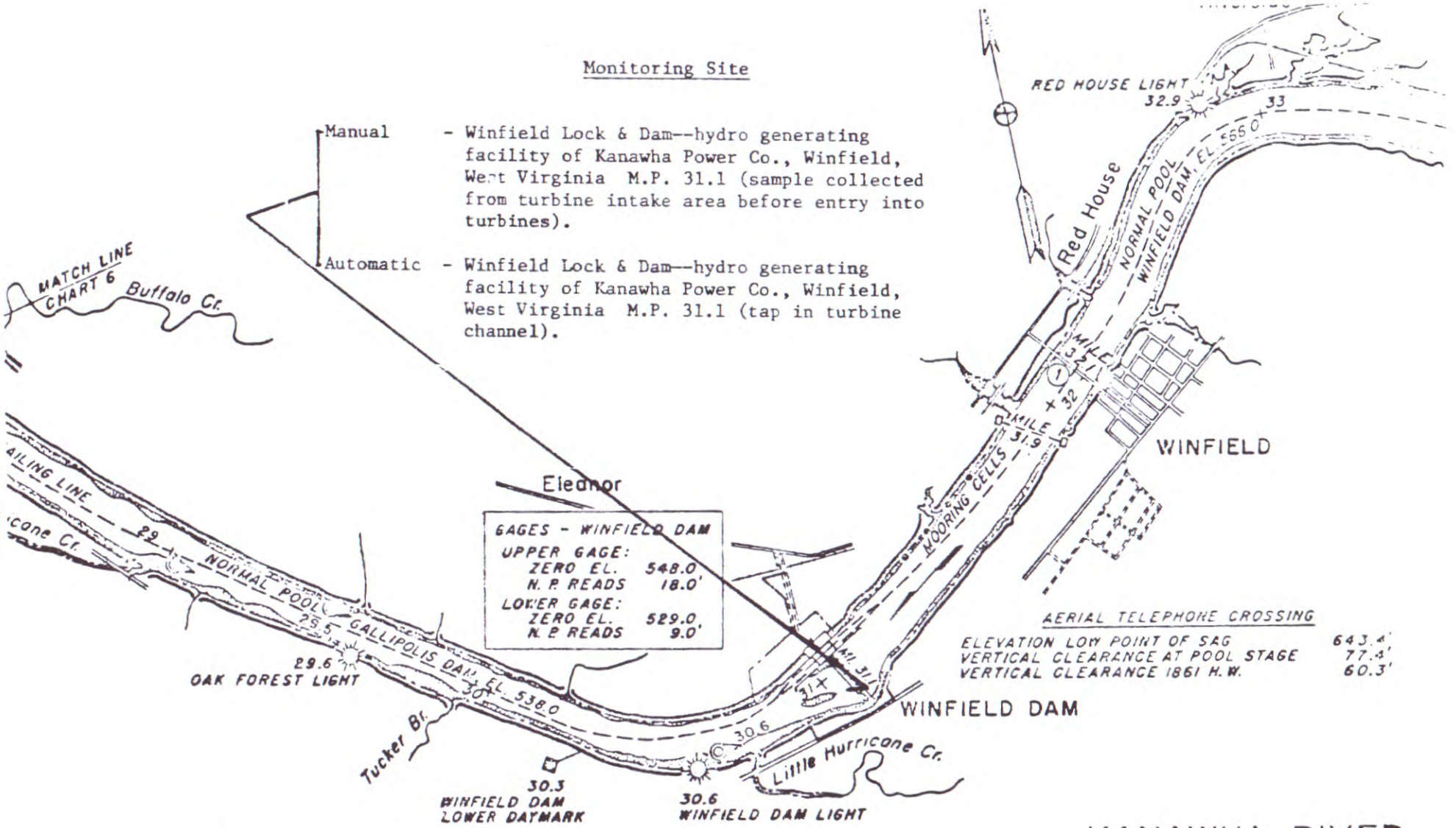
STATION CODES FOR MIDDLE OHIO REGION
MANUAL MONITORING STATIONS

Kanawha River at Winfield, W.Va.	1450
Ohio River at Huntington, W.Va.	1412
Ohio River at Kenova, W.Va. (South Point, Oh.)	1523
Big Sandy River near Louisa, Ky.	1630
Ohio River at Greenup Dam, Ky.	1621
Scioto River at Lucasville, Oh.	1538
Ohio River at Meldahl Dam, Oh.	1511
Ohio River at Cincinnati, Oh.	1504
Little Miami River at Cincinnati, Oh.	1571
Licking River at Covington, Ky.	1634
Ohio River at North Bend, Oh.	1508
Great Miami River at Cleves, Oh.	1551
Ohio River at Markland Dam, Ky.	1600

Monitoring Site

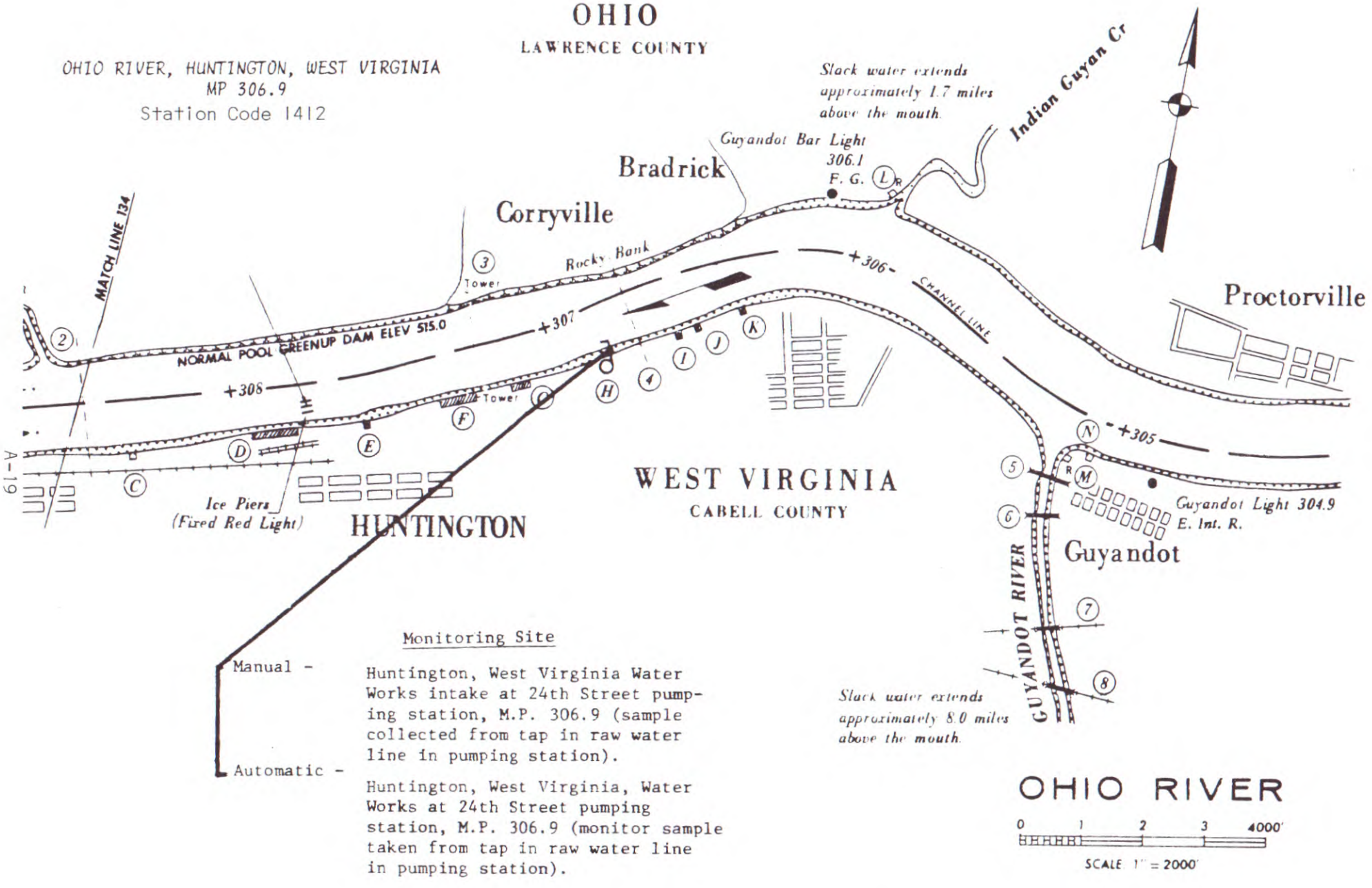
Manual - Winfield Lock & Dam--hydro generating facility of Kanawha Power Co., Winfield, West Virginia M.P. 31.1 (sample collected from turbine intake area before entry into turbines).

Automatic - Winfield Lock & Dam--hydro generating facility of Kanawha Power Co., Winfield, West Virginia M.P. 31.1 (tap in turbine channel).

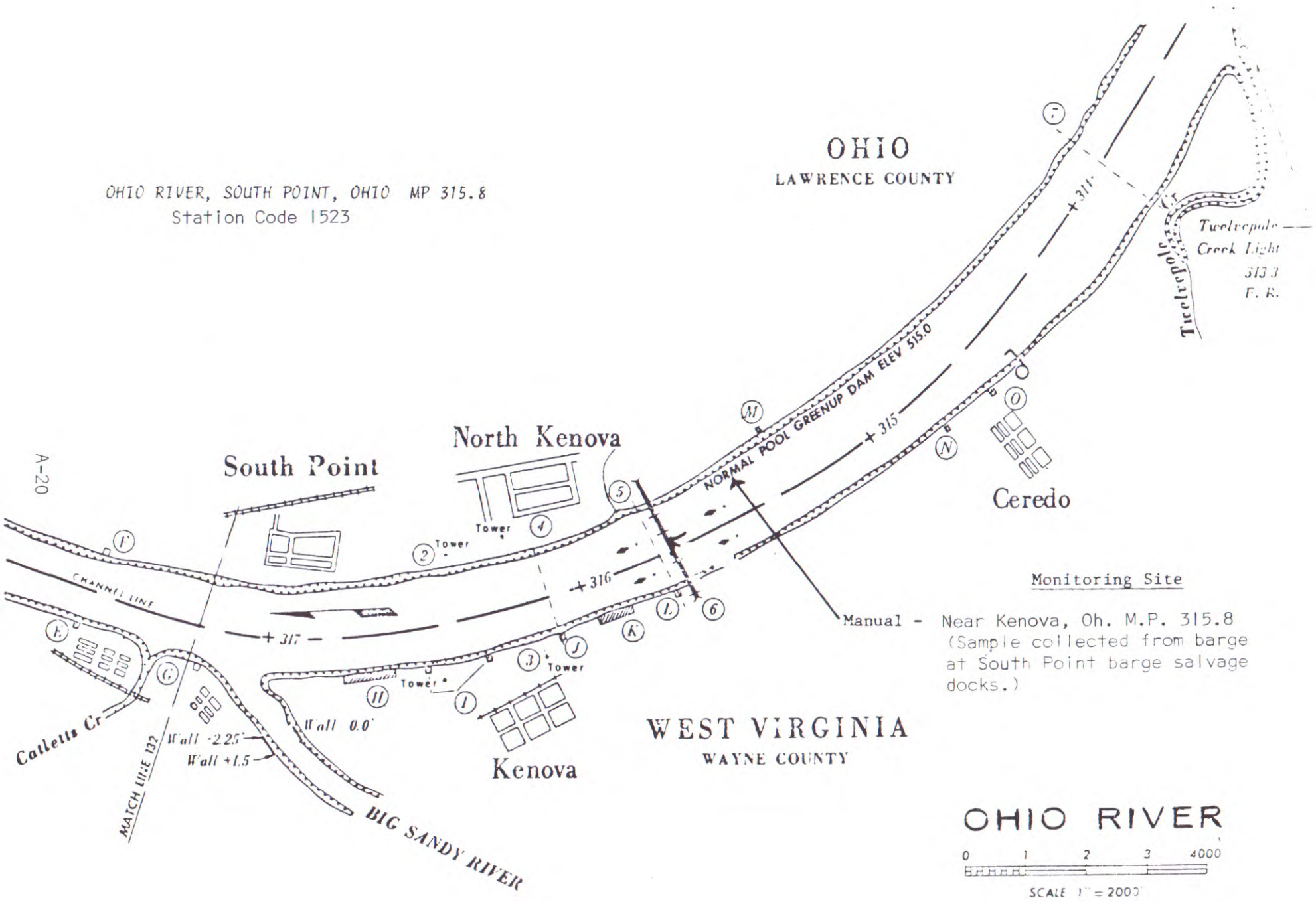


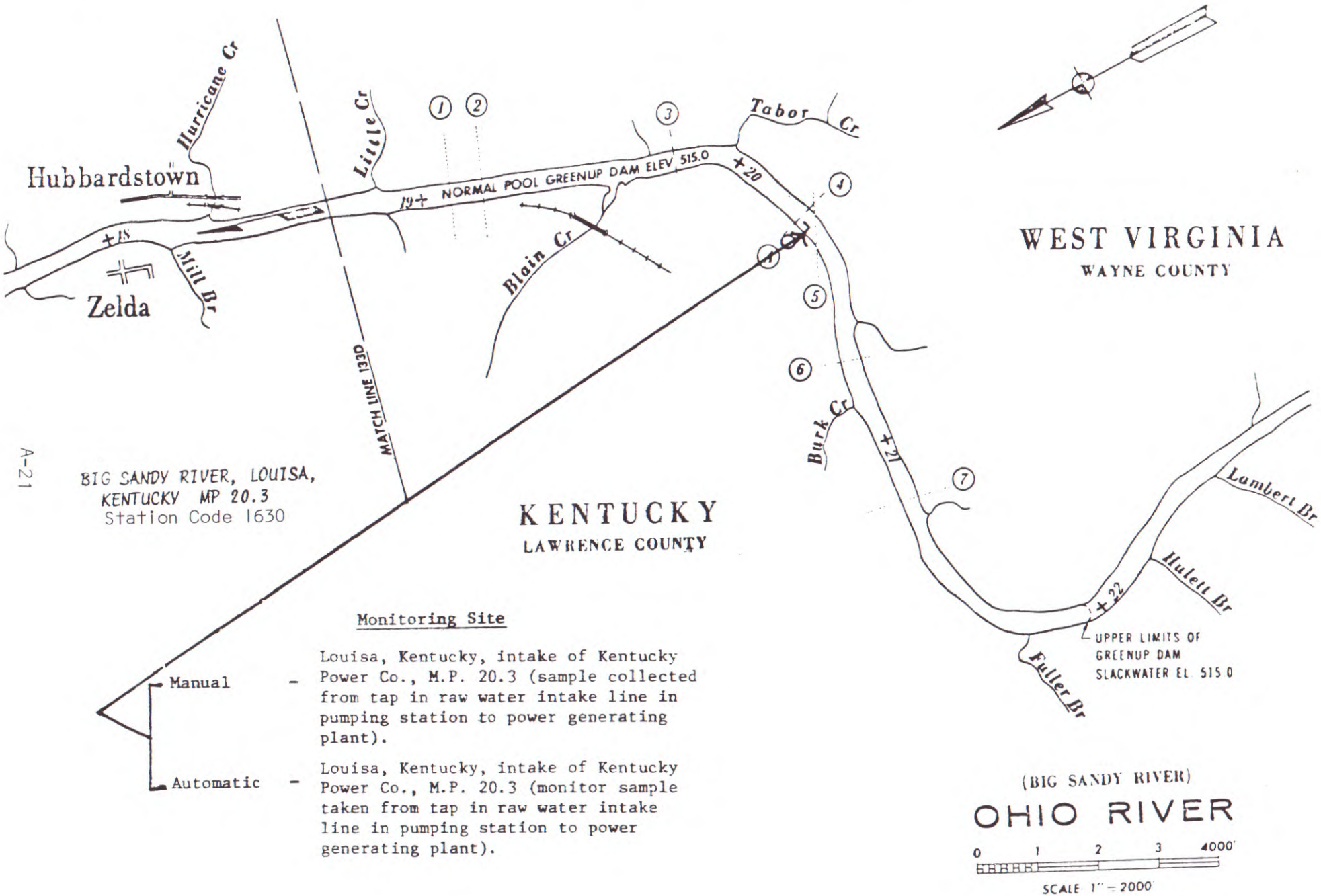
KANAWHA RIVER, WINFIELD, WEST VIRGINIA MP 31.1
Station Code 1422

KANAWHA RIVER
HUNTINGTON DISTRICT
0 1 2 3 4000'
SCALE 1" = 2000'


OHIO
LAWRENCE COUNTY
OHIO RIVER, HUNTINGTON, WEST VIRGINIA
MP 306.9
Station Code 1412
Slack water extends approximately 1.7 miles above the mouth.
Indian Guyan Cr
Guyandot Bar Light
306.1
F. G.
Bradrick
Corryville
Proctorville
MATCH LINE 134
Rocky Bank
Tower
+306
CHANNEL LINE
NORMAL POOL GREENUP DAM ELEV 515.0
+307
+308
Tower
+305
WEST VIRGINIA
CABELL COUNTY
Ice Piers
(Fired Red Light)
HUNTINGTON
Guyandot Light 304.9
E. Int. R.
Guyandot
GUYANDOT RIVER
Slack water extends approximately 8.0 miles above the mouth.
OHIO RIVER
0 1 2 3 4000'
SCALE 1" = 2000'
Monitoring Site
Manual - Huntington, West Virginia Water Works intake at 24th Street pumping station, M.P. 306.9 (sample collected from tap in raw water line in pumping station).
Automatic - Huntington, West Virginia, Water Works at 24th Street pumping station, M.P. 306.9 (monitor sample taken from tap in raw water line in pumping station).

OHIO RIVER, SOUTH POINT, OHIO MP 315.8
Station Code 1523





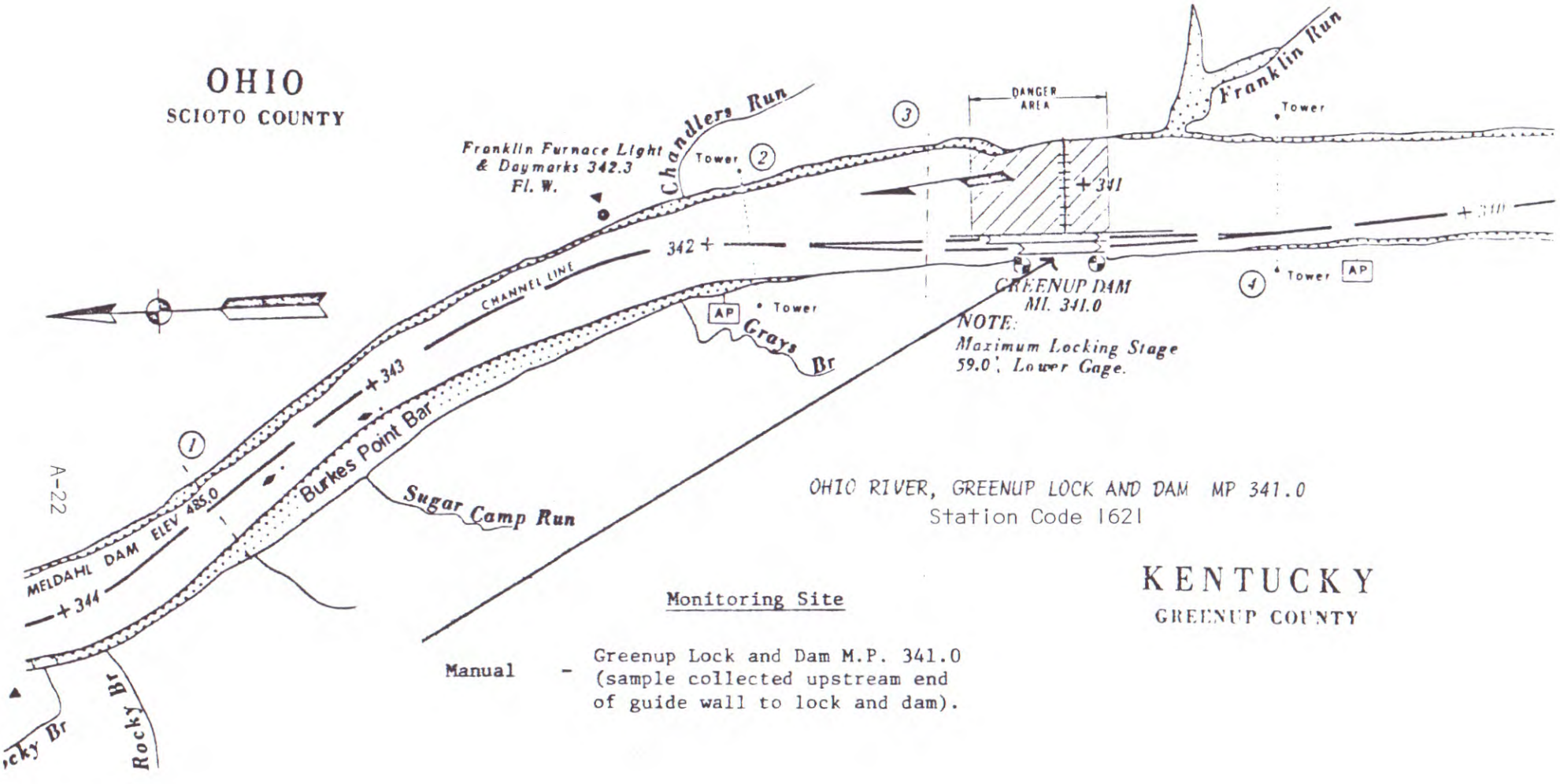
A-21

BIG SANDY RIVER, LOUISA,
KENTUCKY MP 20.3
Station Code 1630

Monitoring Site

Manual – Louisa, Kentucky, intake of Kentucky Power Co., M.P. 20.3 (sample collected from tap in raw water intake line in pumping station to power generating plant).

Automatic – Louisa, Kentucky, intake of Kentucky Power Co., M.P. 20.3 (monitor sample taken from tap in raw water intake line in pumping station to power generating plant).



A-22

OHIO RIVER, GREENUP LOCK AND DAM MP 341.0
Station Code 1621

KENTUCKY
GREENUP COUNTY

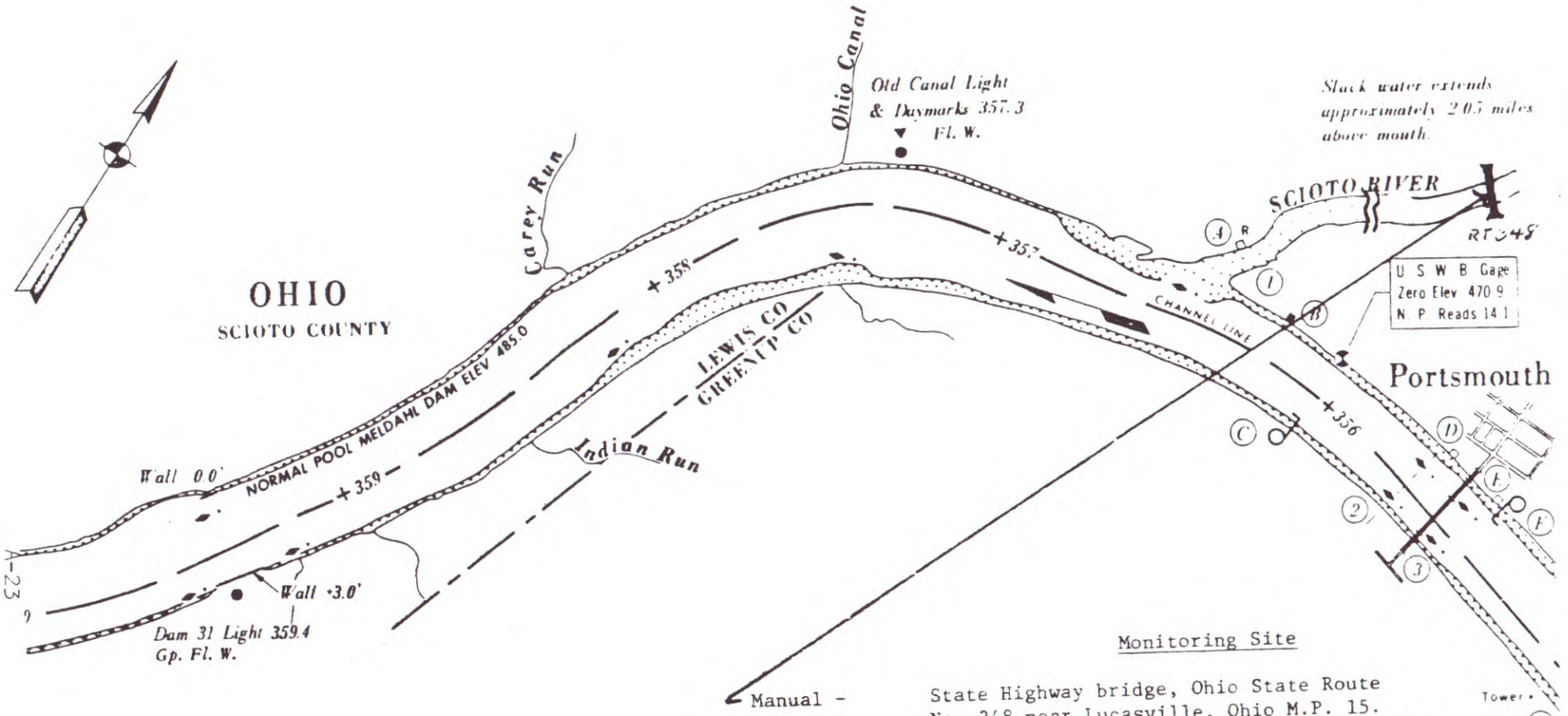
Monitoring Site

Manual - Greenup Lock and Dam M.P. 341.0 (sample collected upstream end of guide wall to lock and dam).

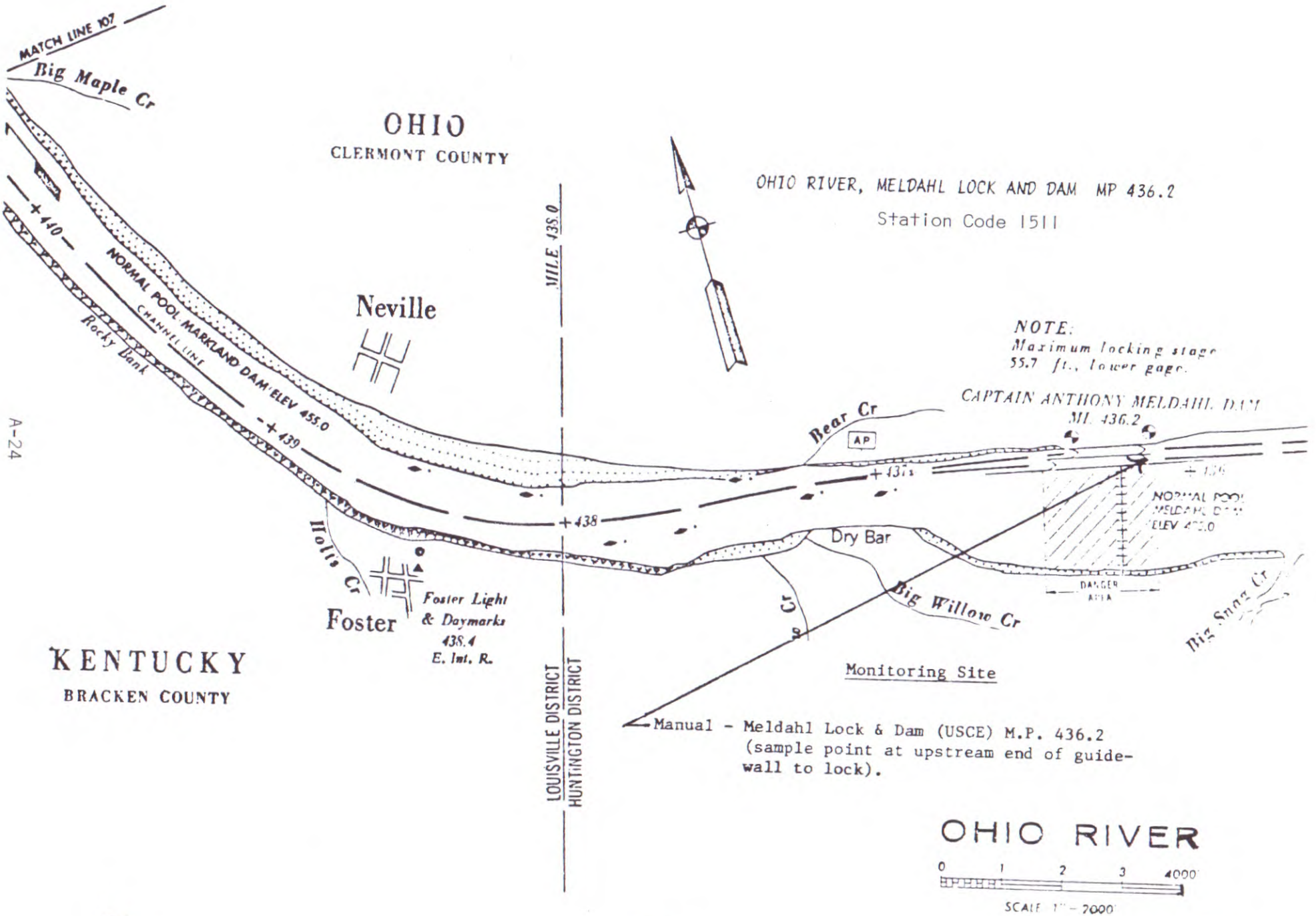
OHIO RIVER

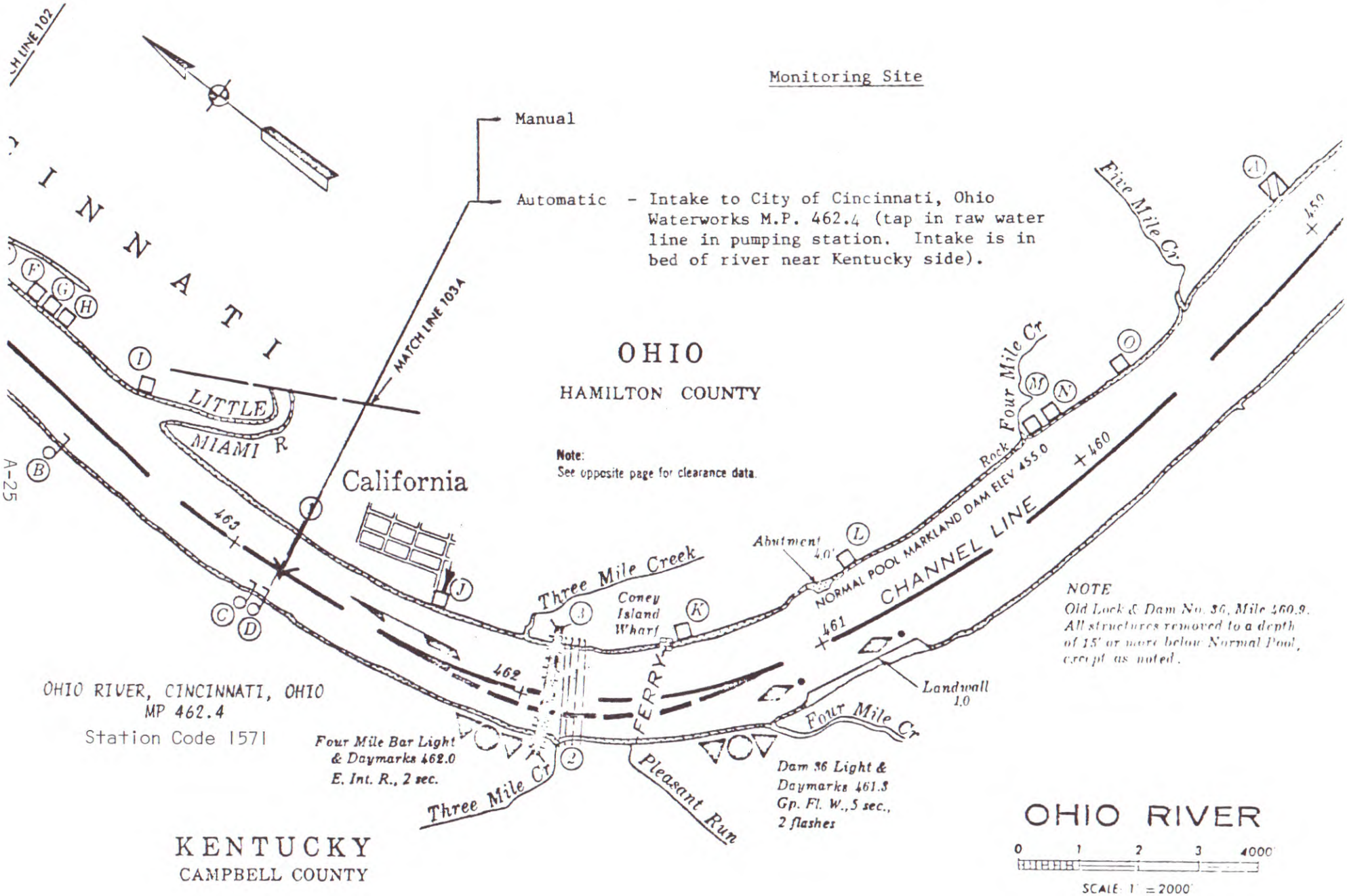
0 1 2 3 4000'

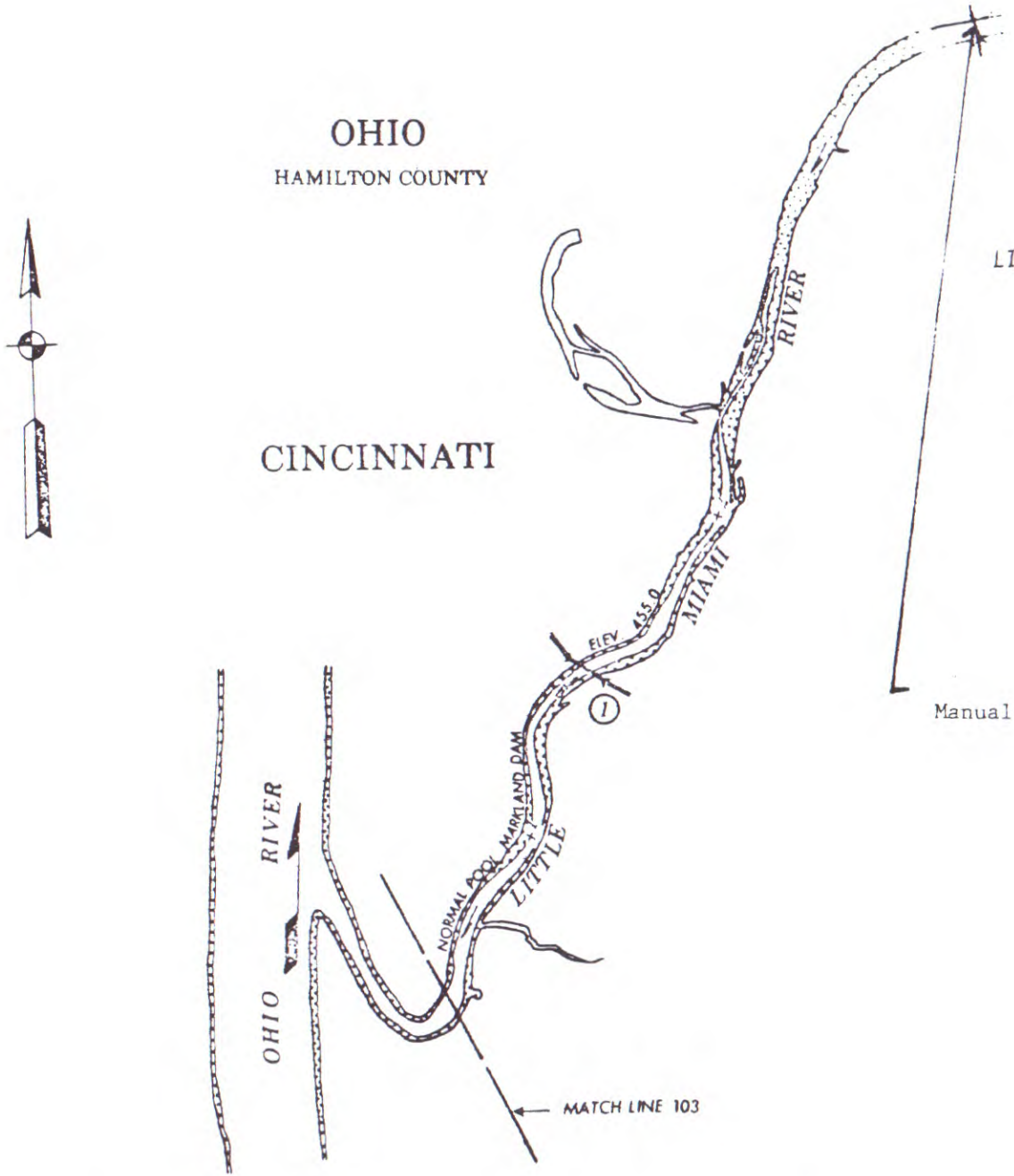
SCALE 1" = 2000'



SCIOTO RIVER, LUCASVILLE, OHIO MP 15
Station Code 1538


MATCH LINE 107
Big Maple Cr
OHIO
CLERMONT COUNTY
OHIO RIVER, MELDAHL LOCK AND DAM MP 436.2
Station Code 1511
MILE 435.0
Neville
NOTE:
Maximum locking stage
55.7 ft., lower gage.
NORMAL POOL MARKLAND DAM ELEV 455.0
CHANNEL LINE
Rocky Bank
+440
+439
+438
+437
Bear Cr
AP
CAPTAIN ANTHONY MELDAHL DAM
MI. 436.2
NORMAL POOL
MELDAHL DAM
ELEV 455.0
DANGER
AREA
Dry Bar
Hollis Cr
Foster
Foster Light
& Daymarks
438.4
E. Int. R.
Big Willow Cr
Big Snag Cr
KENTUCKY
BRACKEN COUNTY
Monitoring Site
Manual - Meldahl Lock & Dam (USCE) M.P. 436.2
(sample point at upstream end of guide-
wall to lock).
LOUISVILLE DISTRICT
HUNTINGTON DISTRICT
OHIO RIVER
0 1 2 3 4000'
SCALE 1" = 2000'


Monitoring Site
Manual
Automatic - Intake to City of Cincinnati, Ohio Waterworks M.P. 462.4 (tap in raw water line in pumping station. Intake is in bed of river near Kentucky side).
MATCH LINE 102
MATCH LINE 103A
OHIO
HAMILTON COUNTY
Note:
See opposite page for clearance data.
California
LITTLE MIAMI R
Three Mile Creek
Coney Island Wharf
Abutment 4.0'
NORMAL POOL MARKLAND DAM ELEV 455.0
CHANNEL LINE
Four Mile Cr
Rock
Fire Mile Cr
+460
+461
+455
463
462
FERRY
Landwall 1.0
Four Mile Cr
Three Mile Cr
Pleasant Run
Four Mile Bar Light & Daymarks 462.0 E. Int. R., 2 sec.
Dam 36 Light & Daymarks 461.3 Gp. Fl. W., 5 sec., 2 flashes
NOTE
Old Lock & Dam No. 36, Mile 460.9. All structures removed to a depth of 15' or more below Normal Pool, except as noted.
OHIO RIVER, CINCINNATI, OHIO
MP 462.4
Station Code 1571
KENTUCKY
CAMPBELL COUNTY
OHIO RIVER
0 1 2 3 4000
SCALE: 1" = 2000'
A-25



LITTLE MIAMI RIVER, CINCINNATI, OHIO MP 7.5
Station Code 1571

(1) U.S. HIGHWAY 52 BRIDGE
VERTICAL CLEARANCE AT POOL STAGE 40.5'
HORIZONTAL CLEARANCE 122.0'

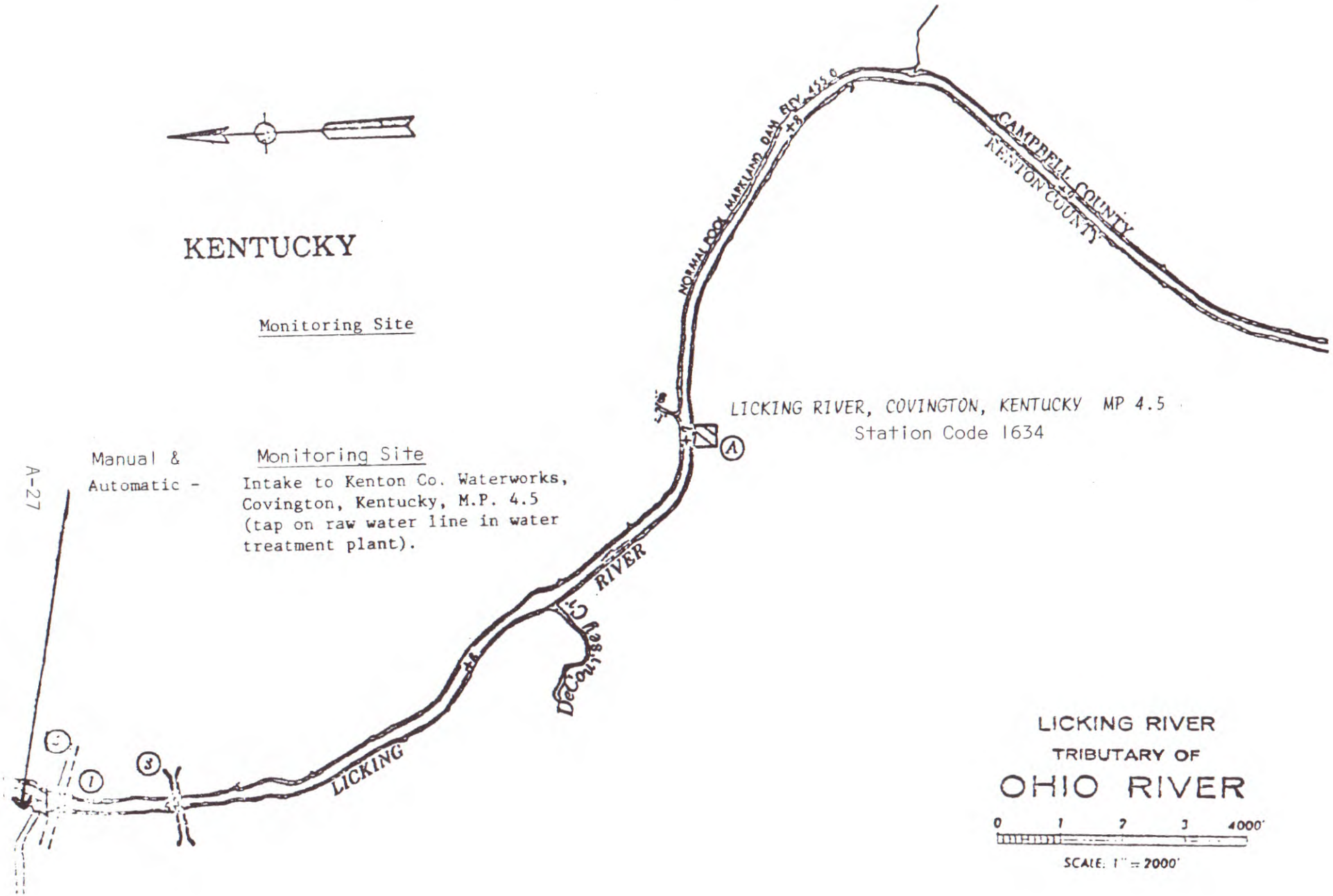
Monitoring Site

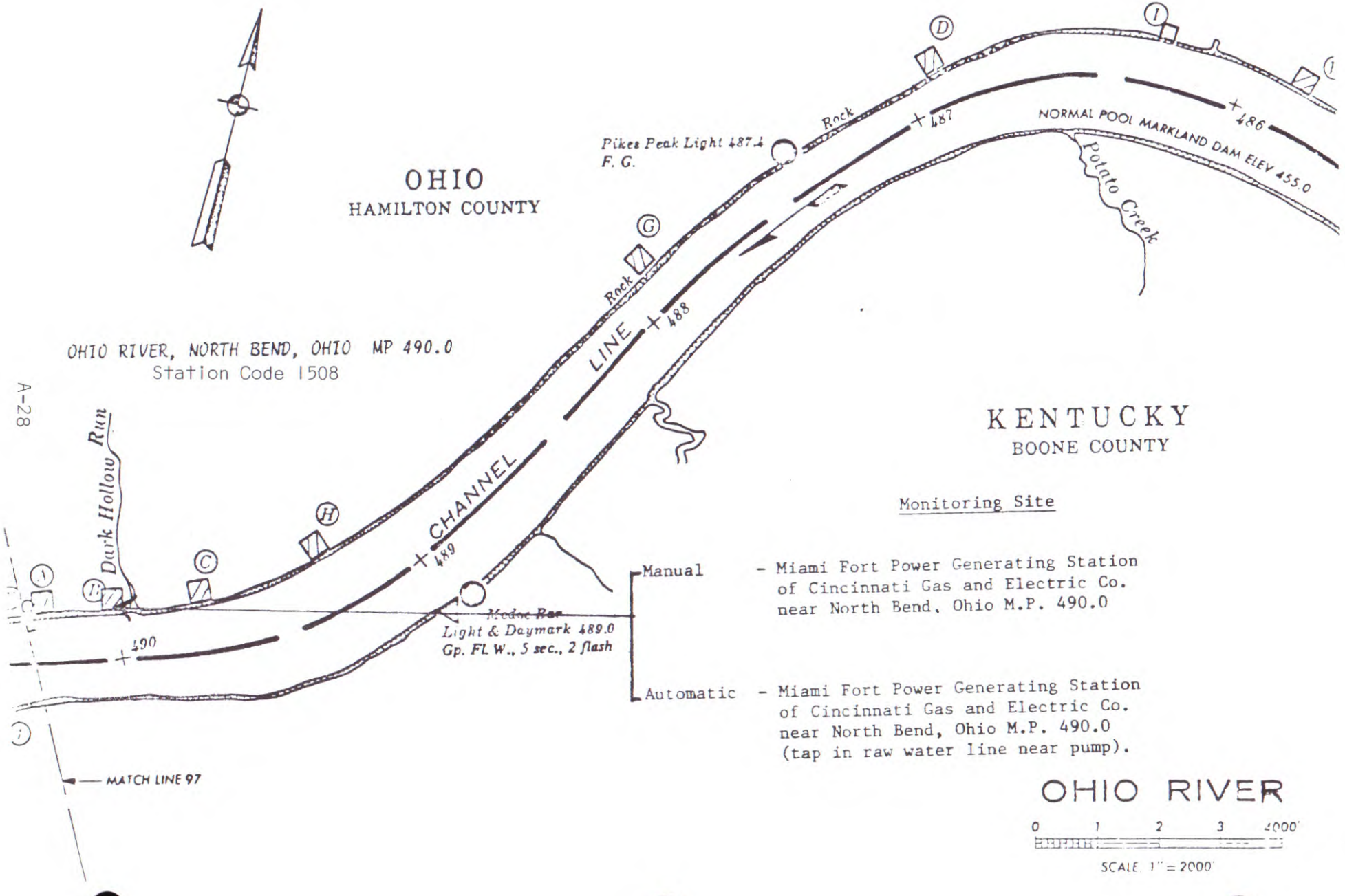
Manual- Newtown Road Bridge over the Little Miami River, M.P. 7.5. (Sample collected from the bridge over the main river channel.)

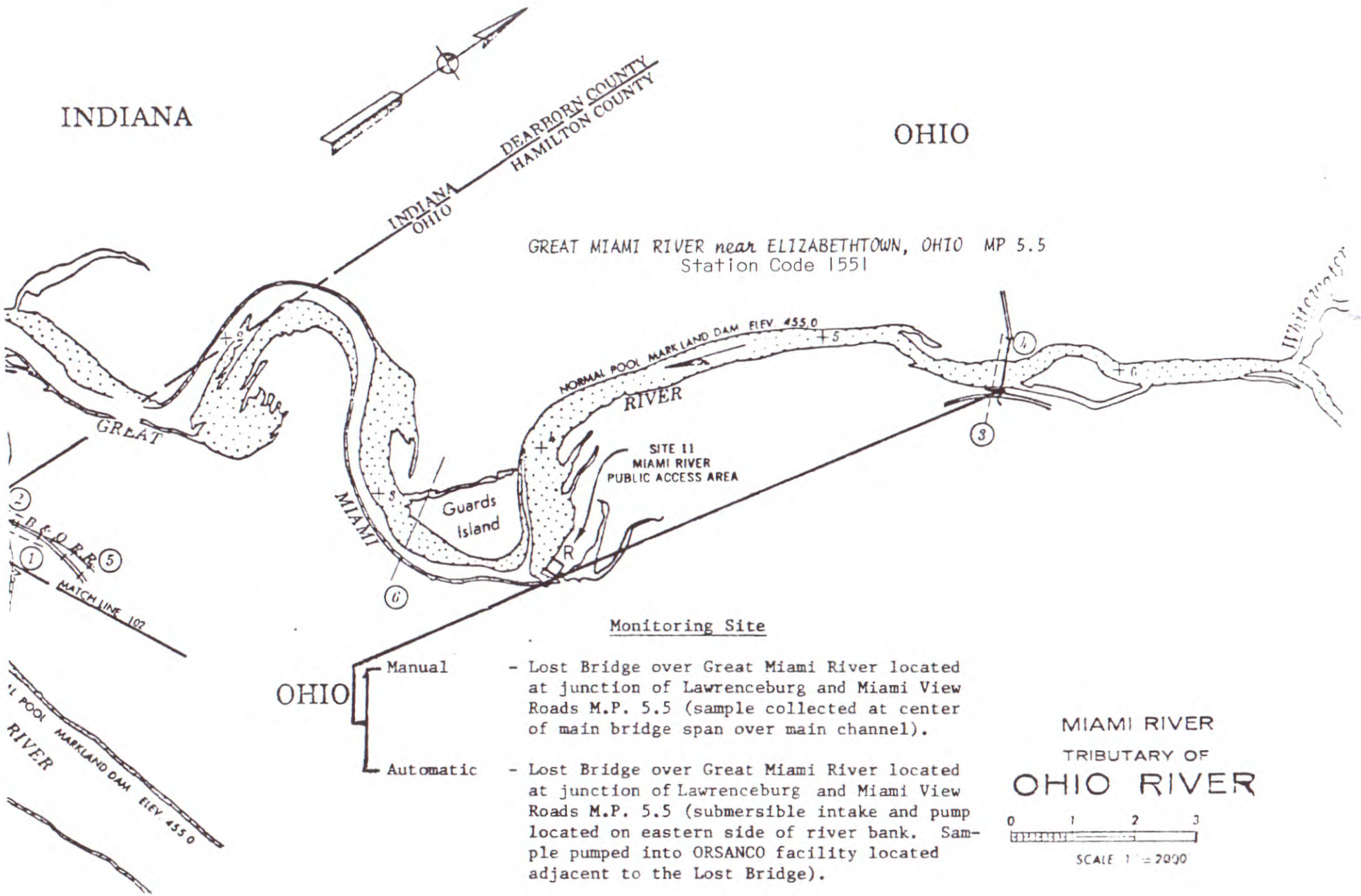
LITTLE MIAMI RIVER
TRIBUTARY OF
OHIO RIVER

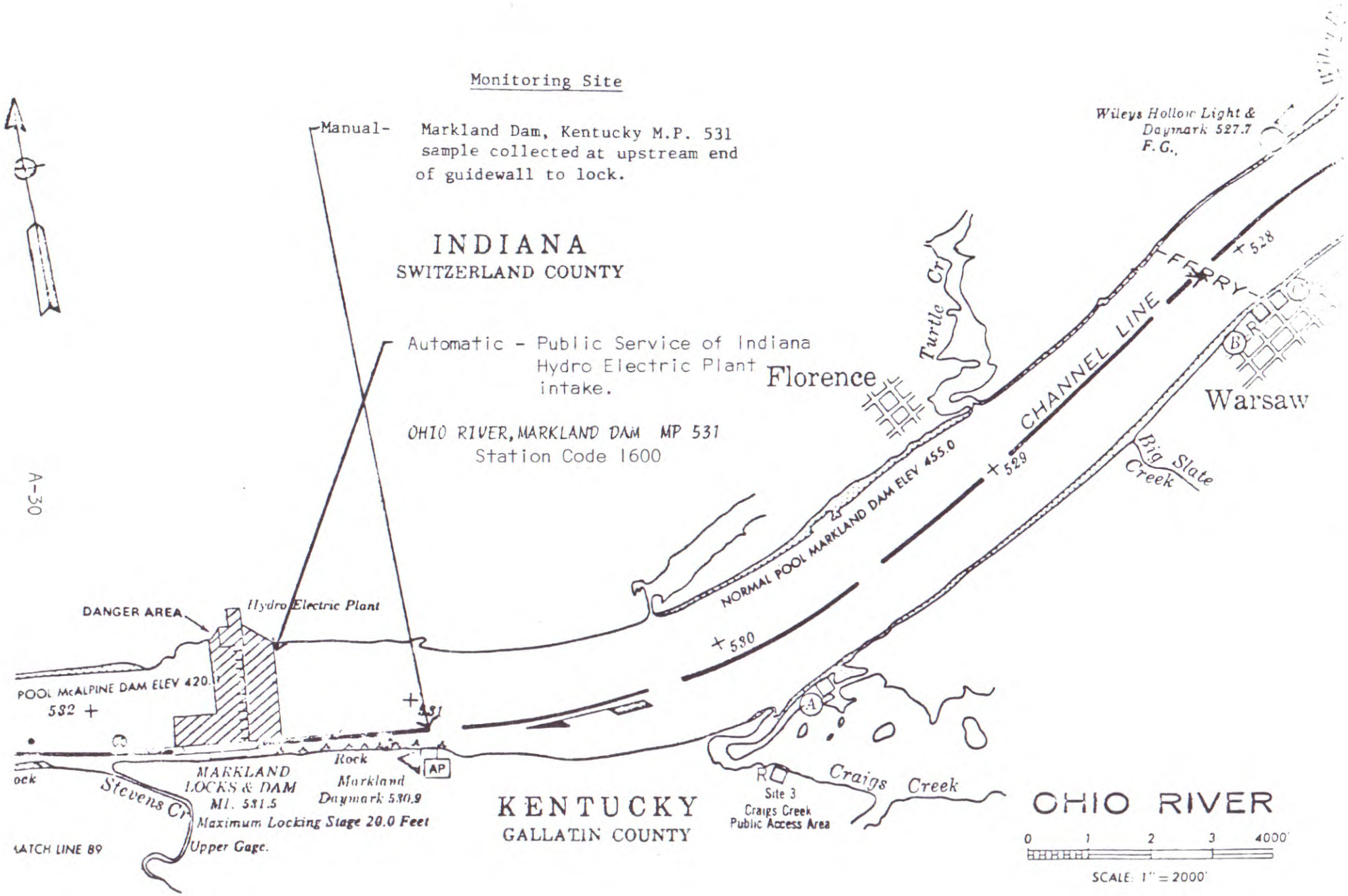
0 1 2 3 4000'

SCALE 1" = 2000


KENTUCKY
Monitoring Site
NORMAL POOL MARYLAND DAM ELEV. 433.0
+8
CAMPBELL COUNTY
KENTON COUNTY
LICKING RIVER, COVINGTON, KENTUCKY MP 4.5
Station Code 1634
A
Manual &
Automatic -
Monitoring Site
Intake to Kenton Co. Waterworks,
Covington, Kentucky, M.P. 4.5
(tap on raw water line in water
treatment plant).
A-27
LICKING RIVER
DeCoursey
LICKING
1
2
3
LICKING RIVER
TRIBUTARY OF
OHIO RIVER
0 1 2 3 4000'
SCALE: 1" = 2000'

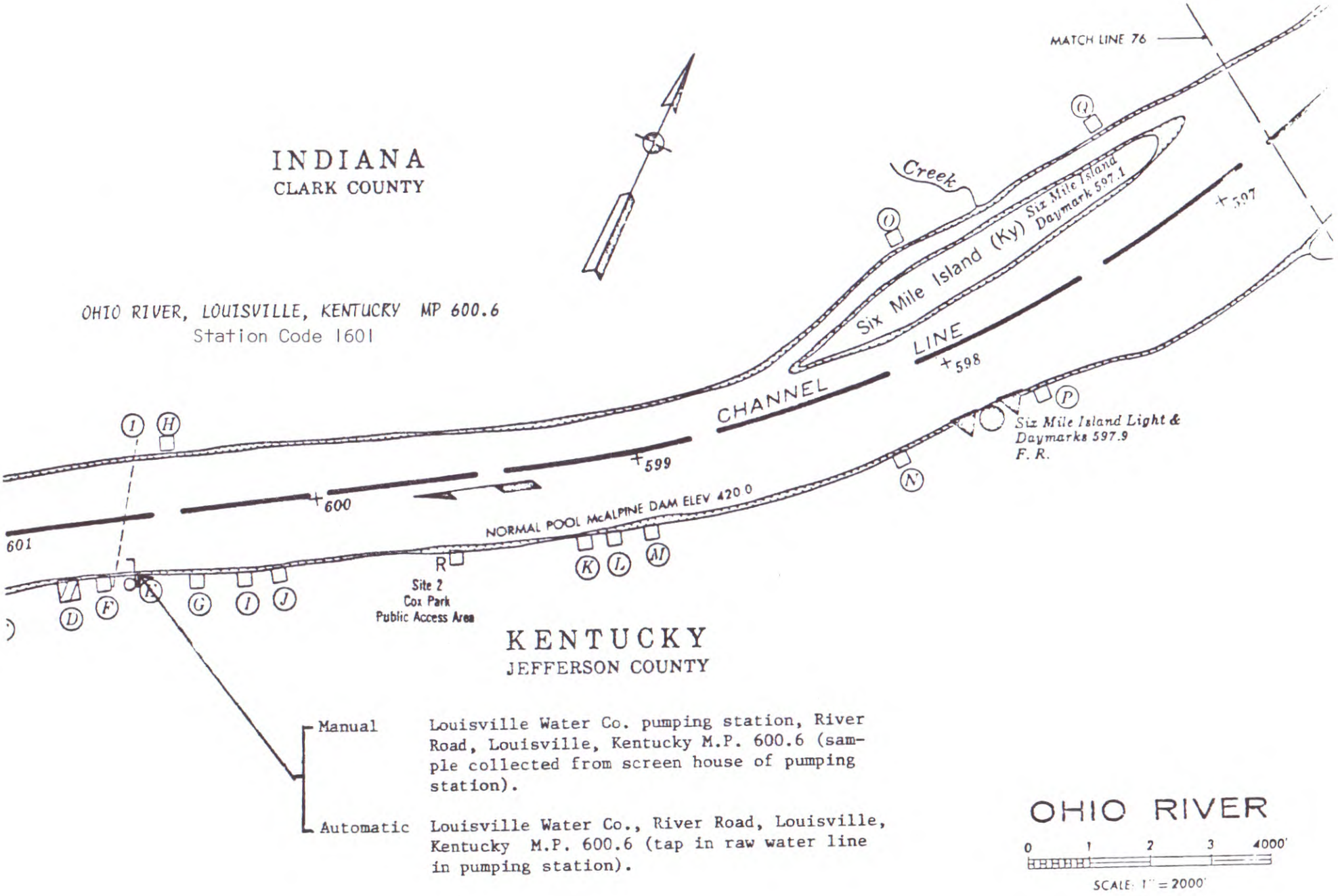

OHIO
HAMILTON COUNTY
OHIO RIVER, NORTH BEND, OHIO MP 490.0
Station Code 1508
A-28
Dark Hollow Run
Pikes Peak Light 487.4
F. G.
Rock
+487
+486
NORMAL POOL MARKLAND DAM ELEV 455.0
Potato Creek
Rock
LINE
+488
CHANNEL
+489
+490
Medoc Bar
Light & Daymark 489.0
Gp. FL W., 5 sec., 2 flash
MATCH LINE 97
KENTUCKY
BOONE COUNTY
Monitoring Site
Manual - Miami Fort Power Generating Station of Cincinnati Gas and Electric Co. near North Bend, Ohio M.P. 490.0
Automatic - Miami Fort Power Generating Station of Cincinnati Gas and Electric Co. near North Bend, Ohio M.P. 490.0 (tap in raw water line near pump).
OHIO RIVER
0 1 2 3 4000'
SCALE 1" = 2000'

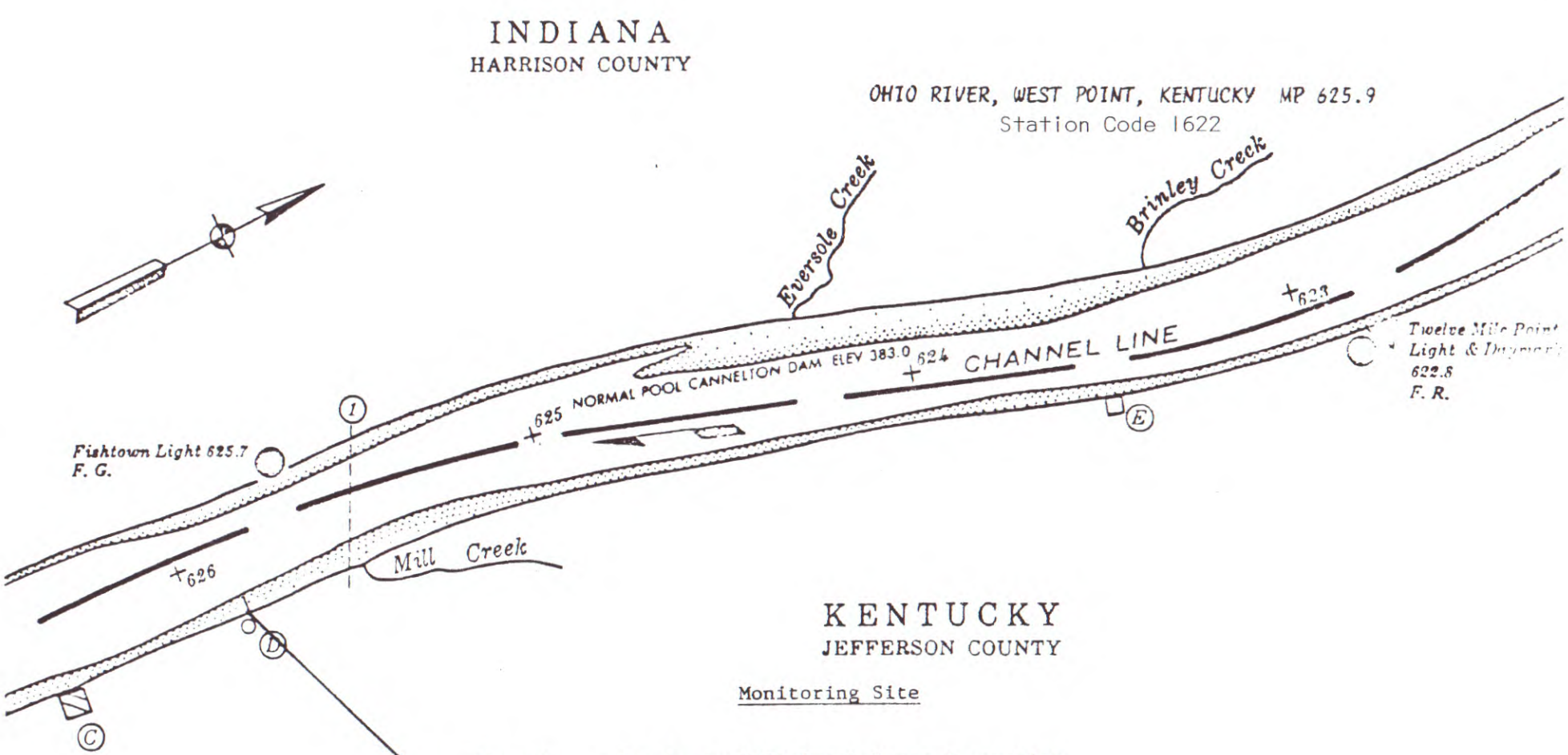

INDIANA
OHIO
DEARBORN COUNTY
HAMILTON COUNTY
INDIANA
OHIO
GREAT MIAMI RIVER near ELIZABETHTOWN, OHIO MP 5.5
Station Code 1551
NORMAL POOL MARKLAND DAM ELEV. 455.0
RIVER
GREAT
MIAMI
Guards Island
SITE 11
MIAMI RIVER
PUBLIC ACCESS AREA
B & O R.R.
MATCH LINE 107
OHIO
POOL MARKLAND DAM ELEV. 455.0
RIVER
Monitoring Site
Manual - Lost Bridge over Great Miami River located at junction of Lawrenceburg and Miami View Roads M.P. 5.5 (sample collected at center of main bridge span over main channel).
Automatic - Lost Bridge over Great Miami River located at junction of Lawrenceburg and Miami View Roads M.P. 5.5 (submersible intake and pump located on eastern side of river bank. Sample pumped into ORSANCO facility located adjacent to the Lost Bridge).
MIAMI RIVER
TRIBUTARY OF
OHIO RIVER
0 1 2 3
SCALE 1" = 2000'

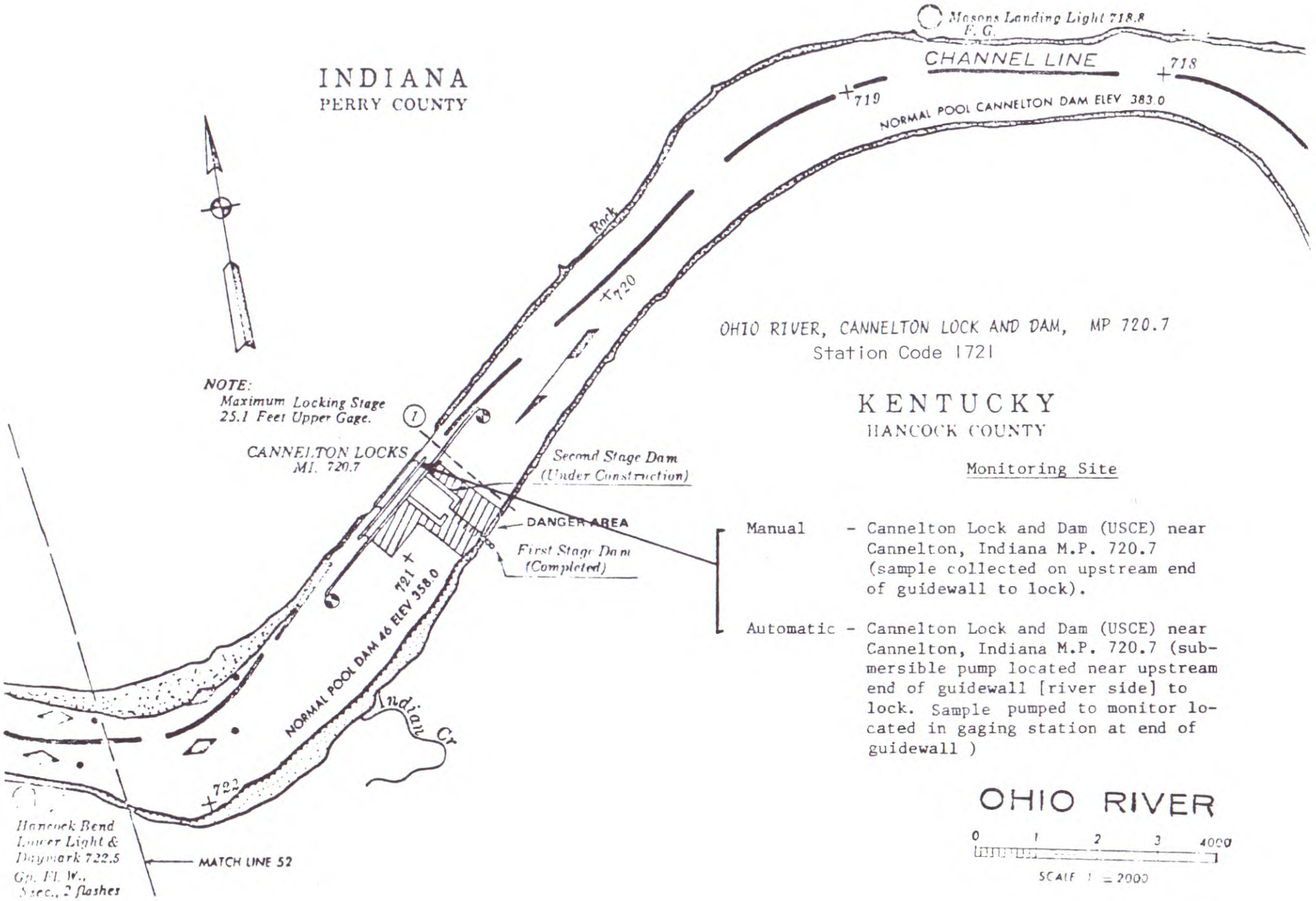

Monitoring Site
Manual- Markland Dam, Kentucky M.P. 531 sample collected at upstream end of guidewall to lock.
INDIANA
SWITZERLAND COUNTY
Automatic - Public Service of Indiana Hydro Electric Plant intake.
OHIO RIVER, MARKLAND DAM MP 531
Station Code 1600
Wileys Hollow Light & Daymark 527.7 F.G.
Turtle Cr
Florence
FERRY
+528
CHANNEL LINE
+529
Warsaw
Big Slate Creek
NORMAL POOL MARKLAND DAM ELEV 455.0
+580
DANGER AREA
Hydro Electric Plant
POOL McALPINE DAM ELEV 420.
532 +
+531
Rock
AP
MARKLAND LOCKS & DAM
MI. 531.5
Maximum Locking Stage 20.0 Feet
Markland Daymark 530.9
Upper Gage.
Stevens Cr
MATCH LINE 89
KENTUCKY
GALLATIN COUNTY
Site 3
Craigs Creek
Public Access Area
Craigs Creek
OHIO RIVER
0 1 2 3 4000'
SCALE: 1" = 2000'
A-30

STATION CODES FOR LOWER OHIO REGION
MANUAL MONITORING STATIONS

Ohio River at Louisville, Ky.	1601
Ohio River at West Point, Ky.	1622
Ohio River at Cannelton Dam, Ind.	1721
Green River at Sebree, Ky.	1656
Ohio River at Evansville, Ind.	1703
Ohio River at Uniontown Dam, Ind.	1722
Wabash River at New Harmony, Ind.	1741
Cumberland River at Barkley Dam, Ky.	1645
Tennessee River at Paducah, Ky.	1650
Ohio River at Joppa, Ill.	1821


MATCH LINE 76
INDIANA
CLARK COUNTY
OHIO RIVER, LOUISVILLE, KENTUCKY MP 600.6
Station Code 1601
Creek
Six Mile Island (Ky) Six Mile Island Daymark 597.1
+597
LINE
+598
CHANNEL
+599
+600
601
NORMAL POOL McALPINE DAM ELEV 420.0
Six Mile Island Light & Daymarks 597.9 F. R.
Site 2
Cox Park
Public Access Area
KENTUCKY
JEFFERSON COUNTY
Manual
Louisville Water Co. pumping station, River Road, Louisville, Kentucky M.P. 600.6 (sample collected from screen house of pumping station).
Automatic
Louisville Water Co., River Road, Louisville, Kentucky M.P. 600.6 (tap in raw water line in pumping station).
OHIO RIVER
0 1 2 3 4000'
SCALE: 1" = 2000'


INDIANA
HARRISON COUNTY
OHIO RIVER, WEST POINT, KENTUCKY MP 625.9
Station Code 1622
Eversole Creek
Brinley Creek
+623
Twelve Mile Point
Light & Daymark
622.8
F. R.
NORMAL POOL CANNELTON DAM ELEV 383.0
+624
CHANNEL LINE
+625
Fishtown Light 625.7
F. G.
1
E
+626
Mill Creek
D
C
KENTUCKY
JEFFERSON COUNTY
Monitoring Site
Manual - Intake to Mill Creek Power Generating Plant of Louisville Gas and Electric Co. near West Point, Ky. M.P. 625.9 (sample collected from walkway over intake to plant).
Automatic - Intake to Mill Creek Power Generating Plant of Louisville Gas and Electric Co. near West Point, Ky. M.P. 625.9 (tap in raw water line [cooling] at pumps).
OHIO RIVER
0 1 2 3 4000'
SCALE: 1" = 2000'



OHIO RIVER, CANNELTON LOCK AND DAM, MP 720.7
Station Code 1721

KENTUCKY
HANCOCK COUNTY

Monitoring Site

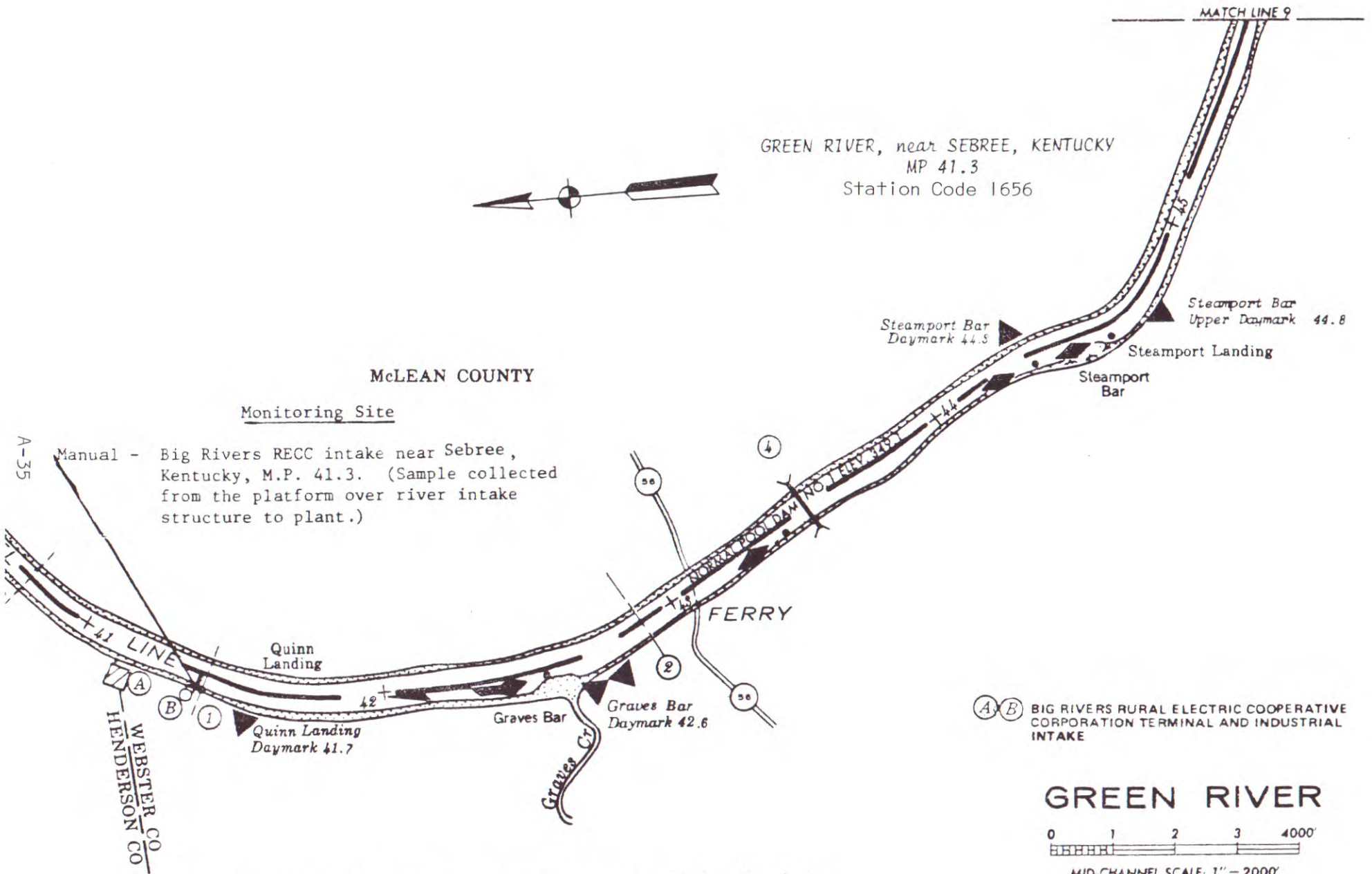
Manual - Cannelton Lock and Dam (USCE) near Cannelton, Indiana M.P. 720.7 (sample collected on upstream end of guidewall to lock).

Automatic - Cannelton Lock and Dam (USCE) near Cannelton, Indiana M.P. 720.7 (submersible pump located near upstream end of guidewall [river side] to lock. Sample pumped to monitor located in gaging station at end of guidewall)

OHIO RIVER

0 1 2 3 4000

SCALE 1" = 2000



Monitoring Site

Manual - Big Rivers RECC intake near Sebree, Kentucky, M.P. 41.3. (Sample collected from the platform over river intake structure to plant.)

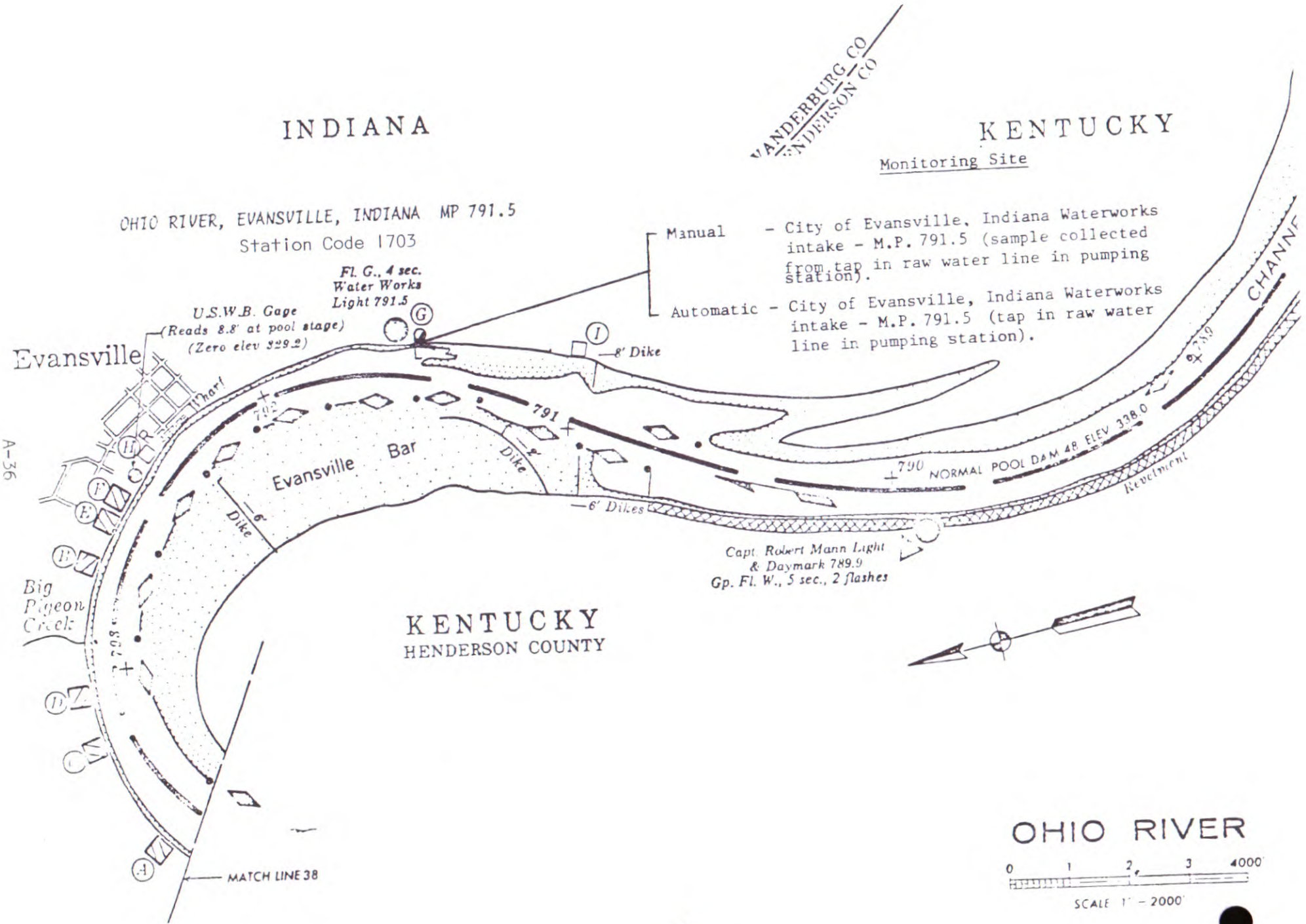
(A) (B) BIG RIVERS RURAL ELECTRIC COOPERATIVE CORPORATION TERMINAL AND INDUSTRIAL INTAKE

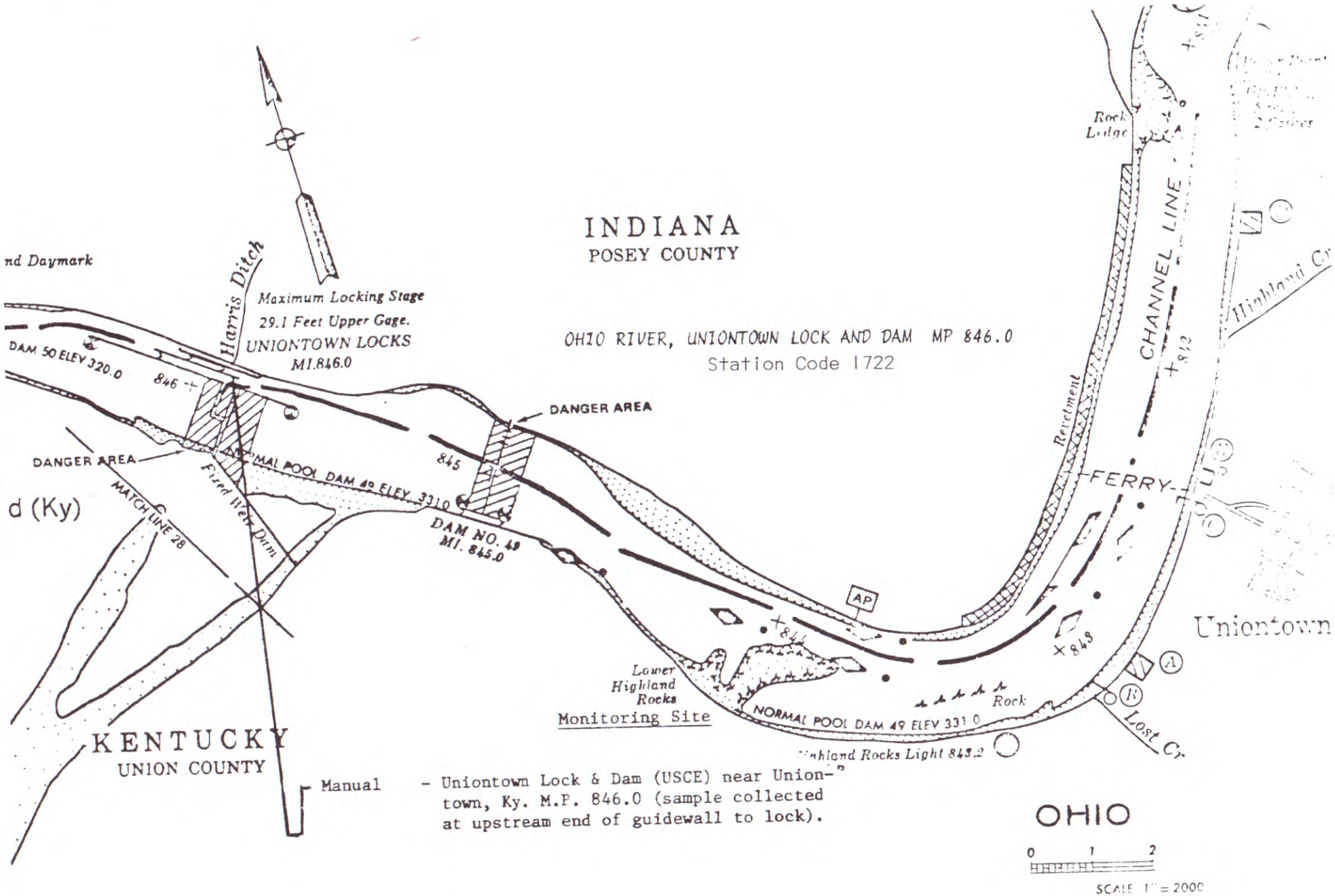
GREEN RIVER

0 1 2 3 4000'

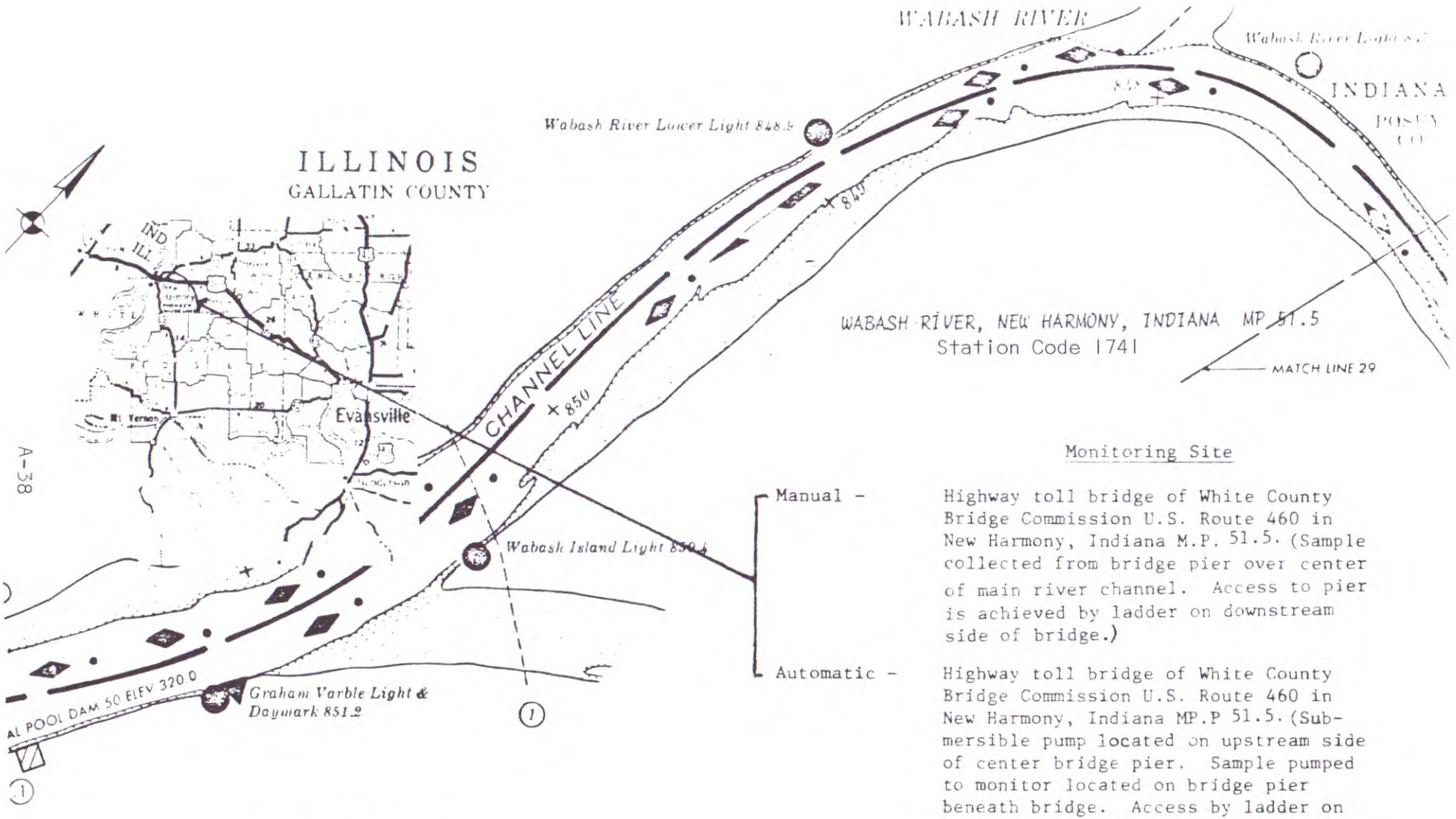
MID-CHANNEL SCALE: 1" = 2000'
LATERAL SCALE: DISTORTED

NOTE: Sample location moved upstream from Lock and Dam No. 1 at Spottsville, Kentucky to avoid backwater from Ohio River.


INDIANA
KENTUCKY
VANDERBURG CO
HENDERSON CO
Monitoring Site
OHIO RIVER, EVANSVILLE, INDIANA MP 791.5
Station Code 1703
Manual - City of Evansville, Indiana Waterworks intake - M.P. 791.5 (sample collected from tap in raw water line in pumping station).
Automatic - City of Evansville, Indiana Waterworks intake - M.P. 791.5 (tap in raw water line in pumping station).
Fl. G., 4 sec.
Water Works
Light 791.5
U.S.W.B. Gage
(Reads 8.8' at pool stage)
(Zero elev 329.2)
Evansville
Wharf
8' Dike
792
791
789
CHANNE
Evansville Bar
Dike
6' Dike
6' Dikes
790
NORMAL POOL DAM 48 ELEV 338.0
Revetment
Capt. Robert Mann Light
& Daymark 789.9
Gp. Fl. W., 5 sec., 2 flashes
Big
Pigeon
Creek
KENTUCKY
HENDERSON COUNTY
MATCH LINE 38
OHIO RIVER
0 1 2 3 4000
SCALE 1" = 2000'



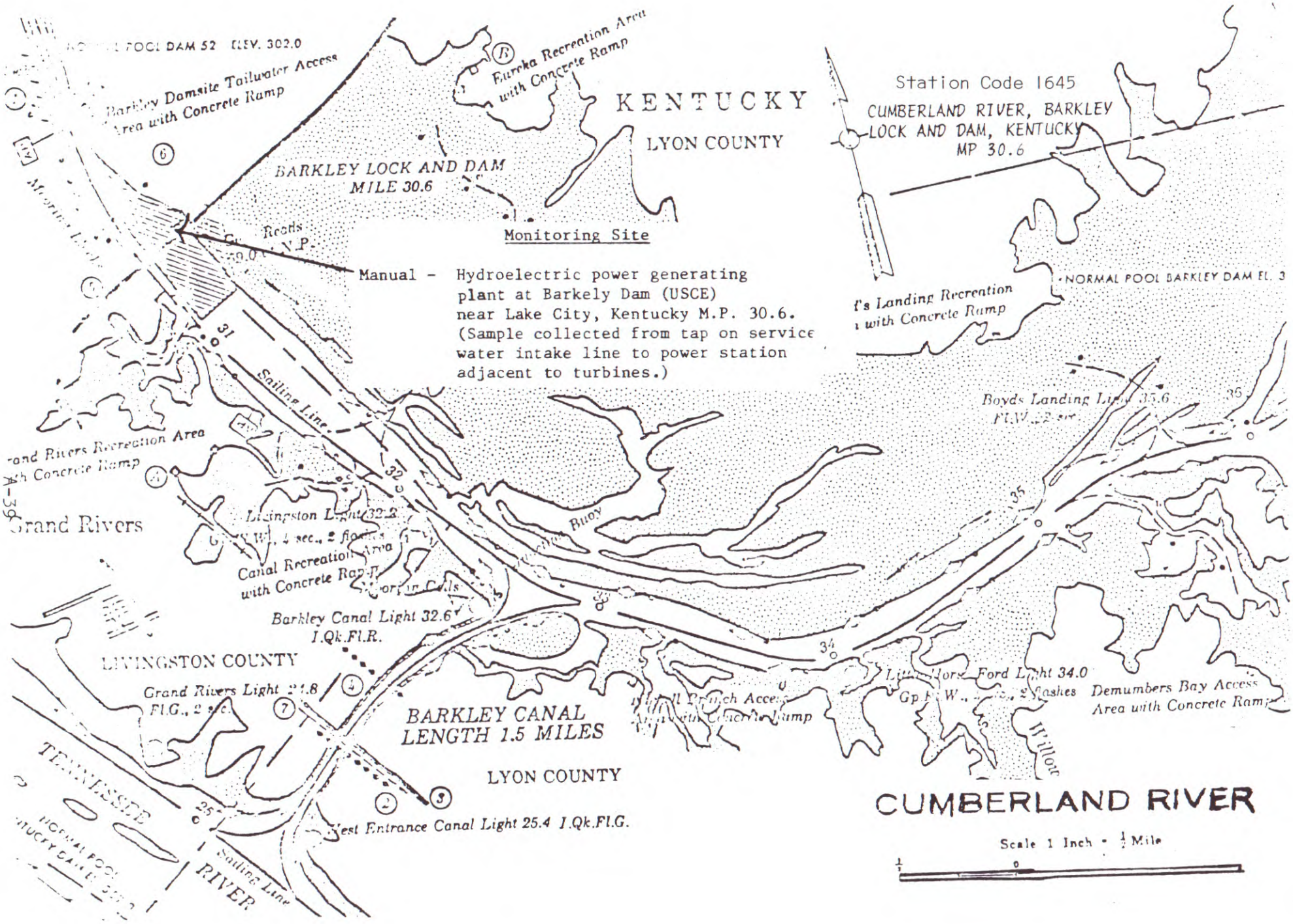
- Uniontown Lock & Dam (USCE) near Uniontown, Ky. M.P. 846.0 (sample collected at upstream end of guidewall to lock).



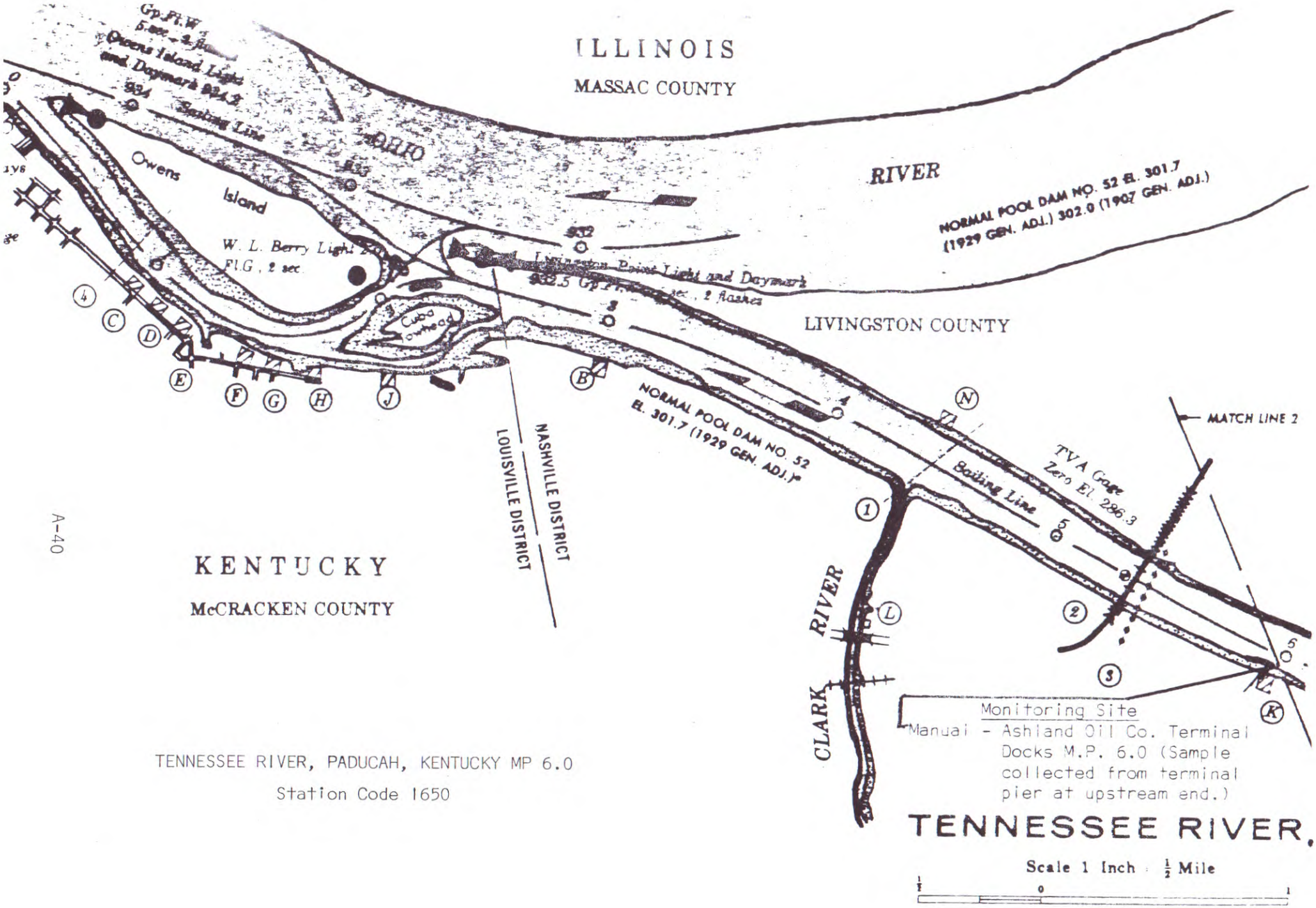
Monitoring Site

Manual - Highway toll bridge of White County Bridge Commission U.S. Route 460 in New Harmony, Indiana M.P. 51.5. (Sample collected from bridge pier over center of main river channel. Access to pier is achieved by ladder on downstream side of bridge.)

Automatic - Highway toll bridge of White County Bridge Commission U.S. Route 460 in New Harmony, Indiana MP.P 51.5. (Submersible pump located on upstream side of center bridge pier. Sample pumped to monitor located on bridge pier beneath bridge. Access by ladder on downstream side of structure.)


Station Code 1645
CUMBERLAND RIVER, BARKLEY LOCK AND DAM, KENTUCKY
MP 30.6
KENTUCKY
LYON COUNTY
BARKLEY LOCK AND DAM
MILE 30.6
Monitoring Site
Manual - Hydroelectric power generating plant at Barkely Dam (USCE) near Lake City, Kentucky M.P. 30.6. (Sample collected from tap on service water intake line to power station adjacent to turbines.)
Eureka Recreation Area with Concrete Ramp
Barkley Damsite Tailwater Access Area with Concrete Ramp
NORMAL POOL DAM 52 ELEV. 302.0
NORMAL POOL BARKLEY DAM EL. 3
Boyds Landing Recreation Area with Concrete Ramp
Boyds Landing Light 35.6
Grand Rivers Recreation Area with Concrete Ramp
Grand Rivers
Sailing Line
Buoy
Livingston Light 32.2
Canal Recreation Area with Concrete Ramp
Barkley Canal Light 32.6 I.Qk.Fl.R.
LIVINGSTON COUNTY
Grand Rivers Light 31.8 Fl.G., 2 sec.
BARKLEY CANAL LENGTH 1.5 MILES
LYON COUNTY
West Entrance Canal Light 25.4 I.Qk.Fl.G.
Little Hors Ford Light 34.0
Demumbers Bay Access Area with Concrete Ramp
TENNESSEE
RIVER
CUMBERLAND RIVER
Scale 1 Inch = ½ Mile

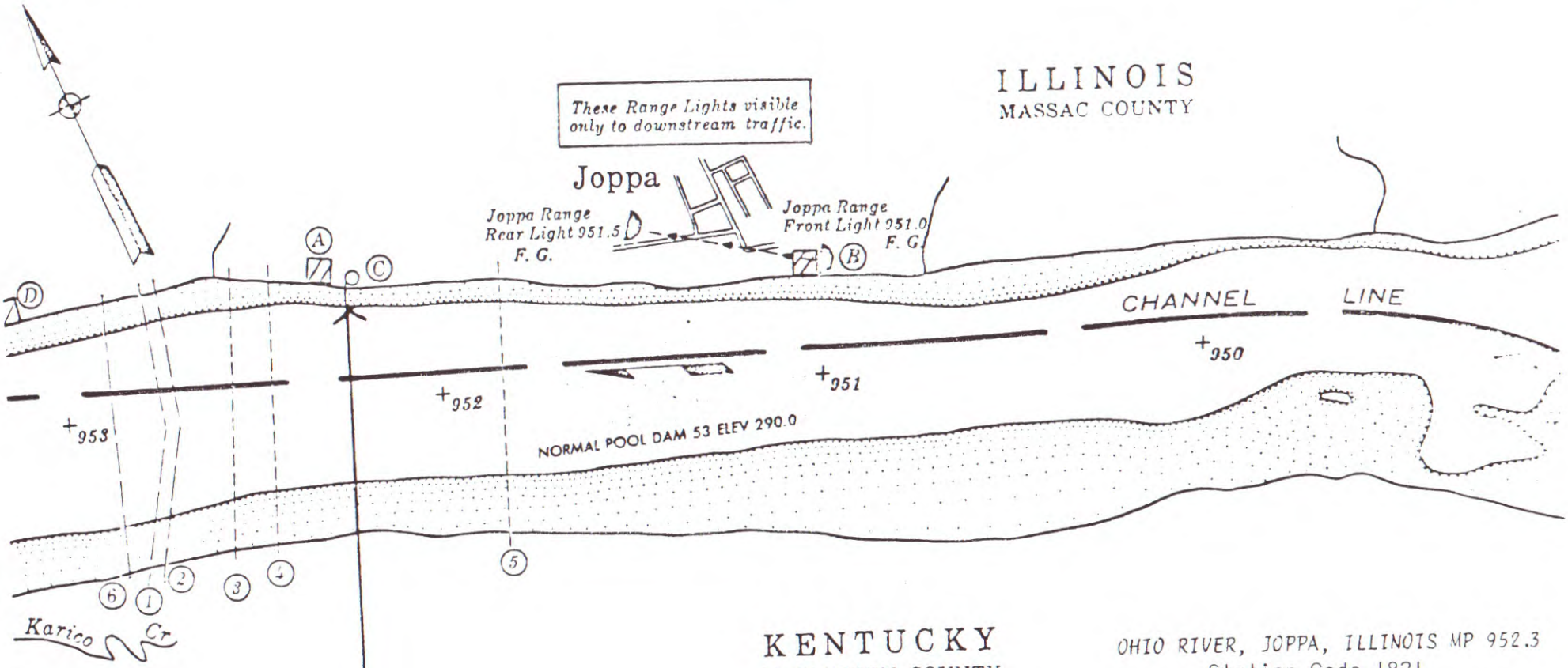
A-39



A-40

TENNESSEE RIVER, PADUCAH, KENTUCKY MP 6.0

Station Code 1650



OHIO RIVER, JOPPA, ILLINOIS MP 952.3
Station Code 1821

Monitoring Site

Manual - Electric Energy Corp Power Generating Plant near Joppa, Ill. M.P. 952.3 (sample collected from moored barge located upstream from intake).

Automatic - Intake to Electric Energy Corp Power Generating Plant near Joppa, Ill. M.P. 952.3 (tap in raw water line in pumping station adjacent to river).

OHIO RIVER

0 1 2 3

SCALE 1" = 2000'

APPENDIX B

REGULATORY AGENCIES OF THE SIGNATORY STATES

ILLINOIS

Environmental Protection Agency
State of Illinois
2200 Churchill Road
Springfield, Illinois 62706
(217) 782-2829

INDIANA

Indiana Stream Pollution Control Board
1330 West Michigan Street
Indianapolis, Indiana 46206
(317) 633-0166

KENTUCKY

Department of Natural Resources
US 127 South
Frankfort, Kentucky 40601
(502) 564-3410

NEW YORK

Department of Environmental Conservation
50 Wolf Road
Albany, New York 12201
(518) 457-6804

OHIO

Ohio Environmental Protection Agency
PO Box 1049
361 East Broad Street
Columbus, Ohio 43216
(614) 466-2390

PENNSYLVANIA

Department of Environmental Resources
PO Box 2063
Harrisburg, Pennsylvania 17120
(717) 787-2666

VIRGINIA

State Water Control Board
PO Box 11143
Richmond, Virginia 23230
(804) 257-0056

WEST VIRGINIA

Division of Water Resources
Department of Natural Resources
1201 Greenbrier Street
Charleston, West Virginia 25311
(304) 348-2107

ORSANCO

414 Walnut Street
Cincinnati, Ohio 45202
(513) 421-1151

OHIO RIVER VALLEY WATER SANITATION COMMISSION

an interstate agency representing: ILLINOIS · INDIANA · KENTUCKY · NEW YORK · OHIO · PENNSYLVANIA · VIRGINIA · WEST VIRGINIA

414 Walnut Street Cincinnati, Ohio 45202

APPENDIX C

MONITORING STRATEGY COMMITTEE

ILLINOIS

Kenneth Rogers
Division of Water Pollution Control
Illinois EPA
Springfield, IL 62706
Phone: 217/782-1696

INDIANA

T.P. Chang, Ph.D. (ALT: C. Lee Bridges)
Stream Pollution Control Board
Indiana State Board of Health
1330 West Michigan Street
Indianapolis, Indiana 46206
Phone: 317/633-0167

KENTUCKY

Robert Ware
Division of Water Quality
Century Plaza, U.S. 127 South
Frankfort, KY 40601
Phone: 502/564-3410

OHIO

Christopher Yoder
Chief, Water Quality Section
Division of Surveillance
Post Office Box 1049
Columbus, OH 43216
Phone: 614/466-9092

PENNSYLVANIA

Robert F. Frey
Water Pollution Biologist
Division of Water Quality
Bureau of Water Quality Management
Department of Environmental Resources
P.O. Box 2063
Harrisburg, PA 17120
Phone: 717/787-9633

VIRGINIA

Albert Willett
Director, Division of Surveillance
State Water Control Board
P.O. Box 11143
Richmond, VA 23230
Phone: 804/257-0792

WEST VIRGINIA

E. Eli McCoy - Chairman
(ALTERNATE: Jack Wolfe or Dave Fisher)
S.A. & E. Branch
W. Va. Department of Natural Resources
1201 Greenbrier Street
Charleston, West Virginia 25311
Phone: 304/348-2837

U.S. CORPS OF ENGINEERS

Mark Anthony, Ph.D., Supervisory Biologist
(ALTERNATE: Glenn Drummond)
U.S. Corps of Engineers
Ohio River District
Post Office Box 1159
Cincinnati, OH 45201
Phone: 513/684-3070

U.S. ENVIRONMENTAL PROTECTION AGENCY

David W. Hill, Ph.D., Chief
Ambient Monitoring Section, S & A Division
U.S. EPA, Region IV
College Station Road
Athens, GA 30601
Phone: 404/546-3113

U.S. GEOLOGICAL SURVEY

Melvin D. Edwards, Hydrologist
Water Resources Division
U.S. Geological Survey
National Center, Mail Stop 440
12201 Sunrise Valley Drive
Reston, VA 20092
Phone: 703/860-6878

NEW YORK

Ronald Maylath
Chief of Monitoring Section
Bureau of Monitoring Surveillance
Dept. of Environmental Conservation - Rm. 300
Fifty Wolfe Road
Albany, NY 12233
Phone: 518/457-7458

ORSANCO

Glenn E. Moore, Manager
Surveillance Programs

ORSANCO
1/81

ORSANCO

414 Walnut Street
Cincinnati, Ohio 45202