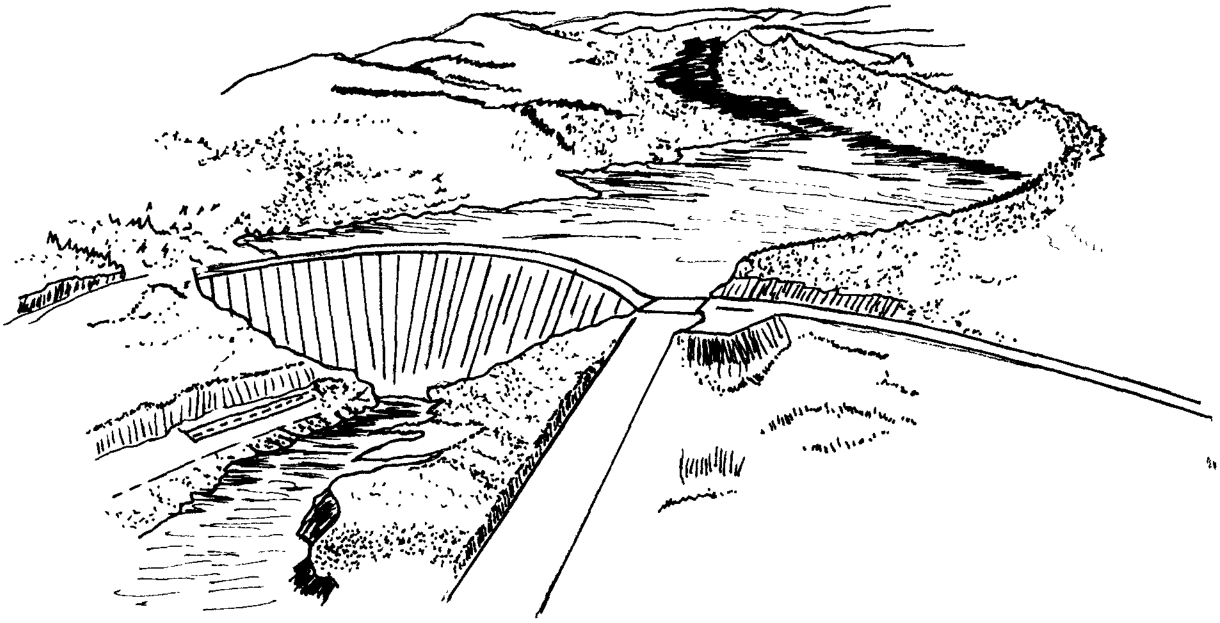
SANITARY SURVEY
OF
DRINKING WATER SYSTEMS
ON
FEDERAL WATER RESOURCE
DEVELOPMENTS

A PILOT STUDY



ENVIRONMENTAL PROTECTION AGENCY

SANITARY SURVEY
OF
DRINKING WATER SYSTEMS
ON
FEDERAL WATER RESOURCE DEVELOPMENTS

A PILOT STUDY IN
COOPERATION WITH THE
U.S. ARMY CORPS OF ENGINEERS AND
THE STATES OF INDIANA AND OHIO

ENVIRONMENTAL PROTECTION AGENCY
Office of Water Programs
Water Hygiene Division
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INTRODUCTION

For many years an increasing level of attention has been given to instream water quality and to a variety of environmental and public health factors in connection with water resources planning, development and operation. However, little attention has been given to the drinking water supplies provided for the use of the millions of visitors who use dams, reservoirs, and related areas for sightseeing and recreational purposes every year.

The purpose of this pilot study was to commence an assessment of the water quality, construction, operation and health surveillance of the water supply systems provided for public use on Federally operated or constructed water resources developments. The findings of the study will have immediate relevance to a host of other Federally constructed or assisted small water supplies such as U.S. park and forest area facilities, rest stops on interstate highways and so forth. It will also hopefully be a start in the direction of more attention to the quality, construction, operation and health surveillance for all Federally-involved public water systems.

With the assistance of the U.S. Army Corps of Engineers and the cooperation of State Departments of Health and State Departments of Natural Resources, the Division of Water Hygiene conducted a pilot study of water supply systems at twelve Corps of Engineers dam and reservoir projects in Indiana and Ohio during the summer of 1970. The locations of these projects are shown by Figure 1.

Water supply systems at five reservoirs located in Indiana and seven located in Ohio were included in this study. Latest available visitation data indicate that approximately one million people are visiting recreation areas at these twelve reservoir developments each year.

The survey covered a total of sixty-one water supply systems. For the purposes of this report, they are divided into four classifications:

1. Surface systems - obtain water from surface sources
2. Well distribution systems - groundwater power-pumped to distribution points.
3. Handpumped wells.
4. Cisterns - Storage tanks for hauled water obtained (in this study) from surface sources.


OHIO AND INDIANA
STUDY AREA
TOLEDO
CLEVELAND
MASSILLON
Atwood
Leesville
Clendening
Dillon
COLUMBUS
Deer Creek
Burr Oak
ATHENS
West Fork
CINCINNATI
Salamonie
Huntington
MARION
Mansfield
INDIANAPOLIS
TERRE
HAUTE
Cagles Mill
BLOOMINGTON
Monroe
Dams and Reservoirs
CITIES

FIGURE 1

CONCLUSIONS AND RECOMMENDATIONS

A. The results of this pilot study lead to the following general conclusions and recommendations.

1. The study revealed sufficient health hazards and sanitary deficiencies to question the ability of a large number of these small water supply systems to constantly produce a safe and satisfactory water. Eighty percent of the water systems in this study produced water which at the time of sampling did not meet constituent limits of the Public Health Service Drinking Water Standards; 44 percent had system facility deficiencies that included inadequate source protection, treatment, and control; and 88 percent were deficient in bacteriological surveillance. The study involved a narrow geographical area of the country and concerned itself with water facilities at only one type of Federal installation - dam and reservoir developments. To fully assess the ability of small Federal water supply facilities to produce and deliver a safe and satisfactory water, this study should be extended to other Federally related small water systems in various geographical areas of the country.

2. The study revealed deficiencies in areas which could have been avoided had the water supply system facilities been constructed, developed and operated along lines of established sanitary standards and practices. Well construction without regard to proper sanitary protection, inadequate operation and control of clarification plants and inter-connections of potable and non-potable wells and well systems were some of the deficiencies found in the study.

   There is difficulty in applying established criteria and standards for municipal systems to small water supply systems such as those in this study. Consumer demands on systems of this type both in quantity and quality differ markedly from the demands on municipal systems. Quantity demands of the small systems are more instantaneous during the week. These demands influence a variety of construction elements including pipe size, storage facilities, distribution system layout and the number of watering points.

   Quality of the source water may be essentially the same for both the large municipal system and the small water supply system; however, the economics involved make sophisticated facilities that enable the large system to deliver a finished water with a high degree of health protection and good esthetic qualities impractical for the small system. One of the problems with the small water systems in this study was the esthetic quality of the water delivered to the consumer.

   The results of this study indicate the need for development of criteria and standards for the construction and operation of small public drinking water systems constructed with Federal funds, or under Federal supervision.

B. The results of the study lead to the following specific recommendations:

1. Every effort should be made to replace all handpumped wells by extending distribution lines from a power-pumped well system or a treated surface supply. In areas where this is not possible, hand-pumped wells should be constructed with good sanitary protection, particularly with protective measures such as leak-proof well covers and cement formation seals around the casing to prevent the entry of contaminants from the surface. Most of the handpumped wells in this study lacked such sanitary protection. This may account for the majority of the bacteriological water quality deficiencies found in the study.

2. Unless they are essential to a recreational area where groundwater is not available for development, cisterns should be replaced with potable water under pressure or with sanitary protected handpumped wells. Until the cisterns can be taken out of service, each shipment of water should be chlorinated as it is placed in the cistern and daily chlorine residual determinations made. The cisterns involved in this study were filled with treated surface water transported via truck from a distant point, a process which presents many avenues for contamination of the water.

3. Health surveillance of small water systems at dam and reservoir developments should include bacteriological and chemical sampling sufficient to meet the Public Health Service Drinking Water Standards, and yearly sanitary surveys of each system should be provided. Bacteriological sampling was inadequate for 88 percent of the water systems in this study. Sanitary deficiencies and health hazards found during the study could have been identified and corrected with a program of frequent and thorough sanitary surveys. Water supply systems located at the dam and overlook areas and operated by the Corps of Engineers should be included in a health surveillance program. Health surveillance was inadequate for all water supply systems operated by the Corps.

4. Small surface water treatment plants should be replaced with groundwater supplies where suitable quality groundwater is available unless an acceptable quality of operation and control can be provided. This study found these plants unattended most of the time with virtually no operational control (even daily chlorine residual determinations were not made) and record keeping. For the most part, the operators were not trained to operate a clarification plant. Surface water systems, by virtue of the lower quality raw water, present a greater hazard than groundwater systems when operation and maintenance is inadequate.

5. To increase the bacteriological safety of the water, all water supplies with pressurized distribution systems should be chlorinated on a continuous basis regardless of the water source. The study found sanitary deficiencies in both groundwater and surface water systems. Unsatisfactory bacteriological samples were collected from both type of systems during the 12 months period preceding the study. Moreover, the majority of the water systems studied are operated on a seasonal basis with a minimum of attention given to health surveillance, including bacteriological sampling. As stated, however, chlorination is recommended to increase the bacteriological safety factor of the water. It is not a substitute for correcting system deficiencies or an adequate health surveillance program.

6. A higher priority should be given to the operation and maintenance of the water systems by reservoir personnel. There is a particular need to increase operator skills through training programs. The study revealed that one of the more serious deficiencies exists in the area of operation and control of the water system facilities.

7. Regular operation and health surveillance should be maintained for all water supply systems that are left in operation after the close of the summer recreational season. Water systems left open to serve administrative and operation areas are also subject to use by visitors and campers throughout the year, and should receive regular operation and health surveillance.

SUMMARY OF PRINCIPAL FINDINGS

A. Drinking Water Quality

1. Drinking water quality was determined by collecting both chemical and bacteriological samples from 56 water supply systems at 10 of the 12 dams and reservoir developments. Timing and schedule problems prevented the collection of samples from the one system at Deer Creek Reservoir; and chemical samples collected at West Fork Reservoir were not analyzed because of a heavy work load in the chemical section of the laboratory. An average of 2 bacteriological and at least one chemical sample were collected from various points in each distribution system. One bacteriological sample and one chemical sample were collected from each handpumped well. The data were recorded from each system and the maximum constituent concentrations found in each system were compared to bacteriological, chemical, and physical constituent limits of the 1962 U.S. Public Health Service Drinking Water Standards (DWS). On this basis:

   a. Eighty percent of the water supply systems delivered water that did not meet the constituent limits of the Drinking Water Standards.

   b. Nineteen percent of the systems delivered water that did not meet the mandatory limits of the Drinking Water Standards. All of the DWS mandatory limits exceeded in this study were bacteriological parameters.

   c. Seventy-five percent of the systems in this study exceeded one or more of the DWS recommended limits for physical and chemical quality. The limits most frequently exceeded were those for iron, manganese, and turbidity.

System Type	Systems Sampled	Systems exceeding DWS recommended limits for chemical and physical quality		Systems exceeding DWS mandatory limits for bacteriological quality	
	Number	Number	Percent	Number	Percent
Surface	10(11)*	4	40	2	19
Well Distribution	23	18	78	1	4
Handpumped Well	22	20	91	7	32
Cisterns	1	0	0	1	100

* Bacteriological Samples were Collected from 11 Surface Systems

2. Four of the 10 surface water systems and 38 of the 45 well supplies (84%) sampled exceeded DWS recommended limits for chemical and physical quality for one or more of the following parameters: iron, magnanese, total dissolved solids, zinc, chloride, color and turbidity. Recommended limits for all these parameters, including turbidity if the turbidity is associated with iron, are based on aesthetic considerations.

3. Eleven water systems exceeded the coliform density limit of the Drinking Water Standards. Seven of these were handpumped wells.

4. Four cisterns were inspected in this study. Only one cistern was sampled since the pumps on three were not operating at the time of the survey. Bacteriological results of samples collected and analyzed during the 1969 recreational season, however, indicate frequent contamination in all four cisterns. During the 1969 summer season, 59 percent of the samples collected from the four cisterns were contaminated.

B. Water Supply System Facilities

1. The status of the facilities used to treat, distribute and store drinking water at the 11 surface supply systems and 23 of the 24 well distribution systems were determined by site surveys, sampling and interviews with reservoir operations personnel. Based on the information obtained, 45 percent of the surface supply systems and 52 percent of the well systems were deficient in one or more of the following: source protection, disinfection and/or control of disinfection, clarification (removal of suspended matter) and/or control of clarification. Two of the 11 surface supply systems that will be discussed in this study are actually distribution and storage systems that are supplied with a finished water from two nearby municipal water systems. These two systems were evaluated only on the quality of the water delivered at the reservoir watering points and the status of the distribution and storage facilities on reservoir lands.

2. A chlorine residual was not detected in the distribution system of 6 of the 11 surface supply systems that chlorinate. A chlorine residual was not detected in the distribution system of 8 of the 10 well systems that chlorinate.

3. Operation and control of chlorination facilities was generally poor, particularly at the 10 well systems. Chlorine residual determinations are not made on a daily basis at any of these systems. Similar deficiencies existed at the 9 surface supply systems that were visited.

4. Three of the 11 surface supply systems sampled delivered a water judged to have inadequate clarification based on excessive turbidity in samples collected from the distribution systems.

5. Samples collected from twenty-seven of the 55 groundwater systems exceeded the turbidity limits of the DWS. Fifteen of the same 27 also exceeded the recommended limit for iron indicating that the turbidity at least in part may have been caused by precipitated iron. Samples collected from the other 12 systems, however, contained low concentrations of iron indicating that the turbidity was from other sources.

6. Areas of low pressure were not detected in any of the well or surface supply systems.

C. Bacteriological Surveillance

1. To determine the status of the bacteriological program for each water supply system investigated, records made available by State and other agencies responsible for the operation, maintenance and surveillance of the systems were examined for the number of bacteriological samples taken during the previous 12 months of records. Based on this information:

(a) Five of the 11 surface supply systems did not meet the bacteriological surveillance criteria. Collection of bacteriological samples at three of these supplies was not practiced.

(b) None of the 24 well distribution systems met the bacteriological surveillance criteria for the collection of the required number of bacteriological samples. Each system was sampled on an average of once per month during the summer season.

(c) Water supply systems yielding unsatisfactory bacteriological samples received inadequate re-sampling and health surveillance. This was particularly true for the handpumped wells and cisterns.

EVALUATION CRITERIA

Each water supply system was investigated on three bases: 1) drinking water quality was determined by sampling the finished and distributed water and returning these samples to the laboratories of the Division of Water Hygiene for bacteriological, chemical, and trace metal analyses (radiochemical samples were not collected in the study); 2) the status of the water supply system facilities were determined by a field survey of the system and the recording of data on three standard forms with respect to a) source (s), b) treatment, if any, c) distribution system pressures, and d) operation; 3) the status for the surveillance program over the water supply system was determined by obtaining bacteriological water quality data for the previous 12 months of record from State and County health department files.

To prevent health hazards from developing in a water supply system, someone not associated with the supply should review operation procedures and the adequacy of physical facilities on a regular basis. These sanitary surveys should be at least as detailed as the reviews made during the pilot study, and may be more time-consuming depending on the complexity of treatment and the capabilities of the operators. Section 2.2 of the Public Health Drinking Water Standards 1962, provides that "Frequent sanitary surveys shall be made of the water supply system to locate and identify health hazards which might exist in the system."

The "number of systems exceeding the DWS" and "the percent of systems exceeding the DWS" will be referred to several times in this report. It should be understood, however, that the frequency and adequacy of the sanitary survey was not one of the criteria used in making these determinations. For some of the water systems it was difficult to obtain information reliable enough to include in an accurate statistical summary for this report. Although not included in the statistical summaries, the adequacy of the sanitary survey for water supply systems in this study is discussed in the body of this report.

Water Quality Criteria

Water quality was judged as follows:

(1) Not to exceed the constituent limits of the PHS Drinking Water Standards.

(2) To exceed at least one "recommended" constituent limit (some are aesthetic parameters), but does not exceed any "mandatory" constituent limit.

(3) To exceed at least one "mandatory" constituent limit.

In this report when a water supply system is referred to as exceeding the constituent limits of the DWS, the determination is based on the maximum concentration of a constituent measured in one or more samples collected from the system.

The Drinking Water Standards constituent limits measured in this study are summarized as follows:

Partial List of Bacteriological, Chemical, and Physical Constituent Concentration Limits Taken from the 1962 U.S. Public Health Service Drinking Water Standards.

RECOMMENDED LIMITS

(If the concentration of any of these constituents are exceeded, a more suitable supply or treatment should be sought).

Constituent	Limit
Alkyl Benzene Sulfonate (Measured as methylene-blue-active substances)	0.5 mg/1
Arsenic	0.01 mg/1
Chloride	250 mg/1
Color	15 Units
Copper	1.0 mg/1
Carbon-Chloroform Extract (CCE)	0.200 mg/1
Cyanide	0.01 mg/1
Fluoride	
Temp. (Ann. Avg. Max. Day, 5 yrs. or more)	
50.0-53.7	1.7 mg/1
53.8-58.3	1.5 mg/1
58.4-63.8	1.3 mg/1
63.9-70.6	1.2 mg/1
70.7-79.2	1.0 mg/1
79.3-90.5	0.8 mg/1
Iron	0.3 mg/1
Manganese	0.05 mg/1
Nitrate	45 mg/1
Sulfate	250 mg/1
Total Dissolved Solids (TDS)	500 mg/1
Turbidity	
Untreated	5 Units
Treated by more than disinfection	1 Unit
Zinc	5 mg/1

MANDATORY LIMITS

(The presence of the following substances in excess of the concentrations listed shall constitute grounds for rejection of the supply; therefore, their continued presence should be carefully measured and evaluated by health authorities and a decision made regarding corrective measures or discontinuing use of the supply.)

Constituent	Limit
Arsenic	0.05 mg/1
Barium	1.0 mg/1
Cadmium	0.01 mg/1
Chromium (hexavalent)	0.05 mg/1
Coliform organisms (Measured by membrane filter technique)	Fails std. if: a) Arithmetic average of samples collected greater than 1 per 100 ml b) Two or more samples (5% or more if more than 20 examined) contain densities more than 4/100 ml
Cyanide	0.2 mg/1
Fluoride	
Temp. (Ann. Avg. Max. Day - 5 yrs. or more)	
50.0-53.7	2.4 mg/1
53.8-58.3	2.2 mg/1
58.4-63.8	2.0 mg/1
63.9-70.6	1.8 mg/1
70.7-79.2	1.6 mg/1
79.3-90.5	1.4 mg/1
Lead	0.05 mg/1
Mercury*	5 µg/l
Selenium	0.01 mg/l
Silver	0.05 mg/1

* Proposed for inclusion in the Drinking Water Standards

Facilities Criteria

Source, treatment, operation, and distribution facilities were judged' either:

1) To be essentially free from major deficiencies, or

2) To be deficient in one or more of the following (where applicable):
   a) Source protection (in absence of disinfection or buying chlorinated water)

   b) Control of disinfection (if practiced or if purchasing chlorinated water)

   c) Control of clarification (if clarification practiced)

   d) Pressure (20 psi) in some or all areas of the distribution system

Bacteriological Surveillance Program Criteria

The bacteriological surveillance program over the water supply system was judged on the following criteria:

1) Collection of the required number** of bacteriological samples during the period of the year the water system is in operation.

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* See "Manual for Evaluating Public Drinking Water Supplies, PHS Publication No. 1820, 1969" for basis of judgement.

**See pages 3-6 of the Drinking Water Standards.

DISCUSSION

General

Sixty-one water supply systems were surveyed at 12 dam and reservoir developments constructed by the U.S. Army Corps of Engineers in Indiana and Ohio. Table 1 lists the water systems surveyed at each reservoir according to the four classifications discussed in the introductory section of this report. With the exception of a .3MGD water treatment plant located at Burr Oak Reservoir in Ohio and two distribution system extensions from nearby municipal water plants, all water supply systems are relatively small with a limited number of watering points confined to a specific recreational or operational area. The Burr Oak treatment plant supplies 8 small towns near the dam as well as the major recreational areas surrounding the reservoir. The major recreational areas at West Fork Reservoir in Ohio and Monroe Reservoir in Indiana are supplied with distribution system extensions from the nearby cities of Cincinnati and Bloomington respectively.

All but one of the 11 surface supply systems obtain their raw water from the reservoirs. The source of the Cincinnati water supply system that serves West Fork is the Ohio River.

The 12 dam and reservoir projects were constructed by the U.S. Army Corps of Engineers for the primary purpose of flood control. Eight of the projects, constructed during the period 1953-1969, were authorized as multiple-purpose water resource developments for recreation and fish and wildlife development.

Two of the eight, Monroe and Burr Oak, also included municipal water supply storage as a purpose. The other four single-purpose projects were constructed in the period 1940-1953 and recreational development was later added.

The twelve reservoirs provide a broad spectrum of recreational activity. Recreational areas include, beaches, camp and picnic grounds, marinas, lodges and rental cottages. Although the major recreational areas at the reservoirs are operated and maintained by either the Indiana Department of Natural Resources, the Ohio Department of Natural Resources or the Muskingum Water Conservancy District, other groups are also involved.

The U.S. Forest Service operates a large recreational area at Monroe Reservoir in Indiana as a part of the Hoosier National Forest. Local chapters of the Boy Scouts of America operate camps at several reservoirs and concessionaires contracted by the responsible State agency operate a number of marinas. All of these areas have some type of small water system. In addition to these, the Corps of Engineers operates water supply systems at most of the damsite areas. These supplies serve the dam operations and overlook areas. The latter areas generally include picnic and rest stop facilities.

Recreational facilities at several of the newer reservoirs, particularly Deer Creek and Huntington, were in an early stage of development during the summer of 1969. Water supply systems at these reservoirs were limited and a number were under construction. As can be seen from Table 1 however, a large number of people visited these areas despite the fact they were not officially open. For this reason as well as for a desire to obtain a broad representation of reservoir situations, a decision was made to include these reservoir developments in the study.

TABLE I
SUMMARY OF WATER SUPPLY SYSTEM TYPES BY RESERVOIR
SUMMER 1970

				NUMBER OF SYSTEMS BY TYPES				
					GROUND SOURCE			
RESERVOIR	RESERVOIR FIRST YEAR OF FULL OPERATION	PRINCIPAL AGENCY 1/ RESPONSIBLE FOR OPERATION OF RESERVOIR LANDS	VISITATION (1969 unless otherwise noted)	SURFACE	WELLS Power pumped to distribution system	WELLS Handpumped	CISTERNS (Hauled Surface Water	TOTAL
INDIANA								
Monroe	1966	IDNR	981,200	4		2	1	7
Salamonie	1967	IDNR	704,600		6			6
Huntington	1969 a/	IDNR	31.500		2			2
Mansfield	1960	IDNR	419,500	1	2	2		5
Cagles Mill	1953	IDNR	318,300	2		1		3
OHIO								
Leesville	1943	MWCD	336,500		5	3		8
Clendening	1940	MWCD	195,300		2	3		5
Burr Oak	1952	ODNR	944,500	2		3		5
Dillon	1961	MWCD	1,040,000	1	1	4		6
Atwood	1947	MWCD	786,800		5	4		9
Deer Creek	1969 a/	ODRN	930,700 (1970)		1 (Not Sampled)			1
West Fork	1953	HCPB	2,590,300	(Bacterio-logical sample only) 1			(Not Sampled) 3	4
			9,279,200	11	24	22	4	61

1/ IDNR - Indiana Department of Natural Resources
ODNR - Ohio Department of Natural Resources
MWCD - Muskingum Water Conservancy District
HCPB - Hamilton County Park Board

a/ Recreation Areas and Facilities Partially Developed at Time of Study

SOURCE OF SUPPLY

Surface Water

Ten of the eleven surface water systems studied, used water from the reservoirs. With one exception, samples collected at each intake exhibited good bacteriological quality. High total coliform (30,000/100 ml) and fecal coliform (1450/100 ml) levels were found in the Lieber State Park water supply intake located near a public marina at Cagles Mill Reservoir. This was in contrast to 650/100 ml and 2/100 ml total and fecal coliform levels respectively from the water intake at the dam less than two miles away. Further sampling should be undertaken in the area of the Lieber State Park Water Supply intake. If pollution presents a threat to the water supply source, measures should be undertaken to protect the intake by locating and eliminating the source of pollution or by moving the intake.

Groundwater

Seventy-five percent of the water supply systems in the study obtained water from groundwater sources. Forty-eight percent of the groundwater systems used handpumps and 52 percent power-pumped to some type of a distribution system. Seven of the 11 positive samples (64%) exceeding the coliform density limit were collected from handpump wells. Only one of the positive samples was collected from wells with a distribution system. This cannot altogether be credited to chlorination since 14 of the 23 do not chlorinate and of the 9 that do, only 2 showed any evidence of a chlorine residual in the system at the time of sampling. Moreover, both the handpumped and power pumped wells are similarly constructed except for the well cover and protection from surface drainage. In general, the handpumped wells were poorly protected from surface drainage with concrete platforms providing easy access to the well for drainage, rodents, etc. The majority of platform covers for the handpumped wells serve little more than to prevent muddy conditions around the wells. Although in many cases difficult to determine, a review of well logs and interviews with reservoir officials revealed that very few of the wells were constructed with a formation seal between the casing and earth. This together with the lack of a good watertight cover provides the wells with poor protection against surface contamination. In addition, a good number of the handpumps showed evidence of worn packing in the stuffing box creating still another avenue for contaminants to enter the well.

Due to their unique location near the shorelines of flood control reservoirs with highly fluctuating levels, it was difficult to determine just how many of the wells were subject to flooding. A determination of each well site elevation in relation to maximum flood levels and spillway crest elevations was not made although several well sites were suspect. For instance, reservoir personnel reported some of the wells at Dillon have been flooded as many as four times in the past five years. The handpump wells in this area are not protected with watertight covers and formation seals. Wells should not be located in floodplain areas if at all possible. In instances where this cannot be avoided, watertight, sanitary well construction is particularly important.

Groundwater samples obtained from wells at the ten reservoir sites in Ohio and Indiana exhibited highly undesirable aesthetic qualities. Excessive iron, manganese, color, and turbidity imparted objectionable qualities to the water that offend the senses of sight, taste, and smell.

Cisterns

Four cisterns were included in this study. Three were located at West Fork and were not operative at the time of the survey and one cistern was located at Monroe. All four cisterns are storage tanks for treated surface water hauled to the site in trucks. Water used to fill the three cisterns at West Fork is obtained from the Cincinnati, Ohio municipal water system and the Monroe cistern is supplied by water from the Bloomington, Indiana municipal water system.

The protection provided by a closed sanitary water system is lost when the water is taken from the system and transported to another system via an intermediate carrier. The water is exposed to many avenues of contamination and should be retreated and tested after it is placed in the second system.

DRINKING WATER QUALITY

Overall Quality

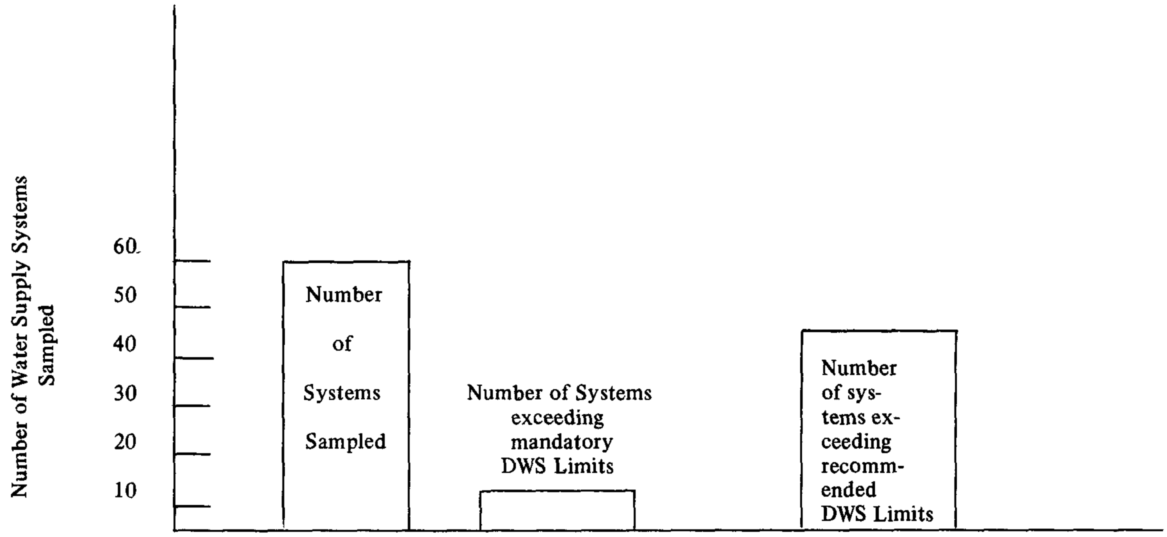
Bacteriological samples were collected and analyzed from 57 of the 61 water systems studied and chemical samples were collected and analyzed from 56 of the 61 water systems. Three inoperable cisterns and one well system were not sampled. The concentrations of the individual constituents were then compared to the constituent limits of the Public Health Service Drinking Water Standards to determine whether or not they exceeded the limits. The percent of water supply systems exceeding each limit is presented in the following table. The percentages are listed by State since this reflects some of the variation in groundwater quality in each area. Twenty-three of the 56 systems were located in Indiana and 33 in Ohio. The other system sampled for bacteriological quality only was located in Ohio.

For Recommended List	Systems Exceeding Limit				From Mandatory List	Systems Exceeding Limit			
	Indiana (23)		Ohio (33)			Indiana (23)		Ohio (34)	
	No.	%	No.	%		No.	%	No.	%
Iron	13	57	13	40	Coliform Organisms	4	17	7	21
Manganese	0	0	14	42					
Total Dissolved Solids	4	17	3	9					
Zinc	4	17	1	3					
Chloride	0	0	1	3					
Turbidity	5	22	24	73					
Color	2	9	4	12					

The percent of each type of water supply system that exceeded each recommended limit is also shown as follows.

Constituent List	Percent of Systems Exceeding Constituent Limit Surface Systems (10)	Well Distribution System (23)	Handpumped Wells (22)	Cisterns (1)
Iron	10	48	64	0
Manganese	0	35	32	0
Total Dissolved Solids	0	13	18	0
Zinc	0	9	14	0
Chloride	0	0	4	0
Turbidity	30	39	82	0
Color	0	13	18	0

Eighty percent of the water supply systems sampled did not meet the Drinking Water Standards. The majority of these systems, however, violated recommended limits for chemical and physical quality. All violations of mandatory limits were biological in nature. Nineteen percent of the total number of systems sampled exceeded the mandatory Drinking Water Standards for bacteriological quality as measured by the coliform parameter. Although none of the water systems exceeded the mandatory limits for chemical quality, 75 percent exceeded the recommended limits for chemical and physical quality.



Bacteriological Quality

At least one or more systems in each of the four types of water supply systems exceeded the DWS mandatory limit for coliform organisms. The water supply types showing the greatest deficiency in this area were the handpumped wells and cisterns. Seventy-three percent of the positive samples were collected from these 2 types of systems. Eighteen percent of the positive samples were collected from the surface supply systems and nine percent came from the well distribution systems.

Bacteriological data was also obtained fromthe Ohio and Indiana State Health Departments and the Muskingum Water Conservancy District. The results of bacteriological samples were obtained for the last 12 months of record. This information was made available for 44 of the 61 water supply systems at 10 of the 12 reservoirs included in this study. A bacteriological surveillance program had not been instituted at Deer Creek and Huntington Reservoirs at the time the study began. Bacteriological samples were collected from each of the 44 water supply systems on an average of once per month over a 4 or 5 month period from May through September. From this data it was determined that one or more unsatisfactory bacteriological samples were collected from 32 percent of the 44 water systems during this period of record. The data is summarized for each type of system as follows:

System Type	No. of Systems for which data was made available	Percent of systems with one or more unsatisfactory sample	Percent of systems with two or more unsatisfactory samples
Surface	3	67	33
Well Distribution	16	19	13
Handpumped Well	22	23	18
Cisterns	4	100	80

It is significant that one-half of the systems from which unsatisfactory samples were collected, had unsatisfactory samples 50 percent of the time. This is particularly true of the handpumped wells and cisterns. The data revealed that once an unsatisfactory sample was collected from these two system types, 2 out of every 3 samples collected would be unsatisfactory. Water supply systems of this nature that show a history of contamination should be reconstructed with proper sanitary protection or should be taken out of service and replaced with a safer and more reliable system.

Bacteriological results for the period of record indicates a higher incidence of unsatisfactory samples from well distribution systems than did the spot samples collected during the survey.

Chemical and Physical Quality

Because of the high content of inorganics in ground water, well sources in this study had the highest percentage of systems exceeding recommended limits for chemical and physical quality. Eighty-four percent of the systems using groundwater exceeded DWS recommended limits for chemical and physical quality compared to 40 percent for the surface water systems.

Pesticides

Pesticide samples were collected from seven surface water supply systems at the five reservoirs used as a source of drinking water supply: Monroe, Cagles Mill, Mansfield, Dillon and Burr Oak. Two surface water systems were sampled at Monroe and Cagles Mill and one system each at Mansfield, Dillon and Burr Oak. Each sample collected was analyzed at the Division of Water Hygiene's Gulfport Laboratory, Dauphin Island, Alabama, for ten pesticides: aldrin, endrin, dieldrin, chlordane, lindane, DDT, toxaphene, methoxychlor, heptachlor and heptachlor epoxide.

Pesticides were detected in two of the samples and were present only in trace amounts. Aldrin and DDT were detected in concentrations of less than 1 part per billion in a sample collected from the Corps of Engineer's water supply system at Monroe Reservoir. DDT was detected in a concentration of less than 1 part per billion in a sample collected from the Corps of Engineers water supply system at Cagles Mill Reservoir. The maximum permissible concentrations for Aldrin and DDT which will be recommended for inclusion in the next revision of the Drinking Water Standards are 10 parts per billion and 100 parts per billion respectively.

FACILITIES

General

The water supply systems in this study have equipment and facilities that provide only a minimal degree of treatment for surface and groundwaters. The water delivered by all 11 surface supply systems receives clarification and disinfection. Two of the 11 systems are actually extensions of nearby municipal water supply systems. The other 9 treat water from their respective reservoirs. Only 3 of the 9 practice coagulation prior to filtration.

Ten of the 24 well distribution systems practice controlled chlorination. Despite the poor physical and chemical quality of groundwater in the study area, only 6 of the 24 provided any additional type of treatment. Four of these employed water softening devices and 2 practiced iron removal. The majority of the systems with treatment devices serve private homes of reservoir personnel.

The following summary illustrates the inadequate operation and control of chlorination at the water systems in this study.

System Type	No. systems with controlled chlorination	No. systems where chlorine residual was not detected at one or more points	No. systems where chlorine residual not detected at any point	No. systems that make daily chlorine residual determinations
Surface	11	7	6	4
Well Distribution	10	8	8	0

The above data confirms a general impression obtained at the time of the survey. Chlorine solution pumps were not operating properly and chlorine solution crocks were left empty. Chlorine solutions were made up and pumps set without any knowledge of concentrations and pump rates. The inspection of these water systems also revealed that little thought had been given to chlorine contact time when the equipment was installed. At several of the supplies the chlorine was applied after the finished water left a large storage tank.

Two of the distribution systems without a detectable chlorine residual were extensions of nearby municipal water supply systems. One system serves the large Fairfax recreational area at Monroe reservoir and is a part of the Bloomington, Indiana system. The other serves the Winton Woods Park at West Fork Reservoir and is an extension of the Cincinnati water supply system.

Clarification

Three of the 9 surface supply systems with clarification facilities were judged to have inadequate clarification due to excessive turbidity in samples collected from the distribution systems. At one of these, the dam area system at Cagles Mill, sand in the pressure filter apparently had not been replaced since the equipment was installed some 18 years ago. Samples collected from this system were turbid, colored and bacteriologically unsatisfactory. This system as well as the dam supply at Mansfield contained a filter by-pass line which should be eliminated.

Inter-Connected Water Systems

A great deal of care should be exercised in consolidating individual wells and well systems into common distribution systems, since each well system may present a possible source of contamination to other wells and their distribution systems. One example of an interconnected water supply system is that serving Atwood Lake Park. This system using 10 well sources consists of four separate systems interconnected with gate valves. These four systems serve a lodge, the park, the marina and utilities at the lodge. The lodge system has four well sources and is softened and chlorinated. The park system is not treated and uses four wells, two of which also provide supplementary water to the lodge system for treatment and use.

The marina system is not treated and uses one well. The utilities system consists of one well, located in the lodge and provides water for the swimming pool, boilers, and air conditioning system. The utilities system is not used for drinking, although it is interconnected to the lodge system. Samples taken at the time of this study showed positive bacteriological results for the lodge system and the utilities system and showed a level of lead exceeding the Drinking Water Standards (0.09 mg/l versus 0.05 mg/l). The July 1969-July 1970 period of record for the park system was poor, with four of seven bacteriological samples showing positive results. These data indicate the need for considering separation of such systems, or bringing the raw water to a common location for treatment before distribution.

Distribution System Pressure

All of the water systems in this study maintained adequate distribution pressures. Storage and pressure is achieved in the majority of the cases through the use of hydro-pneumatic tanks. The larger systems employ elevated storage tanks.

BACTERIOLOGICAL SURVEILLANCE

Bacteriological samples are collected from water supply systems in State operated areas on an average of once per month during the summer recreational season that lasts from May through September. In dam and overlook areas operated by the U.S. Army Corps of Engineers samples are not collected with any uniform frequency. Some of these systems are sampled monthly during the summer season, and some semi-annually or not at all.

Five of the 11 surface supply systems did not collect a sufficient number of bacteriological samples to meet the requirements of the Drinking Water Standards.

None of the 24 well distribution systems met DWS limits for bacteriological sampling frequency. Bacteriological samples were collected from all 22 handpumped wells on an average of once per month during the recreational season including those wells with a history of bacteriological contamination. Bacteriological sample results of handpump well sampling for the latest 12-month period of record indicates that when an unsatisfactory sample is collected for a handpump well, two or more unsatisfactory samples will be collected from that same well 80% of the time. Health surveillance of these particular wells should be increased and include collection of bacteriological samples more than once per month. If unsatisfactory samples continue, the wells should be reconstructed or taken out of service.

Clearly, a need exists for a follow-up program for re-sampling, sanitary investigations and corrective action when positive bacteriological samples are collected from a water supply system. The study revealed that very little effort was made toward prompt follow-up action when positive bacteriological results were obtained. In most cases the water supply systems were not re-sampled. Frequently, a cup of bleach was poured into a well or cistern and presumed to correct the problem until the water supply could be resampled the following month.

Cisterns located at Monroe Reservoir are generally sampled monthly while those at West Fork are sampled on average of twice per month. All cisterns showed a high incidence of contaminated samples. Twnety-five to 50 percent of the samples collected from these four during the last 12-month period of record was unsatisfactory. Five other cisterns located at Monroe Reservoir were not included in this study; however, samples from 4 out of 5 were unsatisfactory for 33 to 100 percent of the time in the 12-month period.

The water supply systems maintained by the Corps of Engineers at the dam and overlook areas had the weakest record of bacteriological surveillance. The dam area supply at Cagles

Mill, a surface supply system, was not sampled at all. Other water supply systems in these areas were sampled anywhere from twice yearly to once per month. Since these supplies are accessible to and are used by the public, the Corps of Engineers should make arrangements for a regular and uniform program of bacteriological collection and health surveillance for all Corps operated water supply systems that will enable the systems to meet the PHS Drinking Water Standards.

Bacteriological surveillance should be maintained throughout the year on all water supply systems that are not closed to the public after the close of the summer season. Several of these systems, left open for the use of reservoir personnel and their families, are also accessible to campers, fishermen and visitors throughout the year and should be protected.

Sanitary Surveys

The sanitary survey program for water supply systems varied from area to area but was generally handled by the local county health departments. Most systems were visited by the local sanitarians as part of the regualr sanitation program. The complexity and detailed nature of the water supply system inspections was not determined. The study, however, uncovered enough deficiencies in water system facilities to indicate the need for a stronger sanitary survey program that will locate problems and health hazards and result in corrective action.

In the majority of cases water supply systems operated by the Corps of Engineers receive inadequate sanitary surveillance or no surveillance at all. As pointed out in the preceding section, the Corps of Engineers should make arrangements for their systems to be included in regular surveillance programs.

TABLE 2

MAXIMUM BACTERIOLOGICAL, CHEMICAL AND PHYSICAL CONCENTRATIONS OBSERVED

RESERVOIR	NAME OR LOCATION OF WATER SYSTEM	TYPE OF SYSTEM	Total Coliform (1)	pH (2)	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Silver	Zinc	Cobalt	Nickel	Sp. Cond. (2)	Fluoride	Arsenic	Chloride	MBAS	Nitrate	Selenium	Sulfate	TDS (2)	Color (2)	Turbidity (2)	Mercury (3)	Barium
ATWOOD	Dam Area	1 Well	0	7.8	0.000	0.000	0.099	0.170	0.002	0.073	0.000	0.150	0.003	0.000	523	0.52	L0.01	7.0	L0.05	L1.0	L0.002	37.0	336	2.0	3.8	L0.1	0.37
	Atwood Lodge Area	4 Wells	5	7.5	0.001	0.000	0.039	0.130	0.000	0.160	0.000	0.069	0.003	0.000	718	0.23	L0.01	130.0	L0.05	L1.0	0.004	5.0	456	3.0	2.8	L0.1	0.19
	Atwood Lake Park Area	4 Wells	0	7.9	0.001	0.000	0.101	1.450	0.002	0.270	0.000	0.076	0.003	0.002	599	0.56	L0.01	2.0	L0.05	1.3	L0.002	16.0	379	40.0	20.0	L0.1	0.32
	Atwood Lake Marina	1 Well	0	7.7	0.000	0.000	0.055	0.240	0.002	0.270	0.000	0.077	0.000	0.001	602	0.56	L0.01	4.0	L0.05	L1.0	L0.002	15.0	379	5.0	7.9	L0.1	0.30
	Dell Roy Marina	1 Well	0	7.8	0.000	0.000	0.028	0.220	0.000	0.017	0.000	0.087	0.000	0.000	693	0.64	L0.01	119.0	L0.05	L1.0	0.003	39.0	392	4.0	7.3	L0.1	0.51
	Dell Roy Campground	1 H.P. Well	0	7.4	0.000	0.000	0.020	0.390	0.002	0.068	0.000	0.610	0.003	0.002	212	0.19	L0.01	2.0	L0.05	L1.0	0.002	19.0	128	2.0	9.8	L0.1	L0.10
	Atwood Lake Picnic Area	1 H.P. Well	0	7.9	0.001	0.000	0.037	0.330	0.002	0.024	0.000	0.940	0.003	0.001	1045	0.81	L0.01	142.0	L0.05	L1.0	0.002	4.0	693	10.0	11.0	L0.1	0.10
	Atwood Lake Camp #1	1 H.P. Well	4	7.9	0.000	0.017	0.084	0.180	0.002	0.037	0.002	0.120	0.003	0.000	548	0.80	L0.01	7.0	L0.05	L1.0	0.003	11.0	335	4.0	5.7	L0.1	0.19
	Atwood Lake Camp #3	1 H.P. Well	0	7.6	0.001	0.000	0.095	0.580	0.002	0.301	0.000	0.510	0.005	0.004	586	0.31	L0.01	1.0	L0.05	L1.0	L0.002	18.0	369	4.0	6.4	L0.1	0.51
DILLON	Dam Area	1 Well	0	7.7	0.000	0.000	0.210	0.230	0.000	0.150	0.000	0.610	0.000	0.000	673	0.27	L0.01	14.0	L0.05	4.0	L0.002	77.0	436	5.0	5.2	L0.1	L0.10
	Dillon State Park Water Treatment Plt.	Surface	0	7.5	0.001	0.000	0.810	0.099	0.000	0.024	0.004	0.100	0.000	0.003	581	0.26	L0.01	52.0	L0.05	5.4	L0.002	70.0	406	7.0	6.1	L0.1	L0.10
	Dillon State Park Camp Area B	1 H.P. Well	0	7.9	0.003	0.000	0.085	0.520	0.000	0.046	0.004	0.130	0.000	0.000	2040	0.72	L0.01	522.0	0.05	L1.0	0.004	7.0	1157	5.0	10.0	L0.1	0.15
	Irville Area	1 H.P. Well	0	8.3	0.000	0.000	0.099	0.081	0.000	0.025	0.004	0.170	0.000	0.000	408	0.26	L0.01	15.0	L0.05	2.0	L0.002	25.0	258	7.0	5.0	L0.1	L0.10
	Pleasant Knob Area	1 H.P. Well	8	7.9	0.000	0.000	0.060	4.130	0.009	0.038	0.000	4.700	0.000	0.003	306	0.18	L0.01	2.0	L0.05	3.5	L0.002	19.0	209	15.0	18.0	L0.1	L0.10
	Big Run Area	1 H.P. Well	0	7.2	0.000	0.000	0.110	3.410	0.009	0.260	0.002	11.600	0.000	0.002	541	0.17	L0.01	13.0	L0.05	3.2	L0.002	77.0	352	20.0	12.0	L0.1	L0.10
BURR OAK	Burr Oak Treatment Plant	Surface	0	7.9	0.000	0.000	0.160	1.740	0.000	0.009	0.002	0.250	0.000	0.000	275	0.10	L0.01	10.0	L0.05	L1.0	0.004	51.0	160	5.0	15.0		L0.10
	Burr Oak Boat Dock #1 Treatment Plant	Surface	0	7.7	0.000	0.000	0.100	0.049	0.000	0.007	0.000	0.091	0.000	0.000	275	0.12	L0.01	20.0	0.05	3.0	0.004	40.0	192	3.0	4.3	L0.1	L0.10
	Burr Oak Boat Dock #2	1 H.P. Well	108	7.6	0.000	0.000	0.210	0.120	0.000	0.045	0.000	0.190	0.000	0.003	510	0.56	L0.01	2.0	L0.05	1.5	L0.002	6.0	313	7.0	12.0	L0.1	0.57
	Burr Oak Boat Dock #3	1 H.P. Well	800	8.0	0.000	0.000	0.210	0.094	0.000	0.032	0.000	0.270	0.000	0.000	622	0.76	L0.01	81.0	L0.05	L1.0	L0.002	7.0	397	5.0	12.0	L0.1	0.39
	Burr Oak Boat Dock #4	1 H.P. Well	0	8.4	0.000	0.000	0.220	1.350	0.000	0.026	0.002	0.420	0.000	0.004	969	1.60	L0.01	24.0	0.05	L1.0	L0.002	75.0	650	40.0	43.0	L0.1	L0.10
CLENDENING	Dam Operations Area	1 Well	0		0.000	0.000	0.011	0.120	0.000	0.033	0.000	0.280	0.003	0.002	350												L0.10
	Dam Picnic Area	1 H.P. Well	144	7.7	0.001	0.000	0.066	0.330	0.002	0.202	0.009	1.530	0.003	0.002	569	0.13	L0.01	4.0	L0.05	L1.0	L0.002	210.0	464	15.0	9.1	L0.1	L0.10
	Marina Store	1 Well	0	7.8	0.000	0.000	0.048	0.160	0.002	0.102	0.006	0.055	0.003	0.001	390	0.18	L0.01	2.0	0.05	L1.0		52.0		3.0	5.3		0.10
	Marina Camp - Well C-2	1 H.P. Well	7	8.1	0.000	0.000	0.078	0.210	0.002	0.045	0.000	0.085	0.003	0.000	362	0.22	L0.01	L1.0	L0.05	L1.0		9.0		3.0	3.2		0.32
	Marina Camp - Well C-3	1 H.P. Well	0	7.8	0.000	0.000	0.096	0.160	0.002	0.032	0.000	0.360	0.003	0.002	285	0.13	L0.01	4.0	L0.05	1.3	L0.002	21.0	190	3.0	5.2	L0.1	L0.10
LEESVILLE	Dam Area	1 Well	0	8.1	0.000	0.000	0.047	0.160	0.000	0.180	0.000	0.170	0.003	0.000	378	0.31	L0.01	3.0	L0.05	L1.0	L0.002	18.0	249	4.0	4.6	L0.1	L0.10
	Clows Marina Building	1 Well	0	7.6	0.000	0.000	0.071	0.074	0.000	0.001	0.002	0.022	0.003	0.000	370	0.13	L0.01	11.0	L0.05	L1.0	L0.002	12.0	265	3.0	5.4	L0.1	L0.10
	Clows Marina Cottages	1 Well	0	7.5	0.000	0.000	0.035	0.037	0.000	0.015	0.000	0.640	0.002	0.000	340	0.17	L0.01	14.0	L0.05	1.3	L0.002	11.0	216	2.0	2.2	L0.1	L0.10
	Petersburg Marina Building	1 Well	0	7.9	0.000	0.000	0.054	0.660	0.000	0.170	0.000	0.022	0.003	0.000	521	0.42	L0.01	3.0	L0.05	L1.0	L0.002	53.0	349	11.0	17.0	L0.1	0.25
	Petersburg Beach & Camp #2	1 Well	0	7.6	0.000	0.000	0.008	2.390	0.000	0.200	0.000	0.440	0.003	0.000	477	0.32	L0.01	6.0	L0.05	L1.0	L0.002	73.0	320	45.0	41.0	L0.1	L0.10
	Petersburg Camp #1	1 H.P. Well	0	7.9	0.000	0.000	0.048	0.290	0.000	0.280	0.000	0.077	0.003	0.002	492	0.23	L0.01	3.0	L0.05	L1.0	L0.002	46.0	315	4.0	9.5	L0.1	0.23
	Southfork Camp #1	1 H.P. Well	0	7.6	0.000	0.000	0.042	0.230	0.000	0.055	0.000	0.260	0.000	0.000	209	0.15	L0.01	2.0	L0.05	1.2	L0.002	16.0	141	5.0	7.6	L0.1	L0.10
	Southfork Camp #2	1 H.P. Well	0	7.5	0.000	0.000	0.060	1.220	0.000	0.320	0.000	0.401	0.003	0.000	284	0.15	L0.01	2.0	L0.05	L1.0	L0.002	7.0	175	5.0	11.0	L0.1	L0.10
CAGLES MILL	Dam Area	Surface	3	7.8	0.000	0.014	0.030	0.023	0.027	0.021	0.002	0.580	0.000	0.000	359	0.13	0.01	11.0	0.05	2.8	0.004	29.0	237	10.0	6.2	L0.1	0.10
	Lieber State Park	Surface	0	8.3	0.002	0.014	0.040	0.072	0.037	0.005	0.002	0.070	0.000	0.008	327	0.12	0.01	14.0	0.05	3.2	0.002	32.0	227	4.0	3.5	L0.1	0.10
	Cataract Falls State Park	1 H.P. Well	0	7.6	0.000	0.011	0.040	1.008	0.048	0.022	0.000	5.350	0.013	0.014	700	0.15	0.01	8.0	0.05	L1.0	0.002	15.0	446	10.0	12.0	0.15	L0.10
MANSFIELD	Dam Area	Surface	0	7.8	0.004	0.015	0.340	0.170	0.027	0.230	0.000	0.490	0.000	0.021	450	0.15	L0.01	14.0	L0.05	3.3	0.004	32.0	292	8.0	4.8	L0.1	L0.10
	Raccoon State Park Camp Area	2 Wells	0	7.9	0.002	0.000	0.036	0.017	0.000	0.056	0.000	0.076	0.000	0.014	653	0.21	L0.01	1.0	L0.05	L1.0	L0.002	5.0	444	3.0	2.9	L0.1	0.15
	Raccoon State Park Beach Area	1 Well	0	7.6	0.000	0.015	0.026	0.230	0.037	0.011	0.002	0.270	0.000	0.000	525	0.29	L0.01	1.0	L0.05	L1.0	L0.002	6.0	327	13.0	8.0	L0.1	L0.10
	Hollandsburg Area	1 H.P. Well	0	7.6	0.000	0.000	0.047	3.350	0.027	0.025	0.000	4.870	0.000	0.000	609	0.25	L0.01	1.0	L0.05	L1.0	L0.002	11.0	399	48.0	32.0	L0.1	L0.10
	Portland Mills Area	1 H.P. Well	0	7.7	0.000	0.015	0.073	2.060	0.027	0.047	0.000	5.870	0.000	0.000	638	0.17	L0.01	8.0	L0.05	L1.0	L0.002	52.0	511	33.0	31.0	L0.1	L0.10
MONROE	Dam Area	Surface	8	7.5	0.006	0.013	0.064	0.031	0.036	0.003	0.007	0.160	0.000	0.026	170	L0.10	L0.01	4.0	L0.05	1.0	L0.002	23.0	107	3.0	4.4	L0.1	L0.10
	Ransburg Boy Scout Camp	Surface	1	7.4	0.005	0.013	0.060	0.950	0.026	0.036	0.000	0.073	0.000	0.026	166	L0.10	L0.01	10.0	0.05	1.1	0.003	22.0	112	10.0	4.6	L0.1	L0.10
	Hardin Ridge & Sycamore Flats Area	Surface	0	7.5	0.004	0.014	0.032	0.044	0.026	0.000	0.010	0.064	0.000	0.000	228	L0.10	L0.01	3.0	L0.05	1.1	0.002	36.0	139	2.0	4.4	L0.1	L0.10
	Fairfax Area	Surface	0	7.9	0.000	0.010	0.042	0.053	0.015	0.002	0.000	0.059	0.000	0.020	173	L0.10		17.0	L0.05	L1.0	0.004	35.0	118	3.0	2.2	L0.1	L0.10
	Fairfax Beach Area	Cistern	36	8.0	0.002	0.010	0.037	0.071	0.026	0.024	0.000	0.028	0.000	0.000	298	0.10	L0.01	13.0	L0.05	L1.0	0.004	26.0	198	6.0	6.2	1.8	L0.10
	Cutright Boat Launch	1 H.P. Well	162	7.1	0.002	0.015	0.067	0.340	0.037	0.012	0.004	0.390	0.000	0.000	543	L0.10	L0.01	24.0	0.05	23.0	0.003	64.0	366	5.0	3.4	L0.1	L0.10
	Paynetown Camp	1 H.P. Well	0	7.9	0.000	0.015	0.046	0.510	0.027	0.046	0.000	0.092	0.000	0.000	498	0.34	L0.01	48.0	L0.05	L1.0	0.004	1.0	292	10.0	5.0	0.35	L0.10
SALAMONIE	Dam and LeGros Area	1 Well	0		0.000	0.000	0.230	0.019	0.016	0.011	0.004	6.170	0.000	0.006	750	0.56	L0.01	3.0	L0.05	L1.0	L0.002	42.0	407	15.0	5.6	L0.1	L0.10
	Lost Bridge West Area	1 Well	0	7.5	0.002	0.000	0.160	2.720	0.000	0.018	0.000	2.580	0.005	0.007	620	0.84	L0.01	11.0	L0.05	L1.0	L0.002	32.0	834	2.0	3.7		L0.10
	Lost Bridge East Area	1 Well	0		0.001	0.000	0.250	1.870	0.000	0.025	0.000	0.360	0.005	0.008	560												L0.10
	Mount Etna Area	1 Well	0	7.6	0.003	0.000	0.140	0.850	0.000	0.013	0.000	1.290	0.005	0.008	660	0.86	L0.01	7.0	L0.05	L1.0	L0.002	38.0	430	5.0	2.4		L0.10
	Dora-New Holland Area	1 Well	0		0.002	0.000	0.110	0.320	0.016	0.011	0.004	3.170	0.000	0.007	680												L0.10
	Mount Hope Area	1 Well	0	7.6	0.000	0.000	0.330	0.740	0.000	0.029	0.004	5.800	0.000	0.007	850	0.98	L0.01	11.0	L0.05	2.8	0.004	41.0	487	5.0	4.2		L0.10
HUNT-ING-TON	Dam Area	1 Well	0	7.5	0.003	0.000	0.440	1.680	0.000	0.048	0.008	1.620	0.000	0.013	990	1.18	L0.01	3.0	L0.05	L1.0	L0.002	83.0	606	2.0	3.6		L0.10
	Beach-Picnic Area	1 Well	0	7.5	0.000	0.000	0.260	1.023	0.027	0.035	0.008	2.600	0.000	0.007	660	0.47	L0.01	8.0	L0.05	L1.0	L0.002	181.0	755	3.0	2.0		L0.10

All Results in mg/l Unless Otherwise Noted. (1) No. Organisms Per 100 ml. (2) S.U. (3) ug/l. L = less than. X Exceeds Mandatory Limits. X.XXX Exceeds Recommended Limits. H.P. = Hand-pumped.

PARTICIPANTS

The following persons and/or agencies made a major contribution to the successful completion of this study.

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APPENDIX A

FIELD EVALUATION AND
WATER SAMPLE FORMS
USED IN SURVEY

MUNICIPAL WATER SUPPLY SANITARY SURVEY

1. LEAVE THIS BLANK (for office use only) 1 – 12 (DUP. ON EVERY CARD)
SURVEY DATE: DATE OF YOUR VISIT — 13 mo. ☐☐ day ☐☐ yr. ☐☐ 18

2. Name of supply ____________________

3. Location ____________________ post office ____________________ common name, if different

4. Demands, MGD:

	PRESENT	10-YR. ESTIMATE	UNKNOWN
A. Avg. day	FROM (19–23)	☐☐☐☐☐ (24–28)	☐ 30
B. Max. day	PLANT (31–35)	☐☐☐☐☐ (36–40)	☐ 42
C. Max. month	RECORDS (43–47)	☐☐☐☐☐ (48–52)	☐ 54

5. Water use has been restricted ☐☐ (55–56) times for a total of ☐☐☐ (57–59) days during any one year of the past 5 years.

6. LABORATORY CONTROL

A. Bacteriological (Distribution system only) FROM FIG. 1 - D.W.S.

(1) Min. number samples recommended per month by PHS DWS ☐☐☐ (60–62) UNKNOWN

(2) Avg. number/month for last 12 months — MAY be ☐☐☐ (63–65) ☐ 67

(3) Range from ZERO (68–70) to ☐☐☐ (71–73) ☐ 75

END CARD ONE 1 (80)

(4) Number of months the Drinking Water Standards were not met during the last 12 months for: NO. OF MONTHS — UNKNOWN

(a) Quality – Sec 3.2 - D.W.S. ☐☐ (13–14) ☐ 15

(b) Number of samples (MONTHS WHEN SAMPLE NUMBERS < NO. IN 6.A.(1)) ☐☐ (16–17) ☐ 18

(c) NONE collected — No samples for —— months ☐☐ (19–20) ☐ 21

(5) Are samples representative of distribution system? JUDGE from map of distribution system ☐ 22 yes ☐ 23 no

(6) Are check samples collected as provided for in the Drinking Water Standards? Sec 3.15 - D.W.S. ☐ 24 yes ☐ 25 no

(7) Are samples requiring check samples reported by telephone? ☐ 26 yes ☐ 27 no

(8) Is the laboratory certified? ☐ 28 yes ☐ 29 no

(a) Within the past 3 years? ☐ 30 yes ☐ 31 no

(b) If "yes" by whom was it certified. ☐ 32 State ☐ 33 PHS

(9) Are samples received by lab within 30 hours? ☐ 34 yes ☐ 35 no

INFORMATION FROM OPERATION

FROM PLANT RECORDS

NAME on each Page

2

B(1)-(4) REFER to Sec 5.2 - D.W.S.

B. Chemical (finished water only)

(1) Samples of finished water are analyzed each ☐ month, ☐ year,
36 37
☐ 2 years, ☐ 3 years, ☐ infrequently and/or ☐ never.
38 39 40 41

(2) Type of analysis: ☐ EVERYTHING complete (DWS) ☐ partial. IF any CONSTITUENT MISSING
42 43

(3) Date of last chemical analysis ☐☐ ☐☐ ☐☐
45 mo. day yr. 50

(4) Analyzed by ☐ utility, ☐ state, ☐ PHS, ☐ university, ☐ other.
51 52 53 54 55

(5) Tests run for operational control and their frequency are:

Tests	Frequency				
	Continuous	Each shift	Daily	Weekly	Infrequently
Alkalinity	☐ 57	☐	☐	☐	☐ 61
Aluminum	☐ 62	☐	☐	☐	☐ 66
Chloride	☐ 67	☐	☐	☐	☐ 71
Chlorine residual (END CARD TWO) ☐2 80	☐ 72	☐	☐	☐	☐ 76
Color	☐ 13	☐	☐	☐	☐ 17
Fluoride	☐ 18	☐	☐	☐	☐ 22
Hardness	☐ 23	☐	☐	☐	☐ 27
Iron	☐ 28	☐	☐	☐	☐ 32
Jar tests	☐ 33	☐	☐	☐	☐ 37
Manganese	☐ 38	☐	☐	☐	☐ 42
pH	☐ 43	☐	☐	☐	☐ 47
Taste & Odor	☐ 48	☐	☐	☐	☐ 52
Turbidity	☐ 53	☐	☐	☐	☐ 57
Zeta potential	☐ 58	☐	☐	☐	☐ 62
Other ________	☐ 63	☐	☐	☐	☐ 67

NOTE OTHER FREQUENCIES

C. Radioactivity

(1) Samples are analyzed each ☐ month, ☐ year, ☐ 2 years, ☐ 3 years,
69 70 71 72
☐ infrequently and/or ☐ never. (END CARD 3) ☐3
73 74 80

(2) Date of last radiological analysis ☐☐ ☐☐ ☐☐
13 mo. day yr. 18

(3) Analyzed by ☐ utility, ☐ state, ☐ PHS, ☐ university, ☐ other.
19 20 21 22 23

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7. SANITARY SURVEY

A. Date of most recent survey ☐ 27 mo. ☐ day ☐ yr. 29 or ☐ 30 none By others - NOT THIS ONE

B. Survey made by: ☐ 31 state, ☐ 32 PHS, ☐ 33 local health department, ☐ 34 utility, and/or ☐ 35 consultant. "Survey" requires written report of finding

C. Facilities surveyed: ☐ 36 source, ☐ 37 transmission, ☐ 38 treatment, ☐ 39 storage, ☐ 40 distribution.

8. FACILITIES & OPERATION (describe deficiencies on reverse side)

	YES	NO
A. Are there common walls between finished and lesser quality water?	☐ 41	☐ 42
B. Are there inter-connections to other "systems" "Sub-divisions private industrial, community		
(1) of known acceptable quality indicated by state health dept. acceptance	☐ 43	☐ 44
(2) of unknown quality		
(a) with protection	☐ 45	☐ 46
(b) without protection	☐ 47	☐ 48
C. Is there a cross-connection control program		
(1) on new construction only	☐ 49	☐ 50
(2) for continuous re-inspection	☐ 51	☐ 52
D. Are finished water reservoirs properly covered?	☐ 53	☐ 54
E. Is there detectable chlorine residual in distant parts of the distribution system?	☐ 55	☐ 56
F. Can the treatment plant be by-passed?	☐ 57	☐ 58
G. Are there satisfactory procedures to:		
(1) prevent personal accidents	☐ 59	☐ 60
(2) prevent chlorine accidents	☐ 61	☐ 62
(3) disinfect all new and/or repaired distribution system mains, valves, fittings, including check samples before being placed in service?	☐ 63	☐ 64
H. Are there areas of low pressure (< 20 psi) in the distribution system under maximum water use?	☐ 65	☐ 66

I. Operating problems most often encountered are: ☐ 67 taste & odor ☐ 68 phenols, ☐ 69 corrosive water, ☐ 70 short filter runs, ☐ 71 other.

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8. FACILITIES & OPERATION, continued

J. Chlorination process was interrupted ☐☐ (72 73) times in the last 12 months.

(1) Interruptions were due to: ☐ (74) chlorinator failure, ☐ (75) feedwater pump, ☐ (76) changing cylinders, ☐ (77) power failure, ☐ (78) other. (END CARD 4) 4 (80)

K. Percent of land area within service area where water is available (nearest whole percent) ☐☐☐ (13 15) %.

	YES	NO
L. Were plans and specs. for treatment plant approved by the state?	☐ 16	☐ 17

9. SOURCE, TREATMENT & DISTRIBUTION (describe deficiencies on reverse side) NOTE

A. Are the following adequate:

	YES	NO
(1) Source, with respect to the following:		
(a) quantity	☐ 18	☐ 19
(b) bacteriological quality	☐ 20	☐ 21
(c) chemical quality	☐ 22	☐ 23
(d) physical quality	☐ 24	☐ 25
(e) adequate protection	☐ 26	☐ 27
(2) Transmission of raw water	☐ 28	☐ 29
(3) Is the raw water sampled for:		
(a) Bacteriological contamination	☐ 30	☐ 31
(b) Chemical contamination	☐ 32	☐ 33
(4) Treatment, with respect to the folowing:		
(a) aeration	☐ 34	☐ 35
(b) chemical feed , capacity	☐ 36	☐ 37
(c) chemical feed, stand-by equipment	☐ 38	☐ 39
(d) chemical mixing	☐ 40	☐ 41
(e) flocculation	☐ 42	☐ 43

} Refer to PHS No. 1820

9. **SOURCE, TREATMENT & DISTRIBUTION**, continued

A. Are the following adequate (continued):

	YES	NO
(4) Treatment, continued:		
(f) settling	☐ 44	☐ 45
(g) recarbonation	☐ 46	☐ 47
(h) filtration AT NORMAL OPERATING RATES	☐ 48	☐ 49
(i) disinfection, capacity	☐ 50	☐ 51
(j) disinfection, stand-by equipment	☐ 52	☐ 53
(k) taste & odor control	☐ 54	☐ 55
(l) fluoridation	☐ 56	☐ 57
(5) Distribution, with respect to the following:		
(a) storage	☐ 58	☐ 59
(b) booster chlorination	☐ 60	☐ 61
(c) high service pumping	☐ 62	☐ 63
(d) booster pumping	☐ 64	☐ 65
(e) pressure	☐ 66	☐ 67
(6) Maintenance	☐ 68	☐ 69
(7) Records for:		
(a) disinfection	☐ 70	☐ 71
(b) filter runs	☐ 72	☐ 73
(c) chemical consumption	☐ 74	☐ 75
(d) operational control tests	☐ 76	☐ 77
(e) bacteriological examinations	☐ 78	☐ 79
(8) Cross-connection control	END CARD 5	5 80
(a) ordinance	☐ 13	☐ 14
(b) program implementation	☐ 15	☐ 16
(c) progress	☐ 17	☐ 18

9. SOURCE, TREATMENT & DISTRIBUTION, continued

B. During the past 3 years, raw water quality has ☐ 19 improved, ☐ 20 deteriorated, or ☐ 21 stayed the same.

10. PERSONNEL

A. Water Purification Operator THIS IS THE RESPONSIBLE PLANT OPERATOR - NOT SUP'T.

GET OPERATOR DATA FOR EACH SUPPLY EVEN IF there IS NO treatment

(1) Highest level of formal education: ☐ 8th grade or less, ☐ 23 high school, ☐ 24 technical or trade school, ☐ 25 university.

(2) Level of training in water treatment: ☐ 26 college course, ☐ 27 technical or trade school, ☐ 28 short school, ☐ 29 on the job, ☐ 30 none, ☐ 31 other ______________________.

(3) Length of time on this job: ☐☐ 32 33 years, ☐☐ 34 35 months.

(4) Number of previous positions as water treatment operator ☐☐ 36 37

(5) Total years of water purification experience ☐☐ 38 39

(6) Level of study in sanitary microbiology: ☐ 40 college course, ☐ 41 technical or trade school, ☐ 42 short school, ☐ 43 on the job, ☐ 44 none, ☐ 45 other ______________________.

(7) Level of study in water chemistry: ☐ 46 college course, ☐ 47 technical or trade school, ☐ 48 short school, ☐ 49 on the job, ☐ 50 none, ☐ 51 other ______________________.

(8) Is the operator a full-time employee? ☐ 52 yes ☐ 53 no

(9) Salary range (per year) of operator: ☐ 54 <$1,000, ☐ 55 $1,000-2,000, ☐ 56 $2,000-5,000, ☐ 57 $5,000-7,500, ☐ 58 $7,500-10,000, ☐ 59 > $10,000.

10. PERSONNEL, continued

A. continued

(10) Is your present staff adequate in: Operators opinion

(a) number ☐ 60 yes ☐ 61 no

(b) quality ☐ 62 yes ☐ 63 no

B. Operator's biggest complaint: ____________________

C. Most frequent customer's complaint: Received by utility

D. Management's most frequent complaint: ____________________

11. FINANCIAL INFORMATION

A. Bonded indebtedness:

(1) General obligation bonds $ ☐☐☐☐☐☐☐☐. 66 73 END CARD 6 ☐6 80

(a) statutory limit $ ☐☐☐☐☐☐☐☐. 13 20

(2) Revenue bonds $ ☐☐☐☐☐☐☐☐. 21 28

(a) statutory limit $ ☐☐☐☐☐☐☐☐. 29 36

B. Capital stock, par value $ ☐☐☐☐☐☐☐☐. 37 44

bonds, par value $ ☐☐☐☐☐☐☐☐. 45 52

C. Water funds are ☐ 53 kept separate or ☐ 54 mingled with other funds.

D. Is there an annual payment to the general fund? ☐ 55 yes ☐ 56 no

E. Operation is controlled by: ☐ 57 mayor-council, ☐ 58 mayor-commission,

☐ 59 independent water board, ☐ 60 other ____________________.

FOR CITY, DISTRICT, etc. OWNED ONLY

F. Is there active planning for expansion or improvement? ☐ 61 yes ☐ 62 no

(1) Value of planned improvement $ ☐☐☐☐☐☐☐☐. 63 70

(2) Planning by utility ☐ 71 yes ☐ 72 no UTILITY ONLY

(3) Planning by consultants ☐ 73 yes ☐ 74 no UTILITY & CONSULTANTS END CARD 7 ☐7 80

G. If expansion is planned, it will be carried out within:

	1 YR.	5 YRS.	10 YRS.
(1) Source	☐ 13	☐	☐ 15
(2) Treatment	☐ 16	☐	☐ 18
(3) Distribution	☐ 19	☐	☐ 21
(4) Other ________________	☐ 22	☐	☐ 24

H. Costs of production:

	CENTS/1,000 GALLONS
(1) Chemicals	☐☐.☐ 26 28
(2) Labor, power, etc.	☐☐.☐ 29 31
(3) Depreciation	☐☐.☐ 32 34
(4) Other, including office, administration, meter reading, collection, etc.	35 ☐☐.☐ 37
(5) Total	☐☐.☐ 38 40

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11. **FINANCIAL INFORMATION**, continued

I. **Tariff**

(1) Connection fee $ ☐☐.☐☐ 41 44

(2) Sales unit is ☐ 45 per 1,000 gallons or ☐ 46 per 100 cu. ft.

(a) ☐☐☐ 47 cents for the first ☐☐ 50 51 units ADJUST ALL

(b) ☐☐☐ 52 cents for the next ☐☐ 55 56 units RATES to these

(c) ☐☐☐ 57 cents for the next ☐☐ 60 61 units UNITS

(d) etc. as needed to cover steps.

END CARD 8 [8] 80

NOTE FLAT RATE here AS #/time UNIT

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Environmental Health Service
Environmental Control Administration

BUDGET BUREAU NO. 85-S70016
EXPIRES 11-30-70

INDIVIDUAL WATER SUPPLY SURVEY QUESTIONNAIRE

Card 1

NAME ______________________ SAMPLE NO. 1 ______________________ 6

ADDRESS ______________________ YEAR ______ 7 ______ 8

I. THE SOURCE

Col.

9 A. Spring ☐ 1; Well ☐ 2; Surface Source ☐ 3; Cistern ☐ 4.

10 B. Ground Water from: Sand/Gravel ☐ 1; Limestone ☐ 2; Sandstone ☐ 3;
Other Formation ☐ 4; Specify ______________________; Not Known ☐ 5.

11 C. Construction: By Contractor ☐ 1; Owner/Occupant ☐ 2; Other ☐ 3.

II. A. SPRING

12 1. Flowing ☐ 1; Non-Flowing ☐ 2: Intermittent ☐ 3.

2. Encasement:

13 Brick, Block, or Stone ☐ 1; Reinforced Concrete ☐ 2; Other ☐ 3.

14 General Condition: Good ☐ 1; Fair ☐ 2; Poor ☐ 3.

15 3. Surface Drainage Controlled? Yes ☐ 1; No ☐ 2.

16 4. Adequate Fencing around spring? Yes ☐ 1; No ☐ 2.

5. Water withdrawn with:

17 Power Pump ☐ 1; Hand Pump ☐ 2; Bucket ☐ 3; Other ☐ 4.

18-19 6. Estimated Minimum Capacity: ☐☐ NUMERIC GPM.

B. WELL

20 1. Dug ☐ 1; Driven ☐ 2; Jetted ☐ 3; Bored ☐ 4; Drilled ☐ 5.

2. Dug Well:

21 Acceptable lining to 10' or more? Yes ☐ 1; No ☐ 2.

22 Acceptable cover? Yes ☐ 1; No ☐ 2.

23 Masonry or other jointed lining, sealed: Yes ☐ 1; No ☐ 2.

24 Reconstructed, sealed and filled: Yes ☐ 1; No ☐ 2.

25 General condition: Good ☐ 1; Fair ☐ 2; Poor ☐ 3.

3. Other Types of Wells:

26-27 a. Casing: Diameter: ☐☐ NUMERIC inches, I.D.

ECA-62 (CIN)
(REV. 6-70)

Col.

28 Steel or Black Iron ☐1; Galvanized Iron or Steel ☐2.

29 Joints Screwed Coupling ☐1; Joints Welded ☐2.

30 Wall thickness, Std. or better? Yes ☐1; No ☐2.

b. Depths:

31-33 Ground surface to bottom of well: ☐☐☐ Ft.

34-36 Ground surface to bottom of casing: ☐☐☐ Ft.
NUMERIC

c. Formation Seal:

37 Cement grout seal from depth of 5 to 10' up to surface ☐1.

Cement grout seal from depth of 10 to 20' up to surface ☐2.

Fine sand (natural) seal 10 to 20' up to surface ☐3.

Puddled clay seal 5 to 20; up to surface ☐4.

No apparent formation seal between casing and earth ☐5.

Concealed (buried) formation grout seal reported ☐6.

d. Sanitary Well Seal

38 Water tight cover? Yes ☐1; No ☐2.

39 Well exposed to flooding? Yes ☐1; No ☐2.

e. Well Pit

40 Pit around well? Yes ☐1; No ☐2.

41 Pit has acceptable cover? Yes ☐1; No ☐2.

42 Pit drains to open air? Yes ☐1; No ☐2.

43 Pit drains to drain line or sewer? Yes ☐1; No ☐2.

44 Possible to flood pit in anyway? Yes ☐1; No ☐2.

45 Pitless adapter? Yes ☐1; No ☐2.

46 Pitless adapter with top of well buried or below ground level Yes ☐1; No ☐2.

47 f. Well ''Filter'' or Screen*

Open hole ☐1; Perforated or slotted pipe ☐2;

Sand (well) point or screen of horizontal, endless slot type ☐3; Other type of screen ☐4.

48 g. Age of Well: < 2 yrs. ☐1; 2-5 yrs. ☐2; 6-10 yrs. ☐3; 11-20 yrs. ☐4; > 20 yrs. ☐5.

C. PUMP AT WELL OR SPRING

49 1. Hand pump ☐1; ''Shallow well'' (low-lift) jet or centrifugal pump ☐2;

''Deep well'' (hi-lift) jet pump ☐3; Submersible pump ☐4.

*Not to be confused with ''filter'' or strainer attached to suction inlet of pump.

Col.

50 2. Pump never breaks suction ☐1 ; Pump sometimes breaks suction ☐2 .

51 3. With existing pump, well delivers: Less than 3 GPM ☐1 ; 3-5 GPM ☐2 ; 5-10 GPM ☐3 ;
10-20 GPM ☐4 ; More than 20 GPM ☐5 .

D. SURFACE SOURCE (Stream; Lake)

52 1. Perennial ☐1 ; Intermittent ☐2 .

53 2. Upstream: Human activity currently on watershed? Yes ☐1 ; No ☐2 .

54 3. Delivery: Flow by pumping ☐1 ; By gravity ☐2 .

E. CISTERN

55 1. Catchment Area: Rooftops ☐1 ; Ground surface paved or covered with impermeable material ☐2 .

56 2. Ground Area Only: Fenced ☐1 ; Signs posted ☐2 ; Unprotected ☐3 .

57 3. Cistern Construction: Above ground ☐1 ; Below ground ☐2 ;

58 Brick or stone ☐1 ; Concrete ☐2 ; Wood ☐3 ; Steel ☐4 .

59 General Condition: Good ☐1 ; Fair ☐2 ; Poor ☐3 .

60 4. Cistern Protection: Screened against rodents, birds? Yes ☐1 ; No ☐2 .

61 5. Cleaning: Does cistern have drain which permits cleaning and flushing to waste?
Yes ☐1 ; No ☐2 .

62 Does cistern need cleaning now? Yes ☐1 ; No ☐2 .

F. WATER TREATMENT (Surface Source; Cistern)

63 1. Sedimentation: Yes ☐1 ; No ☐2 .

64 2. Filtration Through: Sand ☐1 ; Other Medium ☐2 .

65 3. Chlorination: Automatic ☐1 ; Manual ☐2 .

66 4. Softening: Yes ☐1 ; No ☐2 .

67 5. Other* Yes ☐ ____ No ☐2 .
(EXPLAIN)

G. STORAGE (All Sources)

68 1. Pressure tank ☐1 ; Elevated storage ☐2 ; Below ground storage ☐3 .
(ONE OR MORE)

69 2. Construction: Steel ☐1 ; Brick, block or stone ☐2 ; Concrete ☐3 ; Wood ☐4 .

70 3. General Condition: Good ☐1 ; Fair ☐2 ; Poor ☐3 .

H. DELIVERY

71 1. Water flows to point of use by hand pumping ☐1 ; Power pumping ☐2 ; Gravity ☐3 ;
Hand carry ☐4 .

*Describe

Col.

I. PHYSICAL QUALITY OF WATER

72 1. Colored ☐ 1 ; Turbid ☐ 2 ; Clear ☐ 3 ; Contains sand ☐ 4 .

73 2. Taste: Good ☐ 1 ; Fair ☐ 2 ; Poor* ☐ 3 . ____________

74 3. Evidence of iron or manganese problem: Yes ☐ 1 ; No ☐ 2 .

75 4. Water Softener in regular operation: Yes ☐ 1 ; No ☐ 2 .

76 5. Other water conditioner devices used: Yes ☐ 1 ; No ☐ 2 .

80 CARD NUMBER 1

CARD 2 - Dup 1-8

J. PUBLIC AGENCY INTERESTS++

9 1. Has any public agency inspected this supply at any time within the last two years?
Yes ☐ 1 ; No ☐ 2 . ++ ____________

10 2. Has bacteriological analysis ever been made on the water? Yes ☐ 1 ;
Date ________ ; No ☐ 2 ; Unknown ☐ 3 . ++ ____________

11 a. If "yes" was the water found "safe?" Yes ☐ 1 ; No ☐ 2 .

12 b. If "no" (under 2a) were corrections recommended? Yes ☐ 1 ; No ☐ 2 .

13 c. Were corrections made: Yes ☐ 1 ; No ☐ 2 .

14 d. After corrections were made, was water retested? Yes ☐ 1 ; No ☐ 2 . ++ ________

15 3. Did the owner–before attempting any construction at the source or before using the source–consult any agency about its suitability? Yes ☐ 1 ; No ☐ 2 . ++ ____________

16 4. Have any chemical analyses ever been made on the water? Yes ☐ 1 ; Date ________ ,
No ☐ 2 ; Unknown ☐ 3 ; ++ ____________

K. USER'S PREFERENCE

17 1. User prefers: Present supply ☐ 1 ; Another or improved individual supply ☐ 2 ;
A public supply ☐ 3 .

18 2. Reason(s) for Preference: Lower cost ☐ 1 ; Better tasting water ☐ 2 ; Softer water ☐ 3 ;
Independence ☐ 4 ; More reliable source ☐ 5 ; Safer ☐ 6 .
Other ☐ 7 ____________

L. PRESENT CONSUMPTION

19-22 1. Number of persons using system. Adults ________ Children ________

23 2. Is water shortage ever experienced: Yes ☐ 1 ;
Specify ____________ No ☐ 2 .

80 CARD NUMBER 2

---

*Identify if possible.

++Identify agency.

ECA-9 (CIN)
(1-69)

UNITED STATES PUBLIC HEALTH SERVICE
ENVIRONMENTAL CONTROL ADMINISTRATION
BUREAU OF WATER HYGIENE

- 82 -

SERIAL NO.
9441

PUNCH IN COLS.
1 6

IDENTIFICATION OF WATER SAMPLE

1. LOCATION OF WATER SUPPLY NAME OF RESERVOIR, County, State
CITY, COUNTY, STATE

FOR OFFICE USE ONLY ☐☐☐☐☐☐☐☐☐☐☐☐
7

DO NOT WRITE BELOW THIS LINE

2. WATER SUPPLY NAME NAME OR RECREATION AREA SERVED

3. DATE OF SAMPLING
BEGINNING DATE OF COMPOSITE MO. DAY ☐☐☐☐ 19 22
ENDING DATE OF COMPOSITE OR DATE OF GRAB SAMPLE MO. DAY YR. ☐☐☐☐☐☐ 23 28

4. SAMPLE FROM ☐ TREATMENT PLANT 8 ☐ WELL 4 ☐ RESERVOIR 2 ☐ DISTRIBUTION SYSTEM 1 ☐ OTHER 0 ☐ 29

5. SAMPLING POINT LOCATION AND/OR DESCRIPTION i.e. kitchen, 1234 Main ☐☐☐ 30 32

6. TYPE OF WATER SAMPLED ☐ FINISHED 8 ☐ PARTIALLY TREATED 4 ☐ RAW 2 ☐ OTHER 0 ☐ 33

7. SOURCE OF WATER ☐ SURFACE 8 ☐ GROUND 4 ☐ COMBINED 2 ☐ OTHER 0 ☐ 34

8. SAMPLING METHOD ☐ COMPOSITE 8 ☐ GRAB 4 ☐ OTHER 0 ☐ 35

9. ANALYSIS REQUIRED ☐ ORGANIC 8 ☐ TRACE ELEMENTS 4 ☐ WET 2 ☐ RADIO-CHEMICAL 1 ☐ OTHER 0 ☐ 36

10. WATER SUPPLY CATEGORY ☐ COMMUNITY WATER SUPPLY 8 ☐ ICWS 4 ☐ FEDERAL INSTALLATION 2 ☐ SPECIAL STUDY 1 ☐ OTHER 0 ☐☐☐ 37 39

11. APPEARANCE OF SAMPLE ______________________

12. ADDITIONAL REMARKS ______________________

13. COLLECTED BY ______________________ ☐ USPHS STAFF ☐ OTHER ☐ 1 80

DO NOT WRITE BELOW THIS LINE

LAB. SAMPLE NO. ______________ DATE RECEIVED ______________

LABORATORY REMARKS

OVER FOR INSTRUCTIONS

INSTRUCTIONS: EVERY ITEM OF INFORMATION REQUIRED FROM THE SAMPLER IS NUMBERED (1 THROUGH 13). THESE ARE THE ONLY RESPONSES THE SAMPLER SHOULD MAKE. NOTE AREAS MARKED "DO NOT WRITE BELOW THIS LINE" AND "FOR OFFICE USE ONLY."

ITEM 1 SHOULD BE THE LOCATION OF THE WATER SUPPLY FACILITY WHICH PRODUCED THE WATER FOR THE SAMPLE. (EXAMPLE: CINCINNATI, HAMILTON, OHIO.)

ITEM 2 SHOULD BE THE FULL NAME OF THE WATER SUPPLY FACILITY. (EXAMPLE: CINCINNATI MUNICIPAL WATER WORKS)

ITEMS 4, 6, 7, AND 8 - CHECK THE BOX WHICH APPLIES

ITEMS 9 AND 10 - CHECK ONE OR MORE BOXES AS NECESSARY

ITEMS 3, 5, 11, 12, AND 13 SHOULD BE SELF-EXPLANATORY

ANY RESPONSE OF "OTHER" OR "SPECIAL STUDY" SHOULD BE EXPLAINED UNDER ITEM 12 - ADDITIONAL REMARKS..

IF NECESSARY FOR COMPLETE IDENTIFICATION OR EXPLANATION, PLEASE FEEL FREE TO USE THE BACK OF THE ORIGINAL (WHITE) COPY OR ATTACH AN ADDITIONAL PAGE OF LIKE SIZE.

DISTRIBUTION:

MAIL ORIGINAL (WHITE COPY) TO:

WATER QUALITY REGISTER BRANCH
BUREAU OF WATER HYGIENE
222 E. CENTRAL PARKWAY
CINCINNATI, OHIO 45202

BLUE	ENCLOSED WITH ORGANIC SAMPLE
PINK	ENCLOSED WITH TRACE METAL SAMPLE
YELLOW	ENCLOSED WITH WET CHEMISTRY SAMPLE
GREEN	ENCLOSED WITH RADIOCHEMICAL SAMPLE
TAN	RETAINED BY REGIONAL OFFICE OR SAMPLER

APPENDIX B

SUPPLEMENTAL STUDY

A SUPPLEMENTAL STUDY OF THE ADEQUACY AND MAINTENANCE OF ENVIRONMENTAL SAFEGUARDS IN RECREATIONAL AREAS INVOLVED IN THE WATER SUPPLY STUDY

In many instances the planning, provision, and maintenance of facilities in recreation areas have not kept pace with the rapidly increasing visitor load. Available recreation facilities will need to be at least tripled by the year 2000 to meet the needs of the Nation's exploding population and increased leisure time. Estimates are that adequate environmental health safeguards comprise approximately 30 percent of development costs of new recreation areas. Since these safeguards represent such an appreciable investment, care should be taken in properly planning, constructing, and maintaining adequate facilities.

As a corollary to the central study of drinking water facilities a general survey of recreational and sanitary facilities was made in the recational areas involved in this study. The facilities were examined for adequacy and maintenance of environmental health safeguards. In addition, bacteriological samples were collected at 3 and 6 foot levels from bathing waters at each beach and analyzed for total coliform; fecal coliform and fecal streptococci, The Report of the National Technical Advisory Committee to the Secretary of the Interior on Water Quality Criteria, April 1968, recommends that fecal coliforms be used as the indicator organism for evaluating the suitability of water for primary contact recreation. The 200 per 100 ml fecal coliform limit recommended in the report is the criteria used to evaluate the suitability of bathing water at beaches sampled in this study. The general findings of the supplemental study are as follows:

Bathing Beaches

Water Quality

The only sample exceeding the fecal coliform limit of 200 per 100 ml was collected from the Raccoon State Park Beach at Mansfield Reservoir. This beach had fecal coliform levels of 120 and 310 per 100 ml. At Cagles Mill, half of the samples were 2 fecal coliforms or less per 100 ml. At Monroe Reservoir the values ranged from62 to 84 per 100 ml. At Atwood, the highest value was 18 per 100 ml. All other beaches exhibited very high quality bathing water based on the fecal coliform standard.

The effect of high water temperatures (generally in the 79° to 83° F range) and of nutrients in the reservoirs is shown by the very high total coliform levels in Cagles Mill and Atwood waters. Many of these samples had over 1000 total coliforms per 100 ml, with one over 5,000 per 100 ml at Cagles Mill. Because of the correspondingly low fecal coliform levels of these samples, the total coliform values appear to be of little sanitary significance, and it illustrates why the use of total coliforms as bathing beach indicators should be discouraged.

Beach Hazards

The location, construction and operation of beaches should be better controlled for the sake of safety and sanitation. Specific problems noted were:

1. Several beaches had a concrete apron along the shore that extended well out into the water. Erosion of the bottom had left a rough cutting edge at the point where the concrete terminated under water, presenting a hazard to the feet.

2. Other beaches accumulated natural and man-made debris and pollution by virtue of their location with respect to influent stream or waste sources.

3. Several beaches were too steep, presenting a hazard, particularly to the child who is a poor swimmer.

4. Most beaches were inadequately roped or marked to separate the shallowwater from deep water or to exclude boating activities from the bathing area.

Recreational Area Sanitation

Facilities

Sanitation facilities were generally adequate in most areas. A notable exception was the quality and maintenance of privies. Several areas contained pit privies that should be replaced with sanitary constructed vault privies, or better. Fly and odor problems were obnoxious around most vault privies not receiving adequate daily care. Vault privies already installed should receive daily care in order to present an acceptable aesthetic and sanitary condition.

Grounds Maintenance

Recreational grounds should be maintained in a clean and well-cut fashion. Grounds maintenance in fee areas was generally good. This was not true, however, for free access areas. The weeds, high grass and debris noted in these recreational areas not only detracted from the areas esthetically but also promoted insect, poison ivy and rodent problems. Operational and health authorities should give more attention to the problems summarized above as well as other related aesthetic and sanitary problems in recreational areas.

TABLE 3
BACTERIOLOGICAL RESULTS
OF SWIMMING BEACH WATERS

	Name of Beach	Depth 1/	Total Coliform 2/	Fecal Coliform 2/	Fecal Strep 2/
ATWOOD	Northshore Beach #1	3	800	8	27
		6	650	6	39
	Northshore Beach #2	3	350	2	27
		6	800	0	18
	Northshore Beach #3	3	650	0	12
		6	1600	2	39
	Atwood Glens Beach # 1	3	950	0	3
		6	1050	2	9
	Atwood Glens Beach #2	3	1250	0	2
		6	1050	0	66
	Atwood Glens Beach #3	3	1200	0	27
		6	1900	0	12
	Atwood Village Beach	3	1350	0	190
		6	1600	2	27
	Lodge Beach	3	1450	6	18
		6	1500	6	120
	Atwood Park Beach	3	1400	18	72
		6	1100	8	33
BURR OAK	Main Public Beach	3	110	38	240
		6	145	46	310
	Long Beach	3	15	0	116
		6	20	0	104
CLENDENING	Clendening Beach	3	940	4	48
		6	1050	2	42
DILLON	Dillon Beach	3	800	4	4
		6	1400	0	18
LEESVILLE	Leesville Beach	3	350	12	0
		6	1100	8	0
MANSFIELD	Raccoon State Park Beach	3	860	310	240
		6	180	120	140
MONROE	Fairfax Beach	3	300	6	98
		6	500	2	30
	Paynetown Beach	3	660	84	520
		6	560	56	280
	Sycamore Flats Beach	3	300	20	210
		6	280	22	50
	Buehler (Boy Scout) Beach	3	340	12	224
		6	80	14	96
HUNTINGTON	Huntington Beach	3	2	1	0
		6	4	0	0
SALAMONIE	Lost Bridge West Beach	3	4	1	2
		6	14	5	2
CAGLES MILL	Hulman Beach	3	5300	44	16
		6	550	6	4
	Cataract Yachr Club Beach	3	700	0	0
		6	110	0	0
	Croy Crest Beach	3	2300	10	20
		6	2100	4	8
	Lakeshore Hills Beach	3	2500	2	8
		6	950	0	12
	Forest Cave Beach	3	1900	10	36

(continued)

TABLE 3
BACTERIOLOGICAL RESULTS
OF SWIMMING BEACH WATERS

CAGLES MILL (cont'd)

Name of Beach	Depth 1/	Total Coliform 2/	Fecal Coliform 2/	Fecal Strep 2/
Allmeyer Highland Lake Beach	3	400	0	0
	6	800	6	4
Hidden HollowBeach	3	4100	28	124
	6	2900	24	280
Indiana Gear Works Beach	3	550	20	44
	6	20	0	24
Shrine Club Beach	3	10	2	20
Hawks Lake Beach	3	2250	2	52

[1	Depth in feet at which sampled was collected
[2	Number of organisms per 100 ml of sample - membrane filter test