STATE OF ILLINOIS
DEPARTMENT OF REGISTRATION AND EDUCATION

DIVISION OF THE

STATE WATER SURVEY

EDWARD BARTOW, Chief

BULLETIN NO. 15

CHEMICAL AND BIOLOGICAL SURVEY OF THE WATERS OF ILLINOIS

REPORT FOR YEAR ENDING DECEMBER 31, 1917

[Printed by authority of the State of Illinois.]

URBANA, ILLINOIS

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[1] With the American Expeditionary Forces in France. [2] In charge of chemical work from October. [3] Acting chief from October. [4] Services terminated with changes in organization of the State Government, June 30. [5] To February. [6] To September. [7] To July. [8] From November. [9] To December. [10] To June. [11] To November. [12] Summer assistant. [13] Part time. [14] From August. [15] To August. [16] To October.

LETTER OF TRANSMITTAL.

STATE OF ILLINOIS,
DEPARTMENT OF REGISTRATION AND EDUCATION,
STATE WATER SURVEY DIVISION.

URBANA, ILLINOIS, *February 11, 1919.*

Francis W. Shepardson, Chairman, and Members of the Board of Natural Resources and Conservation Advisors.

GENTLEMEN: Edward Bartow, Chief, is serving as Lieutenant-Colonel in the Sanitary Corps with the American Expeditionary Forces in France. In his absence I herewith submit a report of the work of the State Water Survey Division for the year ending December 31, 1917, and request that it be printed as Bulletin No. 15.

Respectfully submitted,

G. C. HABERMEYER, *Acting Chief.*

STATE OF ILLINOIS.

DEPARTMENT OF REGISTRATION AND EDUCATION.

Francis W. Shepardson, Director.

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JOHN W. ALVORD.

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GENERAL REPORT.

ADMINISTRATION.

At a meeting of the Board of Trustees of the University of Illinois held in 1895 it was resolved that the Professor of Chemistry proceed to make a systematic survey of the waters of the State and accordingly work on such survey was begun in September of that year. By authority of the Fortieth General Assembly of Illinois, the Board of Trustees of the University of Illinois in 1897 created the Illinois State Water Survey and made-it-.a.-division of the Department of Chemistry. The Forty-seventh General Assembly in 1911 authorized-and instructed the State Water Survey "* * * to visit municipal water supplies and to inspect watersheds, to make such field studies and to collect such samples as are necessary, to analyze and test samples and to make any investigations to the end that a pure and adequate public water supply for domestic and manufacturing purposes may be maintained in each municipality . * * *."

In 1917 the Fiftieth General Assembly enacted The Civil Administrative Code of Illinois. It repeals "An Act to establish a chemical survey of the waters of the State of Illinois" and "An Act imposing new and additional duties upon the State Water Survey. * * *." Nine departments of the State government and advisory and non-executive boards were created including the Department of Eegistration and Education and a Board of Natural Eesources and Conservation Advisors in this department. The State Water Survey Division of the Department of Eegistration and Education was created in accordance with provisions of the act. Cooperating with other divisions of the department, the State Water Survey Division is to investigate and study the natural resources of the State and to prepare plans for the conservation and development of the natural resources; to cooperate with and advise departments having administrative powers and duties relating to the natural resources of the State and to cooperate with similar departments in other states and with the United States Government; to study the geological formation of the State with reference to its resources in mineral and artesian water; to collect facts and data concerning the water resources of the State; to determine standards of purity of drinking water for the various sections of the State; to publish, from time to time, the results of its investigations of the waters of the State to the end that the available water resources of the State may be better known and that the welfare of the people in the various communities may be conserved; to make analyses of samples of water from municipal or private sources; to distribute, in its discretion, to the various educational institutions of the State specimens, samples and materials collected by it after the same have served the purposes of the department; to consider and decide all matters pertaining to water and water resources and allied research, investigational and scientific research; to cooperate with the University of Illinois in the use of scientific staff and equipment and to cooperate with the various departments in research, investigational and scientific work useful in the prosecution of the work of any department.

During 1917 to July 1 the laboratory and field work of the State Water Survey was continued along lines inaugurated late in 1911 and described in Bulletins 9 to 14. Since July 1 a gradual change in the work has been made in accordance with change in duties as outlined above.

There were many changes on the staff during the year. Edward Bartow, Chief, was given leave of absence to serve as Major in the Sanitary Corps with the American Expeditionary Forces in Prance. Arthur Norton Bennett, Harry Poster Ferguson and Philip Dorset Jenks wore commissioned lieutenants. The services of Samuel Wilson Parr as consulting chemist and Arthur Newell Talbot as consulting engineer were terminated on July 1 by changes in the organization of the State government. Other changes are noted on page 5.

Instruction in the analysis and purification of waters and sewage has been given by members of the Water Survey staff. There is one course for undergraduates, Chemistry 10 and one course for graduates, Chemistry 110. Graduates and undergraduates registered in Chemistry 11 or Chemistry 111 may prepare theses on subjects connected with the chemistry of water and sewage. Many of the theses thus prepared have been published in the scientific and technical press and in bulletins of the State Water Survey. During the year, rooms formerly occupied as laboratories have been remodeled for instructional work in the chemistry of water and sewage.

LABORATORY WORK.

During 1917, 2,131 samples of water were examined at the direct request of private citizens or local officials and 460 samples were collected by or under the direction of members of the staff. From the time of its foundation in September, 1895, to December 31, 1917, 38,725 samples of water have been received. The number collected from various sources for each month of the year and the total number collected since the foundation of the Survey is given in Table 1.

TABLE 1.—NUMBER OF WATER SAMPLES EXAMINED DURING EACH MONTH OF THE TEAR 1917, AND TOTAL TO DATE, CLASSIFIED BY SOURCE.

Samples by request.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total for year 1917.	Total Oct. 1895, to Dec. 31, 1917.
Surface waters, rivers, lakes and ponds	56	44	52	51	67	40	64	53	48	68	55	47	645	6,337
Springs	2	1	4	1	3	....	5	1	1	1	1	....	20	836
Cisterns	6	1	....	2	9	3	4	8	9	2	5	3	52	497
Natural ice	2	1	3	1	....	4	....	....	....	....	....	....	11	174
Artificial ice	....	....	2	....	....	....	....	....	....	....	....	....	2	35
Water for artificial ice	....	....	....	....	....	....	....	....	....	....	....	....	....	21
Water for natural ice	....	....	....	....	....	....	....	....	....	....	....	....	....	21
Mine water	....	....	....	....	....	....	....	....	....	....	....	....	....	35
Shallow wells in rock	....	....	....	2	....	....	....	....	....	....	....	....	2	478
Deep wells in rock	23	30	20	24	14	20	17	16	18	18	19	10	229	3,200
Flowing wells in rock	....	....	....	....	....	....	....	....	....	....	....	....	....	243
Shallow wells in drift	53	33	38	53	51	58	72	57	76	73	41	16	621	9,374
Deep wells in drift	19	15	13	5	13	13	21	13	22	16	8	23	181	2,248
Flowing wells in drift	....	....	....	....	....	....	....	....	....	....	....	....	....	164
Sewage	1	....	....	....	....	....	....	....	....	2	5	....	8	232
Distilled water	....	....	....	....	....	....	....	....	....	2	....	....	2	22
Miscellaneous	1	4	3	3	1	2	7	3	1	6	6	3	40	114
Swimming pools	6	6	3	22	21	24	17	19	23	36	28	14	219	282
Unknown	3	5	7	12	11	....	5	4	2	18	10	22	99	233
Total	172	140	145	176	190	164	212	174	200	242	178	138	2,131	24,546

MADE ON INITIATIVE OF WATER SURVEY.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total for year 1917.	Total Oct. 1895, to Dec. 31, 1917.
Surface waters, rivers, lakes and ponds	2	....	....	....	....	9	13	6	9	9	....	2	50	......
Springs	....	....	....	....	1	....	1	1	2	....	....	2	7	......
Mine water	....	....	....	2	....	....	....	....	....	....	....	....	2	......
Shallow wells in rock	....	1	....	....	....	....	....	....	2	2	....	....	5	......
Deep wells in rock	....	....	....	....	1	8	19	11	8	16	7	....	70	......
Shallow wells in drift	1	....	....	7	1	7	14	14	5	1	3	....	52	......
Deep wells in drift	....	2	13	....	6	14	11	10	6	7	7	....	77	......
Sewage	....	....	....	....	....	....	3	....	....	....	1	4	8	......
Distilled water	....	....	....	....	....	....	....	....	....	2	....	....	2	......
Miscellaneous	1	5	1	....	....	3	....	2	1	....	....	....	13	......
Swimming pool	18	19	36	27	5	....	10	....	2	1	....	....	168	......
Unknown	....	2	....	....	....	....	1	3	....	....	....	....	6	......
Total	22	29	100	36	14	41	72	47	35	38	18	8	460	14,179
Grand total of samples by request and those on initiative of Water Survey	193	169	245	212	204	205	284	221	235	280	196	148	2,591	38,725

As the greater part of the State is covered by from 50 to 300 feet of glacial drift, the greatest number of samples has been taken from wells in drift. Satisfactory water can be obtained from the deep wells in rock in the northern part of the State and from deep wells in drift in the east central part of the State.

Well waters sent to the Survey for examination from 1907 to 1917 have been classified according to the depth of the wells. The percentage from each depth which has been condemned is given in Table 2.

TABLE 2.—PERCENTAGE OF WELL WATERS CONDEMNED BY THE WATER SURVEY, CLASSIFIED BY DEPTH, 1907-1917.

	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	Total.
DEPTH LESS THAN 25 FEET.												
Number examined....	284	254	242	148	113	168	230	235	269	391	262	2,596
Number condemned....	240	192	183	118	74	113	155	189	176	291	145	1,876
Percentage condemned.	85	75	75	79	65	67	67	81	65	74	55	72
DEPTH 25 TO 50 FEET.												
Number examined....	224	395	354	201	196	353	262	331	391	544	326	3,577
Number condemned......	173	250	226	137	122	185	166	206	236	343	172	2,216
Percentage condemned.	77	63	63	65	62	52	63	62	60	63	52	61
DEPTH 50 TO 100 FEET.												
Number examined....	111	192	161	90	89	129	164	158	239	270	208	1,811
Number condemned...	42	66	54	46	S	28	54	47	80	149	64	638
Percentage condemned.	37	34	53	51	9	22	33	29	33	55	31	35
DEPTH MORE THAN 100 FEET.												
Number examined	161	312	376	205	171	339	603	633	428	229	428	3,855
Number condemned.......	22	31	62	43	30	49	59	51	65	46	86	544
Percentage condemned.	13	9	16	20	17	14	10	8	15	20	20	14
DEPTH UNKNOWN.												
Number examined........	88	46	72	67	19	27	83	65	66	103	86	709
Number condemned...	34	22	38	35	9	6	21	24	29	66	41	325
Percentage condemned.	3S	47	65	52	47	22	25	37	44	64	47	45
TOTAL												
Number examined....	868	1,199	1,205	711	588	1,016	1,342	1,422	1,393	1,537	1,310	12,591
Number condemned...	511	561	563	379	243	381	455	517	586	895	508	5,599
Percentage condemned.	60	46	47	53	41	38	34	36	42	58	38	44

The number condemned decreases as the depth of the wells increases. During the eleven years mentioned 72 per cent of the samples from wells less than 25 feet deep were condemned, whereas only 15 per cent of those from wells more than 100 feet deep were condemned. Many samples of water from the deepest wells were condemned not because of contamination but rather because of excessive mineral content. As ordinarily constructed the chances for contamination from the top and upper part of a well are much less with drilled than with dug wells. Of all well waters 44 per cent were condemned. About two-thirds of the waters from dug wells and one-fifth of the waters from drilled wells were condemned. The character of the well waters examined is not representative of all well waters from the State, as by far the greater number of samples are sent in because of suspected contamination.

FIELD INVESTIGATIONS

During the past year investigations were made of. the water supplies of 118 municipalities listed in Table 3.

TABLE 3.—PLACES VISITED FOE INVESTIGATION OF WATER SUPPLIES OH PROPOSED WATER SUPPLIES.

Albion.	Coal City.	Johnston City.	Paxton.
Altamont.	Colfax.	Jonesboro.	Pecatonica.
Alton.	Compton.	Kincaid.	Piper City.
Anna.	Crystal Lake.	Kirkwood.	Plainfield.
Area.	Cuba.	LaRose.	Piano.
Assumption.	Desplaines.	Leonore.	Princeville.
Astoria.	Dundee.	LeRoy.	Rantoul.
Aurora.	Earlville.	Lewistown.	Roseville.
Beecher.	East Dundee.	Lexington.	Salem.
Belleville.	East St. Louis.	Libertyville.	Shawneetown.
Bement.	Elburn.	Lincoln.	Shermerville.
Benld.	Eldorado.	Little York.	Sparta.
Blue Mound.	Elgin.	Lovington.	Springfield.
Bourbonnais.	Elmwood.	Low Point.	Standard.
Braceville.	El Paso.	Malta.	Steward.
Bradford.	Fairbury.	Manhattan.	Stonington.
Braidwood.	Fairfield.	Marion.	Stronghurst.
Breese.	Farmer City.	Metropolis.	Sublette.
Brookport.	Flanagan.	Milford.	Taylorville.
Bunker Hill.	Gillespie.	Murphysboro.	Toluca.
Cairo.	Girard.	Mounds.	Vandalia.
Camp Grant.	Glencoe.	Minonk.	Virden.
Canton.	Grand Park.	Mound City.	Westville.
Carbondale.	Greenville.	Monticello.	Wheaton.
Carpentersville.	Gross Point.	Niles Center.	Wilmington.
Carrollton.	Hennepin.	O'Fallon.	Winnetka.
Centralia.	Hillsboro.	Oglesby.	Winslow.
Chenoa.	Huntley.	Onarga.	Yorkville.
Chicago Heights.	Ipava.	Oswego.	
Clinton.	Jacksonville.	Palatine.	

The possibilities of securing adequate water supplies for cantonments, aviation fields, and for an armor plate plant were investigated at various localities. The results of these investigations were reported to waterworks and other interested officials. The water resources at Scott Field, an aviation field near Belleville, were investigated and recommendations were made for securing a permanent supply. A chlorine control apparatus was installed at Camp Grant and the water supply was chlorinated under supervision of members of the staff until government officials arrived to take charge.

An extended investigation of water resources in the vicinity of Jacksonville was made in cooperation with the State Department of Public Health and the State Geological Survey Division of the Department of Eegistration and Education. As many State institutions are located at Jacksonville, the State is especially interested in the development of an adequate water supply. An abstract of information secured is given on page 57. A report on possible sources of supply will be presented early in 1918.

The microscopical survey of streams and impounded waters used for public water supplies begun in 1916 was continued. Surveys were made at Benton, Breese, Carlyle, Christopher, Danville, Freeburg, Harrisburg, Herrin, Johnston City, Kankakee, Louisville, Murphysboro, New Athens, Newton, Olney, Pontiac, Salem, Sparta, Streator and Tiskilwa.

Investigations of stream pollution were made at Urbana where Salt Fork is polluted by sewage from Champaign and Urbana, at Eantoul where Upper Salt Pork is polluted by sewage from Chanute Field, at Flora where a stream is polluted by sewage containing large quantities of salt, and at Chicago Heights where sewage from the city and wastes from factories pollute a stream.

The work from 1912 to 1917 is briefly summarized in Table 4.

TABLE 4.—FIELD INVESTIGATIONS, CONFERENCES, INSPECTIONS, AND REPORTS PREPARED, 1912-1917.

Nature of work.	1912	1913	1914	1915	1916	1917	Total.
Inspections of public water supplies	60	101	101	117	52	115	546
Conferences concerning the installation and extension of public water supplies	1	59	34	19	20	32	165
Inspections of sewer systems	25	28	34	20	4	5	116
Conferences concerning proposed sewer systems	3	24	8	11	2	1	49
Special investigations	18	41	26	25	18	26	154
Reports prepared on public water supplies	60	85	82	96	46	94	463
Reports prepared on proposed water supplies and extensions	19	34	28	18	20	8	127
Reports prepared on sewer systems	11	6	22	17	4	7	67
Reports prepared on proposed sewer systems	14	10	5	11	2	......	42

There are 433 municipalities in the State with public water supplies. These municipalities with the source of supply and data in regard to treatment are given in Table 5 and are shown on the insert map. The municipalities supplied include 296 or 81 per cent of those with more than 1,000 population and 137 or 19 per cent of those with less than 1,000 population. Of these municipalities 189 are sup-


PUBLIC
WATER SUPPLIES
IN
ILLINOIS
1917
Stream
Spring
Drift Well
Rock Well
Purified
JO DAVIESS
STEPHENSON
WINNEBAGO
BOONE
McHENRY
LAKE
CARROLL
OGLE
DE KALB
KANE
DU PAGE
COOK
WHITESIDE
LEE
ROCK ISLAND
HENRY
BUREAU
LA SALLE
KENDALL
WILL
MERCER
PUTNAM
GRUNDY
KANKAKEE
HENDERSON
WARREN
KNOX
STARK
MARSHALL
LIVINGSTON
PEORIA
WOODFORD
IROQUOIS
HANCOCK
McDONOUGH
FULTON
TAZEWELL
McLEAN
FORD
MASON
SCHUYLER
DE WITT
LOGAN
VERMILION
CHAMPAIGN
ADAMS
BROWN
CASS
MENARD
PIATT
MACON
SANGAMON
MORGAN
DOUGLAS
EDGAR
SCOTT
PIKE
MOULTRIE
COLES
CHRISTIAN
SHELBY
GREENE
CALHOUN
MACOUPIN
MONTGOMERY
CUMBERLAND
CLARK
JERSEY
FAYETTE
EFFINGHAM
JASPER
CRAWFORD
BOND
MADISON
CLAY
RICHLAND
LAWRENCE
MARION
CLINTON
ST CLAIR
WABASH
WAYNE
EDWARDS
WASHINGTON
MONROE
JEFFERSON
HAMILTON
RANDOLPH
PERRY
FRANKLIN
WHITE
JACKSON
WILLIAMSON
SALINE
GALLATIN
UNION
JOHNSON
POPE
HARDIN
ALEXANDER
PULASKI
MASSAC

plied with water from rock wells, 145 with water from wells in drift, 10 with water from springs, 67 with water from streams and 22 with water from Lake Michigan. Twenty-six supplies from streams serving 35 communities and 2 supplies from Lake Michigan serving 5 communities are filtered for purification. The stream supply of Breese is treated by coagulation and sedimentation. The ground water supplies of Champaign-Urbana, Freeport and Hinsdale are treated for iron removal and the well supply from Hinsdale is also softened.

Public supplies of communities not incorporated are not given. There may be some installations or changes in supply of which we have no record.

TABLE 5.—PUBLIC WATER SUPPLIES IN ILLINOIS.

Privately owned supplies are indicated by the letter P.

Municipality.	Source of supply.	Treatment.
Abingdon	Wells in rock—1,350 feet deep	
Aledo	Wells in rock—1,450 feet deep	
Alexis	Wells in rock—1,204 feet deep	
Algonquin	Spring	
Alpha	Well in rock—1,480 feet deep	
Altamont	Wells in rock—131, 145 and 225 feet deep	
Alton—P	Stream—Mississippi River	Filtration and chlorination.
Amboy	Well in rock—2,400 feet deep	
Anna	Wells in rock—650 feet deep	
Antioch	Well in drift—220 feet deep	
Arcola	Wells in drift—100 feet deep	
Area	Well in rock—243 feet deep	
Arlington Heights	Wells in rock—140 feet deep	
Arthur	Wells in drift—75 feet deep	
Ashton	Well in rock—545 feet deep	
Assumption	Wells in drift—18½ feet deep	
Astoria	Well in rock—1,658 feet deep	
Atkinson	Well in rock—1,120 feet deep	
Atlanta	Wells in drift—151 feet deep	
Aurora	Wells in rock—2,000-2,330 feet deep	
Averyville	From Peoria—wells in drift	
Avon—P	Stream	
Barrington	Well in rock—305 feet deep	
Barry	Well in rock—2,510 feet deep	
Bartonville	From Peoria—wells in drift	
Batavia	Well in rock—1,270 feet deep	
Beardstown	Wells in drift—100 and 40 feet deep	
Beecher	Well in rock—164 feet deep	
Belleville—P	From East St. Louis—Stream	Filtration and chlorination
Bellwood	Well in rock—1,538 feet deep	
Belvidere	Wells in rock—1,803 and 1,861 feet deep	
Bement	Wells in drift—137 to 140 feet deep	
Benson	Well in drift—80 feet deep	
Benton—P	Stream	
Berwyn	Part of Chicago—lake	Chlorination.
	Wells in rock	
Bloomington	Wells in drift—60 and 80 feet deep	
Blue Island	Wells in rock	Chlorination.
	Part from Chicago—lake	
Blue Mound	Well in drift—55 feet deep	
Bourbonnais	Well in rock—181 feet deep	
Braceville	Well in drift—30 feet deep	
Bradford	Well in rock—2,050 feet deep	
Bradley	Well in rock—332 feet deep	
Bradley—P	Part from Kankakee—stream	Filtration and chlorination.
Braidwood	Wells in drift—12 feet deep	
Breese	Stream	Coagulation and sedimentation.
Bridgeport	From Lawrenceville—stream	Filtration and chlorination.

TABLE 5.—Continued.

Municipality.	Source of supply.	Treatment.
Brookfield	From LaGrange—wells in rock	
Brooklyn—P	From East St. Louis—stream	Filtration and chlorination.
Brookport	Well in drift—226 feet deep	
Buckley	Wells in drift—147 feet deep	
Buda	Well in rock—1,612 feet deep	
Bureau	Wells in rock—305 feet deep	
Burnham	From Chicago—lake	Chlorination.
Bushnell	Well in rock—1,352 feet deep	
Byron	Well in rock—2,000 feet deep	
Cairo—P	Stream—Ohio River	Filtration and chlorination.
Cambridge	Well in rock—1,380 feet deep	
Campus	Well in drift—130 feet deep	
Canton	Wells in rock—1,646 to 2,012 feet deep	
Capron	Well in rock—650 feet deep	
Carbon Hill	Well in rock—1,900 feet deep	
Carbondale—P	Wells in rock—410 and 640 feet deep	
Carlinville—P	Stream—Macoupin Creek	Filtration.
Carlyle	Stream—Kaskaskia River	
Carmi	Stream—Little Wabash River	
Carpentersville	Well in drift—17 feet deep	
Carrollton	Spring	
Carthage	Wells in rock—1,000 feet deep	
Cary	Well in rock—300 feet deep	
Casey	Wells in drift—90 and 131 feet deep	
Cedar Point—P	Well in rock—1,750 feet deep	
Central City	From Centralia—stream	
Centralia	Stream—Martin's Branch	
Cerro Gordo	Wells in drift—150 feet deep	
Chadwick	Well in rock—600 feet deep	
Champaign—P	Wells in drift—160 feet deep	Filtration for iron removal.
Charleston	Stream—Embarass River	Filtration (not in use).
Chatsworth	Well in rock—1,285 feet deep	
Chenoa	Well in rock—2,035 feet deep	
Cherry	Well in drift—98 feet deep	
Chester—P	Stream—Mississippi River	
Chicago	Lake Michigan	Chlorination.
Chicago Heights	Wells in rock—200 feet deep	
Chillicothe—P	Wells in drift—100 feet deep	
Chrisman	Well in drift—135 feet deep	
Christopher	Stream	
Cicero	From Chicago—lake	Chlorination.
Cisna Park	Wells in drift—150 and 237 feet deep	
Clinton	Wells in drift—341 feet deep	
Coal City	Well in rock—350 feet deep	
Colfax	Wells in drift—105 feet deep	
Collinsville	Wells in drift—70 and 90 feet deep	
Compton	Wells in drift—335 feet deep	
Crescent City	Well in drift—120 feet deep	
Creston	Well in rock—582 feet deep	
Crete	Well in rock—192 feet deep	
Crystal Lake	Well in drift—32 feet deep	
Cuba	Well in rock—1,768 feet deep	
Cullom	Well in rock—1,470 feet deep	
Danvers	Wells in drift—218 feet deep	
Danville—P	Stream—Vermilion River	Filtration and chlorination.
Decatur	Stream—Sangamon River	Filtration and chlorination.
Deer Creek	Well—267 feet deep	
Deerfield	From Highland Park—lake	Chlorination.
DeKalb	Wells in rock—800 and 1,300 feet deep	
Delavan	Wells in drift—140 feet deep	
Depue	Well in rock—1,278 feet deep	
DesPlaines	Well in drift—112 feet deep	
Dixon—P	Wells in rock—1,637 feet and 1,810 feet deep	
Dolton	From Chicago—lake	Chlorination.
Downers Grove	Wells in rock—240 and 2,250 feet deep	
DuQuoin—P	Well in rock (mine shaft)—60 feet deep	
Dwight	Wells in drift—136 feet deep	
Earlville	Wells in rock—150 and 625 feet deep	
East Dubuque	Well in rock—940 feet deep	
East Dundee	Spring	
East Moline	Wells in rock—1,300 and 2,000 feet deep	
East Peoria	Wells in drift—25 feet deep	
East St. Louis—P	Stream—Mississippi River	Filtration and chlorination.
East Wenona	From Wenona—well in rock	
East Alton	Wells in drift—60 feet deep	
Edison Park	From Chicago—lake	Chlorination.

TABLE 5.—Continued.

Municipality.	Source of supply.	Treatment.
Edwardsville—P.	Wells in drift—55 and 80 feet deep	
Effingham—P	Stream—Little Wabash River	Filtration and chlorination.
Eileen	Well in rock	
El Paso	Well in drift—60 feet deep	
Elburn	Well in rock—1,450 feet deep	
Elgin	Wells in rock—38, 1,300 and 2,000 feet deep	
Elmhurst—P	Spring	
	Well in rock	
Elmwood	Well in rock—1,487 feet deep	
Eureka	Wells in drift—90 feet deep	
Evanston	Lake Michigan	Filtration.
Fairbury	Well in rock—2,000 feet deep	
Fairfield	Stream	
Farmer City	Wells in drift—176 feet deep	
Farmington	Well in rock—1,461 feet deep	
Flanagan	Well in drift—170 feet deep	
Flora	Wells in rock—240 feet deep	
Forest Park	Wells in rock—2,000 and 1,650 feet deep	
Forrest	Wells in drift—mine shaft 80 feet deep	
Forreston	Well in rock—300 feet deep	
Freeburg	Stream	
Freeport—P	Wells in drift—35 to 45 feet deep	Filtration for iron removal.
Fulton	Wells in rock—1,246 and 1,500 feet deep	
Galena—P	Well in rock—1,530 feet deep	
Galesburg	Wells in drift 70 feet deep	
	Well in rock—1,226 feet deep	Chlorination.
Galva	Wells in rock—1,500 and 1,535 feet deep	
Geneseo	Spring	
Geneva	Well in rock—1,000 feet deep	
Genoa	Well in rock—1,500 feet deep	
Gibson City	Wells in drift—55 feet deep	
Gilman	Wells in drift—120 feet deep	
Glasford	Well in rock—1,685 feet deep	
Glen Ellyn	Well in rock—310 feet deep	
Glen View	Well in rock—1,251 feet deep	
Glencoe	From Winnetka—lake	Chlorination.
Grand Ridge	Well in drift—160 feet deep	
Granite City—P	From East St. Louis—stream	Filtration and chlorination.
	A Granite City plant for emergency	
Grant Park	Well in rock—147 feet deep	
Granville	Well in rock—1,742 feet deep	
Grayslake	Well in rock—1,200 feet deep	
Grayville	Stream—Wabash River	
Greenup	Stream—Embarrass River	
Greenview	Well in drift—80 feet deep	
Greenville	Wells in drift—50 feet deep	
Gross Point	From Wilmette—lake	Filtration.
Hamilton	Stream—Mississippi River	Filtration.
Harmon	Well in rock—532 feet deep	
Harrisburg—P	Stream—Saline River	Filtration and chlorination.
Harvard	Wells in rock—1,600 and 742 feet deep	
Harvey—P	Wells in rock—1,600 feet deep	
	Part from Chicago—lake	
Havana	Wells in drift—72 feet deep	
Hebron	Well in drift—160 feet deep	
Hennepin	Well in rock—800 feet deep	
Henry	Wells in drift—40 feet deep	
Herrin	Stream	Filtration and chlorination.
Highland Park	Lake Michigan	Chlorination.
Highwood	From Highland Park—lake	Chlorination.
Hillsboro	Stream—Shoal Creek	
Hinckley	Well in rock—350 feet deep	
Hinsdale	Well in rock—200 feet deep	Softening and iron removal.
Homewood	Well in rock—250 feet deep	
Hoopestown	Wells in drift—360 and 118 feet deep	
Huntley	Wells in drift—69 to 74 feet deep	
Ipava	Well in rock—1,324 feet deep	
Jacksonville	Stream—Mauvaise Terre Creek	
	Wells in drift—58 to 74 feet deep	
Jerseyville	Wells in rock—2,008 and 1,542 feet deep	
Johnston City—P	Stream	
Joliet	Wells in rock—1,200 and 1,700 feet deep	
	Wells in drift—98 and 117 feet deep	
Kankakee—P	Stream—Kankakee River	Filtration and chlorination.
Kansas	Well in drift—80 feet deep	
Keithsburg	Wells in drift—30 to 50 feet deep	

TABLE 5.—Continued.

Municipality.	Source of supply.	Treatment.
Kempton	Well in rock—404 feet deep	
Kenilworth	Lake Michigan	Filtration and chlorination.
Kewanee	Wells in rock—1,460 feet deep	
Kirkwood	Well in rock—127 feet deep	
Knoxville	Well in rock—1,350 feet deep	
LaGrange—P	Wells in rock—2,000 feet deep	
LaGrange—P	From LaGrange—wells in rock	
LaHarpe	Wells in drift—55 feet deep	
Lacon	Wells in drift—60 feet deep	
Ladd	Well in drift—187 feet deep	
Lake Bluff	Wells in rock—300 and 700 feet deep	
Lake Forest—P	Lake Michigan	Filtration and chlorination.
Lake Zurich	Well in drift—218 feet deep	
Lanark	Well in rock—600 feet deep	
LaSalle	Wells in drift—39 feet deep	
Lawrenceville—P	Steam—Embarrass River	Filtration and chlorination.
Lee	Well in drift—335 feet deep	
Leland	Well in rock—230 feet deep	
Lemont	Wells in rock—2,200 and 1,000 feet deep	
Lena	Well in rock—600 feet deep	
Leonore	Well in drift—34 feet deep	
Leroy	Wells in drift—90 feet deep	
Lewistown	Well in drift—25 feet deep	
Lexington	Wells in drift—115 feet deep	
Libertyville	Wells in drift—170 and 180 feet deep	
Lincoln—P	Wells in drift—10 and 20 feet deep	
Litchfield—P	Stream—Shoal Creek	
Little York	Well in drift—400 feet deep	
Lockport	Well in rock—1,650 feet deep	
Lombard	Well in rock—93 feet deep	
London Mills	Stream—Spoon River	
Lostant	Well in drift—70 feet deep	
Louisville	Stream	
Lovington	Wells in drift—147 feet deep	
Low Point	Well in drift—51 feet deep	
Lyons	Well in rock—1,600 feet deep	
McHenry	Well in drift—71 feet deep	
McLeansboro	Stream—Saline River	Filtration.
Mackinaw	Wells in rock—170 feet deep	
Macomb	Stream—Crooked Creek	Filtration and chlorination.
Madison—P	From East St. Louis—stream	Filtration and chlorination.
Malta	Well in rock—855 feet deep	
Manhattan	Well in rock—105 feet deep	
Manteno	Wells in rock—60, 310 and 426 feet deep	
Maple Park	Well in drift—250 feet deep	
Marengo	Wells in drift—14 feet deep	
Marion—P	Wells in rock—700 to 960 feet deep	
Mark	From Granville—well in rock	
Maroa	Wells in drift—85 feet deep	
Marseilles—P	Wells in rock—600 and 800 feet deep	
Marshall	Wells in drift—43 and 55 feet deep	
Mascoutah	Wells in drift—35 and 40 feet deep	
Mason City	Wells in drift—200 feet deep	
Matteson	Well in rock—288 feet deep	
Mattoon—P	Wells in drift—80 feet deep	
	Stream	
Maywood	Wells in rock—2,200 and 1,600 feet deep	
Melrose Park	Wells in rock—1,620 feet deep	
Melvin	Well in drift—231 feet deep	
Mendota	Wells in rock—400 and 480 feet deep	
Metamora	Well in drift—85 feet deep	
Metropolis	Well in drift—125 feet deep	
Milan	Well in rock—1,157 feet deep	
Milford	Wells in drift—65 feet deep	
Milledgeville	Wells in rock 250 and 300 feet deep	
Minier	Well in drift—143 feet deep	
Minonk	Well in rock—1,850 feet deep	
Minooka	Well in rock—620 feet deep	
Mokena	Well in drift—139 feet deep	
Moline	Stream—Mississippi River	Filtration and chlorination.
Momence	Wells in rock—85 and 135 feet deep	
Monee	Wells in rock—166 feet deep	
Monmouth	Wells in rock—1,222 feet deep	
Monticello	Wells in drift—212 and 309 feet deep	
Morgan Park	From Chicago—lake	Chlorination.
Morris	Wells in rock—550 and 800 feet deep	

TABLE 5.—Continued.

Municipality.	Source of supply.	Treatment.
Morrison	Well in rock—2,048 feet deep	
Morrisonville	Wells in drift—35 feet deep	
Morton	Wells in drift—230 feet deep	
Morton Grove	Well in rock—1,468 feet deep	
Mound City—P	Well in rock—750 feet deep	
Mounds	Wells in rock—650 feet deep	
Mt. Carmel—P	Stream—Wabash River	Filtration and chlorination.
Mt. Carroll	Well in rock—2,500 feet deep Well in drift—100 feet deep	
Mt. Morris	Well in rock—500 feet deep	
Mt. Olive	Stream—Cahokia River	
Mt. Pulaski	Wells in drift—31 to 52 feet deep	
Mt. Sterling	Well in rock—2,235 feet deep	
Mt. Vernon—P	Stream—Casey Fork	Filtration.
Moweaqua	Wells in drift—56 feet deep	
Murphysboro—P	Stream Big Muddy River	Filtration.
Naperville	Wells in rock—700 and 1,375 feet deep	
National City—P	From East St. Louis—stream	Filtration and chlorination.
Nauvoo—P	Stream—Mississippi River	
Neoga	Well in drift—16 feet deep	
New Athens	Stream—Kaskaskia River	
Newton	Stream—Embarrass River	
Niles Center	Well in rock—1,440 feet deep	
Nokomis	Wells in drift—42 feet deep	
Normal	Well in drift—204 feet deep	
North Chicago	Lake Michigan	Chlorination.
North Crystal Lake	From Crystal Lake—well in drift	
Oak Park	From Chicago—lake	Chlorination.
Oakland	Wells in rock—95 and 110 feet deep	
Odell	Wells in rock—1,360 and 1,298 feet deep	
O'Fallon	Wells in drift—40 to 50 feet deep	
Oglesby	Well in rock—1,645 feet deep	
Ohio	Wells in drift—385 feet deep	
Olney	Stream—Fox River	
Onarga	Wells in drift—110 feet deep	
Oregon	Well in rock—1,610 feet deep	
Orland Park	Well in rock—329 feet deep	
Oswego	Well in rock—18 feet deep	
Ottawa	Wells in rock—1,200 feet deep	
Palatine	Wells in rock—168 feet deep	
Palestine	Same supply as Robinson—well in drift	
Pana	Stream—Beck Creek	Filtration.
Paris	Stream—Sugar Creek	Chlorination.
Park Ridge	From Chicago—lake	Chlorination.
Paw Paw	Well in rock—1,018 feet deep	
Paxton	Wells in drift—142 to 148 feet deep	
Pearl—P	Spring	
Pearl City	Wells in drift—40 feet deep	
Pecatonica	Well in rock—20 feet deep	
Pekin—P	Wells in drift—75 to 85 feet deep	
Peoria—P	Wells in drift—40 to 94 feet deep	
Peoria Heights	From Peoria—wells in drift	
Peotone	Well in drift—100 feet deep	
Peru	Wells in rock—1,200 to 1,505 feet deep	
Petersburg	Well in drift—44 feet deep	
Pinckneyville	Stream—Beaucomp Creek	
Piper City	Wells in drift—70 feet deep	
Pittsfield—P	Well in rock—2,200 feet deep	
Plainfield	Well in rock—1,318 feet deep	
Plano	Well in rock—18 feet deep	
Polo	Wells in rock—2,100 and 1,200 feet deep	
Pontiac—P	Stream—Vermilion River	Filtration and chlorination.
Poplar Grove	Well in drift—35 feet deep	
Princeton	Wells in rock—2,550 and 2,092 feet deep Well in drift—245 feet deep	
Princeville	Well in rock—1,600 feet deep	
Prophetstown	Wells in drift—16 feet deep	
Quincy—P	Stream—Mississippi River	Filtration and chlorination.
Rantoul	Wells in drift—120 feet deep	
Redbud	Well in rock—294 feet deep	
Riverdale	Part from Chicago—lake Well in rock—430 feet deep	Chlorination.
River Forest	Wells in rock—1,000 feet deep	
Riverside	Wells in rock—2,000 feet deep	
Roanoke	Wells in drift—30 feet deep	

TABLE 5.—Continued.

Municipality.	Source of supply.	Treatment.
Roberts	Well in drift—216 feet deep	
Robinson—P	Well in drift—28 feet deep	
Rochelle	Well in rock—1,026 feet deep	
Rock Falls—P	From Sterling—wells in rock	
Rock Island	Stream—Mississippi River	Filtration and chlorination.
Rockdale	Well in rock—660 feet deep	
Rockford	Wells in rock—400 to 2,000 feet deep	
Roodhouse	Stream	
Roseville	Wells in rock—50 and 1,220 feet deep	
Rossville	Wells in drift—130 feet deep	
Rushville	Well in drift—24 feet deep	
St. Anne—P	Well in rock—210 feet deep	
St. Charles	Wells in rock—350 and 850 feet deep	
St. Elmo—P	Stream—Sugar Creek	
Salem	Stream	
San Jose	Well in drift—105 feet deep	
Sandwich	Wells in rock—600 feet deep	
Savanna	Wells in rock—1,435 and 1,500 feet deep	
Secor	Wells in drift—115 and 185 feet deep	
Sheffield	Wells in drift—46 and 50 feet deep	
Shelbyville—P	Wells in drift—20 and 25 feet deep	
Sheldon	Well in rock—1,850 feet deep	
Shermerville	Well in rock—1,345 feet deep	
Silvis	Well in rock—2,000 feet deep	
	Well in drift—28 feet deep	
Somonauk	Well in drift—190 feet deep	
	Well in rock—500 feet deep	
S. Chicago Heights	Well in rock—2,700 feet deep	
Sparta	Stream—Mary's River	Filtration and chlorination.
Spring Valley	Wells in rock—1,480 feet deep	
Springfield	Wells in drift—50 feet deep	
Standard	Well in rock—1,767 feet deep	
Stanford	Well in drift—131 feet deep	
Staunton	Stream—Cahokia Creek	
Steger	Well in rock—318 feet deep	
Sterling—P	Wells in rock—1,334 and 1,829 feet deep	
Steward—P	Well in drift—100 feet deep	
Stockton	Well in rock—1,500 feet deep	
Stonington	Wells in drift—40 feet deep	
Strawn	Well in drift—50 feet deep	
Streator—P	Stream—Vermilion River	Filtration and chlorination.
Stronghurst	Well in rock—1,009 feet deep	
Sublette	Well in rock—752 feet deep	
Sullivan	Well in rock—284 feet deep	
	Well in drift—79 feet deep	
Summit	Well in rock—1,864 feet deep	
Sycamore	Wells in rock—950 feet deep	
Tampico	Wells in drift—25 feet deep	
Taylorville	Wells in drift—92 feet deep	
Thomson	Well in drift—37 feet deep	
Tinley Park	Well in rock—900 feet deep	
Tiskilwa	Spring	
Tolono	Wells in drift—146 feet deep	
Toluca	Well in rock—2,040 feet deep	
Toulon	Well in rock—1,445 feet deep	
Tremont	Well in drift—132 feet deep	
Trenton	Wells in rock—234 feet deep	
Tuscola—P	Wells in rock—287 and 300 feet deep	
Union	Well in drift—35 feet deep	
Urbana	Wells in drift—160 feet deep	Filtration for iron removal.
Utica	Wells in rock—225 to 350 feet deep	
Vandalia	Stream—Kaskaskia River	
Venice—P	From East St. Louis—stream	Filtration and chlorination.
Villa Park	Wells (in rock?)	
Viola	Well in rock	
Walnut	Wells in drift—230 feet deep	
Warren	Wells in rock—875 and 700 feet deep	
Warsaw	Stream—Mississippi River	Filtration and chlorination.
Washington	Wells in drift—90 feet deep	
Waterloo	Stream—Forenkum Creek	
Waterman	Well in drift—73 feet deep	
Watseka	Wells in drift—150 feet deep	
Waukegan	Lake Michigan	Chlorination.
Waynesville	Well in drift—116 feet deep	
Weldon	Well in drift—86 feet deep	
Wenona	Well in rock—1857 feet deep	

TABLE 5.—Concluded.

Municipality.	Source of supply.	Treatment.
West Chicago	Wells in rock—775 and 322 feet deep	
West Dundee	Spring	
West Frankfort	Wells in drift—62 feet deep	
West Hammond	From Hammond, Indiana—lake	
Western Springs	Well in rock—2,046 feet deep	
Westfield	Well in rock—155 feet deep	
Wheaton	Wells in rock—175 feet deep	
White Hall	Stream	
Wilmette	From Evanston—lake	Filtration.
Wilmington	Stream—Kankakee River	
Winchester	Well in drift—42 feet deep	
Winnetka	Lake Michigan	Chlorination.
Winslow	Well in rock—200 feet deep	
Wood River	Wells in drift—110 to 140 feet deep	
Woodhull	Well in rock—1,294 feet deep	
Woodstock	Wells in rock—2,000 feet deep	
	Wells in drift—85 feet deep	
Wyoming	Well in rock—1,557 feet deep	
Yorkville	Spring	
Zion City	Wells in rock—1,000 feet deep	

Abstracts of reports of water supplies visited during the year are given on pages 20 to 99. Abstracts of reports made in former years may be found in Bulletins **9**, 15-33; **10**, 89-185; **11**, 28-141; **12**, 28-147; **13**, 30-143; **14**,22-74.

SCIENTIFIC AND SPECIAL STUDIES.

The members of the staff are called upon to study special problems relating to water resources that are brought to the attention of the Water Survey. The following summary indicates the studies completed during 1917, the results of which are published elsewhere in this report. The regular staff has been assisted at times by instructors and graduate students in the University.

The significance of lactose-fermenting organisms in water. Waters from various sources were tested for gas formation in lactose broth, and confirmatory tests for B.coli were made after 24 hours and after 48 hours. Overgrowth of B.coli found present in 24 hours was not more than 1 per cent. Lactose-fermenting organisms were isolated and identified. Supplementary tests of these did not show consistent relation to the types of classification nor to fecal and non-fecal strains of organisms.

Air diffusion in the activated sludge process of sewage treatment. Filtros plates, blocks of wood, and perforated pipes were used to diffuse air in the treatment of sewage by the activated sludge process. Filtros plates proved to be the most efficient.

Extraction of grease from sludge produced in the activated sludge process of sewage treatment. Using petroleum ether as a solvent, from 4.16 to 6.00 per cent of grease was extracted from untreated dried sludge produced in an experimental activated sludge plant. After treating sludge with acid the yield of grease was from 5.81 to 8.10 per cent.

Studies of methods of determining total organic nitrogen in sewage. A study was made of the decomposition of sewage on standing, of results obtained by determining total organic nitrogen with or without first removing the ammonia nitrogen, of the effect of nitrites and nitrates on organic nitrogen determinations, and the accuracy of the data was investigated.

ABSTRACTS OF REPORTS.

The following pages contain abstracts of detailed reports of various investigations made during 1917 and references by number and page to preceding bulletins for abstracts of reports made in former years. The population in 1910 is given in the parentheses immediately following the name of the municipality. References to abstracts in previous reports are given in parentheses after the title of each investigation. Capacities of pumps, yields of wells, ,and consumption of water are stated in gallons per 24 hours unless otherwise specified. Depths of wells are given in feet from the surface of the ground unless otherwise specified. Estimates of capacity, yield, daily consumption, consumption per capita, discharge of sewage, and similar amounts are rounded off to avoid expression of fictitious accuracy.

ABINGDON. Water supply.—(Bull. **11**, 28.)

ALBION (1,281). Proposed water supply.—(Bull. **10**, 8a.) Visited July 25 to investigate water resources. Plans, specifications, and an estimate of cost for a proposed water supply were prepared in January,' 1917, by T. N. Jacob, engineer. The installation was to include an impounding reservoir with an area of about 17 acres, capacity of 50,000,000 gallons, and tributary drainage area of about 250 acres. The water was to be filtered, treated with hpochlorite of calcium, and then pumped through a 6-inch. pipe line to the distribution system. An elevated steel tank of 75,000 gallons capacity was to be connected to the distribution system. The total estimated cost of the improvements was $24,000. A bond issue for waterworks had been defeated in April.

Samples of water were collected from a well at one corner of the public square and from a cistern in the court house yard. On analysis both were found to be polluted.

It is desirable to have a water supply of unquestioned purity.. Although prices are high, waterworks and sewerage should be installed in the near future before many streets are paved. In case the city should increase in size, the drainage area of the proposed reservoir, 250 acres, would not be sufficient to furnish an abundant supply for universal use.

ALEDO. Water supply.—(Bull. .**10**, 90.)

Sewage disposal.—(Bull. **13**, 30.)

ALEXIS. Wate r supply.—(Bull. **13**, 30.)

ALGONQUIN. Water supply.—(Bull. **13**, 30.)

Sewerage.—(Bull. **13**, 31.)

ALPHA. Water supply.—(Bull. **14**, 23.)

ALTAMONT (1,328). Water supply.—(Bull. **11**, 28.) Visited August 6. Altamont is in the west central part of Effingham County on the watershed between Little Wabash and Kaskaskia Rivers. The installation of waterworks was completed in 1913. Water is obtained from three wells, Nos. 1, 2, and 3. The depths of the wells are 131, 225, and 145 feet, respectively. Nos. 1 and 2 are about 40 feet apart; No. 3 is 600 or 700 feet distant. Well No. 1 is 6 inches in diameter and enters rock at a depth of about 55 feet. It is equipped with a deep-well pump with the cylinder placed at a depth of 124 feet. The static water level in this well is 55 feet below the ground surface. The top of the well casing ends in a shallow pit about 6 feet deep below the station floor. Surface drainage, oily wastes, and floor washings have access to this pit, and can undoubtedly pollute the water. Well No. 2 yielded only a small quantity of water, and the yield was increased by blasting at a depth of 150 feet. The static water level in wells 2 and 3 is 50 feet below the ground surface. The wells are equipped with deep-well pumps which discharge into a brick collecting reservoir 12 feet in diameter and 7 feet deep, with a capacity of 7,000 gallons. The reservoir is covered with a conical concrete roof with a 3-foot tile opening at the top. When the reservoir is cleaned, an oily iron sediment is pumped out. Water is pumped from the reservoir into the distribution system by a 7½ by 4½ by 10-inch duplex pump. The boiler plant consists of two 120-horsepower boilers. The distribution system includes about 1 mile of 4-inch, 6-inch and 8-inch cast-iron pipe. A 40,000-gallon elevated steel tank is connected to the distribution system. Only about one-tenth of the population uses the public supply. All services are metered. The average daily water consumption is about 20,000 gallons. The waterworks system has cost about $12,000.

Analyses of the water indicate that the supply is contaminated. Surface drainage into well No. 1,. which is to be abandoned, or seepage through the wall of the collecting reservoir may be the source of contamination. Waters from the 225-foot and 145-foot wells have mineral contents of 881 and 758, hardness of 188 and 148, and contents of iron of 0.5 and 0.2 parts per million, respectively.

ALTON (17,528). Water supply.—(Bull. **9**, 15; **l0**, 90; **11**, 29; **12**, 28; 13, 31.) Visited June 13 to examine the water purification plant and to collect samples of water for analysis. The Mississippi River was high, being within a few feet of the top of the coagulating basins. Part of the pumping equipment was being overhauled. Two filter units had been recently installed. Otherwise conditions were practically the same as when the plant was last-visited by a representative of the Survey.

At this plant the operation consists of coagulation and sterilization, followed by filtration. The coagulants used are lime and iron sulphate. Previous to the war, alum and lime were used. The coagulants are first dissolved, or held in suspension by stirrers, and are then added to the water through a special device made by the engineer, Mr. Parker. The chemicals are all added at the same point. It would be of advantage at times to apply the lime before the iron, and to add the sterilizing agent to the water as it enters the pipe lines leading to town. It is inadvisable to apply the sterilizing agent as the water leaves the filters, since the water passes over weirs into the clear water reservoir.

The water was being well coagulated and apparently efficiently filtered, but not sufficiently sterilized, as is shown by analyses of water collected at the time. The water is of fair sanitary quality.

ALTON. Proposed additional sewers.—(Bull. **12**, 29.)

Nuisance complaint.—(Bull. **12**, 30.)

AMBOY. Water supply.—(Bull. **11**, 29.)

ANNA (2,809). Water supply.—(Bull. **9**, 15; **11**,. 30.) Visited July 16. There have been no changes in the waterworks system since the last report was made, except the addition of 11,000 feet of 4-inch pipe to the distribution system. Due to a boiler breakdown and lack of duplicate equipment the plant was shut down for three days in July. The consumption of water as shown by a meter is about 40,000 gallons a day.

The water Is of excellent sanitary quality.

ANNA. Sewerage.—(Bull. **9**, 15; **11**, 30.)

ANNA, State Hospital. Water supply.—(Bull. **9**, 15; **10**, 91; **12**, 30; **13**, 31.)

Proposed sewage treatment.—(Bull. **12**, 32.)

ARCOLA. Water supply.—(Bull. **l0**, 91.)

AREA (358). Water supply.—Visited October 17. Area is located in Lake County about 6 miles east of Lake Michigan on the drainage area of DesPlaines River.

Waterworks were installed in 1915. The installation includes a well, a motor-driven pump, a pump house, an elevated steel tank, and a distribution system. Water is obtained from a 6-inch well *2i2* feet deep. The well penetrates drift for a depth of 235 feet, where rock is encountered. The static water level is 40 feet below the ground surface. The working barrel of the pump is at a depth of 150 feet. A test at the time of completion showed that at least 75 gallons per minute could be pumped for 48 hours without materially lowering the water level.

The distribution system, which serves practically the entire village, includes 18,960 feet of cast-iron pipe, 22 valves, 42 fire hydrants, and 42 metered service connections. The system has three dead ends. A 40,000-gallon steel tank on a 100-foot tower is connected to the distribution system. The daily water consumption does not exceed 3,000 gallons, and the quantity available is ample to supply the present demand. Water is sold for 35 cents per thousand gallons. The waterworks cost the village $25,285. The receipts from water rents, amounting to about $360 per year, are about equal to the operating expenses.

The water is of satisfactory sanitary quality. It has a mineral content of 353, a hardness of 84, and a content of iron of 0.3 parts per million.

ARLINGTON HEIGHTS. Water supply.—(Bull. **12**, 32.)

Sewage disposal.—(Bull. **10**, 91; **12**, 32; **13**, 31.)

ARTHUR. Water supply.—(Bull. **10**, 94; **12**, 33.)

ASHLEY. Public wells.—(Bull. **13**, 32.)

ASHTON. Water supply.—(Bull. **13**, 32.)

Sewage-treatment plant.—(Bull. **13**, 33.)

ASSUMPTION (1,918). Water supply.—(Bull. **11**, 31; **12**, 33.) Visited August 14. The wells described in former reports have been abandoned, and three new wells located about 20 feet west of Spring Creek and from 150 feet to 300 feet southeast of the pumping station have been installed. The wells are 10 inches in diameter and 18½ feet deep. They have brass screens, two of which are 8 feet and one 10 feet long. The tops of the casings are 2½ feet below the ground surface and are capped to prevent leaking. A 4-inch suction pipe passes through the cap and nearly to the bottom of each well. The quantity of water available from this source has not been determined, but it seems to be sufficient to meet the demands. A 7 by 8-inch triplex pump gear-connected to a 10-horsepower electric motor has been installed. The old triplex pump, now driven by electric motor, is held as a reserve unit.

Some consumers have complained of bad odors of the water. There seems to be less complaint since the elevated tank was cleaned in July. Examinations of water from hydrants at dead ends did not reveal pronounced odors. Bad odors can be eliminated by keeping the water fresh. The water is of good sanitary quality.

ASSUMPTION. Sewerage.—(Bull. 11, 32.)

ASTORIA (1,357). Water supply.—(Bull. 11, 32.) Visited July 10. Astoria is in the southern part of Fulton County on the drainage area of Illinois River. No important changes have been made in the waterworks since 1913.

The water is of good sanitary quality but not suitable for drinking on account of the high mineral content, 3,620 parts per million. Sodium chloride and sodium sulfate constitute the greater part of the mineral content.

ATKINSON. Proposed water supply.—(Bull. 13, 33.)

ATLANTA. Water supply.—(Bull. 11, 33.)

AURORA (29,807). Water supply.—(Bull. 9, 16; 11, 34; 12, 33.) Visited September 13. The emergency supply from a stone quarry, which was described in Bulletin 12, has been abandoned; and water is now obtained from eight artesian wells.

Five wells, Nos. 1, 2, 3, 4 and 5, which are from 2,000 to 2,250 feet deep, are located on the east bank of Fox River about 1½ miles north of the center of the city. These wells are equipped with air lifts. Their total yield during a test in 1916 was 1,200 gallons a minute. A discharge pipe choked with mineral deposit was removed from well No. 2 and by repairs the yield of this well was increased from 60 gallons a minute to 280 gallons a minute. The air lift equipment is being improved and boosters are being installed at the top of each well.

Well No. 6 is in the southern part of the city, more than 1 mile distant from No. 7, the nearest of the other wells. It is 18 inches in diameter at the top, 15 inches in diameter at the bottom and 2,200 feet deep. The depth of pumping has been increased in order to increase the yield. The depths of pumping and corresponding yields per minute were given as follows: 125 feet, 280 gallons; 225 feet, 450 gallons; 325 feet, 750 gallons. The efficiency of the installation is high, but due to the high cost of pumping from such a depth only 10,000,000 gallons were pumped from this well during the past year.

Well No. 7 is in the southwestern part of the city, nearly a mile distant from well No. 8, the nearest of the other wells. It is 18 inches in diameter at the top, 15 inches in diameter at the bottom and 2,262 feet deep. The pump is at a depth of 225 feet. The discharge at the time of visit was

990 gallons a minute. With long-continued pumping the discharge decreases to about 900 gallons a minute.

Well No. 8 is on Stolp's Island near the center of the city. It is 2,330 feet deep. When not pumped for several days the water overflows. It is now pumped daily. Wells Nos. 6, 7, and 8 are equipped with motor-driven centrifugal pumps.

It will be possible by recording water levels in wells, to secure information in regard to relation of yield and water level and lowering of water level during long-continued pumping. This would be of value in determining proper spacing of wells and economical rates of pumping.

Power to operate the five wells equipped with air lift is furnished by a municipal power plant operated in connection with an electric lighting plant. Electric power to operate pumps in wells 6, 7, and 8 is purchased from the Western United Gas and Electric Company.

A covered reinforced concrete reservoir has been built near the pumping station above the water level in the river. Water from the five wells nearby may be discharged either into an open concrete reservoir formerly in use or into the new reservoir.

Chances of contamination of the supply have been lessened by inclosing the tops of the wells operated by air lift, by oiling a public road near the pumping station in order to prevent dust from blowing into the uncovered surface reservoir, by building the new covered concrete reservoir above the water level in the river, and by adding new wells. With the new reservoir and wells it should not be necessary to draw the water level down in the old reservoir and thus give chance of contamination by polluted water entering through fissures in the rocks and through the walls.

AURORA. Alleged pollution of Indian Creek.—(Bull. 14, 23.)

AVERYVILLE. Proposed sewerage.—(Bull. 12, 34.)

AVISTON. Copper-sulfate treatment of reservoir.—(Bull. 11, 34.)

AVON. Water supply.—(Bull. 13, 33.)

BARRINGTON. Water supply.—(Bull. 12, 34.)

Proposed sewerage.— (Bull. l0, 94.)

BARRY. Water supply.—(Bull. 12, 35.)

BATAVIA. Water supply.—(Bull. 9, 16.)

BEARDSTOWN. Water supply.—(Bull. 11, 35.)

Pollution of Illinois River by Chicago Drainage Canal.—(Bull. 11, 35.)

BEECHER (543). Water supply.—Visited November 13. Beecher is in the southwestern part of Will County on the drainage area of Kankakee River. Glacial drift in the vicinity is from 80 to 120 feet deep, varying in depth with differences in surface elevation. There are 35 or 40 dug wells for private supply, and about the same number of drilled wells, which latter extend down 100 to 150 feet, obtaining water from limestone.

Waterworks were installed in 1911. The source of supply is a 10-inch well 164 feet deep penetrating a limestone formation at a depth of 80 feet. The well is cased to rock with black iron pipe. The outer casing of the well extends about 4 inches above the concrete floor of the pump house, and between the 4-inch suction pipe and the casing wooden blocks have been fitted, to eliminate chances of pollution. The static water level is 15 feet below the ground surface. A one-hour test lowered the water level 15 feet. Water is pumped from the well into the distribution system by a 216,000-gallon triplex pump. The pump is belt-connected to a shaft turned by either a 20-horsepower gasoline engine or a 50-horsepower kerosene engine. These engines also furnish power for a municipal lighting plant. A pressure varying between 50 and 80 pounds is maintained at the station. The distribution system includes about 3 miles of 6-inch and 8-inch cast-iron mains which reach most of the built-up districts. Two steel pressure tanks are connected to the distribution system. About one-half the people in the village use the public supply. The normal water consumption is about 15,000 gallons a day. The cost of the waterworks, including the distribution system, was $25,000. The water is of fair sanitary quality. It is very hard, and, from an industrial standpoint, not very desirable. It has a mineral content of 958, a hardness of 708, and a content of iron of 0.5 parts per million.

BELLEVILLE. Water supply.—(Bull. 11, 36.)

Sewage disposal.—(Bull. 12, 35; 13, 34.)

BELLEVILLE. Scott Field, Aviation Cantonment. Water supply.—Visited August 15 at the request of the construction superintendent for the purpose of investigating possible sources of water supply. The field is located about 7 miles east of Belleville on the north side of the Southern Railroad.

The possible sources of water supply were: (1) deep wells, (2) shallow wells along Silver Creek, and (3) the Belleville city supply, which comes from the East St. Louis filtration plant.

(1) The city of Belleville formerly obtained a supply of soft water from 30. wells at the southern edge of the city. These wells ranged in depth from 400 to 450 feet. This supply was always inadequate for the city and was finally abandoned.

(2) The quantity of water available in the lowlands near Silver Creek is not known. To secure water from this source it would be necessary to install a special pumping station which would have to be maintained at a distance of 2 miles or more from the field. Before developing such a supply test wells should be drilled to determine the character of the water.

(3) Water could be obtained from the mains of the Belleville Water Company, at a point about 7 miles from the field. This water is filtered Mississippi River water and is of good quality.

Deep wells had been chosen as a source of supply on the supposition that suitable water had been obtained for a coal mine near Shiloh Station about 2 miles east of the field, and also from mines at New Baden about 7 miles east of the field. The strata from which the water was obtained are undoubtedly similar to those of Mascoutah, for at a depth of about 450 feet salt water with head sufficient to overflow the casing was encountered. This water contains 9,000 parts per million of chlorine, corresponding to 14,900 parts per million of sodium chloride. It is much too salty for domestic use. A comparison of depths of wells in the vicinity indicates a dip to the east of about 25 feet per mile. The surface elevation at the field is 114 feet lower than at the northeastern limits of Belleville. This would indicate that the water-bearing strata from which good water was obtained by the Belleville Water Company would be about 60 feet deeper or at a depth of from 450 to 500 feet. The water from such a source might be very highly mineralized. While the possibility of getting a good water below the salt water stratum seems remote, yet the additional expense, a few hundred dollars, of determining whether good water was present seemed to be justified, and the well driller was casing off the salt water and continuing the drilling.

Owing to the need of an immediate water supply it seemed inadvisable to make tests of shallow wells along the creek, as to make such tests would require several weeks or perhaps months.

Obtaining water from the Belleville Water Company is most rapid, most certain, and most reliable. City water mains extend nearly to the eastern and northeastern limits of the city and are of such size as to warrant extending along Carlyle road to the Aviation Field. The Water Company is willing to extend the mains to the city limits and to insert the necessary valve and meter.

The elevation of the land at the Water Company office is 525, and at the Aviation Field it is 440. A water pressure of 50 pounds per square inch is carried on the gage in the office of the Water Company. During fires the pressure is increased to 85 pounds per square inch.

The following table gives a comparison of the respective costs and capacities of 6-inch and 8-inch pipe from Belleville to the field:

Diameter of pipe in inches.	Discharge in gallons per day.		Approximate cost of pipe line Class C pipe.
	Ordinary pressure at Belleville.	Fire pressure at Belleville.	
6	130,000	400,000	$56,000
8	280,000	720,000	82,000

Additional fire protection capacity could be secured by building a reservoir at the Field and installing a fire pump. A 100,000-gallon reservoir and a 1,000-gallon per minute fire pump would cost approximately $4,500.

At the suggestion of this department the 7 miles of pipe line were laid, and within a month the camp was receiving filtered water from the East St. Louis filtration plant.

BELLWOOD. Water supply.—(Bull. 11, 37; 12, 36.)

BELVIDERE. Water supply.—(Bull. 11, 36.)

Alleged pollution of Kishwaukee River by gas-house wastes.—(Bull. 11, 36; 13, 34.)

BEMENT (1,530). Water supply.—(Bull. 10, 95.) Visited January 3, June 19, July 28, and August 10 in connection with the development of the public water supply.

Water is obtained from two 6-inch wells, 137 and 140 feet deep, which were the original sources of supply. The pump cylinders are at a depth of about 119 feet. Water is drawn below the bottom of the cylinders at a maximum rate of pumping, which is about 50 gallons per minute. During 1916 and 1917 a number of improvements were made, at a total cost of about $3,600. A 100,000-gallon concrete reservoir was built adjacent to the pumping station and is used in connection with an old reservoir of 40,000-

gallons capacity. A new 60,000-gallon elevated wooden tank was built to replace a wooden tank formerly in use. Double-acting deep well pump cylinders were installed to replace single-acting cylinders. Additional boilers and equipment were installed.

For a time water was pumped by the local electric light company at a cost to the city of seven cents per thousand gallons. The light company drilled seven wells in an effort to secure a more adequate supply. Only one of these yielded sufficient water to warrant the installation of a pump. This well, located about 1,000 feet northeast of the city wells, was pumped for a few months. The contract with the light company was allowed to lapse and the city resumed pumping from the two original wells. The static water level is 20 feet below the ground surface. When one well is pumped, water in another well about 6 feet away is sometimes lowered to 70 feet below the ground surface.

On January 3 three methods of procedure were suggested as follows: (1) Drill test holes until a suitable water-bearing stratum is found, provided a low contract price for the drilling test wells can be secured, and then drill a large well, (2) Buy or lease the electric light company well, (3) Drill a new well close to the pumping station. As wells have been drilled north and west of the station a new well, if drilled, should be to the south or east. A short screen in fairly coarse material is better than a long screen with most of the screen in very fine sand.

A well was drilled on the pumping station lot southeast of the station. On June 19 the well was 140 feet deep. A test was to be made as soon as a screen arrived.

On July 27 word was received that the well had been drilled to a depth of 275 feet. It was reported that when tested at a depth of 140 feet fine sand was drawn into the well and the yield was less than could be baled out with a sand bucket.

The well is 12 inches in diameter to a depth of 140 feet, below which it is 6 inches in diameter. It is cased to rock which is at a depth of 209 feet. The yield of the well was tested on August 10. After 7½ hours pumping at a rate of 85 gallons a minute, water in the well was 66½ feet below the ground surface. Pumping at a rate of 88 gallons a minute lowered the water level to the bottom of the pump suction which was 68½ feet below the ground surface. This yield would probably not continue indefinitely without further lowering of the water level. If the well were to be used it should be equipped with a pump of at least 100 gallons a minute capacity placed at a depth of about 125 feet.

The water from the well 275 feet deep has a mineral content of about 1,600 parts per million of which 680 are chloride. Unless treated, it would corrode boilers, water heaters, and gear trains of meters. Water from this well should not be used for a public supply as long as enough water of better quality can be secured.

BENLD (1,912). Water Supply.—(Bull. 12, 36.) Visited February 14. Nothing further has been done with regard to the installation of a public water supply since the last report. The bond issue which was favorably voted upon at the end of 1914 was not used. The well that was dug by the city has been boarded over and is now used to furnish water for cattle.

BENSON. Water supply.—(Bull. 13, 35.)

BENTON. Proposed improvement of water supply.— (Bull. 9, 16; 10, 95; 11, 38; 12, 36.)

Sewage treatment.—(Bull. 10, 96; 12, 37.)

BERWYN. Water supply.—(Bull. 13, 35.)

BLOOMINGTON (25,768). Water supply.—(Bull. 10, 96; 12, 37; 14, 26.) Visited November 12. Water is now obtained from five wells, an additional well, No. 5, having been drilled during the past year near well No. 3. This well has a shaft 20 feet in diameter and 65 feet deep. Eight wrought-iron pipes equipped with strainers made by boring holes in the pipe extend through the bottom of the shaft into the water-bearing stratum. A 6,000,000-gallon centrifugal pump, direct-connected to a 350-horsepower electric motor, has been installed in the pumping station. Water rrom the Normal public supply is used in the pumping station boilers.

BLUE ISLAND. Water supply.—(Bull. 12, 37; 13, 37.)

Pollution of Stony Creek and Calumet Lake.— (Bull. 13, 37.)

BLUE MOUND (900). Water supply.—(Bull. 12, 38.) Visited June 25. Water is secured from a 6-inch well 55 feet deep, equipped with a single-acting deep-well pump driven by a 7½-horsepower motor. The well is cased to the bottom. A pit around the top is partly filled with water, thus allowing chances for contamination. For a reserve water supply another well is being drilled to the same water-bearing stratum.

The water is of good sanitary quality. The conditions around the top of the well do not conform to good practice and improvements should be made.

BOURBONNAIS (611). Water supply.—Visited November 12. Bourbonnais is in the central part of Kankakee County, 1¼ miles from Kankakee River. St. Viator's College and Notre Dame Convent are located here. A few sanitary and storm sewers are provided which discharge directly into Kankakee River.

Waterworks were installed in 1900. The installation included a well, a pumping station, a pump, an elevated tank, and a distribution system. In 1911 a new pump and an elevated steel tank were installed. The well and pumping machinery are located at the power house of the College campus. The source of supply is a 10-inch well 181 feet deep cased to rock. The static water level is 16 feet below the ground surface. When pumped 6 or 7 hours a day the well yields sufficient water to meet the demand. Water is pumped from the well into the distribution system by a deep-well pump belt-driven by a 7½-horsepower electric motor. The distribution system includes 8-, 6-, and 4-inch cast-iron pipe. A 50,000-gallon elevated steel tank is connected to the distribution system and when full provides a pressure of about 54 pounds. The consumption of water is 30,000 gallons a day. Thus far the waterworks have cost $8,000. Operation costs about ?50 a month.

Samples of water from Bourbonnais were lost in transit to the laboratory.

BRACEVILLE (971). Water supply.—(Bull. 12, 39.) Visited June 11. The source of supply is a dug well about 30 feet deep.

The water is of fair sanitary quality. It is highly mineralized and would cause the formation of a hard tenacious scale if used in boilers. In general, it may be said that the water is not satisfactory for a community supply. It has a mineral content of 968, a total hardness of 450, and a content of iron of 0.1 parts per million.

BRADFORD (770). Water supply.—Visited August 27. Bradford is in the northeastern part of Stark County on the drainage area of Spoon River. Waterworks were installed about 14 years ago. The source of supply is a well 2,050 feet deep which enters St. Peter sandstone at a depth of 1,625 feet and Potsdam sandstone at a depth of 1,979 feet. The upper 1,730 feet of the well is cased. It is equipped with a deep-well pump driven by a 10-horsepower motor. The pump cylinder is at a depth of 360 feet. The pump is operated about six hours a day at a rate estimated to be 130 gallons' a minute. Water rises to within 160 feet of the top of the well and is reported not to be lowered appreciably by pumping. The well pump discharges into a 94,000-gallon reservoir. From this the water is pumped into the distribution system by an electrically-driven pump. The distribution system includes approximately 4½, miles of 4-inch, 6-inch and 8-inch mains. An elevated steel tank is connected to the mains.

Analyses of a sample of water indicated pollution. A sample collected later, on September 24, was of good sanitary quality. It has a mineral content of 1,377, a total hardness of 350, and a content of iron of 0.4 parts per million.

BRADLEY. Water supply.—(Bull. 14, 26.)

Proposed sewerage.— (Bull. 11, 38.)

BRAID'WOOD. Water supply.—(Bull. 12, 39.) Visited June 11. Water is obtained from the same source as was in use in 1914. The water is in fair sanitary condition.

BREESE (2,128). Water supply.—(Bull. 9, 16; 11, 39; 12, 40; 13, 38.) Visited June 11 and 12. Water from Shoal Creek is treated by coagulation and sedimentation. During 1916 the average daily water consumption was 176,000 gallons. Several large consumers are furnished with untreated water.

Clarification of the water is attempted by applying iron sulfate and hydrated lime, hut scarcely any coagulation could be observed. The solution tanks are charged every 12 hours. No record is kept of the amount of coagulant used. Six feet of mud had been removed from the basin the previous week. Due to poor mixing of chemicals and water, insufficient settling capacity, improper baffling, and improper outlet facilities, the plant is not efficient. The capacity of the settling basin is 350,000 gallons, but due to the water taking a diagonal path parts of the basin near corners are of little use. A hanging baffle that extends within about 1 foot of the bottom of the basin causes a scouring action, stirring up the mud accumulation as the water passes along.

The following changes are suggested with a view to increasing the efficiency of the plant: first, more frequent charging of the solution tanks or the installation of calibrated feeding devices to obtain a uniform application of chemicals; second, raising the inlet to the coagulating basin to or above the surface of the water in order to secure better mixing of coagulant and water; third, removing all but the upper 2 feet of the hanging baffles so that scouring action will not take place, and replacing the opening in the first division wall by a weir; and fourth, using a floating intake on the outlet pipe so that the high service pumps may draw the clearer water from the basin.

It is also suggested that a sterilization plant be installed.

About 2 miles above the intake on the same side of Shoal Creek are two oil wells from which salt water and some oil reach the stream. The oil gives the water a very bad taste and odor, and the salt corrodes boilers in which the water is used.

BREESE. Microscopic survey of the water supply.—Visited September 4. Water for the public water supply is obtained from Shoal Creek at a point about 2 miles east of the city and is passed through coagulating basins. At times when the water is exceptionally turbid iron and lime are applied as coagulants. The creek has a drainage area above the intake of about 760 square miles of rolling prairie land. The population on the drainage area was about 42,000 in 1910. The intake is in the center of the stream about 18 inches above the bottom. A dam has been constructed a short distance below the intake.

ORGANISMS IN WATER.

Organisms.	Number of organisms per cubic centimeter.		
	At surface near sbore at intake.	50 feet below dam in swift water at surface.	At surface coagulating basin near outlet.
Diatomacaea—			
Asturionella	4	8	20
Stauroneis			12
Nitzschia	18	20	20
Navicula			24
Melosira (filaments)	36	30	50
Tabellaria			28
Chlorophyceae—			
Raphidium	4	8	10
Protococcus	20	32	30
Volvox	12	76	70
Scenedesmus	10	6	
Coelastrum	6	16	8
Pedastrum	8	4	20
Closterium	2	6	6
Protozoa and Rotifera—			
Peridinium	80	90	4
Euglypha	2	2	100
Synura	4	2	6
Euglena	2	20	2
Vorticella	20	24	40
Thiarthra	28	20	20
Total	256	364	470
STANDARD UNITS PEE CUBIC CENTIMETER.			
Chlorophyceae—			
Spirogyra			1,200
Cyanophyceae—			
Coelocphaerium	1,000	1,500	
Oscillaria			600
Amorphous matter	30,000	25,000	26,000

The stream was low. Above the dam it was about 100 feet wide and appeared stagnant. The intake was about 7 feet under water. At the dam there was an accumulation of brush-wood and debris, and associated with this was a surface growth of filamentous algae decidedly green in color and perhaps 5 feet broad, extending nearly across the stream. Along the shores near the intake there was no evidence of filamentous algal growth and very little growth could be seen above this point. A short distance above the intake there is a bend in the river above which no investigation was made. At the intake the water was very turbid due chiefly to the presence of finely divided clay. Surface water near the intake and near the dam contained about 7.0 parts per million of dissolved oxygen. The number of organisms present is given in the accompanying table.

The water in the coagulating basins was very heavily laden with growths plainly visible to the naked eye. Great floating masses of slimy algal growth were scattered on the surface. The water leaving the purification system seemed to show heavier algal growth than did the water in the stream. The walls of the basin were covered with a blue-green growth. Above the water line they were heavily coated with a growth of Oscillaria. Much Spirogyra was growing in the water along the edge of the walls.

Organisms capable of producing tastes and odors were present in sufficient numbers to give considerable odor to the water. It would probably not be feasible to treat the water in Shoal Creek with copper sulfate for the removal of these growths, but possibly a satisfactory form of treatment could be given at the purification plant.

BREESE. Catholic Institute. Sewage disposal.—Visited June 12. A tank which receives the sewage from the institute was working as well as could be expected. The effluent did not contain much suspended matter, but the odors around the tank were distinctly noticeable. About 8 inches of sludge floated on top of the sewage. An examination of the stream receiving the effluent showed an accumulation of black and white sludge and considerable slime along its sides and bottom for a distance of perhaps a quarter of a mile down stream. The tank was in need of cleaning.

BROOKFIELD. Water supply.—(Bull. 13, 38.)

BROOKPORT (1,443). Water supply.—(Bull. 11, 40; 13, 38.) Visited July 18. No important changes have been made in the waterworks since the last report. There are now 81 service connections. About 40 per cent of the people use cistern or well water. The Illinois Central Railroad obtains water from the city supply at a rate of 6½ cents per thousand gallons. The total consumption is about 30,000 gallons a day.

The water is of good sanitary quality.

BUCKLEY. Water supply.—(Bull. 13, 39.)

BUDA. Water supply.—(Bull. 13, 40.)

BUNKER HILL (1,046). Water supply.—(Bull. 13, 40.) Visited July 24 at the request of the Litchfield Creamery Company, which was contemplating the establishment of a condensery at that place if an adequate water supply could be obtained.

Three sources of water supply were examined; first, a small reservoir in the western part of town; second, an abandoned coal mine; and third, three 8-inch tubular wells about 100 feet apart located a mile east of town. The reservoir was not feasible as a source of supply on account of its small drainage area, about 10 acres, and its small storage capacity. The coal mine might give a sufficient yield. During the working of the mine, pumps were operated continuously; but as the discharge was handled through a 2-inch pipe, it was probably less than 100,000 gallons a day. The mine no doubt has a large storage capacity which would care for periodical fluctuations in demand. The mine supply has the advantage of being located within a few hundred feet of the proposed site for the creamery. As the mine is 280 feet deep, pumping would be rather expensive. Analysis of water from this source has not been made and it may be too highly mineralized for use in creamery machinery and boilers.

Three wells are reported to have given a yield of 147,000 gallons a day during a test, with a 12-foot lowering of the water level. Pumping one well affected the water level in the other two. The exact depth of the wells is not known; but in drilling rock was encountered at 50 feet and water was obtained after penetrating the rock a few feet and blasting. It is thought that these wells will yield all the water required for the creamery, and the cost of pumping from them would be less than that of pumping from the abandoned mine.

The sanitary quality of water from the wells should be determined after they are protected from surface contamination. The mineral content of water from the mine could be determined, and if suitable it could be used as a reserve supply.

BUREAU. Water supply.—(Bull. 13, 41.)

BUSHNELL. Water supply.—(Bull. 12, 40.)

Sewerage.— (Bull. 9, 17; 12, 41.)

BYRON. Water supply —(Bull. 11, 40.)

CAIRO (14,548). Water supply.—(Bull. 10, 96; 11, 40; 12, 42; 13, 41.) Visited July 17 and 19. Cairo is located at the junction of the Ohio and Mississippi Rivers at the southern tip of Pulaski County, of which it is the county seat.

The Cairo Water Company was incorporated January 29, 1886 with an authorized capital stock of $125,000, which on January 29, 1887 was increased to $200,000. No extensive improvements have been made recently as the franchise of the company expired October 1, 1915, and has not been renewed.

The source of supply is the Ohio River. The intake protected by a crib is located in the main channel about 175 feet from the shore at normal stage of the river. The low-service pumps, which raise the water to the filters, are located in a pit 28 feet 6 inches in diameter and 22 feet 7 inches below the main floor of the pumping station. The low-service pumping equipment includes two 3,000,000-gallon steam pumps, and one 6,000,000-gallon 10-inch centrifugal pump driven by a 100-horsepower steam turbine. The high-service pumping equipment includes one 6,000,000-gallon crank-and-fly-wheel pump, one 5,000,000-gallon direct-acting pump, and one 1,250,000-gallon direct-acting pump.

The water is filtered in six wooden tub filters installed in 1901. An average of 2.5 grains of aluminium sulfate per gallon is used as a coagulant. The effluent from the filters is treated with about 0.4 parts of chlorine per million.

The distribution system includes about 26 miles of mains, 255 valves, 301 fire hydrants, and about 3,300 service connections. A 200,000-gallon elevated tank, 180 feet high, is located near the center of the distribution system. The average daily pumpage is 4,310,000 gallons, or 287 gallons per capita per day, probably the highest consumption recorded in Illinois.

The water is of good sanitary quality. The necessary bacterial and chemical tests are made in a laboratory in the filter plant. During the past year the raw water had an average turbidity of 275 and an average color of 10. These were reduced in the filtered water to 25 and 0 respectively.

CALUMET RIVER. Pollution.—(Bull. 12, 42.)

CAMBRIDGE. Water supply.—(Bull. 10, 96.)

CAMP GRANT. Water supply.—Visited August 5 to September 14 at the request of the consulting engineers, to determine the sanitary quality of the water supply. Camp Grant is located on the east bank of Rock River 5 miles south of the city of Rockford.

A temporary water supply consisting of three wells about 130 feet deep had been developed to be used by the workmen during the construction of the camp. Samples of water collected from the wells on August 6 showed rather high bacterial counts and the presence of gas formers. These results confirmed tests previously made by local bacteriologists and tests made at Fort Leavenworth, Kansas. A chlorine control apparatus was secured and chlorine was applied to two of the wells. The well casings were tapped and galvanized iron pipe connections were made to the chlorine control apparatus. The flow of chlorinated water was divided so that one-half went to each well. The treatment was successful. Additional apparatus was secured and sterilization of this supply was continued until the permanent supply for the camp was developed.

The permanent supply then being developed is derived from six 10-inch wells from 150 to 185 feet deep into a coarse sand stratum. The wells are cased the entire depth and are equipped with strainers. The wells are equipped with air lifts. Water is discharged into a 300,000-gallon concrete reservoir from which it is pumped by electrically driven centrifugal pumps into a distribution system. An elevated tank of about 250,000 gallons capacity is connected to the distribution system. Sterilization of the water with chlorine began immediately upon the completion of the first well.

Before using water from the distribution system chlorine of lime in large quantities was added in the elevated tank and the chlorinated water was drawn from various parts of the distribution system. The tank was then refilled and examination of the water showed that the distribution system had been effectively sterilized.

It was found that a smaller quantity of chlorine was required to sterilize the iron pipes than to sterilize the wooden pipes. This is probably due to the fact that chlorine was used up by organic matter in the wooden pipes.

Chlorine control apparatus has been installed in the pumping station and can be used if it is necessary. Temporary wells have been abandoned.

CAMP POINT. Proposed water supply.— (Bull. 11, 41.)

CAMPUS. Water supply.—(Bull. 14, 27.)

CANTON (10,453). Water supply.—(Bull. 11, 41; 12, 43.) Visited July 9. No important changes have been made in the waterworks since the visit of July 1, 1914. There seems to be little chance of contamination of the wells, but some contamination might enter the open reservoir. No improvement has been made with regard to the fire protection connections between the city mains and the mains of the Parlin and Orendorff Company. The average daily consumption is estimated at 500,000 gallons.

CANTON. Sewage-disposal nuisance.—(Bull. 9, 17.)

CAPRON. Water supply.—(Bull. 14, 27.)

CARBON HILL. Water supply.—(Bull. 12, 44.)

CARBONDALE (5,411). Water supply.—(Bull. 11, 42.) Visited October 30. Water is obtained from five wells from 400 to 640 feet equipped with deep-well pumps. Two of these pumps are motor-driven and steam heads on two others are being replaced by power heads to be electrically operated. Two centrifugal fire pumps direct-connected to 35-horsepower motors have been installed. Each has a capacity of 500 gallons per minute against a head of 230 feet when operating at 1,740 revolutions per minute.

The water is not up to the standards of the U. S. Treasury Department for interstate carriers. The company is making an effort to improve conditions and to supply a water of excellent quality.

CARLINVILLE. Water purification.—(Bull. 10, 97; 12, 44.)

CARLYLE. Proposed water-purification plant.—(Bull. 9, 17; 11, 43; 13, 41.)

Sewerage.—(Bull. 12, 45.)

CARLYLE (1,982). Microscopic and sanitary survey of water supply.—Visited September 5. Untreated water from Kaskaskia River is used for the public water supply. The drainage area of the stream above Carlyle comprises about 274 square miles of comparatively low, level land. There are nine or ten towns of more than 1,000 population on the drainage area. A small stream which receives sewage from the County Poor Farm, located about 2½ miles from Carlyle, and sewage from several houses in the northern part of the city empty into the river on the same side as, and about 50 feet

ORGANISMS IN WATER.

Organisms.	Number of organisms per cubic centimeter.		
	At surface near intake.	At surface 35 feet above dam.	At surface in center of stream.
Chlorolphyceae—			
Protococcus	8	6	4
Volvox	20	10	
Cloesterium	2	2	
Cyanophyceae—			
Coelosphaerium			6
Protozoa—			
Glenodinium	40	30	16
Euglena	2	4	
Spongidae—			
Sponge spicules	6	6	4
Total	78	5S	30

upstream from, the waterworks intake. The intake is about 15 feet from the bank and 50 feet upstream from a loose rock dam. The stream was about 100 feet wide at this place and considerable water was flowing over the dam. The river banks are of clay and loam, and in general were rather clean, except for the growth of trees and bushes above the high water line. About one-half mile upstream from the intake, at a camping ground, there is a sandy beach said to be used extensively for bathing.

The water was very turbid, probably due to recent rains, and was polluted. There were no visible evidences of algal growths near the dam or intake nor on the sandy beach. Only a very few microorganisms were present in the water. Samples collected had a faint musty odor, but the amount of microscopic growth present was not sufficient to give any serious annoyance. It is possible that at other seasons and especially after sudden rises in temperature, difficulty with odor and taste-producing organisms might be encountered. The number of organisms present are given in the accompanying table.

The water is polluted and unless given proper treatment should not be used for drinking. The most satisfactory method of treating this supply would be by means of a properly constructed and properly operated filtration plant. Pending the construction of such a plant, the water should be sterilized.

CARMI. Water supply.—(Bull. 11, 44.)

CARPENTBRSVILLE (1,128). Water supply.—(Bull. 13, 42.) Visited June 19. No changes have been made in the waterworks system since the time* of the previous visit.

The water is of excellent sanitary quality and very satisfactory for domestic use. It has a mineral content of 494, a, hardness of 460, and a content of iron of 2.8 parts per million.

CARROLLTON (2,323). Water supply.—(Bull. 11, 44.) Visited December 12. Water for the public supply is secured from the spring in use at the time of former visit. The spring is not covered, allowing some chance of pollution of the supply. Water may be pumped by either of two pumps driven by gas engines. There are 380 service connections and the average daily consumption of water is 113,000 gallons. Operating expenses for the year are about $4,000.

Analyses of samples gives indication of some pollution. The water has a mineral content of 331, a total hardness of 280, and a content of iron of 0.2 parts per million.

CARTERVILLE. Proposed water supply.—(Bull. 12, 45.)

CARTHAGE. Sewage disposal.—(Bull. 10, 99.)

CARY. Water supply.—(Bull. 14, 28.)

CASEY. Proposed improved water supply.—(Bull. 10, 100; 13, 43; 14, 28.)

CEDAR POINT. Water supply.—(Bull. 11, 45.)

CENTRAL CITY. Water supply.—(Bull. 14, 29.)

CENTRALIA (9,680). Water supply.—(Bull. 10, 102; 11, 45; 12, 46; 13, 43; 14, 30.) Visited July 21. Bonds to the amount of $20,000 were issued August 1 to pay the remainder of the indebtedness to the company organized to provide funds for the impounding reservoir. As soon as the bonds have been retired a water purification plant will probably be built. Treatment of the water with hypochlorite of calcium has been discontinued. During the winter the water is used by some for drinking purposes.

It is recommended that treatment of the. water to destroy disease organisms be resumed. When the water is not treated all citizens should be warned to sterilize it before using for drinking so that there will be little chance of an epidemic being spread by means of the public water supply. Measurements of the water level in the reservoir should be made as they will be of considerable value in the future when the water consumption incrases and it becomes necessary to increase the supply. The present supply will be ample for many years but long-time records of yield may at some time be of great value.

CENTRALIA. Microscopic survey of reservoir.—(Bull. 14, 29.)

Sewerage.—(Bull. 10, 102; 12, 46.)

CERRO GORDO. Water supply.—(Bull. 12, 46.)

CHADWICK. Water supply.— (Bull. 11, 46.)

CHARLESTON. Water supply.—(Bull. 10, 103; 11, 46; 12, 47; 13, 43.)

CHATSWORTH. Water supply—(Bull. 9, 17; 14, 30.)

CHENOA (1,314). Water supply.—(Bull. 9, 17; 12, 48.) Visited June 19. No changes have been made in the public water supply since the last visit in 1914.

The water is of good sanitary quality. The amount of sodium salts is very high. It has a total mineral content of 1,275, a hardness of 240, and a content of iron of 1 part per million.

CHERRY. Water supply.—(Bull. 13, 43.)

CHESTER. Water supply.—(Bull. 9, 18; 11, 47.)

CHICAGO HEIGHTS (14,525). Water supply.—(Bull. 11, 47.) Visited October 13, after receiving word from the city engineer that water from the public water supply of the city had a peculiar odor and taste.

Water is obtained from five wells, each 200 feet or more in depth. The discharge pipes from the well pumps are connected to the suction pipes of the service pumps and to a surface reservoir of 180,000 gallons' capacity which acts as an equalizing basin. The reservoir is of stone and concrete construction and has a wooden roof. The reservoir is at a sufficient elevation to eliminate chance of pollution from surface drainage. There are some openings around the tops of the wells through which contaminating matter may enter. City officials thought that gas-house wastes might have gained access to the wells through fissures in the rock in which the wells are drilled.

Samples of water were sent by city officials and were analyzed in the laboratory. One sample taken from an iron service tap, one from a lead service tap, and one from the reservoir had disagreeable odors and tastes, while one taken directly from a well had no disagreeable odor. W. T. Goodman, assistant engineer, stated that at times of forced pumping the water from the wells has a strong odor. A boiler water analysis showed the presence of a large amount of sulfate, which will dissolve iron from iron pipes and form a precipitate in the water upon standing. In order to draw conclusions an inspection will be necessary.

The water is of good sanitary quality. It has a mineral content of 728, a hardness of 558, and content of iron of 1.0 parts per million.

CHICAGO HEIGHTS (14,525). Sewerage.—(Bull. 11, 48.) Visited October 13. Sanitary sewage from the city after passing through a septic tank and contact beds discharges into Thorn Creek. The effluent from the contact beds had a very dark color and rather strong odor, and was apparently septic and stale. Storm water and the wastes from many factories are discharged through a public storm sewer into an open ditch. A sewer from a chemical works, carrying trade wastes and sanitary sewage, also discharges into this ditch. The ditch discharges into Thorn Creek at a point a few hundred feet from where the sanitary sewage enters the creek. The wastes contained large quantities of light colored suspended matter, the greater part of which came from the public sewer. There was little change in the appearance of this waste along the open ditch. Experiments to determine the rate of settling of the suspended matter in the sewage, in the trade wastes, and in mixtures of the two were made in the laboratory, using a depth of sewage of 8 inches. These tests indicated that neither the sewage nor the trade wastes alone would settle clear in one hour. Mixtures of sanitary sewage and trade wastes settled practically clear in one hour. A mixture of one-fourth sanitary sewage and three-fourths trade wastes settled practically clear in one-half hour.

More complete investigations would require determination of what wastes should be withheld from the sewers in order to prevent clogging of the sewers; experiments on settling and treating the wastes while in a fresh condition and disposing of sludge; and probably other problems not yet anticipated.

CHILLICOTHE. Water supply.—(Bull. 12, 49.)

Pollution of Illinois River by Chicago Drainage Canal.—(Bull. 9, 19; 11, 50.)

CHRISMAN. Proposed sewerage.—(Bull. 11, 50; 13, 44.)

CISSNA PARK. Water supply.—(Bull. 13, 44.)

CLINTON. (5,165). Water supply.—(Bull. 12, 50.) Visited October 24. Clinton, the county seat of DeWitt County, is on the drainage area of Salt Creek, a tributary of Sangamon River.

Waterworks were installed in 1888. Water was obtained from wells 100 feet deep, near Salt Creek, 3 miles south of the city. These wells proving inadequate, in 1906 two wells 65 feet deep were drilled near the pumping station. Later, two wells 285 feet deep were drilled. As the quantity of water was not sufficient to meet the demand it became necessary to draw water from Salt Creek at times. This method of supplying water to the city continued until about 1911, when the work of enlarging the waterworks was started. A 10-inch well 340 feet deep was drilled near the pumping station in 1913. This well proved so satisfactory that in 1914 a second well 12 inches in diameter was drilled to the same water-bearing stratum. These two wells are cased to a depth of 320 feet, and below this a 20-foot strainer is placed' in each. They yield a total of about 1,500 gallons a minute with a lowering of the water level of about 10 feet. The quantity is more than ample to supply the needs of the city at the present time. Due to the failure of an old reservoir a new one was constructed in 1915. It has a capacity of 750,000 gallons and is divided into compartments so that one-half of it may be cleaned without emptying the other half. During 1917 two 1,500,000-gallon high service pumps have been installed. The average consumption is estimated to be about 600,000 gallons a day. As there are about 1,000 service connections the average daily consumption per service is about 600 gallons. This rate is rather high, probably due to the fact that only a very small percentage of the services is metered. The improvements to the waterworks since 1913 have cost approximately $20,000.

The water is of good sanitary quality. It has a mineral content of 523, a hardness of 312, and a content of iron of 0.7 parts per million.

COAL CITY (2,667). Water supply.—(Bull. 12, 50.) Water is obtained from a drilled well 350 feet deep and is equipped by an electrically-driven centrifugal pump with automatic control.

The water is of good sanitary quality.

COLFAX (965). Water supply.—Visited July 16. Colfax is in the northeastern part of McLean County on the watershed of Mackinaw River. The glacial drift in this vicinity ranges in depth from 100 to 125 feet. The surface elevation is about 750 feet above sea level. Water is obtained from two wells 105 feet deep. One well is 10 inches and the other 4 inches in diameter. The larger well is used ordinarily, the smaller one oeing held in reserve for emergency. The ground-water level is approximately 10 feet below the surface, and the operation of the well pumps lowers the water-level very little. The wells are cased to the water-bearing stratum, where strainers have been placed. The water-bearing formation is of sand and gravel. The larger well is equipped with a deep-well pump which has a capacity of about 125 gallons a minute. The end of the suction pipe is placed at a depth of 72 feet. The smaller well is equipped with a 75 gallon per minute pump. The pumps are belt-connected to' a gas engine, but a 15-horsepower electric motor is to be installed. These pumps discharge directly into the distribution system, which reaches practically all the built-up portion of the village. A 50,000-gallon elevated tank is connected to the distribution system. About 30,000 gallons of water is used daily.

Around the top of each well a concrete pit has been built, and the casing of each well extends about 1½ feet above the floor of the pit. There seemed to be very little chance for contamination. The water as it comes from the wells is very cloudy, due to dissolved gases, but clears up on standing a few minutes.

The water is of good sanitary quality. It has a mineral contest of 758, a hardness of 325, and a content of iron of 0.4 parts per million.

COLFAX. Proposed sewerage.— (Bull. 11, 51.)

COLLINSVILLE. Water supply —(Bull. 10, 104.)

Typhoid fever.—(Bull. 12, 51.)

Sewage disposal.—(Bull. 10, 104; 11, 51; 12, 50; 13, 45; 14, 31.)

COLUMBIA. Proposed water supply.—(Bull. 10, 105; 11, 51; 12, 51; 13, 46; 14, 31.)

Proposed sewerage and sewage treatment.—(Bull. 13, 46.)

COMPTON (387). Water supply.—Visited August 7. Compton is in the southeastern part of Lee County on the drainage area of Big Bureau Creek, a tributary of Illinois River.

The public water supply is derived from two wells 335 feet deep, one 6 inches and the other 3 inches in diameter. At the top of the wells is a pit about 4 feet deep, drained through a tile. The wells are equipped with electrically operated deep-well pumps with pump cylinders at a depth of 272 feet. The cylinder of the pump in the large well is attached to a drop pipe. Originally a cylinder was wedged in the well casing, but since the pump rods wore holes in the casing it was necessary to use the drop pipe. The well casing extends up into a cement block on the floor of the pit. The space between the outer casing and the drop pipe is open at the top, and oil and grease from the pump may run into the well. The pump cylinder in the smaller well is wedged in the well casing. A 75,000-gallon elevated tank is connected to the distribution system. The water consumption varies from 15,000 to 18,000 gallons a day. Practically the entire village is served by the public supply.

The water is of fair sanitary quality. The space between the drop pipe and the outer casing of the larger well should be closed to exclude contaminating matter. The water has a mineral content of 320, a hardness of 208, and a content of iron of 1.2 parts per million.

COOK, County poor farm. Sewage disposal.—(Bull. 11, 52.)

CREAL SPRINGS. Water supply conditions.—(Bull. 11, 52.)

CRBSENT CITY. Water supply.—(Bull. 13, 47.)

CRETE. Water supply.—(Bull. 13, 48.)

Proposed sewerage.—(Bull. 13, 48.)

CRYSTAL LAKE (1,242). Water supply.—(Bull. 9, 19; 11, 52.) Visited June 19. Crystal Lake and North Crystal Lake have been combined into one village and are supplied with water by the water works of Crystal Lake.

The water is of excellent sanitary quality.

CRYSTAL LAKE. Typhoid fever.—(Bull. 9, 19.)

CUBA (2,019). Water supply.—(Bull. 12, 51; 13, 48.) Visited July 9. The source of public water supply is a well 1,768 feet deep. The well and equipment are as described in Bulletin 13. The pump is operated about three hours every other day. The outside casing of the well extends 1½ feet above the floor. The top of the casing is open, allowing a slight chance for contamination.

The water is of excellent sanitary quality. It has a very salty taste and a very noticeable odor of hydrogen sulfide as it comes from the well. It is highly mineralized, having a mineral content of 2,326, a hardness of 836, and a content of iron of 12 parts per million. Such water is very unsatisfactory for industrial purposes.

CUBA. Proposed sewerage.— (Bull. 13, 49.)

CULLOM. Water supply.—(Bull. 14, 32.)

DANVERS. Water supply.—(Bull. 12, 51; 13, 50.)

DANVILLE. Water supply.—(Bull. 9, 19; 12, 52.)

Microscopic survey of reservoir.— (Bull. 14, 32.) Visited July 13. A microscopic survey was made of the 400,000,000-gallon reservoir located about 4 miles north of the pumping station. There had been a period of warm weather followed by a rather generous supply of rain, conditions favorable for algal growths.

At a few places in the upper portion of the reservoir small amounts of algal scum were noticed. The microscopical flora was not materially different from what it was when examined in 1916. Diatoms, Protozoa, Rotifers and Crustaceans, in addition to algae forms were present, and rather evenly distributed throughout the reservoir. The water contained a large amount of amorphous organic matter. The number of organisms present is shown in the accompanying table. Dissolved oxygen tests showed higher contents at the surface than at the bottom. Samples from the surface near the dam and near the upper end of the reservoir were supersaturated. A sample from the bottom near the center was 34 per cent saturated and a bottom sample at the upper end of the reservoir was 48 per cent saturated. Bottom samples from the channel above the reservoir showed higher percentages of dissolved oxygen. No trouble from odors or difficulty in operating the filters should be expected from the number of organisms present at this time. During prolonged periods of warm weather or at times of sudden rise in temperature microscopic growths might occur in sufficient quantities to cause annoyance. Treatment of the reservoir to destroy growths is unnecessary at this time.

ORGANISMS IN WATER.

Organisms.	Number of organisms per cubic centimeter.		
	Reservoir sample.	Sample from middle of main reservoir.	Samplefrom large reservoir at dam.
Diatomacaca—			
Nitzschia	80	40	20
Chlorophyceae—			
Protococcus	100	120	
Scenedesmus	30		
Pediastrum		6	4
Cyanophyceae—			
Mycrocystis	20		20
Coelosphaerium	30		
Protozoa, Rotifera, etc.—			
Anuraea	80	100	60
Vorticella	40	80	80
Codonella	30	90	70
Rotifers			80
Total	410	436	334

Horseshoe Lake, an emergency supply located near the pumping station, had been treated with copper sulfate five days previously, to remove an algal growth said to have been rather troublesome. The appearance of the water was very good. Few organisms were found and but a limited number of types were represented. The treatment with copper sulfate had been very successful. Samples collected were supersaturated with oxygen. A growth of common pond weed, Potamegeton filiformice, was noticeable but probably would cause no trouble.

The condition of the water, which had not changed appreciably since the first survey was made ten months before, was very good.

DECATUR (31,140). Water supply.—(Bull. 10, 106; 11, 53; 12, 55; 13, 51.) The amount of water available for the public supply is inadequate at times of very low water in Sangamon River. In regard to securing a supply from wells attention was called to a previous investigation. Water from two test wells examined in 1906 had very high mineral contents. Additional samples may be tested but it is improbable that an adequate supply of water of good quality could be developed from wells. It is proposed to provide a larger impounding reservoir. See sewage disposal.

DECATUR. Sewage disposal.—(Bull. 10, 107; 11, 253; 12, 55.) Meetings of city officials, of the City Club, and of the Commercial Club were attended. The employment of a competent consulting engineer to report on water supply and sewage disposal for the city was recommended. A report by a consulting engineer to the Association of Commerce outlined a plan for impounding water for public water supply and for treatment of sewage before discharge into the river and a plan for impounding sufficient water to provide a public water supply and to dilute the sewage flow from the city during times' of low stream flow. Plans for an impounding reservoir are being prepared.

DECATUR. Microscopic survey of reservoir.— (Bull. 14, 33.)

DEER CREEK. Water supply.—(Bull. 10, 107; 11, 53; 14, 33.)

DEKALB. Water supply.—(Bull. 13, 56.)

Sewage disposal.—(Bull. 13, 57.)

Pollution of Kiswaukee River.—(Bull. 13, 57.)

DELAND. Proposed water supply.—(Bull. 12, 55; 13, 58.)

DELAVAN. Water supply.—(Bull. 12, 56.)

DEPUE. Water supply.—(Bull. 13, 59.)

Proposed sewerage.— (Bull. 13, 59.)

DESPLAINES (2,348). Water supply.—(Bull. 13, 60.) Visited June 20. The well under construction described in Bulletin 13 has been completed by digging to a depth of 112 feet and sinking several tubular wells from that depth.

The water is of excellent sanitary quality. It has a residue of 1,030 and a chloride content of 250 parts per million.

DESPLAINES. Sewerage.—(Bull. 10, 66; 11, 54; 13, 61.)

DIXON. Water supply—(Bull. 11, 58; 13, 61.)

DOWNERS GROVE. Water supply.—(Bun. 13, 61.)

Sewerage and sewage disposal.— (Bull. 13, 62.)

DUQUOIN. Water supply.—(Bull. 9, 19; 11, 58; 13, 62.)

Sewage disposal.—(Bull. 12, 56; 13, 63.)

DWIGHT. Water supply.—(Bull. 12, 57.)

Sewerage and sewage treatment.—(Bull. 12, 57.)

EARLVILLE (1,059). Water supply.— (Bull. 9, 20.) Visited August 8. Since the previous visit in October, 1911, a new well has been drilled and a new electric motor installed. The well is in diameter 16 inches at the top and 12 inches at the bottom and 625 feet deep. A drop pipe is connected with the pump cylinder at a depth of 100 feet. The space between the casing and the drop pipe is open, allowing chances for contamination. Water is now discharged directly into the distribution system, to which a standpipe is connected. A motor-driven centrifugal pump for emergency use is now installed in the pumping station.

The water is of excellent sanitary quality. It has a mineral content of 309, a hardness of 241, and a content of iron of 0.8 parts per million.

EAST DUBUQUE. Water supply.—(Bull. 11, 60.)

EAST DUNDEE (1,405). Water supply.—(Bull. 9, 20.) Visited June 19 to collect samples of water. Springs on a hillside were developed in 1915 as a source of supply.

About 500 feet of sewer pipe laid with open joints at a depth of about 20 feet lead from the springs to a concrete collecting reservoir about half way down the hillside. The reservoir is 60 feet in diameter and 18 feet deep, and has a capacity of 340,000 gallons. It is divided into two parts, so that one part may be cleaned while the other is in use. It has a conical wooden roof on which are five cupolas with well-screened windows. From the reservoir the water flows by gravity to a pumping station near the center of the village.

No other material changes have been made since the plant was visited in 1911. The yield from the springs is sufficient to cause the reservoir to overflow frequently.

The water is of good sanitary quality. People living near dead ends on the distribution system complain of red' water.

EAST MOLINE. Water supply.—(Bull. 14, 33.)

EAST PEORIA. Water supply.—(Bull. 11, 61; 12, 58; 14, 34.)

EAST ST. LOUIS. Water supply.—(Bull. 11, 61; 13, 63.)

Pollution of Cahokia Creek.—(Bull. 13, 63.)

EAST ST. LOUIS (58,547). Well water supply in East St. Louis industrial district.—Visited March 22-23 at the request of the manager of the East St. Louis Chamber of Commerce.

The United States Government had requested that the East St. Louis Chamber of Commerce recommend sites for the location of a proposed armor-plate' factory, and that information regarding the available water supply be presented to the Government as follows:

(1) "Character of the nearest water supply suitable for use in boilers and for drinking and miscellaneous uses."

(2) "Water supply available for flushing and condensers if different source from that in previous question."

(3) "Is the water supply silt-bearing? Give chemical and bacteriological analyses, if possible, or refer to documents where these can be found."

Visits were made to factories located near the sites which the city is offering as possible locations for the armor-plate factory, and samples were collected from the wells from which these factories obtain their water supply. Two main sources of supply are available in the East St. Louis district: namely, Mississippi River and wells in the American Bottom along the river. Many of the factories have connections with the public water supply system, which supplies filtered river water; but these connections are generally for emergency use. Nearly all factories have obtained supplies of their own by sinking wells from 90 feet to 140 feet deep in the sand and gravel deposits of the bottom lands. Large quantities of water can be obtained at small cost from such wells. The wells yield from 150 gallons to 1,000 gallons or more a minute, depending upon their sizes and depths. The locations of the wells may also influence the yields. The static level of the water in the wells is high, and by constructing pump pits it is possible to draw water by direct suction.

Sanitary and mineral analyses were made of samples of water from six wells located in Mississippi River bottom lands. The samples were of good sanitary quality and suitable for drinking. Mineral analyses show that the waters from wells located in the East St. Louis industrial districts have higher mineral contents, are harder, and contain more iron than waters from wells at Wood River, Collinsville, and Edwardsville. Water from this industrial district contains a large amount of iron, which precipitates on standing, giving the water a brownish, turbid appearance. All samples contain both carbonate and non-carbonate hardness, making it desirable to treat the water before using it in boilers.

EAST WENONA. Water supply.—(Bull. 13, 65; 14, 34.)

EDWARDSVILLE. Water supply.—(Bull. 12, 58.)

Sewage disposal.— (Bull. 12, 59.)

EFFINGHAM. Water supply.—(Bull. 10, 108; 11, 63; 13, 65.)

Disposal of wastes from catsup factory.— (Bull. 9, 20; 10, 108.)

ELBURN (613). Water supply.—Visited September 11. Elburn is in the central part of Kane County on the drainage area of Fox River.

Waterworks were installed in 1900. The source of supply is a well 10 inches in diameter at the top, 4 inches at the bottom, and 1,450 feet deep. It penetrates about 120 feet of drift. Originally a deep-well pump driven by a gasoline engine was used to discharge water into the distribution system. Later, power was furnished by a producer gas engine which has been replaced by a steam plant. The cylinder of the deep-well pump, formerly at a depth of 130 feet, has been lowered to a depth of 154 feet. The capacity is about 125 gallons a minute. A surface reservoir into which the well pump now discharges has been built adjoining the pumping station, and a triplex pump has been installed to pump water from the reservoir into the distribution system. The surface reservoir is 50 feet long, 30 feet wide and 8⅔ feet deep. Two steel pressure tanks located within the pumping station are connected to the distribution system. The tanks are 8 feet in diameter and 36 feet long. The pressure carried varies from 35 pounds to 60 pounds. The distribution system includes 5 miles of 4-inch, 6-inch, and 8-inch cast-iron pipe, and 91 metered service connections. A minimum charge of $1.50 per quarter is made to consumers.

The water is of good sanitary quality. It has a mineral content of 361, a hardness of 271, and a content of iron of 1.6 parts per million.

ELDORADO (3,366). Proposed water supply and sewerage.—(Bull. 9, 20.) Visited November 1 to investigate water resources and the possibility of the installation of a public water supply.

During 1911 several plans were made to secure water from the north branch of Saline River and also from deep wells located in or near the village. Nothing has since been done to encourage the installation of a public water supply. Oil wells are being drilled about one-half mile north of the city, and should oil be encountered it is probable that the population of Eldorado will increase and that the installation of a public water supply will again be considered. In prospecting for oil three wells have been sunk to depths of from 1,700 to 1,800 feet. As yet no oil has been encountered. Water-bearing strata were entered at depths of 200, 700, and 1,600 feet. The water at 200 and at 700 feet was of good quality but very limited in quantity. At 1,600 feet water was found in considerable quantity but it had a very high salt content. The well driller said that the water encountered during the drillings was not taken account of, and he could give no reliable information concerning it. Water from shallow wells in this vicinity has a high mineral content, from 1,000 to 2,000 parts per million. Water from a 108-foot well has a mineral content of 1,417 parts per million, most of which is sodium carbonate and sodium chloride.

ELGIN. Water supply.—(Bull. 9, 20; 14, 34.)

Factory water supplies.— (Bull. 14, 35.)

ELGIN. Elgin National Watch Company, water supply.— (Bull. 14, 35.) Visited January 27. City water is being used except in boilers. A new connection to the city mains makes it possible to supply drinking water and flushing water directly. The receiving basin at the factory is being remodelled so that the chances of pollution of water stored in it will be eliminated. An elevated steel tank is being erected for the fire protection system. Before remodeling, tests were made to determine the points of high pressure in the different water systems in the factory. According to these tests the pressure on the drinking water system was normally higher than the pressure on the river water system at the connection through which the drinking water was contaminated as described in Bulletin 14.

ELGIN. Proposed sewage treatment.—(Bull. 9, 163; 12, 60.)

ELGIN. State Hospital. Water supply and typhoid fever.—(Bull. 10, 109.)

ELMHURST. Proposed improved water supply.—(Bull. 11, 64; 12, 61.)

Sewerage.—(Bull. 11, 64.)

Sewage pollution of Salt Creek.—(Bull. 12, 61.)

ELMWOOD (1,390). Water supply.—(Bull. 12, 62.) Visited July 6. No material changes have been made in the waterworks or source of supply since the examination made July 2, 1914.

The source of supply is a drilled well which was 1,487 feet deep, but is thought to be filled to within 600 feet of the ground surface. In drilling the well much trouble was experienced with quicksand, and after the easing was put in place the upper part of the well caved in and pushed the casing out of line. The top of the casing extends up into the concrete foundation upon which the pump head is placed. There appears to be little chance of contamination at this point. The pump cylinder is placed at a depth of about 84 feet. It is impossible to lower it because of a bend in the casing. The starting and stopping of the pump is automatically regulated by the height of water in the reservoir. The electric current used is obtained from Peoria. The average daily pumpage is from 20,000 to 30,000 gallons. Most of the people in the village use the public supply. The majority of services are metered.

EL PASO (1,470). Water supply.—(Bull. 10, 109.) Visited July 17. No changes have been made since the inspection in 1913. The station presents a very clean appearance and chances of the water becoming contaminated seem to be very slight.

The water is of good sanitary quality.

EL PASO. Sewerage.—(Bull. 10, 110.)

Disposal of corn-canning wastes.— (Bull. 13, 66.)

EUREKA. Water supply.—(Bull. 9, 21; 12, 62.)

Disposal of cannery wastes.— (Bull. 12, 235.)

Proposed sewerage.— (Bull. 13, 67.)

EVANSTON. Water supply.— (Bull. 9, 21; 10, 110; 13, 67.)

FAIRBURY (2,505). Water supply.—(Bull. 9, 22; 12, 63.) Visited June 20. Water is supplied from a well 2,000 feet deep described in **Bull.** 12. Another well drilled to a depth of 2,160 feet deep has not been equipped. This well yielded 80 gallons a minute during a test.

The water was in good sanitary condition.

FAIRFIELD (2,479). Water supply.—(Bull. 9, 22; 10, 110; 12, 64.) Visited July 25. Water for a public supply is obtained from an impounding reservoir. An 8-inch well near the pumping station, which was formerly used, has been partly dismantled. The reservoir is divided into two parts by an embankment. Many water lilies were growing in the western part. The banks were being cleared of brush. Cleaning the bottom and removing all fish is being considered. Increasing the impounding capacity is also being considered.

The water supply could be increased by building a dam a short distance downstream from the reservoirs or by increasing the size of the reservoirs by excavation, and increasing the size of pipe line which carries water to the pumping station. Excavation would probably be expensive. Fish could be killed by applying copper sulphate, the necessary amount being about 3 pounds per million gallons of water for catfish and 17 pounds per million gallons for black bass. To secure an even distribution of the chemical would be difficult.

FAIRFIELD (2,479). Sewerage.—(Bull. 12, 65.) Visited July 25. A system of sanitary sewers and a sewage disposal plant were installed in 1915. The system reaches nearly all parts of the city. The sewage plant is covered with a concrete roof and is not accessible to inspection. The plant is built practically as described in Bulletin 12. The effluent discharged was black. Considerable gas was generated in the tank and large amounts of sludge were being carried into Johnson Creek.

FARMER CITY (1,603). Water supply.—(Bull. 10, 111.) Visited June 18. No important changes have been made since the visit in 1913. Water is obtained from two 8-inch wells 176 feet deep. Six-inch drop pipes are used. In one well the drop pipe extends to a depth of 100 feet, in the other 80 feet. The water level is 30 feet below the ground surface. The pumping station has a concrete floor which comes up tightly against the well casing and apparently protects the well from pollution. At the time the last well was drilled considerable trouble was experienced with the quality of water pumped into the mains. Upon investigation it was found that an old well into which the engine and boiler room waste was discharged, penetrated the same vein or stratum, which allowed the oil and waste to enter the new well. Since this condition was remedied there has been no trouble.

The water is of good sanitary quality. It has a mineral content of 692, a hardness of about 260, and a content of iron of 1.0 parts per million.

FARMER CITY. Sewerage.—(Bull. 10, 111.)

FARMINGTON. Water supply.—(Bull. 12, 65; 13, 67.)

Sewerage and sewage disposal.— (Bull. 12, 66; 13, 68.)

FLANAGAN (590). Water supply.—Visited July 16. Flanagan is in the western part of Livingston County on the drainage area of Vermilion River. There are nine flowing wells in the village. The source of the public water supply is a 6-inch well 170 feet deep, cased to the bottom. When the well was first drilled water rose to a height of 11 feet above the ground surface. At present when not being pumped water flows into a watering trough. One flowing well 160 feet deep ceases to flow after the city well has been pumped for four hours. Water is drawn from the well and discharged into the distribution system by a triplex pump driven by a gasoline engine. An elevated wooden tank supported on a brick tower is connected to the distribution system. The pump is housed in the tower.

The water collected from the village well is of excellent sanitary quality. It has a mineral content of 604, a hardness of 103, and a content of iron of 0.1 parts per million.

FLOOD RELIEF WORK.—(Bull. 11, 65, 431.)

FLORA (2,704). Water supply.—(Bull. 9, 22; 12, 67.) Visited July 23 and 24.

Water for a public supply is obtained from three wells, two of which have been leased by the city. One well owned by the city, located in a school yard in the east part of town, is 157 feet deep. The upper 12 feet is in drift and the remainder is in rock. It is equipped with a motor-driven deep-well pump. One of the wells is owned by a lumber company and is located in their yard in the eastern part of the village. It also is equipped with a motor-driven deep-well pump. These two wells each have a capacity of about 24,000 gallons a day and the other well, leased from a resident, yields about 8,000 gallons a day. Wells are pumped almost continuously excepting in the evening when the electric power load is high. Another well, 165 feet deep, has been recently drilled by the city and is to be equipped with an electrically-driven deep-well pump. The well pumps discharge directly into the distribution system. None of the wells described in Bulletin 12 are in use, but an air-compressor is maintained in working order and two of the wells could be pumped in case of necessity. No material changes have been made in the pumping station since 1914. A reservoir formerly used as a collecting reservoir is now used as an equalizing reservoir, the water flowing into it when the pressure exceeds 18 pounds. When the water consumption is high, water is pumped from the reservoir into the mains. The elevated tank is not in use. The water consumption is about 45,000 gallons a day, the total yield of the wells.

The two largest water consumers in the city, a railroad company and an ice company, have private supplies. The railroad company has an impounding reservoir, and the ice company has a well 900 feet deep. The railroad company and city use the company supply in boilers. The ice company uses city water in its boilers. The ice company supply has a mineral content of about 60,000 parts per million and is used principally in cooling. The ice company has drilled five wells to a depth of 150 feet without securing water.

The public supply should be increased. If sufficient water can be secured by operating a few more wells, the well supply should be developed. Otherwise a surface supply should be developed.

From sanitary analyses of water from the city wells and from the leased well at the lumber yard it was evident that they were receiving some contamination. Waters from these two wells have mineral contents of 624 and 816, hardness of 419 and 547, and contents of iron of 0.7 and 0.4 parts per million respectively.

FLORA. Sewerage.—(Bull. 12, 68.)

FLORA (2,704). Stream pollution.—(Bull. 12, 68.) Visited July 23-24 to investigate the pollution of Seminary Creek. Farmers living near the creek claim that the water is unfit for stock to drink and that fish cannot live in it.

The greatest source of pollution is sewage from Flora. The sewage, as far as could be learned, consists of ordinary domestic sewage, wastes from the Ebner Ice and Cold Storage plant, and wastes from a creamery and an ice cream factory located in the cold storage building. About 45,000 gallons of water from the city supply is used daily. The Ebner Ice Company has a 900 foot well which yields water with a mineral content of 64,000 and a chloride content of 36,000 parts per million. Due to scarcity of other water this is used in brine tanks, ammonia cooling coils, and condensers. After use it was discharged into the city sewers, but notice had been given by the city a few days before to discontinue that practice. Apparently the wastes which enter the sewers from the creamery and ice cream factory are small in amount and are relatively unimportant factors in pollution.

The sewage after passing through a tank of 100,000 gallons' capacity discharges into Seminary Creek about a mile south of the city. Seminary Creek discharges into Elm Creek about 5½ miles downstream from the tank. About 1½ miles farther downstream Elm Creek joins Raccoon Creek.

The entire length of Seminary Creek and Elm Creek from the mouth of Seminary Creek to the junction of Raccoon Creek were inspected.

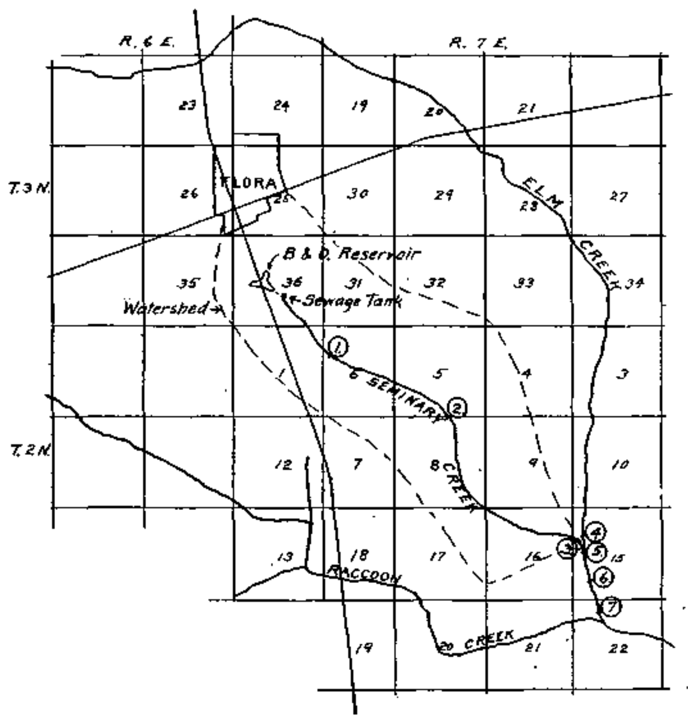

Figure 1.—Plat of Seminary Creek, Flora.

Numbers in circles on the above plat (Figure 1) give locations at which samples from streams were collected. The sewage tank influent and effluent had mineral contents of about 13,000 and chloride contents of about 8,000 parts per million. About one mile downstream the mineral and chloride contents were 20,000 and 11,000 parts per million respectively and the flow was at a rate of about 60,000 gallons a day. A short distance below the sewage tank there was a luxuriant growth of green algae, and at station 1, about a mile downstream, the water was supersaturated with oxygen; the ammonia nitrogen content, which was 15.2 at the tank outlet, was only 0.4 parts per million and the number of bacteria was very small.

Downstream the algae growth disappears. The flow decreased to zero at the mouth of the creek and the mineral and chloride content of water standing in pools increased. No fish were seen in the stream. Views of pools are shown in Figures 2 and 3.

Figure 2.—Seminary Creek, Flora.

In Elm Creek water from a pool above the mouth of Seminary Creek contained 2,400 parts per million of chloride, and water from a pool below Seminary Creek contained 10,300 parts per million of chloride. One live turtle and no dead fish were seen up the stream from the mouth of Seminary Creek. There were nine dead fish in a pool at the mouth of Seminary Creek. Within about one-fourth mile downstream from the mouth of Seminary

Figure 3.—Elm Creek at Station 5, Flora.

Creek were six pools from a few feet to a hundred feet or more in length in which 56 dead fish were seen. Nearly all the fish were small cat-fish but three were small bass. A few of the dead fish were more than 6 inches long.

Two dead turtles and a number of clam shells were seen. No dead fish were found downstream from these six pools. One-half mile below the mouth of Seminary Creek cattle were drinking from a pool. When approached they left the pool but stopped to drink from depressions on the bank filled by the rain then falling. They were apparently thirsty and preferred rain water for drinking. Water in this pool contained 9,800 parts of chloride per million.

Elm Creek above its junction with Raccoon Creek for a distance of one-fourth to one-half mile appeared to be similar to the other streams in the vicinity and many water-lilies were growing in the stream. Residents from nearby stated that cattle drank this water. It contained 8,000 parts per million of chloride.

The concentration of salt necessary to kill various kinds of fish, according to M. M. Wells, varies from 1.45 to 2.90 per cent. The concentration of salt in the stream was as follows:

Location.	Per cent salt.
Seminary Creek at sewage tank outlet	1.30
Seminary Creek at station 1	1.90
Seminary Creek at station 2	2.38
Seminary Creek at mouth	1.86
Elm Creek above mouth of Seminary Creek	0.39
Elm Creek at mouth of Seminary Creek	1.86
Elm Creek at station 6	1.62
Elm Creek at junction with Raccoon Creek	1.31
Raccoon Creek above Elm Creek	0.005

Seminary Creek has been polluted by sewage from the city of Flora. Part of the time the creek has no flow other than the effluent from the city sewage tank. Without this effluent it would contain pools of water which, if not contaminated from other sources, would be suitable for watering stock for several months each year. Pollution has been due principally to salty waste from the Ebner Ice Company. The city of Flora should, if possible, supply the Ice Company with sufficient water so that use of the well yielding salty water could be discontinued. If sufficient water to supply all demands cannot be secured from wells, a surface water supply should be developed by the city or by others. If the condition of Seminary Creek and Elm Creek is not sufficiently improved by increasing the supply of fresh water and eliminating salty wastes from the sew'age it will be necessary to install additional sewage purification works.

FOREST PARK. Water supply.—(Bull. 10, 112.)

FORREST. Water supply.—(Bull. 14, 39.)

FORRESTON. Water supply.—(Bull. 11, 65.)

FORT SHERIDAN. Water supply.—(Bull. 9, 23; 10, 111; 13, 68.)

FOX RIVER WATERSHED.—(Bull. 9, 147; 11, 66.)

FREEBURG. Water supply.—(Bull. 11, 66.)

FREEBURG. Microscopic and sanitary survey of the public water supply.—Visited September 6. Water for the public supply is obtained from Freeburg Lake, a reservoir on privately owned land formed by an earthen dam across a ravine near the east edge of the village. The dam is about 150 feet long and 30 feet high. The reservoir has a capacity of about 20,000,000 gallons and covers an area of 6 or 8 acres. The tributary drainage area is about four square miles. A well-kept park surrounds the lake. The banks are of sandy clay and the approaches to the lake are rather steep in nearly all places. At the upper end of the lake are several small ravines. These contained little or no water at the time. The land around the lake is rolling and is well covered with trees.

Near the dam extending over an area of perhaps 12 square feet was a rather heavy algal scum. Little evidence of filamentous algal growth could be seen at any place near the shore of the lake. The water was not highly colored and showed very little inorganic turbidity. It did, however, show a rather heavy precipitate that appeared to be due to the presence of a fine algal growth that existed throughout the reservoir. Odor-producing organisms were present in sufficient quantity to give the water a very decided taste and odor which would be objectionable in case the water were used for drinking. The dissolved oxygen content of the water was high at the surface and low near the bottom. This was doubtless due to the presence of algae near the surface, since these organisms in their process of growth liberate large quantities of oxygen. Samples from the deepest point were 5° C. colder than other samples, indicating the presence of a spring. They gave off the odor of H_2S and their dissolved oxygen content could not be determined as colors were destroyed by what appeared to be a sulfide.

GRGANISMS IN WATER.

Organisms.	Number of organisms per cubic centimeter.		
	Surface sample 40 feet from shore.	Surface sample 7 foot depth.	Surface sample 6 foot depth.
Chlorophyceae—			
Protococcus	20	200	160
Protozoa—			
Ceratium	58	40	360
Anuraea		368	50
Stentor		58	60
Vorticella			6
Total	78	666	636
STANDARD UNITS PER CUBIC CENTIMETER.			
Cyanophaceae—			
Anabaena	3,940	3,800	4,000
Aphanizomenon	3,380	3,400	300
Amorphous matter	1,500	1,600	1,200
Total	8,820	8,800	S,200

Organisms in the water could be killed, thereby doing away with the accompanying tastes and odors, greatly improving the appearance of the water and overcoming difficulties if the water were filtered, by treating from time to time with copper sulfate.

Water is pumped directly into the mains. It was in fair sanitary condition at the time, but as it receives surface drainage from a portion of the city, it can not be considered safe for drinking. It is recommended that the village secure an adequate supply of water which may be used for drinking.

FREEPORT. Water supply.—(Bull. 10, 113; 13, 68.)

FULTON. Water supply.—(Bull. 11, 67.)

Sewerage.—(Bull. 11, 68.)

GALENA. Water supply.—(Bull. 11, 69; 12, 68.)

Sewage disposal.—(Bull. 12, 68.)

GALESBURG. Water supply—(Bull. 9, 23; 10, 114; 12, 69; 13, 71.)

Sewage disposal.—(Bull. 9, 23; 10, 114; 12, 70.)

Pollution of Cedar Creek.—(Bull. 9, 23; 10, 114; 12, 70, 196-224; 13, 72.)

GALVA. Water supply and sewerage.—(Bull. l0, 115.)

GENESEO. Water supply—(Bull. 10, 116.)

Pollution of Geneseo Creek by city sewage.—(Bull. 10, 117; 11, 70; 12, 70.)

GENEVA. Water supply.—(Bull. 9, 23.)

Sewage treatment.—(Bull. 12, 70.)

Illinois State Training School for Girls. Plans for sewage treatment—(Bull. 12, 71.)

GENOA. Water supply.—(Bull. 11, 70.)

Sewage disposal.—(Bull. 12, 71; 13, 72.)

GEORGETOWN. Proposed water supply.—(Bull. 9, 24; 10, 117.)

Proposed sewerage and sewage treatment.—(Bull. 12, 72.)

GIBSON CITY. Water supply.—(Bull. l0, 118.)

Disposal of cannery wastes.—(Bull. 12, 73.)

Typhoid fever.—(Bull. 10, 118; 13, 73.)

GILLESPIE (2,241). Proposed . water supply.—Visited February 14 and December 13. Preliminary plans and. estimates for a public water supply have been prepared, the estimated cost of the project being about $90,000. Since the finances of the village are so nearly exhausted it is improbable that a waterworks can be constructed by the municipality, but a private company is prospecting for a suitable supply. Four sources have been considered: (1) an impounding reservoir to be made by damming Cahokia Creek, with a tributary drainage area of 20 square miles, (2) an impounding reservoir to be made by damming up Spring Creek, with a tributary drainage area of approximately 3½ square miles, (3) a deep-rock well, (4) deep-drift wells. This last-mentioned source has not been investigated very thoroughly. The strata to be penetrated are not known, but from well drillings near the village, the drift is known to be from 60 to 70 feet thick. In one drilling a hard shale was encountered at a depth of 30 feet. The private water company was preparing to drill a test well. The project of a deep-rock well has been abandoned because of the high mineral content of the water from mines and wells at various places in the neighborhood.

The residue in waters from many shallow dug wells in the vicinity varies from 270 to 1,670 parts per million.

GILLESPIE. Sewerage.—(Bull. 13, 73.)

GILMAN. Water supply.—(Bull 11, 71.)

GIRARD (1,891). Proposed water supply.—(Bull. 11, 71.) Visited February 17. The installation of a water supply was considered in 1913 when a party proposed to develop a well northwest of the city. No guarantee of the quantity of water was made and the city did not accept the proposition. Previous to the visit there had been a prolonged dry period and it was necessary to ship water from outside the city for use in a coal mine. During the week of the visit about 50,000 gallons of water were hauled to the city to be used in the mine. This mine is over 300 feet deep and by pumping about half an hour a day with a small duplex pump it is possible to keep the mine free of water. There are some springs southwest of the city, but neither the amount of flow from these nor the possibility of obtaining good wells in that vicinity has been determined. The installation of a public water supply has not been considered further.

GLENCOE. Water supply and sewerage.—(Bull. 9, 24.)

GLEN ELLYN. Water supply.—(Bull. 12, 75.)
Sewage disposal.— (Bull. 12, 74.)

GLENVIEW. Water supply.—(Bull. 14, 40.)

GRAFTON. Pollution of Illinois River.—(Bull. 11, 72.)

GRAND RIDGE. Water supply.—(Bull. 11, 72; 13, 74.)

GRANITE CITY. Water supply.—(Bull. 11, 72; 13, 74.)
Proposed improved sewerage.— (Bull. 13, 75.)

GRANT PARK (692). Water supply.—Visited November 13. Grant Park is in the northeastern part of Kankakee County on the drainage area of Kankakee River. The village has a limited storm sewer system with an outlet one-fourth mile south of town. The drift is generally about 50 feet in thickness, at which depth limestone is encountered.

Waterworks were installed in 1887. The source of supply is an 8-inch well, 147 feet deep, cased to a depth of 75 feet. Water is obtained from a limestone formation. The normal water level is 30 feet below the ground surface. Extensive pumping tests failed to reduce the quantity of water available. For an emergency supply a 10-inch well 180 feet deep located in a nearby brick yard is available, from which water may be pumped into the distribution system through a 4-inch cast-iron pipe. Water is pumped from the village well by a deep-well pump operated by a gasoline engine. The distribution system includes 1.8 miles of 8-inch, 6-inch and 4-inch cast-iron pipe. There are 96 service connections. In the pumping station are two pressure tanks each 8 feet in diameter and 36 feet long. A pressure of about 50 pounds per square inch is carried. About three-fourths of the population use the public supply. All services are metered. The average daily consumption is estimated at 13,000 gallons. The cost of the waterworks has been about $20,000.

The water is of excellent sanitary quality. It has a mineral content of 473, a hardness of 394, and a content of iron of 0.9 parts per million.

GRANVILLE. Water supply.—(Bull. 13, 75.)

GRAYSLAKE. Sewage disposal.—(Bull. 12, 75; 13, 76.)

GRAYVILLE. Water supply.—(Bull. 10, 119.)

GREAT LAKES, Naval Training Station. Water supply.— (Bull. 9, 28; 11, 34; 13, 76.)

GREENUP. Water supply.—(Bull. 10, 119; 11, 74; 13, 76.)

GREENVIEW. Water supply.—(Bull. 11, 75.)

GREENVILLE (3,178). Water supply.—Visited June 14. Greenville is located near the center of Bond County, of which it is the county seat, on the drainage area of Shoal Creek, a tributary of Kaskaskia River. Beneath 25 feet of clayey soil is a water-bearing stratum of sand and gravel from which a great many private wells obtain their supplies.

Waterworks were installed in 1884. Water is obtained from wells 50 feet deep, cased with S-inch iron pipe and equipped with brass strainers. The water level is 14 feet below the ground surface, and the ends of the pump suctions are placed at a depth of 45 feet. The yield of the wells is not known, but it is estimated that 100,000 gallons of water a day is used. The supply has always been adequate to meet this demand. The original installation included two wells operated on the Hawley direct-pressure plan, the pump drawing from the wells and discharging directly into the distribution system. In 1910 an elevated tank was installed, deep-well pumps were placed in each of the wells and a 45,000-gallon concrete surface reservoir was built. Two 500,000-gallon duplex pumps installed in a pit are now used to force water into the distribution system at a pressure of about 85 pounds. The waterworks were run in connection with the city electric plant and the , pumping machinery is electrically operated. The distribution system includes three miles of 4-inch, 6-inch, and 8-inch cast-iron pipe and 155 service connections, 70 per cent of which are metered. About four-fifths of the population use the public supply. A 50,000-gallon elevated tank connected to the distribution system is located on the highest land in the town. The top of the tank is approximately 180 feet above the lowest part of the town. The original cost of waterworks was $20,000.

Greenville is situated near oil fields and there are many gas wells within two miles of the city. Formerly, trouble was experienced with odors and tastes of gas and oil in the water, but during the past two years these have not been noticed by the consumers. Odors were noticed when a manhole cover was removed from the top of the reservoir. The spaces between the drop pipes and well casings should be covered, as they give some opportunity for contamination to enter the well.

The water is of fair sanitary quality. It has a mineral content of 673 and a hardness of 460 parts per million and contains no iron.

GREENVILLE. Sewerage and sewage disposal.—(Bull. 11, 75; 12, 76; 13, 77.)

GROSS POINT (1,008). Water supply.—Visited October 16. Gross Point is located in Cook County about 20 miles north of Chicago. The center of the village is about one mile west of the center of Wilmette. At different times during the past few years there has been agitation for the installation of a public water supply. Water is secured mostly from shallow drift wells. In the main street there is about one-half of 6-inch cast-iron pipe connected to the water mains of Wilmette. This line is primarily for fire protection, but there are a few service connections from it. The supply is filtered Lake Michigan water secured from Evanston.

The water from the water main in Gross Point is of excellent sanitary-quality. It has a residue of about 170 parts per million.

HAMILTON. Water supply.—(Bull. 10, 120; 11, 76; 13, 77.)

HARMON. Water supply.—(Bull. l0, 121 14, 41.)

HARRISBURG. Water supply.—(Bull. 9, 24; 10, 121; 11, 76; 12, 76.)

Pollution of public water supply by improper sewage disposal.—(Bull. 11, 77; 13, 79.)

HARRISBURG. Microscopic and sanitary survey of water supply.—Visited September 10. Water for a public water supply is obtained from a 48,000,000-gallon reservoir formed by a dam about 7 or 8 feet high across the Middle Fork of Saline River about two miles northeast from the city. The water is filtered and treated with chlorine. The tributary drainage area of the reservoir is about 210 square miles. Heavy rain had fallen three days before and water was flowing over the dam to a depth of 3 or 4 inches. At times, however, there is little flow in the stream. The water is turbid even at times of low flow.

The banks of the stream are of yellow clay and in general are free from growth for one or two feet above the water level.

The dissolved oxygen content of the water on the surface and at the bottom of the stream was 5.2 parts per million above the dam and 6.9 and 6.6 parts per million respectively below the dam. No filamentous algal growths were seen. The number of organisms in two samples collected are shown in the accompanying table.

ORGANISMS IN WATER.

Organisms.	Number of organisms per cubic centimeter.	
	Surface and bottom sample 10 feet from bank.	Surface and bottom sample 15 feet from bank.
Chlorophyceae—		
Coelastrum	4	....
Protozoa—		
Codonella	8	....
Paramoecium	4	2
Euglena	4	60
Syncrypta	....	2
Crustacea—		
Cyclops	....	4
Total	20	6S

The number is not great. Types of organisms capable of producing odors were present and it is probable that at times they may be numerous enough to cause mechanical clogging of the filters and to produce sufficient oxygen to cause air binding in the filters, thus increasing the expense of operation.

The stream flows through a mining district and is subject to contamination. The filtered water was in excellent sanitary condition.

HARVARD. Water supply.—(Bull. 12, 78.)

Sewage disposal.—(Bull. 10, 122; 12, 79.)

HARVEY. Water supply.—(Bull. 13, 81.)

Investigation of nuisance.— (Bull. 10,]23.)

HAVANA. Water supply.—(Bull. 12, 79.)

Pollution of Illinois River by Chicago Drainage Canal.— (Bull. 11, 77.)

HENNEPIN (451). Water supply.—Visited November 23. Hennepin, the county seat of Putnam County, is in the northwestern part of the county of the east bank of Illinois River. Private wells are in general use and there is no sewer system.

Waterworks, including an artesian well, storage tank and distribution system were installed in 1875 at a cost of $3,000. The well is 4 inches in diameter and 800 feet deep. It penetrates about 400 feet of drift. In 1875 the pressure at the top of the well was 65 feet. It has decreased to 18 pounds" and a pump has been installed to pump water into an elevated tank. Water in the tank is held for use in emergencies and ordinarily water is supplied to the distribution system direct from the well. There are eight service connections and the annual income is $40.00.

The water is of good sanitary quality but highly mineralized. It has a mineral content of 2,910, a hardness of 36, and a content of iron of 1.0 parts per million.

HENNEPIN. Pollution of Illinois River by Chicago Drainage Canal.—(Bull. 9, 24.)

HENRY. Water supply.—(Bull. 12, 80.)

Pollution of Illinois River.—(Bull. 11, 77.)

HERRIN. Water supply.—(Bull. 10, 125; 13, 82.)

Proposed sewerage.—(Bull. 10, 125.)

HEYWORTH. Proposed water supply.—(Bull. 14, 42.)

HIGH LAKE. Proposed water supply.—(Bull. 9, 24.)

HIGHLAND. Proposed water supply.—(Bull. 10, 126; 13, 83.)

Proposed sewerage.—(Bull. 13, 83.)

HIGHLAND PARK. Water supply and sewerage.—(Bull. 9, 24; 10, 126.)

Sewage treatment.— (Bull. 9, 24; 13, 83.)

HILLSBORO (3,424). Water supply.—(Bull. 10, 127; 12, 81; 13, 84.) Visited February 14. An earthen dam is being built 1 mile northeast of the city on the middle fork of Shoal Creek, near the mouth of Brush Creek, for the purpose of impounding a public water supply. A concrete core wall about 1 foot wide at the top is built in sections about 15 feet long. At the time of visit the work had been temporarily stopped.

HILLSBORO. Sewage pollution of Middle Fork of Shoal Creek.—(Bull. 12, 83.)

HINCKLEY. Water supply.—(Bull. 11, 78.)

HINSDALE. Water supply.—(Bull. 11, 78; 13, 84.)

HOLLYWOOD. Water supply.—(Bull. 13, 86.)

HOMER. Pollution of private wells—(Bull. 12, 84; 13, 86.)

HOMEWOOD. Water supply.—(Bull. 12, 84.)

HOOPESTON. Water supply.—(Bull. 10, 128.)

Flooding of cellars by sanitary sewage.— (Bull. 14, 42.)

Sewage disposal.—(Bull. 11, 78; 14, 42.)

HUNTLEY (773). Water supply.—Visited September 12. Huntley is located in the southern part of McHenry County on the drainage area of Kishwaukee River.

Installation of the village waterworks was begun in 1903 and completed in 1905. Water is obtained from three 6-inch wells located near the center of the village, two of which are 74 feet and the other 69 feet deep. The wells are connected by a suction line to a triplex pump which discharges into the distribution system and an elevated wooden tank. The pump is located in a pit 3 feet deep in a room in the village hall. It has been operated by a 12-horsepower gasoline engine, but a 10-horsepower electric motor is now being installed. While this change is being made, water is being supplied to the city by the J. F. Jelke Company from wells of about the same depth as the city wells. The distribution system extends to nearly all parts of the village. There are 121 service connections. The average consumption during the summer is about 30,000 gallons a day. Water is sold on a flat rate basis.

Water from the village wells and water from the J. F. Jelke supply are of good sanitary quality and satisfactory for drinking. Water from the village wells has a mineral content of 430, a hardness of 374, and a content of iron of 0.8 parts per million.

ILLINOIS RIVER. Examination of Illinois River between the cities of Morris and Peoria.—(Bull. 14, 44.)

IPAVA (652). Water supply.—(Bull. 12, 85.) Visited July 10. The well in use in July, 1915, has been abandoned, and a new well 1,324 feet deep, extending 20 feet into St. Peter sandstone, has been drilled and is now supplying the village with water. The static water level is 82 feet below the ground surface and by 24 hours' continuous pumping, the water is lowered 2 feet. On account of leaks in the elevated tank the lower 4 feet of it has been filled with concrete and a row of plates has been removed from the top. The water consumption is about 24,000 gallons a day. Water is pumped from the well into a reservoir by an electrically driven deep-well pump which is operated four or five hours a day. A pump driven through gearing by an electric motor delivers water from the reservoir into the distribution system, to which an elevated tank is connected. The distribution system includes 14,350 feet of mains, 30 fire hydrants, and 99 service connections, . 63 of which are in use.

The water is of fair sanitary quality.

JACKSONVILLE. Water supply.—(Bull. 10, 89; 12, 85.) At the request of a committee of citizens and the city commissioners a joint investigation of water supply conditions was made by the State Geological Survey, the State Board of Health, and the State Water Survey. A report on proposed improvements of the public water supply of Jacksonville was made April 21.

In accordance with recommendations, tests were made by the city to determine the amount of water available from wells in the vicinity of the city wells now in use. Following the change of State administration, effective July 1, the State Department of Public Health and the State Geological Survey and State Water Survey Divisions of ,the Department of Education and Registration cooperated with the city and made further investigations of possible sources of water supply.

A public water supply was installed in 1871 with a small impounding reservoir known as Morgan Lake, located south of the city as the source of supply. Later, to increase the supply a well was drilled to a depth of 2,200 feet and three other wells were drilled to a depth of more than 3,000 feet. As the water contained considerable mineral matter and hydrogen sulfide gas, making it objectionable for domestic use, the wells were abandoned. A water supply was developed at Bluffs by the Jacksonville Water Works Company, organized in 1905, and a 20-inch steel pipe line was built from Bluffs to the city of Jacksonville. Several tests were made but water was not supplied to the city for any considerable length of time.

At the present time water is secured from the impounding reservoir, Morgan Lake; from wells near the north city limits known as the North wells or Widenham-Daub wells; and from the south branch of Mauvaise Terre Creek. Some water has been pumped from a small drainage ditch in the southwest part of town, formerly used to supply the State School for the Deaf and Dumb. During dry seasons the total water supply has been little more than the yield of the wells, which is only about one-third of the normal consumption.

The North wells vary in depth from 60 to 74 feet. Each is equipped with an electrically driven deep-well pump of a capacity varying from 230,000 to 460,000 gallons a day. The well pumps discharge into a small basin from which water flows by gravity to a reservoir 30 feet 10 inches in diameter. Water is pumped from the reservoir into the city mains by an electrically driven centrifugal pump. Measurement of the rise of water in the reservoir made by Joshua Vasconcellos, Commissioner of Public Property, showed that the yield during the spring and summer was about 470,000 gallons a day. On February 28 the yield of each well was as follows:

	Well number—				
	1	3	4	5	2
Yield in gallons per day	96,500	23,000	150,000	57,600	115,000

As the flow from each well was less than the capacity of the well pump it is probable that the water level while pumping was close to the bottom of the suction pipe near the bottom of the well.

The yield of wells No. 1 and No. 2 increased from 230,000 gallons on May 9 to 310,000 gallons on May 13 when the other wells were not pumped.

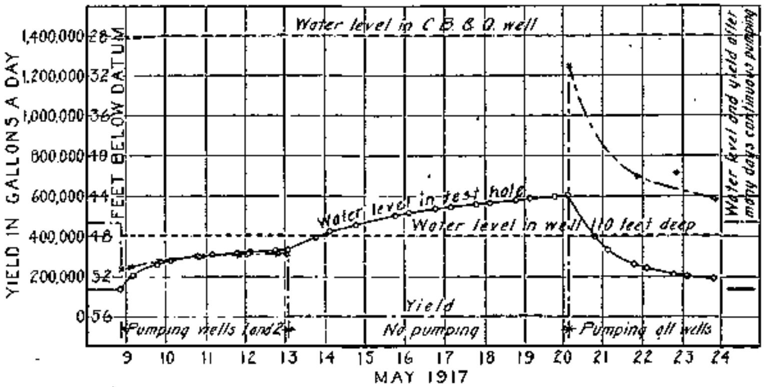

Figure 1.—Water levels and yield of north wells, Jacksonville.

The depth to water in an old well 20 feet from well No. 3 known as the square hole, was about 50 feet when pumping all wells continuously, 46 feet on May 13 after four days' pumping from wells 1 and 2 only, and 41 feet on May 20 after seven days without pumping. Rates of pumping and water levels are shown in Figure 1. In the square hole are two wells, one in the upper stratum and one extending to a lower water-bearing stratum. During the summer a leak in a plug in the deeper well developed, raising the water

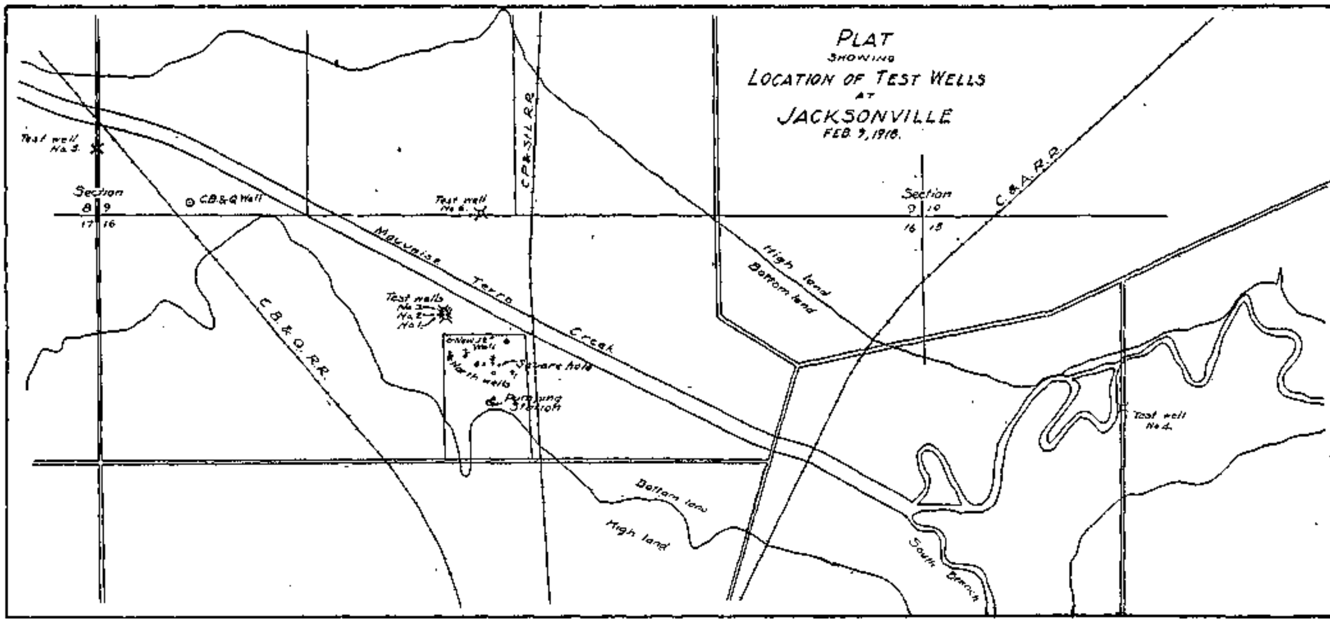

Figure 2.—Plat showing' location of lets wells, Jacksonville.

about 20 feet and making further measurments valueless for comparison with measurements previously taken. Measurements of water level were taken in an abandoned well of the C. B. & Q. R. R. located in the valley about 2,000 feet down-stream from the city wells. This well was dug to a depth of 25 feet, below which 2-inch pipes were driven. These pipes were apparently partly filled and water did not flow freely into nor from them. Water in this well stood about 25 feet below the level of the ground surface at the city wells. No appreciable change was noted during 1917.

Six tests wells were drilled in the valley of Mauvaise Terre Creek near the north city wells. One, No. 4, is about three-fourths of a mile east, four a short distance north and another is on North Main Street, about half a mile northwest of the north city wells. The location of the test wells is given in Figure 2. The north wells and test wells near-by penetrate a water-bearing stratum of fine sand containing a small amount of gravel, the bottom of which is at a depth of about 70 feet. Near the center of the valley north of the north wells this stratum is at about the same depth or slightly higher and contains more coarse material. At test well no. 4 in a public road near the center of the valley of the north branch of Mauvaise Terre Creek about three-fourths of a mile east of the north wells, no sand or gravel was encountered from the ground surface to a depth of 90 feet. At test well No. 5 on North Main Street, a sand stratum containing very little coarse sand or gravel was encountered between depths of 58 and 62 feet. Test well No. 2 about 200 feet north from the north city wells was drilled to a depth of 170 feet. A second water-bearing stratum was encountered between depths of 140 and 146 feet.

Preliminary pumping tests were made of test wells Nos. 1, 2, and 3. Considerable difficulty was encountered due to fine sand. The maximum rate of pumping a test well was about 80 gallons a minute. As the lower water-bearing stratum yielded water of poor quality, no attempt was made to determine its maximum yield. A long-time test of the upper stratum is to be made after the completion of all test wells.

In the valley of the south branch of Mauvaise Terre Creek near the Jacksonville cemetery are three wells 125 feet deep which were to be used as a source of supply for the Illinois School for the Blind. These penetrated quicksand which filled the casings and after trying several kinds of screens the wells were abandoned. Several wells have been drilled in the city.

None except the city wells have yielded a large quantity of water.

Water of good sanitary quality is secured from the north wells. The iron content, about 3 parts per million, is, however, very high and after coming in contact with air the water would become turbid. A growth known as crenothrix would thrive in mains through which this water flows. No other city in the State as large as Jacksonville is supplied with a water containing more than 1 part per million of iron. At Champaign-Urbana and at Freeport where the supplies contain 2.0 and 0.7 parts per million of iron respectively the water is filtered to remove the iron. The water from the lower stratum is highly mineralized and would not be very satisfactory for a public supply.

Indian Creek, Snake Creek, Big Sandy Creek and the north and south branches of Mauvaise Terre Creek in the vicinity of Jacksonville were inspected to note the possibilities of impounding water for a public supply.

The drainage area of a stream chosen for a public water supply should be great enough to supply sufficient water for the needs of the city in the driest year. Occasionally the run-off is less than 6 inches, or 100,000,000 gallons per square mile per year. A report of the Rivers and Lakes Commission of Illinois gives rainfall records and records of run-off on several drainage areas in Illinois. On three of the drainage areas a rainfall of 20 inches during the six summer months gives a run-off of about 1 inch. With a rainfall of 12 inches in the summer months the run-off from a drainage area of a few square miles may be less than the amount lost by leakage from a reservoir. At Alexander for six months from December, 1900, to May, 1901, inclusive, the rainfall was 8.8 inches and for the six months from June to November, 1901, inclusive, it was 10.93 inches. During the winter months precipitation may be in the form of snow and be unavailable for water supply for some time after its fall. It is advisable to impound a sufficient supply for about 200 days allowing for loss by evaporation during that time.
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To supply 2,000,000 gallons a day, assuming a run-off of 6 inches and allowing 100,000,000 gallons for evaporation from a reservoir, would require 800,000,000 gallons a year or 8 square miles drainage area. Unless a reservoir can be built large enough to store up the total flow during wet seasons it may be desirable to choose a larger drainage area. A large drainage area is especially desirable for Jacksonville, as sites for very large reservoirs cannot be found, the water consumption may increase in the future, and the run-off may occasionally be less than 6 inches.

It is not probable that an impounding water supply can be developed on Snake Creek or Indian Creek as economically as at other locations.

Big Sandy Creek for part of its course is about four miles from the city in a southerly direction. The hills near the stream are estimated to be from 30 to 50 feet high. The size of an impounding reservoir would be limited only by the distance upstream to which lands can be flooded. At a point about 4 miles south and 2 miles west of the center of Jacksonville the stream has a drainage area of about 18 square miles. Considerable areas of the bottom lands are used for pasture.

Plats of impounding reservoirs on the north and south branches of Mauvaise Terre Creek were prepared by the Jacksonville Engineering Company. With a dam impounding water to a depth of 12 feet located near the south pumping station the reservoir capacity would be 286,000,000 gallons and the drainage area would be from 24 to 28 square miles. Possibly the dam could be made higher without flooding very much more land at times of flood flow. With a dam impounding water to a depth of 12 feet on the north branch near the center of the northwest quarter of section 15 the reservoir capacity would be a little over 400,000,000 gallons and the tributary drainage area about 50 square miles. Both of these would be close to the city, thus avoiding the expense' of a long pipe line.

JACKSONVILLE. Water supply of Jacksonville schools.—At the request of the superintendent of schools an investigation of the water supply of Jacksonville schools was made on September 19.

Jacksonville has a municipal water supply, part of the water coming from wells and part from surface sources. The wells yield water of good sanitary quality, hut as it is mixed with unfiltered surface water the supply is unsuitable for drinking purposes. The inhabitants secure drinking water from private wells or cisterns, or purchase water from private companies. Cistern supplies are available at nearly all of the public schools. In each supply the water from the roof passes through a coarse stone filter contained in a sewer tile placed close to the building, then through a cistern equipped with an upward flow filter of coarse material and into a clear water cistern. Tile filters have wooden covers which fit into the bells on the tiles. Contaminating matter may pass through or around the cover into the filter. The cisterns are surrounded with concrete pavements, some of which are cracked. A manhole in the top of each cistern is provided with a cast-iron frame and cover. The tops of the frames and covers are level with the top of the pavement and the frames are generally loose. Vents are set in the tops of some cisterns. Around some of the vents are small cracks. Contaminating matter may enter the cisterns through cracks and through openings around the frames and covers. The pumps are attached to the covers of the clear-water cisterns. The joints between them were apparently water-tight in all of the installations.

Concrete pavements should have a slight slope away from the cisterns. All cracks in the concrete and joints around the manhole frames should be made water-tight. Covering with a thin coat of asphalt would aid greatly. Wherever covers are used they should shed water away from the cistern or filter and not into a joint at the edge of the cover through which it can pass. All covers should be locked. Run-off from the roofs should be allowed to waste until the roofs are clean before turning water into the cisterns. The quality of the supply could be improved by adding bleaching powder to the supply at intervals.

Analyses of samples of water from the supplies give evidence of serious contamination in nearly all cases. Water for drinking purposes is being purchased from private companies. Unless the school supplies are greatly improved purchasing from private companies should be continued.

JACKSONVILLE. Sanitary inspection of Chautauqua ground.—(Bull. 12, 87.)

JACKSONVILLE. Illinois School for the Deaf. Water supply.—(Bull 13, 86.)

JERSEYVILLE. Water supply.—(Bull. 12, 88.)

JOHNSTON CITY (3,248). Proposed improved water supply.—(Bull. 11, 79; 14, 44.) Visited April 16 at the request of representatives of the Central Illinois Public Service Company, owners of the public water supply. In July, 1914 consulting engineers submitted a report recommending the development of a water supply from Oak Ridge Mine with a possible later use of stored water from a reservoir to be constructed on the drainage basin of Lake Creek. The Oak Ridge Mine project was abandoned. After investigating the water from a mine of the Williamson County Coal Company and after drilling several test holes, it was decided to try to use water from an abandoned mine belonging to the coal company. Two 10-inch test holes were drilled into this mine to a depth of 215 feet, and samples of water were analyzed by the Water Survey each week. The water proved to be very highly mineralized, having a residue of over 4,000, a content of iron of 85, and a sulfate content of 2,500 parts per million. Treatment to remove the iron would be exceedingly difficult with this water. There would still remain' over 3,000 parts per million of sodium sulfate (Glauber salts) which would have a physiological action, especially on those not accustomed to its use.

Tentative arrangements had been made for the installation of two pressure filters, each with a capacity of 100,000 gallons per day. The installation was to include chemical tanks, aerators, and a settling basin of 11,000 gallons capacity. The filter company guaranteed complete removal of iron when 2 parts or less per million were present and a 95 per cent removal when more than 2 parts per million were present. The Public Service Company had on hand two wooden tub gravity filters with capacities of 225,000 and 325,000 gallons a day, and a wooden settling tank with a capacity of about 46,700 gallons. We suggest that this plant be installed at Johnston City in place of the pressure filters and that water from Lake Creek be used whenever possible. If the mine water were emptied into the stream some distance above the intake the water would be aerated and diluted and thus made easier to handle. It is recommended that the company investigate locations for impounding reservoirs in the drainage basin of Lake Creek.

Samples of water from the mine shaft show mineral contents varying from 3,500 to 4,000, non-carbonate hardness from 425 to 560, and a content of iron varying from 56 to 95 parts per million. This water would be very unsatisfactory for use unless treated, and would be difficult to treat.

JOLIET. Water supply.—(Bull. 11, 79.)

Illinois State Penitentiary. Water supply.—(Bull. 11, 81.)

JOLIET. Contamination of wells by gas liquors.—Visited July 10 to note the location of wells affected by tastes and odors. Six wells on Broadway and Hickory Streets from one to two blocks north of the north city limits were visited. The wells are from 98 to 117 feet deep and enter limestone from which water is derived. The distance from each well to the nearest privy, feed lot, or stable was from 50 to 75 feet.

At the time of collection of samples no special taste nor odor was noticeable in water from wells at 1047 North Broadway and at the corner of Ingles Street. These wells were cased with iron pipe to depths of about 20 or 25 feet. An open sewer is about 30 feet distant from the well at the corner of Ingles Street. Odor and taste of gas liquor were noticeable in water from wells at 1316 and 1402 North Broadway and 1401 North Hickory Street. Slops and dish water were dumped about 5 feet from the well at 1316 North Broadway. An open drain was about 50 feet distant from the well at 1402 North Broadway. An open ditch 75 to 100 feet from the well on North Hickory Street contained gas liquor.

Water had not been used from a well at 1404 North Broadway for some time because of a very decided odor and taste which were noticeable at the time of collection of the sample.

It is generally supposed that the gas liquor might serve to some extent as a disinfectant, yet the largest number of bacteria was found in the sample of water from the well at 1404 North Broadway, which had the greatest odor and taste.

Prom a bacteriological standpoint the water from the wells would not conform to the standards of the United States Treasury Department. The contamination is probable due to crevices in the limestone formation through which surface water reaches the wells below the casings.

We suggest that some eosin or fluorescein be emptied on the ground where gas liquor was formerly emptied or in some near-by privies. If the color of the chemical reaches the well, it would indicate connection with the surface and a possibility that infection might reach the water at some future time.

City water should, if possible, be substituted for the well water.

JONESBORO (1,169). Water supply.—Visited July 16. Jonesboro is located in the central part of Union County, of which it is the county seat. At the present time cisterns are depended upon to supply water for domestic use. The construction of a public supply has not been given serious consideration. A safe public water supply could be secured from a well drilled to a depth of probably from 600 to 700 feet. This could be obtained at low cost by means of an electrically operated deep-well pump, pumping into the distribution system. Connected with the distribution system there should be an elevated tank to store water for emergency and to allow for economical operation of the pump. Probably the most practicable method of securing water would be to connect with the water mains of Anna, about 1 mile east of Jonesboro, and to buy water through a meter.

The cost of a water supply would be low compared with the benefits derived in fire protection, convenience, and improved public health.

KANKAKEE. Water supply.—(Bull. 11, 83; 13, 88.)

KANSAS. Proposed water supply.—(Bull. 13, 88.)

KEITHSBURG. Water supply.—(Bull. 12, 89.)

KEMPTON. Water supply.—(Bull. 14, 45.)

KENILWORTH. Water supply.—(Bull. 9, 24; 13, 88.)

KEWANEE. Water supply.—(Bull. 10, 130.)

KINCAID (2,000). Water supply.—Visited December 11. Kincaid is in Christian County on the drainage area of Sangamon River. Its development was promoted by the Peabody Coal Company and the Middle West Public Utilities Company. Two coal mines employing 1,100 men are located just outside the city limits. About one-fourth of the present population of the community is served by sewers. Water for drinking and domestic use is obtained from about 225 private dug wells, from 15 to 25 feet in depth, entering a sand stratum which lies directly on hardpan.

Waterworks were installed in 1914. The source of supply is a small, shallow pond which is subject to contamination. A house, barn and livery stable are located on the small drainage area. In 1914 a hypochlorite treatment plant was installed for sterilizing the water; but its use has been abandoned. Unfiltered and untreated water is now pumped to the distribution system and is used only for flushing and for laundry purposes. Water is pumped to a 50,000-gallon elevated tank by a triplex pump driven by a 35-horsepower electric motor. In case of fire, water can be pumped directly into the mains at a pressure of 100 pounds. The daily consumption is estimated at 20,000 gallons. There are about 75 service connections. The Kincaid Land Syndicate pays the operating expenses, and no charge is made to the consumers for water.

The water is unsafe for domestic use. At the time of 'visit it had, a mineral content of 156, a hardness of 118, and a content of iron of 0.2 parts per million.

KIRKWOOD (926). Water supply.—(Bull. 10, 131.) Visited July 17, Water is secured from a well 127 feet deep. The pump formerly operated by steam is now run by a 3-horsepower electric motor. The well is pumped for about 4 hours a day. Water drains toward the well from every direction, and water and grease were standing in a small pit around the well. This contaminating matter may not enter the well, but it would be an improvement to drain it away so that there would be no possibility of its gaining access.

The water is of fair sanitary quality. It has a mineral content of 531, a temporary hardness of 422, and a content of iron of 1.4 parts per million.

KNOXVILLE. . Water supply.—(Bull. 9, 25; l0, 131; 12, 90; 13, 88.)
Sewage disposal.— (Bull. 12, 90.)

LACON. Water supply.—(Bull. 12, 91.)

LADD. Water supply.—(Bull. 11, 84; 12, 91; 13, 88.)

LAGRANGE. Water supply.—(Bull. 13, 89.)
Sewage-treatment plant.— (Bull. 10, 134.)

LAGRANGE PARK. Water supply.—(Bull. 13, 90.)

LA HARPE. Water supply.—(Bull. 12, 92.)

LAKE BLUFF. Water supply and sewerage.—(Bull. 9, 25; lO, 135.)

LAKE FOREST. Water supply.—(Bull. 9, 25; 13, 93; 13, 90.)
Sewage disposal.—(Bull. 9, 25; 11, 85.)

LAKE ZURICH. Water supply.—(Bull. 13, 90.)

LAMOILLE. Proposed water supply.—(Bull. 14, 46.)

LANARK. Water supply.—(Bull. 11, 85.)

LA ROSE (155). Water supply conditions.— (Bull. 13, 91.) Visited November 20. No public water supply has been installed. Owing to the present high cost of materials it is doubtful if a plant will be installed in. the near future. The village well has been abandoned except for watering cattle.

LA SALLE Water supply.—(Bull. 11, 86.)
Investigation of the pollution of two deep wells.— (Bull. 9, 25.)

LAWRENCEVILLE. Water supply.—(Bull 9, 25; 11, 86; 12, 93; 13, 91.)
Pollution of Embarrass River and Indian Creek by oil.— (Bull. 14, 48.)

LEAF RIVER. Proposed water supply.—(Bull. 12, 94.)

LE CLAIRE. Typhoid fever.—(Bull. 11, 87.)

LELAND. Water supply.—(Bull. 12, 95; 13, 91.)

LEMONT. Water supply.— (Bull. 14, 49.)

LENA. Water supply.—(Bull. 11, 88.)

LEONORE (203). Water supply.—Visited November 21. Leonore is located in the southwestern part of LaSalle County on the drainage area of Vermilion River.

Waterworks were installed in 1900. The source of supply is a dug well 10 feet in diameter and 34 feet deep, terminating in a 4-foot stratum of water-bearing gravel. The well is lined with concrete blocks with vertical joints cemented but with horizontal joints open. The top of the well is very poorly protected from the entrance of surface drainage, oil, and dust. Water is pumped from the well into the distribution system by a 250,000-gallon triplex pump. The pump operates for only a few minutes each day. The working barrel of the pump is 28 feet below the pump house floor. The distribution system includes 1,800 feet of 4-inch and 6-inch cast-iron mains, six fire hydrants, one 6-inch gate valve, and 12 service connections. A 13,500-gallon steel pressure tank is connected to the distribution system. A reservoir with a capacity of 15,750 gallons is located beneath the floor of the town hall, and is used as an emergency supply. In case of fire, a fire engine pumps directly from this reservoir into the distribution system. The average daily consumption is estimated at 340 gallons. The total cost of the waterworks has been $6,900.

The water is of good sanitary quality. It has a mineral content of 433, a hardness of 320, and a content of iron of 0.2 parts per million.

LEROY (1,702). Water supply.—(Bull. 10, 136.) Visited June 18. No important changes have been made in the waterworks since July', 1913. Water is obtained from three wells from S7 to 90 feet deep.

A combined system of sewers has been built in the past year. The sewage passes through a septic tank before discharging into the north fork of Salt Creek. Although there is some evidence of contamination, the water is of fair sanitary quality.

LEWISTOWN (2,312). Water supply.—(Bull. 12, 95.) Visited July 9. The upper 15 feet of the city well has been re-concreted. During high water the water came up to within one foot of the top of the well curbing, but did not raise the level inside the well. There seems to be little chance of contamination of the supply. In 1915 a new 500,000-gallon pump was installed, and seven new hydrants, 6,000 feet of 4-inch mains, and 65 feet of 8-inch mains were added to the distribution system. There are now 400 service connections, 80 per cent of which are metered. A new 90,000-gallon elevated steel tank is connected to the distribution system. The daily consumption is estimated as being from 100,000 to 150,000 gallons. The water is not used for industrial purposes except in an electric light plant. The water is of excellent sanitary quality.

LEXINGTON (1,318). Water supply.—(Bull. 12, 96.) Visited June 19. No important changes have been made at the pumping station since the last visit. There are no public sewers.

The water is of excellent sanitary quality.

LIBERTYVILLE (1,724). Water supply.—(Bull. 10, 137.) Visited October 15. The source of supply is the same as was described in 1912, and furnishes an abundant supply for the needs of the city. A 30-horsepower electric motor furnishes the power to operate the pumps and the gasoline engine formerly used is held in reserve. In 1916 about 2,600 feet of 4-inch and 6-inch cast-iron pipe were added to the distribution system. At the present time there are 470 service connections and the average daily consumption is 60,000 gallons.

The water is of excellent sanitary quality. It has a mineral content of 660, a hardness of 337, and a content of iron of 0.8 parts per million.

LINCOLN (10,892.) Water supply.—(Bull. 10, 138; 11, 89.) Visited January 19-20. Water is obtained from wells and infiltration galleries located on the banks of Salt Creek about 2 miles southwesterly from the center of the village. Water is withdrawn from the wells and galleries through a suction pipe by pumps located about 2,000 feet distant and is forced by these pumps into the distribution system. Sometime before, the water in the creek was very low and an investigation by the water company showed that the creek bed was frozen so that a portion of the supply of the wells was choked off.

A large gravel pit is located near the suction line. Sand and gravel are taken from the pit by a suction pipe from a dredge boat which, although located several hundred feet from the point where the emergency intake would be located, might be a source of contamination. It is suggested that it would be better to pump pure water from the present source of supply into a well-protected reservoir for use in case of emergency than to have an emergency intake in the gravel pit or Salt Creek. The reservoir would . furnish better water than could be obtained from the gravel pit or the creek and would also serve as a supply in case of accident to the present long suction line. If necessary to use water from the creek we recommend that a liquid chlorine apparatus be installed so that a creek water may never be used without sterilization.

In order to remove the possibility of freezing the creek bed at time of unusually low stream flow, it is contemplated to back up the stream by the erection of a dam below the wells.

LINCOLN. Sewerage.—(Bull. 12, 96.)

State school and colony. Water supply.— (Bull. 12, 97; 13, 92.)

Sewage disposal.— (Bull. 12, 97.)

Sanitary condition of water supply.—(Bull. 14, 50.)

LITCHFIELD. Water supply.—(Bull. 9, 26; 10, 141; 11, 89; 13, 92.)

Typhoid fever conditions.— (Bull. 11, 90.)

LITTLE YORK (358). Water supply.—(Bull. 13, 92.) Visited July 17. Mains have been laid, six service connections have been installed, and construction of a pump house has been started. Water in the well comes from a limestone formation entered at a depth of 200 feet and penetrated to a depth of 326 feet. A pit about 8 feet deep around the top of the well contained about one foot of water at the time of visit. The elevated tank is filled every three or four days. About ten hours' time is required to pump 20,000 gallons, and the water level in the well is probably lowered to the bottom of the suction pipe of the deep-well pump.

No analysis was made as the bottle containing a sample of the water was broken in transit to the laboratory.

LOCKPORT. Water supply.—(Bull. 13, 93.)

Inspection of private well.—(Bull. 13, 93.)

Pollution of Illinois River by Chicago Drainage Canal.— (Bull. 9, 26.)

LONDON MILLS. Water supply.—(Bull. 13, 94.)

LOSTANT. Water supply.—(Bull. 11, 90.)

LOUISVILLE. Water supply.—(Bull. 14, 50.)

LOVINGTON (1,011). Water supply.—(Bull. 12, 97.) Visited June 26. The waterworks is as described in Bulletin 12. Water is obtained from two 6-inch wells 147 feet deep. One well is in use, and another is available in case of emergency. The tops of the wells are in pits containing water.

The water is of fair sanitary quality.

LOW POINT. Water supply.—Visited August 28. Low Point is located in the northern part of Woodford County on the drainage area of Richland Creek, a tributary of Illinois River.

Water for a public supply is obtained from a dug well 5 feet in diameter and 51 feet deep, curbed with brick, owned and operated by Banda Bros. Every other day water is pumped from the well into an elevated tank, located about two blocks distant, by a gasoline engine driven pump. The water surface is lowered during pumping to within 3 feet of the bottom of the well, and rises, when water is not being pumped, to within a few feet of the top of the well. The pump head is on a loose plank platform.

Contaminating matter can enter the top of the well. Analyses show evidence of some contamination. The water has a mineral content of 553, a hardness of 430, and a content of iron of 0.02 parts per million.

LYONS. Water supply.—(Bull. 13, 94; 14, 50.)

McHENRY. Water supply.—(Bull. 9, 27.)

McLEAN. Proposed water supply.— (Bull. 13, 94.)

McLEANSBORO. Water supply.—(Bull. l0, 147; 12, 98; 13, 95.)

MACKINAW. Water supply.—(Bull. 12, 98.)

MACOMB. Water supply.—(Bull. 9, 26; 12, 99.) •'

MACON. County Almshouse. Sewage disposal.—(Bull. 11, 90.)

MALTA (450). Water supply.—Visited September 11. Malta is in the central western part of DeKalb County, on the drainage area of the Kishwaukee River.

Waterworks were installed in 1915. Water is pumped from a deep well into a distribution system by a deep-well pump driven by a 20-horsepower oil engine. The top of the well casing is in the pit. The distribution system includes 1.7 miles of 4-inch and 6-inch cast-iron pipe and 65 service connections. A pressure tank, 9 feet in diameter and 36 feet long, is connected to the distribution system. Water is sold at flat rates.

The water is of excellent sanitary quality. Water drawn from a tap near a dead end had considerable odor, indicaing the desirability of periodic flushing. The water has a mineral content of 268, a hardness of 188, and a content of iron of 0.1 parts per million.

MANHATTAN (443). Water supply.—Visited November 14. Manhattan is in the central part of Will County on the watershed between DesPlaines and Kankakee Rivers. The glacial drift is about 45 feet thick. The wells in the village have an average depth of 100 feet. The village has a limited sewer system.

Waterworks were installed in 1892, the installation consisting of a well, a triplex pump, a gas engine, two pressure tanks, and cast-iron mains on one street only. In 1906 a new pump and electric motor were installed. Water is obtained from a 6-inch well 105 feet deep, cased to rock. The static water level is 26 feet below the ground surface. The working barrel of the pump is placed at a depth of 85 feet. During a test of the well with the triplex pump, the water level lowered to 52 feet, at which point the pump drew air. The present pump is smaller, having a capacity of 100 gallons a minute, and never draws air. The distribution system includes 1.9 miles of 4-inch and 6-inch cast-iron pipe. Two pressure tanks are connected to the distribution system. The average daily consumption is about 20,000 gallons. The annual income is about equal to the cost of operation.

The water is of good sanitary quality. It has a mineral content of 480, a hardness of 397, and a content of iron of 0.2 parts per million.

MANSFIELD. Proposed water supply.—(Bull. 12, 100.)

MANTENO. Water supply.—(Bull. 12, 100.)

MAPLE PARK. Water supply.—(Bull. 13, 95.)

MARENGO. Water supply.—(Bull. 11, 91.)

MARION (7,093). Water supply.—(Bull. 10, 142; 12, 101; 13, 95; 14, 51.) Visited October 31. Since the last visit a new well has been drilled, about 40 feet from the southeastern corner of the reservoir at the ice plant. It is 960 feet feet deep with a 12-inch casing to rock at a depth of 50 feet. Through the rock the well is 10 inches in diameter and is not cased. At the present time the pump is operated by a steam head, but an electrically operated head is soon to be installed. The pump discharges into the concrete reservoir. The wells at the old pumping station are almost exhausted, and the water company is planning to abandon them and drill more wells at the ice plant.

Samples of water collected indicate that it is polluted.

MARION. Sewage disposal.—(Bull. 12, 101; 13, 96; 14, 51.)

MARISSA. Proposed water supply.—(Bull. 12, 102.)

MARK. Water supply.—(Bull. 13, 96.)

MAROA. Water supply.—(Bull. 10, 143.)

MARSEILLES. Water supply.—(Bull. 9, 26; 13, 96.)

Pollution of Illinois River by Chicago Drainage Canal.—(Bull. 9, 26.)

MARSHALL. Water supply.—(Bull. 12, 102.)

Typhoid fever.—(Bull. 12, 103.)

MASCOUTAH. Water supply.—(Bull. 12, 103.)

MASON CITY. Water supply.—(Bull. 12, 104.)

MATTESON. Water supply.—(Bull. 12, 105; 14, 51.)

Proposed sewerage.—(Bull. 12, 105.)

MATTOON. Pollution of public water supply by improper disposal of city wastes.—(Bull. l0, 144; 12, 105.)

Proposed sewerage.—(Bull. 11, 92.)

Microscopic survey of reservoir at Paradise near Mattoon.—(Bull 14, 52.)

MAYWOOD. Water supply.—(Bull. lO, 146.)

MELROSE PARK. Water supply.—(Bull. 10, 148.)

MELVIN. Water supply.—(Bull. 13, 97.)

MENARD, Southern Illinois Penitentiary. Water supply.—(Bull 11, 92.)

MENDOTA. Water supply.—(Bull. 11, 93.)

Sewerage.—(Bull. 11, 94.)

Treatment of gas-house wastes.—(Bull. 12, 106; 13, 97.)

MEREDOSIA. Pollution of Illinois River.—(Bull. 11, 94.)

METAMORA. Water supply.—(Bull. 13, 98.)

METROPOLIS (4,655). Water supply.—(Bull. 9, 27; 11, 94; 13, 99.) Visited July 18. The pressure pump and generator in use in 1916 have been replaced by two steam turbine-driven centrifugal pumps. An engine direct-connected to a 375 k.v.a. generator, and a second-hand 150-horsepower boiler have also been installed at a total cost of $12,000. A concrete basin that surrounds the well is cracked and leaks considerably. There are now 675 service connections. All are furnished with water at a flat-rate basis. There is no means for determining the quantity of water pumped.

The water is of excellent sanitary quality.

MILAN. Water supply.—(Bull. 14, 52.)

MILFORD (1,316). Water supply.—(Bull. 11, 95.) Visited June 25. One of the two old wells has been abandoned, and another 8-inch well 65 feet deep has been drilled about 15 feet from the other well. The pump is in a pit 20 feet deep. It is operated about six hours a day, indicating a daily water consumption of about 70,000 gallons.

The water is of excellent sanitary quality. It has a mineral content of' 687, a hardness of 485, and a content of iron of 1.4 parts per million.

MILFORD. Sewerage.—(Bull. 11, 95.)

Corn—canning wastes.—(Bull. 12, 106.)

MILLEDGEVILLE. Water supply.—(Bull. 14, 52.)

MINIER. Water supply.—(Bull. 14, 53.)

MINONK (2,070). Water supply.—(Bull. 12, 107.) Visited July 17. Water is pumped from a collecting reservoir by a centrifugal pump supported on a wooden platform built in the reservoir. The platform has large openings through which contaminating matter may fall into the reservoir. This condition should be remedied, so that there will be no possibility of pollution of the water.

The water is of good sanitary quality. It is very highly mineralized.

MINONK. Disposal of sewage.—(Bull. 12, 107; 13, 100.)

MINOOKA. Water supply.—(Bull. 11, 95.)

Sewerage.—(Bull. 11, 96.)

MOKENA. Water supply.—(Bull. 13, 100.)

MOLINE. Water supply.—(Bull. 13, 100.)

Additional sewerage.—(Bull. 11, 96.)

Sanitary survey of Mississippi River.—(Bull. 9, 27.)

MOMENCE. Water supply.—(Bull. 11, 97.)

Sewerage.—(Bull. 11, 97.)

MONEE. Water supply.—(Bull. 13, 103.)

MONEY CREEK TOWNSHIP. Typhoid fever.—(Bull. 13, 104.)

MONMOUTH (9,128). Water supply.—(Bull. 10, 149.) Visited October 13 at the request of the water committee of the city council. The public water supply is obtained from three wells entering St. Peter sandstone, each of which is about 1,200 feet deep. The most objectionable feature of the plant was the fact that two of the wells are still connected to the old pumpihg pit which is 185 feet deep and 10 feet in diameter. The pit is lined with brick, down to solid rock at a depth of 65 feet. Water from the wells can enter the pit and flow back into the wells when the water level in the wells is lowered. Therefore, although the wells are 1,200 feet deep, protection from contamination is afforded by a well only 185 feet deep. However, practically all wells 175 feet deep and cased as is this pit would be amply protected.

The results of analyses indicate that from a sanitary standpoint the water is above suspicion. Very few bacteria of any form were found and none which could be considered of intestinal origin. The water would probably have a physiological action on persons unaccustomed to it. It has a mineral content of 1,686, a hardness of 460, and a content of iron of 0.1 parts per million.

MONTGOMERY. Sewage disposal.—(Bull. 12, 108.)

MONTICELLO (1,981). Water supply.—(Bull. l0, 150; 12,109.) Visited June 19. The waterworks have been improved considerably since 1914. A fourth well has been drilled, the old service pump has been replaced by two steam pumps, another collecting reservoir has been built, the elevated tank has been removed, and minor changes have been made. The new well is 12 inches in diameter and 209 feet deep. It has a 12-inch casing extending to a depth of 195 feet, below which there is a 12-inch brass covered galvanized! iron screen. Each well is equipped with a steam-head deep-well pump with the cylinder at a depth of 100 feet.

The pump on the new well has a double-acting 8½-inch working barrel with a 24-inch stroke. Pumping the 8-inch well one hour lowered the water level in the 10-inch well 4 inches. Tests on the three original wells showed the 6-inch well to deliver 25 gallons, the 8-inch well 102 gallons, and the 10-inch well 167 gallons a minute.

The old 56,000-gallon reservoir is still in use and a 200,000-gallon reservoir with reinforced concrete wall and roof has been built. Windows in the old reservoir are well screened. There is little chance of contamination of the water in either reservoir.

Tests were made by the engineers at nine different points in the distribution system to determine the height and greatest horizontal distance to which fire stream could be thrown. The results obtained at eight of tha points showed the pressure to be satisfactory.

MORRIS. Water supply.—(Bull. 12, 109.)

Pollution of Illinois River by Chicago Drainage Canal.—(Bull. 9, 27.)

MORRISON. Water supply.—(Bull. 12, 110.)

MORRISONVILLE. Water supply.—(Bull. 11, 98.)

MORTON. Water supply.—(Bull. 13, 106.)

MORTON GROVE. Water supply.—(Bull. 14, 54.)

MOUND CITY (2,837). Water supply.—(Bull. 13, 106.) Visited July 17. No changes have been made since 1915. The daily consumption is from, 75,000 to 80,000 gallons. Almost every house has a service connection. Very few of the connections are metered.

The water is of excellent sanitary quality.

MOUND CITY. Proposed sewerage.—(Bull. 13, 107.)

MOUNDS (1,686). Water supply.—(Bull. 9, 27; 11, 98.) Visited July 17 at the request of the Central Illinois Public Service Company, owners of the waterworks. Complaints had been made that the water furnished to the Illinois Central Railroad had been causing stomach trouble.

Water is pumped by air lift from two 10-inch wells 650 feet deep into a reservoir with a capacity of 32,000 gallons. The use of the open impounding reservoir has been discontinued. Water is pumped into the city mains by an 860,000-gallon simplex pump. There are three electrically operated pumps for pumping water for an ice plant and for the Illinois Central Railroad. The water pumped to the railroad and to the city is metered. The city meter is provided with a by-pass for use in times of fire. Within the city there are about 300 service connections, all of which are metered. The mains are thoroughly flushed once a month, but no particular turbidity is noticed.

The water is of excellent sanitary quality.

MOUNDS. Sewerage and sewage-treatment plant.—(Bull. 13, 107.)

MOUNT CARMEL. Water supply.— (Bull. 9, 27; 12, 111; 13, 108.)

MOUNT CARROLL. Water supply.—(Bull. 11, 100.)

MOUNT MORRIS. Water supply.—(Bull. 11, 100.)

MOUNT OLIVE. Water supply.—(Bull. 10, 151.)

MOUNT PULASKI. Proposed additional water supply.—(Bull. 11, 101; 12, 113.)

Sewerage.—(Bull. 12, 113.)

MOUNT STERLING. Water supply.—(Bull. 11, 102.)

Proposed sewerage.— (Bull. 11, 101.)

MOUNT VERNON. Water supply.—(Bull. 10, 152; 11, 102; 12, 113; 13, 109.)

Microscopic survey of reservoir.—(Bull. 14, 54.)

MOWEAQUA. Water supply.—(Bull. 11, 99.)

MURPHYSBORO (7,485). Water supply.—(Bull, l0 155; 11, 103; 12, 114; 13, 109.) Visited October 30 to inspect the new water purification plant.

During the early part of 1915 the water works changed hands but the name "Murphysboro Waterworks and Electric and Gas Light Company" was retained. Immediately following the change plans and specifications for a new purification plant were prepared, and in September, 1915, the reconstruction of the purification plant was begun. The first water was run through the new plant in January, 1916. About a week later, high water in the river flooded the filters, so that the water had to be bypassed for a time. Since then the plant has been operated continuously, apparently with good results. No means have been provided for measuring the quantity of water pumped. Meters to determine the quantity of water pumped to the consumers and to determine the quantity of wash water used on the filters would probably aid in reducing the present high rate of consumption, namely 1,200,000 gallons a day.

An 18-inch intake-pipe leads from an intake which consists of a section of perforated pipe to the low-lift pump. The river is rather deep at the point of intake and for a distance of about a mile up and down stream, forming a natural reservoir. The purification plant has a nominal capacity of 2,000,000 gallons a day. The process includes: coagulation by lime and alum, sedimentation, filtration, and sterilization by hypochlorite. The filter house is a two-story brick structure built on a concrete foundation. The first floor is divided transversely by the operating platform below which is the pipe gallery and on either side of which are located two filter units. The second floor is used for a laboratory and a store room, and for the mixing of chemicals. The main floor of the filter house is located about 12 feet above the surrounding ground in order to keep the filters from being flooded at times of high water in the river.

The raw water is pumped through a 16-inch vertical pipe, extending S feet above the water level, into one end of the mixing chamber. On leaving the pipe the water is aerated by splashing over three iron plates. After the aeration the coagulant is added. The mixing chamber is 24½ by 12 feet, and 11% feet deep. This chamber is provided with alternate hanging and supported wooden baffles causing the water to have an upward and downward course in passing through. When the plant is operated at its designed rate of 2,000,000 gallons a day, there is a retention period of 18 minutes, but when operated at 1,200,000 gallons a day the retention period is 33 minutes. Coagulants are mixed in four concrete tanks in the second floor of the filter house. Two of these are 4¾ by 6 feet, and two are 5 feet 10½ inches by 6 feet, and all average 5 feet in depth. Dissolving boxes with slotted bottoms are built along the top of one side wall in each tank. Each tank is equipped with a small agitator of the propellor type operated by a water motor. Beneath the solution tanks are float control orifice boxes which are used to feed the chemicals at the desired rate. Frequent observations of turbidity of the raw and filtered water are made in order to establish a relation between the two, to serve as a guide in determining the quantities of chemicals required. Since the operation of the plant was started no lime had been used. Up to October 18, 1917, 144 pounds of alum were used each day. Since then 100 pounds a day have been used, which is equivalent to a rate of 10 parts per million.

The coagulated water flows into a circular reinforced concrete sedimentation basin 100 feet in diameter, with a capacity of 700,000 gallons which gives a retention period of 8.4 hours when the plant is being operated at a rate of 2,000,000 gallons a day. In three months the sludge collects to a depth of 3 feet at the entrance of the sedimentation chamber, after which it is cleaned out.

There are four filters, each of which is 10 by 18 feet in plan and 7 feet deep. They contain 10 inches of graded gravel, and 32 inches of St. Peter sand obtained at Ottawa. The sand has an effective size of 0.46 mm. and a uniformity coefficient of 1.65. The filters were designed to operate at a rate of 125,000,000 gallons an acre a day. The rate of filtration is regulated by controllers of the Venturi type. The filters are equipped with loss-of-head gages, but recently these have not been used. In washing filters air and water are used alternately. Water for washing is obtained from the high service discharge line. In washing it is customary to use air agitation for the first three to five minutes at an estimated rate of 3 cubic feet per square foot, and then water until the overflow runs fairly clear, usually for about five minutes. Air is supplied at 3½ pounds pressure by a blower operated by a motor. At present the filters are washed every 12 hours. Such frequent washing is not efficient. The use of the loss-of-head gages should be resumed.

From the filters the water runs to the clear well, a 350,000-gallon reinforced concrete reservoir. This provides storage for about seven hours average consumption. The walls of the reservoir now extend 12 feet above the ground in order to keep out river water during floods. Hypochlorite of lime is added to the effluent before it reaches the clear well. The solution is prepared in one of the mixing tanks on the second floor of the filter house. The tank has a capacity of 300 gallons and is equipped with a revolving agitator connected to the shaft of a water motor. The solution flows to an adjustable orifice box and from there through a 1-inch wrought-iron pipe to the point of application. The average quantity of hypochlorite used is 15 pounds per day, which is equivalent to about 1.0 parts per million available chlorine.

A 3,000,000-gallon low-lift vertical centrifugal pump direct-connected to a 35-horsepower motor is located in a pit in the bottom of a suction well about 30 feet deep. A 1,750,000-gallon centrifugal pump, driven by a 100-horsepower motor, discharges into the distribution system. Current for operating the motors which drive the pumps is obtained from the company's electric plant. The distribution system includes 14 miles of cast-iron pipe, ranging from 4 to 12 inches in diameter, 95 fire hydrants, and 1,188 service connections. The system reaches nearly all the built-up portions of the city. The recent improvements in the waterworks have cost about $20,000.

Analyses of the water show that it has been fairly satisfactorily treated. The treated water shows a good reduction of turbidity, color, odor and bacteria. Unless exact methods of control and operation are used good operation cannot be expected to be maintained as the plant grows older. The room on the second floor in the filter house which at present is used for turbidity tests could be readily equipped as a control laboratory.

MURPHYSBORO. Microscopic survey of the source of the water supply.—Visited September 11. Big Muddy River is the source of the public water supply. A pumping station and filter plant are located on the west bank of the river at the east edge of the city. Two intakes are located about 20 feet from shore and 7 feet above the bottom of the river. The river had a moderately strong current but at times the flow is very small. At time of high water, the river floods the filter plant. Extensive alterations are being made to remedy this condition.

The banks of the river are of yellow clay. Grass, willows, and other vegetation grow in places, and some brush and drift wood collect along the banks and in the stream. The water was more turbid than usual, following a heavy rain-fall on September 8. An algal growth in the form of a slight scum extended along each shore for a width of 10 feet, up and down the river. Certain odor-producing types were present, but were not numerous and the water did not have a bad taste nor odor. It would be difficult to treat the water in the river for the removal of growths

Algal growths that might cause considerable annoyance in the plant were present in the sedimentation basin, and in such amount that they were undoubtedly causing some mechanical clogging of the filters. In growing, algae produce large quantities of oxygen and often supersaturate water. Air-binding or air-locking of the filters is then apt to occur, with a consequent decrease in efficiency and increase in cost of operation. Possibly these growths in the basin could be removed successfully by proper treatment with copper sulfate.

NAPERVILLE. Water supply.—(Bull. 13, 109.)

NAUVOO. Water supply.—(Bull. 10, 157.)

NEOGA. Proposed water supply.—(Bull. 13, 110.)

Proposed sewerage.—(Bull. 13, 110.)

NEW ATHENS. Proposed water supply.—(Bull. 10, 158.)

NEW ATHENS. Microscopic and sanitary survey of the water supply.—Visited September 7. Water from the Kaskaskia River is used without purification for a public water supply. The drainage area above New Athens is about 5,000 square miles, and has a population of approximately 84,000. Opposite the intake and for a considerable distance up and down stream the river is about 200 fe'et wide. The river was low, exposing black, muddy banks and some sandy beach. The banks are rather steep and are free from vegetation. A considerable amount of dead brush was exposed in the river at its low stage.

Water near the intake at the surface and near the bottom at a depth of 5 feet contained 11.0 and 11.6 parts per million respectively of dissolved oxygen. Organisms capable of producing tastes and odors were present in the water. A surface sample near the intake contained 40 Anabaena per c.c. and the following Protozoa: Glenodinium, 30; Euglena, 4; Ceratium, 16 and Stentor, 56. They were not numerous although the water had a slight musty odor. It would be difficult to treat the supply for the removal of microscopic growths and under existing conditions this is not recommended.

The water is dangerously polluted. Drinking water is secured from private wells from 12 to 20 feet deep. '

NEW WINDSOR. Typhoid fever.—(Bull. 11, 103.)

Proposed water supply.— (Bull. 11, 104.)

NEWTON. Water supply.—(Bull. 10, 159; 13, 111.)

NEWTON. Microscopic and sanitary survey of the water supply.—Visited August 22. The public water supply is taken from Embarrass River at a point about one-eighth mile north of the city. The tributary drainage area is about 1,100 square miles. On this drainage area are six towns with a population of 1,000 or more. Sewage from two of the cities and from part of Newton is discharged into the river above the Newton intake. The river was low as no rain had fallen for several weeks. A 12-inch intake pipe, the end of which is covered with a screen, leads from mid-stream to a concrete collecting well on the river bank.

ORGANISMS IN WATER.

Organisms.	Number of organisms per cubic centimeter.	
	Sample 5 feet above intake.	Sample 10 feet below intake.
Diatomaceae—		
Nitzschia	16	20
Asterionella	10	8
Chlorophyceae—		
Polyedrium	8	12
Scenedesmus	80	72
Cosmarium	150,000	140,000
Eudorina	60	44
Pediastrum	8	4
Cyanophyceae—		
Microcystis	16	16
Total	150,198	140.176
STANDARD UNITS PER CUBIC CENTIMETER.		
Amorphous matter	300	200

The water was rather clear. Diatoms and very large numbers of types of green and blue-green algae, principally cosmarium, were present in two samples taken near the intake. The number of organisms present is shown in the accompanying table. The samples contained 9.6 parts per million of dissolved oxygen. The large number of algae was undoubtedly the cause of the high color and odor of the water. A moderate amount of amorphous matter was present. It would not be feasible to treat a flowing stream of the size of the Embarrass River for the removal of these! growths.

A sanitary analysis showed the presence of contaminating matter. Previous analyses indicate that the water is usually turbid and dangerously polluted. The public water supply would be of good quality if properly filtered. The city should make an attempt to install a filter plant.

NILES CENTER (568). Water supply.—Visited October 16. Niles Center is in the east central part of Cook County, about 12 miles northwest of Chicago, on the watershed of DesPlaines River. A comprehensive sanitary sewer system is being installed.

Waterworks were installea in 1911. The installation includes a well, a deep-well pump, a pumping station, a gasoline engine, an elevated steel tank, and a distribution system. The source of supply is a well 1,440 feet deep, 10 inches in diameter at the top and 6 inches at the bottom, cased] the entire depth. Water is pumped from the well into the distribution system by a deep-well pump, belt-connected to a 35-horsepower gasoline engine. The normal water level is 60 feet below the ground surface. The working barrel of the pump is fastened to the casing 160 feet below the station floor. Chances of contamination of the water seem remote. The distribution system includes 1.8 miles of 6 and 8 inch cast-iron mains, 27 fire hydrants, and 80 service connections. A 40,000-gallon elevated steel tank is connected to the distribution system. All service connections are metered. Practically the entire population uses the public supply. The average daily consumption is about 24,000 gallons. The total cost of the waterworks was $22,100.

The supply is of good sanitary quality. It has a mineral content of 353, a hardness of 176, and a content of iron of 0.6 parts per million.

NOKOMIS. Water supply.—(Bull. 11, 105.)

Proposed sewerage and sewage treatment.— (Bull. 12, 114.)

NORMAL. Water supply.—(Bull. 10, 159; 14, 55.)

NORTH CHICAGO. Sewerage.—(Bull. 9, 28; 11, 105; 12, 115; 13,112.)

NORTH CRYSTAL LAKE. Water supply.—(Bull. 12, 116.)

OAK PARK. Typhoid fever.—(Bull. 13, 112.)

OAKLAND. Water supply.—(Bull. 12, 116.)

OBLONG. Proposed water supply.—(Bull. 13, 112.)

ODELL. Water supply.—(Bull. 12, 116; 13, 113.)

Test of operation of apparatus for removal of hydrogen sulfide from the water supply.— (Bull. 14, 56.)

O'FALLON (2,018). Water supply.—Visited June 12. O'Pallon is in the northern part of St. Clair County about 20 miles east of St. Louis. It is near the western edge of the drainage area of Kaskaskia River. In about 1877 a coal shaft was sunk to a depth of 60 feet. So much water was encountered that the project was abandoned. Several years later the electric lighting company built a power and pumping station near the abandoned shaft and has since been supplying the B. & O. R. R. with water for boiler use. A few water mains were laid by the company into O'Fallon to provide fire protection. In 1907 the mains were bought by the city and have been extended so that the city is now completely served. The electric company was givn the contract to pump water into the mains.

The original well is located just outside the pumping station. It is about 8 feet square and is curbed with timbers. The covering consists of loose boards and the top of the curbing is by no means proof against the inwash of surface water. Two other wells have been put in use. They are located in a concrete lined pit within the pumping station. The floor of the pit is 10 feet below the ground surface. Two shafts, 3 feet in diameter lined with concrete, extend to a depth of 20 feet below the floor of the pit. An 8-inch tubular well has been drilled in each shaft to a depth of 7 feet below the pit and on the bottom of each is a 6-foot long strainer. The bottoms of strainers are about 43 feet below the ground surface. The tops of the 8-inch casings are connected directly to the suctions of the pumps which are in the pit. The shafts are open at the top, and dirt or wash water from the pump room has easy access to them. It is stated that the stratum from which the wells now draw is cut off from the shaft above by a layer of very stiff blue clay about 1 foot thick. The water-bearing stratum is of fine sand and occasional cleaning of the wells is necessary. In the coal shaft well this cleaning is accomplished by pumping out the accumulation of sand with a motor-driven centrifugal pump. In one of the tubular well connections are made such as will permit the turning of water under high pressure back into it, thus flushing the strainer when it becomes clogged. Water is pumped from the wells directly into the distribution system.

The plant has recently been completely electrified. The present pumping equipment consists of one triplex, one centrifugal, and one plunger pump. The triplex pump has a capacity of 730,000 gallons a day. The plunger pump is used for fire protection only. A gasoline engine is available for use in emergency. The pumps are electrically controlled from the company office in the business district. They are also actuated by floats in a new 58,000-gallon elevated tank. The distribution system includes three miles of 4-inch, 6-inch, and 8-inch cast-iron pipe. Only a very small proportion of the population uses the public water supply. All of the services are metered. The daily consumption is about 33,000 gallons.

Analyses indicate that the water received contamination, probably from the open well or drainage from the pump pit.

OGLESBY (3,194). Water supply.—(See Portland, Bull. 11, 115; 13, 118.) Visited May 9. The installation of waterworks was completed in 1916. Water is obtained from a well 1,645 feet deep, 14 inches in diameter to a depth of 300 feet, and 8 inches in diameter at the bottom. The top of the well casing is in a pit about 3 feet deep. The pit and a tunnel through which the discharge pipe passes are drained to the city sewer. The opening between the discharge pipe and the foundation of the pump head is covered with a piece of tin. The static water level in the well is 100 feet below the ground surface. During a pumping test lasting 13 hours the well showed a yield of 350 gallons a minute. Later it was necessary to lower the pump cylinder from a depth of 200 feet to a depth of 280 feet below the ground surface. The capacity of the pump was 500,000 gallons but has been reduced to 252,000 gallons. It is electrically operated and discharges into the distribution system, to which a 100,000-gallon elevated steel tank is connected. There are 115 service connections, all of which are metered. The daily consumption is estimated at 60,000 gallons. The total cost of the waterworks was about $50,000.

The water is of good sanitary quality. It has a mineral content of 951, a hardness of 218, and a content of iron of 0.5 parts per million.

OHIO. Water supply.—(Bull. 14, 57.)

OLNEY. Water supply.—(Bull. 11, 106.)

Sewerage and sewage disposal.—(Bull. 12, 117.)

OLNEY. Microscopic and sanitary survey of the water supply.—Visited August 21. Water for the public supply is obtained from an impounding reservoir of 100,000,000 gallons capacity, and from Fox River. Water from the river is used only when the reservoir supply is inadequate and had not flowed into the reservoir at any time during the preceding four weeks. The drainage area of the river is 80 square miles. The water in the reservoir was about four feet below the high water level, exposing rather clean banks, a considerable part sandy but in general clay. Considerable swampy ground exists above the high water line. A club-house is maintained on the bank near the largest stretch of sandy beach. The reservoir is said to be much used for boating and swimming. The feasibility of making the reservoir more desirable for amusement, has been considered by the city.

ORGANISMS IN WATER.

Organisms	Number of organisms per cubic centimeter.	
	Sample from center of reservoir at S f oot depth.	Sample rom reservoir 10 feet from shore.
Cyanophyceae—		
Microcystis	110	.....
Anabaena (filaments)	2	12
Protozoa, Rotifers, etc.—		
Anuraea	8	8
Glenodinium	12	.....
Ceratium	4	4
Actinophrys	2	.....
Total	138	24
STANDARD UNITS PER CUBIC CENTIMETER.		
Chlorophyceae—		
Spirogyra	.....	small amount
Cyanophyceae—		
Coelosphaerium	.....	164
Amorphous matter	1,500	4,000
Total	1,500	4,164

No filamentous types of algae were noticeable except over very restricted areas within about a foot of shore in the upper portion of the reservoir. The water contains only very small numbers of microscopic organisms;

the majority of these were protozoan forms and Rotifers, although there were a number of Cyanophyceae. A moderately large amount of amorphous matter was present. Analyses of samples collected are given in the accompanying table.

Types of organisms were present which would be capable of producing tastes and odors if they should become abundant following periods of prolonged growth or sudden rise in temperature. Proper treatment of water in the reservoir with copper sulfate would remove any annoying growths. The public water supply could be rendered entirely satisfactory by purificastion.

ONARGA (1,273). Water supply.—(Bull. 11, 107.) Visited June 25. Water is pumped three or four hours a day. There is apparently no chance of contamination of the supply. The mains have been extended 2,200 feet, making a total of 3.5 miles of main.

The water is of good sanitary quality.

ONARGA. Proposed sewerage.—(Bull. 12, 118.)

OREGON. Water supply.—(Bull. 11, 107.)

Pollution of creek by wastes from a silica sand-washing plant.— (Bull. 13, 113.)

OSWEGO (600). Water supply.—Visited September 10. Oswego is located in the northwestern part of Kendall County on the eastern bank of Fox River. Waterworks were installed in 1895. The source of supply is a dug well 12 or 14 feet in diameter and 18 feet deep, curbed with stone and covered with a frame building. The lower 13 feet of the well is in rock. The static water level is 11 to 12 feet below the ground surface. After pumping for several hours the water is lowered about 5 feet. Water is pumped from the well by a single-cylinder double-acting horizontal pump driven by a 3-horsepower motor. A triplex pump operated by a gasoline engine is maintained in working order. An elevated steel tank is connected to the distribution system. The average daily consumption is about 22,000 gallons. All services are metered.

The water is of good sanitary quality. It has a residue of 600 parts per million.

OTTAWA. Water supply.—(Bull. 9, 28.)

PALATINE (1,144). Water supply.—(Bull. 12, 119.) Visited June 20. No important changes have been made in the waterworks since 1914. The source of supply is apparently well protected from contamination.

The water is of good sanitary quality. It has a mineral content of 743, a hardness of 430, and a content of iron of 0.8 parts per million.

PALATINE. Sewage treatment.—(Bull. 10, 161; 12, 119.)

PANA. Water supply.—(Bull. 9, 29; 10, 161; 13, 114.)

Pollution of a tributary of Beck Creek.—(Bull. 13, 115.)

Sewage disposal.—(Bull. 12, 120; 13, 115.)

Typhoid-fever epidemic—(Bull. 12, 120; 14, 57.)

PARIS. Water supply.—(Bull. 10, 164.)

PARK RIDGE. Typhoid fever.—(Bull. 13, 116.)

PAW PAW. Water supply.—(Bull. 14, 59.)

PAXTON (2,912). Water supply.—(Bull. 10, 165.) Visited May 14. A well 2,666 feet deep was drilled in 1879 or 1880. The water was of poor quality, having a very high mineral content. The drift was found to be 400 feet deep. In June, 1912, three wells were in use, a 6-inch well, 142 feet deep; a 5-inch well, 148 feet deep; and an 8-inch well, 148 feet deep. Later in 1912 a fourth well 6 inches in diameter was drilled to a depth of 200 feet without penetrating a water-bearing stratum. An attempt to improve the yield of the 2,666-foot well by blasting at the depth of 400 feet was unsuccessful. Later an 8-inch well 140 feet deep was drilled. This is equipped with a 16-foot brass screen, inside of which is placed a 6-inch perforated pipe attached to the top and bottom of the screen. The bottom of the pump cylinder is screwed to this pipe. Water is pumped from the well by a double-acting pumping with a 5¾-inch cylinder and a 24-inch stroke. The static water level is 98 feet below the ground surace. There are about 650 service connections.

The yield of the wells is not sufficient to insure an adequate supply for any considerable time in the future. The Illinois Central Railroad has three wells 140 feet deep at Paxton. Pump cylinders formerly in use have been replaced by others of smaller size. This may indicate decreased yield of the stratum or clogging of the well screens.

The water has a mineral content of 498, a hardness of 340, and a content of iron of 0.4 parts per million.

PEARL. Water supply.—(Bull. 12, 120.)

Pollution of Illinois River.—(Bull. 11, 108.)

PEARL CITY. Water supply.—(Bull. 14, 60.)

PECATONICA (1,022). Water supply—(Bull. 11, 108; 13, 116.) Visited May 7. The source of public water supply is a well 12 feet in diameter and! 20 feet deep in limestone. At the present time there are 196 service connections. The consumption is about 40,000 gallons a day. By continued pumping the well is emptied.

To increase the supply it is proposed to lay a pipe line to the well from a spring about 900 feet distant. The quantity of water available from the spring is not known.

Several wells in the vicinity enter St. Peter sandstone at a depth of about 200 feet. A well 225 feet deep located at a condensary is pumped only at night, because during the day the operation of other wells draws the water level down beyond reach of the pump. The condensary has five wells but only three are used, as the total yield is about the same as when all five are operated. A well 1,575 feet deep furnishes a large yield. Another well 900 feet deep supplies water for drinking. The three wells furnish from 800,000 to 900,000 gallons of water a day.

Developing a well supply for the city would be more expensive than developing the spring, but it may be that a well would have a much better yield than the spring, especially during summer months. It would be advisable to have an analysis made of water from a well into St. Peter sandstone at Pecatonica.

Waters from the village well and from the spring proposed as a source of supply were of excellent sanitary quality, but both, in their present condition, are subject to pollution. Waters from the village well, from the spring, and from the St. Peter sandstone stratum at Freeport have mineral contents of 357, 300, 356; hardnesses of 330, 236, 346; and contents of iron of 0.1, 0.0 and 0.3 parts per million, respectively.

PBKIN. Water supply.—(Bull. 10, 166.)

Pollution of Illinois River by Chicago Drainage Canal.—(Bull. 11, 108.)

PEORIA. Water supply.—(Bull. 9, 29; 11, 109.)

Microscopic survey of reservoir.—(Bull. 14, 60.)

State hospital. Water supply.— (Bull. 10, 166.)

PEORIA HEIGHTS. Water supply.—(Bull. 9, 29; 10, 166; 11, 109.)

PEOTONE. Water supply—(Bull. 11, 109.)

PERU. Water supply.—(Bull. 11, 109; 13, 116.)

PETERSBURG. Water supply.—(Bull. 10, 167; 14, 61.)

PINCKNEYVILLE. Water supply.—(Bull. 11, 110.)

PIPER CITY (663). Water supply.—(Bull. 11, 111; 12, 122.) Visited June 19. No important changes have been made since 1914. The water was in good sanitary condition.

PITTSFIELD. Water supply.—(Bull 11, 111.)

Disposal of sewage at high school.— (Bull. 13, 117.)

PLAINFIELD (1,019). Water supply.—(Bull. 11, 112.) Visited June 18. Since 1913 a well 1,380 feet deep has been drilled and equipped with a deep-well pump operated by an electric motor. The old well is used only in emergencies.

Water from the new well is of excellent sanitary quality. It has a mineral content of 650, a hardness of 386, and a content of iron of 0.4 parts per million.

PLAINFIELD. Sewage disposal.—(Bull. 12, 122.)

PLANO (1,627). Water supply.—(Bull. 9, 29.) Visited September 10. Piano is in the northwest part of Kendall County on Big Rock Creek, a tributary of Fox River.

Waterworks were installed in 1891. The source of supply was a well 10 feet in diameter and 14 feet deep, located about 50 feet from Big Rock Creek in the eastern end of the city. The well has been deepened to a total depth of 18 feet. Water was standing 10 feet deep in the well, the surface being about 6 feet lower than water in the creek above a dam close-by. With long continued pumping the water in the well is lowered 4 feet.

Water is pumped from the well into the distribution system by two duplex pumps, belt-connected to a shaft which is driven by a water wheel or by a gasoline engine, and by an electrically driven centrifugal pump. As the water power was not sufficient to do all the pumping one pump driven by water power was running at night and the centrifugal pump was run about seven hours each day. The distribution system includes an 8-inch cast-iron main to the city, a small amount of 4-inch and 6-inch cast-iron pipe, and small galvanized iron pipes extending to nearly all parts of the city. An elevated steel tank is connected to the distribution system.

The water is of good sanitary quality. It has a mineral content of 384 and a hardness of 298 parts per million. It contains no iron.

PLANO. Sewerage and sewage disposal.—(Bull. 12, 122.)

PLEASANT HILL. Typhoid fever.—(Bull. 11, 113.)

POLO. Water supply.—(Bull. 11, 113.)

PONTIAC. Water supply.—(Bull. 9, 30; 11, 113; 13, 117.)

Sewage disposal.—(Bull. 12, 123.)

PONTIAC. Microscopic and sanitary survey of the water supply.—Visited August 31. Water taken from Vermilion River is filtered and chlorinated to furnish a public supply. The river above Pontiac has a drainage area of 470 square miles of rather flat prairie land in a relatively high state of cultivation. The river is extensively used for amusement purposes.

The waterworks intake is about 1 mile up-stream from a dam near the east edge of the city. At the dam and the intake the river is about 200 feet wide. Above the intake it is from 100 to 150 feet wide for the three miles that were surveyed.

Although there had been little rain for some time the river was very turbid. From the dam to the intake there was no evidence of filamentous algae growth. Above the intake the surface of the river was covered from bank to bank with a heavy green algal scum. The water contained several types of algae, together with rotifers, and protozoan forms. The number of organisms present is shown in the accompanying table. A sample of the growth collected from the surface near a slough consisted chiefly of Volvox, Gleocapsa, and Protococcus with which were associated numerous protozoan and crustacean forms. Odor-producing types were present in sufficient numbers to impart a slight taste and odor to the water. These odors could not be detected in samples taken from mains in the city. At the intake the surface water had a dissolved oxygen content of 2.4 parts per million. In other samples tested the dissolved oxygen content was from 4.2 to 5.5 parts per million. Considering the growths of algae it would appear evident that the algae were the cause of this high oxygen content. The growth of algae may on certain occasions cause odors and tastes noticeable to consumers and may supersaturate the water, causing air-binding and reduction in the efficiency of the filters.

ORGANISMS IN WATER.

Organisms.	Number of organisms per cubic centimeter.		
	Sample near intake 50 feet from bank.	At Hughes' slough.	Surface in center of stream 30 feet above dam.
Diatomaceae—			
Staureonis	2,000	1,800	2,200
Chlorophyceae—			
Volvox	120	100	80
Protococcus	10	12	10
Cyanophyceae—			
Microcystis	80	76	64
Anabaena (filaments)	10	10	6
Rotifera—			
Anuraea	4	6	8
Asplanchna	4	12	14
Protozoa—			
Peridinium	70	86	76
Glenodinium	16	14	10
Euglena	6	8	4
Arcella	6	14	6
Total	2,326	2,138	2,478

The river water was polluted but the filtered water was of good quality and satisfactory for use. In so large a stream it would be difficult to treat the water with copper sulphate for the removal of growths. However, these growths might be treated in areas where they are most prevalent or at places near the dam and intake.

PORTLAND. See Oglesby.

PRINCETON. Water supply.—(Bull. 12, 124.)

Sewage disposal.—(Bull. 12, 125.)

PRINCEVILLE (982). Water supply.—(Bull. 11, 116; 12, 126.) Visited August 28. Water is obtained from a well 1,600 feet deep, cased to a depth of 1,400 feet. The pump cylinder is attached to a drop pipe at a depth of 300 feet. The water level is 145 feet below the ground surface. It was not appreciably lowered by 24 hours of pumping. Water is pumped from the well into the distribution system by an electrically driven deep-well pump. A 50,000-gallon elevated tank is connected to the distribution system.

Analyses indicate that contaminating matter was entering the well. The water has a total mineral content of 1,635, a hardness of 395, and a content of iron of 1.4 parts per million.

PROPHETSTOWN. Water supply.—(Bull. 14, 61.)

QUINCY. Water supply.—(Bull. 9, 30; 11, 116; 12, 126.)

RANKIN (858). Proposed water supply.—(Bull. 13, 118; 14, 62.) At the request of the village president several conferences were held with interested parties in regard to workmanship in the water distribution system.

During 1916 about 8,000 feet of the distribution system was laid. The work was not satisfactory. Part of the pipe was taken up and relaid, and part was repaired by burning out and repouring some joints and recaluking other joints.

All cracked pipe should be removed; and where pipes are not fitted tightly or where the amount of lead used was not sufficient, joints should be rerun. It would seem reasonable to allow the contractor to try to clear the pipe of dirt by flushing.

A steel pressure tank 9 feet in diameter and 36 feet long, of ⅜-inch plates has been installed. The tank was to withstand a test pressure of 125 pounds but during the test leaks developed before a pressure of 125 pounds was reached.

RANKIN. Proposed sewerage.—(Bull. 11, 117; 12, 127.)

RANTOUL (1,384). Water supply.—(Bull. 10, 168.) Visited May 24. Few changes have been made in the waterworks since 1912. An aviation training camp, to be located south of and adjoining the village, will secure water from the public supply of Rantoul.

Water is obtained from two 10-inch wells .120 feet deep, about 16 feet apart. The static water level is 60 feet below the ground surface. Pumping water from one well does not affect the water level in the other well. There are about 450 service connections, and the consumption is estimated to be from 120,000 to 140,000 gallons a day. By pumping 24 hours a day about 140,000 gallons a day more than the present maximum demand could be supplied. With any considerable increase in demand there would be little reserve capacity.

The water has a total mineral content of 350, a hardness of about 300, and a content of iron of 0.8 parts per million.

RANTOUL. CHANUTE FIELD. Water supply.—Visited September 3. A Signal Corps Aviation School is located at Chanute Field, south of and adjoining the city of Rantoul. Water is supplied to the field from the Rantoul city mains through a 6-inch pipe. Samples of water were collected for analyses. The analyses indicated that the water, excepting that from mains which had been in use only a short time, was of excellent sanitary quality.

RANTOUL. CHANUTE FIELD. Sewerage.—Visited December 22 and 24 at the request of government officials.

Sewage and waste water from the post pass through a sewage tank of the plain sedimentation type located near the north border of the field. The tank was designed to treat 60,000 gallons of sewage a day. Allowing for an accumulation of sludge, it will hold 20,000 gallons. It is divided into two compartments. From the tank the effluent flows northward about 800 feet through an 8-inch sewer and empties into a 30-inch tile which drains the city of Rantoul. This tile discharges into an open ditch beside a public road about one mile from the tank. The ditch follows the road for a distance of about two-thirds of a mile, where it discharges into another ditch known as Upper Salt Fork. At the point where sewage from the 30-inch tile enters, Upper Salt Fork has a drainage area of about 15 square miles. Five miles downstream the drainage area is about 50 square miles.

On December 22 practically all sewage was flowing through the north compartment of the tank, and on December 24 a large portion of the sewage was flowing through this compartment. The inlet end of the north compartment was practically full of sludge. The effluent from the tank contained no coarse matter in suspension. The liquid in the 30-inch tile above the point where sewage entered, as compared to the sewage from the tank, contained a considerably greater residue, more chlorine, and less nitrogen, and the amount of oxygen consumed was less. Near the tile outlet black sludge had accumulated, and when this was stirred gas was given off.

There was a noticeable odor in the ditch for about one-fourth of a mile below the tile outlet. In flowing through the ditch to its outlet into Upper Salt Fork the solids in suspension and the bacterial content were greatly reduced. At the ditch outlet there was no appreciable odor or unsightly condition.

Measures should be taken to reduce the nuisance caused by discharging wastes into the open ditch. The tank should be cleaned and the flow divided about equally between the compartments. The amount of polluting matter entering the 30-inch tile should be reduced if possible. Extending the tile to Upper Salt Fork, which does not follow a public road, would improve conditions.

Improvement could be made by giving additional treatment to sewage from the field. The activated sludge process or percolating filters could be used. For a temporary installation or an installation the capacity of which could be greatly reduced within a few years the activated sludge process would probably have an advantage in having a lower first cost, but would probably have a higher operating cost. Other processes of purification should be considered. A plant at the Great Lakes Naval Training Station gives promise of success.

RED BUD. Water supply.—(Bull. 12, 127; 13, 119.)
REDDICK. Proposed water supply.—(Bull. 11, 117.)
RIVER FOREST. Water supply.—(Bull. 10, 169.')
RIVERDALE. Water supply.—(Bull. 13, 119.)
RIVERSIDE. Water supply.—(Bull. 11, 118.)
ROANOKE. Water supply.—(Bull. 11, 119; 13, 120.1
ROBERTS. Water supply.—(Bull. 13, 120.)
ROBINSON. Water supply.— (Bull. 9, 30; 12, 127.)
ROCHELLE. Water supply—(Bull. 11, 120.1
Sewerage.—(Bull. 11, 120.)
ROCK FALLS. Water supply.—(Bull. 13, 121.)
ROCK ISLAND. Water supply.—(Bull. 9, 30; 13, 121.)
Disposal of gas wastes.—(Bull. 12, 128, 225-8; 13, 124.)
ROCK ISLAND. Arsenal. Water supply.—(Bull. 11, 120; 13, 125.)
ROCKDALE. Water supply.—(Bull 13, 125.)
ROCKFORD. Water supply.—(Bull. 10, 170.)
Water supply conditions at Camp Grant.—*See* Camp Grant.
ROODHOUSE. Water supply.—(Bull. 11, 121.)

ROSEVILLE (882). Water supply.—Visited July 16. Roseville is in the south central part of Warren County on the drainage area of Swan Creek, a tributary of Spoon River. The glacial drift in this locality is about 50 feet in thickness.

Waterworks were installed in 1895. The first supply was obtained from a 12-inch well which penetrated an abandoned coal mine at a depth of 50 feet. The mine has a tunnel 3 feet deep, 6 feet wide, and about 300 feet long. The working barrel of the pump is at a depth of 45 feet. The normal water level is 18 feet below the ground surface. In 1902 a 6-inch well 1,220 feet deep was drilled penetrating St. Peter sandstone. It is cased to a depth of 500 feet, and equipped with a 100,000-gallon deep-well pump with the working barrel at a depth of 260 feet. The distribution system includes 2 miles of 4-inch and 8-inch cast-iron pipe. There are about 80 service connections, most of which are metered. A 60,000-gallon steel standpipe 100 feet high is connected to the distribution system. About one-half the population uses the public supply. The average daily consumption of water is 20,000 gallons.

' The well casings are cemented around the top and the drainage is away from the wells. There is little chance of contamination. The water was in good sanitary condition. Mineral analyses show varying results. Four samples collected within a period of three months show mineral contents of 543, 1,039, 1,050, and 2,527 parts per million. The first three samples were ' collected after the pump had been in operation only a few minutes after standing idle for some time. The fourth sample was collected after pumping for one and one-half hours. The iron contents in these samples are 0.0, 0.6, 0.6 and 1.4 parts per million respectively.

ROSEVILLE. Sewerage.—(Bull. 13, 126.)
ROSSVILLE. Water supply.—(Bull. 10, 172.)
RUSHVILLE. Water supply.—(Bull. 9, 30; 12, 128.)
ST. ANNE. Water supply.—(Bull. 13, 126.)
Proposed sewerage.—(Bull. 11, 122.)
ST. CHARLES. Water supply—(Bull. 9, 30; 12, 129.)
ST. ELMO. Water supply.—(Bull. 10, 174.)

ST. PETERS. Typhoid fever epidemic.—(Bull. 14, 63.)

SALEM (2,669). Water supply—(Bull. 11, 123). Visited June 23. During the spring of 1917 a bond issue of $13,000 was voted to cover the cost of erecting a water filtration plant. Plans for the improvement had been prepared. The cost of materials has increased but it was the intention of the city officials to build the plant if the cost does not exceed the bond issue by more than a few thousand dollars.

The spillway was found to be in need of some repair, and its lower end should be protected from under-mining. If large weeds or trees are allowed to grow on the pavement on the dam, the roots may in time cause damage by moving the concrete.

SALEM. Microscopic and sanitary survey of reservoir.—Visited August 20. The source of the public water supply is an impounding reservoir of about 170,000,000-gallon capacity, located on a small tributary of Crooked Creek about a mile north of the city. An area of about 77 arces is inundated. No special preparation of the site was made other than the cutting out of trees and brush wood. The tributary drainage area is about 4 square miles and the soil is principally yellow clay. Near the dam the reservoir is 14 feet deep in the center but the upper portion contains large areas of shallow water and nearby is much marshy land.

The water was turbid due to the presence of finely divided clay. Spirogyra, a filamentous algae, was very noticeable in the upper part of the reservoir. Water in the main portion of the reservoir appeared to be free from filamentous algae; but as a boat could not be secured it was impossible to collect samples out from shore. A small number of algae, Protozoa, Rotifers, and Diatoms were found. A slight algal odor was noticeable. A very large amount of amorphous matter was present in practically all sam-

ORGANISMS IN WATER.

Organisms.	Numbers of organisms per cubic centimeter.	
	Sample from impounding reservoir.	Sample near dam from reservoir 12 foot depth.
Chlorophyceae—		
Protococcus	12	68
Closterium	20	
Diatomaceae—		
Asterionella		8
Cyanophyceae—		
Anabaena (filaments)	56	76
Microcystis	168	180
Protozoa, Rotifers, etc.—		
Chlomydomonas	8	56
Anuraea	8	8
Total	272	396
STANDARD UNITS PER CUBIC CENTIMETER.		
Chlorophyceae—		
Spirogyra	Moderately heavy	Moderate growth
Amorphus matter	2,800	48,000

ples collected. Results of analyses of two samples are given in an accompanying table.

The surface water at the upper end of. the reservoir where algae growths were most numerous was much more highly impregnated with dissolved oxygen than was water at the bottom of the reservoir near the gate-house where the water was 10 feet deep, or at the dam where the depth was only 2 feet. The oxygen content of the water is directly associated with the algae growths, as these organisms give off oxygen during their process of growth. The presence of oxygen might give rise to difficulty in filtering water.

The reservoir is liable to pollution from fishing parties, from road-ways close to its edge, and from several habitations. The water was polluted and should not be used for drinking purposes without purification.

SALEM (2,669). Sewerage.—(Bull. 11, 123; 13, 127.) Visited June 23. A sanitary sewer system is being installed. The sizes of pipe range from 6 to 18 inches in diameter. Sewage is to be passed through a two-story tank. The cost of the system will be approximately $70,000.

SALEM. Disposal of sewage from high school.—(Bull. 13, 128.)

SAN JOSE. Water supply.—(Bull. 12, 131.)

SANDWICH. Water supply.—(Bull. 9, 30; 12, 130.)

Sewage treatment—(Bull. 13, 128.)

SANGAMON, County poor farm. Proposed sewage treatment.—(Bull. 11, 123.)

SAVANNA. Water supply.—(Bull. 11, 124; 14, 64.)

SEARS. Proposed water supply.—(Bull. 12, 131; 13, 129.)

SECOR. Water supply.—(Bull. 13, 129.)

SHAWNEETOWN (1,863). Water supply conditions.—Visited Novemher 2. Shawneetown, the county seat of Gallatin County, is located in the southeastern part of the county on the west bank of Ohio River. It is the oldest town in the State and in 1812 was a great commercial center. At the present time the population is said to he decreasing. The land at Shawneetown and vicinity is low and subject to floods from the Ohio River. There is a possibility of the county seat being removed to Ridgeway, a town more centrally located in the county on higher ground.

The drift in this vicinity is thin, and water-bearing sand and gravel is encountered at a depth of from 10 to 15 feet. Most wells are dug or driven to depths of from 30 to 40 feet and furnish sufficient water to meet the demands placed upon them. This is ordinarily only for domestic use. An analysis of water from a well 113 feet deep showed it to be very highly mineralized, containing 5,900 parts per million of mineral matter. A well 200 feet deep contained 565 parts per million total solids. Either of these waters would probably be unsatisfactory for a public supply.

The village is now bonded to its limit, and as many of the people are not greatly interested in a public water supply it did not seem advisable to make further investigations at this time.

SHAWNEETOWN. Flood conditions on Ohio River.—(Bull. 11, 124.)

SHEFFIELD. Water supply.—(Bull. 12, 131.)

SHELBYVILLE. Water supply.—(Bull. 11, 125.)

SHELDON. Water supply.—(Bull. 11, 125.)

SHERMERVILLE (441). Water supply.—Visited October 15. Shermerville is in Cook County about 21 miles north of Chicago on the drainage area of a tributary of Chicago River. There is no sewer system in the village.

Waterworks construction was started in 1915 but has not yet been completed. Water is obtained from a well 1,345 feet deep, 10 inches in diameter at the top and 6 inches at the bottom. A casing of steel pipe extends the entire depth. The static water level is 65 feet below the ground surface. Pumping had not been continued for a sufficient length of time to determine the recession of the water level caused by the withdrawal of a large quantity of water. The well is equipped with a 144,000-gallon pump direct-connected to an electric motor. The working barrel of the pump is placed at a depth of 114 feet. The casing is connected directly to the pump head and to the distribution system, thereby eliminating chances of contamination. The distribution system includes 3.7 miles of 4-inch, 6-inch, and 8-inch cast-iron pipe; 13 valves, and 27 fire hydrants. A pressure tank 9 feet in diameter and 38 feet long is connected to the distribution system. At present there are no service connections, but applications for about 30 are on file. Due to the limited quantity of water available from private wells, it is probable that almost the entire population will use the public supply. The waterworks will cost the village about $31,000.

Water collected at the pump was of unsatisfactory sanitary quality; but it will undoubtedly improve after the system has been put in use. The water has a mineral content of 1,169, a hardness of 615, and a content of iron of 0.9 parts per million.

SILVIS. Water supply.—(Bull. 10, 173.)

SOMONAUK. Water supply.—(Bull. 13, 129.)

Stream pollution.—(Bull. 13, 130.)

SOUTH BELOIT. Pollution of Turtle Creek.—(Bull. 13, 130.)

SPARTA. Proposed water supply.—(Bull. 12, 132.)

Typhoid fever.—(Bull. 12, 132.)

Proposed sewerage.— (Bull. 14, 64.)

SPRING VALLEY. Water supply.—(Bull. 11, 126.)

Pollution of Illinois River.—(Bull. 11, 126.)

SPRINGFIELD (51,678). Water supply.—(Bull. 9, 31; 11,126.) Visited July 18, August 6, 10, and 21 for the purpose of making special bacteriological studies of municipal supply.

Water is obtained from wells and galleries along Sangamon River as described in Bulletin No. 11. Additional wells have been drilled. Water is obtained from sand and gravel at a depth of about 50 feet. The bacterial count in water as it comes from the wells is very low. Gas formers were absent in 10-cc. portions. The water is of good sanitary quality and safe for drinking. Samples collected from the mains some years ago during a period when raw river water was sometimes used showed the presence of gas-forming bacteria, as was to be expected. Analyses of the river water indicate that it is never safe for use without treatment. The raw river water has not been used as an auxiliary supply for some time. More recent analyses of samples from the mains show better water both by the fewer bacteria present and by the fewer positive tests for gas-forming bacteria. Gas formers are present, however, in many of the 10-cc. samples.

Samples collected at Camp Lowden on August 21 were of good sanitary quality. Water from the main receiving well showed the presence of contamination. Possible sources of contamination are: (1) seepage of surface water into the galleries, one of which extends under the lagoon; (2) seepage of water into the main receiving well; (3) a slight leakage of river water through a shut-off valve.

The ground water supply at Springfield is safe for drinking. A slight contamination exists at present. While the danger of infection could be removed by the addition of a small amount of chlorine to the water just before it is pumped into the mains, it would be better to remove the cause of contamination. The operation of a liquid chlorine apparatus would make very little extra work at the waterworks, and would render the water free from any contamination.

SPRINGFIELD. Sanitary conditions of State fair grounds.—(Bull. 12, 132.)

Pollution of Sangamon River.—(Bull. 13, 131.)

SPDINGFIELD. CAMP LOWDEN. Water supply.—Camp Lowden was visited August 21, 1917 at the request of Colonel Gordon Strong for the purpose of collecting samples of water for analysis. The request was made on account of the fact that two cases of typhoid fever had developed in the regiment.

The water supply is from the Springfield public supply. Samples for bacteriological examination were collected from the kitchens and barracks of the Third Regiment, Field Artillery. Analyses of all the samples indicated that the water was in very good sanitary condition. It is improbable that typhoid was due to the use of this water.

STANDARD (793). Water supply.—Visited November 22. Standard is in Putnam County on the drainage area of Illinois River. The present population is estimated at 1,800. There is no sanitary sewer system in the village. A coal mine employing about 400 men is located here.

Waterworks were installed in 1914. The source of supply is a well 16 inches in diameter at the top, 6 inches in diameter at the bottom, and 1,767 feet deep, terminating in St. Peter sandstone. The well is cased with wrought iron pipe to a depth of 1,297 feet. The static water level is 100 feet below the ground surface. Water is pumped from the well into the distribution system by a steam-head deep-well pump with a daily capacity of about 100,000 gallons. The working barrel is at a depth of 250 feet. Water is discharged into a 6,000-gallon circular wooden tank from which it is pumped to the distribution system by a duplex steam pump. The distribution system includes about 0.4 miles of 6 and 8-inch cast iron mains, 22 fire hydrants, 7 valves, and about 100 service connections, none of which are metered. A 75,000-gallon elevated steei tank is connected to the distribution system. About one-fifth of the population uses the public supply. The average daily consumption is estimated at 19,000 gallons. The distribution system and elevated tank are owned by the city. The well and pump equipment are owned by a local coal company. The village has a contract with the coal company to furnish 500,000 gallons of water a month at a cost of $75 and additional water at 15 cents per thousand gallons.

The water is of excellent sanitary quality. It has a mineral content of 1,117, a hardness of 194, and a content of iron of 1.4 parts per million.

STANFORD. Water supply.—(Bull. 13, 131.)

STAUNTON. Water supply.—(Bull. 10, 174; 13, 132.)

Proposed sewerage and sewage disposal.—(Bull. 12, 134.)

STEGER. Water supply.—(Bull. 12, 134.)

STERLING. Water supply.—(Bull. 11, 127; 13, 132.)

STEWARD (353). Water supply.—Visited August 7. Steward is in the northeastern part of Lee County on the drainage area of Kyte River, a tributary of Rock River. The village is not sewered.

Waterworks and an electric lighting plant were installed about 1909. by C. T. Beitel & Son who have since supplied the village. Water is obtained from an. 8-inch well 100 feet deep and is pumped into a pressure tank connected to the distribution system by a deep-well pump driven by an oil engine. The working barrel of the pump is attached to a 6-inch drop pipe and is placed at a depth of 72 feet. The space between the casing and the drop pipe is open at the top, allowing drip and oil from the pump to run into the well. The distribution system includes 1.9 miles of 4-inch and 6-inch cast-iron mains, 14 fire hydrants, and 30 service connections. Practically the entire population uses the public supply for drinking. All services are metered.

One sample of water collected was of excellent sanitary quality and another was contaminated, possibly in collection. The water has a mineral content of 303, a hardness of 242, and a content of iron of 0.7 parts per million.

STOCKTON. Water supply.—(Bull. 11, 127.)

Sewerage.—(Bull. 11, 128.)

STONINGTON (1,118). Water supply.—(Bull. 11, 128.) Visited June 25. Water is now obtained from three wells. There are no apparent chances of contamination of the supply.

The water is of good sanitary quality. It has a mineral content of 482, a hardness of 365, and a content of iron of 2.5 parts per million.

STRAWN. Water supply.—(Bull. 11, 130; 13, 134.)

Typhoid fever.—(Bull. 11, 130.)

STREATOR. Water supply.—(Bull. 9, 31; 11, 128; 13, 134.)

Pollution of Vermilion River.—(Bull. 13, 134.)

STREATOR. Microscopic survey of reservoir;—Visited August 30. Water from an impounding reservoir formed by a dam across Vermilion River is filtered and treated with liquid chlorine to furnish a public water supply. The reservoir was inspected for a distance of about 5 miles up stream from the dam. Its width in this part is about 175 feet.

At and near the dam practically no filamentous algal growth was noted, nor could any be seen near the pumping station except along the shore over a small area perhaps 3 feet square. Near the dam, however, a large amount of oily scum had collected on the surface of the water. A half mile above the dam and as far up stream as the inspection was made, the surface of the water was covered from shore to shore with a very heavy green scum of algae. This scum was practically unbroken over the entire surface of the water. The water in the river was very turbid at the time of visit, with bottom samples much more turbid than surface samples. Results of analyses of three samples are given in the accompanying table.

ORGANISMS IN WATER.

Organisms.	Number of organisms per cubic centimeter.		
	Surface sample 75 feet above dam.	Sample 5 miles above intake.	Sample near shore.
Chlorophyceae—			
Volvox	86	68	118
Protococcus	....	4	8
Cyanophyceae—			
Microcystis	80	80	76
Rotifera—			
Anuraea	60	10	6
Asplanchna	12	4	2
Protozoa—			
Peridinium	46S	48	72
Euglena	....	12	14
Glenodinium	22	12	10
Total	728	238	306

The microscopic analyses show the presence of a large number of types of microorganisms. Specimens of the growth on the surface of the water consisted mostly of Volvox, Gleocapsa, Protococcus, and Uroglena. With these forms were associated Protozoa and Rotifers.

Near the intake and about five miles upstream the surface water contained about 1 part per million more oxygen than did the water at the bottom of the stream. Considered in connection with the microscopical examination and the heavy growths of floating algae this would seem to be due to the growths of algae in the water since these organisms liberate large quantities of oxygen in their life processes.

As the supply is filtered the growths would cause no annoyance excepting that at times odors might be noticeable to consumers. Should the growths which prevail in the upper part of the reservoir reach the filters they would undoubtedly cause considerable annoyance in the operation of the filter plant due to mechanical clogging of the sand and to liberation of oxygen formed by algae.

STRONGHURST (762). Water supply.—(Bull. 12, 135.) Visited July 16. Stronghurst is in the southern part of Henderson County about 10 miles from the Mississippi River.

Waterworks were installed in 1915. Water is derived from a drilled well 10 inches in diameter at the top, 6 inches in diameter at the bottom, and 1,009 feet deep. The lower 137 feet of the well is in St. Peter sandstone. The static water level is 65 feet below the ground surface. Water is pumped from the well into the distribution system by a 140,000-gallon deep-well pump, driven by an oil engine. The distribution system includes 3.33 miles of 4-inch, 6-inch and 8-inch cast-iron pipe, 23 valves, and 34 hydrants. A 50,000-gallon elevated steel tank is connected to the distribution system. The total cost of the waterworks was about $23,000.

The water is of good sanitary quality. It has a mineral content of 2,890, a hardness of 660, and a content of iron of 2.0 parts per million.

SUBLETTE (287). Water supply.—Visited August 6. Sublette is the center of a farming community in the southeastern part of Lee County on

Big Bureau Creek, a tributary of Illinois River. There is no sanitary sewer system in the village.

Waterworks were installed in about 1897. In 1913 a new elevated tank was erected and two new electric motors were installed. Water is obtained from a 10-inch well 752 feet deep, located near the center of the village. The well is equipped with an electrically driven deep-well pump. The pump cylinder is attached to an 8-inch drop pipe and is placed at a depth of 300 feet. The well casing extends about 1 foot above the bottom of a pit at the top of the well. The drop pipe is hung from the casing and is flanged and bolted to it so that chance of contamination of the water is very slight. Water is pumped from the well into a 96,000-gallon brick collecting reservoir. This reservoir has a tight concrete roof with a well-screened cupola in the center. The top is about 6 feet above the surrounding ground. Operating the pump about two hours a day supplies sufficient water for the demand and to flush the reservoir. The overflow is carried away through a tile. From the reservoir, water is pumped to the distribution system by an 8 by 7-inch triplex pump driven by a 15-horsepow'er motor. An elevated steel tank is connected to the distribution system.

The water is of good sanitary quality. Tt has a mineral content of 275, a hardness of 196, and a content of iron of 0.4 parts per million.

SULLIVAN. Water supply.—(Bull. 11, 130; 13, 134; 14, 65.)
Proposed sewerage.—(Bull. 13, 135.)

SULLIVAN, Masonic Home. Proposed improved water supply.—(Bull. 14, 66.)

SUMMIT. Water supply.—(Bull. 14, 66.)

SYCAMORE. Water supply.—(Bull. 11, 131.)

TAMPICO. Water supply.—(Bull. 14, 67.)

TAYLORVILLE (5,446). Water supply.—(Bull. 11, 132.) Visited June 19. No changes have been made in the source of supply since the last visit. There is no apparent chance of contamination. Four deep well pumps are equipped each with a 6-inch steam head which requires 120 pounds of steam for operation. Two other pumps equipped with 10-inch steam heads require only 60 pounds of steam. Changing the small steam cylinders for cylinders of larger size is contemplated.

The water is of good sanitary quality. It has a mineral content of 789, a hardness of 570, and a content of iron of 2.4 parts per million.

THOMSON. Water supply.—(Bull. 14, 67.)

TINLEY PARK. Water supply.—(Bull. 12, 136.)

TISKILWA. Water supply.—(Bull. 9, 31; l0, 175.)

TISKILWA. Microscopic and sanitary survey of the public water supply.—Visited August 28. Water for the public supply is secured from springs located about 1 mile southwest of the center of the village. An impounding reservoir of about 25,000 gallons' capacity has been formed by building a concrete dam across a small spring-fed ravine but is not used for the public water supply at present. Land surrounding the reservoir is used for pasture and stock is allowed access to the reservoir. A concrete wall about 150 feet long extending to a stratum of impervious clay at a depth of from 6 to 11 feet has been built to prevent water from the reservoir from backing up into the spring supply. Water from the springs flows to a central well from which it passes through a 4-inch pipe under the reservoir to two concrete tanks of 30,000 gallons' capacity each. From these tanks water flows to the village mains.

The spring supply contains practically no microscopical growths. The reservoir water contained large number of microscopical organisms: Diatoms, green algae, Rotifers and Crustaceans being represented. Heavy growths of green algae were very noticeable at all places around the edge of the reservoir. A heavy growth of Spirogyra was found accompanied by many Cyclops and Closteria and by Calpidium, Protococcus, Anabaena and Daphnia. A small amount of amorphous matter was present in all samples collected.

If the reservoir were to be used as a source of supply for the village, treatment with copper sulphate would be necessary. The swamp conditions prevailing around the reservoir would make it necessary to treat it at regular intervals.

A sample of water from the village supply collected from a tap indicated that the water was contaminated and not very satisfactory for drinking.

TOLEDO. Proposed water supply.—(Bull. 13, 135.)

TOLONO. Water supply.—(Bull. 12, 139.)

TOLUCA (2,407). Water supply.—(Bull. 11, 132.) Visited August 28. Water is obtained from a well 2,040 feet deep and is now pumped by an electrically driven deep-well pump, which is operated about four hours a day. The working barrel of the pump is at a depth of 245 feet. Water rises to within 138 feet of the ground surface.

There is no apparent chance for contamination at the top of the well. Containers for samples did not arrive.

TOULON. Water supply.—(Bull. 11, 133.)

Sewage-treatment plant.—(Bull. 12, 140.)

TREMONT. Water supply.—(Bull. 12, 140.)

TRENTON. Water supply.—(Bull. 12, 140.)

TROY. Proposed water supply.—(Bull. 14, 68.)

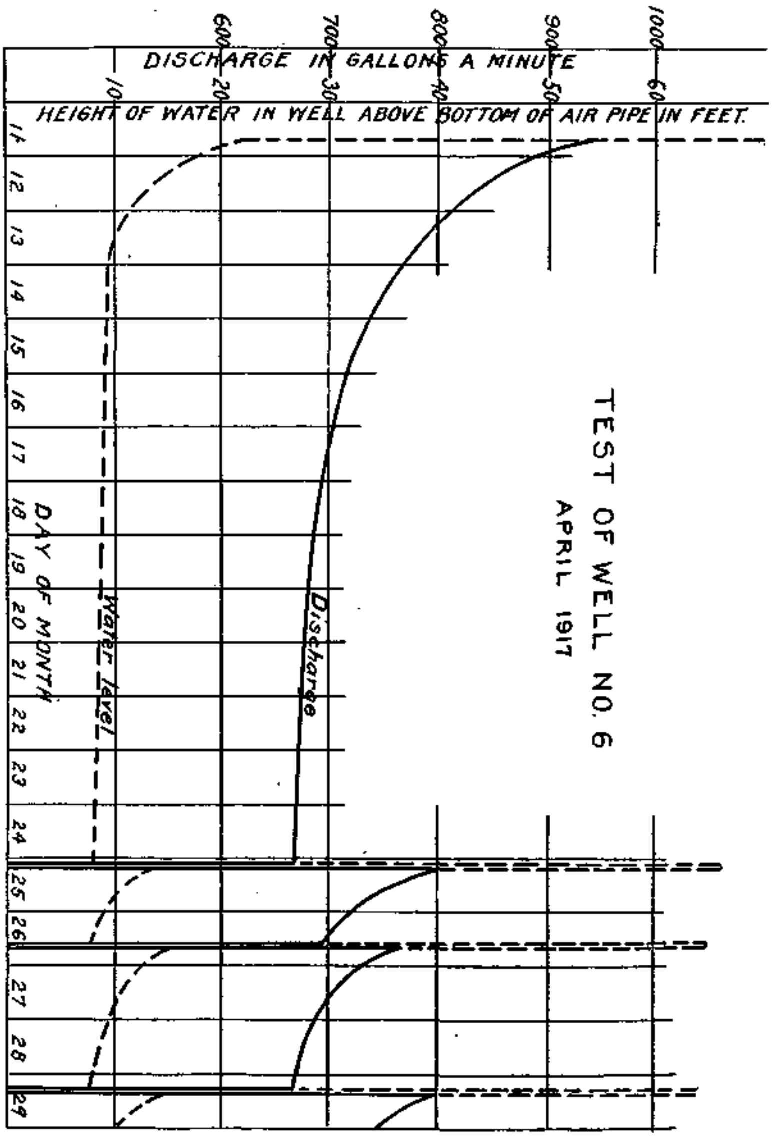
TUSCOLA. Proposed improved water supply.—(Bull. 12, 141; 13, 136.)

Proposed sewerage.— (Bull. 12, 142.)

URBANA, University of Illinois. Water supply.—During the year a 36-inch well drilled by the rotary process was completed. A 24-inch riveted steel casing and a Layne patent shutter screen were put in and an attempt was made to fill the space between screen and wall of well by pouring in gravel from above. It was hoped that the gravel would take the place of the sand which was pumped out of the well. There has been, however, no movement of the surface of the gravel to indicate that it has been moving downward although a considerable amount of sand has been pumped out. The gravel was later taken out to a depth of 6 feet below the floor of the pump pit and replaced with clay.

The well is equipped with a six-stage No. 5, 15-inch type C.L.C. Layne pump driven through a flexible coupling by a 50-horsepower induction motor.

Several tests were made. Results of a test made after the permanent equipment was installed are shown in the accompanying figure. The water level went down quite rapidly during the first two days of the test and con-tiued to go down slowly until the morning of the twelfth day when trouble at the switchboard caused pump to stop. It was started again about 20 minutes later but during that time the hydraulic constants of the well had greatly changed. Before stopping, the discharge had been about 670 gallons a minute for several days. During the 24 hours following the 20 minute shutdown the discharge averaged about 730 gallons a minute.



Plat showing test of well No. 6, University of Illinois, Urbana.

The average results of a test made on October 17 were as follows: Power input, 29.41 kilowatts; rate of pumping, 651.8 gallons a minute; total head, 130.0 feet; power output, 16.0 kilowatts; efficiency, 54.4 per cent.

The depth of the water in the well was measured by means of an electric sounding device, which was lowered inside of a one and one-half-inch pipe which extended some distance below the water level in the well. The rate of discharge was measurerd by a 90° triangular weir. The pressure in the discharge pipe was determined by means of a calibrated Bourdon gage.

In order to maintain continuous records of the water level in the well and also of the operation of the pump a recording gage is used to record the pressure required to keep a small quantity of air bubbling from the end of a one and one-half-inch pipe which hangs in the well and reaches below the water level at all times. The pressure in the air pipe is equal to the head of the water above the end of the pipe. Hence, the record made by the gage shows the submergence of the air pipe at all times. The weir has been replaced by a vertical jet apparatus located in a manhole near the well.

As a result of the tests payment is to be based on a capacity of 600 gallons a minute. The contract calls for a payment of $19 a gallon a minute capacity after one year's operation, making the total cost of the well and pumping machinery (not including wiring, switches, starting box, etc.), $11,400.

The water is of excellent sanitary quality.

UTICA. Water supply.—(Bull. 11, 134.)

VANDALIA (2,974). Water supply.—Visited June 14 and July 10. Vandalia, the county seat of Fayette County, is situated in the central part of the county on Kaskaskia River. The surface soil consists of about 20 feet of clayey material beneath which there is a stratum of water-bearing sand and gravel.

Waterworks were installed in 1898. The source of supply is Kaskaskia River. Water is pumped from the river directly into the distribution system. Until recently steam pumps were used. An 8 by 12 by 7 by 10-inch compound duplex steam pump is maintained for emergencies. A 1,000,000-gallon centrifugal pump driven by a 75-horsepower motor and a 600,000-gallon centrifugal pump driven by a 35-horsepower motor have been installed. Sand in the water causes considerable wear on the pumps, making frequent repairs necessary. A 65,000-gallon elevated tank is connected to the distribution system.

It would be desirable to furnish a water for the public water supply which would be satisfactory for drinking. A spring near the pumping station and another spring known as the Ritter spring northwest of the city were visited. A rough weir was constructed at the latter, the larger of the two, and the flow was found to be about 90,000 gallons a day. Measurements of flow from four springs were made in 1911. The flow was as follows: Rocky ford spring, 180,000 gallons a day; spring near paper mills, 40,000 gallons a day; spring near bottling works, 30,000 gallons a day; spring north of pumping station, 25,000 gallons a day.

During the recent visit no record of additional measurements of the yield of any of these springs could be secured. It was stated that other springs near the Rocky Ford spring could be developed.

Last fall a hole was drilled to a depth of 76 feet on the river bottom land north of the pumping station. A considerable amount of sand and gravel was encountered.

An investigation of the amount of water used for commercial purposes should be made, to aid in determining the required capacity of a new installation. A test well should be drilled on low ground near the pumping station. If water of satisfactory quality and in sufficient quantity is secured, a well supply should be developed. It is possible that the water would be very highly mineralized and unsuitable. Measurements of the flow of springs should be made. It would not be advisable to attempt to develop a supply from springs unless measurements of flow extending over a long period of time gave evidence of a sufficient yield. The cost of measuring the flow is very small. If a satisfactory water supply cannot be developed economically from wells or springs a filtration plant should be installed.

VILLA GROVE. Proposed water supply.—(Bull. 12, 142; 13, 137.)

VIRDEN (4,000). Proposed water supply.—(Bull. 11, 135; 14, 68.) Visited February 13, 15-18, 20, and April 19, at the request of the city officials to be present at well tests, and to attend a mass meeting held for the purpose of discussing the installation of a public water supply. At a special election in March, 1917, it was voted to issue $27,000 in bonds for the purpose of installing waterworks.

During 1916 a number of investigations and tests on wells had been made to determine the best source of supply. Consulting engineers had recommended that wells east of the city be tested. An 8-inch well 47½ feet deep with water level drawn down to 42% feet below the ground surface yielded about 8 gallons a minute.

In order to determine more definitely the amount of water obtainable in this vicinity, 13 more test wells have been put down, east and northeast of town. One well is 135 feet deep, another is 97 feet deep, and others are from 50 to 73 feet deep. The wells for which logs are available penetrate from 12 to 16 feet of soil and clay, below which are strata of sandstone, limestone, and shale. During a test of wells east of the city the greatest yield of any well pumped was 29 gallons a minute. The well was 10 inches in diameter and 50 feet deep. Pumping from this well lowers the ground water level over a very wide area. Two of the wells northeast of the city are to be tested.

It would not be advisable to develop a public water supply from wells in this vicinity unless additional wells yield as much or more than the best well that has been tested.

Water from the well of greatest yield is of good quality for a public supply. It has a mineral content of 300, a hardness of 214, and a content of iron of 0.3 parts per million.

WALNUT. Water supply.—(Bull. 14, 68.)

WARREN. Water supply.—(Bull. 11, 136.)

WARSAW. Water supply.—(Bull. l0, 176; 11, 136; 13, 137.)
Sewerage.—(Bull. 10, 177.)

WASHINGTON. Water supply.—(Bull. 14, 69.)
Disposal of canning-factory wastes.—(Bull. 11, 339-73.)

WATERLOO. Water supply.—(Bull. 10, 178; 14, 69.)
Microscopic and sanitary survey of reservoir.—(Bull. 14, 69.)

WATERMAN. Water supply.—(Bull. 14, 70.)

WATSEKA. Water supply.—(Bull. 10, 179.)

WATSEKA. Iroquois County poor farm. Sewage disposal.—(Bull. 12, 143.)

WAUKEGAN. Water supply.—(Bull. 9, 31; 11, 137; 13, 139.)

WELDON. Water supply.—(Bull. 14, 70.)

WENONA. Water supply.—(Bull. 13, 139; 14, 71.)

Proposed sewage.—(Bull. 13, 139.)

WEST BROOKLYN. Water supply.—(Bull. 14, 71.)

WEST CHICAGO. Water supply.—(Bull. 12, 143.)

WEST DUNDEE. Water supply.—(Bull. 9, 32.)

WEST FRANKFORT. Proposed water supply.— (Bull. 11, 137; 12, 144; 14, 72.)

WEST HAMMOND. Water supply.—(Bull. 12, 144.)

WESTERN SPRINGS. Water supply.—(Bull. 13, 140.)

WESTVILLE (2,607). Proposed water supply.—(Bull. 13, 140; 14, 72.) Visited April 15. Samples of water were collected from Kelley Mine No. 2, a proposed source of water supply for the village. Water from this abandoned mine flows into a sump at the foot of the mine shaft, from which it is pumped to the surface. Samples were collected from the sump and from the pump discharge at the ground surface. Sanitary, bacteriological, and boiler water analysis of the samples were made. The water was clear when first drawn but developed a slight turbidity on standing, due probably to manganese, which would separate on standing and might cause trouble from sedimentation in mains. The manganese can be removed by aeration and filtration.

The water is very highly mineralized. A sample from the pump discharge had a mineral content of 3,096 pp.m., of which 1,742 was sodium sulphate; a content of manganese of 0.75, and a content of iron of 0.2 parts per million. The water could be softened with lime, a process used by the coal company which uses the water. If used in boilers it would form a soft scale or sludge. When other water is available it is not advisable to use water containing so high a residue for a city supply. If, however, no other water is available this water could be used with or without softening and with or without filtration. Treatment would of course greatly improve the water.

WHEATON (3,423). Water supply.—Visited August 6. Wheaton, the county seat of DuPage County, is located about 25 miles west of Chicago on the drainage area of DuPage River. Glacial drift in this vicinity contains large bodies of sand and gravel which form a natural reservoir for the collection of rainfall. The drift is underlain by Niagara limestone which contains numerous joints, fissures, and cavities supplied with water from the overlying sand and gravel. Wheaton is served by storm-water and sanitary sewer systems.

Waterworks were installed about 1890. Water is obtained from two 10-inch wells 175 feet deep, penetrating 110 feet of drift and 65 feet of Niagara limestone. The wells are located about 20 feet apart, and between them is a brick-lined pump pit 5 feet in diameter and 34 feet deep. Two low-service pumps are located in the bottom of this pit and a suction pipe extends to each of the wells. The water level in the drift is about 26 feet below the ground surface. When pumps are operating, the water level in the wells is about 66 feet below the ground surface. Water is pumped from the wells into a 100,000-gallon surface reservoir from which it is pumped into the distribution system. There are two pumping units. One consists of a 1,000,000-gallon low-service centrifugal pump and a 1,000,000-gallon high-service centrifugal pump belt-connected to a 105-horsepower gas engine, and a 125-horsepower gas producer. The other has a 1,000,000-gallon low-service centrifugal pump and a 700,000-gallon high-service centrifugal pump belt-connected to a 60-horsepower gas engine, and a 75-horsepower gas producer. A 200,000-gallon elevated steel tank is connected to the distribution system. Nearly all residents of the city use water from the public supply. Practically all services are metered. The daily consumption is about 250,000 gallons in winter and 400,000 gallons in summer.

The water is of good sanitary quality. It has a mineral content of 362, a hardness of 287, and a content of iron of 0.2 parts per million.

WHEATON. Sewage purification.—(Bull. 10, 180.)

WHITEHALL. Incrustation of mains and filtration of water supply.—(Bull. 11, 138; 13, 142.)

Sewerage.—(Bull. 11, 139.)

WILMETTE. Water supply and sewerage.—(Bull. 9, 31.)

WILMINGTON (1,450). Water supply.—Visited November 12. Wilmington is in the southwestern part of Will County on Kankakee River. The drift in this locality averages probably not more than 20 feet in thickness. In some places rock appears on the surface. A system of sewers is being installed.

Waterworks were installed about 1892. Water is obtained from Kankakee River and is pumped into the mains without treatment. Water is pumped by the Public Service Co. of Northern Illinois. During 1917 a well 720 feet deep was drilled near the center of the city. It has a 12-inch casing extending to a depth of 21 feet into rock. Below the 12-inch casing are 189 feet of 10-inch casing. The well is not equipped. The static water level is 17 feet below the ground surface.

The distribution system is being extended to include about 6 miles of mains from 4 inches to 10 inches in diameter.

WINCHESTER. Water supply.—(Bull. 11, 139; 12, 145; 14, 73.)

WINNETKA. Water supply.—(Bull. 10, 184; 11, 140; 13, 143.)

WINSLOW (426). Water supply.—Visited May 10. Winslow is in the northwestern part of Stephenson County on the drainage area of Pecatonica River.

Waterworks were installed in 1916. The source of supply is a well located in an abandoned quarry near the bank of Indian Creek. The bottom of the quarry slopes toward the creek, and has sometimes been covered with water when the creek was very high. The well is 8 inches in diameter and 200 feet deep. It penetrates about 40 feet of limestone; the remainder is in St. Peter sandstone. Through the limestone the well was drilled 10 inches in diameter and cased with 8-inch pipe. Cement was poured around the outside of the casing to shut out surface drainage. The water level in the well is 16 feet below the surface when not pumping and is lowered 2 feet by pumping two or three hours. Water is pumped from the well into the distribution system by a single-acting 6½ by 8-inch triplex pump, operated by a gasoline engine. The distribution system includes 1¼ miles of

4-inch and 6-inch cast-iron pipe, and serves almost the entire village. A 40,000-gallon elevated steel tank is connected to the distribution system. There are 34 service connections. The consumption is estimated at 7,000 gallons a day. The total cost of the waterworks was about $12,000.

Several analyses made during the year show that the water is not of very good sanitary quality, possibly due to the entrance of surface water.

WITT. Proposed water supply.—(Bull. 11, 140.)

WOOD RIVER. Water supply.—(Bull. 14, 73.)

WOODHULL. Water supply.—(Bull. 14, 74.)

WOODSTOCK. Water supply.—(Bull. 9, 32; 12, 145.)

WYOMING. Water supply.—(Bull. 12, 146.)

YORKVILLE (431). Water supply.—(Bull. 9, 32.) Visited September 10. Yorkville, the county seat of Kendall County, is situated on the south bank of Fox River on a hillside that rises about 100 feet above the river.

Waterworks were installed in 1886. Water is obtained from a number of springs on a hillside about 1½ miles east of town. Water flows through tile into a collecting reservoir. At the time of visit the tile pipe lines were being taken up and cleaned. Water is pumped from the collecting reservoir by a motor-driven centrifugal pump, and discharged into a 64,000-gallon storage reservoir located on higher ground on the hillside. Water flows from the storage reservoir to the distribution system by gravity. An automatic electrical float control starts and stops the pump. There are 110 service connections, a few of which are metered. The consumption of water is about 24,000 gallons a day.

Water collected at the springs was of good sanitary quality. Water collected from a tap in a store was polluted, probably due to the fact that some of the tile collecting lines were being dug up. The water has a mineral content of 382, a hardness of 310, and a content of iron of 0.1 parts per million.

YORKVILLE. Proposed sewerage.—(Bull. 11, 141.)

ZION CITY. Water supply and sewerage conditions.—(Bull. 9, 32.)

SIGNIFICANCE OF LACTOSE—FERMENTING ORGANISMS IN WATER. *

The significance of lactose-fermenting organisms in the judgment of a water supply, recognized by Theobald Smith in 1905, has been subjected to careful and increasingly discriminating inquiry through subsequent years. What specific forms are definitely associated with fecal pollution is still an open question.

The bacteria fall in two groups:

1. Aerobic non-spore forming bacteria.
2. Anaerobic spore-forming organisms.

The former is more important as including intestinal bacteria, chief among which the B. coli group.

Various classifications have been proposed by different investigators in the attempt to characterize those of fecal origin by their reaction with several sugars, formation of indol, acid formation, the relative amounts of carbon dioxide and hydrogen liberated, the Voges-Proskauer and methyl red reactions.

Eogers, Clark and Davis, Rogers, Clark and Evans, Eogers, Clark and Lubs, Clark and Lubs and Levine have recently made extensive attempts to separate the fecal from the non-fecal members of this group. They have studied the reactions of a large number of carbohydrates, the ratio of CO_2: H_2 in the gas produced, the Voges-Proskauer reaction, gelatin liquefaction, indol production, final H-ion concentration, and acidity or alkalinity produced in a K_2HPO_4 dextrose-broth, using methyl red as an indicator. It was found that cultures of coli-type organisms from bovine feces belonged to the low gas-ratio group (below 1.4:1) ; cultures obtained from grains belonged to the high-ratio group (above 1.4:1). Organisms isolated from human feces, like those from bovine feces, belong to the low gas-ratio group. The methyl red test and Voges-Proskauer reaction were found to be well correlated; the Voges-Proskauer reaction positive and methyl red alkaline orgamisms were rarely isolated from feces, while the Voges-Proskauer negative and methyl red acid organisms were found chiefly in feces or were obtained from polluted sources.

* Abstract of a thesis prepared by Madeleine Bixby under supervision of Edward Bartow.

B. R. Johnson, in 1916, found that of 363 coli-like bacteria of soil origin, 251 gave a positive Voges-Proskauer reaction, and of these 97 per cent were methyl red alkaline.

The most recent classification is that given in the third edition of Standard Methods of Water Analysis which divides the group into four sub-groups according to their reactions:

B. coli of fecal origin.	Methyl red+ Voges-Proskauer— Gelatin— Adonite— Indol usually+ Saccharose usually—
B. aerogenes of fecal origin	Methyl red— Voges-Proskauer+ Gelatin— Adonite+ Indol usually— Saccharose+
B. aerogenes probably not of fecal origin	Methyl red— Voges-Proskauer+ Gelatin— Adonite— Indol usually— Saccharose+
B. cloacae, may or may not be of fecal origin	Methyl red— Voges-Proskauer+ Gelatin+ Adonite+ Indol usually+ Saccharose+

Sellards, and Prescott and Winslow express the view commonly held that, since tests for the presence of B. coli in waters are made in mixed culture, it is possible that in tubes in which the reaction could not be confirmed, typical B. coli was present, and might have given its characteristic confirmatory reaction within the first 24 hours; but in the subsequent overgrowth, it may have been killed by antagonistic bacteria, or its proportion with respect to the other bacteria may have been so diminished that its recovery would be difficult or impossible.

In attempts to test this hypothesis, the relation of gas formation to confirmatory tests made after 24 and 48 hours was studied, using cultures of 210 waters from various sources (deep and shallow wells, treated and untreated surface supplies, cisterns, etc.). The discovery of many cases of gas formation in lactose wherein confirmatory tests for B. coli failed, led to an attempt to isolate and identify the organism that produced gas, and to show whether it was significant in overgrowing B. coli.

Cultures of aerobic lactose-fermenting organisms obtained during the work above mentioned were submitted to all the tests of the Standard Methods classification to establish the character of organisms found in the waters tested and to learn how closely they conformed to the categories of the classification.

STUDY OF OVERGROWTHS.

1. Confirmatory tests for B. coli were made after 24 hours and after 48 hours on all lactose-broth tabes in which gas had formed. The results were studied in relation to the sources of the waters. An aerobic organism which produced gas in lactose. broth but did not grow on Endo's medium, was isolated, and an attempt was made to determine the significance of this and other organisms of the normal water flora in overgrowing B. coli.

To determine the relation between the total number of waters that would produce gas in lactose broth and the number that formed gas in 24 hours and in 48 hours, 1,160 waters were tested. Tubes of lactose broth were inoculated in each case with 10 cc of water (1 tube), 1 cc (2 tubes), and 0.1 cc (2 tubes). Gas was formed after 24 hours by 40 per cent of the waters, and after 48 hours by 19 per cent additional or by a total of 59 per cent of the 1,160 waters examined.

In 24 per cent of the waters, the 24 and 48 hour readings were the same in all tubes, but in 16 per cent of the 10 cc tubes gas formed in 24 hours, while the 1 cc and 0.1 cc tubes required 48 hours. The tardiness of gas formation in the tubes containing the small amounts of water may have been due to the presence of a different strain of organisms, or to the presence of only a small number of the organisms. In 50 cases in which this was observed, direct inoculation was made by transferring a loopful of the broth into another broth tube. Eighty-six per cent of these formed gas in 24 hours, and only 6 per cent of the remainder formed gas in 48 hours. These results indicate that in the majority of the cases in which gas formed in the 10 cc tube in 24 hours and in the 1 cc and 0.1 cc tubes in 48 hours, the tardiness of the 1 cc and 0.1 cc tubes was due to the presence of only a small number of organisms.

Confirmatory tests for B. coli were made according to the methods of the U. S. Treasury Department and the Standard Methods of Water

Analysis, by streaking Endo's plates with broth dipped from the tubes, incubating the plates at 37½°C for 48 hours, and inoculating two broth tubes each from a well isolated, typical colony. Gas production in these tubes within 48 hours was considered as indicating the presence of members of the B. coli group. One hundred and ninety-one (90.9 per cent) of 210 waters confirmed by these tests contained B. coli: 125 of these by which gas was formed in 24 hours contained B. coli, while only 66 (77.6 per cent) of those by which gas was formed in 48 hours contained B. coli. Gas formation in 24 hours apparently indicates that B. coli is present, but gas formation only in 48 hours may or may not be due to the presence of B. coli.

From 3 waters, or 1.4 per cent of all cases, B. coli was recovered from the gas tubes at the end of 24 hours, but was not recovered at the end of 48 hours showing that the percentage of possible overgrowth of B. coli was small.

Prom 20 of these waters 5 tubes instead of one were inoculated with 10 cc of the water. Confirmatory tests were made on all tubes showing gas formation, making 58 additional, or a total of 268 10 cc tubes. The 20 waters were chosen for additional tests because of their use on interstate carriers; 12 were from deep drilled wells, 7 from treated surface supplies and 1 from a shallow well. Two hundred and twenty-nine (85.5 per cent) of the total number of tubes in which gas was formed contained B. coli: 140 (100 per cent) of those in which gas was formed in 24 hours contained B. coli, while only 89 (69.6 per cent) of the tubes in which gas was formed in 48 hours contained B. coli. The gas forming organisms in the waters tested according to the interstate carrier definition of B. coli were in many cases probably some other organism. The eases of overgrowth are 3, as before, or 1.1 per cent on the basis of a total of 268 tubes.

To determine whether the presence of B. coli was dependent upon the sources of the waters, the presumptive and confirmed tests were considered. Of those which gave a positive presumptive test for B. coli (gas formation) 97 per cent from shallow wells, 97 per cent from untreated surface supplies and only 75 per cent from treated surface supplies, were confirmed. Gas formed in 24 hours in 69.5 per cent and 87 per cent respectively of the waters from shallow wells and untreated surface supplies, but in only 20 per cent of the treated surface supplies.

An anaerobic, spore-forming organism was isolated from lactose cultures giving gas formation but yielding no confirmed B. coli. It agreed very well in characteristics with the organism mentioned by

Frost, Cummings, Stewart and West and others, and probably belongs to the B. Welchii group.

To determine whether this organism, when present with B. coli in a water, would give an antibiotic reaction toward the B. coli, or would overgrow it, and so prevent the confirmation, suspensions of varying numbers of the two organisms were incubated together in broth tubes and confirmatory tests were made. Two suspensions of the anaerobe containing 3,000 and 30,000 bacteria per cc respectively, and seven suspensions of B. coli, ranging from 3 to 1,000,000 per cc were inoculated in 1 cc quantities into the broth tubes, in 14 combinations: (1) 3,000 anaerobes and 3 B. coli; (2) 30,000 anaerobes and 3 B. coli; (3) 3,000 anaerobes and 7 B. coli; (4) 30,000 anaerobes and 7 B. coli, etc.; in every case B. coli was recovered by the confirmatory tests. It appears that there is no overgrowth of the B. coli by the anaerobe even when the ratio of the numbers of the B. coli to the numbers of the anaerobe is very small.

Twelve samples of water which contained bacteria of the normal water flora in numbers from 1 to 2,200 but none fermenting lactose with gas formation, were inoculated with 30 B. coli per cc and were than tested in 1 cc amounts for the presence of B. coli, to determine whether under approximately natural conditions, the B. coli would be overgrown; B. coli was recovered in every case.

CLASSIFICATION OP B. COLI.

The bacteria isolated were studied according to the classification in the third (1917) edition of Standard Methods of Water Analysis, considering the relation of the production of indol and of the formation of gas in adonite and saccharose broth to the four types of organisms.

Prom colonies isolated on Endo plates and shown by the above confirmatory tests to belong to the B. coli group, 287 agar stroke cultures of lactose-fermenting organisms were made. Some were taken from plates that had been inoculated from both the 24-hour old, and the 48-hour old broth tubes. These were then submitted to all the tests of the Standard Methods classification. Carbohydrate fermentation was observed after 48 hours, indol production after 72 hours, methyl red and Voges-Proskauer tests after 7 days, and gelatin liquefaction after 16 days. Sixty-five per cent of the total number of organisms were B. coli, 14 per cent were B. cloacae, 10 per cent B. aerogenes of non-fecal origin, and 8 per cent B. aerogenes of fecal origin.

				Per cent of conformity to S. M. Classification.
1S7	B. coli of fecal origin 65%	Methyl red	+ 187	100
		Voges-Proskauer	—187	100
		Gel. not liq.	—187	100
		Adonite	—151 + 36	81
		Indol	+ 119 — 68	63
		Saccharose	— 82 + 106	44
25	B. aerogenes fecal 8%	Methyl red	— 25	100
		Voges-Proskauer	+ 25	100
		Gelatin	— 25	100
		Adonite	+ 25	100
		Indol	— 14 + 11	56
		Saccharose	+ 24 — 1	96
28	B. aerogenes non-fecal 10%	Methyl red	— 28	100
		Voges-Proskauer	+ 28	100
		Gelatin	— 28	100
		Adonite	— 28	100
		Indol	— 24 + 4	86
		Saccharose	+ 22 — 6	78
40	B. cloacae, fecal or non-fecal 14%	Methyl red	— 40	100
		Voges-Proskauer	+ 40	100
		Gelatin	+ 40	100
		Adonite	+ 13 — 27	67.5
		Indol	+ 12— 28	70
		Saccharose	+ 27 — 13	67.5
6	2.5%	Methyl red	+	
		Voges-Proskauer	+	
1	.5%	Methyl red	—	
		Voges-Proskauer	—	
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Between 73 and 87 per cent of the organisms would be considered of fecal origin (B. coli, B. aerogenes of fecal origin and B. cloacae), and between 10 and 24 per cent of non-fecal origin (B. aerogenes of non-fecal origin, and B. cloacae) depending upon the uncertain origin of the B. cloacae. To make sure that the disagreement between the methyl Ted test and the Voges-Proskauer reaction was not due to impure cultures, the cultures were purified by plating them on Endo's medium and the test repeated with well isolated colonies. Three per cent of the organisms gave results not reducible to the Standard Methods classification.

It should be mentioned that in many cases two organisms were isolated from the same water, one from the 24-hour old tube and one from the 48-hour old culture, and that in 41 cases these two organisms were of different types according to the classification.

Tests for the production of indol and the fermentation of saccharose and adonite were made to show the relation to the other tests. Of the 187 organisms grouped as B. coli, 81 per cent were adonite negative, and

63 per cent were indol positive, showing the usefulness of these supplementary tests in determining the presence of B. coli. Fifty-six per cent were saccharose positive and 44 per cent saccharose negative; the fermentation of saccharose is of little significance.

Since 44 per cent of the cultures of B. aerogenes of fecal origin were indol positive and 56 per cent were indol negative, the indol test would be of little value in this connection. That 96 per cent of the cultures of B. aerogenes of fecal origin formed gas from saccharose would indicate this as a good supplementary test for B. aerogenes of fecal origin.

Adonite fermentation is the essential test given by the classification for differentiating between the fecal and non-fecal strains of B. aerogenes, the fecal type producing gas in adonite and the non-fecal type producing no gas. Indol production and saccharose fermentation are rather satisfactory supplementary tests for B. aerogenes of non-fecal origin, giving 86 per cent negative, and 78 per cent positive, respectively.

The fermentation of saccharose and adonite and the production of indol are almost equally good supplementary tests for B. cloacae; 67.5 per cent were saccharose positive, 67.5 per cent adonite negative, and 70 per cent indol negative.

Dividing all cultures obtained, except the uncertain B. cloacae,. according to their fecal or non-fecal origin, 61 per cent were indol positive and 61 per cent were saccharose positive; 86 per cent of the non-fecal types were indol negative, but only 22 per cent were saccharose negative. The fermentation of saccharose, therefore, does not differentiate between the fecal and non-fecal types, since in both cases a high-percentage of saccharose positive organisms was obtained.

A study of these few organisms shows no relation between the nature of the organisms and the sources from which they were isolated. If, however, a larger number of organisms from these or similar sources was studied, it is possible that some relation might be observed.

CONCLUSIONS.

Overgrowth of B. coli by ordinary water bacteria or by anaerobic sporeformers could not be developed through direct experiment. A discrepancy noted in about 1 per cent of cases where B. coli was found in 24-hour but not in 48-hour cultures was possibly attributable to overgrowth. The presence of only a small number of organisms was responsible for slow gas formation (in 48 hours) from 1 cc. and 0.1 cc. portions of water of which 10 cc. portions yielded gas in 24 hours.

The classification of B. coli in Standard Methods of Water Analysis (Third Edition, 1917) does not provide for all lactose-fermenting organisms isolated in the course of this investigation. The supplementary tests (indol production, saccharose and adonite fermentations) show no consistent relation to the four types of the classification nor to the fecal and non-fecal strains of the colon group.

EXPERIMENTAL STUDY OF THE EXTRACTION OF GREASE FROM DRIED ACTIVATED SLUDGE.

(By D. F. McFarland.)

In a consideration of the advantages of the activated sludge process of sewage treatment, the possibility of extracting grease from the sludge is of interest because of the potential value of the grease as a marketable by-product and also because of the possibly harmful effect of the grease left in the sludge on its value as a fertilizer.

It is a well-known fact that sewage contains more or less fat and oily matter and that in some cities the amount of this is very considerable. In certain cases, notably at Bradford and Oldham, England, grease extraction from sewage has been carried out for several years with a very satisfactory profit. (Eng. & Cont. **40**, 601.) In these cases and others the grease content of the sludge is high because of certain special industries in the district and is higher than is to be expected from the average city or community.

Therefore, to ascertain the amount of grease extractable from sewage coming from an average residence community and to study the possibility of carrying on the extraction of such grease either at a profit or with notable improvement of the product, experiments were conducted with sludge produced at the State Water Survey experimental plant treating sewage from the city of Champaign by the activated sludge process.

METHODS OF EXTRACTION.

The methods used in degreasing low grade materials usually involve extraction with either steam or hot water under pressure or percolation with a volatile solvent, cold or hot, and with or without pressure.

For the purpose of laboratory studies to determine the amount and nature of grease extractable, percolation with a volatile solvent offers the most satisfactory and convenient method.

OUTLINE OF INVESTIGATION.

Information is desired upon the following points:

A. Determination of the amount of grease which can be extracted by different appropriate solvents.

B. Study of optimum conditions of extraction, such as time of extraction, volume of solvent required, losses of solvent, etc.

C. Study of effect of acid in liberating fatty acids from insoluble soaps in the sludge, in improving the physical condition of the sludge and in facilitating its separation.

D. Properties of grease obtained by different methods of treatment.

EXTRACTION TESTS.

Solvents. For experimental purposes petroleum ether boiling from 60°-70°C. was selected as a solvent. On a commercial scale this would have to be replaced by a low boiling naphtha or gasoline.

Some experiments were also made with carbon tetra-chloride and with benzene as solvents but with unsatisfactory results.

Apparatus. The extractor used was modeled on the principle of a Soxhlet extractor and had a capacity of 1 kilogram (2.2 pounds) of dried sludge. A sketch of the apparatus is shown in Figure 1.

The volatile solvent boiling in a three-liter flask B is condensed in the reflux condenser C and is delivered through tube X into the upper portion of the extraction cell A. This is made of an aspirator bottle and holds 1 kilogram of dried sludge. The solvent rises in the cell in contact with the sludge until its level is above the highest point of the siphon tube Y when it passes through the cloth filter D and the siphon Y into flask B.

When properly adjusted the extractor will run for long periods of time without any attention and with practically no loss of solvent.

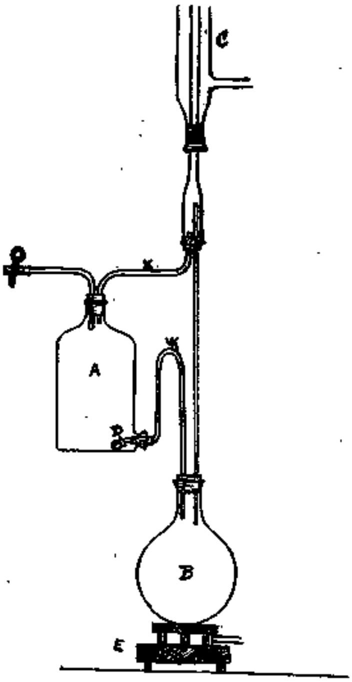

Figure 1.—Experimental grease extraction apparatus.

After extraction is complete the greater part of the solvent is distilled off and the final traces are removed by heating on a steam bath in an open, tared dish. The dish containing the dry extract is weighed to obtain the weight of grease extracted. One kilogram of dried sludge occupies approximately 90-100 cubic inches of space, depending on size of particles and closeness of packing. From 1,500 to 1,800 cc. of solvent is required for the extraction of 1 kilogram of material. This is all recovered excepting about 200 cc. which adheres to the residual sludge after extraction and 100 cc. more which is allowed to remain with the extracted grease and to evaporate spontaneously.

Extractions were carried out as follows:

(a) On untreated dry sludge.

(b) On residues from the first extraction after treatment with varying proportions of sulfuric acid.

(c) On sludge treated with acid before dewatering in the centrifugal separator, and then dried.

(d) On dried sludge treated with dilute acid to acid reaction, and then dried.

(e) On untreated sludge with coarse and fine grinding.

RESULTS AND EFFECT OF VARIATION OF CONDITIONS.

The results of these various extractions are shown in Table 1. The amount of grease extracted from the untreated material varied with different lots of dried sludge from 4.16 to 6.00 per cent. Acid treatment increased the yield to from 5.81 to 8.10 per cent.

The effect of size of particles upon the degree of extraction does not appear to be very great. The highest and the lowest yields were obtained from rather coarsely ground material. The material giving the low result was not exhausted at the end of 22 hours and gave some additional yield with another six hours' extraction. The total result after 28 hours was 4.16 per cent compared with 5.89 per cent from material from the same lot after treatment with acid.

The optimum conditions of treatment and extraction as shown by these experiments appear to be as follows: Treatment with slight excess of acid before dewatering and drying sludge. This assists in separation of colloids, and sets free fatty acids from lime soaps. It also decomposes sulfides and carbonates, and apparently improves the physical condition of the material. Extraction with low-boiling gasoline or petroleum ether for at least eight hours.

Time of extraction. A test to determine the best time of extraction gave results as follows:

In 4 hours, 3.91 per cent or 66.04 per cent of total.
In 8 hours, 5.59 per cent or 94.84 per cent of total.
In 36 hours, 5.89 per cent or 100 per cent of total.

Temperature of solvent. Under the conditions used, the solvent was at room temperature or only a few degrees above it. Use of heated solvent, especially under pressure, might greatly improve the extraction.

TABLE 1—RESULTS OF EXPERIMENTS ON EXTRACTION OF DRIED SEWAGE SLUDGE.

Extraction number.	Weight of sludge in grams.	Previous treatment with H_2SO_4.	Sizo of particles.	Time of extraction in hours.	Weight of extract in grams.	Per cent of extract.	Per cent unsaponifiable.	Saponification number.	Iodine number.	Acid number.	Description.
1	500	None.	Coarse 5-10 mesh.	15	30.0	6.0	41.05	126.5	43. 0	25.7	Very dark brown very viscous liquid. Unpleasant odor.
la	Residue from 1.	72 grins. H_2SO_4 (cone.) nor kilo 7.2%.	Coarse 5-10 mesh.	20	3.0	0.6					Light brown; odor of fatty acid only. Solid, low melting point.
				35 total		6.6 total					
2	1,000	None.	Coarse 5-10 mesh.	33	59.7	5.97	41.05	126.5	43.0	25. 7	Same as No. 1.
2a	Residue from 2.	181 grins. H_2SO_4 per kilo 18.1%.	Coarse 5-10 mesh.	24	13.0	1.3	37.22			70.9	Same as No. la.
				54	72.7	7.27					
4	1,000	None.	Coarse 5-10 mesh.	30	58.9	5.89	41.05	126.5	43.0	25.7	Same as No. 1.
4a	Residuo from 4.	302 grms. H_2SO_4 per kilo. 36.2%.	Coarse 5-10 mesh.	23	10.0	1.00					Dark brown solid.
				59	68.9	6.89					
5	500	H_2SO_4 added to acid reaction before filtering at plant.	Finely ground 10-40 mesh.	20	40. 5	8.10				41.65	Dark brown semi-solid. Bad bad odor.
6	1,000	None.	Finely ground 10-40 mesh.	24	44.0	4.40					Similar to No. 1.
7	1,000	Covered dry sludge with water. Added moderate excess dilute H_2SO_4, dried and extracted.	Coarse 5-10 mesh.	26	58.95	5.89					Similar to No. 1.
8	1,000	Nono.	Coarse 5-10 mesh.	22	29.12	2.91					Similar to No. 1.
				6	12.13	1.25					
				28	41.25	4. 16					

EXAMINATION OF EXTRACTED GREASE.

The grease extract obtained from samples which had not been acidified was very dark in color and of disagreeable odor.

The extract from acidified samples was lighter in color and not so unpleasant in odor.

The extract obtained by treatment with acid after a preliminary extraction of unacidified grease was light brown in color and had an odor characteristic of free fatty acids. This contained a high percentage of free fatty acids.

In order to determine the value of the grease for soap-making or other purposes, the customary analytical determinations of unsaponifiable material, saponification number, iodine number, and acid number were made. The results are shown in Tables 2, 3, 4, and 5.

Any portion of the grease which will not react with alkali to form a soap is termed unsaponifiable matter. The amount of this material is therefore an important index of the soap-making value of the grease. The usual limit for unsaponifiable matter in grease for soap-making is about 5 per cent.

The saponification number is also an indication of the amount and quality of available soap-making fat in the grease.

The iodine number is an index of the amount of unsaturated compounds in the grease, and shows its probable stability toward oxidation, or its liability to change on exposure.

The acid number is an index of the amount of free fatty acids in the grease as distinguished from fatty acids combined with glycerine in the form of fat. These free fatty acids are fully available for soap making and add to, rather than detract from, the value of the grease used for such purposes.

UNSAPONIFIABLE MATTER.

Considerable difficulty was experienced in obtaining satisfactory results on this determination. It was found that the period allowed for saponification by the standard method given by Lewkowitsch was too short, thus giving results entirely too high. In later determinations the saponification was carried out by boiling the mixture of fat and alcoholic potash four or more hours with a reflux condenser. The results gave a much lower percentage of unsaponifiable matter. It is not unlikely that even lower results might be obtained if the saponification were carried out under a higher temperature, under pressure, or using glycerine potash solution instead of alcoholic potash.

Determinations were made upon grease extracted without acid (a mixture of the product from extractions No. 1, 2, and 4) and upon that obtained from acid-treated sludge (extraction No. 5). As might be expected, the proportion of unsaponifiable matter was somewhat lower in the extract from acid-treated sludge because of the presence of a large proportion of free fatty acids.

TABLE 2—UNSAPONIFIABLE MATTER.

Number.	Weight of sample in grams.	Per cent unsaponifiable.	Number.	Weight of sample in grams.	Per cent unsaponifiable.
WITHOUT ACID TREATMENT.			WITH ACID TREATMENT.		
1.	10	48.0			
1a	10	40.0	5a	5. 2485	63.1
1b	5.0685	57.2	5b	6. 0141	54.04
1c	6. 5261	40.9	5c	5.2594	34.79
1d	7.4802	41.2	5d	5. 8121	39.66
		45.4			
Average of last two determinations	41.05				37.22

According to the averages of the last two determinations shown in table 2, which are most reliable, fat extracted from untreated sludge with a total extraction of 6.00 per cent or 120 pounds to the ton, would yield 58.95 per cent saponifiable material, or 70.74 pounds to the ton.

On acid-treated sludge with an extraction of 8 per cent of grease, or 160 pounds to the ton, a yield of 62.78 per cent saponifiable would be obtained, or 100.45 pounds to the ton. At 2 cents per pound the prices obtained would be respectively $1.42 and $2.01.

TABLE 3—SAPONIFICATION NUMBER OF UNTREATED SLUDGE (SAMPLE NO. 1.)

Weight of sample in grains.	Weight of KOH in grams.	Saponification number.
2.3531	.1264	126.4.
2.1902	.1236	123.6.
2.0658	.1209	120.9.
2.1900	.1302	130.2. These results are better.
2.0635	.1310	131.0.
2.1133	.1272	127.2.
		Average 126.5.

The low saponification number is due to the fact that only about 60 per cent of the material is saponifiable. This indicates that the saponifiable portion would have a saponification value of nearly 200.

TABLE 4—IODINE NUMBERS OF UNTREATED SLUDGE (SAMPLE NO. 1).

Weight of samples in grams.	Iodine absorbed.	
	Grams.	Per cent.
.6535	.2697	41.07
.5127	.2307	45.02
.5706	.2462	43.15
.4634	.2104	45.40
Average		43.66
.6715	.2811	41.9
.7036	.2980	42.3
.6736	.2885	42.8
Average		42.3

TABLE 5—ACID NUMBER OF SLUDGE.

Acid treatment.	Weight of sample in grams.	Weight of KOH in grams.	Acid number.
None. (Sample No. 1)	3.2976	.08825	26.78
	4.1476	.1111	26.52
	4.9934	.1335	22.27
	5.6008	.1389	24.79
Average			25.7
Spent sludge treated. (Sample No. 2a)	3.5638	.25267	70.9
	2.5610	.18188	70.9
Average			70.9
Treatment at plant before filtering. (Sample No. 5)	4.5416	.1881	41.4
	4.1361	.1742	42.15
	4.0015	.1656	41.4
Average			41.65

The extracts from acid-treated sludge show much higher proportions of fatty acids.

GENERAL, CONCLUSIONS.

From the results of the experiments performed it is evident that the amount of extractable grease in the dried activated sludge is very low, not exceeding 6 per cent of the unacidified dried material. The yield is increased to a maximum of 8 per cent if the sludge is treated with acid either before or after drying.

It is interesting to compare this extraction with that obtained on sludge from sewage from the same original source as that which yielded the sludge tested in these experiments, but obtained by different methods of treatment. Mr. Hatfield of the State Water Survey Division reports in some unpublished data of tests on the Miles Acid process, the following results:

	Fat.
Sludge from ordinary sedimentation process—Champaign sewage	18.4 per cent
Sludge from Miles acid process obtained in parallel run	26.4 per cent

Both of these show much higher fat content than that obtained from activated sludge and these results agree well with other published information regarding tests of fat in sewage sludge.

Hendrick (Eng. News **75**, 1,155, 1916) obtained from Baltimore sewage sludge 27.5 per cent of grease, 86.34 per cent of which was saponiflable.

Weston (Eng. News, **75**, 913, 1916) reports 21.7 per cent of grease extracted from sludge obtained in tests on Boston sewage using the Miles Acid process.

. These figures are so high in comparison with the recovery from dried activated sludge that it seems probable that a considerable portion of the original fat in the sewage may have been decomposed and rendered soluble by the aeration and bacterial action of the activated sludge treatment.

The quality of the extracted grease is poor. The color is very dark, the odor is very unpleasant, and the per cent of unsaponifiable material high. These factors lower the value of the grease and make it almost unsalable. It is possible that distillation would greatly improve the product but it would also cut down the quantity to be sold.

It is impossible to judge from these experiments the probable cost or efficiency of larger scale operation. Much better extraction and greater efficiency could be attained and the costs cut down in a plant having a proper system of solvent recovery.

Inquiry concerning the market value of the grease obtained indicated that it would hardly find a sale unless first distilled and that even after distillation it would bring a very low price per pound.

In view of these results grease extraction from this activated sludge is not a very promising field for operation.

NOTE.—As this is going to publication, the results obtained by Winslow and Mohlman in tests of the Miles Acid process on New Haven sewage have been published (Eng. News Record, 81, 1,034, 1918). These investigators report a maximum of 30.9 per cent of ether extractable material with 15.7 per cent of unsaponifiable material and 41.5 per cent of free fatty acids, on Miles process sludge from sewage coming from residence district. On grease from sludge obtained from sewage in a manufacturing district the unsaponifiable material was 21.1 per cent. Both of these figures are higher than those on grease recovery obtained here.

AIR DIFFUSION IN THE ACTIVATED-SLUDGE PROCESS OF SEWAGE TREATMENT.*

The fundamental principle underlying the activated sludge process of sewage treatment is the oxidation of the organic constituents of sewage through the agency of the bacterial content of activated sludge under conditions that are maintained through forced aeration. Aeration being the essential function involved, an efficient means of introducing air into sewage has been from the start a primary consideration. Many varieties of diffusers to introduce air into sewage have been experimented with. Statements made concerning the use of diffusers were, so decidedly at variance that it seemed advisable to carry out experiments with different varieties of diffusers under identical conditions.

Eeinforced concrete tanks located in the basement of the University of Illinois power house were remodeled for the experiments. Diffusers of perforated pipe, basswood blocks, and filtros plates were used. The tanks and accessories, excepting the air diffuser and remodeled bottoms of tanks, are illustrated and described in bulletin 14, pages 89-92. The tanks will be designated as "A," "B," "C," and "D."

Each tank is 3 feet 2 inches square, inside measurement, and about 8 feet 6 inches deep to the air diffuser. Each is equipped with an adjustable outlet made of 2-inch pipe connected with three loose joints. Each outlet was equipped with measuring chains so that at the end of the aeration periods the sludge could be allowed to settle and the outlet lowered to any desired depth for drawing out the effluent. A petcock is provided on each tank to relieve the air pressure while the tank is being drained and prevent air bubbles from rising and stirring up the sludge. Air was obtained from the University of Illinois supply and was measured by gas meters. The pressure was reduced by reducing, gate, and needle valves.

Tank A was equipped with a perforated pipe diffuser. The bottom of the tank is sloped from the center and sides at an angle of about 45°, thus forming two V-shaped channels of equal size 1 foot in depth entirely across the tank. A perforated iron pipe with one end capped and the other end connected to the compressed air supply was laid in the bot-

* Abstract of a thesis prepared by F. L. Mickle under supervision of Edward Bartow, presented June, 1917.

torn of each channel. The perforations were one twenty-fifth of an inch in diameter spaced 2 inches apart and staggered at an angle of 45° from the top of the pipe.

The basswood blocks used for diffuser in tank B were generously furnished by the Milwaukee, Wisconsin Sewerage Commission, and many valuable suggestions regarding their installation were given by T. Chalkley Hatton, Chief Engineer, and Carl H. Nordell, Engineer of designs. The blocks were 6 inches long, 2½ inches wide and one-half inch thick. They were held in a concrete container in a depression 2 feet 3 inches long, 1 foot 3 9/16 inches wide, ¾ of an inch deep at the edge, and 1¼ inches deep at the center. The surface of the depression was cast on a concave curve so that the tendency of the blocks' on swelling would be to wedge themselves more firmly into position. There are 13 ridges one-half inch wide and one-quarter inch high running crosswise of the container. The wooden blocks rest upon the ridges, leaving a one-fourth inch air space below. These are connected by a central air channel one inch wide and one-half inch deep. Air enters through a pipe cast in the center of the container. Strips of galvanized iron were placed on edge between each two rows of blocks for reinforcement. Leaky joints were caulked with oakum.

Tanks C and D each contained 3 filtros plates covering one-third of the floor area of the tank and forming the bottom of a central trough with sides sloping at an angle of 45°. Below the plates in each tank was an air space 4 inches deep. The plates were 12 inches square and one and one-half inches thick. The plates in tank C were marked "fine" because on the manufacturing basis of dry rating they passed 5.8 cubic feet of air per minute per square foot under a water pressure of 2 inches. Tank D was equipped with plates marked “coarse” which on the same basis passed 12 cubic feet of air per minute per square foot. When saturated with water and passing 2 cubic feet of air per minute the plates marked "fine" showed a resistance on a water gage of from 11.4 to 11.8 inches and the plates marked "coarse" a resistance of from 8.8 to 9.6 inches. The General Filtration Company of Eochester, N. Y., kindly supplied these plates.

Sewage was pumped from the Champaign outlet sewer just outside of the city limits. It is fresh, fairly strong domestic sewage containing no trade wastes. Chloroform was used as a sample preservative and samples were placed in a refrigerator until analyzed. The addition of chloroform to stable effluents was unnecessary. The methods of analysis were those given in the 1917 edition of the American Public Health Association's, "Standard Methods for the Examination of Water and Sewage."

Three series of tests were made. There was no sludge present in any tank at the beginning of any series of tests. Results of tests are summarized in tables Nos. 1 and 2, and the rate of aeration is given in table No. 3.

TABLE I—AVERAGE RESULTS OF ANALYSES OE INFLUENTS AND EFFLUENTS OF TANKS.

(Parts per million.)

Series.	Turbidity.					Amonia nitrogen.					Nitrate andinitrite nitrogen.					Oxygen consumed.				
	Sewage.	Effluents.				Sewage.	Effluents.				Sewage.	Effluents.				Sewage.	Effluents.			
		A	B	C	D		A	B	C	D		A	B	C	D		A	B	C	D
1..	375	90	...	67	50	34	27	...	28	29	.2	.1	...	.2	.2	82	38	...	34	30
2...	273	52	30	24	26	24	18	21	19	19	3.9	1.3	5.1	4.4	6.3	57	23	17	14	15
3...	274	13	10	11	11	21	20	19	6	6	2.5	1.7	1.9	12.6	13.6	52	21	22	20	19
1*..	391	98	...	42	38	34	29	...	30	30	.1	.1	...	.4	.4	85	31	...	20	21
2*.	153	18	7	5	5	14	11	14	13	13	6.6	2.2	9.6	8.0	11.8	42	17	12	10	11
3*.	2S3	5	5	5	5	24	24	23	0	0	1.7	.3	.1	17.8	19.4	55	32	26	25	16

* Results after activated sludge was formed.
A. Tank with perforated pipe diffuser.
B. Tank with basswood blocks diffuser.
C. Tank with fine filtros plates diffuser.
D. Tank with coarse filtros plates diffuser.

TABLE II—PERCENTAGE REMOVAL OF TURBIDITY, AMMONIA NITROGEN AND OXYGEN-CONSUMING CAPACITY.

Series.	Period 1917.	Turbidity.				Amonia nitrogen.				Oxygen consumed.			
		Effluents.				Effluents.				Effluents.			
		A	B	C	D	A	B	C	D	A	B	C	D
1. Reduction..	Feb. 2	75	....	82	85	19	....	16	14	53	....	59	63
2. Reduction..	Mar. 1-20	81	89	91	90	26	13	21	21	60	70	75	74
3. Reduction..	Mar. 27-Apr. 30	95	96	96	96	5	10	71	71	60	58	62	63
1. Reduction*.		76	....	88	90	13	....	10	7	63	....	75	75
2. Reduction*.		8S	95	97	97	21	0	7	7	60	71	76	74
3. Reduction*.		98	98	98	98	0	4	100	100	41	53	54	70

* Results after activated sludge was formed.

In the first series of tests extending over a period of 15 days filtros plates and perforated pipes were used. About 19,000 gallons of sewage was treated in each tank with an average of 2.5 cubic feet of free air per gallon of sewage. In the second series of tests extending over a period of 20 days all four tanks were in operation. About 17,000 gallons of sewage was treated in each tank with an average of 1.8 cubic feet of air per gallon of sewage. Measured in terms of removal of turbidity, removal of oxygen-consuming capacity and the production of nitrate nitrogen, the purification was best in the tanks containing filtros plates, and in series 2 the tank with wooden blocks gave better results than the tank with perforated pipes. Measured in terms of Temoval of ammonia nitrogen the purification was best in the tank with the perforated pipes. The third series of tests, which lasted 35 days, was the most satisfactory. About 30,000 gallons of sewage was treated in each tank with an average of 3.2 cubic feet of free air per gallon of sewage. No accurate comparison of the sludge accumulation at the end of the series could be made, for owing to the length of the run the excess of accumulated sludge was wasted at times. Measured in terms of removal of ammonia nitrogen and in production of nitrate nitrogen the tanks with filtros plates were decidedly superior. Ammonia nitrogen was entirely removed in the tanks with filtros plates after 17 days. Owing to rain, nitrate nitrogen was present in the raw sewage during the early part of the series, and continued to increase in the tanks containing filtros plates, reaching about 25 parts per million. Practically all of the nitrate nitrogen disappeared from the other tanks. The poor results from the tank with wooden blocks were probably caused by the development of a hole which prevented the formation of finely divided bubbles.

The stability to methylene blue was tested on and after the eleventh day. All effluents from the tanks containing filtros plates were stable for 10 days at 20°C. The majority of the effluents from the other tanks was unstable. Nearly 30,000 gallons of sewage was treated in each tank with 3.2 cubic feet of free air per gallon. A summary of operating data is given in table 3.

CONCLUSIONS.

The results of this investigation justified the following conclusions:

1. Filtros plates proved the most efficient of the three types of diffusers, as evidenced by the anlytical data. They gave sludge that settled rapidly leaving clear and stable effluents.

2. The degree of porosity of the filtros plates made no apparent difference, for the coarse and the fine grades of plates gave practically the same results.

3. The wooden-block diffusers gave unstable effluents in the majority of the samples. With these effluents the chemical results were not as satisfactory as with those from the filtros plates.

4. The wooden blocks were very difficult to install and even in the short time they were in service they showed evidence of marked deterioration. Until these defects can be remedied their installation in working-scale plants is impracticable.

5. The perforated pipes gave the least satisfactory chemical results. The majority of the effluents were unstable.

TABLE III—AMOUNT OF AIR USED.

Series.	Cubic feet of free air used per gallon of sewage.			
	A	B	C	D
1	2.5	....	2.5	2.3
2	1.8	1.7	1.9	1.8
3	3.2	3.1	*4.5	3.2

* Figure high due to leak which developed in air line. The actual amount of air supplied was about the same as supplied to the other tanks in this series.

6. Clogging of the diffusers during the period covered by these experiments was not sufficient to have practical significance.

ASSOCIATIONS AND COMMISSIONS.

Certain phases of Illinois water problems are of interest to several state, interstate, national and international associations and commissions, which have been cooperating as far as possible in order to prevent duplication of work. In order to place before the citizens interested in the water supplies of the State information concerning the activity of these associations, it has been customary to publish a list of the organizations with abstracts of articles pertaining to the water supplies of Illinois. The organizations are noted below.

STATE OP ILLINOIS. DEPARTMENT OF REGISTRATION AND EDUCATION.

F. W. Shepardson, Springfield, director. One of the departments of State Government created according to provisions of the Civil Administrative Code on July 1, 1917.. The Code provides for a board of Natural Resources and Conservation Advisors in this department. This department has power to "investigate and study the natural resources of the State and to prepare plans for the conservation and development of the natural resources * * *." At a meeting of the board of advisors the State Natural History Survey Division, the State Geological Survey Division, and the State Water Survey Division were organized.

The State Natural History Survey Division. S. A. Forbes, Urbana, chief. This division is interested in the character of streams of the State with respect to their effect on aquatic life. A special study is being made to determine the effect of Chicago sewage on the plankton and food fishes in Illinois rivers, the chemical work of which has been done under the direction of the State Water Survey Division. Volume XI, Article VI of the bulletin contains a report on "Experimental study of the effects of gas waste upon fishes with special reference to stream pollution" by Victor E. Shelford.

The State Geological Survey Division. F. W. DeWolf, Urbana, chief. This division has records of well borings and information in regard to horizons from which water may be obtained.

STATE OP ILLINOIS. DEPARTMENT OF PUBLIC HEALTH.

C. St. Clair Drake, M. D., Springfield, director. The powers of the department include the power "to act in advisory capacity relative to public water supplies, water purification works, sewerage system, and sewage treatment works, and to exercise supervision over nuisances growing out of the operation of such water and sewage works, and to make, promulgate and enforce rules and regulations relating to such nuisances." A monthly bulletin, "Health News," is published by the department.

STATE OF ILLINOIS. DEPARTMENT OF PUBLIC WORKS AND BUILDINGS.

F. I. Bennett, Springfield, director. This department has power "to exercise the rights, powers and duties vested by law in the rivers and lakes commission of Illinois, its officers and employees; * * *." It is the duty of the department to have general supervision of every body of water within the State wherein the State or the people of the State have any rights or interests. A Division of Waterways has been created.

Division of Waterways. W. L. Sackett, Springfield, superintendent. Among the duties of this division is to see that all of the streams and lakes of the State of Illinois wherein the State of Illinois or any of its citizens has any right or interest, are not polluted nor defiled by the deposit or addition of any injurious substances.

PUBLIC UTILITIES COMMISSION OF ILLINOIS.

Established January '1, 1914. Thomas E. Dempcy, Springfield, chairman. The commission, as an administrative body, has jurisdiction over all private corporations and individuals who own or operate water or power plants as public utilities. Its powers do not extend to municipally owned plants. It has extensive authority over reports, accounts, capitalization, mergers, intercorporate contracts, rates, services, and facilities. A certificate of convenience and necessity from the commission is necessary to authorize a new enterprise as a public utility, and the operation of the undertaking is brought under its active control and regulation. Under the present law a public utility must be incorporated by the Secretary of State, before receiving a certificate of convenience and necessity from the Utilities Commission. No fees are charged by the commission in any action, except authorization of security issues. Much of the commission's work consists of the regulation of rates and the adjudication of complaints concerning the practices of public utilities.

ILLINOIS STATE BOARD OP HEALTH.

Established in 1877. Since July 1, 1917, the rights and powers and duties vested by law in the State Board of Health have been exercised by departments of State Government created on that date.

ILLINOIS STATE GEOLOGICAL SURVEY.

Established in 1905. See State of Illinois, Department of Registration and Education, State Geological Survey Division.

STATE LABORATORY OF NATURAL HISTORY.

Established in 1884. See State of Illinois, Department of Registration and Education, State Natural History Survey Division.

RIVERS AND LAKES COMMISSION.

Established in 1909. The rights, powers and duties vested by law in the rivers and lakes commission of Illinois, its officers and employees, are now exercised by the Department of Public Works and Buildings.

UNITED STATES PUBLIC HEALTH SERVICE.

Dr. Eupert Blue, Washington, D. C., Surgeon-General. The Public Health Service publishes bulletins and a weekly journal entitled "Public Health Reports," containing current information regarding the prevalance of disease, the occurrence of epidemics, sanitary legislation and related subjects. Volume 32 contains the following articles on water.

Hasseltine, H. E. Bacteriological examination of water—comparative studies of media used.

Whittaker, H. A. Fallacies in the investigation of water supplies.

UNITED STATES GEOLOGICAL SURVEY.

George Otis Smith, Washington, D. C., director. The Survey has charge of stream measurements and other investigations of water resources of the country. Water-Supply Papers are issued at frequent intervals.

SANITARY DISTRICT OP CHICAGO.

Established in 1889. Charles H. Siegel, Chicago, president; George M. Warner, Chicago, chief engineer, 910 South Michigan Avenue, Chicago. The Sanitary District of Chicago has continued its investigations of sewage disposal for Chicago during the past year.

NORTH SHORE SANITARY ASSOCIATION.

Established in 1908. James O. Heyworth, Lake Forest, president; James F. King, Lake Forest, secretary. This association advocates proper sewage disposal and water supply for municipalities on the "north shore" of Lake Michigan, and its work until recently has consisted mainly in accumulating necessary data and promoting a campaign of education. A bill passed in 1913 by the State Legislature granted permission to organize a sanitary district in Lake County, and on April 7, 1914, the North Shore Sanitary District, extending as far north as the north limits of Waukegan, was formally organized by a vote of the people. W. J. Allen of Waukegan was elected president of the North Shore Sanitary District.

INTERNATIONAL JOINT COMMISSION.

For the United States, Obadiah Gardner, chairman; Whitehead Kluttz, Southern Building, Washington, D. C, secretary. For Canada, Charles A. Magrath, chairman; Lawrence J. Burpee, secretary. Problems involving the sanitary condition of the boundary waters between Canada and the United States are referred to this commission.

AMERICAN PUBLIC HEALTH ASSOCIATION.

Established in 1872. Dr. William A. Evans, Chicago, Ill., president; Prof. Selskar M. Gunn, Boston, Mass., secretary. The 1917 annual meeting was held at Washington, D. C. "Standard Methods of Water Analysis" is published by the association. The official publication is The American Journal of Public Health. Volume 7 includes the following articles of interest to waterworks men:

Bartow, Edward, Mohlman, F. W., Schnellbach, J. F., Activated Sludge Experiments at the University of Illinois, p. 679.

Whittaker, H. A., Fallacies in the Investigation of Water Supplies, p. 785.

AMERICAN WATER WORKS ASSOCIATION.

Established in 1880. Theodore A. Leisen, Detroit, Mich., president; J. M. Diven, Troy, N. Y., secretary. The 1917 annual meeting was held at Eichmond, Va. "The object of this Association shall be the advancement of knowledge of the design, construction, operation and management of waterworks, and the encouragement, by social intercourse among its members, of the friendly exchange of information and experience." Many interesting articles are published in the quarterly journal.

ILLINOIS SECTION, AMERICAN WATER WORKS ASSOCIATION.

Established as Illinois Water Supply Association in 1909 and became a section of the' American Water Works Association in 1915. E. MacDonald, Lincoln, chairman; Dr. Edward Bartow, State Water Survey Division, Urbana, secretary. This section is composed of persons interested in the waterworks and water supplies of Illinois. Papers dealing with topics of interest to waterworks men are read at the annual meetings, which are held at the University of Illinois. A one-day fall meeting was held at Peoria on November 15, 1917.

WESTERN SOCIETY OF ENGINEERS.

Established in 1895. H. J. Burt, 1400 Monroe Building, Chicago, president; Edgar S. Nethercut, 1735 Monadnock Building, Chicago, secretary. The annual meeting is held in Chicago.

The official publication is a monthly journal. Volume 22, issued in 1917, contains the following papers:

Clausen, H. W., Survey Methods used on the Wilson Avenue Water Tunnel, Chicago.

Hatten, T. Chalkley, Modern Sewage Treatment.

ILLINOIS SOCIETY OP ENGINEERS.

Established in 1885. Winifred D. Gerber, Chicago, president; E. E. E. Tratman, Wheaton, secretary. Water-supply and sewage-disposal problems form an important part of the work of the members of this organization. The official publication in 1917, the Thirty-second Annual Eeport, includes the following articles:

Habermeyer, George C. Eemoval of Iron from Water.

Sjoblom, M. C. Operation of Sewage Disposal Plants.

ILLINOIS ACADEMY OF SCIENCE.

Established in 1917. J. C. Hessler, Decatur, president; J. L. Pricer, Normal, secretary. The functions of the Academy are the promotion of scientific research, the diffusion of scientific knowledge, and the unification of the scientific interests of the State. All residents of the State who are interested in scientific work are eligible to membership. Transactions are published annually.

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