APPENDICES

Appendix 1.

GLOSSARY

Alluvial—describes deposits of clay, silt, sand, gravel, or other particulate rock material in a streambed, on a flood plain, or on a delta

Aquifer—a saturated permeable geologic unit that can transmit significant quantities of water under ordinary hydraulic gradients

Bank storage—the water absorbed into the banks of a stream channel when the stage rises above the water table in bank formations, then returns to the channel as effluent seepage when the stage falls below the water table

Base flow—the portion of stream flow derived largely or entirely from ground-water seepage

Bucket-rig well—a large-diameter well typically utilized in areas of low ground-water yields

Buried valley—depression in an ancient land surface or in bedrock now covered by younger deposits; especially a preglacial valley filled with glacial drift

Channel slope—the slope of the streambed between points that are 10 and 85 percent of the distance from the location on the stream to the basin divide, as determined from topographic maps; expressed in feet per mile

Climatic year—the 12-month period, April 1 to March 31, designated by the calendar year in which it begins; for example, climatic year 1984 is from April 1, 1984 to March 31, 1985; climatic year is designed to encompass the annual summer-fall low-flow period

Colluvium—loose rock debris at the foot of a slope or cliff deposited by rock falls, landslides, and slumpage

Combined sewer overflow—a discharge composed of untreated or partially treated sewage mixed with stormwater

Confined—describes an aquifer in which ground water is isolated from the atmosphere by impermeable formations; confined ground-water is generally subject to pressure greater than atmospheric

Contaminant (drinking water)—as defined by the U.S. Environmental Protection Agency, any physical, chemical, biological , or radiological substance in water, including constituents which may or may not be harmful

Continuous-record station—a site on a stream or lake where continuous, systematic observations of stage and/or discharge are obtained by recording and nonrecording instruments and periodic measurements of flow

Cyclonic—describes a roughly circular area of low atmospheric pressure in which the winds blow counterclockwise in the northern hemisphere

Direct runoff—water entering a stream channel promptly after a precipitation event; it is presumed to consist of surface runoff and a substantial portion of the interflow.

Dissected—cut by erosion into hills and valleys or into flat upland areas separated by valleys

Diurnal—having a daily cycle

Drainage density—ratio of total length of all channels within a drainage basin to the area of that basin

Drawdown (ground water)—difference between the water level in a well before and during pumping

Appendix 1. Continued

Drawdown (surface water)—artificial lowering of the water level of a lake or reservoir

Drift—unconsolidated sediment and rock debris transported and deposited by glaciers or glacial streams

Dry hole—a well that produces little or no water

End moraine—see moraine

Epilimnetic—describes the upper layer of a thermally stratified lake in which the water is nearly uniformly warm, circulating, and fairly turbulent

Estimate (population)—a number based on events that have already occurred

Eutrophic—describes a body of water which has become enriched with plant nutrients, most commonly phosphorus and nitrogen

Evapotranspiration—collective-term that includes water discharged to the atmosphere as a result of evaporation from the soil and surface water bodies and by plant transpiration

Fecal coliform—bacteria that occur naturally in the intestines of humans and animals; bacterial counts in waterways are used as indicators of pollution from human and animal wastes

First-order stream—a channel reach which has no tributaries

Flood, 100-year—a statistically-derived flood discharge having an average frequency of occurrence of once in 100 years, or a one percent chance of being equaled or exceeded in any given year

Flowing well—a well deriving its water from a confined aquifer and in which the water level stands above the ground surface

Fragipan—a loamy, brittle subsurface soil horizon which is low in porosity, low or moderate in clay, but high in silt or very fine sand; a fragipan appears cemented and restricts plant roots and the percolation of water

Frequency analysis—a statistical method for attaining the probability that a given hydrologic event will be equaled or exceeded

Grab sample—water collected at a single location and at a single time as opposed to a sample composited over space or time

Growing season—the average number of days between the last spring and first autumn temperature of 32^{0}F

Ground moraine—rock and soil material deposited from a glacier on the ground surface over which the glacier has moved; it is bordered by lateral and/or end moraines.

Ground-water discharge—in this usage, the part of total runoff which has passed into the ground and has subsequently been discharged into a stream channel

Hummock—a mound, knoll, or hillock

Hydraulic conductivity—a constant describing the rate at which water moves through a permeable medium; often expressed in gallons per day per square foot

Hydrograph—graph showing stage, flow, velocity, or other properties of water with respect to time

Appendix 1. Continued

Hypolimnion—the lower layer of a thermally stratified lake in which the water is nearly uniformly cool and relatively quiescent

Igneous—describes rocks that solidified from molten or partly molten material

Intercalated—interstratified; inserted among other layers

Interflow—the part of precipitation which infiltrates the surface soil, and moves laterally toward streams as perched ground water

Intratill—describes geologic materials contained within a single till unit

Lacustrine—pertaining to, produced by, or formed in a lake or lakes

Loamy—describes a soil composed of a mixture of clay, silt, sand, and organic matter

Loess—a homogeneous, fine-grained deposit consisting predominantly of silt, and chiefly deposited by wind

Macrophytes—macroscopic forms of aquatic vegetation

Maximum contaminant level—the maximum permissible level of a contaminant in water which is delivered to the free-flowing outlet of the user of a public water system

Median—the middle value of a set of observations arranged in order of magnitude

Metamorphic—describes rocks that have formed in the solid state in response to pronounced changes of temperature, pressure, and chemical environment

Moraine—a mound, ridge, or other distinct accumulation of unsorted, unstratified glacial drift deposited chiefly by the direct action of glacial ice

Normal (climatic)—average (or mean) value for a particular parameter over a designated period, usually the most recent 30-year period ending every decade (1941-70, 1951-80, for example)

Outwash—sand and gravel deposited by meltwater streams in front or beyond the margin of active glacial ice

Overland flow—the part of runoff which passes over the land surface to the nearest stream channel

Paleosol—an ancient, buried soil

Partial-body contact—any contact with water up to but not including complete submergence

Partial-record station—a site where limited stream-flow and/or water quality data are collected systematically over a period of years

Per capita income—total money income of the residents of a given area divided by the resident population of that area; represents the amount of income received before deductions for personal income taxes, social security, bond purchases, etc.; receipts not counted include ''lump sums'' payments such as capital gains or inheritances

Phytoplankton—an assemblage of microscopic aquatic plants having no or very limited powers of locomotion

Physiography—the origin and evolution of landforms

Appendix 1. Continued

Piezometric surface—an imaginary surface representing the level to which water from a given aquifer will rise under its own head

Polychlorinated biphenyls (PCBs)—a family of chlorinated hydrocarbons toxic to animals and humans

Projection (population)—a number based on trends and patterns of the past

Recharge (ground water)—process of entry of water into the zone of saturation

Recurrence interval—the average time interval, in years, within which the magnitude of a given event, such as a flood, storm, or low-flow event will be equaled or exceeded

Regression analysis—a statistical method for determining linear dependence, and, where significant correlation exists, in making predictions

Regulation (stream)—artifical manipulation of the flow of a stream

Residuum—rock material remaining essentially in place after all but the least soluble constituents have been removed

Runoff (total)—the part of precipitation that appears in surface-water bodies; it is the same as stream flow unaffected by artificial manipulation; runoff expressed in inches shows the depth to which the drainage area would be covered if all the runoff for a given period were uniformly distributed

Second-order stream—a channel reach which receives flow from two or more first-order streams

Static water level—the level of water in a well that is not being affected by withdrawal of ground water

Stratigraphy—geological study of the formation, composition, sequence, and correlation of unconsolidated or rock layers

Surface runoff—water which passes over the land surface to the nearest stream channel (overland flow) plus precipitation falling directly on the stream

Tailwater—water in a channel or pool immediately downstream of a structure such as a bridge, culvert, or dam

Terminal moraine—a moraine formed across the front edge of a glacier marking its farthest advance

Terrace—a bench or discontinuous segments of a bench, in a valley at some height above the modern floodplain, and which is part of an abandoned floodplain

Till—unsorted, unstratified drift deposited directly by a glacier without subsequent reworking by meltwater; it consists of a heterogeneous mixture of clay, silt, sand, and gravel ranging widely in size and shape

Topography—the relief and contour of a surface, especially land surface

Toxic—describes materials which are or may become harmful to plants or animals when present in sufficient concentrations

Transmissivity—rate at which water is transmitted through a unit width of an aquifer under a unit hydraulic gradient

Unconfined—describes an aquifer whose upper surface is a water table free to fluctuate under atmospheric pressure

Unit discharge—a general term used to describe a streamflow parameter uniformly distributed over the drainage basin during a specified unit of time

Appendix 1. Continued

Valley train—a long, narrow body of outwash confined within a valley

Water year—the 12-month period, October 1 to September 30, designated by the calendar year in which it ends; for example, water year 1984 is from October 1, 1983 to September 30, 1984; water year is designed to encompass the annual winter-spring high-flow period

Weathering—the decay of earth materials through a complex interaction of physical, chemical, and biological processes

Whole-body contact—direct contact with water to the point of complete submergence

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Glossary is partially adapted from Langbein and Iseri, 1960; U.S. Geological Survey, 1984; and the American Geological Institute, 1976.

Appendix 2. Historic and projected county population

Upper figures: Division of Water estimates, in-basin portion only.
Lower figures: U.S. Census Bureau, total county (1900-1980); Indiana State Board of Health (1983), total county (1985-2000).

County	1900	1910	1920	1930	1940	1950	1960	1970	1980	1985	1990	1995	2000
Dearborn	3036	2927	2741	2880	3154	3439	3923	4026	4691	4966	5239	5472	5677
	22194	21396	20033	21056	23053	25141	28674	29430	34291	36300	38300	40000	41500
Decatur	1727	1663	1576	1532	1568	1612	1772	2012	2110	2124	2151	2177	2204
	19518	18793	17813	17308	17722	18218	20019	22738	23841	24000	24300	24600	24900
Fayette	12365	13208	15707	17632	17786	21433	22407	24022	25906	26389	26939	27489	27856
	13495	14415	17142	19243	19411	23391	24454	26216	28272	28800	29400	30000	30400
Franklin	15537	14539	14038	13746	13664	15202	16132	16064	18594	19436	20289	21237	21996
	16388	15335	14806	14498	14412	16034	17015	16943	19612	20500	21400	22400	23200
Henry	2732	3241	3777	3837	4379	4955	5325	5728	5808	5739	5695	5663	5641
	25088	29758	34682	35238	40208	45505	48899	52063	53336	52700	52300	52000	51800
Randolph	5301	5367	4900	4599	4950	5021	5260	5349	5549	5550	5606	5661	5716
	28653	29013	26484	24859	26755	27141	28434	28915	29997	30000	30300	30600	30900
Ripley	934	914	879	850	888	882	970	993	1147	1199	1246	1293	1335
	19881	19452	18694	18078	18898	18763	20641	21138	24398	25500	26500	27500	28400
Rush	691	664	660	666	649	679	699	698	672	641	621	611	604
	20148	19349	19241	19412	18927	19799	20393	20352	19604	18700	18100	17800	17600
Union	5299	4916	4728	4618	4725	5035	5071	5169	5387	5497	5497	5576	5654
	6748	6260	6021	5880	6017	6412	6457	6582	6860	7000	7000	7100	7200
Wayne	38775	43538	47895	54535	57938	68223	73669	78713	75678	73530	72237	71242	70545
	38970	43757	48136	54809	58229	68566	74039	79109	76058	73900	72600	71600	70900
Total	86397	90977	96901	104895	109701	126481	135228	142774	145542	145071	145520	146421	147228
	211083	217528	223052	230381	244643	268970	289025	304026	316269	317400	320200	323600	326800

Appendix 3. General Soil Map

AGRICULTURAL EXPERIMENT STATION AND COOPERATIVE EXTENSION SERVICE, PURDUE UNIVERSITY: AND THE SOIL CONSERVATION SERVICE, U.S. DEPARTMENT OF AGRICULTURE (1971)

Note: This map is intended for general planning. Each delineation contains soils different from those shown in the legend. For operational planning, use detailed soil maps that may be available in published or unpublished form at the local Soil and Water Conservation District Office.

SOIL ASSOCIATIONS

3. *Wakeland-Stendal-Haymond-Bartle:* Nearly level, somewhat poorly drained, silty Wakeland and Stendal and well drained, silty Haymond in alluvial deposits, and somewhat poorly drained, silty Bartle with fragipans in acid alluvial deposits.

4. *Genesee-Shoals-Eel:* Nearly level, well drained, loamy Genesee, moderately well drained, loamy Eel, and somewhat poorly drained, loamy Shoals in alluvial deposits.

18. *Fox-Martinsville-Alluvial soils:* Sloping and nearly level, well drained, loamy Fox on outwash sand and gravel, and loamy Martinsville on outwash sand and silt and associated soils in alluvial deposits.

19. *Fox-Nineveh-Ockley:* Nearly level, well drained, loamy soils on outwash sand and gravel.

62. *Blount-Pewamo:* Nearly level, somewhat poorly drained, clayey Blount and very poorly drained, clayey Pewamo in glacial till.

64. *Crosby-Brookston:* Nearly level, somewhat poorly drained, clayey Crosby and very poorly drained, loamy Brookston in glacial till.

66. *Fincastle-Ragsdale-Brookston:* Nearly level, somewhat poorly drained, silty Fincastle in wind-blown silts and glacial till, very poorly drained, silty Ragsdale in wind-blown silts and loamy Brookston in glacial till.

72. *Reesville-Ragsdale:* Nearly level, somewhat poorly drained, silty Reesville and very poorly drained, silty Ragsdale in wind-blown silts.

81. *Miami-Russell-Fincastle:* Sloping, well drained, loamy Miami in glacial till and silty Russell in wind-blown silts and glacial till and nearly level somewhat poorly drained, silty Fincastle in wind-blown silts and glacial till.

83. *Miami-Crosby:* Sloping, well drained, loamy Miami and nearly level, somewhat poorly drained, clayey Crosby in glacial till.

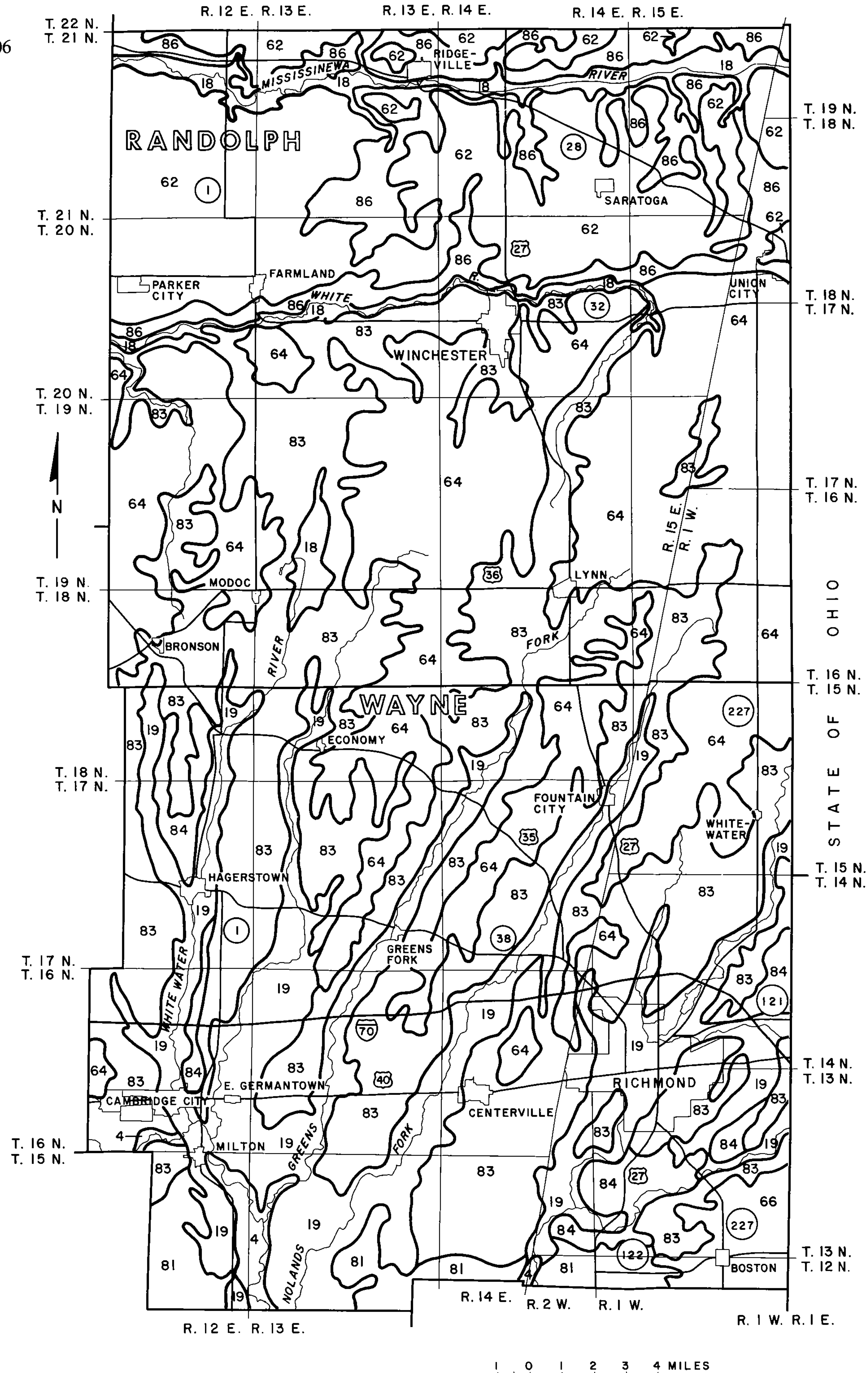
84. *Miami-Hennepin:* Sloping, well drained, loamy Miami and steep, well drained, shallow, loamy Hennepin in glacial till.

86. *Morley-Blount:* Sloping, well drained, clayey Morley and nearly level, somewhat poorly drained, clayey Blount in glacial till.

91. *Avonburg-Clermont:* Nearly level, somewhat poorly drained, silty Avonburg and poorly drained, silty Clermont, both with fragipans, in wind-blown silts and weathered glacial till.

93. *Cincinnati-Rossmoyne-Hickory:* Sloping, well drained, silty Cincinnati and moderately well drained, silty Rossmoyne, both with fragipans, in wind-blown silts and weathered glacial till, and steep, well drained, loamy Hickory in weathered till.

101. *Fairmount-Switzerland:* Steep, well drained, shallow, clayey Fairmount and deep, clayey Switzerland in weathered shale and limestone.


RANDOLPH
WAYNE
STATE OF OHIO
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R. 13 E. R. 14 E.
R. 14 E. R. 15 E.
R. 15 E.
R. 1 W.
R. 14 E.
R. 2 W.
R. 1 W.
R. 1 W. R. 1 E.
R. 12 E. R. 13 E.
T. 22 N.
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MISSISSINEWA
RIVER
RIDGE-VILLE
SARATOGA
PARKER CITY
FARMLAND
WHITE R.
UNION CITY
WINCHESTER
MODOC
BRONSON
RIVER
LYNN
FORK
ECONOMY
FOUNTAIN CITY
WHITE-WATER
HAGERSTOWN
GREENS FORK
WHITE WATER
E. GERMANTOWN
CAMBRIDGE CITY
RICHMOND
CENTERVILLE
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GREENS
FORK
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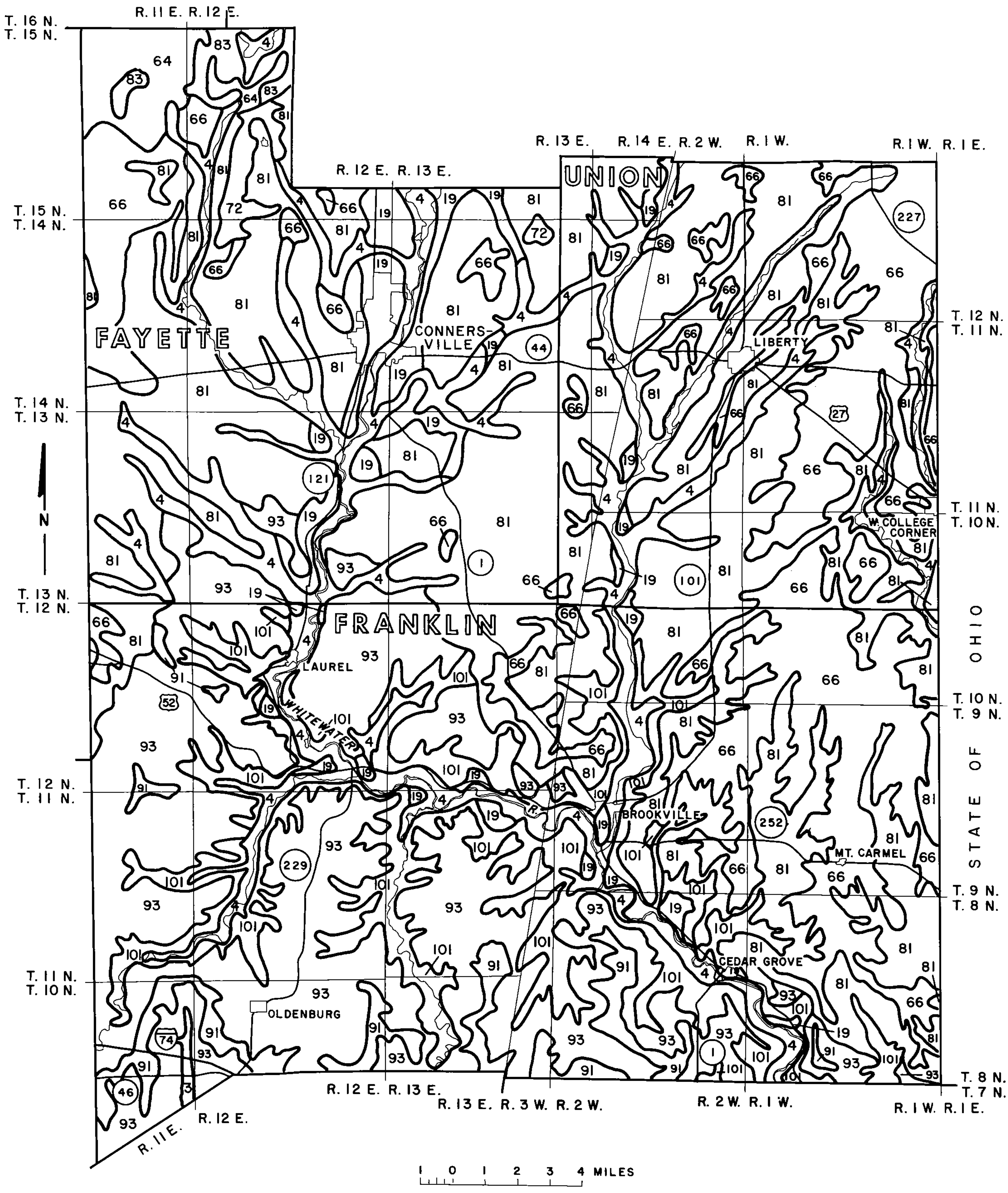
FAYETTE
UNION
FRANKLIN
CONNERS-VILLE
LIBERTY
W. COLLEGE CORNER
LAUREL
WHITEWATER R.
BROOKVILLE
MT. CARMEL
CEDAR GROVE
OLDENBURG
STATE OF OHIO
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T. 15 N.
T. 14 N.
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T. 8 N.
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R. 11 E.
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Appendix 4. Discussion of exposed stratigraphic units

The Kope Formation consists dominantly of bluish- to brownish-gray clay shale, but about five percent is thin discontinuous beds of fossiliferous limestone that occur mostly in the upper one-half to one-third of the formation. These beds are more prevalent southward, so that a considerable part the of the formation exposed in the southeastern extremity of the basin consists of limestone.

Approximately 100 feet of the upper Kope Formation is exposed in the Whitewater River Basin, although the formation ranges in thickness from about 250 feet in Dearborn County to more than 550 feet at the northern limit of the basin. The lower Kope Formation grades laterally southward through a progressive facies change into the Lexington Limestone, which otherwise underlies the Kope.

The Dillsboro Formation conformably and gradationally overlies the Kope and is about 300 feet thick in much of the Whitewater drainage area. The Dillsboro is a sequence of alternating, mostly thin-bedded, fossiliferous limestone and calcareous shale. The limestones tend to be better exposed than the shale, but comprise only about 30 percent of the Dillsboro and are less prominent northward.

The Whitewater Formation overlies the Dillsboro and encompasses the youngest Ordovician rocks in Indiana. The formation was named for exposures along the Whitewater River at Richmond, Indiana. Throughout most of the basin the lower part of the formation is recognized as the Saluda Dolomite Member, a unit that makes a relatively sharp, but conformable boundary with the underlying Dillsboro. The Saluda is mostly varicolored, fine-grained dolomite but includes a zone rich in the corals **Columnaria** and **Tetradium.** The Saluda thins to the north and is less than 10 feet thick in Wayne County. The remaining part of the Whitewater Formation is mostly argillaceous, fossiliferous limestone interbedded with calcareous shale.

Although there is more limestone in the Whitewater Formation than in the underlying Dillsboro and Kope Formations, the upper part of the Whitewater Formation in Wayne County consists mostly of shale. The Whitewater is about 90 feet thick in Wayne County and maintains nearly the same thickness to the south because the part of the formation above the Saluda thins to the south in compensation for the thickening of the Saluda.

The Brassfield Limestone of Silurian age unconformably overlies the Dillsboro in the Whitewater River Basin. The Brassfield is generally a medium- to coarse-grained fossiliferous limestone with numerous irregular blebs and stringers of shale. The formation is commonly yellowish-brown to salmon pink, but near Richmond the basal part is nearly white, and the overlying limestone is dark gray. Maximum thickness at the north end of the drainage basin is about 15 feet, but a thickness of less than 4 feet is common.

The Salamonie Dolomite unconformably overlies the Brassfield Limestone. In the southeastern part of the basin, the Salamonie includes some shale and very argillaceous limestone in its lower part, which is normally less than 40 feet thick. This lithology is transitional to the north into a more pure dolomite. The upper part of the Salamonie, though absent from the Whitewater Basin, commonly is cherty.

Appendix 5. Characteristics of subsurface stratigraphic units

	Group	Rock unit	Thickness (ft)	Description
Ordovician Series		Lexington Limestone	0-225	Gray fossiliferous limestone with lesser amounts of shale
	Black River	Plattin Formation	195-210	Tan, fine-grained to very fine-grained argillaceous and dolomitic limestone
		Pecatonica Formation	75-90	Gray and brown lithographic to fine-grained limestone and dolomite; commonly argillaceous or silty near base
	Ancell	Joachim Dolomite	105-180	Varicolored fine-grained dolomite and limestone; middle part more pure; black shale interbeds in upper part
		Dutchtown Formation	10-55	Light-gray and brown argillaceous dolomite; some thin green shale interbeds
	Prairie du Chien	Shakopee Dolomite	0-280	Light-gray to brown fine-grained to very fine-grained dolomite with interbedded shale, siltstone, and sandstone
		Oncota Dolomite	250-310	Gray and brown, mostly medium- to fine-grained cherty dolomite
Cambrian System		Potosi Dolomite	700-1125	Gray and brown fine- to medium-grained dolomite and a few thin zones of shale or siltstone
	Munising	Davis Formation	75-95	Mixed gray dolomite, siltstone, shale, and limestone
		Eau Claire Formation	440-510	Variable oolitic limestone, shale, siltstone, sandstone, and dolomite
		Mt. Simon Sandstone	375-625	White to gray, poorly sorted, poorly consolidated sandstone; includes several gray and maroon shale beds
Precambrian rocks				

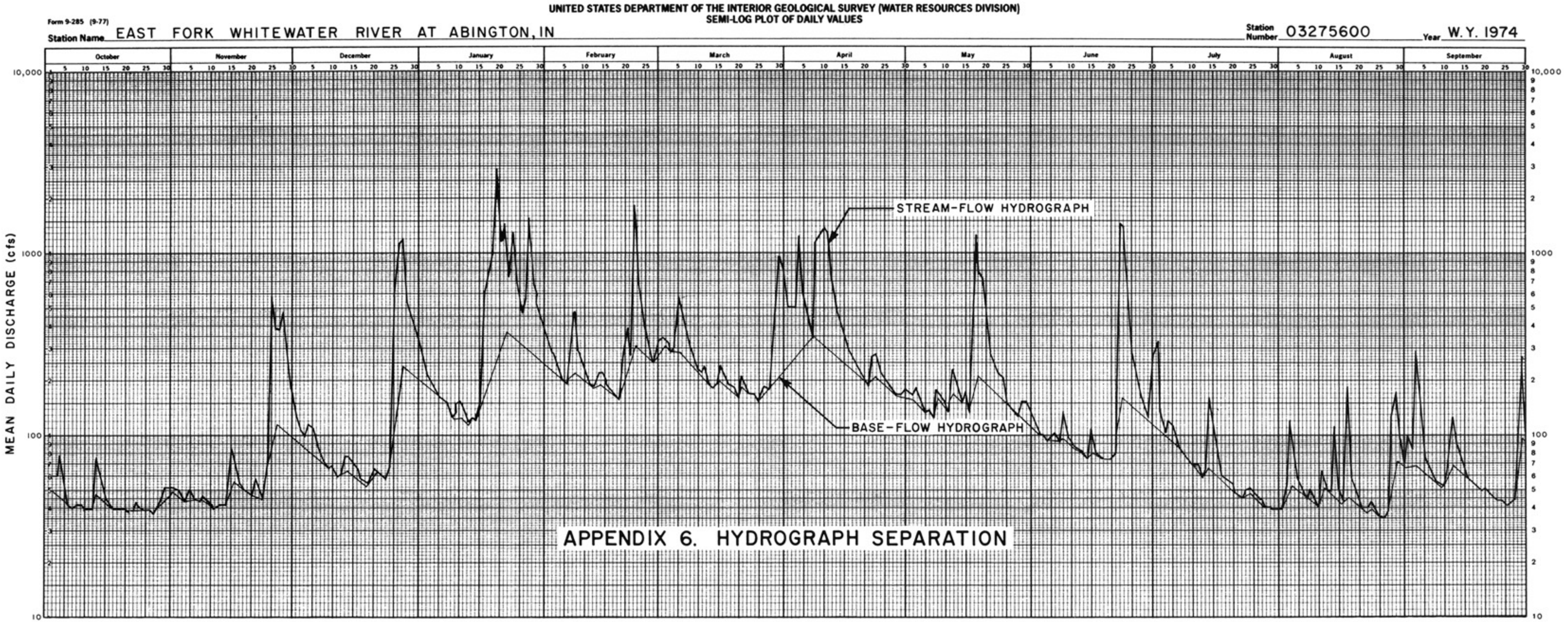
Appendix 6. Example of hydrograph separation for East Fork Whitewater River at Abington

While the peaks of an annual stream hydrograph represent overland and subsurface flow and sometimes ground water flow, base flow is a slow response to long-term changes in the regional ground-water flow (see Freeze and Cherry, 1979, p. 225). The base-flow hydrograph therefore will be much smoother than the stream hydrograph. A good first approximation to the base-flow hydrograph could be obtained by simply cutting off the peaks of the stream hydrograph. However, it is quite possible to have base-flow hydrograph peaks (see Linsley and others, 1982, pp. 210-213).

An ideal base-flow recession is a straight line on semi-logarithmic graph paper. Hence, one can assume that when the falling limb (recession limb) of the stream hydrograph becomes a straight line, the hydrograph is essentially all base flow. However, if a precipitation event occurs before overland and subsurface flows cease, the recession limb of the stream hydrograph will not be a straight line. If the second precipitation event and any following precipitation events produce successively smaller peaks, there will be a recession trend. It may be possible to glean from the trend an estimated base-flow recession segment. This segment may be sketched in below the stream hydrograph (see accompanying figure).

To help detect the slope of the recession segments of multiple precipitation events, it is useful to inspect the entire yearly stream hydrograph. The slope of the base-flow recession for single precipitation events can be used to help determine the base-flow recession segments for multiple precipitation events. Although the slope of base-recession will vary throughout the year, the general trend of the recession can be estimated from single precipitation events.

The next problem is to determine when the base-flow peaks occur, and when to begin each rising limb. The methods for constructing this portion of the base-flow hydrograph are arbitrary. However, it is reasonable to believe that a base-flow hydrograph peak should not occur before the stream hydrograph peak. The base-flow rising limb will probably be steeper than the base-flow recession limb.



APPENDIX 6. HYDROGRAPH SEPARATION

Appendix 7. Maximum contaminant levels for selected inorganic chemicals

{All values except pH are in milligrams per liter; if multiple uses have been designated, the most protective standard applies; dash indicates no available criterion. References to standards are current as of early 1987.}

Aquatic life: Values for all constituents except iron, pH, selenium, and silver are for one-hour averages; selenium and silver are not to be exceeded at any time; trace metals where applicable - at a hardness of 250 milligrams per liter.

Public supply: Maximum permissable level of a contaminant in water at the tap; national secondary regulations (reference e) are not enforceable; both national primary regulations and state regulations are enforceable (references b,c and f).

Irrigation and livestock: All values from National Academy of Sciences, 1974.

Constituent	Aquatic life		Public supply		Irrigation	Livestock
	Value	Reference	Value	Reference		
Arsenic (trivalent)	0.360	a	0.05	b,c	0.1	0.2
Barium	—	—	1.0	b,c	—	—
Cadmium	0.011	a	0.01	b,c	0.1	0.5
Chloride	0.019	a	250	d,e	—	—
Chromium (hexavalent)	0.016	a	0.05	b,c	0.10	1.0
Copper	0.042	a	1.0	e	0.2	0.5
Fluoride	—	—	4.0 prim	b,f	1.0	2.0
			2.0 sec	f		
Iron	1.00	d	0.3	e	5.0	—
Lead	0.264	a	0.05	b,c	5.0	0.1
Manganese	—	—	0.05	e	0.2	—
Mercury	0.002	a	0.002	b,c	—	0.01
Nitrate (as nitrogen)	—	—	10.0	b,c	—	10.0
pH (standard unit)	6.0-9.0	d	6.5—8.5	e	4.5—9.0	—
Selenium	0.260	g	0.01	b,c	0.02	0.05
Silver	0.020	g	0.05	b,c	—	—
Sulfate	—	—	250	d,e	—	—
Total dissolved solids	—	—	500	e	500—1000	3000
Zinc	0.254	h	5.0	e	2.0	25.0

[a]U.S. Environmental Protection Agency, 1985a
[b]Indiana Environmental Management Board, 1979
[c]U.S. Environmental Protection Agency, 1986c
[d]Indiana Stream Pollution Control Board, 1985
[e]U.S. Environmental Protection Agency, 1979
[f] ________1986a
[g] ________1980
[h] ________1987

Appendix 8. Summary of selected stream quality constituents collected by the Indiana Department of Environmental Management, 1976-85

{All values in milligrams per liter except as indicated; dash indicates no data.}

Station 1: East Fork Whitewater River near Abington.
Station 2: Mainstem Whitewater River at Brookville.

Constituent	Station	Mean	Range	Constituent	Station	Mean	Range
Temperature (°C)	1	13	1—28	Nitrogen (TKN)	1	0.7	0.2—2.3
	2	13	1—27		2	—	——
Specific conductance	1	659	420—960	Nitrate-Nitrite,	1	3.7	0.6—10.8
(micromhos/cm)	2	544	310—780	total as N	2	3.3	0.6—11.0
pH (field; std unit)	1	7.7	6.7—8.2	Phosphorus,	1	0.17	0.03—0.4
	2	7.8	6.5—8.1	total as P	2	0.12	0.03—1.3
Dissolved oxygen	1	10.3	4.8—14.7	Chloride	1	37	19—78
	2	10.2	4.9—14.6		2	19	11—33
Biochemical oxygen	1	2.0	1.0—9.4	Sulfate	1	57	37—100
demand (5-day)	2	1.9	1.0—5.7		2	41	25—59
Chemical oxygen	1	14	5—31	Cyanide (µg/l)	1	5	1—14
demand	2	—	——		2	—	——
Alkalinity as $CaCO_3$	1	227	140—264	Nickel (µg/l)	1	16	10—60
	2	—	——		2	—	——
Hardness as $CaCO_3$	1	307	182—352	Zinc (µg/l)	1	20	10—60
	2	—	——		2	—	——
Organic carbon,	1	4.9	2.6—9.8	Suspended solids	1	30	1—152
total as C	2	6.1	2.5—15.3		2	81	1—1260
Ammonia,	1	0.2	0.1—2.1	Fecal coliform	1	4040	10—90,000
total as N	2	0.1	0.1—0.8	(col/100 ml)	2	4690	10—110,000

Appendix 9. Concentrations of common stream quality constituents and selected metals collected by the U.S. Geological Survey, 1974-81

{Excerpted from Smith and Alexander, 1983; data for Whitewater River at Brookville; all values in milligrams per liter except as indicated.}

Constituent	Number of samples	Mean
Temperature (degrees C)	77	12.6
Turbidity (JTU)	38	25.2
Specific conductivity (micromhos/cm)	74	522.9
pH (std unit)	75	8.0
Dissolved oxygen	59	11.3
Alkalinity as $CaCO_3$	64	211.7
Dissolved solids	75	296.4
Organic carbon, total as C	33	4.4
Ammonia, total as N	41	0.1
Nitrate-Nitrite, total as N	74	2.1
Phosphorus, total as P	74	0.1
Calcium	75	66.8
Magnesium	74	24.4
Sodium	75	9.5
Potassium	75	2.5
Chloride	75	17.9
Sulfate as SO_4	74	39.9
Silica	75	4.3
Fecal coliform (col/100 ml)	6	7148.0
Fecal streptococci (col/100 ml)	40	2074.0
Phytoplankton (cells/ml)	53	13370.0
Metals (total)	**Number of samples**	**Median**
Arsenic (µg/l)	24	1.0
Barium (µg/l)	13	100.0
Iron (µg/l)	24	220.0
Manganese (µg/l)	24	40.0
Zinc (µg/l)	23	20.0

Appendix 10. Summary of selected stream quality constituents collected by the U.S. Army Corps of Engineers, 1972-86

{All values in milligrams per liter except as indicated.}

Station 1: East Fork Whitewater River near Liberty.
Station 2: East Fork Whitewater River below Brookville Lake dam.
Station 3: Silver Creek below Whitewater Lake.

Constituent	Station	No. of samples	Mean (mg/l)	Range (mg/l)	Constituent	Station	No. of samples	Mean (mg/l)	Range (mg/l)
Temperature	1	88	16.8	1.1—27.2	Nitrate-nitrite,	1	82	3.0	0.1—9.0
(degrees C)	2	89	15.3	0.6—27.8	total as N	2	72	2.0	0.1—5.7
	3	82	16.9	2.8—29.7		3	63	2.1	0.1—8.0
Turbidity (NTU)	1	66	20.2	0.2—247.0	Phosphorus,	1	85	245.3	10.0—1060.0
	2	65	6.7	0.5—150.0	total as P	2	72	129.8	10.0—670.0
	3	60	9.5	0.6—78.0	(µg/l)	3	66	86.5	10.0—750.0
Specific	1	85	626	210—930	Calcium	1	42	86.2	13.0—127.6
conductance	2	87	496	60—720	(as Ca)	2	42	66.4	10.0—219.0
(micromhos/cm)	3	79	478	20—740		3	40	64.0	6.0—119.0
pH (field;	1	81	8.0	6.9—8.7	Magnesium	1	42	17.3	0.7—38.3
std unit)	2	83	7.8	6.0—8.5		2	42	12.5	0.4—23.0
	3	77	8.0	6.4—8.8		3	40	13.6	0.3—27.0
Dissolved oxygen	1	91	9.8	4.8—16.4	Sodium	1	17	16.0	6.0—39.0
	2	92	10.0	6.1—16.8		2	17	6.9	4.0—9.0
	3	85	9.1	2.1—16.0		3	18	9.4	3.0—27.0
Biochemical	1	36	2.9	0.2—6.4	Potassium	1	17	2.3	1.0—5.0
oxygen demand	2	36	2.8	0.1—6.3		2	17	2.2	1.0—6.0
(5-day)	3	34	3.4	0.2—7.7		3	17	3.0	2.0—7.0
Alkalinity	1	60	247	116—400	Chloride	1	48	35.4	2.0—73.0
as $CaCO_3$	2	59	193	111—289		2	49	19.6	9.1—33.0
	3	57	195	51—380		3	49	24.5	13.1—60.0
Hardness	1	83	312	170—842	Sulfate	1	48	58.4	5.0—123.0
as $CaCO_3$	2	84	248	95—526		2	49	43.2	18.5—73.0
	3	78	240	105—347		3	49	35.7	10.9—100.0

Appendix 10. Continued

Constituent	Station	No. of samples	Mean (mg/l)	Range (mg/l)	Constituent	Station	No. of samples	Mean (mg/l)	Range (mg/l)
Total dissolved solids	1	58	450	222—723	Aluminum (µg/l)	1	21	1197.1	130.0—9940.0
	2	62	343	198—756		2	19	328.2	50.0—2296.0
	3	58	325	150—553		3	19	539.0	70.0—2970.0
Organic carbon, total as C	1	18	5.9	1.0—20.0	Barium (µg/l)	1	18	78.2	50.0—113.0
	2	18	4.5	1.0—9.0		2	16	55.5	20.0—122.0
	3	18	5.9	1.0—10.0		3	19	47.6	10.0—95.0
Ammonia, total as N	1	82	0.14	0.05—1.4	Iron (µg/l)	1	80	1444.6	100.0—13650.0
	2	71	0.14	0.05—1.0		2	80	786.7	100.0—9250.0
	3	66	0.27	0.05—1.8		3	61	603.1	100.0—3000.0
Nitrogen (TKN)	1	84	0.9	0.1—4.4	Manganese	1	80	75.4	10.0—690.0
	2	73	0.8	0.1—7.0		2	81	111.6	10.0—1090.0
	3	67	1.0	0.1—4.3		3	61	79.6	10.0—400.0

Appendix 11. Concentrations of selected water quality constituents collected by the U.S. Army Corps of Engineers at Brookville Lake, 1974-86

{Data from U.S. Army Corps of Engineers; all values in milligrams per liter except as indicated; dash indicates no data.}

Station 1: near Dunlapsville causeway.
Station 2: at Fairfield causeway.
Station 3: near dam.

Constituent	Station	No. of samples	Mean	Range	Constituent	Station	No. of samples	Mean	Range
Temperature	1	358	20.2	4.7—30.0	Nitrate-nitrite,	1	—	—	——
(degrees C)	2	998	17.4	4.5—29.7	total as N	2	77	1.3	0.1—4.7
	3	1523	14.9	0.6—29.1		3	262	2.1	0.1—21.7
Turbidity (NTU)	1	106	12.1	2.0—140.0	Phosphorus,	1	—	—	——
	2	138	4.5	0.1—33.0	total as	2	86	42.0	10.0—165.0
	3	261	4.5	0.0—175.0	as P (µg/l)	3	253	43.0	10.0—480.0
Secchi (inches)	1	44	31	18—84	Calcium (as Ca)	1	64	76.2	48.8—113.0
	2	56	48	24—120		2	78	73.7	46.5—199.0
	3	64	59	24—144		3	170	58.5	6.0—101.0
Specific	1	252	470	300—750	Magnesium	1	64	7.6	0.0—18.5
conductance	2	662	474	315—785		2	79	8.6	0.0—22.4
(micromhos/cm)	3	1103	470	320—780		3	173	12.8	0.4—27.0
pH	1	239	7.9	6.8—8.8	Chloride	1	46	21.2	11.2—50.4
(field; std unit)	2	600	7.8	——		2	92	19.7	9.2—50.8
	3	981	7.7	6.3—9.7		3	189	19.8	2.0—47.3
Dissolved	1	299	7.7	0.0—17.6	Sulfate	1	47	41.3	34.2—58.7
oxygen	2	680	5.4	0.0—15.8		2	92	38.6	2.7—69.8
	3	1104	4.8	0.0—15.0		3	188	40.7	5.0—100.0
Biochemical	1	—	—	——	Iron (µg/l)	1	—	—	——
oxygen demand	2	—	—	——		2	101	304.8	100.0—925.0
(5-day)	3	161	2.6	0.1—7.7		3	246	527.0	100.0—32400.0
Alkalinity	1	57	182	115—300	Manganese	1	—	—	——
as $CaCO_3$	2	111	108	108—314	(µg/l)	2	104	296.7	17.0—3000.0
	3	219	176	——		3	249	176.6	10.0—3560.0
Hardness	1	109	226	162—332	Chlorophyll a	1	76	22.0	1.2—50.0
as $CaCO_3$	2	169	224	126—321	(µg/l)	2	87	9.7	0.0—27.2
	3	272	226	52—672		3	100	8.1	0.5—31.0

Appendix 11. Continued

Constituent	Station	No. of samples	Mean	Range
Total dissolved solids	1	46	311	206—577
	2	92	294	68—402
	3	192	312	27—866
Ammonia, total as N	1	—	—	— —
	2	82	0.3	0.0—2.4
	3	257	0.2	0.0—2.9
Nitrogen (TKN) as N	1	—	—	— —
	2	82	0.8	0.1—5.9
	3	261	0.7	0.1—4.2
Station 3				
Total organic carbon		73	4.6	1.0—26.0
Sodium		74	6.7	1.0—10.0
Potassium		74	2.4	1.0—6.0
Aluminum (µg/l)		82	660.3	50.0—22640.0
Barium (µg/l)		70	47.0	20.0—197.0
Chromium (µg/l)		29	8.7	1.0—85.0
Copper (µg/l)		29	19.7	5.0—169.0
Lead (µg/l)		25	5.0	2.0—29.0
Mercury (µg/l)		33	31.5	1.0—260.0
Thallium (µg/l)		30	397.0	174.0—1000.0

Appendix 12. Results of chemical analysis from selected water wells (in mg/l except as indicated)

Location number: *, analysis of softened water; —, anomalous analysis (EMP balance error >5%); +, bucket rig well; #, bucket rig well with six inch casing.
Well owner: DNR, Department of Natural Resources; N, north; OBS, observation well; PW, pumping well; S, south; T, test well.
Township: N, north.
Range: E, east; W, west.
Aquifer system: DB, Dearborn; FU, Fayette-Union; O, Ordovician; S, Silurian; WH, Wayne-Henry; WO, Whitewater Valley Outwash.
Date sampled: month and year.
[1]Results in standard pH units; [2]Laboratory analysis; [3]TDS values are the calculated sum of major constituents in a ground-water sample; [4]TDS values are the calculated sum of major constituents expected in an anhydrous residue of a ground-water sample with bicarbonate converted to carbonate in the solid phase.

Location No.	Well Owner	Township	Range	Section	Well Depth (feet)	Aquifer System	Date Sampled	pH[1]	Hardness as $CaCO_3$	Calcium	Magnesium	Sodium	Potassium	Iron	Manganese	Alkalinity as $CaCO_3$[2]	Chloride	Sulfate	Fluoride	Nitrate as Nitrogen	Total Dissolved Solids[3]	Total Dissolved Solids[4]
1*	P Pierson	18N	13E	2	157	WH	10/85	7.5	2	0.2	0.3	161.9	0.1	<0.10	<0.10	343.2	1.4	17.5	1.2	<0.02	609	396
2	L McCormic	19N	14E	28	181	S	10/85	7.2	339	82.9	32.0	19.8	1.3	1.50	<.10	361.4	3.5	23.2	1.0	<.02	618	394
3	E Bruns	17N	12E	21	105	WH	10/85	6.9	394	99.5	35.4	4.7	.7	.90	<.10	320.8	16.5	62.6	.2	<.02	618	419
4	P Monger	17N	12E	24	144	WH	10/85	7.1	367	93.0	32.8	4.5	.7	1.50	<.10	347.2	5.8	38.7	.3	<.02	609	394
5	H Bolen	18N	13E	30	247	WH	10/85	7.4	285	58.4	33.9	50.8	1.0	.30	.20	298.1	18.9	94.2	1.0	<.02	630	445
6	L Litton	17N	13E	4	139	WH	10/85	7.4	268	64.7	25.9	25.4	1.0	1.00	<.10	326.4	1.3	9.5	1.3	<.02	543	341
7	R Doerstler	17N	13E	20	64	WH	10/85	7.0	379	91.7	36.5	6.1	.8	<.10	.10	355.7	2.2	38.3	.5	<.02	619	398
8	W Evans	17N	11E	22	120	WH	10/85	7.2	312	72.4	32.1	8.2	.6	1.30	<.10	311.4	2.5	30.2	1.0	<.02	539	346
9	N Wright	18N	12E	2	156	WH	10/85	7.1	359	86.3	34.9	16.8	.9	1.30	<.10	401.0	1.8	21.4	.9	<.02	667	418
10	Peoples Bank	18N	13E	6	205	S	10/85	7.2	264	59.5	28.2	22.9	.8	1.30	<.10	298.1	4.9	21.5	.7	<.02	510	325
11	R Cates	19N	13E	32	86	WO	10/85	6.9	381	93.7	35.7	5.2	.7	2.10	<.10	347.7	4.0	50.0	.5	<.02	624	408
12	R Davis	18N	13E	10	200	S	10/85	7.1	310	70.8	32.4	27.3	.9	1.40	<.10	353.3	6.2	23.2	.8	<.02	601	382
13	Hillside Nurs	16N	11E	25	50	WH	10/85	7.2	253	62.0	23.8	26.8	.9	1.10	<.10	304.9	1.7	0.8	1.2	<.02	500	311
14	P Suttles	16N	12E	18	94	WH	10/85	7.1	287	72.6	25.6	13.0	.8	1.20	<.10	327.7	3.4	<0.1	.7	<.02	527	324
15	E Miller	16N	12E	2	57	WO	10/85	7.0	352	87.8	32.4	4.6	.9	.90	<.10	313.2	6.0	45.9	.4	<.02	568	374
16	C Litton	18N	12E	33	131	WH	10/85	7.1	317	80.3	28.3	10.3	.8	1.90	<.10	342.7	1.2	5.6	.7	<.02	559	347
17	A Tarr	18N	12E	35	31	WO	10/85	6.9	385	98.3	34.0	8.2	1.3	<.10	<.10	320.4	23.6	36.0	.2	3.30	613	403
18	Hagerstown 3	17N	12E	23	112	WO	07/78	7.1	373	94.0	33.0	8.0	2.0	<.10	<.02	307.0	19.0	43.0	1.2	3.20	577	387
	Hagerstown 4	17N	12E	23	112	WO	10/85	6.9	368	94.3	32.3	7.9	1.4	<.10	<.10	297.1	18.0	44.2	1.4	3.60	583	386
19	G Crull	17N	13E	7	122	WH	10/85	7.3	347	84.8	32.9	11.2	.9	.20	<.10	363.0	1.2	5.0	.3	<.02	590	365
20	D Scammahorn	18N	13E	31	38	WH	10/85	6.9	453	118.4	38.2	3.5	1.0	<.10	<.10	363.5	8.7	66.9	.1	4.40	705	465
21	D Lewis	17N	14E	7	26	WO	10/85	7.5	354	88.1	32.6	4.4	1.6	<.10	<.10	240.7	45.8	29.3	.1	16.50	573	366

Appendix 12. Continued

Location No.	Well Owner	Township	Range	Section	Well Depth (feet)	Aquifer System	Date Sampled	pH[1]	Hardness as $CaCO_3$	Calcium	Magnesium	Sodium	Potassium	Iron	Manganese	Alkalinity as $CaCO_3$[2]	Chloride	Sulfate	Fluoride	Nitrate as Nitrogen	Total Dissloved Solids[3]	Total Dissolved Solids[4]
22	D Bushman	17N	14E	31	63	WH	10/85	7.0	374	94.4	33.6	6.4	1.2	0.90	0.10	300.7	21.2	64.5	0.1	<0.02	593	407
23	S Hubell	17N	14E	11	168	WH	10/85	7.3	317	78.3	29.5	12.5	1.1	.40	.40	290.4	3.2	23.5	.8	<.02	518	338
24	R Manning	18N	14E	12	217	S	10/85	7.3	309	80.2	26.6	37.0	1.0	1.20	<.10	323.5	5.1	34.1	.6	<.02	590	389
25*	K Norton	18N	14E	14	43	WH	10/85	7.1	64	15.2	6.4	166.3	.5	<.10	<.10	319.9	22.2	80.5	.6	<.02	688	489
26	D Anderson	18N	14E	17	99	WH	10/85	7.4	262	64.9	24.3	36.7	1.0	1.60	<.10	310.6	3.3	29.4	1.3	<.02	556	364
27	J Burke	16N	14E	28	46	WH	10/85	7.2	385	95.3	35.9	6.4	.3	<.10	<.10	312.2	28.6	53.9	.3	1.70	619	421
28	E Jenkins	15N	14E	6	35	WH	10/85	7.5	430	99.2	44.5	8.0	.6	1.80	.40	398.3	20.9	48.2	.8	<.02	721	474
29	D Walther	16N	13E	36	30	WO	10/85	7.1	411	103.9	37.0	5.9	.8	<.10	<.10	297.1	26.5	34.6	.1	14.60	641	406
30	H Gwinnup	15N	12E	16	132	FU	10/85	7.7	340	84.6	31.5	17.6	.6	1.00	<.10	357.5	12.8	5.6	.2	<.02	599	378
31	Bentonville Farm Supply	15N	12E	19	46	WH	10/85	7.3	315	83.7	25.9	3.8	.4	1.40	<.10	256.8	9.6	62.8	.1	<.02	507	347
32	M Geise	14N	12E	6	35	FU	10/85	7.1	414	105.3	36.8	4.5	.5	<.10	<.10	317.2	14.4	77.5	.1	2.80	644	437
33	N Jeffers	17N	13E	22	83	WH	10/85	7.2	361	86.9	35.0	6.2	.5	1.60	<.10	348.9	11.1	27.4	.6	<.02	605	389
34	R Moyer	16N	13E	6	49	WH	10/85	7.9	300	72.6	29.0	14.7	.6	.40	<.10	312.2	16.5	19.5	.8	.50	547	352
35*	H Hall	16N	11E	2	190	WH	10/85	7.3	125	32.7	10.5	196.0	.5	1.10	<.10	400.8	44.8	108.7	.4	<.02	893	645
36	H Foulke	17N	11E	1	91	WH	10/85	7.4	369	92.7	33.5	5.4	.4	2.10	<.10	307.6	9.9	62.0	.8	<.02	591	400
37	C Retz	17N	11E	33	42	WH	10/85	7.4	351	84.3	34.2	7.0	.4	2.90	<.10	321.7	8.1	43.1	1.0	<.02	582	383
38	P Wesseler	16N	12E	16	130	WH	10/85	7.6	286	70.8	26.6	21.2	.4	1.00	<.10	312.2	20.3	1.0	.6	<.02	532	339
39	H Brockman	16N	13E	30	132	WH	10/85	7.1	364	93.6	31.8	4.6	.4	<.10	<.10	340.4	3.9	18.1	.3	2.70	588	367
40	Richmond 11	13N	1W	5	62	WO	10/85	—	369	93.0	33.3	17.9	1.3	<.10	<.10	295.2	33.7	67.4	1.4	.30	614	429
41	L Bourne	12N	1W	28	91	FU	10/85	7.5	249	58.0	25.4	46.0	.7	1.60	<.10	355.0	2.5	<.1	.3	<.02	576	356
42	J Andrews	18N	14E	35	195	WH	10/85	7.4	321	79.3	29.9	25.9	.7	5.00	.10	379.9	5.3	9.8	.2	<.02	634	399
43	R Swallow	16N	13E	28	45	WO	10/85	6.1	447	112.3	40.6	38.3	.9	<.10	<.10	339.8	105.0	64.5	.9	6.90	816	580
44	C Sanders	15N	13E	36	84	WH	10/85	7.2	358	91.9	31.3	5.0	.4	1.30	<.10	351.2	2.6	20.4	.3	<.02	592	374
45	C Upchurch	15N	14E	9	230	0	10/85	7.0	425	103.1	40.8	7.8	.6	.50	<.10	389.7	15.7	40.9	.3	<.02	695	453
46	A Gates	14N	1W	14	101	WH	10/85	7.1	295	70.4	29.0	21.9	.9	.60	.10	306.6	14.8	16.4	1.3	<.02	537	339
47	J Smith	14N	1W	11	100	S	10/85	7.3	286	66.3	29.3	28.1	1.2	.70	.10	347.4	25.3	16.7	.5	<.02	612	397
48	Tomlinson	15N	1W	23	50	WH	10/85	7.1	396	98.8	36.5	3.8	.4	.70	.10	320.8	19.1	61.9	.9	<.02	622	423
49	R Warvel	15N	1W	1	202	S	10/85	7.4	250	63.4	22.4	20.7	.5	1.70	<.10	293.6	15.4	5.7	.3	<.02	498	315
50*	P Hacker	15N	12E	25	102	WO	10/85	7.5	0	0.1	0.1	181.6	.2	<.10	<.10	295.3	44.5	34.2	.6	7.60	660	450

Appendix 12. Continued

Location No.	Well Owner	Township	Range	Section	Well Depth (feet)	Aquifer System	Date Sampled	pH[1]	Hardness as $CaCO_3$	Calcium	Magnesium	Sodium	Potassium	Iron	Manganese	Alkalinity as $CaCO_3$[2]	Chloride	Sulfate	Fluoride	Nitrate as Nitrogen	Total Dissloved Solids[3]	Total Dissolved Solids[4]
51	T Ryckman	14N	12E	30	83	S	10/85	7.4	350	86.7	32.5	10.0	0.5	2.20	<0.10	356.8	20.6	9.4	0.2	<0.02	607	386
52	D Lane	14N	11E	13	45	FU	10/85	7.1	426	112.9	35.0	5.9	.6	2.50	.20	344.4	21.1	66.8	.9	<.02	674	460
53	C Conley	13N	11E	15	90	DB	10/85	7.7	312	75.8	29.9	13.5	.4	3.10	<.10	346.8	18.7	.9	.3	<.02	577	362
54	A Bertsch	16N	12E	36	86	WO	10/85	7.7	306	74.7	29.0	6.1	.4	5.90	.10	294.3	13.8	31.2	.8	<.02	529	347
55	F Rogers	13N	1W	34	105	FU	10/85	7.4	260	66.5	22.9	26.4	.8	.90	<.10	329.1	15.7	1.2	.4	<.02	546	342
56	B Druly	13N	1W	23	53	FU	10/85	7.3	360	92.6	31.4	7.3	.5	2.30	<.10	313.9	19.8	67.8	.8	<.02	613	419
57	M Sittloh	13N	1W	23	155	S	10/85	7.3	269	61.9	27.8	32.5	2.5	<.10	<.10	340.1	24.9	<.1	.4	<.02	572	361
58	J Fuller	13N	1W	11	78	FU	10/85	7.3	378	98.7	32.0	2.9	.7	1.80	<.10	317.2	29.3	56.8	.2	<.02	615	419
59—	D Delk	14N	1W	36	56	WH	10/85	7.0	441	114.9	37.5	96.6	2.3	.90	.20	396.9	208.0	64.2	.2	<.02	1015	769
60	R Young	15N	13E	32	28	WH	10/85	7.2	349	96.5	26.3	4.5	.9	<.10	<.10	284.8	20.5	42.4	.1	9.40	585	375
61	R McDaniel	14N	13E	9	115	FU	10/85	7.7	375	95.3	33.4	8.8	.4	1.60	<.10	401.6	.9	6.1	.2	<.02	647	398
62	D Wampler	15N	13E	17	40	WO	10/85	7.4	389	95.8	36.4	3.8	.9	<.10	<.10	269.5	17.6	30.9	.2	22.00	618	374
63	L Walker	15N	13E	4	100	WH	10/85	6.5	374	93.2	34.3	4.4	.4	1.20	.10	372.5	1.3	16.0	.2	<.02	615	384
64	C Paul	16N	14E	19	111	WH	10/85	7.1	328	82.9	29.4	3.7	.4	1.20	<.10	309.1	2.6	30.0	.2	<.02	535	343
65	B Barker	14N	12E	11	65	0	11/85	6.8	433	115.5	35.1	20.4	1.5	<.10	<.10	353.4	40.8	61.6	.4	5.40	736	498
66	Union Church	14N	12E	15	161	FU	11/85	7.5	274	66.4	26.2	58.8	.8	1.00	<.10	369.7	21.6	<.1	.4	<.02	634	406
67+	D Maxie	13N	12E	34	35	WO	11/85	7.1	319	83.2	27.1	3.6	.9	<.10	<.10	273.9	10.1	27.0	.1	6.40	521	329
68+	G Gettinger	13N	13E	14	38	FU	11/85	7.0	331	86.8	27.9	3.6	.6	<.10	<.10	269.0	6.7	57.4	.1	3.10	530	353
69	G Wilson	12N	13E	8	50	DB	11/85	6.9	367	91.8	33.4	9.6	.3	<.10	<.10	339.8	9.5	28.5	.1	2.80	610	389
70	D Platt	14N	1W	21	134	WH	11/85	7.4	256	60.8	25.3	35.0	.9	1.50	<.10	315.8	16.0	8.1	.9	<.02	546	350
71	O Allen	14N	2W	25	77	WH	11/85	7.4	339	74.7	37.2	8.1	.6	2.60	<.10	341.4	6.3	24.4	.8	<.02	584	372
72	W Elliott	16N	14E	5	37	WO	11/85	7.3	373	93.8	33.7	4.4	.6	.30	<.10	326.7	19.8	50.3	.2	.60	609	404
73	J Richardson	16N	13E	13	88	WH	11/85	7.1	362	93.2	31.4	4.4	.4	.10	<.10	331.1	19.9	30.5	.2	1.30	597	387
74	J Legg	15N	13E	23	62	WH	11/85	7.0	420	107.5	36.9	15.0	.6	.60	.10	360.4	15.7	82.9	.2	<.02	706	483
75	L Rose	14N	13E	3	50	FU	11/85	7.0	382	99.5	32.5	3.9	.4	<.10	.10	308.2	19.6	65.3	.1	<.02	604	413
76	C Eggleston	13N	12E	2	85	FU	11/85	6.6	315	83.9	25.6	12.0	.5	<.10	.50	318.0	16.8	14.0	.1	1.00	554	353
77	C Hurst	11N	2W	27	50	WO	11/85	7.0	350	91.3	29.7	5.5	.5	<.10	<.10	321.8	8.0	37.0	.1	2.80	583	374
78	T Cornett	13N	2W	35	43	WO	11/85	6.7	323	87.1	25.7	9.5	1.0	<.10	<.10	275.5	24.7	44.1	.1	2.30	542	367
79	G Fagan	16N	12E	12	59	WH	11/85	6.6	309	76.7	28.5	3.1	.4	.80	<.10	287.4	8.2	42.8	.2	<.02	517	339
80	J Bane	17N	13E	26	29	WO	11/85	6.9	345	87.6	30.7	4.4	.6	<.10	<.10	291.5	14.1	50.3	.1	4.30	566	371

Appendix 12. Continued

Location No.	Well Owner	Township	Range	Section	Well Depth (feet)	Aquifer System	Date Sampled	pH[1]	Hardness as $CaCO_3$	Calcium	Magnesium	Sodium	Potassium	Iron	Manganese	Alkalinity as $CaCO_3$[2]	Chloride	Sulfate	Fluoride	Nitrate as Nitrogen	Total Dissolved Solids[3]	Total Dissolved Solids[4]
81	J Belcher	18N	13E	25	142	WH	11/85	6.8	364	74.9	43.2	8.9	0.7	1.90	<0.10	379.1	4.6	44.0	1.1	<0.02	655	420
82	J Thornton	17N	14E	4	37	WH	11/85	6.9	421	105.7	38.2	5.4	.6	.80	<.10	339.4	15.0	66.9	.4	<.02	655	444
83	D Stults	15N	1W	33	89	WH	11/85	7.2	290	73.8	25.8	21.7	.9	1.30	.10	348.1	1.9	20.5	1.4	<.02	597	381
84	L Berry	15N	1W	27	176	S	11/85	7.2	302	72.3	29.5	20.6	.8	.90	<.10	347.0	8.9	12.0	.8	<.02	579	364
85	J Logue	11N	1W	21	208	0	11/85	7.3	259	58.6	27.5	365.4	5.1	1.90	<.10	211.8	640.0	<.1	.4	<.02	1372	1241
86	S Felton	11N	1W	15	40	FU	11/85	6.9	327	87.2	26.5	11.3	3.3	<.10	<.10	288.1	15.1	37.1	.4	2.90	552	363
87 +	U Charles	14N	13E	1	32	FU	11/85	7.0	347	94.0	27.4	6.5	.7	<.10	<.10	305.1	17.1	38.2	.2	3.20	578	377
88	J Bowman	14N	13E	14	31	FU	11/85	6.8	351	93.0	28.9	3.8	.4	2.00	.10	322.1	8.5	47.7	.3	<.02	585	385
89	C Ripberger	13N	13E	5	183	FU	11/85	6.9	265	68.5	22.7	110.4	2.3	2.70	<.10	312.5	161.0	<.1	.1	<.02	761	567
90	M Grey	11N	12E	23	40	DB	11/85	6.8	308	85.1	23.2	12.8	.3	<.10	<.10	283.5	18.0	45.3	.3	2.10	552	369
91 +	C Allen	11N	13E	2	42	WO	11/85	7.0	348	116.2	13.9	5.6	.7	<.10	<.10	341.9	5.1	20.6	.2	3.50	600	376
92	Sperry Rubber	8N	2W	3	134	WO	11/85	7.1	360	97.1	28.7	7.7	.8	<.10	<.10	282.6	12.6	55.4	.2	2.70	565	380
93 +	C Shell	11N	13E	20	34	DB	11/85	7.0	307	74.8	29.3	20.1	.4	<.10	<.10	273.4	31.1	32.2	.3	1.80	540	364
94	K Reineking	11N	13E	31	100	O	11/85	6.8	768	214.7	56.3	565.9	23.8	1.20	<.10	312.0	1160	148.0	.2	.80	2573	2377
95	Wolf & Dresser	7N	1W	13	45	WO	11/85	6.4	394	117.7	24.3	16.5	2.0	<.10	<.10	290.4	22.8	83.8	.2	2.70	639	449
96 +	D Laker	11N	11E	34	52	DB	11/85	6.7	256	67.4	21.5	16.0	.3	<.10	<.10	247.7	7.3	21.7	.3	3.70	461	295
97	C Jackson	11N	11E	17	105	S	11/85	7.3	381	94.2	35.4	28.8	.7	2.50	<.10	437.0	15.4	5.3	.5	<.02	722	452
98	J Carter	13N	12E	8	55	S	11/85	6.8	356	85.6	34.6	5.2	.6	3.40	<.10	345.2	5.1	23.5	.4	<.02	587	373
99	W Gronning	13N	13E	9	82	FU	11/85	7.1	392	97.4	36.3	8.9	.5	.80	.20	434.3	3.3	5.4	.5	<.02	694	425
100	S Locke	13N	13E	4	50	FU	11/85	7.3	351	89.5	31.1	11.4	.5	3.20	<.10	325.3	9.8	39.6	.4	<.02	590	388
101	DNR Metamora	12N	12E	36	106	WO	11/85	7.5	280	78.5	20.5	3.7	.8	<.10	<.10	233.8	8.2	37.4	.2	1.90	447	295
102	D Snyder	12N	2W	24	79	FU	11/85	6.3	290	69.4	28.5	6.8	.5	1.70	<.10	325.3	1.4	3.7	.5	<.02	518	316
103	S Felton	11N	1W	15	96	FU	11/85	7.3	304	68.0	32.8	38.4	1.0	.90	<.10	406.1	1.9	<.1	.7	<.02	649	397
104 +	J Jenkins	11N	1W	31	30	FU	11/85	7.2	404	101.0	36.8	6.2	.7	<.10	<.10	325.9	16.4	61.4	.5	<.02	629	427
105	M Radar	10N	1W	30	80	FU	11/85	7.3	353	92.4	29.8	47.3	1.4	.70	.20	379.5	33.5	4.0	.4	3.60	696	449
106 +	J Dickman	10N	12E	15	42	DB	11/85	7.1	203	52.9	17.4	9.9	.6	<.10	<.10	170.4	9.8	20.5	.4	2.00	337	224
107 +	D Eckerle	10N	13E	10	42	DB	11/85	7.3	190	47.3	17.5	19.1	.6	<.10	<.10	210.8	10.1	25.2	.5	.90	393	259
108	D Bruns	9N	13E	21	41	DB	11/85	7.0	215	61.8	14.7	8.0	.5	<.10	<.10	195.3	8.6	23.1	.2	.90	366	242
109	K Galey	7N	1W	36	75	0	11/85	7.0	446	109.9	41.8	34.3	1.3	<.10	<.10	359.6	21.0	154.1	.4	2.30	817	586
110	LTM Water T-1	18N	12E	10	140	WH	9/78	7.4	428	96.0	46.0	12.0	2.0	—	—	425.0	3.0	14.0	1.2	.10	693	429

Appendix 12. Continued

Location No.	Well Owner	Township	Range	Section	Well Depth (feet)	Aquifer System	Date Sampled	pH[1]	Hardness as $CaCO_3$	Calcium	Magnesium	Sodium	Potassium	Iron	Manganese	Alkalinity as $CaCO_3$[2]	Chloride	Sulfate	Fluoride	Nitrate as Nitrogen	Total Dissloved Solids[3]	Total Dissolved Solids[4]
111#	S Stirn	11N	12E	9	42	DB	11/85	7.0	436	141.3	20.1	15.1	1.9	<0.10	0.70	346.9	33.2	66.1	0.1	3.60	724	496
112—	W Rose	13N	13E	9	290	0	11/85	7.0	450	116.5	38.6	324.0	5.8	1.70	.10	401.1	656.0	.7	.3	<.02	1641	1392
113	W Cook	12N	11E	6	124	S	11/85	7.9	280	71.3	24.8	16.4	.5	1.30	<.10	323.1	1.7	<.1	1.1	<.02	516	316
114#	J Kennedy	12N	11E	11	40	DB	11/85	8.5	263	73.4	19.5	5.2	.6	<.10	<.10	239.6	4.2	24.8	.3	2.50	437	280
115	H Thompson	9N	1W	35	70	O	11/85	7.3	312	87.0	23.1	4.8	4.6	<.10	<.10	232.4	21.3	44.0	.1	13.80	535	343
116	Lynn 2	19N	14E	34	210	S	3/66	7.2	355	77.0	40.0	19.0	2.0	1.60	.00	368.0	4.0	21.0	1.2	—	615	387
117	Lynn 3	19N	14E	34	200	S	7/76	7.5	360	80.0	39.0	19.0	2.0	1.10	<.02	365.0	2.0	21.0	1.5	<0.10	611	385
118	Lynn 4	19N	14E	35	91	WH	7/76	7.4	400	94.0	40.0	10.0	1.0	2.30	.03	372.0	2.0	32.0	1.1	—	636	406
120	Hagerstown 2	17N	12E	23	70	WO	1/75	7.7	376	95.0	34.0	5.0	2.0	—	—	300.0	13.0	62.0	.2	—	577	391
121	Perfect Circle	17N	12E	23	62	WO	10/64	7.6	340	92.8	26.3	—	—	—	.00	324.0	16.0	80.0	—	—	—	—
122	Camb. City 3	16N	12E	26	57	WO	1/75	7.7	346	87.0	31.0	6.0	2.0	<.10	<.02	284.0	13.0	47.0	.2	1.30	534	358
	Camb. City 1	16N	12E	26	57	WO	1/75	7.6	372	96.0	32.0	11.0	3.0	.50	.02	304.0	20.0	53.0	.2	1.90	588	400
	Camb. City 2	16N	12E	26	63	WO	1/75	7.6	370	95.0	32.0	10.0	3.0	.10	.02	298.0	20.0	53.0	.2	1.70	578	394
123	Milton 2	15N	12E	2	100	WO	8/86	8.3	262	72.0	20.0	39.0	1.7	.90	.00	286.0	39.0	8.0	.6	—	566	353
	Milton 1	15N	12E	2	100	WO	8/86	8.1	286	73.0	25.0	39.0	1.6	.91	.03	310.0	40.0	8.0	.6	—	530	374
124	USGS Wayne 6	15N	12E	24	49	WO	7/66	7.4	318	83.0	27.0	5.5	.9	.77	.50	256.0	9.0	38.0	.1	6.78	507	348
125	I-70 E RestPark	16N	13E	12	134	WH	3/83	8.1	350	93.0	28.0	8.0	1.3	<.05	<.02	358.0	<5.0	6.0	.3	.20	574	352
126	Fountain City 2	17N	14E	2	96	WH	12/70	7.5	360	78.0	40.0	17.0	2.0	1.20	.02	362.0	4.0	24.0	1.3	.40	610	385
	Fountain City 1	17N	14E	2	97	WH	7/74	7.6	338	76.0	36.0	18.0	2.0	2.60	.03	328.0	4.0	26.0	1.2	.20	566	363
127	Centerville 2	16N	14E	29	52	WH	4/75	7.6	352	90.0	31.0	3.0	1.0	<.10	.05	274.0	22.0	52.0	.2	<.10	534	364
	Centerville 1	16N	14E	29	50	WH	4/75	7.6	364	90.0	34.0	4.0	1.0	1.80	.07	282.0	21.0	54.0	.2	<.10	550	375
128	Centerville 3	16N	14E	20	52	WH	12/70	7.6	334	73.0	37.0	4.0	1.0	1.50	.10	252.0	14.0	60.0	.2	2.10	500	344
129	Richmond St. Hospital	14N	1W	31	130	WH	11/58	7.5	390	96.0	36.0	29.0	2.0	3.20	.05	305.0	27.0	94.0	.6	.30	660	471
130	Dublin 1	16N	12E	30	89	WH	10/58	7.6	392	96.0	37.0	9.0	1.0	.40	.10	326.0	13.0	62.0	.1	—	618	414
131	Abbattoir T-PW	14N	12E	36	49	WO	8/63	7.1	380	100.0	37.4	—	—	.42	.00	—	16.0	95.0	—	—	—	—
132	Everton 1	13N	12E	1	78	WO	2/67	7.3	300	75.0	27.0	4.0	2.0	.40	.09	254.0	7.0	51.0	.2	—	477	319
133	Connersville 5	14N	13E	18	97	WO	6/75	7.5	346	89.0	30.0	5.0	2.0	1.70	.08	272.0	10.0	61.0	.2	<.10	531	362
	Connersville 4	14N	13E	18	95	WO	6/75	7.5	374	96.0	33.0	5.0	2.0	1.90	.10	292.0	12.0	65.0	.2	.10	572	390
	Connersville 3	14N	13E	18	95	WO	6/75	7.8	306	78.0	27.0	5.0	2.0	<.10	.03	242.0	18.0	42.0	.2	2.20	462	320

Appendix 12. Continued

Location No.	Well Owner	Township	Range	Section	Well Depth (feet)	Aquifer System	Date Sampled	pH[1]	Hardness as $CaCO_3$	Calcium	Magnesium	Sodium	Potassium	Iron	Manganese	Alkalinity as $CaCO_3$[2]	Chloride	Sulfate	Fluoride	Nitrate as Nitrogen	Total Dissloved Solids[3]	Total Dissolved Solids[4]
133	Connersville 2	14N	13E	18	81	WO	6/75	7.8	300	75.0	27.0	5.0	2.0	<0.10	<0.02	238.0	10.0	42.0	0.2	2.40	454	306
	Connersville 1	14N	13E	18	95	WO	6/75	7.2	320	82.0	28.0	5.0	2.0	<.10	<.02	252.0	12.0	44.0	.2	2.40	483	327
135	Liberty 1	14N	14E	29	42	WO	6/69	7.5	306	77.0	28.0	10.0	2.0	.20	.03	241.0	13.0	46.0	4.7	3.00	478	329
136	Brookville Res	14N	14E	29	55	WO	11/78	7.2	402	115.0	28.0	3.0	2.0	.20	.02	344.0	16.0	28.0	.2	5.80	618	405
137	USGS Union 6	11N	2W	14	65	O	7/67	7.6	294	75.0	26.0	88.0	6.0	.66	.10	357.0	74.0	12.0	.5	.10	718	497
138	Dunlapsvlle T-N	11N	2W	21	39	WO	6/75	7.4	314	80.0	28.0	4.0	2.0	<.10	<.02	266.0	5.0	38.0	.2	.50	482	317
139	Dunlapsvlle T-S	11N	2W	28	60	WO	5/75	7.7	282	72.0	25.0	4.0	5.0	<.10	<.02	236.0	8.0	32.0	.2	4.10	438	292
140	Liberty 1 Old	11N	1W	6	56	FU	4/58	7.8	408	104.0	36.0	9.0	1.0	1.20	.20	356.0	10.0	54.0	.2	.10	651	430
141	Laurel 2	12N	12E	10	57	WO	8/74	7.6	456	129.0	33.0	29.0	5.0	—	—	352.0	47.0	57.0	.1	8.60	738	520
142	Franklin Co 2	10N	2W	28	152	WO	5/80	7.6	368	99.0	29.0	11.0	1.7	.55	.11	324.0	20.0	39.0	.4	.10	596	395
	Franklin Co 2	10N	2W	28	134	WO	5/80	7.5	320	82.0	28.0	24.0	1.6	2.25	.03	308.0	30.0	26.0	.5	—	570	379
143	Brookville 1	9N	2W	20	91	WO	5/80	7.4	430	114.0	35.0	28.0	3.3	<.05	<.02	358.0	55.0	52.0	.2	2.60	727	505
	Brookville 3	9N	2W	20	150	WO	5/80	7.9	388	106.0	30.0	24.0	4.3	.08	.03	308.0	52.0	50.0	.2	2.10	644	454

Appendix 13. Discussion of Reservoir Yield Dependability

The dependability of the yield of a reservoir at a particular site depends upon the level of demand and the storage capacity of the reservoir. The YIELD computer program (Biek, 1986) determines various reservoir capacities needed to maintain a given draft with various levels of dependability.

Dependability is the fraction of time that demand is met (McMahon and Mein, 1986). The time increment for calculating dependability is one year. Years in which demand is not met are called deficit years. In the YIELD program, the deficit years are controlled deficits.

Controlled deficits occur when, during one or more of the dry years on record, controlled cutbacks in demand are made. For example, if it is anticipated that farmers may be able to tolerate a cutback to 80 percent of their allotted supply during the months of irrigation for the two severest dry years of record, then there will be two years of controlled deficit. If users of the reservoir can tolerate some shortages during these few dry years, then a smaller reservoir can be constructed.

The YIELD program computes the reliability or dependability of the yield for each number-of-years deficit. The dependability may be defined by the equation:

$$R = m/(n+1) = (n-d)/(n+1)$$

where

m = number of years demand is met,

n = the period of record of stream flow data,

d = number of years of deficit in which supply is cut back.

For example, suppose we have 50 years of stream data and one year of deficit will be acceptable. The dependability of the yield is:

$$R = (50-1)/(50+1) = 0.96$$

There is a 96 percent probability that the demand will be met in any given year.