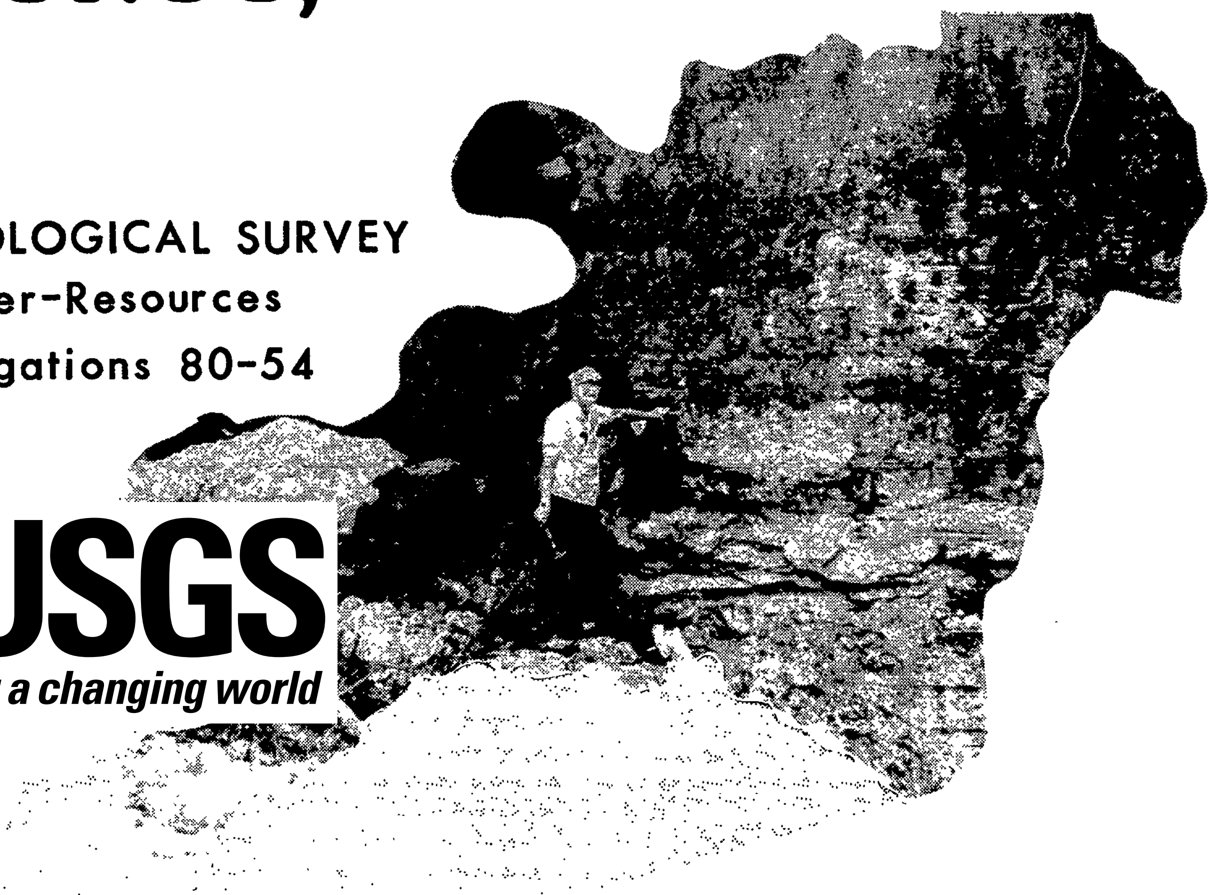
APPRAISAL OF HYDROLOGIC INFORMATION NEEDED IN ANTICIPATION OF LIGNITE MINING IN LAUDERDALE COUNTY, TENNESSEE



U.S. GEOLOGICAL SURVEY
Water-Resources
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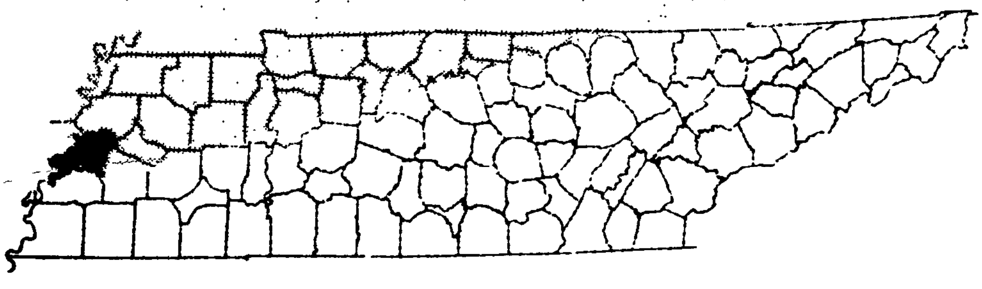


PREPARED IN COOPERATION WITH

TENNESSEE DEPARTMENT of CONSERVATION,
DIVISION of GEOLOGY

Lauderdale County is in a seismically active region and has been subject to major earthquakes in the past. The severest earthquakes known to have occurred in this region during recorded history were the three principal shocks of the new Madrid earthquakes of 1811-12. These principal shocks were also the severest earthquakes experienced within historic time in the central and eastern United States (Nuttli, 1974).

Water Use

Water use in Lauderdale County was inventoried in 1970 by Kernodle and Wilson (1973, tables 1-4) as part of a state-wide water-use survey. At that time, water use in the county amounted to an average daily withdrawal of about 3.5 Mgal/d of which 1.5 Mgal/d was ground water and 2.0 Mgal/d was surface water. The ground water was chiefly for municipal, industrial, commercial, and domestic use, and the surface water was for agricultural use. The report showed that 12 major users in the county were canvassed during the survey; the many domestic and farm wells were not canvassed.

Ground-Water System

From about 2,500 to 3,000 ft of sand, clay, silt, gravel, and lignite underlie Lauderdale County above the Paleozoic rocks. These deposits make up geologic units ranging in age from Late Cretaceous to Holocene. Although much of this sequence is saturated with fresh water (less than 1,000 mg/L of dissolved solids), only the post-Midway units (Wilcox Group and younger) will be considered in this report because these units contain the principal aquifers for present and future use. Table 2 gives the stratigraphic relations of the post-Midway geologic units and their hydrologic significance; figure 11 is a geohydrologic cross-section of western Tennessee through Lauderdale County.

Ground-water supplies in Lauderdale County are now derived from several aquifers, as follows: (1) Mississippi alluvial deposits, (2) fluvial deposits, (3) Jackson and Cockfield Formations and (4) Memphis Sand. The alluvial deposits beneath the flood plains of the streams in the county--particularly the Hatchie River and the South Fork Forked Deer River--may provide water to a few shallow wells. These deposits, however, are not described in this report because they are not considered an important source of ground-water supply.

An aquifer not presently used but worthy of mention is the Fort Pillow Sand ("1400-foot" sand). Although this aquifer is deeper than the Memphis Sand and does not have aquifer characteristics to produce as much water, the Fort Pillow Sand may have potential for supplying somewhat better quality water than is available from the shallow aquifers, as in northern Mississippi and eastern Arkansas. However, specific data on the quality of water from the Fort Pillow Sand in Lauderdale County are not available.

Table 3 gives records of wells in Lauderdale County for which water-quality analyses are available; figure 12 shows locations of these wells; table 4 gives analyses of the water.

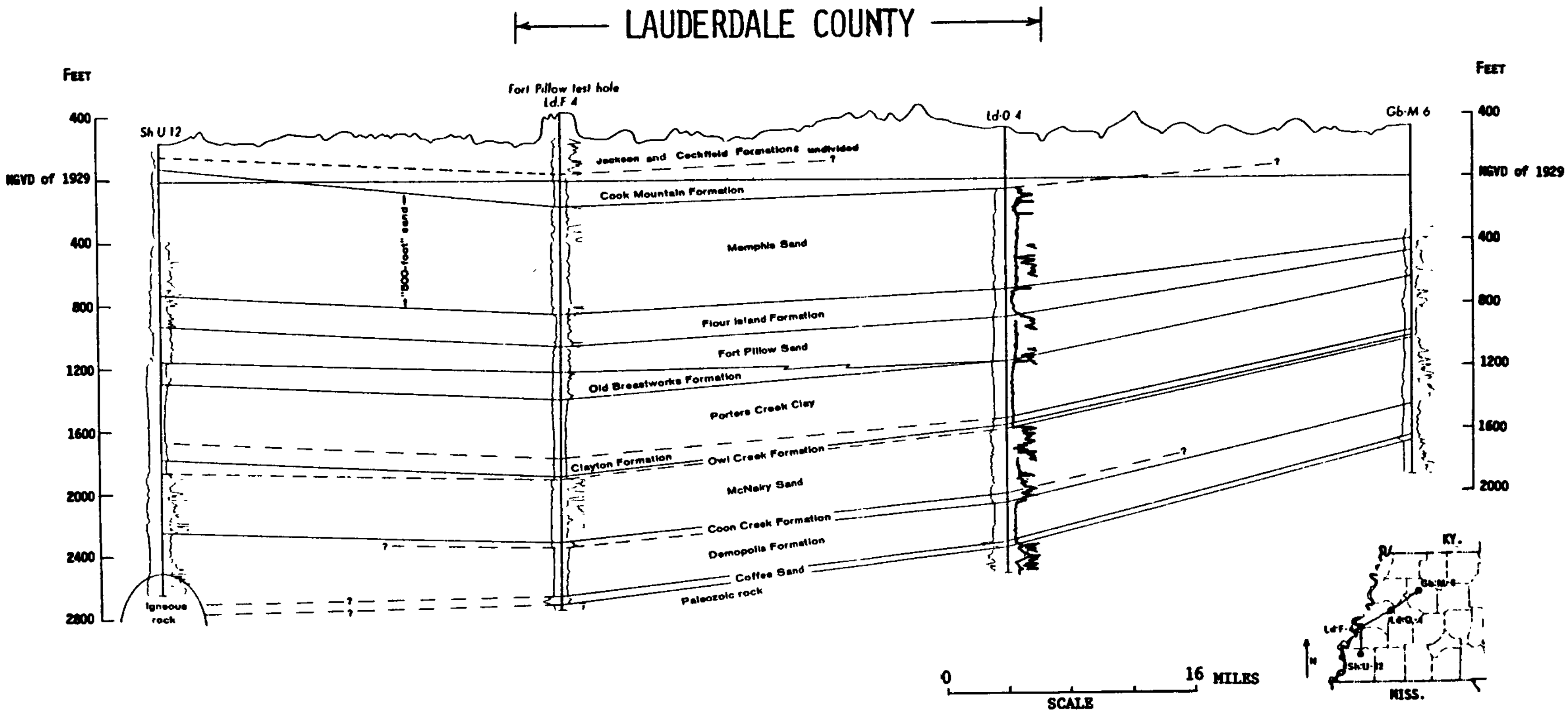


Figure 11.--Geohydrologic electric-log cross-section of western Tennessee through Lauderdale County (modified from Moore and Brown, 1969).

Table 2.--Post-Midway geologic units underlying Lauderdale

<table>
<tr><th>System</th><th>Series</th><th>Group</th><th>Stratigraphic unit</th><th>Thickness (ft)</th></tr>
<tr><td rowspan="2">Quaternary</td><td>Holocene and Pleistocene</td><td></td><td>Alluvial deposits (alluvium)</td><td>0-200</td></tr>
<tr><td>Pleistocene</td><td></td><td>Loess</td><td>0-80</td></tr>
<tr><td>Quaternary and Tertiary (?)</td><td>Pleistocene and Pliocene (?)</td><td></td><td>Fluvial deposits (terrace deposits)</td><td>0-100</td></tr>
<tr><td rowspan="6">Tertiary</td><td rowspan="5">Eocene
?</td><td rowspan="3">?
Claiborne</td><td>Jackson Formation and Cockfield Formation of Claiborne Group</td><td>0-400</td></tr>
<tr><td>Cook Mountain Formation</td><td>30-200</td></tr>
<tr><td>Memphis Sand ("500-foot" sand)</td><td>650-700</td></tr>
<tr><td rowspan="3">Wilcox</td><td>Flour Island Formation</td><td>150-200</td></tr>
<tr><td>Fort Pillow Sand ("1400-foot" sand)</td><td>150-300</td></tr>
<tr><td>Paleocene</td><td>Old Breastworks Formation</td><td>0-300</td></tr>
</table>

[1] Stratigraphic nomenclature and usage modified from Moore and Brown (1969).

County and their hydrologic significance[1]

Lithology and hydrologic significance[1]
Sand, gravel, silt, and clay. Underlies the Mississippi Alluvial Plain and flood plains of other streams. Thickest beneath the Alluvial Plain; probably no more than 50 ft elsewhere. Supplies water to domestic and farm wells in the Alluvial Plain where this aquifer has potential for large capacity wells to provide a source of irrigation water.
Silt, silty clay, and minor sand. Forms principal formation at the surface in the Coastal Plain. Thickest on bluffs that border Mississippi Alluvial Plain. Not an aquifer; tends to retard downward movement of water recharging the water-table aquifers.
Sand, gravel, and minor clay. Generally underlies the loess in the Coastal Plain, but locally may be absent. Thickness highly variable because of erosional surfaces at top and base. Locally supplies water to domestic, farm, and municipal wells where of sufficient thickness and contains enough water.
Sand, silt, clay, and lignite. Because of similarities in lithology, the Jackson and Cockfield cannot be subdivided based on available information. Preserved section probably mostly Cockfield, but at places upper part includes the Jackson. Principal aquifer in the Coastal Plain supplying water for domestic, farm, commercial, industrial, and municipal use.
Clay, silt, sand, and lignite. Identified in Fort Pillow test well; not enough information available to identify elsewhere. Believed to consist generally of clay and silt, but locally may consist largely of sand. Forms upper confining bed for the Memphis Sand where chiefly clay and silt.
Sand, silt, and clay. Consists of a thick body of sand with lenses of clay and silt at various stratigraphic horizons. Thickest in southern part of county. Used for public, municipal, commercial, and industrial supplies where shallower aquifers do not yield enough water for installation of large capacity wells.
Silt, clay, and sand. Not an aquifer; serves as lower confining bed for the Memphis Sand and upper confining bed for Fort Pillow Sand.
Sand and minor clay. Relatively deep aquifer not presently used in the county because of the availability of water at shallower depths. May have potential for supplying water of better quality than available from shallower aquifers, but specific information on ground-water quality not available.
Silt, clay, sand, and lignite. Not an aquifer. Thickest in southern part of County; may be absent in northern part. Serves as the lower confining bed for the Fort Pillow Sand. Underlain by the Porters Creek Clay of the Midway Group.

Table 3.--Records of wells in Lauderdale
[See figure 12 for well locations

Well number[1]	Owner	Type of well	Date drilled	Alti- tude (ft)	Well depth (ft)
					MISSISSIPPI
S-1	T. C. Meeks	Driven	---	258	20
25	Ashport	do	---	251	23
F-2	T. E. Hutcherson	do	---	246	35
M-2	James Porter	do	---	251	36
M-3	E. M. Harrison	do	---	252	44
R-1	F. E. Pough	Drilled	---	262	59
					FLUVIAL
386	Henning Ice & Coal Co.	---	---	---	50
H-1	Henning Ice, Water & Elec. Co.	Drilled	1935	---	60
					JACKSON AND
126	M. A. Whitaker	Drilled	---	---	100
6	West Tenn. Power & Light Co. (Halls)	do	---	---	181
0-2	Town of Halls	do	---	315	185
9	Mrs. James Hunt	do	---	---	196
					MEMPHIS
M-A	E. M. Harrison	Drilled	---	252	396
38c	Henning Ice & Coal Co.	do	---	---	440
H-3	Henning Ice, Water & Elec. Co.	do	1936	295	480
G-5	Fort Pillow State Prison Farm	do	1957	270	656
21	West Tenn. Power & Light Co. (Ripley)	do	---	---	695
H-5	Town of Ripley	do	1942	427	755
H-6	Town of Ripley	do	1951	414	755
F-4	U.S. Geological Survey	do	1965	437	879

[1] Well numbers with letters preceding number, e.g. H-3, are U.S.G.S. local
Lauderdale County; other numbers correspond to those given in Wells

County for which water quality analyses are available
and table 4 for water analyses]

Well diameter (in.)	Water level: Depth (ft)	Water level: Date	Pumping rate (gal/min)	Method of lift	Use of water
ALLUVIAL DEPOSITS					
1¼	4	5-56	---	Pitcher pump	Domestic
1½	---	---	---	do	do
1¼	17	3-56	---	do	Domestic, stock
1¼	8	3-56	---	do	Domestic
1¼	7	3-56	---	do	Domestic, stock
2	13	9-56	---	do	Domestic
DEPOSITS					
4	---	---	---	Lift pump	Public supply
18x8	5	10-53	50	Turbine	do
COCKFIELD FORMATIONS					
2	---	---	---	Lift pump	Domestic
8	---	---	70	Lift pump, elec.	---
4	60	1953	304	Turbine	Public supply
2	---	---	---	Lift pump	Domestic
SAND					
2	+3	9-58	---	Pitcher pump	Unused
4	---	---	---	Lift pump	Public supply
4	---	---	60	Turbine	do
10x6	26	8-57	600	Turbine	do
---	---	---	250	Air lift	do
12	165	1953	350	Turbine	do
12	140	5-60	400	do	do
6x3	198	11-65	---	None	Observation well

well-numbering system for Tennessee and are generally prefixed "Ld:" for
(1933; p. 217-220).

Table 4.--Water quality analyses

[Dissolved constituents and hardness in milligrams per liter;

Well number[1]	Well depth (ft)	Year of collection	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)
									MISSISSIPPI
S-1	20	1956	26	0.13	6.4	1.5	6.7	0.8	18
25	23	1929	26	1.7	97	34	2.0	1.5	434
F-2	35	1956	28	15	101	33	5.2	1.8	478
M-2	36	1956	25	12	101	28	5.9	2.2	438
M-3	44	1956	37	19	111	40	10	2.6	574
R-1	59	1956	29	16	110	24	20	2.2	459
									FLUVIAL
38b	50	1929	41	.02	38	24	5.9	1.2	185
H-1	60	1951	42	.18	55	31	14	.9	211
									JACKSON AND
12b	100	1929	14	41	15	9.4	5.1	1.8	102
6	181	1929	22	1.7	33	19	5.7	1.1	196
0-2	185	1951	19	1.9	24	12	7.9	1.4	144
9	196	1929	17	1.8	68	41	7.6	.9	410
									MEMPHIS
M-4	396	1958	18	16	18	8.3	5.5	6.6	117
38c	440	1929	12	5.6	17	8.7	6.9	1.6	105
H-3	480	1951	13	6.6	17	11	8.7	3.4	122
G-5	656	1960	--	10	18	11	---	---	119
21	695	1929	14	6.1	18	10	6.1	1.6	113
H-5	755	1951	8.8	4.5	18	9.5	7.3	2.9	114
H-6	755	1961	5.0	2.4	17	9.3	6.3	1.9	109
F-4	879	1965	11	2.0	47	12	11	.6	228

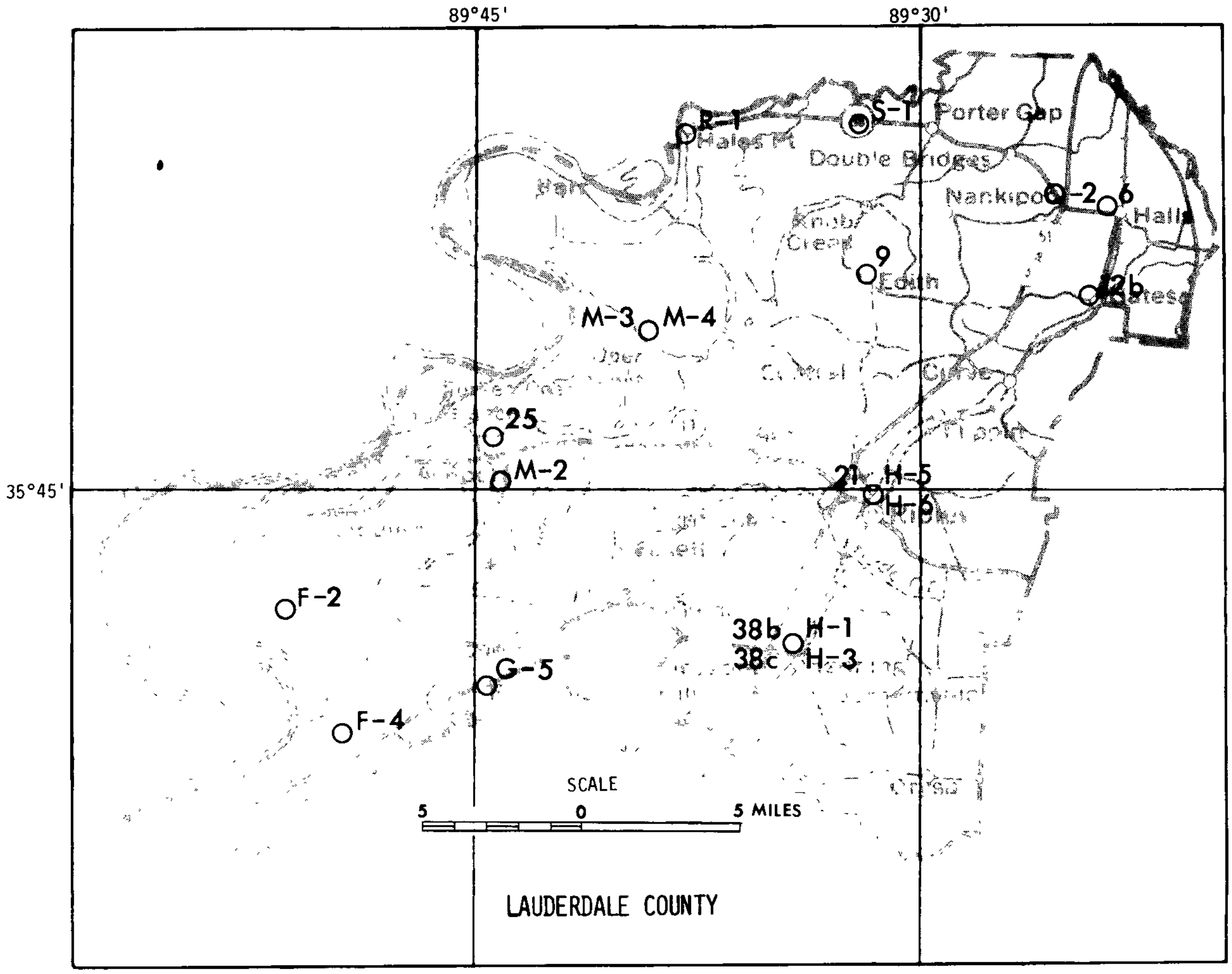
[1] Well numbers with letters preceding number, e.g. H-3, are U.S.G.S. local well-
County; other numbers correspond to those given in Wells (1933, p. 217-220).

[2] Temperatures converted from °F to °C and rounded to the nearest half degree.

from wells in Lauderdale County
see figure 12 for well locations and table 3 for well records]

Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3) as N	Dissolved solids (residue)	Hardness as $CaCO_3$	Specific conductance (Micromhos at 25°C)	pH (units)	Color (units)	Temperature °C[2]
ALLUVIAL DEPOSITS									
11	7.3	0.1	5.0	78	25	111	6.0	3	14
16	6.8	--	2.6	373	382	---	---	---	17
5.3	1.2	.2	.7	409	390	720	6.9	6	15
13	3.5	.4	.7	400	370	694	7.0	15	16
1.5	1.0	.4	.9	491	443	833	6.8	15	15
42	2.0	.2	.3	456	379	750	6.9	2	15.5
DEPOSITS									
8.0	14	--	29	236	193	---	---	---	17
23	37	.0	58	382	264	563	6.3	5	16.5
COCKFIELD FORMATIONS									
4.1	1.7	--	.05	94	76	---	---	---	16.5
7.1	1.8	--	.10	176	160	---	---	---	16.5
5.9	1.8	.0	.5	132	109	229	6.4	5	17
4.5	2.4	--	13	349	338	---	---	---	16.5
SAND									
1.8	1.5	.0	.1	120	78	187	7.7	3	16.5
6.3	2.1	--	.05	101	78	---	---	---	---
3.7	4.8	.1	.8	121	88	200	6.2	3	18
1.2	3.0	--	.0	---	88	183	6.5	---	18
6.6	2.0	--	.15	107	86	---	---	---	17
3.4	3.8	.0	.7	110	84	182	6.2	2	18
3.2	2.0	.6	1.1	104	80	175	6.8	5	18
7.4	1.4	.2	.0	206	167	356	8.1	---	17.5

numbering system for Tennessee and are generally prefixed "Ld:" for Lauderdale



EXPLANATION

Well numbers with letters preceding number, for example, H-3,are local well-numbering system of U. S. Geological Survey for Tennessee and are generally prefixed "Ld:" for Lauderdale County; other numbers correspond to those given in Wells (1938, p. 217-220). See table 3 for well records and table 4 for water analyses.

Figure 12.--Wells for which water-quality analyses are available.

Mississippi Alluvial Deposits

The Mississippi alluvial deposits underlie the Mississippi Alluvial Plain in western Lauderdale County. These deposits consist generally of relatively impermeable fine sand, silt, and clay in the upper part and permeable sand and gravel in the lower part. The alluvial deposits locally may be as much as 200 ft thick, but probably are more commonly 100 to 150 ft thick. The lower sand and gravel is about nine-tenths to three-quarters of the thickness of the alluvial deposits and provides a source of water for domestic and farm wells.

Wells in the Mississippi alluvial deposits are shallow, ranging from about 10 to 110 ft in depth. For domestic and farm supplies these wells are typically of small capacity, pumping from about 5 to 25 gal/min. Nevertheless, according to Strausberg and Schreurs (1958, p. 4), this aquifer is known to have potential for large capacity wells of 1,500 to 4,000 gal/min to provide a source of irrigation water.

Water levels in the Mississippi alluvial deposits range from near land surface to about 35 ft below land surface. According to Strausberg and Schreurs (1958, p. 37), hydrographs of observation wells show that water levels in the alluvial deposits fluctuate in response to seasonal or long-term changes in stage of the Mississippi River as far as 3 mi away.

Water from the Mississippi alluvial deposits is typically very hard and is high in iron and dissolved solids (table 4). At places, shallower wells provide softer water with less iron and dissolved solids than the deeper ones, probably because of infiltration of water to the aquifer from nearby streams or lakes.

Fluvial Deposits

The fluvial deposits comprise a local water-table aquifer beneath the loess in the Coastal Plain. These deposits consist chiefly of sand or sand and gravel with clay present as small lenses or balls and fragments. The fluvial deposits drape over the Jackson and Cockfield Formations from high to low altitudes and commonly merge with the alluvial deposits of present streams, except along the bluffs facing the Mississippi Alluvial Plain. The fluvial deposits are generally less than 100 ft thick and at places may be absent. This aquifer provides a local source of water for domestic, farm, and municipal wells where it is of sufficient thickness and contains enough water.

Wells in the fluvial deposits are less than 100 ft deep and are small capacity, pumping from about 5 to 50 gal/min. At one time this aquifer probably was used extensively for dug and bored wells, but many shallow wells have been replaced with deeper wells in other aquifers to meet increased demands for water and to avoid contamination.

Water levels in the fluvial deposits are highly variable from place to place because the water-table configuration is controlled largely by the topography. Water levels, however, probably range from about 20 to 90 ft below land surface. Water levels are generally at higher altitudes but at greater depths beneath hill tops and ridges and at lower altitudes but at lesser depths beneath the valley slopes.

Water from the fluvial deposits is hard to very hard and high in dissolved solids (table 4). Iron content is locally lower than in water from the deeper aquifers so at places water from the fluvial deposits may be desirable as a source of supply because of lower treatment costs.

Jackson and Cockfield Formations

The Jackson and Cockfield Formations underlie most of the county beneath the alluvial deposits, fluvial deposits, or loess. This unit consists of lenticularly bedded sand, silt, clay and lignite. Not much specific information is available about the thickness of the Jackson and Cockfield Formations. However, based on the logs of the Fort Pillow test well at Fort Pillow State Historic Area, it is about 300 ft thick. In other areas of the county, the aquifer probably ranges from about 0 ft to 400 ft in thickness. This is the principal aquifer utilized in the Coastal Plain, providing water for domestic, farm, commercial, industrial, public and municipal supplies.

Wells in the Jackson and Cockfield Formations are generally less than 500 ft deep and most are less than 200 ft deep. Sands range from very fine to coarse, but commonly are of the finer sizes. These sands give up water to small to moderate capacity wells, pumping from about 5 to 300 gal/min. A pump test made at the U.S. Military Reservation near Halls in 1961 indicated a transmissivity of about 2,500 $(ft^3/d)ft$ and a storage coefficient of $3x10^{-4}$ for this aquifer.

Water levels in wells in the Jackson and Cockfield Formations generally range from near land surface to about 200 ft below land surface, depending on location and altitude. Most water-level data available for this aquifer are those supplied by water-well contractors on driller's records filed with the TDWR. Water in this aquifer exists under both water table and confined conditions.

Water from the Jackson and Cockfield Formations is moderately hard to very hard, and dissolved solids range from less than 100 mg/L to more than 300 mg/L (table 4). Iron is locally an undesirable constituent, requiring treatment for removal.

Memphis Sand

The Memphis Sand ("500-foot" sand) is a widespread and important aquifer in western Tennessee. It is the principal aquifer supplying water to the City of Memphis, about 50 mi to the south (Criner and Parks, 1976, p. 5).

In Lauderdale County, the Memphis Sand consists chiefly of a thick body of sand containing subordinate lenses or beds of clay at various stratigraphic horizons. This aquifer is about 650 ft thick to the north in the vicinity of Halls and about 700 ft thick to the south in the Fort Pillow State Historic Area. The Memphis Sand is presently being used for public, municipal, commercial, and industrial supplies where the sands of the shallower aquifers do not yield enough water for the installation of large-capacity wells.

Wells in the Memphis Sand range from about 500 to 800 ft in depth. The sands range from very fine to coarse and supply water to small and large capacity wells, pumping from 30 to 850 gal/min. It is commonly necessary to drill to the middle of the aquifer to find a suitable sand to supply large-capacity wells. A pump test made at Ripley in 1961 indicated a transmissivity of 22,400 $(ft^3/d)/ft$ for this aquifer. A map prepared by Moore (1965, pl. 7) shows a range of apparent and potential transmissivity (transmissibility in Moore's report) for Lauderdale County of about 33,500 to 43,500 $(ft^3/d)/ft$ for wells that are partially penetrating and screened in the top of the aquifer.

Water levels in wells in the Memphis Sand range from near land surface to about 250 ft below land surface, depending on location and altitude. Moore (1965, pl. 5) gives a potentiometric-(piezometric) surface map that shows the altitude at which water rose in wells in the Memphis Sand ("500-foot" sand in Moore's report) in January 1960. In addition to water levels reported by water well contractors on driller's logs filed with the TDWR, the Geological Survey maintains an automatic recorder on an observation well at Fort Pillow State Historic Area. Preliminary analysis of the record from this well indicates that water levels in the Memphis Sand respond to large changes in stage on the Mississippi River, about 2.5 mi away at its closest point.

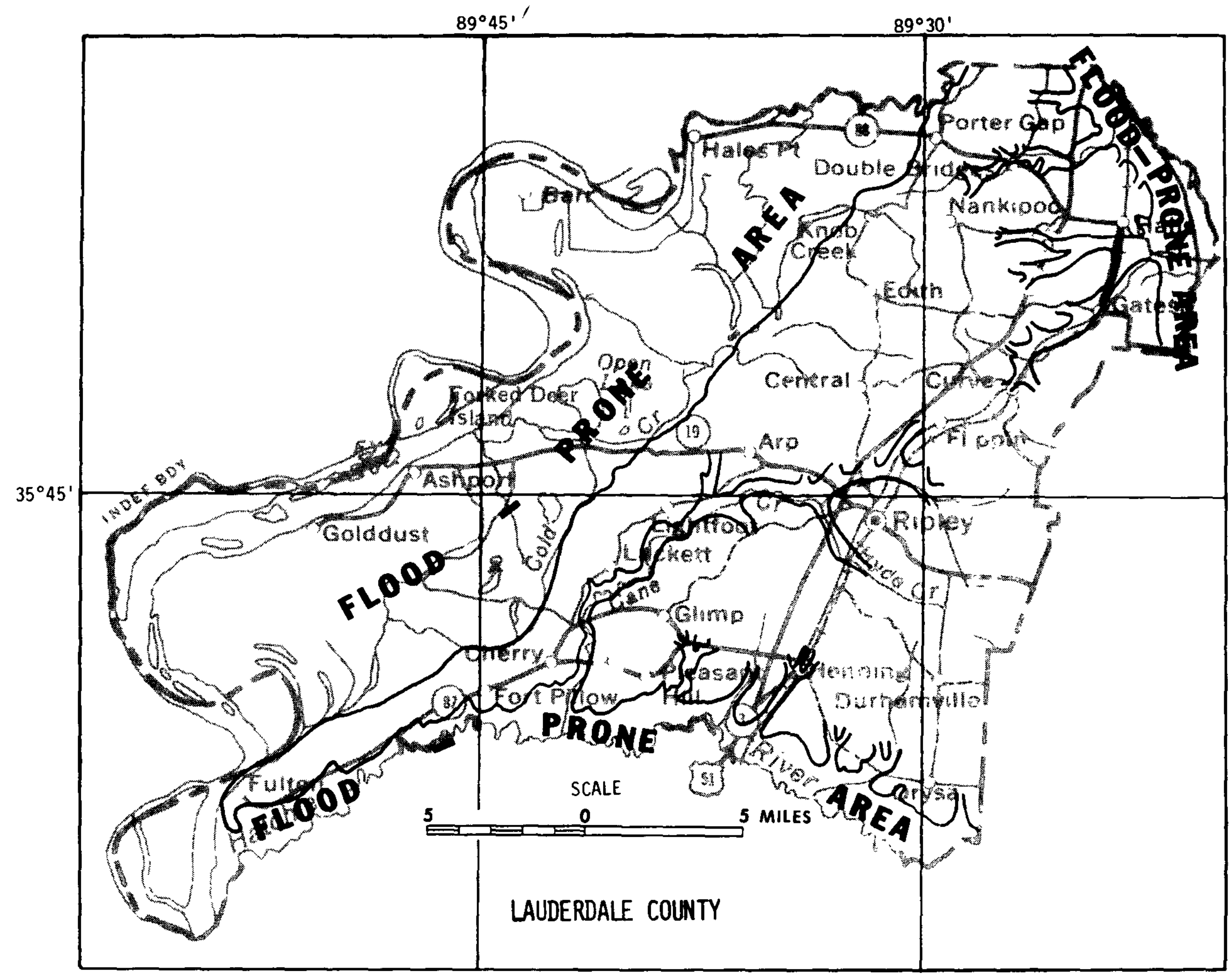
Water from the Memphis Sand is moderately hard and contains small amounts of dissolved solids (table 4). Iron is locally an undesirable constituent, requiring treatment for removal.

Surface-Water System

The surface-water drainage system in Lauderdale County is entirely within the Lower Mississippi River Basin and includes parts of the Hatchie River and the Obion River Basins. Natural divides within the county allow subdivision of this drainage system into three areas for the purpose of discussion. These areas are drainage to: (1) the Mississippi River, (2) the Hatchie River, and (3) the South Fork Forked Deer River (Obion River Basin). Figure 13 shows major drainage and generalized flood-prone areas in Lauderdale County; table 5 gives the low-flow characteristics of some streams.

Drainage to Mississippi River

The Mississippi River flows southward along the western boundary of the county except where the boundary follows abandoned courses. Drainage to the Mississippi consists of a complex network of interconnecting streams, lakes, and ditches that drain the flat-lying Mississippi Alluvial Plain and some adjacent uplands of the Coastal Plain. None of the Alluvial Plain is protected by the system of man-made levees along the Mississippi River built and maintained by the Corps of Engineers. Thus a large part of the area is subject to seasonal floods on the Mississippi, and the entire area has been inundated during historic floods. Flow in this network of streams, lakes, and ditches is variable in direction and in the courses followed because of backwater from the Mississippi River during high stages.



EXPLANATION

Flood-prone areas are generalized from U.S.G.S. maps prepared on 15- and 7.5-minute topographic quadrangles. See "Flood-Prone Area Maps" in text for list of maps and for mapping criteria.

Figure 13.--Major drainage and generalized flood-prone areas.

Table 5.--Low flow characteristics of some streams in Lauderdale County[1]

[Partial-record stations correlated with daily-record station 07029000, see below]

Station number	Class of Station	Drainage area (mi^2)	Annual low flow [in $(ft^3/s)/mi^2$] for indicated period of consecutive days and for indicated recurrence interval (in years)				Flow [in $(ft^3/s)/mi^2$] which was equaled or exceeded for indicated percent of time	
			7-day		30-day			
			2-yr	10-yr	2-yr	10-yr	90	95
07028000	Daily-record	1,100	0.16	0.11	0.18	0.13	0.18	0.15
07029200	Partial-record	16.4	.04	.02	.06	.03	.05	.04
07030100	Partial-record	30	.01	.003	.02	.0007	.02	.01
07030140	Partial-record	88	.001	0	.003	0	.002	.001

[1] From Speer and others (1965, table 2).

Station	Station name
07028000	South Fork Forked Deer River at Chestnut Bluff
07029000	Middle Fork Forked Deer River near Alamo
07029200	Cold Creek near Arp
07030100	Cane Creek at Ripley
07030140	Cane Creek near Cherry

At stages when flow is not affected by backwater from the Mississippi River, drainage in the northern part of the Alluvial Plain is into Chisholm Lake and the Old Bed Forked Deer River. Principal tributaries are Cold Creek (north one) and Knob Creek. Cold Creek heads in the Coastal Plain northeast of Central and drains the uplands north of Central and Arp. Cold Creek flows westward from the uplands and enters Chisholm Lake at its south end. Knob Creek heads in the Coastal Plain northwest of Dry Hill and drains the uplands north of Edith. Knob Creek flows westward and enters the Old Bed Forked Deer River west of the community of Knob Creek. Other drainage in the northern part of the Alluvial Plain is through Middle Fork Forked Deer River and Waldrons Pocket, both of which drain into the Mississippi.

The central part of the Alluvial Plain, for the most part, drains into and out of Open Lake. Several bayous or sloughs drain into Open Lake from the east and north, and Lower Forked Deer River provides drainage westward to the Mississippi. Cold Creek (south one) also provides drainage from Open Lake.

The southern part of the Alluvial Plain is drained by Cold Creek (south) and its major tributary - Jones Bayou (or Jones Slough). Cold Creek flows southward from Open Lake through the southeast part of the Alluvial Plain and is joined southeast of Golddust by Jones Bayou, which heads near Ashport. Ultimately Cold Creek flows into The Chute, an abandoned channel of the Mississippi, north of Fort Pillow State Park.

Drainage to Hatchie River

The Hatchie River, a westward flowing stream, forms the southern boundary of Lauderdale County. Drainage to the Hatchie consists of Cane Creek which drains the uplands of the Coastal Plain in the eastern, central, and southern parts of the county, and of many small southward flowing streams that drain the uplands in the southern part. The Hatchie is affected by backwater from the Mississippi River at least as far upstream as U.S. Highway 51.

Cane Creek is by far the largest tributary of the Hatchie that originates in the county. This stream heads in the eastern part east of Ripley, flows westward passing north of Ripley, turns southward near Lightfoot, and enters the Hatchie south of Cherry. The principal tributary of Cane Creek is Hyde Creek, which heads southeast of Ripley, passes through south Ripley, and enters Cane Creek west of Ripley.

In recent years, Cane Creek has undergone channel modification to reduce floodwater and sediment damage under a project of the U.S. Soil Conservation Service. This project is sponsored by the Lauderdale County Soil Conservation District and Cane Creek Watershed District. In addition to land treatment measures by farmers, the work consists of channelization of the main channel and tributaries and the construction of many flood retarding structures in the basin. The estimated completion date of this project is 1981.

Of the small southward flowing streams that drain southern parts of the county, the larger are Cooper Springs Creek and its tributary Campground Creek east of Pleasant Hill and Camp Creek east of Orysa and Durhamville. Camp Creek flows into Lagoon Creek, which makes up the county's boundary at the southeast corner, and in turn flows into the Hatchie River.

Drainage to South Fork Forked Deer River

The South Fork Forked Deer River makes up the northeast boundary of Lauderdale County, flowing northward and passing east of Gates and Halls. Drainage to the South Fork is from Lost, Tisdale, Sumrow, and Mill Creeks, and Chambers Branch. These streams drain the uplands of the Coastal Plain in the northeastern parts of the county. The South Fork is affected by backwater from the Mississippi River at least as far upstream as the Illinois Central Railroad bridge north of Halls. The main channel and major tributaries have been channelized under past projects of the Corps of Engineers.

Tisdale Creek heads near Curve and Dry Hill, flows northeastward through Gates, and as a result of channelization, joins Halls Creek southeast of Halls. A small segment of the lower reach of Tisdale still flows eastward into the South Fork. Sumrow Creek heads near Nankipoo, flows eastward, is joined by its principal tributary, Beech Bluff Creek, south of Halls, and becomes Halls Creek. Halls Creek originates from Sumrow and Tisdale Creeks southeast of Halls and flows eastward into the South Fork.

Mills Creek heads in the uplands southeast of Porter Gap, flows eastward through Double Bridges, and enters the South Fork north of Halls. Chamber Branch drains the northernmost part of the county and enters the South Fork at the northeast corner. Lost Creek, which heads near Curve, drains a relatively small area of the uplands in the eastern part of the county.

IMPACT OF STRIP-MINING ON THE HYDROLOGIC SYSTEM

General Considerations

Strip-mining lignite in Lauderdale County could cause a variety of effects on the ground-water and surface-water systems. Major effects could result from the disequilibrium created in the hydrologic system by extensive alterations of the land surface, redistribution of earth materials, and dewatering of mine sites.

For the ground-water system, the most obvious effects of strip-mining could be (1) an increase or decrease in hydraulic conductivities and recharge relations of the aquifers at the mine sites from the disturbance and mixing of aquifer and other earth materials, (2) a lowering of water levels from pumping large quantities of water in dewatering, (3) a decrease in ground-water contribution to base flows in streams from lowering of water levels, and (4) a change in ground-water quality by the introduction of water of different quality into the aquifers from the mining operation.

For the surface-water system, the most obvious effects of mining could be (1) modification of local drainage by diversion of stream channels in the vicinity of mine sites and construction of ditches and levees for drainage and flood protection, (2) changes in stream-flow characteristics and channel cross-section geometry from disposal of large quantities of water from dewatering, (3) an increase in sediment loads in streams from erosion of cleared land and displaced earth materials, and (4) a change in surface-water quality by the introduction of water of different quality into streams from the mining operation and dewatering activities.

Not knowing the location of any future strip mine or the specific methods by which mining would be conducted, many assumptions must be made in consideration of the impact of strip-mining on the hydrologic system. The following generalizations of strip-mining in the Mississippi Alluvial Plain and the Coastal Plain is intended to show conditions under which mining would occur in these geologically and topographically different areas.

Mining in Mississippi Alluvial Plain

Lignite in the Mississippi Alluvial Plain occurs in the Jackson and Cockfield Formations beneath the Mississippi alluvial deposits. Strip-mining lignite in this area would require dewatering the alluvial deposits and part of the Jackson and Cockfield Formations and displacing large volumes of sand, gravel, silt, and clay that make up these geologic units. Overburden would range from about 100 to 150 ft depending on the local thickness of the alluvial deposits, and mine depths could exceed 200 ft depending on the thickness of minable lignite. The Mississippi Alluvial Plain lacks protection from floods on the Mississippi River so levees would be needed around mine sites for flood protection.

Water levels in the aquifers to be dewatered would be high because of the low altitudes of the Mississippi Alluvial Plain, and saturated thickness would include most of the depth to be excavated. The lower sand and gravel of the Mississippi alluvial deposits generally has a high hydraulic conductivity. Consequently, special techniques probably would be needed to dewater mine sites. For example, the slurry trench method used by the U.S. Army Corps of Engineers (1978) in the construction of the Huxtable Pumping Plant near Marianna, Ark., may have application in dewatering the alluvial deposits for lignite mining. In brief, this method consists of enclosing an excavation site with a trench filled with impermeable material to isolate the area to be dewatered from surrounding aquifers. The trench is dug to a depth necessary to intersect on impermeable clay, which restricts flow of water from below. The use of this method would minimize the effects of dewatering on the water levels in the surrounding aquifers.

Disposal of large quantities of water from dewatering would be into nearby streams or lakes. Water of different quality from dewatering and from oxidation and leaching of dewatered earth materials would cause changes in surface-water quality.

Mining in Coastal Plain

Lignite in the Coastal Plain occurs in the Jackson and Cockfield Formations beneath the fluvial deposits and loess or alluvial deposits of the streams that drain the county. Strip-mining lignite in this area would require dewatering the fluvial deposits or alluvial deposits and part of the Jackson and Cockfield Formations and displacing large volumes of silt, sand, gravel, and clay that make up these geologic units. Overburden would range from about 0 to 150 ft depending on the mine-site geology, and mine depths could be as much as 200 ft depending on the thickness of minable lignite. The loess, which is primarily silt, is highly susceptible to erosion where denuded of vegetation and disturbed by excavation so erosion control would be needed to minimize sediment contribution to streams.

Water levels in the aquifers to be dewatered would depend largely on topograpic position of mine sites. In general, water levels in respect to land surface are shallow beneath the valleys and deep beneath the hills. Saturated thicknesses and hydraulic conductivities would depend on the local water levels and geology of the aquifers at the mine sites. The fluvial deposits locally are disconnected and function independently, and at these places, this aquifer could be virtually "dried up" from dewatering of mine sites. Dewatering of the Jackson and Cockfield Formations would reduce water levels updip and downdip from mine sites.

Large quantities of water from dewatering would be disposed of in streams draining basins in which mines are located. This water would change the stream-flow characteristics and surface-water quality and could change the channel cross-section geometry. In addition, the dewatering of mine sites and the displacement and redistribution of overburden would expose large volumes of earth materials to oxidation and leaching, and mineralized water from these materials would cause changes in ground-water and surface-water quality.

NEEDS FOR HYDROLOGIC INFORMATION AND PROPOSED DATA COLLECTION ACTIVITIES

Surface Geologic Maps

The latest geologic map that covers the county is the "Geologic Map of Tennessee" (scale 1:250,000) by Hardeman and others (1966, west sheet). This map is very generalized and is limited in usefulness to regional aspects of the geologic units. Detailed geologic maps (scale 1:62,500) by Saucier and others (1964-78) are available for the Mississippi Alluvial Plain. These maps include features of fluvial deposition and are adequate for most purposes, but do not include the geology of the Coastal Plain areas.

It is proposed that detailed geologic maps for Lauderdale County be prepared on 7.5-minute topographic quadrangles (scale 1:24,000) for those maps that include Coastal Plain areas. These geologic maps would provide a description of the local geology on a quadrangle-by-quadrangle basis and would meet most requirements for general information concerning the surface geologic formations.

Of the 20 topographic quadrangles (7.5-minute) that cover the county, the 15 that include Coastal Plain areas are:

Knob Creek	Gates	Durhamville
Fowlkes	Chestnut Bluff	Nodena
Bonicord	Golddust	Gilt Edge
Open Lake	Ft. Pillow	Gift
Ripley North	Ripley South	Turnpike

Priorities may be set on certain maps based on the size of the Coastal Plain area and the likelihood of mining within a particular quadrangle area.

An optional proposal is the preparation of geologic maps on available 15-minute topographic quadrangles for those maps that include Coastal Plain areas. Because of the relatively uncomplicated surface geology and the immediate need for geologic information, the preparation of less detailed maps may be justified. Nevertheless, completion of 15-minute geologic maps for publication would require mapping larger areas of adjacent counties than would be necessary for 7.5-minute maps. Most of the Coastal Plain of Lauderdale County is included on four 15-minute quadrangles as follows:

Hales Point	Osceola
Halls	Rialto

Ground-water Information

The shallow aquifers--Mississippi alluvial deposits, fluvial deposits, and Jackson and Cockfield Formations--provide water to the majority of wells in Lauderdale County and supply the greatest variety of uses. These wells are generally less than 300 ft deep. Specific information concerning existing water wells, subsurface stratigraphy, water-level trends and configurations, aquifer characteristics, and ground-water quality is needed inasmuch as the shallow aquifers would be most affected by any future strip-mining of lignite. Of the shallow aquifers, the Jackson and Cockfield Formations are by far the most extensively used.

Water-well Inventory

The Geological Survey has records for about 50 wells drilled in Lauderdale County prior to 1966, and the TDWR has records for about 600 wells drilled since 1963. Maximum use of these records is greatly hindered because of inadequate or inaccurate locations and lack of land-surface altitudes. In addition to these wells, many others are suspected to exist for which no records are on file. A comprehensive water-well inventory is needed for (1) appraising the ground-water resource, (2) locating wells with potential for use in collecting hydrologic and geologic data, (3) assessing any future damage to ground-water supplies that might result from mining activities, and (4) planning alternative supplies for areas that might be affected by mining.

It is proposed that a comprehensive water-well inventory be made for the county. Emphasis would be placed on a complete inventory of wells used for public, industrial, commercial, and irrigational supplies. The records of wells on file with the Geological Survey and TDWR would provide the basis for beginning this inventory. Inventoried wells would be located on the twenty 7 1/2 minute topographic quadrangles that cover the county. An effort would be made to locate the wells to an accuracy of about 50 feet horizontal distance on the maps so that usable altitudes of the land surface at the well sites can be interpolated. Location to this accuracy could be facilitated by using aerial photographs of the same approximate scale along with the topographic quadrangles reproduced on clear base-stable materials for overlaying.

Many owners of known wells would be interviewed for information concerning other wells in the vicinity. For wells for which no records are on file, owners would be asked to supply pertinent information for later use in contacting the water-well contractors to obtain these records. Basically, this information would consist of (1) present or previous owner when the well was drilled, (2) water-well contractor who drilled the well, (3) year the well was drilled, and (4) diameter and depth of the well, if known. As the inventory of each quadrangle is completed, the water-well contractors would be contacted and asked to provide the needed records, if available.

Special attention would be given the location of unused or abandoned wells with potential for use in monitoring water levels or in making geophysical logs. During the inventory, water levels would be measured in wells that are accessible for this purpose. For these wells, depth to water, date of measurement, description of the measuring point, and vertical distance to the nearest tenth of a foot of the measuring point above land surface would be recorded.

Well data collected during this inventory would be coded and entered into the Geological Survey or TDWR computer systems for storage and retrieval. The inventory would be kept up-to-date by periodically locating new wells as records are submitted to the TDWR by water-well contractors. These additional well records then would be added to the computer system.

Subsurface Stratigraphy

The subsurface stratigraphy of the shallow aquifers is known only in very general terms. Information is needed concerning the variability of the lithology and thickness of these aquifers and the depth to the base of and occurrence of lignite in the Jackson and Cockfield Formations.

It is proposed that 12 test holes be drilled at selected sites for stratigraphic information. Nine of these test holes would be drilled through the Mississippi alluvial deposits or fluvial deposits, through the Jackson and Cockfield Formations, and into the underlying Cook Mountain Formation. Two test holes would be drilled through the Mississippi alluvial deposits into the Jackson and Cockfield Formations, and one test hole would be drilled through the fluvial deposits into the Jackson and Cockfield Formations.

In drilling the test holes, samples of cuttings would be collected at 10-ft intervals and a driller's log would be kept for compiling detailed descriptive logs for each well. Geophysical logs--resistance, spontaneous potential, gamma-ray, and gamma-gamma--would be made to provide supplemental information on lithology and thickness of the aquifers and a graphical record of each well for compiling cross-sections, and so forth. The gamma-gamma log would provide information on bulk densities, which is important in the recognition of lignite beds. The resistance and gamma-ray logs along with sand samples would provide a basis on which to select screen intervals for observation wells.

Table 6 is a list of the proposed stratigraphic test holes, and figure 14 shows their tentative locations. Prediction of the total depth for each test hole is very approximate because of the limited information as to the depth to the base of the Jackson and Cockfield Formations and the lack of knowledge as to the land-surface altitudes at the final drilling sites.

Water-Level Trends and Configurations

The only water-level data available for the shallow aquifers in Lauderdale County are miscellaneous measurements made for previous studies by the Geological Survey and water levels reported on driller's records filed with the TDWR. Inasmuch as extensive areas would have to be dewatered in conjunction with any future strip-mining of lignite, baseline information is needed on water-level trends and configurations in the shallow aquifers--particularly in the Mississippi alluvial deposits and Jackson and Cockfield Formations.

It is proposed that the 12 test holes drilled for stratigraphic information be completed as observation wells--two in the Mississippi alluvial deposits, one in the fluvial deposits, and nine in the Jackson and Cockfield Formations. The observation wells would be cased from land surface down to the screen and would be screened in a suitable sand or sand and gravel in the selected aquifers. Shelters and digital records would be installed on five observations wells for the collection of continual records. The digital recorders would be geared to provide water levels on an hourly basis. Service of recorders and tape measurements would be at 4 to 6 week intervals, and the data would be processed using computer techniques. The observation wells without recorders would be sealed at their tops with provision made for making monthly tape measurements.

Table 6 gives the approximate depth of the proposed observation wells, and figure 14 shows their tentative locations. The depths given are very approximate because of the lack of stratigraphic information to be provided by the test holes. Many of the observation wells possibly could be completed at shallower depths than those indicated. The site of well 9 would be located adjacent to an observation well in the Jackson and Cockfield Formations, but its final location may depend on the drilling of several test holes in the Coastal Plain to find satisfactory sand and gravel in which to screen an observation well in the fluvial deposits. Well 8 would be located adjacent to the existing observation well in the Memphis Sand at the Fort Pillow State Historic Area.

A recorder would be installed on well 2 to determine water-level trends in the Mississippi alluvial deposits and any water-level response to changes in stage on the Mississippi River. Recorders would be

Table 6.--Proposed stratigraphic test holes and observation wells in Lauderdale County
(See figure 14 for locations)

Well number	7.5-minute topographic quadrangle	Tentative location	Approximate altitude (ft above mean sea level)	Estimated depth of stratigraphic test hole[1] (ft)	Estimated depth of observation well[2] (ft)	Aquifer for observation well completion[3]
1	Chic	near Hales Point	260	450	400	Tjc
2	Knob Creek	W. of Knob Creek	250	100	70	Qal
3	Fowlkes	near Poplar Grove	390	500	470	Tjc
4	Rosa	near Ashport	250	350	320	Tjc
5	Ripley North	near Central	490	550	500	Tjc
6	Chestnut Bluff	E. of Gates	280	220	150	Tjc
7	Golddust	S. of Ashport	250	120	80	Qal
8	Golddust	Ft. Pillow State Historic Area	440	420	370	Tjc
9	Ft. Pillow	near Glimp	380	100	90	QTf
10	Ft. Pillow	near Glimp	380	370	350	Tjc
11	Ripley South	SE of Henning	310	200	180	Tjc
12	Durhamville	E. of Ripley	470	400	370	Tjc

[1] Estimated total footage of stratigraphic test holes is 3,780 ft.
[2] Estimated total footage of cased and screened observation wells is 3,350 ft.
[3] Qal - Missississi alluvial deposits, QTf - Fluvial deposits, Tjc - Jackson and Cockfield Formations.

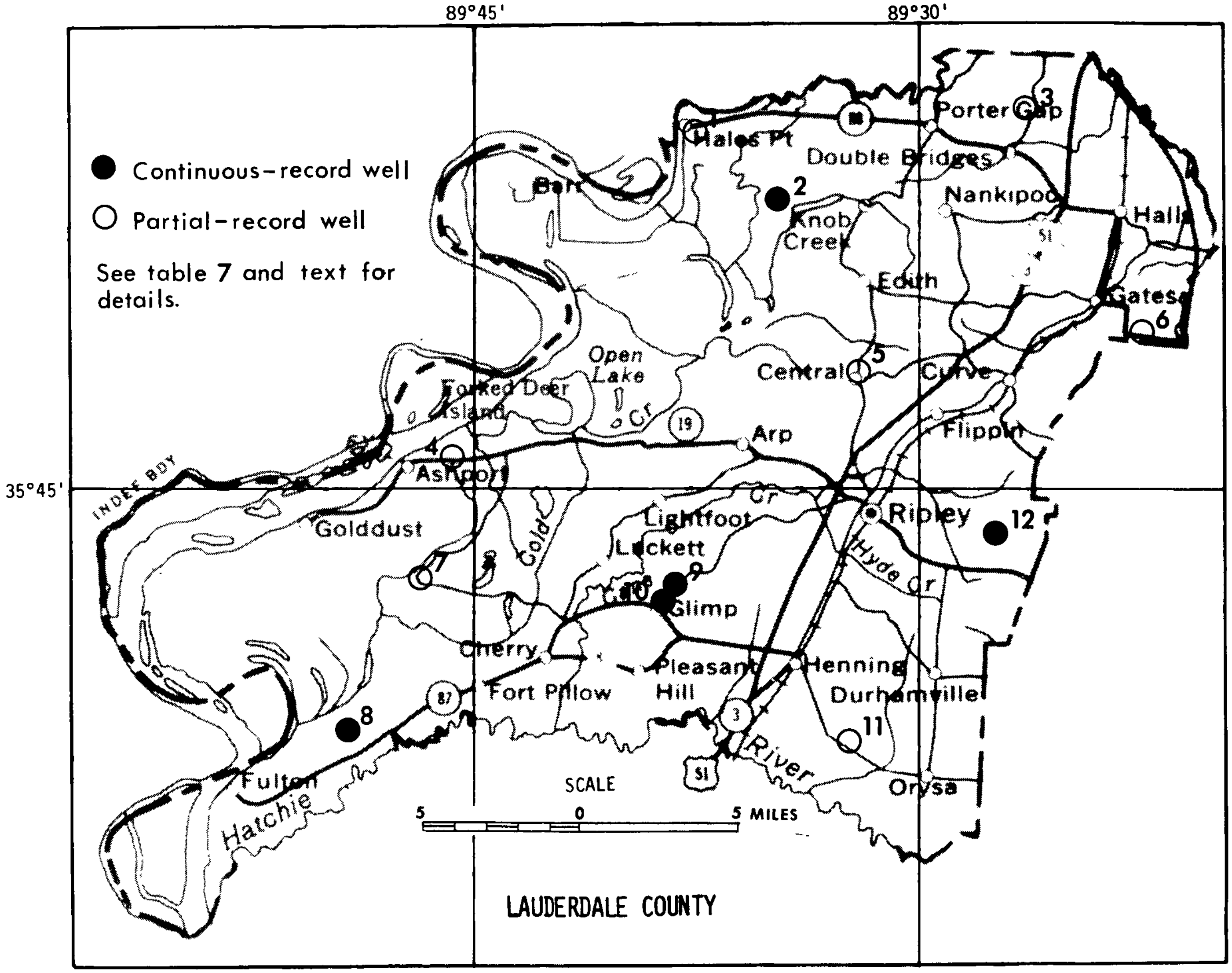


Figure 14.--Tentative locations of proposed stratigraphic test holes and observation wells.

installed on wells 9 and 10 (tentative companion well, see above) to determine water-level trends in the fluvial deposits and Jackson and Cockfield Formations, and to provide a basis of comparison of water levels in these two aquifers. A recorder would be installed on well 8 for a basis of comparison of the water levels in the Jackson and Cockfield Formations and those in the Memphis Sand and to determine any water-level response in the Jackson and Cockfield Formations to changes in stage on the Mississippi River. A recorder would be installed on well 12 to detemine water-level trends in the Jackson and Cockfield Formations in an area away from pumping and the Mississippi River.

Optional work proposed is the making of water-level measurements in observation wells and selected water wells at times of high and low water levels for the purpose of drawing potentiometric-surface maps of the Mississippi alluvial deposits and the Jackson and Cockfield Formations. Success of this work would depend on the cooperation of well owners and accessibility into the well casing for taping water levels.

Aquifer Characteristics

Aquifer-test results are available for only one well in the Jackson and Cockfield Formations at the U.S. Military Reservation near Halls. Values for transmissivity and storage for this aquifer were determined from this test. Determination of the aquifer characteristics of the shallow aquifers is needed for predicting the effects of dewatering on water levels in the aquifers and for calculating the rate of movement of contaminants from any future strip-mining activity.

It is proposed that single-well pumping tests be performed in each of the 12 wells completed as observation wells to obtain values of transmissivity. To perform these tests, the observation wells would have to be properly constructed and developed to give reliable pump-test results. The wells would have to be at least 6 in. in diameter to allow the installation of a portable pump capable of pumping at least 100 gal/min. The screens would have to be about 20 ft in length, depending on the slot size selected to screen a particular sand. Residual drilling mud would have to be pumped from the well and flushed from the formation surrounding the screen by using well development techniques. The portable pump would be installed and pumped at a constant rate for a period of no less than 4 hours. A provision would have to be made for measuring water levels with the pump installed. Recovery data is important in single-well pumping tests so the necessary water-level measurements would have to be made during the pumping period and also during the recovery period.

To obtain values of coefficient of storage, small diameter offset wells would have to be drilled at specified distances from the pumped wells for additional water level measurements. It is proposed that, if undertaken, this work would be limited to about three of the sites with observation wells in the Jackson and Cockfield Formations. These offset wells also would have to be cased and screened in the sand to be pumped. Data for proposed offset wells is not included in table 6.

Additional data on the hydrologic characteristics of the aquifers and their confining beds could be derived by monitoring water levels in both wells during pumping tests at sites where two wells are screened in different aquifers.

Ground-water Quality

Available analyses of ground water from wells in Lauderdale County include 12 samples from the shallow aquifers--six from the Mississippi alluvial deposits, two from the fluvial deposits, and four from the Jackson and Cockfield Formations (table 4). These analyses were made between 1929 and 1956.

Ground-water quality changes little with time except in heavily pumped areas where water of different quality may enter as replenishment of water removed. Nevertheless, monitoring changes in ground-water quality is essential in determining the effects of any future strip-mining activity, particularly where extensive areas are to be dewatered. Additional baseline information is needed on the quality of ground water from the shallow aquifers, using modern methods of sampling and analytical procedures and including data on trace metals and organic compounds.

It is proposed that the 12 wells completed as observation wells be sampled for water quality near the conclusion of each pumping test. The water samples would be collected using Geological Survey procedures and analyzed in the Survey's laboratories. Water-quality paramaters to be determined are listed below:

Field measurements of water-quality parameters:

Water temperature
Specific conductance
pH
Alkalinity

Laboratory analyses of dissolved major constitutents:

Calcium (Ca)	Manganese (Mn)
Magnesium (Mg)	Chloride (Cl)
Sodium (Na)	Fluoride (F)
Potassium (K)	Silica (SiO_2)
Iron (Fe)	Sulfate (SO_4)

Nitrite (NO_2) plus Nitrate (NO_3), dissolved as N
Dissolved solids, residue on evaporation at 180°C
Total organic carbon (TOC)
Phosphorus dissolved as P

Laboratory analyses of dissolved minor elements:

Arsenic (As)	Lead (Pb)
Cadmium (Cd)	Mercury (Hg)
Chromium (Cr)	Selenium (Se)
Copper (Cu)	Zinc (Zn)

It also is proposed that two wells--well 7 in the Mississippi alluvial deposits and well 5 in the Jackson and Cockfield Formations (table 6)--be completed with pumps for the collection of monthly water samples for a period of one year to determine whether short-term changes in ground-water quality occur. After the first year these wells would be sampled twice-a-year, at times of low and high water levels to determine long-term changes in water quality. In installing pumps, provision would be needed to allow monthly tape measurements in these wells. The water samples would be analyzed according to the above ground-water parameters.

Surface-water Information

Strip-mining lignite in Lauderdale County could cause significant changes in the surface-water system in those basins in which mining occurs. Therefore, baseline information is needed on the stream-flow characteristics and surface-water quality of the major streams that drain the county. Rainfall data is also needed in determining rainfall-runoff relationships.

Stream-flow Characteristics

Except for data for the discontinued gaging station on Cane Creek at Ripley and some discharge measurements at miscellaneous sites, little surface-water information is being collected for the streams that drain the county. Speer and others (1965, table 2) gave the low-flow characteristics for Cane Creek at Ripley, Cane Creek near Cherry, and Cold Creek at Arp (table 5). Since the gaging station on Cane Creek at Ripley was discontinued, changes in the stream-flow characteristics have occurred as a result of the U.S. Soil Conservation Service's project to reduce floodwater and sediment damage. Presently, the only stream-flow data being collected for the tributary streams are once-a-year low-flow measurements on Cane Creek near Cherry.

It is proposed that 13 partial-record and 4 continuous-record gaging stations be established at 17 sites--12 in the Coastal Plain and 5 in the Mississippi Alluvial Plain--to provide data on the stream-flow characteristics of the major streams. At the partial-record stations, discharge measurements would be made three times a year at low, medium, and high flows. The continuous-record gaging stations would be equipped with shelters, bubble gages, and digital recorders geared to provide stage at 5-minute intervals. These stations, located on selected streams of different basin sizes and topographical characteristics, would provide the information needed for correlation and rating of the partial-record stations. Servicing of recorders would be monthly at which times discharge measurements would be made. Additional discharge measurements would be made at low, medium, and high flows. The data from the digital recorders would be processed using computer techniques.

Table 7 lists the proposed partial-record and continuous-record gaging stations, and figure 15 shows their tentative locations. The sites proposed were selected from 7.5-minute topographic quadrangles and must be evaluated as to suitability by field investigation.

Table 7.--Proposed stream-flow gaging stations and surface-water data collection sites in Lauderdale County
[See figure 15 for locations]

Site number	7.5-minute topographic quadrangle	Tentative location	Proposed data collection activities[1]
		Drainage to Mississippi River	
1	Knob Creek	Old Bed Forked Deer River near Knob Creek	PR, QW, S
2	Knob Creek	Knob Creek at Knob Creek	PR, QW, S
3	Ripley North	Cold Creek (north) near Arp	CR, QW, S, RG
4	Open Lake	Middle Fork Forked Deer River near Arp	PR, QW, S
5	Ft. Pillow	Cold Creek (south) near Olive Branch	PR, QW, S
6	Golddust	Jones Bayou near Golddust	PR, QW, S
7	Golddust	Cold Creek (south) near Fulton	PR, QW, S
		Drainage to Hatchie River	
8	Ripley North	Cane Creek at Ripley (north)	PR, QW, S
9	Ripley South	Hyde Creek at Ripley	PR, QW, S
10	Ripley North	Cane Creek near Ripley (west)	PR, QW, S
11	Ft. Pillow	Cane Creek near Cherry	CR, QW, S, RG
12	Ft. Pillow	Cooper Springs Creek near Pleasant Hill	PR, QW, S
13	Ripley South	Hatchie tributary near Henning	PR, QW, S
14	Gift	Hatchie tributary near Orysa	PR, QW, S
15	Turnpike	Camp Creek at Orysa	CR, QW, S RG
		Drainage to South Fork Forked Deer River	
16	Fowlkes	Mill Creek near Halls	PR, QW, S
17	Chestnut Bluff	Halls Creek near Chestnut Bluff	CR, QW, S, RG

[1] PR - partial-record station, CR - continuous-record station, QW - quality of water sample, S - sediment sample, RG - rainfall gage.

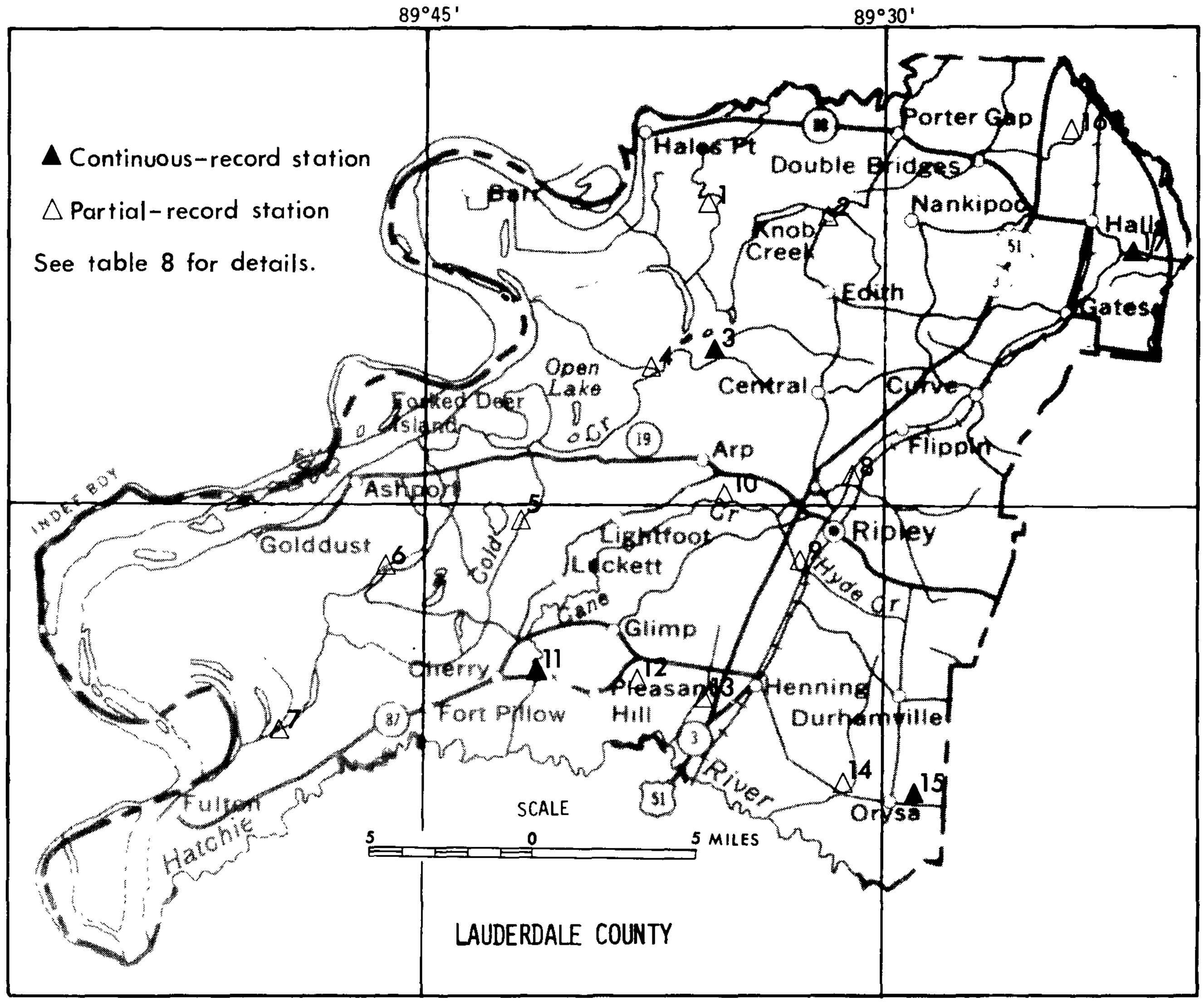


Figure 15.--Tentative locations of proposed stream-flow gaging stations and surface-water data collection sites.

Surface-Water Quality

Very limited data are available concerning the surface-water quality in Lauderdale County. A few measurements of water temperature and specific conductance have been made in conjunction with discharge measurements on Cane Creek at Ripley and Cane Creek at Cherry. Table 8 gives sediment data collected for the Hatchie River at Rialto.

Surface-water quality changes with time in relation to amount of discharge, season of the year, and man-made changes in the basin, and data must be collected over a period of time to establish water-quality characteristics of a particular stream. Any future strip-mining of lignite would affect the surface-water quality in those basins where mining takes place. Therefore, it is essential to collect baseline information on surface-water quality of the major streams that drain the county before mining begins.

It is proposed that water-quality parameters be measured at each of the 17 partial or continuous-record stations. The parameters that would be measured are basically those selected as mandatory or suggested for the Geological Survey's coal hydrology program in support of Public Law 95-87 (F. A. Kilpatrick, written commun., 1979). At each station a discharge measurement and water sample for on site and laboratory analysis would be collected at low, medium, and high flows each year. Bed material samples for particle size analysis would also be taken during these low, medium, and high flows. These particle size analyses would be used in conjunction with hydraulic data to compute bed-load transport rates.

The bed material samples taken at all stations once-a year during low flow would also be analyzed for minor elements. In addition, water samples would be taken at continuous record stations once-a-year during low flow for analyses of common constituents and minor elements. Water-quality parameters to be determined are listed below.

Water quality of surface-water for partial and continuous-record stations, measured on site three times a year at low, medium, and high flows:

- Discharge
- Water temperature
- Specific conductance
- pH
- Alkalinity
- Macro-invertebrates (presence or absence at low flow)

Laboratory analyses of water quality for partial- and continuous-record stations, sampled three times a year at low, medium, and high flows·

Table 8.--Sediment data collected for the Hatchie River at Rialto
[Station number 07030050]

Date	Time	Instantaneous discharge (ft^3/s)	Specific conductance (micromhos)	Temperature (°C)	Suspended sediment (mg/L)	Suspended sediment discharge (tons/d)	Suspended sediment sieve diameter percent finer than .062 mm
Feb. 10, 1977	1300	1,620	85	8.0	38	166	--
Mar. 7, 1977	1300	8,100	40	13.5	222	4,860	--
Mar. 8, 1977	1200	10,360	55	12.0	164	4,590	--
Mar. 10, 1977	1100	20,160	58	12.0	103	5,610	--
Aug. 10, 1977	0945	5,680	38	18.0	3,000	46,000	81
Sep. 12, 1977	1000	452	65	25.0	289	353	--
Sep. 25, 1977	1100	1,990	60	21.0	277	1,490	95
Sep. 26, 1977	1030	--	59	22.0	619	--	93
Sep. 26, 1977	1900	2,530	54	23.0	2,100	14,400	61
Sep. 27, 1977	0100	--	80	23.0	2,220	--	98
Sep. 27, 1977	1030	--	57	22.0	1,260	--	95
Sep. 27, 1977	1730	2,810	52	24.0	1,360	10,300	92
Sep. 28, 1977	0230	2,840	53	22.0	1,120	8,560	85
Sep. 28, 1977	1030	2,840	53	21.0	1,830	14,000	96
Sep. 28, 1977	1730	2,930	--	23.0	1,820	14,400	86
Sep. 30, 1977	1415	2,860	--	22.0	1,080	8,370	90
May 3, 1978	1145	2,930	60	15.5	501	3,960	96
May 3, 1978	1700	3,000	60	16.5	428	3,470	99
May 4, 1978	1230	3,360	60	15.5	320	2,900	98
May 5, 1978	1100	3,590	65	15.0	407	3,950	98

Sulfate (SO_4)
Iron (Fe, total and dissolved)
Manganese (Mn, total and dissolved)
Acidity (when field pH less than 4.5)
Suspended sediment (concentration and sand-silt split)
Dissolved solids, residue on evaporation at 180°C

Laboratory analyses of bed materials for partial- and continuous-record stations, sampled annually at low flow:

Arsenic (As)	Lead (Pb)
Cadmium (Cd)	Manganese (Mn)
Chromium (Cr)	Mercury (Hg)
Copper (Cu)	Selenium (Se)
Iron (Fe)	Zinc (Zn)

Laboratory analyses of water quality for continuous-record stations, sampled annually at low flow:

Common constituents (dissolved)

Calcium (Ca)	Manganese (Mn)
Chloride (Cl)	Potassium (K)
Fluoride (F)	Silica (SiO_2)
Iron (Fe)	Sodium (Na)
Magnesium (Mg)	Sulfate (SO_4)

Dissolved solids, residue on evaporation at 180°C
Alkalinity, as dissolved $CaCO_3$
Phosphorus, dissolved as P
Nitrite (NO_2) plus Nitrate (NO_3), dissolved as N

Minor elements

Arsenic (As)	Lead (Pb)
Cadmium (Cd)	Mercury (Hg)
Chromium (Cr)	Selenium (Se)
Copper (Cu)	Zinc (Zn)

Rainfall-Runoff Relations

Daily rainfall data are available for Lauderdale County from NOAA's weather station at Ripley. However, detailed rainfall data for individual storms is needed in determining the general rainfall-runoff relations for basins of different sizes and topographical characteristics.

It is proposed that recording rainfall gages be established at each of the four continuous-record gaging stations. Shelters, rainfall gages, and digital recorders would be installed with the digital recorders geared to record rainfall at 5-minute intervals. Servicing of recorders would be conducted monthly along with the recorders on the stream-flow gages. The data from the digital recorders would be processed using computer techniques.

PLANS TO MONITOR STRIP-MINING OF LIGNITE

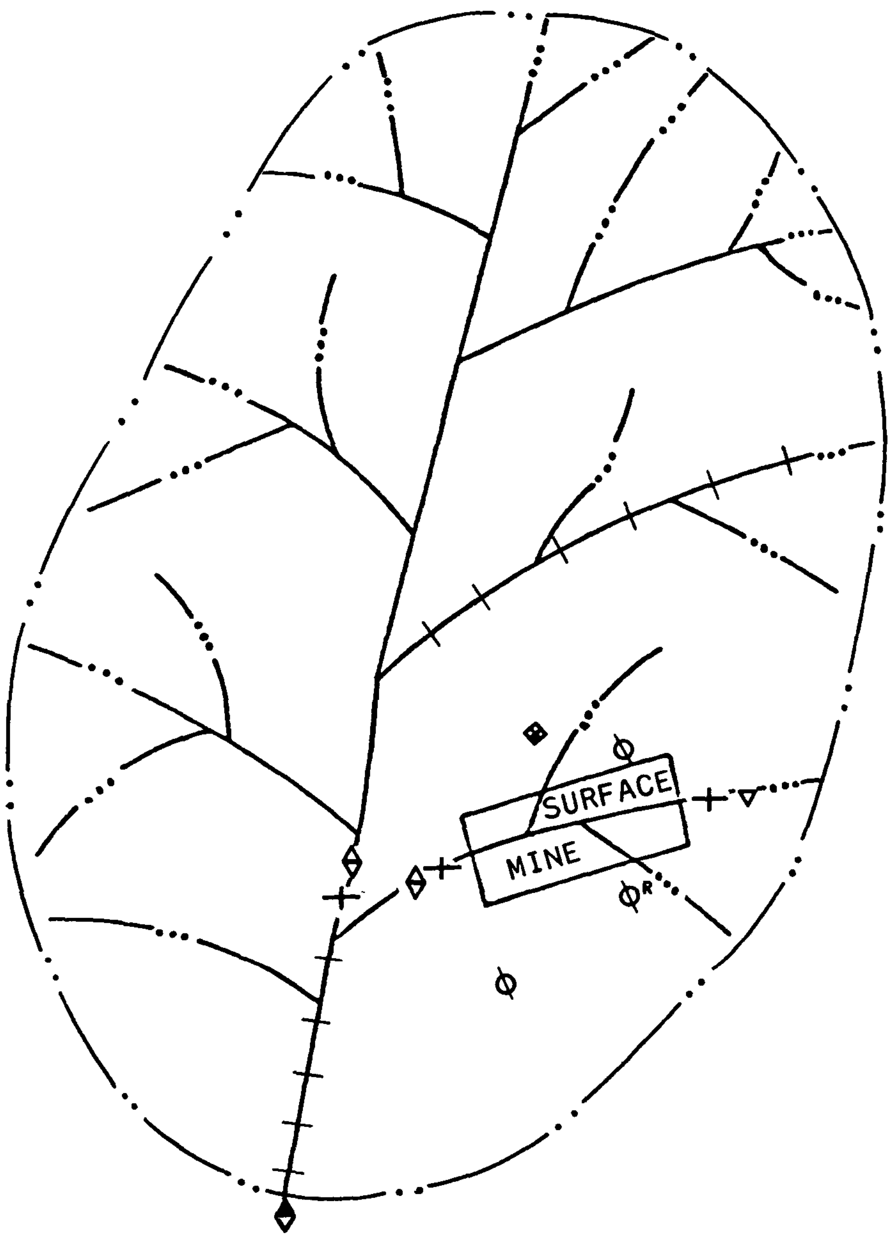
Collection of Mine-Site Data

At the time an announcement is made that a strip mine for lignite is to be opened, a plan should be ready for collection of mine-site data so that premining, mining, and postmining hydrologic conditions can be determined for the basin(s) in which mining will take place. This plan would need to be implemented soon after an announcement so that baseline information could be collected prior to the clearing of land, disturbance of the land surface, and dewatering of aquifers. Monitoring the effects of mining would be for the duration of the mining activity and extend beyond reclamation to determine any delayed or lasting effects on the hydraulic system.

Figure 16 is a schematic diagram of a generalized basin with surface mine and proposed sites for hydrologic monitoring (Dalsin, 1979, fig 8). Not knowing the location of any future strip mine, this plan would need to be modified to take into account local hydrologic conditions of the particular basins(s) in which mining will take place. For example, monitoring hydrologic conditions in the Mississippi Alluvial Plain may require a somewhat different approach than monitoring those in the Coastal Plain.

Basically, the plan for collection of ground-water data would consist of the installation of six observation wells--two wells in three sets with wells in each set in two different aquifers. A minimum of three observation wells per aquifer would be needed to determine changes in the gradient of ground-water movement. In the Coastal Plain, one well in each set would be in the fluvial deposits and the other would be in the Jackson and Cockfield Formations, and in the Mississippi Alluvial Plain one well would be in the Mississippi alluvial deposits and the other would be in the Jackson and Cockfield Formations.

These observation wells would be drilled to meet the specifications proposed elsewhere in this report for construction of observation wells for baseline information. In brief, formation samples would be taken at 10-ft intervals during drilling; geophysical logs would be run in the uncased boreholes; single-well pumping tests would be conducted in the cased wells; and water samples would be collected near the conclusion of the pumping tests for ground-water quality determinations. The ground-water-quality parameters would be the same as those listed on page 52 for baseline information. Digital recorders would be installed on one set of wells for the collection of continuous water level data, and provision would be made for periodic taping of water levels in the other two sets of wells. After initial sampling for ground-water quality, additional samples would be collected for analysis twice-a-year at times of high and low water levels.



EXPLANATION

▲ Continuous streamflow gaging station
Observation well set
Observation well set equipped with recorders
▼ Water-quality monitor and sediment sampler
Water-quality survey and seepage measurement site
Channel cross-section survey
Rain gage
Drainage basin boundary

Figure 16.--Generalized drainage basin with surface mine and proposed sites for hydrologic monitoring (from Dalsin, 1979, fig. 8).

The plan for collection of surface-water data would consist of the installation at two outflow sites downstream from the strip mine of: (1) a continuous-record stream-flow gaging station, (2) a surface-water quality monitor, and (3) an automatic suspended-sediment sampler. A recording rain gage also would be installed near the mine site. The continuous-record gaging stations would be equipped with digital recorders and bubble gages, and discharge measurements would be made monthly. The surface-water quality monitors would be equipped to measure temperature, specific conductance, pH, and dissolved oxygen on a continuous basis. Additional water-quality parameters would be determined for these sites in accordance with those listed on pages 56 and 58 for continuous-record gaging stations. The automatic samplers for suspended sediment would sample twice daily and more frequently during rainfalls. Photographs of the channel and cross-section measurements would be made at the gaging station reach to record changes in channel degradation or siltation.

Other data collection activities would include surface-water quality surveys, seepage measurements, and monumented channel cross-section surveys conducted upstream and downstream from the mine site. The surface-water quality surveys would be conducted monthly, and the parameters determined would be those listed for partial record gaging stations listed on pages 56 and 58. Seepage measurements and channel cross-section surveys would be conducted annually at low flow.

Application of Computer Modeling Techniques

After several years of baseline data collection in accordance with the plan proposed in this report, sufficient data would be available for the application of computer modeling techniques. Computer modeling of the ground-water and surface-water systems would be a highly desirable tool for analyzing and interpreting large amounts of data and in predicting the effects of mining on the hydrologic system. The Geological Survey has developed several digital models that would be adaptable for this purpose. Because of the sophistication of computer modeling, a detailed proposal would be needed for this activity, which is beyond the scope of this project.

SUMMARY OF PLAN TO STUDY HYDROLOGY

Although some information is available on the geology and hydrology of Lauderdale County, much additional information is needed to define the hydrologic system before mining begins, and a plan is needed to monitor the effects of mining on the hydrologic system once it is begun. For general geologic information, it is proposed that geologic maps be prepared for the Coastal Plain areas of the county on either 7.5- or 15-minute topographic quandrangles.

For ground water, information is needed on the location of existing water wells, subsurface stratigraphy, water-level trends and configurations, aquifer characteristics, and ground-water quality of the shallow aquifers--Mississippi alluvial deposits, fluvial deposits, and Jackson and

Cockfield Formations. These shallow aquifers, which provide water to the mejority of wells in the county and supply the largest variety of uses, would be the most affected by strip-mining and dewatering activities. The Jackson and Cockfield Formations are by far the most extensively used of the shallow aquifers.

It is proposed that a comprehensive water-well inventory be made for the county and that 12 test holes be drilled for stratigraphic information. The stratigraphic information would include the variability of the lithology and thickness of the shallow aquifers and the depth to the base and occurence of lignite in the Jackson and Cockfield Formations. The 12 stratigraphic test holes would be completed as observation wells--two in the Mississippi alluvial deposits, one in the fluvial deposits, and nine in the Jackson and Cockfield Formations. Single-well pumping tests would be conducted to determine values of transmissivity. Near the conclusion of the pumping tests, water samples would be collected for determination of ground-water quality, including common constituents and minor elements. Recorders would be installed on five observation wells for the collection of continual water-level data for the shallow aquifers, and the other wells would be tape measured monthly. Two wells--one in the Mississippi alluvial deposits and the other in the Jackson and Cockfield Formations--would be sampled monthly for one year to provide data on short-term changes in ground-water quality. After the first year, these well would be sampled twice-a-year at times of low and high water levels to determine long-term changes in ground-water quality. Optional work proposed includes the drilling of offset wells near some observation wells for measuring water levels during pumping tests to determine values of coefficient of storage. Also optional would be the twice-a-year measurement of water levels in observation wells and selected water wells at times of high and low water levels for use in drawing potentiometric-surface maps for the Mississippi alluvial deposits and the Jackson and Cockfield Formations.

For surface-water, information is needed on the stream-flow characteristics, surface-water quality, and rainfall-runoff relations of the streams that drain the county. Strip-mining of lignite could cause significant changes in the surface-water system in those basins in which mining occurs. It is proposed that 13 partial-record and 4 continuous-record stream-flow gaging stations be established on the major streams that drain the county --12 in the Coastal Plain and 5 in the Mississippi Alluvial Plain. At partial-record stations, a discharge measurement would be made each year at low, medium, and high flows. At continuous-record stations, discharge measurements would be made monthly at the time recorders are serviced and also once-a-year at low, medium, and high flows. At all stations on site surface-water quality parameters would be measured and water samples for analysis of selected constituents and suspended sediment and bed material for particle-size analysis would be collected once-a-year at low, medium, and high flows when discharge measurements are made. Also at all stations, bed materials would be sampled once a year during low flow for analyses of minor elements. At continuous-record stations, water samples would be collected once-a-year during low flow for analyses of common constituents and minor elements. Rainfall gages would be installed near each continuous-record gaging station for the collection of continuous rainfall data.

A plan to monitor strip-mining of lignite would need to be implemented soon after the opening of a mine is announced so that local baseline information could be collected in advance of any effects on the hydrologic system. For ground water, additional observation wells would be installed near the mine site to monitor water levels in the aquifers affected. Single-well pumping tests would be conducted and water samples would be collected to provide additional information on values of transmissivity and ground-water quality. Recorders would be installed on a well in each aquifer affected, and periodic tape measurements would be made in the other wells. Pumps would be installed in wells down-gradient from the mine site for monitoring changes in ground-water quality. For surface water, a continuous-record stream-flow gaging station, a surface-water quality monitor, and a automatic suspended-sediment sampler would be installed at two sites downstream from the mine, and a recording rain gage would be installed near the mine site. Other data to be collected would be surface-water quality surveys, seepage measurements, and channel cross-section surveys with photographs upstream and downstream from the mine site.

After several years of baseline data collection, sufficient data would be available for application of computer modeling techniques. Computer modeling would be a highly desirable tool for analyzing and interpreting large amounts of data and in predicting the effects of strip-mining lignite on the hydrologic system.

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