Reference 7

Subsurface Disposal Corporation

5555 West Loop South, Suite 646 • Bellaire, Texas 77401 • (713) 666-8158 • Telex: 77-5907

22 September 1980

Mr. Thomas Thoms
Development Supervisor
P.O. Drawer 1937
Hattiesburg, MS 39401

Dear Tom:

I am enclosing the report of our investigation concerning a groundwater monitoring program at your plant. Thank you for the time extension you have afforded us in submitting the final report. We have been so busy this year that the extra time was much appreciated.

It was a real pleasure working with you during the study. If we can be of any further service, or if you have any questions, please don't hesitate to call.

Sincerely,

Larry Browning
Senior Hydrologist

LB/dr

Enclosure

1.0 PURPOSE AND SCOPE

The purpose of this report is to present the results of a preliminary hydrogeologic analysis of the Hercules Hattiesburg, Mississippi plant, for purposes of designing a groundwater monitoring system. The objects of this monitoring system are a process water pond located near the southeastern boundary of the plant, and a series of active and inactive sludge disposal pits located in the unused northwestern part of the plant (the "Back 40").

The data utilized in this study consisted of general geologic reports for the area, six electric logs run in water wells in the area, field observation, and two borings with related soil and groundwater sampling. Field testing was conducted between July 21-25, 1980.

2.0 STUDY AREA

The Hercules Hattiesburg, Mississippi plant is located at Highway 42 and Providence Street, within the city limits of Hattiesburg in Forrest County, Mississippi. The climate of the area is humid and subtropical. Average annual rainfall is approximately 64 inches. The study area lies in the East Gulf Coastal plain, within the drainage area of the Leaf River.

The rocks exposed at the surface at the plant site are a thin veneer of alluvial terrace sands and gravels of Eocene to recent age. Immediately underlying these terrace deposits is a sequence of clays, sands, and gravels known as the Miocene Hattiesburg formation (Figure 1). This formation dips regionally southward at from 20 to 25 feet per mile. Aerial photo interpretation does not reveal any significant fault expression near the plant site.

The primary drinking water aquifer in the area is a series of sands and gravels of Miocene age. This aquifer exists at a depth of approximately 400 feet at the plant site.

2.1 PROCESS WATER IMPOUNDING BASIN AND SLUDGE PITS

The process impounding basin is located near the eastern plant boundary on Providence street. The basin is approximately 250 feet by 70 feet. The pond was excavated in native clays to a depth of approximately 10 feet. The basin sides are lined with boards, diked, and bordered to the south by a runoff collection ditch. No evidence of seepage was observed. Sludge accumulation is approximately 8 cu. yards per day, which corresponds to 1 inch per week within the basin. The basin is periodically dredged, and the sludge is disposed of in a series of pits located in the "Back 40".

Fig. 1. Geohydrologic section (C-C') through the Hattiesburg area

The "Back 40" pits have been used for sludge disposal for at least 10 years. These beds vary in size. The largest pit is approximately 180' x 220', and the smallest is 80' x 140'. These pits were excavated by bulldozer into native clays to a depth of approximately 8 feet. The pits are diked on all sides with a combination of native clay and topsoil gravels. Four sludge pits are active, and consist of varying proportions of solidified black sludge, sludge liquors, and rainwater. One area of pits is inactive and covered by a cap of native clay.

This investigation was conducted during a period of higher than average rainfall. Some lowlying areas surrounding the active pits were marshy. Some leakage of pit contents was noticeable. This leakage was observed to result from both pit overflow and seepage at the dike toe.

Chemical analyses of impounding basin and sludge pit contents are presented in Appendix 1.

3.0 BORING PROGRAM

Two borings were completed at the plant site. One boring (B-1) was located at the southeast corner of the "Back 40" sludge pit area, and one boring was located across Providence Road, 100 feet east of the impounding basin. Drilling logs of these borings are presented in Appendix 2.

A generalized subsurface section of the soils beneath the plant site may be described as:

0-11	Sands and gravels, Fill
11-62	Very stiff blue clay
*62-69	Fine sands, coarse sand and gravel
*69-75	Stiff blue clay
75-102	Fine sands, coarse sand and gravel
102-Termination	Hard brown clay.

*Thickness varies.

The results of laboratory soil tests are presented in Appendix 2.

3.1 DISCUSSION

Borings B-1 and B-2, although located approximately one mile apart, exhibited very similar lithologies. This stratigraphic consistency is described in several soil and groundwater reports completed in the study area. Several points should be noted.

A. A thin veneer (approximately 10 feet) of fill and alluvial terrace deposits was noted in each boring. These sands, although relatively permeable, were not saturated at the time the wells were drilled. The thickness of the surficial deposits is highly variable at other locations within the Plant, ranging from 0 to 12 feet. The boring sites were located down-slope topographically from each facility. The thickness of the surficial deposits was observed to be less than 6 feet immediately surrounding both facilities.

B. At least 50 feet of relatively homogeneous, very dense blue clay underlies the area. Laboratory testing indicates the permeability of this clay to be at least 1.9×10^{-7} cm/sec. One in-place falling head permeability test of this clay was attempted in Boring B-2, but was discontinued after no inflow was determined after eight (8) hours. Furthermore, the upper 30 feet of this clay unit was unsaturated.

C. The lower sand and gravel units were observed to be very permeable, and correspond closely to established models of alluvial point-bar deposits. These deposits terminated unconformably upon a dense brown clay.

4.0 MONITORING WELLS

Borings B-1 and B-2 were completed as permanent monitoring wells. Two-inch schedule 40 PVC casing and #10 well screen were run to T.D. Bentonite clay pellets and portland cement were used to seal the wells according to EPA specification. The wells were pumped using a one-inch PVC air lift line and a portable air compressor. Both wells were pumped for four (4) hours prior to sampling. Results of chemical analyses and water level observation are presented in Table 1.

4.1 DISCUSSION

A. The sand and gravel zones below 62 feet constitute the first saturated "aquifer" to be encountered beneath each hazardous waste facility. These were the zones chosen for monitoring.

B. The permeability of the finest sand zones encountered was tested as 4.2×10^{-6} cm/sec. The permeability of the coarsest basal gravels is estimated to be at least 1×10^{-3} cm/sec. These extremes of permeability would correspond to a rate of water movement of from .03 to 4 feet/yr, under the observed hydraulic gradient.

C. Based on preliminary data, the hydraulic gradient of this zone is observed to generally correspond to the predicted dip of the aquifers. The general hydraulic gradient is from B-1 towards B-2, that is, from northwest to southeast. Supplementary data is necessary to determine the absolute direction and amount of gradient. The monitoring wells were sited generally downgradient of the subject facilities, and were observed to provide representative samples of formation water.

GW Flow NW to S

D. No evidence of groundwater contamination due to facility leakage was discovered in samples from the monitoring wells. Total Organic Carbon values are consistent with those encountered in shallow ground water of alluvial origin. Analysis for DELNAV (a Hercules product) was chosen as an indicator of organic contamination, as it is the chief organic constituent of facility contents and indicative of a wide range of organic species. All DELNAV analyses were below the limit of detection (1 part per billion).

5.0 REGULATORY REQUIREMENTS

The contents of both the impounding basin and "Back 40" sludge pits will be classified as hazardous waste under provisions of the Resource Conservation and Recovery Act (RCRA). RCRA also requires that a hydrologic assessment be made of each hazardous waste facility to determine the potential of each facility to contaminate ground water. A system of monitoring wells may be required for each facility. Details of these requirements are presented in Appendix 3.

6.0 CONCLUSIONS

Conclusions

A. The subject hazardous waste facilities have been in operation for over 10 years. No evidence of groundwater contamination was discovered.

B. The subject facilities are excavated into native clays of extremely low permeability. The pond bottoms are separated from the uppermost fresh water aquifers by over 50 feet of dense, very homogeneous, unsaturated clay of very low permeability. Electric logs of water wells indicate that this clay can be correllated throughout the study area. From a practical perspective, it is impossible for pond contents to migrate vertically through this clay and contaminate the uppermost fresh water aquifer.

C. Preliminary studies have shown that no water wells are completed in the uppermost aquifer within at least one (1) mile of the facilities. Drinking water supplies in the area are taken from aquifers at least 300 foot deep.

Recommend

7.0 RECOMMENDATIONS

A. Field observation and testing have demonstrated an extremely remote potential for contamination of the uppermost aquifer by leakage of the contents of the subject facility. As provided in Section 265.90 (c) of RCRA, we recommend that these facilities be exempted from the groundwater monitoring requirements.

B. Surficial terrace deposits and fill material exist near each facility to some depth below land surface. These deposits were not found to be saturated at the time of this investigation and, as such, are neither considered "aquifers" nor subject to monitoring within the framework of RCRA. However, these deposits could conceivably transmit leakage from the facilities as a "perche water table atop the dense clay described previously. This leakage would not pose any threat to the uppermost aquifer, but might run off laterally to ditches or streams. Therefore, we recommend that a series of dry auger borings to a depth of 12 feet be sited around each facility. These borings should be observed to determine if these soils are saturated. The boring may then be screened so as to intercept any shallow leakage, and sized to accept a bailer.

C. The sludge pits on the "Back 40" which are no longer used should be closed out. This closure would consist of a sloped native clay cap. This closure would not only prevent any future leaking of the contents, but also would eliminate any odor problem.

D. We recommend that an improved "housekeeping" program be instituted for the "Back 40". Better maintenance of dikes and periodic drainage of rainwater and sludge liquors from the pits would eliminate the hazard of surface contamination.

E. Details of construction of the present "Back 40" pits are not available. In the future, optimum construction techniques would allow for lining and compacting the pit sides and bottom with native clays. In light of better maintenance, optimum construction techniques for new pits, and correct closure of inactive pits, we can recommend the continued usage of the "Back 40" area for sludge disposal.

I certify that all of the data, conclusions, and recommendations contained in this report are true and correct, and represent an analysis based on sound engineering principles.

Lawrence A. Browning

Lawrence A. Browning
Senior Hydrologist

APPENDIX 1

TAPLE 2

METALS CONCENTRATION (PPM)

Type Metal	Water Extract mg/1	Extract Limit mg/1	Extracted Ash ppm	Original ASH ppm	% Extracted
Arsenic	0.008	0.500	0.011	0.170	93.6
Barium	0.860	10.000	2.130	19.330	89.0
Cadium	0.019	0.100	0.062	0.440	86.0
Chromium	0.044	0.500	0.108	0.990	89.1
Lead	0.083	0.500	0.159	1.820	91.2
Mercury	0.000	0.020	0.003	0.003	0.0
Selenium	0.006	0.100	0.039	0.160	75.5
Silver	0.000	0.500	0.000	0.000	-
Nickel	0.121	-	0.378	2.800	86.5
Aluminum	0.134	-	0.457	3.140	85.4
Zinc	0.208	- 50 mg/l	0.688	4.850	85.8
Copper	0.164	- 10 mg/l	0.219	3.500	93.7
Iron	1.392	- 3 mg/l	1.753	29.590	94.1

WHERE

Water extract = heavy metals concentration in the actual water extract from the sample being analyzed.

Extract limit = the maximum heavy metals concentration which if exceed in the water extract would define the sample as being a hazardous waste under toxic waste characteristics.

Extracted Ash = heavy metals concentration left in the sample after extraction.

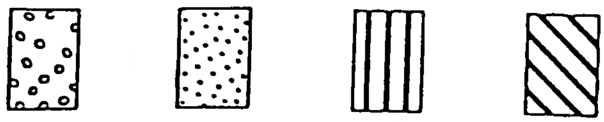
Original ash = heavy metals concentration is the ashed sample. This was calculated based on the amount of water and sample used during extraction and the amount of heavy metals left in the extracted ash sample.

% Extracted = percent heavy metals extracted based on the above data.

APPENDIX 2

SYMBOLS AND TERMS USED ON BORING LOGS

SOIL TYPES
(SHOWN IN SYMBOL COLUMN)



Gravel — Sand — Silt — Clay

Predominant type shown heavy.

SAMPLER TYPES
(SHOWN IN SAMPLES COLUMN)

Shelby Tube — Pit Cutings — Split Spoon — No Recovery

TERMS DESCRIBING CONSISTENCY OR CONDITION

COARSE GRAINED SOILS (major portion retained on No. 200 sieve): Includes (1) clean gravels and sands, and (2) silty or clayey gravels and sands. Condition is rated according to relative density, as determined by laboratory tests.

DESCRIPTIVE TERM	RELATIVE DENSITY
Loose	0 to 40%
Medium dense	40 to 70%
Dense	70 to 100%

FINE GRAINED SOILS (major portion passing No. 200 sieve): Includes (1) inorganic and organic silts and clays, (2) gravelly, sandy, or silty clays, and (3) clayey silts. Consistency is rated according to shearing strength, as indicated by penetrometer readings or by unconfined compression tests.

DESCRIPTIVE TERM	UNCONFINED COMPRESSIVE STRENGTH TON/SQ FT
Very soft	less than 0.25
Soft	0.25 to 0.50
Firm	0.50 to 1.00
Stiff	1.00 to 2.00
Very stiff	2.00 to 4.00
Hard	4.00 and higher

Note: Slickensided and fissured clays may have lower unconfined compressive strengths than shown above, because of planes of weakness or cracks in the soil. The consistency ratings of such soils are based on penetrometer readings.

TERMS CHARACTERIZING SOIL STRUCTURE

Slickensided	– having inclined planes of weakness that are slick and glossy in appearance.
Fissured	– containing shrinkage cracks, frequently filled with fine sand or silt; usually more or less vertical.
Laminated	– composed of thin layers of varying color and texture.
Interbedded	– composed of alternate layers of different soil types.
Calcareous	– containing appreciable quantities of calcium carbonate.
Well graded	– having wide range in grain sizes and substantial amounts of all intermediate particle sizes.
Poorly graded	– predominantly of one grain size, or having a range of sizes with some intermediate size missing.

Terms used in this report for describing soils according to their texture or grain size distribution are in accordance with the UNIFIED SOIL CLASSIFICATION SYSTEM, as described in Technical Memorandum No 3-357, Waterways Experiment Station, March 1953

LOG OF BORING NO. 1
HERCULES POWDER COMPANY
HATTIESBURG, MISSISSIPPI

TYPE: 3" Shelby tube & 2" split-spoon   LOCATION: As directed by Larry Browning

SURFACE EL.: Not known

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT LB/CU FT	COHESION, KIP/SQ FT (1, 2, 3, 4) / PLASTIC LIMIT – WATER CONTENT, % – LIQUID LIMIT (20, 40, 60, 80)	ELEVATION, FT
0–4	Medium dense light gray clayey fine sand	13			
4–10	Dense light gray fine to medium sand with coarse sand and gravel	62 33			
10–23	Hard gray and greenish clay, slightly silty -blue, slightly sandy below 18'				
23–36	Hard blue silty clay with silty fine sand laminations and seams				
36–	Hard blue clay -blue and brown below 43' -slightly sandy below 53'				

(continued next page)

LOG OF BORING NO. 1

(Continued)

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT LB/CU FT	COHESION, KIP/SQ FT (1, 2, 3, 4) / PLASTIC LIMIT, WATER CONTENT, %, LIQUID LIMIT (20, 40, 60, 80)	ELEVATION, FT
			Hard blue clay (continued)				
60			Hard blue very sandy clay with fine sand seams				
65			Dense blue clayey fine sand				
70			Hard blue clay, slightly sandy				
75 – 90			Dense blue silty fine sand -hard sandy clay layer 77'-80' -coarse sand and fine gravel seam at 87'	40 35		Note: A well screen was set in this stratum from 73' to 76'	
95 – 100			Dense coarse sand and gravel -large gravel below 96'			Note: A well screen was set in this stratum from 93' to 96' and from 97' to 100'	
105			Hard brown clay				

COMPLETION DEPTH: 105 ft

DATE: 9/22/80

LOG OF BORING NO. 2

HERCULES POWDER COMPANY

HATTIESBURG, MISSISSIPPI

TYPE: 3" Shelby tube & 2" split-spoon   LOCATION: As directed by Larry Browning

SURFACE EL.: Not determined

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT LB/CU FT	COHESION, KIP/SQ FT (1, 2, 3, 4) / PLASTIC LIMIT, WATER CONTENT, %, LIQUID LIMIT (20, 40, 60, 80)	ELEVATION, FT
0–3	Loose medium to coarse sand with gravel (Fill)				
3–12	Loose gray and tan silty fine sand	9			
	-occasional clay seams 8'-11'	14			
	-medium dense below 8'				
12–17	Very stiff blue clay	14			
17–22	Very stiff blue silty clay with silty fine sand partings				
22–32	Hard brown and blue clay				
	-blue, slightly sandy with occasional silty fine sand partings below 28'				
32–52	Hard blue silty clay, slightly sandy with occasional silty fine sand partings				
	-very sandy 38'-43'				
	-blue and brown 43'-46'				

(continued next page)

LOG OF BORING NO. 2

(Continued)

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT LB/CU FT	COHESION, KIP/SQ FT / PLASTIC LIMIT – WATER CONTENT, % – LIQUID LIMIT	ELEVATION, FT
60	Hard blue-green fine sandy clay with clay pockets (continued)				
65, 70	Dense medium to coarse sand with fine gravel	100 76		Note: A well screen was set in this stratum from 62' to 72'	
75, 80, 85	Hard blue clay, slightly sandy with silty fine sand partings and seams -very sandy to 74'			Note: A well screen was set in this clay stratum and the underlying sand stratum from 84' to 104'	
90, 95, 100	Dense blue silty fine sand -occasional clay pockets 88'-98' -clay pockets 103'-104'	55			
105	Hard blue-green clay -slightly sandy to 106' -brown and blue 106'-110'				

COMPLETION DEPTH: 110 ft

DATE: 7/23/80

WARE LIND
SOIL AND FOUNDATION CONSULTANTS

SOIL BORINGS
LABORATORY TESTS ENGINEERING REPORTS

859 PEAR ORCHARD ROAD • POST OFFICE BOX 10115 • JACKSON, MISSISSIPPI 39206 • AREA CODE 601 TELEPHONE 956-4467

August 13, 1980

Subsurface Disposal
5555 West Loop South
Belaire, Texas 77401

Report No. 80095

Attention: Mr. Larry Browning

Soil Borings, Piezometer Installation
and Laboratory Tests
Hercules Power Company
Hattiesburg, Mississippi

Gentlemen:

Submitted here is a summary of work recently performed for you at the Hercules Power Company site in Hattiesburg, Mississippi. This work was authorized verbally by Mr. Browning on July 8, 1980.

Two borings were completed at the site to depths of 105 ft and 110 ft during the period July 21 through July 24, 1980. Undisturbed samples of clayey soils were taken from the borings at about 5-ft intervals of depth. In sands, disturbed samples were taken at about 5-ft intervals of depth by driving a 2-in. OD split-spoon sampler 18 in. with a 140-lb hammer falling 30 in. Representative portions of all samples were sealed in glass jars for later use in the laboratory.

After completion of the borings, piezometers were installed to approximately the bottom of each boring using 2-in. OD PVC pipe and 3-ft long by 2-in. OD continuous slot well screens. The piezometers were later sealed and pumped in accordance with your instructions.

In the laboratory, one falling head permeability test was performed on a sample of gray silty fine sand taken from 74-ft depth in Boring 1. Results of this latter test indicate a coefficient of permeability of 4.18×10^{-6} cm/sec. In addition, five permeability tests and four liquid and plastic limit tests were performed on selected samples of clays using floating ring consolidometers. The tests were performed using consolidation loads of 500 and 1000 lbs per sq ft. Results of these latter tests are as follows:

Boring No.	Depth, ft	Material	(1) k, cm/sec	(2) LL	(3) PL
1	14.5	clay	1.87×10^{-7}	51	23
1	54.5	silty clay	3.42×10^{-7}	35	18
2	19.5	silty clay, slightly sandy	6.08×10^{-7}	36	25
2	59.0	clay, sand and clayey sand	6.30×10^{-7}	43	20
2	79.5	silty clay	7.84×10^{-7}	-	-

(1) Permeability
(2) Liquid limit
(3) Plastic limit

If we could furnish you with any additional information at this time, please call on us.

Very truly yours,

WARE LIND ENGINEERS, Inc.

Edwin E. Ware, P. E.

EEW/cw

CULPEPPER TESTING LABORATORIES

Air and Water Analyses

205 SOUTH MAIN STREET TELEPHONE 601 583-0411

HATTIESBURG, MISSISSIPPI 39401

Client: Hercules, Inc.
Date: July 30, 1980
Invoice No.: 0425

Date Received: July 25, 1980
Date Analysis Begun: July 25, 1980
Collected By: Client

Laboratory Number: H-72580-4A
Remarks:
Sample labeled HT-517-36-1 B-1
Water Well
Back 40

Analytical Parameter	Concentration	Methodology*
Total Chlorides	1.25 mg/l	112B
Total Sulfate	7.82 mg/l	156B
Alkalinity, Total	210.0 mg/l	102
Alkalinity, Phenolphtalein	0.0 mg/l	102
Alkalinity, Bicarbonate	210.0 mg/l	102
Sodium	None detectable	Atomic Absorptior
Potassium	None Detectable	Atomic Absorptior
Calcium	11.0 mg/l	Atomic Absorptior
Magnesium	2.0 mg/l	Atomic Absorptior
pH	7.25 SU	144A

*Standard Methods for the Examination of Water and Wastewater

Certified by: [signature]
T. J. Culpepper, Ph.D.

CULPEPPER TESTING LABORATORIES

Air and Water Analyses

805 SOUTH MAIN STREET TELEPHONE 601 583-0411

HATTIESBURG, MISSISSIPPI 39401

Client: Hercules, Inc.
Date: July 30, 1980
Invoice No.: 0425

Date Received: July 25, 1980
Date Analysis Begun: July 25, 1980
Collected By: Client

Laboratory Number: H-72580-4B
Remarks:

Sample labeled HT-517-36-2 8-2
Well Water
Providence Street

Analytical Parameter	Concentration	Methodology*
Total Chlorides	1.00 mg/l	112B
Total Sulfate	8.23 mg/l	156B
Alkalinity, Total	245.0 mg/l	102
Alkalinity, Phenolphtalein	5.0 mg/l	102
Alkalinity, Bicarbonate	235.0 mg/l	102
Sodium	None detectable	Atomic Absorption
Potassium	None detectable	Atomic Absorption
Calcium	None detectable	Atomic Absorption
Magnesium	3.0 mg/l	Atomic Absorption
pH	8.25 SU	144A

*Standard Methods for the Examination of Water and Wastewater

Certified by: [signature]
T. J. Culpepper, Ph.D.

RI NO. DATE [illegible]-4-80 RECORD BOOK NO. HT-517

SUBJECT: New Water Well Sample for Analysis

Bock 40 Well

P.H. 6.8
Selenium < 1 ppb
T.O.C. 9
Micromhos Sp. Cond. = 220

Providence St Well

P.H. 9.0
Selenium < 1 ppb
T.O.C. 15
Sp. Cond 270

SIGNED BY ______ (SIGNATURE OF PERSON DOING WORK) ______ (DATE OF SIGNATURE)

WORK OBSERVED BY [signature] (SIGNATURE OF OBSERVER) ______ (DATE OF SIGNATURE) Hercules, Inc. REPORTED

APPENDIX 3

percent in weight, and (2) for batch waste, any variation in piece count, such as a discrepancy of one drum in a truckload. Significant discrepancies in type are obvious differences which can be discovered by inspection or waste analysis, such as waste solvent substituted for waste acid, or toxic constituents not reported on the manifest or shipping paper.

(b) Upon discovering a significant discrepancy, the owner or operator must attempt to reconcile the discrepancy with the waste generator or transporter (e.g., with telephone conversations). If the discrepancy is not resolved within 15 days after receiving the waste, the owner or operator must immediately submit to the Regional Administrator a letter describing the discrepancy and attempts to reconcile it, and a copy of the manifest or shipping paper at issue.

§ 265.73 Operating record.

(a) The owner or operator must keep a written operating record at his facility.

(b) The following information must be recorded, as it becomes available, and maintained in the operating record until closure of the facility:

(1) A description and the quantity of each hazardous waste received, and the method(s) and date(s) of its treatment, storage, or disposal at the facility as required by Appendix I;

(2) The location of each hazardous waste within the facility and the quantity at each location. For disposal facilities, the location and quantity of each hazardous waste must be recorded on a map or diagram of each cell or disposal area. For all facilities, this information must include cross-references to specific manifest document numbers, if the waste was accompanied by a manifest;

[*Comment:* See §§ 265.119, 265.279, and 265.309 for related requirements.]

(3) Records and results of waste analyses and trial tests performed as specified in §§ 265.13, 265.193, 265.225, 265.252, 265.273, 265.345, 265.375, and 265.402;

(4) Summary reports and details of all incidents that require implementing the contingency plan as specified in § 265.56(j);

(5) Records and results of inspections as required by § 265.15(d) (except these data need be kept only three years);

(6) Monitoring, testing, or analytical data where required by §§ 265.90, 265.94, 265.276, 265.278, 265.280(d)(1), 265.347, and 265.377; and,

[*Comment:* As required by § 265.94, monitoring data at disposal facilities must be kept throughout the post-closure period.]

(7) All closure cost estimates under § 265.142 and, for disposal facilities, all post-closure cost estimates under § 265.144.

§ 265.74 Availability, retention, and disposition of records.

(a) All records, including plans, required under this Part must be furnished upon request, and made available at all reasonable times for inspection, by any officer, employee, or representative of EPA who is duly designated by the Administrator.

(b) The retention period for all records required under this Part is extended automatically during the course of any unresolved enforcement action regarding the facility or as requested by the Administrator.

(c) A copy of records of waste disposal locations and quantities under § 265.73(b)(2) must be submitted to the Regional Administrator and local land authority upon closure of the facility (see § 265.119).

§ 265.75 Annual report.

The owner or operator must prepare and submit a single copy of an annual report to the Regional Administrator by March 1 of each year. The report form and instructions in Appendix II must be used for this report. The annual report must cover facility activities during the previous calendar year and must include the following information:

(a) The EPA identification number, name, and address of the facility;

(b) The calendar year covered by the report;

(c) For off-site facilities, the EPA identification number of each hazardous waste generator from which the facility received a hazardous waste during the year; for imported shipments, the report must give the name and address of the foreign generator;

(d) A description and the quantity of each hazardous waste the facility received during the year. For off-site facilities, this information must be listed by EPA identification number of each generator;

(e) The method of treatment, storage, or disposal for each hazardous waste;

(f) Monitoring data under § 265.94(a)(2)(ii) and (iii), and (b)(2), where required;

(g) The most recent closure cost estimate under § 265.142, and, for disposal facilities, the most recent post-closure cost estimate under § 265.144; and

(h) The certification signed by the owner or operator of the facility or his authorized representative.

§ 265.76 Unmanifested waste report.

If a facility accepts for treatment, storage, or disposal any hazardous waste from an off-site source without an accompanying manifest, or without an accompanying shipping paper as described in § 263.20(e)(2) of this Chapter, and if the waste is not excluded from the manifest requirement by § 261.5 of this Chapter, then the owner or operator must prepare and submit a single copy of a report to the Regional Administrator within 15 days after receiving the waste. The report form and instructions in Appendix II must be used for this report. The report must include the following information:

(a) The EPA identification number, name, and address of the facility;

(b) The date the facility received the waste;

(c) The EPA identification number, name, and address of the generator and the transporter, if available;

(d) A description and the quantity of each unmanifested hazardous waste the facility received;

(e) The method of treatment, storage, or disposal for each hazardous waste;

(f) The certification signed by the owner or operator of the facility or his authorized representative; and

(g) A brief explanation of why the waste was unmanifested, if known.

[*Comment:* Small quantities of hazardous waste are excluded from regulation under this Part and do not require a manifest. Where a facility receives unmanifested hazardous wastes, the Agency suggests that the owner or operator obtain from each generator a certification that the waste qualifies for exclusion. Otherwise, the Agency suggests that the owner or operator file an unmanifested waste report for the hazardous waste movement.]

§ 265.77 Additional reports.

In addition to submitting the annual report and unmanifested waste reports described in §§ 265.75 and 265.76, the owner or operator must also report to the Regional Administrator:

(a) Releases, fires, and explosions as specified in § 265.56(j);

(b) Ground-water contamination and monitoring data as specified in §§ 265.93 and 265.94; and

(c) Facility closure as specified in § 265.115.

§§ 265.78–265.89 [Reserved]

Subpart F—Ground-Water Monitoring

§ 265.90 Applicability.

(a) Within one year after the effective date of these regulations, the owner or operator of a surface impoundment, landfill, or land treatment facility which is used to manage hazardous waste must implement a ground-water monitoring program capable of determining the facility's impact on the quality of ground water in the uppermost aquifer underlying the facility, except as § 265.1 and paragraph (c) of this Section provide otherwise.

(b) Except as paragraphs (c) and (d) of this Section provide otherwise, the owner or operator must install, operate, and maintain a ground-water monitoring system which meets the requirements of § 265.91, and must comply with §§ 265.92–265.94. This ground-water monitoring program must be carried out during the active life of the facility, and for disposal facilities, during the post-closure care period as well.

(c) All or part of the ground-water monitoring requirements of this Subpart may be waived if the owner or operator can demonstrate that there is a low potential for migration of hazardous waste or hazardous waste constituents from the facility via the uppermost aquifer to water supply wells (domestic, industrial, or agricultural) or to surface water. This demonstration must be in writing, and must be kept at the facility. This demonstration must be certified by a qualified geologist or geotechnical engineer and must establish the following:

(1) The potential for migration of hazardous waste or hazardous waste constituents from the facility to the uppermost aquifer, by an evaluation of:

(i) A water balance of precipitation, evapotranspiration, runoff, and infiltration; and

(ii) Unsaturated zone characteristics (i.e., geologic materials, physical properties, and depth to ground water); and

(2) The potential for hazardous waste or hazardous waste constituents which enter the uppermost aquifer to migrate to a water supply well or surface water, by an evaluation of:

(i) Saturated zone characteristics (i.e., geologic materials, physical properties, and rate of ground-water flow); and

(ii) The proximity of the facility to water supply wells or surface water.

(d) If an owner or operator assumes (or knows) that ground-water monitoring of indicator parameters in accordance with §§ 265.91 and 265.92 would show statistically significant increases (or decreases in the case of pH) when evaluated under § 265.93(b), he may install, operate, and maintain an alternate ground-water monitoring system (other than the one described in §§ 265.91 and 265.92). If the owner or operator decides to use an alternate ground-water monitoring system he must:

(1) Within one year after the effective date of these regulations, submit to the Regional Administrator a specific plan, certified by a qualified geologist or geotechnical engineer, which satisfies the requirements of § 265.93(d)(3), for an alternate ground-water monitoring system;

(2) Not later than one year after the effective date of these regulations, initiate the determinations specified in § 265.93(d)(4);

(3) Prepare and submit a written report in accordance with § 265.93(d)(5);

(4) Continue to make the determinations specified in § 265.93(d)(4) on a quarterly basis until final closure of the facility; and

(5) Comply with the recordkeeping and reporting requirements in § 265.94(b).

§ 265.91 Ground-water monitoring system.

(a) A ground-water monitoring system must be capable of yielding ground-water samples for analysis and must consist of:

(1) Monitoring wells (at least one) installed hydraulically upgradient (i.e., in the direction of increasing static head) from the limit of the waste management area. Their number, locations, and depths must be sufficient to yield ground-water samples that are:

(i) Representative of background ground-water quality in the uppermost aquifer near the facility; and

(ii) Not affected by the facility; and

(2) Monitoring wells (at least three) installed hydraulically downgradient (i.e., in the direction of decreasing static head) at the limit of the waste management area. Their number, locations, and depths must ensure that they immediately detect any statistically significant amounts of hazardous waste or hazardous waste constituents that migrate from the waste management area to the uppermost aquifer.

(b) Separate monitoring systems for each waste management component of a facility are not required provided that provisions for sampling upgradient and downgradient water quality will detect any discharge from the waste management area.

(1) In the case of a facility consisting of only one surface impoundment, landfill, or land treatment area, the waste management area is described by the waste boundary (perimeter).

(2) In the case of a facility consisting of more than one surface impoundment, landfill, or land treatment area, the waste management area is described by an imaginary boundary line which circumscribes the several waste management components.

(c) All monitoring wells must be cased in a manner that maintains the integrity of the monitoring well bore hole. This casing must be screened or perforated, and packed with gravel or sand where necessary, to enable sample collection at depths where appropriate aquifer flow zones exist. The annular space (i.e., the space between the bore hole and well casing) above the sampling depth must be sealed with a suitable material (e.g., cement grout or bentonite slurry) to prevent contamination of samples and the ground water.

§ 265.92 Sampling and analysis.

(a) The owner or operator must obtain and analyze samples from the installed ground-water monitoring system. The owner or operator must develop and follow a ground-water sampling and analysis plan. He must keep this plan at the facility. The plan must include procedures and techniques for:

(1) Sample collection;

(2) Sample preservation and shipment;

(3) Analytical procedures; and

(4) Chain of custody control.

[*Comment:* See "Procedures Manual For Ground-water Monitoring At Solid Waste Disposal Facilities," EPA-530/SW-611, August 1977 and "Methods for Chemical Analysis of Water and Wastes," EPA-600/4-79-020, March 1979 for discussions of sampling and analysis procedures.]

(b) The owner or operator must determine the concentration or value of the following parameters in ground-water samples in accordance with paragraphs (c) and (d) of this section:

(1) Parameters characterizing the suitability of the ground water as a drinking water supply, as specified in Appendix III.

(2) Parameters establishing ground-water quality:

(i) Chloride

(ii) Iron

(iii) Manganese

(iv) Phenols

(v) Sodium

(vi) Sulfate

[*Comment:* These parameters are to be used as a basis for comparison in the event a ground-water quality assessment is required under § 265.93(d).]

(3) Parameters used as indicators of ground-water contamination:

(i) pH

(ii) Specific Conductance

(iii) Total Organic Carbon

(iv) Total Organic Halogen

(c)(1) For all monitoring wells, the owner or operator must establish initial background concentrations or values of all parameters specified in paragraph (b) of this Section. He must do this quarterly for one year.

(2) For each of the indicator parameters specified in paragraph (b)(3) of this Section, at least four replicate measurements must be obtained for each sample and the initial background arithmetic mean and variance must be determined by pooling the replicate measurements for the respective parameter concentrations or values in samples obtained from upgradient wells during the first year.

(d) After the first year, all monitoring wells must be sampled and the samples analyzed with the following frequencies:

(1) Samples collected to establish ground-water quality must be obtained and analyzed for the parameters specified in paragraph (b)(2) of this Section at least annually.

(2) Samples collected to indicate ground-water contamination must be obtained and analyzed for the parameters specified in paragraph (b)(3) of this Section at least semi-annually.

(e) Elevation of the ground-water surface at each monitoring well must be determined each time a sample is obtained.

§ 265.93 Preparation, evaluation, and response.

(a) Within one year after the effective date of these regulations, the owner or operator must prepare an *outline* of a ground-water quality assessment program. The outline must describe a more comprehensive ground-water monitoring program (than that described in §§ 265.91 and 265.92) capable of determining:

(1) Whether hazardous waste or hazardous waste constituents have entered the ground water;

(2) The rate and extent of migration of hazardous waste or hazardous waste constituents in the ground water; and

(3) The concentrations of hazardous waste or hazardous waste constituents in the ground water.

(b) For each indicator parameter specified in § 265.92(b)(3), the owner or operator must calculate the arithmetic mean and variance, based on at least four replicate measurements on each sample, for each well monitored in accordance with § 265.92(d)(2), and compare these results with its initial background arithmetic mean. The comparison must consider individually each of the wells in the monitoring system, and must use the Student's t-test at the 0.01 level of significance (see Appendix IV) to determine statistically significant increases (and decreases, in the case of pH) over initial background.

(c)(1) If the comparisons for the *upgradient* wells made under paragraph (b) of this Section show a significant increase (or pH decrease), the owner or operator must submit this information in accordance with § 265.94(a)(2)(ii).

(2) If the comparisons for *downgradient* wells made under paragraph (b) of this Section show a significant increase (or pH decrease), the owner or operator must then immediately obtain additional ground-water samples from those downgradient wells where a significant difference was detected, split the samples in two, and obtain analyses of all additional samples to determine whether the significant difference was a result of laboratory error.

(d)(1) If the analyses performed under paragraph (c)(2) of this Section confirm the significant increase (or pH decrease), the owner or operator must provide written notice to the Regional Administrator—within seven days of the date of such confirmation—that the facility may be affecting ground-water quality.

(2) Within 15 days after the notification under paragraph (d)(1) of this Section, the owner or operator must develop and submit to the Regional Administrator a specific plan, based on the outline required under paragraph (a) of this Section and certified by a qualified geologist or geotechnical engineer, for a ground-water quality assessment program at the facility.

(3) The plan to be submitted under § 265.90(d)(1) or paragraph (d)(2) of this Section must specify:

(i) The number, location, and depth of wells;

(ii) Sampling and analytical methods for those hazardous wastes or hazardous waste constituents in the facility;

(iii) Evaluation procedures, including any use of previously-gathered ground-water quality information; and

(iv) A schedule of implementation.

(4) The owner or operator must implement the ground-water quality assessment plan which satisfies the requirements of paragraph (d)(3) of this Section, and, at a minimum, determine:

(i) The rate and extent of migration of the hazardous waste or hazardous waste constituents in the ground water; and

(ii) The concentrations of the hazardous waste or hazardous waste constituents in the ground water.

(5) The owner or operator must make his first determination under paragraph (d)(4) of this Section as soon as technically feasible, and, within 15 days after that determination, submit to the Regional Administrator a written report containing an assessment of the ground-water quality.

(6) If the owners or operator determines, based on the results of the first determination under paragraph (d)(4) of this Section, that no hazardous waste or hazardous waste constituents from the facility have entered the ground water, then he may reinstate the indicator evaluation program described in § 265.92 and paragraph (b) of this Section. If the owner or operator reinstates the indicator evaluation program, he must so notify the Regional Administrator in the report submitted under paragraph (d)(5) of this Section.

(7) If the owner or operator determines, based on the first determination under paragraph (d)(4) of this Section, that hazardous waste or hazardous waste constituents from the facility have entered the ground water, then he:

(i) Must continue to make the determinations required under paragraph (d)(4) of this Section on a quarterly basis until final closure of the facility, if the ground-water quality assessment plan was implemented prior to final closure of the facility; or

(ii) May cease to make the determinations required under paragraph (d)(4) of this Section, if the ground-water quality assessment plan was implemented during the post-closure care period.

(e) Notwithstanding any other provision of this Subpart, any ground-water quality assessment to satisfy the requirements of § 265.93(d)(4) which is initiated prior to final closure of the facility must be completed and reported in accordance with § 265.93(d)(5).

(f) Unless the ground water is monitored to satisfy the requirements of § 265.93(d)(4), at least annually the owner or operator must evaluate the data on ground-water surface elevations obtained under § 265.92(e) to determine whether the requirements under § 265.91(a) for locating the monitoring wells continues to be satisfied. If the evaluation shows that § 265.91(a) is no longer satisfied, the owner or operator must immediately modify the number, location, or depth of the monitoring wells to bring the ground-water monitoring system into compliance with this requirement.

§ 265.94 Recordkeeping and reporting.

(a) Unless the ground water is monitored to satisfy the requirements of § 265.93(d)(4), the owner or operator must:

(1) Keep records of the analyses required in § 265.92(c) and (d), the associated ground-water surface elevations required in § 265.92(e), and

he evaluations required in § 265.93(b) hroughout the active life of the facility, and, for disposal facilities, throughout the[…]closure care period as well; and

([…]port the following ground-water nonitoring information to the Regional Administrator:

(i) During the first year when initial background concentrations are being established for the facility: concentrations or values of the parameters listed in § 265.92(b)(1) for each ground-water monitoring well within 15 days after completing each quarterly analysis. The owner or operator must separately identify for each monitoring well any parameters whose concentration or value has been found to exceed the maximum contaminant levels listed in Appendix III.

(ii) Annually: concentrations or values of the parameters listed in § 265.92(b)(3) for each ground-water monitoring well, along with the required evaluations for these parameters under § 265.93(b). The owner or operator must separately identify any significant differences from initial background found in the upgradient wells, in accordance with § 265.93(c)(1). During the active life of the facility, this information must be submitted as part of the annual report required under § 265.75.

(iii) As a part of the annual report required under § 265.75: results of the evaluation of ground-water surface elevations under § 265.93(f), and a description of the response to that evaluation, where applicable.

(b) If the ground water is monitored to satisfy the requirements of § 265.93(d)(4), the owner or operator must:

(1) Keep records of the analyses and evaluations specified in the plan, which satisfies the requirements of § 265.93(d)(3), throughout the active life of the facility, and, for disposal facilities, throughout the post-closure care period as well; and

(2) Annually, until final closure of the facility, submit to the Regional Administrator a report containing the results of his ground-water quality assessment program which includes, but is not limited to, the calculated (or measured) rate of migration of hazardous waste or hazardous waste constituents in the ground water during the reporting period. This report must be submitted as part of the annual report required under § 265.75.

§§ 265.95–265.109 [Reserved]

Subpart G—Closure and Post-Closure

§ 265.110 Applicability.

Except as § 265.1 provides otherwise:

(a) Sections 265.111–265.115 (which concern closure) apply to the owners and operators of all hazardous waste facilities; and

(b) Sections 265.117–265.120 (which concern post-closure care) apply to the owners and operators of all disposal facilities.

§ 265.111 Closure performance standard.

The owner or operator must close his facility in a manner that: (a) minimizes the need for further maintenance, and (b) controls, minimizes or eliminates, to the extent necessary to protect human health and the environment, post-closure escape of hazardous waste, hazardous waste constituents, leachate, contaminated rainfall, or waste decomposition products to the ground water, or surface waters, or to the atmosphere.

§ 265.112 Closure plan; amendment of plan.

(a) On the effective date of these regulations, the owner or operator must have a written closure plan. He must keep this plan at the facility. This plan must identify the steps necessary to completely close the facility at any point during its intended life and at the end of its intended life. The closure plan must include, at least:

(1) A description of how and when the facility will be partially closed, if applicable, and ultimately closed. The description must identify the maximum extent of the operation which will be unclosed during the life of the facility, and how the requirements of § 265.111 and the applicable closure requirements of §§ 265.197, 265.228, 265.280, 265.310, 265.351, 265.381, and 265.404 will be met;

(2) An estimate of the maximum inventory of wastes in storage or in treatment at any given time during the life of the facility;

(3) A description of the steps needed to decontaminate facility equipment during closure; and

(4) A schedule for final closure which must include, as a minimum, the anticipated date when wastes will no longer be received, the date when completion of final closure is anticipated, and intervening milestone dates which will allow tracking of the progress of closure. (For example, the expected date for completing treatment or disposal of waste inventory must be included, as must the planned date for removing any residual wastes from storage facilities and treatment processes.)

(b) The owner or operator may amend his closure plan at any time during the active life of the facility. (The active life of the facility is that period during which wastes are periodically received.) The owner or operator must amend his plan any time changes in operating plans or facility design affect the closure plan.

(c) The owner or operator must submit his closure plan to the Regional Administrator at least 180 days before the date he expects to begin closure. The Regional Administrator will modify, approve, or disapprove the plan within 90 days of receipt and after providing the owner or operator and the affected public (through a newspaper notice) the opportunity to submit written comments. If an owner or operator plans to begin closure within 180 days after the effective date of these regulations, he must submit the necessary plans on the effective date of these regulations.

§ 265.113 Time allowed for closure.

(a) Within 90 days after receiving the final volume of hazardous wastes, the owner or operator must treat all hazardous wastes in storage or in treatment, or remove them from the site, or dispose of them on-site, in accordance with the approved closure plan.

(b) The owner or operator must complete closure activities in accordance with the approved closure plan and within six months after receiving the final volume of wastes. The Regional Administrator may approve a longer closure period under § 265.112(c) if the owner or operator can demonstrate that: (1) the required or planned closure activities will, of necessity, take him longer than six months to complete, and (2) that he has taken all steps to eliminate any significant threat to human health and the environment from the unclosed but inactive facility.

§ 265.114 Disposal or decontamination of equipment.

When closure is completed, all facility equipment and structures must have been properly disposed of, or decontaminated by removing all hazardous waste and residues.

§ 265.115 Certification of closure.

When closure is completed, the owner or operator must submit to the Regional Administrator certification both by the owner or operator and by an independent registered professional engineer that the facility has been closed in accordance with the

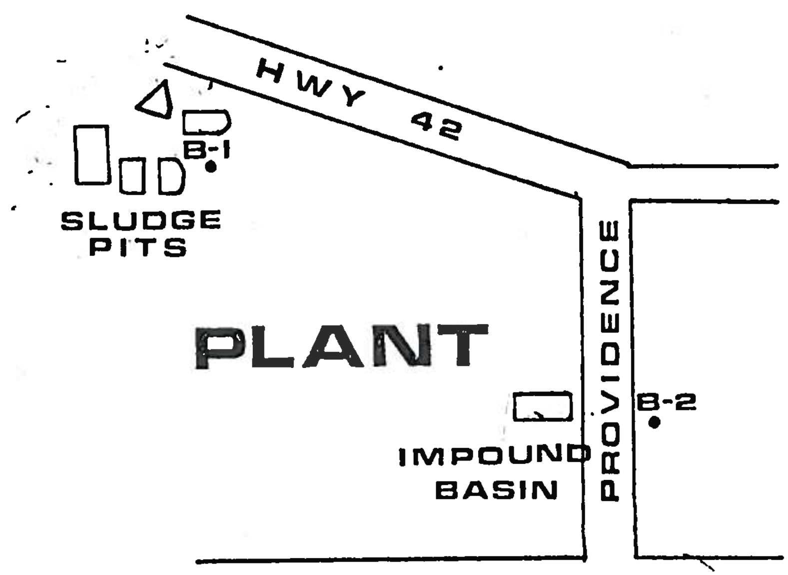
TABLE 1 - RESULTS OF CHEMICAL ANALYSES AND WATER LEVEL OBSERVATION

WELL NO.	pH	SP. COND (μ mhos)	Cl	SO4	ALK. TOTAL	ALK PHEN	ALK BICARB	Na	K	Ca	Mg	TOC	DELNAV
B-1	7.25	220	1.25	7.82	210	0.0	210.0	<1	<1	11.0	2.0	9	<1 ppb
B-2	8.25	270	1.00	8.23	245	5.0	235.0	<1	<1	<1	3.0	15	<1 ppb

Appearance of Samples: Clear
Odor: None
All units are mg/l unless specified

WATER LEVEL OBSERVATION (8/4/80)

WELL NO.	LAND ELEVATION (+MSL)	WATER LEVEL (+MSL)
B-1	155.0	130.6
B-2	159.7	121.5



(fill-in areas are spaced for elite type, i.e., 12 characters/inch).

Form Approved OMB No. 158-R0175

FORM 1 GENERAL

EPA

U.S. ENVIRONMENTAL PROTECTION AGENCY

GENERAL INFORMATION

Consolidated Permits Program

(Read the "General Instructions" before starting.)

I. EPA I.D. NUMBER

F | M S D 0 0 8 1 8 2 0 8 1

LABEL ITEMS

I. EPA I.D. NUMBER

III. FACILITY NAME

V. FACILITY MAILING ADDRESS

VI. FACILITY LOCATION

MSD008182081

HERCULES INCORPORATED
PO BOX ~~1932~~ 1937
HATTIESBURG, MS 39401

W SEVENTH ST
HATTIESBURG, MS 39401

Reference 8

...that should appear), please provide it in the proper fill-in area(s) below. If the label is complete and correct, you need not complete Items I, III, V, and VI (*except VI-B which must be completed regardless*). Complete all items if no label has been provided. Refer to the instructions for detailed item descriptions and for the legal authorizations under which this data is collected.

II. POLLUTANT CHARACTERISTICS

INSTRUCTIONS: Complete A through J to determine whether you need to submit any permit application forms to the EPA. If you answer "yes" to any questions, you must submit this form and the supplemental form listed in the parenthesis following the question. Mark "X" in the box in the third column if the supplemental form is attached. If you answer "no" to each question, you need not submit any of these forms. You may answer "no" if your activity is excluded from permit requirements; see Section C of the instructions. See also, Section D of the instructions for definitions of bold-faced terms.

SPECIFIC QUESTIONS	YES	NO	FORM ATTACHED
A. Is this facility a publicly owned treatment works which results in a discharge to waters of the U.S.? (FORM 2A)		X	
B. Does or will this facility (*either existing or proposed*) include a concentrated animal feeding operation or aquatic animal production facility which results in a discharge to waters of the U.S.? (FORM 2B)		X	
C. Is this a facility which currently results in discharges to waters of the U.S. other than those described in A or B above? (FORM 2C)	X		
D. Is this a proposed facility (*other than those described in A or B above*) which will result in a discharge to waters of the U.S.? (FORM 2D)		X	
E. Does or will this facility treat, store, or dispose of hazardous wastes? (FORM 3)	X		X
F. Do you or will you inject at this facility industrial or municipal effluent below the lowermost stratum containing, within one quarter mile of the well bore, underground sources of drinking water? (FORM 4)		X	
G. Do you or will you inject at this facility any produced water or other fluids which are brought to the surface in connection with conventional oil or natural gas production, inject fluids used for enhanced recovery of oil or natural gas, or inject fluids for storage of liquid hydrocarbons? (FORM 4)		X	
H. Do you or will you inject at this facility fluids for special processes such as mining of sulfur by the Frasch process, solution mining of minerals, in situ combustion of fossil fuel, or recovery of geothermal energy? (FORM 4)		X	
I. Is this facility a proposed stationary source which is one of the 28 industrial categories listed in the instructions and which will potentially emit 100 tons per year of any air pollutant regulated under the Clean Air Act and may affect or be located in an attainment area? (FORM 5)		X	
J. Is this facility a proposed stationary source which is NOT one of the 28 industrial categories listed in the instructions and which will potentially emit 250 tons per year of any air pollutant regulated under the Clean Air Act and may affect or be located in an attainment area? (FORM 5)		X	

III. NAME OF FACILITY

1 SKIP HERCULES INCORPORATED

IV. FACILITY CONTACT

A. NAME & TITLE (last, first, & title)	B. PHONE (area code & no.)
2 THOMS TE DEVELOPMENT SUPV.	601 545 3450

V. FACILITY MAILING ADDRESS

A. STREET OR P.O. BOX

3 PO BOX 1937

B. CITY OR TOWN	C. STATE	D. ZIP CODE
4 HATTIESBURG	MS	39401

VI. FACILITY LOCATION

A. STREET, ROUTE NO. OR OTHER SPECIFIC IDENTIFIER

5 WEST 7TH STREET

B. COUNTY NAME

[illegible]RREST

C. CITY OR TOWN	D. STATE	E. ZIP CODE	F. COUNTY CODE (if known)
6 HATTIESBURG	MS	39401	

CONTINUED FROM THE FRONT

VII. SIC CODES (4-digit, in order of priority)

A. FIRST — 7 2861 (specify) Gum and wood chemicals	**B. SECOND** — 7 2821 (specify) Synthetic resins
C. THIRD — 7 2822 (specify) Synthetic rubber	**D. FOURTH** — 7 2879 (specify) Pesticides & Agricultural Chemica

VIII. OPERATOR INFORMATION

A. NAME: 8 HERCULES INCORPORATED

B. Is the name listed in Item VIII-A also the owner? [X] YES [ ] NO

C. STATUS OF OPERATOR (Enter the appropriate letter into the answer box; if "Other", specify.)

F = FEDERAL
S = STATE
P = PRIVATE
M = PUBLIC (other than federal or state)
O = OTHER (specify)

P (specify) Private

D. PHONE (area code & no.) A 601 545 3450

E. STREET OR P.O. BOX: PO BOX 1937

F. CITY OR TOWN: B HATTIESBURG

G. STATE: MS

H. ZIP CODE: 39401

IX. INDIAN LAND

Is the facility located on Indian lands? [ ] YES [X] NO

X. EXISTING ENVIRONMENTAL PERMITS

A. NPDES (Discharges to Surface Water) — 9 N MS0001830	**D. PSD** (Air Emissions from Proposed Sources) — 9 P NA
B. UIC (Underground Injection of Fluids) — 9 U NA	**E. OTHER** (specify) — 9 0800-00001 (specify) Air Permit
C. RCRA (Hazardous Wastes) — 9 R NA	**E. OTHER** (specify) — 9 NA (specify) NA

XI. MAP

Attach to this application a topographic map of the area extending to at least one mile beyond property bounderies. The map must show the outline of the facility, the location of each of its existing and proposed intake and discharge structures, each of its hazardous waste treatment, storage, or disposal facilities, and each well where it injects fluids underground. Include all springs, rivers and other surface water bodies in the map area. See instructions for precise requirements. (See attached)

XII. NATURE OF BUSINESS (provide a brief description)

Manufacture of wood naval stores products; rosin, turpentine and pine oil. Manufacture modified resins, polyamides, Ketene dimer, wax emulsions, synthetic rubber, and an agricultural pesticide. Also, crude tall oil and pulp mill liquid refining, rosin, fatty acids, and terpene derivatives.

XIII. CERTIFICATION (see instructions)

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this application and all attachments and that, based on my inquiry of those persons immediately responsible for obtaining the information contained in the application, I believe that the information is true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

A. NAME & OFFICIAL TITLE (type or print)	B. SIGNATURE	C. DATE SIGNED
D. H. Little Vice President - Production	[signature]	Nov. 18. 1980

COMMENTS FOR OFFICIAL USE ONLY

C

(DO NOT USE) (1-5)

FORM A: GENERAL FACILITY INFORMATION

Company Name: Hercules Incorporated

Division/Subsidiary

Facility Name: Hattiesburg Plant

Address: West 7th Street
No. Street

Hattiesburg, Mississippi 39401
City State Zip Code

Name of Person Completing Form: R. H. Heller [signature]

Position: Plant Manager

Phone Number: (601) 545-3450

1. Year Facility Opened .... 19 | 2 3 | (10-11)

2. Primary SIC Code .... | 2 | 8 | 6 | 1 | (12-15)

3. Estimate the total amounts of process wastes (excluding wastes sold for use) generated by this facility during 1978:
USE ONLY TONS IF POSSIBLE - right justify response
   - thousand gallons .... | | | | | | | | | | (16-24)
   - hundred tons .... | | | | | | 3 | 5 | 0 | (25-32)
   - thousand cubic yards .... | | | | | | | | | | (33-41)

4. Estimate (in whole percents) how these process wastes generated in 1978 were disposed of:
   - in landfill .... | | 9 | 8 | (42-44)
   - in pit/pond/lagoon .... | | | 2 | (45-47)
   - in deep well .... | | | | (48-50)
   - incinerated .... | | | | (51-53)
   - reprocessed/recycled .... | | | | (54-56)
   - evaporated .... | | | | (57-59)
   - unknown .... | | | | (60-62)
   - other (Specify______________________).......... | | | | (63-65)

5. What is the total number of known sites (including disposal on the property where this facility is located as one site) that have been used for the disposal of process wastes from this facility since 1950?.. | | 1 | 4 | (66-68)

COMPLETE ONE FORM "B" FOR EACH OF THE SITES

6. Have any of the process wastes generated at this facility been hauled (removed) from this facility for disposal? (Yes=1; no=2) .... | 1 | (69)

IF YES, COMPLETE FORM "C"

7. Do you know the disposal site locations of all of the process waste hauled from your facility since 1950? (Yes=1; no=2) .... | 2 | (70)

IF NO, COMPLETE ONE FORM "D" FOR EACH FIRM OR CONTRACTOR WHO TOOK WASTE TO AN UNKNOWN LOCATION

8. Specify the earliest year represented by information from company or facility records supplied on this and other forms ....19 | 7 | 1 | (71-72)

9. Specify the earliest year represented by information from employee knowledge supplied on this and other forms ....19 | 6 | 7 | (73-74)

FORM B: DISPOSAL SITE INFORMATION

(1-8) (DO NOT USE)

COMPLETE THIS FORM FOR EVERY SITE (INCLUDING THE LOCATION OF THIS FACILITY AS ONE SITE) USED FOR THE DISPOSAL OF PROCESS WASTES GENERATED BY THIS FACILITY SINCE 1950.

Company Name: Hercules Incorporated Division/Subsidiary
Facility Name: Hattiesburg Plant
Name of Site: Back 40
Address of Site: West 7th St.
no. street

Hattiesburg Mississippi 39401
city state zip code

Name of Owner (while used by facility): Hercules Incorporated
Address: West 7th St.
no. street

Hattiesburg Mississippi 39401
city state zip code

Current Owner (if different from above): Same
Address:
no. street

city state zip code

1. Location (1= the property on which facility is located; 2= off-site)..... 1 (10)
2. Ownership at time of use (1= company ownership; 2=private but not company ownership) 3=public ownership) 1 (11)
3. Current status (1= closed; 2= still in use; 9=don't know) 2 (12)
   IF CLOSED, specify year closed ..... (12)
4. Year first used for process waste from this facility ..... 19__ (13-14)
5. Year last used for process waste from this facility (enter "79" if still in use) 19 23 (15-16)
6. Total amount of process waste from this facility disposed at site: 19 79 (17-18)
   USE TONS ONLY IF POSSIBLE
   Right justify response
   thousand gallons ..... (19-26)
   hundred tons 3471 (27-33)
   thousand cubic yards ..... (34-41)
7. Specify type(s) of disposal method(s) used at site and whether method is still in use (1=currently in use; 2=no longer in use; 3=never used; 9=don't know)

landfill, mono industrial waste	1	(42)
landfill, mixed industrial waste	1	(43)
landfill, drummed waste	1	(44)
landfill, municipal refuse co-disposed	3	(45)
pits/ponds/lagoons	1	(46)
deep well injection	3	(47)
land farming	3	(48)
incineration	2	(49)
treatment (eg. neutralizing)	3	(50)
reprocessing/recycling	3	(51)
other (specify)	3	(52)

8. Users of this site (1=this facility; 2=this facility and other company facilities only; 3=this company and others; 9=don't know) 1 (53)

LIST NAMES AND ADDRESSES OF OTHER KNOWN USERS BELOW

FORM B CONTINUED ON SECOND PAGE

1 (80)

(DO NOT USE)

Company Name: Hercules Incorporated
Division/Subsidiary
Facility Name: Hattiesburg Plant

Site Name: Back 40

9. Components (or characteristics) of process waste from this facility disposed at site: (1=present in waste; 2=not present in waste; 9=don't know)

FILL IN EVERY BLOCK SPACE

Acid solutions, with pH < 3		
pickling liquor	2	(10)
metal plating waste	2	(11)
circuit etchings	2	(12)
inorganic acid manufacture	2	(13)
organic acid manufacture	2	(14)
Base solutions, with pH > 12	2	(15)
caustic soda manufacture	2	(16)
nylon and similar polymer generation	2	(17)
scrubber residual	2	(18)
Heavy metals & trace metals (bonded organically & inorganically)	2	(19)
arsenic, selenium, antimony	2	(20)
mercury	2	(21)
iron, manganese, magnesium	2	(22)
zinc, cadmium, copper, chromium (trivalent)	1	(23) Trace
chromium (hexavalent)	1	(24) Trace
lead	2	(25)
Radioactive residues, > 50pico curies/liter	2	(26)
uranium residuals & residuals for UF_6 recycling	2	(27)
lathanide series elements and rare earth salts	2	(28)
phosphate slag	2	(29)
thorium	2	(30)
radium	2	(31)
other alpha, beta & gamma emitters	2	(32)
Organics	2	(33)
pesticides & intermediates	1	(34)
herbicides & intermediates	1	(35) Trace
fungicides & intermediates	2	(36)
rodenticides & intermediates	2	(37)
halogenated aliphatics	2	(38)
halogenated aromatics	1	(39) Trace
acrylates & latex emulsions	2	(40)
PCB/PBB's	2	(41)
amides, amines, imides	2	(42)
plastizers	1	(43) Trace
resins	2	(44)
elastomers	1	(45)
solvents polar (except water)	1	(46)
carbontetrachloride	1	(47) Trace
trichloroethylene	2	(48)
other solvents nonpolar	2	(49)
solvents halogenated aliphatic	1	(50) Trace
solvents halogenated aromatic	1	(51) Trace
oils and oil sludges	2	(52)
esters and ethers	1	(53)
alcohols	1	(54)
ketones & aldehydes	1	(55) Trace
dioxins	1	(56) Trace
Inorganics	2	(57)
salts	1	(58)
mercaptans	1	(59)
Misc.	1	(60)
pharmaceutical wastes	2	(61)
paints & pigments	2	(62)
catalysts (eg. vanadium, platinum, palladium)	2	(63)
asbestos	2	(64)
shock sensitive wastes (eg. nitrated toluenes)	2	(65)
air water reactive wastes (eg. P_4, aluminum chloride)	2	(66)
wastes with flash point below 100° F.	2	(67)
	2	(68)

|2| (80)

FORM C: HAULER INFORMATION

(DO NOT USE) (1-5)

PROVIDE A COMPLETE LIST OF ALL FIRMS AND INDEPENDENT CONTRACTORS, INCLUDING THE COMPANY AND ITS AFFILIATES AND SUBSIDIARIES, USED TO REMOVE PROCESS WASTES FROM THIS FACILITY SINCE 1950.

Company Name: Hercules Incorporated
Division/Subsidiary
Facility Name: Hattiesburg Plant

Name of Firm or Contractor	Address	ICC # (If Known)	Years Used
Hercules Incorporated	Hattiesburg, Mississippi		9
Rollings Enviromental Services Inc.	Baton Rouge, LA.		9
City of Hattiesburg	Hattiesburg, Mississippi		7
Hover Gravel Co.	Hattiesburg, Mississippi		3
Chem Dyne Corp.	Hamilton, Ohio		1

Please print or type in the unshaded areas only
(fill-in areas are spaced for elite type, i.e., 12 chara[illegible]inch).

Form Approved OMB No. 158-S80004

FORM 3 RCRA

EPA

U.S. ENVIRONMENTAL PROTECTION AGENCY

HAZARDOUS WASTE PERMIT APPLICATION

Consolidated Permits Program

(This information is required under Section 3005 of RCRA.)

I. EPA I.D. NUMBER

S												T/A
F	M	S	D	0	0	8	1	8	2	0	8	1

FOR OFFICIAL USE ONLY

[illegible]LICATION [illegible]PROVED	DATE RECEIVED (yr., mo., & day)	COMMENTS
23	24 - 29	

Reference 9

II. FIRST OR REVISED APPLICATION

Place an "X" in the appropriate box in A or B below *(mark one box only)* to indicate whether this is the firs[illegible] revised application. If this is your first application and you already know your facility's EPA I.D. Number, or if this is a revised application, enter your facility's EPA I.D. Number in Item I above.

A. FIRST APPLICATION *(place an "X" below and provide the appropriate date)*

[X] 1. EXISTING FACILITY *(See instructions for definition of "existing" facility. Complete item below.)*

[ ] 2. NEW FACILITY *(Complete item below.)*

C	YR.	MO.	DAY
8	42	03	20

FOR EXISTING FACILITIES, PROVIDE THE DATE *(yr., mo., & day)* OPERATION BEGAN OR THE DATE CONSTRUCTION COMMENCED *(use the boxes to the left)*

YR.	MO.	DAY

FOR NEW FACILITIES PROVIDE THE DATE *(yr., mo., & day)* OPERA[illegible] TION BEGAN OR IS EXPECTED TO BEGIN

B. REVISED APPLICATION *(place an "X" below and complete Item I above)*

[ ] 1. FACILITY HAS INTERIM STATUS

[ ] 2. FACILITY HAS A RCRA PERMIT

III. PROCESSES – CODES AND DESIGN CAPACITIES

A. **PROCESS CODE** — Enter the code from the list of process codes below that best describes each process to be used at the facility. Ten lines are provided for entering codes. If more lines are needed, enter the code(s) in the space provided. If a process will be used that is not included in the list of codes below, then describe the process *(including its design capacity)* in the space provided on the form *(Item III-C)*.

B. **PROCESS DESIGN CAPACITY** — For each code entered in column A enter the capacity of the process.

1. AMOUNT — Enter the amount.
2. UNIT OF MEASURE — For each amount entered in column B(1), enter the code from the list of unit measure codes below that describes the unit of measure used. Only the units of measure that are listed below should be used.

PROCESS	PROCESS CODE	APPROPRIATE UNITS OF MEASURE FOR PROCESS DESIGN CAPACITY
Storage:		
CONTAINER *(barrel, drum, etc.)*	S01	GALLONS OR LITERS
TANK	S02	GALLONS OR LITERS
WASTE PILE	S03	CUBIC YARDS OR CUBIC METERS
SURFACE IMPOUNDMENT	S04	GALLONS OR LITERS
Disposal:		
INJECTION WELL	D79	GALLONS OR LITERS
LANDFILL	D80	ACRE-FEET *(the volume that would cover one acre to a depth of one foot)* OR HECTARE-METER
LAND APPLICATION	D81	ACRES OR HECTARES
OCEAN DISPOSAL	D82	GALLONS PER DAY OR LITERS PER DAY
SURFACE IMPOUNDMENT	D83	GALLONS OR LITERS
Treatment:		
TANK	T01	GALLONS PER DAY OR LITERS PER DAY
SURFACE IMPOUNDMENT	T02	GALLONS PER DAY OR LITERS PER DAY
INCINERATOR	T03	TONS PER HOUR OR METRIC TONS PER HOUR; GALLONS PER HOUR OR LITERS PER HOUR
OTHER *(Use for physical, chemical, thermal or biological treatment processes not occurring in tanks, surface impoundments or incinerators. Describe the processes in the space provided; Item III-C.)*	T04	GALLONS PER DAY OR LITERS PER DAY

UNIT OF MEASURE	UNIT OF MEASURE CODE
GALLONS	G
LITERS	L
CUBIC YARDS	Y
CUBIC METERS	C
GALLONS PER DAY	U
LITERS PER DAY	V
TONS PER HOUR	D
METRIC TONS PER HOUR	W
GALLONS PER HOUR	E
LITERS PER HOUR	H
ACRE-FEET	A
HECTARE-METER	F
ACRES	B
HECTARES	Q

EXAMPLE FOR COMPLETING ITEM III *(shown in line numbers X-1 and X-2 below)*: A facility has two storage tanks, one tank can hold 200 gallons and the other can hold 400 gallons. The facility also has an incinerator that can burn up to 20 gallons per hour.

C	DUP	T/A	C
C	DUP		1

LINE NUMBER	A. PROCESS CODE (from list above)	B. PROCESS DESIGN CAPACITY 1. AMOUNT (specify)	2. UNIT OF MEASURE (enter code)	FOR OFFICIAL USE ONLY
X-1	S 0 2	600	G	
X-2	T 0 3	20	E	
1	T 0 2	5,900	U	
2	S 0 2	28,000	G	
3				
4				
5				
6				
7				
8				
9				
10				

tinued from the front.

PROCESSES (continued)

PACE FOR ADDITIONAL PROCESS CODES OR FOR DESCRIBING OTHER PROCESSES (code "T04"). FOR EACH PROCESS ENTERED HERE NCLUDE DESIGN CAPACITY.

T02 - The plant neutralizes ~~5,000~~ 5900 gals./day of waste H_2SO_4 from the rosin polymerization operation.

should be design capacity

DESCRIPTION OF HAZARDOUS WASTES

PA HAZARDOUS WASTE NUMBER — Enter the four–digit number from 40 CFR, Subpart D for each listed hazardous waste you will handle. If you andle hazardous wastes which are not listed in 40 CFR, Subpart D, enter the four–digit number(s) from 40 CFR, Subpart C that describes the characteris- ics and/or the toxic contaminants of those hazardous wastes.

STIMATED ANNUAL QUANTITY — For each listed waste entered in column A estimate the quantity of that waste that will be handled on an annual asis. For each characteristic or toxic contaminant entered in column A estimate the total annual quantity of all the non–listed waste(s) that will be handled hich possess that characteristic or contaminant.

NIT OF MEASURE — For each quantity entered in column B enter the unit of measure code. Units of measure which must be used and the appropriate odes are:

ENGLISH UNIT OF MEASURE	CODE	METRIC UNIT OF MEASURE	CODE
POUNDS	P	KILOGRAMS	K
TONS	T	METRIC TONS	M

f facility records use any other unit of measure for quantity, the units of measure must be converted into one of the required units of measure taking into ccount the appropriate density or specific gravity of the waste.

ROCESSES

. PROCESS CODES:

For listed hazardous waste: For each listed hazardous waste entered in column A select the code(s) from the list of process codes contained in Item III to indicate how the waste will be stored, treated, and/or disposed of at the facility.

For non–listed hazardous wastes: For each characteristic or toxic contaminant entered in column A, select the code(s) from the list of process codes contained in Item III to indicate all the processes that will be used to store, treat, and/or dispose of all the non–listed hazardous wastes that possess that characteristic or toxic contaminant.

Note: Four spaces are provided for entering process codes. If more are needed: (1) Enter the first three as described above; (2) Enter "000" in the extreme right box of Item IV-D(1); and (3) Enter in the space provided on page 4, the line number and the additional code(s).

. PROCESS DESCRIPTION: If a code is not listed for a process that will be used, describe the process in the space provided on the form.

E: HAZARDOUS WASTES DESCRIBED BY MORE THAN ONE EPA HAZARDOUS WASTE NUMBER — Hazardous wastes that can be described by than one EPA Hazardous Waste Number shall be described on the form as follows:

. Select one of the EPA Hazardous Waste Numbers and enter it in column A. On the same line complete columns B,C, and D by estimating the total annual quantity of the waste and describing all the processes to be used to treat, store, and/or dispose of the waste.
. In column A of the next line enter the other EPA Hazardous Waste Number that can be used to describe the waste. In column D(2) on that line enter "included with above" and make no other entries on that line.
. Repeat step 2 for each other EPA Hazardous Waste Number that can be used to describe the hazardous waste.

MPLE FOR COMPLETING ITEM IV (shown in line numbers X-1, X-2, X-3, and X-4 below) — A facility will treat and dispose of an estimated 900 pounds ear of chrome shavings from leather tanning and finishing operation. In addition, the facility will treat and dispose of three non–listed wastes. Two wastes orrosive only and there will be an estimated 200 pounds per year of each waste. The other waste is corrosive and ignitable and there will be an estimated pounds per year of that waste. Treatment will be in an incinerator and disposal will be in a landfill.

A. EPA HAZARD. WASTE NO (enter code)	B. ESTIMATED ANNUAL QUANTITY OF WASTE	C. UNIT OF MEASURE (enter code)	D. PROCESSES 1. PROCESS CODES (enter)				D. 2. PROCESS DESCRIPTION (if a code is not entered in D(1))
K 0 5 4	900	P	T 0 3	D 8 0			
D [illegible] 2	400	P	T 0 3	D 8 0			
D 0 0 1	100	P	T 0 3	D 8 0			
[illegible] 0 0 2							included with above

CONTINUE ON PAGE 3

Continued from page 2.
NOTE: Photocopy this page before completing if you [illegible] more than 26 wastes to list.

Form Approved OMB No. 158-S80004

EPA I.D. NUMBER (enter from page 1)	T/A	C	FOR OFFICIAL USE ONLY	T/A	C	
W M S D 0 0 8 1 8 2 0 8 1		1	W DUP		2	DUP

IV. DESCRIPTION OF HAZARDOUS WASTES (continued)

LINE NO.	A. EPA HAZARD. WASTE NO. (enter code)	B. ESTIMATED ANNUAL QUANTITY OF WASTE	C. UNIT OF MEASURE (enter code)	D. PROCESSES 1. PROCESS CODES (enter)				D. PROCESSES 2. PROCESS DESCRIPTION (if a code is not entered in D(1))
1	D 0 0 2	3,500	T	S 0 2	T 0 2			
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								

Form 3510-3 (6-80)

CONTINUE ON REVERSE

Continued from the front.

IV. DESCRIPTION OF HAZARDOUS WASTE (continued)

E. USE THIS SPACE TO LIST ADDITIONAL PROCESS CODES FROM ITEM D(1) ON PAGE 3.

EPA I.D. NO. (enter from page 1)	T/A	C
F Y S D 0 0 8 1 8 2 0 8 1		6

V. FACILITY DRAWING

All existing facilities must include in the space provided on page 5 a scale drawing of the facility *(see instructions for more detail).*

VI. PHOTOGRAPHS

All existing facilities must include photographs *(aerial or ground—level)* that clearly delineate all existing structures; existing storage, treatment and disposal areas; and sites of future storage, treatment or disposal areas *(see instructions for more detail).*

VII. FACILITY GEOGRAPHIC LOCATION

LATITUDE *(degrees, minutes, & seconds)*	LONGITUDE *(degrees, minutes, & seconds)*
89 18 30	31 20 30

VIII. FACILITY OWNER

[X] A. If the facility owner is also the facility operator as listed in Section VIII on Form 1, "General Information", place an "X" in the box to the left and skip to Section IX below.

B. If the facility owner is not the facility operator as listed in Section VIII on Form 1, complete the following items:

1. NAME OF FACILITY'S LEGAL OWNER	2. PHONE NO. *(area code & no.)*
E	

3. STREET OR P.O. BOX	4. CITY OR TOWN	5. ST.	6. ZIP CODE
F	G		

IX. OWNER CERTIFICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

A. NAME *(print or type)*	B. SIGNATURE	C. DATE SIGNED
D. H. Little Vice President - Production	[signature]	Nov. 18, 1980

X. OPERATOR CERTIFICATION

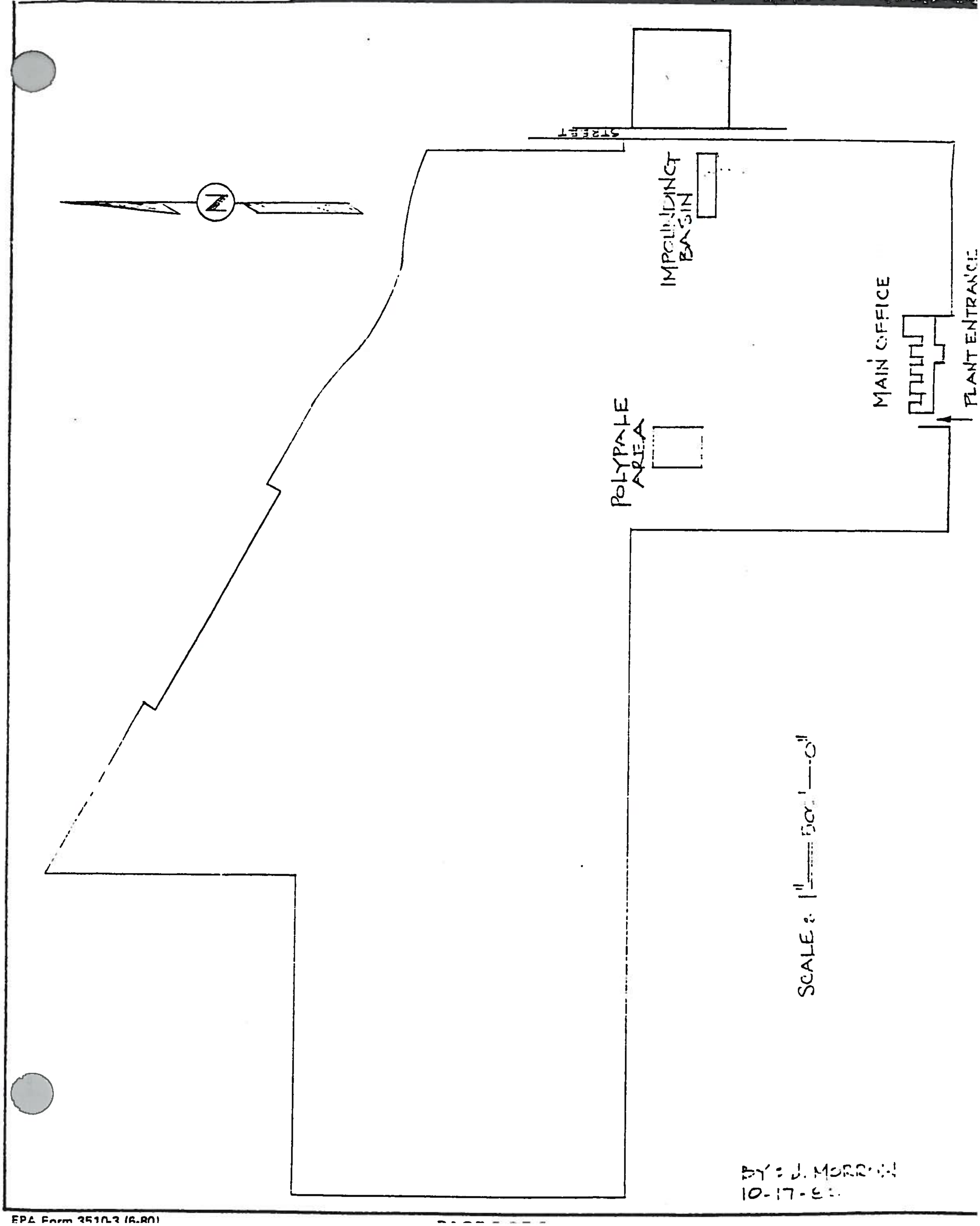
I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

A. NAME *(print or type)*	B. SIGNATURE	C. DATE SIGNED
D. H. Little Vice President - Production	[signature]	Nov. 18, 1980

 CONTINUE ON PAGE 5

...tinued from page 4.

V. FACILITY DRAWING *(see page 4)*



Reference 10

HERCULES

Hercules Incorporated
West 7th Street
P.O. Box 1937
Hattiesburg, MS 39401
(601) 545-3450

February 18, 1983

RECEIVED
1983 FEB 22 AM 9:38
AIR & WATER POLLUTION
CONTROL COMMISSION
STATE OF MISSISSIPPI

Mississippi Department of Natural Resources
Bureau of Pollution Control
Division of Solid Waste Management
P. O. Box 10385
Jackson, MS 39209
Attn: Mr. John Herrmann

Dear Mr. Herrmann:

On January 27, 1983, we met with you to review our initial notification of hazardous waste activity and subsequent hazardous waste permit application. The meeting was very beneficial with your clarification of several aspects of hazardous waste activity.

In summary, we agreed that our initial notification and subsequent hazardous waste permit application as a storer and treater of hazardous waste (spent sulfuric acid) was misleading. All of the acid is beneficially used for pH control during primary wastewater treatment and supplemented with the purchase of additional fresh acid. In fact, the spent acid does not meet any of the criteria in part 261.2 (definition of a solid waste) and therefore we conclude if it is not a solid waste it is not a hazardous waste. The "storage" tanks are only used to control optimum discharge of the spent acid. As you requested, we also looked at heavy metals, using the EP toxicity procedure, in our impounding basin sludge (the continuous flowthrough basin is for wastewater equalization and pH control) and also in the wastewater from the process generating the spent acid. No levels were found anywhere near the levels listed as maximum concentration of contaminants characteristic of EP toxicity. Also, the only reason underground injection was marked on our original notification was because of sanitary septic tanks and after talking to David Lee on February 17, 1983, we concur that underground injection should also be removed. Therefore, we are submitting the enclosed amended notification of hazardous waste activity.

With your concurrence that the spent sulfuric acid is not a hazardous waste, we respectfully request that we be removed as a storer and treater of hazardous waste and be listed only as a generator of hazardous waste. Although we are not generating any hazardous waste on a regular basis we do feel that in the future we may generate non-specific hazardous waste from non-specific sources on occasions as the result of process malfunctions, contamination, etc., and therefore we wish to retain our EPA ID number. Please advise us on the procedure to accomplish being removed as a storer and treater of hazardous waste (eliminating the hazardous waste permit application) while retaining our EPA ID number.

If I can answer any questions or be of any help, please call me.

Yours truly,

Charles S. Jordan
Environmental Coordinator

CSJ:ps

Enclosure

FILE COPY

State of Mississippi
Water Pollution Control
PERMIT

TO DISCHARGE WASTEWATER IN ACCORDANCE WITH THE NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

THIS CERTIFIES THAT

HERCULES, INC.
Hattiesburg, Mississippi

has been granted permission to discharge wastewater into

Bowie River

in accordance with effluent limitations, monitoring requirements and other conditions set forth in Parts I, II, and III hereof. This permit is issued in accordance with the provisions of the Mississippi Water Pollution Control Law (Section 49-17-1 et seq., Mississippi Code of 1972), and the regulations and standards adopted and promulgated thereunder, and under authority granted pursuant to Section 402 (b) of the Federal Water Pollution Control Act.

MISSISSIPPI NATURAL RESOURCES PERMIT BOARD

Original Signed By
CHARLES H. CHISOLM

DIRECTOR, BUREAU OF POLLUTION CONTROL
MISSISSIPPI DEPARTMENT OF NATURAL RESOURCES

Issued: September 29, 1986

Permit No . MS0001830

Expires: September 28, 1991

Reference 12

HERCULES

HERCULES INCORPORATED
P.O.DRAWER 1937
HATTIESBURG, MS. 39401
601-545-3450
FAX # 601-584-3225

FAX COVER SHEET

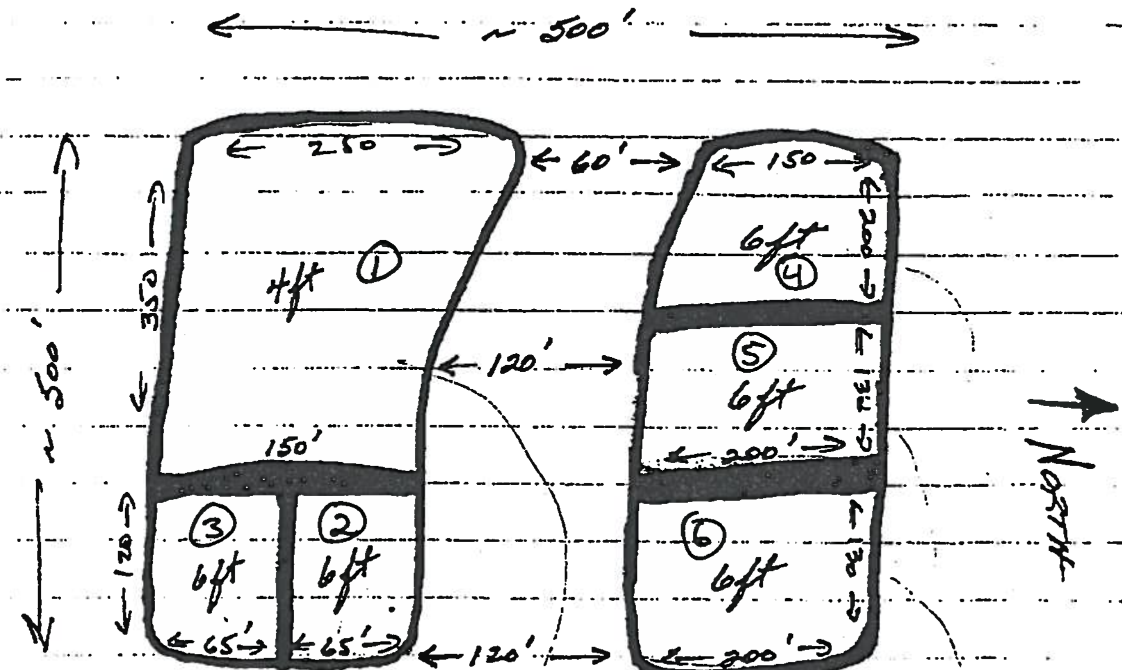
MESSAGE TO: CARTER HELM (NAME) ph - 404 901 5106 — 11-3-92 (DATE:)

(FIRM NAME) — 404 392 9289 (FAX #)

(CITY) — (STATE)

FROM CHARLES JORDAN — SHT. 1 OF 1

MESSAGE: "ALL ESTIMATES"



Here is Rough Est.

1) 350 × 200 × 4 = 280,000 FT³.
2) 120 × 65 × 6 = 46,800
3) 120 × 65 × 6 = 46,800
4) 175 × 200 × 6 = 210,000
5) 200 × 130 × 6 = 156,000
6) 200 × 130 × 6 = 156,000

895,600 FT³

Reference 13

MISSISSIPPI
STATE GEOLOGICAL SURVEY

[illegible]

BULLETIN [illegible]

FORREST COUNTY MINERAL RESOURCES

GEOLOGY

BY

VELORA MEEK FOSTER, M.S.

TESTS

BY

THOMAS EDWIN McCUTCHEON, B.S., Cer. Engr.

UNIVERSITY, MISSISSIPPI

[illegible]

[illegible]

:EK FOSTER

1941

OLOGIST FRIEND MAN

MISSISSIPPI

STATE GEOLOGICAL SURVEY

WILLIAM CLIFFORD MORSE, Ph.D.

DIRECTOR

BULLETIN 44

FORREST COUNTY MINERAL RESOURCES

GEOLOGY

By

VELLORA MEEK FOSTER, M.Sc.

TESTS

By

THOMAS EDWIN McCUTCHEON, B.S., Cer.Engr.

Prepared in cooperation with the Forrest citizens and the WPA as a report on O. P. 465-62-3-275.

UNIVERSITY, MISSISSIPPI

1941

TESTS

ILLUSTRATIONS

CONTENTS

GEOLOGY

Page

FORREST COUNTY MINERAL RESOURCES
GEOLOGY

VELLORA MEEK FOSTER, M.S.

INTRODUCTION

GENERAL

Forrest County is located in the southeastern part of the State and is bounded by Covington and Jones Counties on the north, Perry County on the east, Stone County on the south, and Pearl River and Lamar Counties on the west (Figure 1). It is made up of 13 townships and embraces an area of 460 square miles.[1]

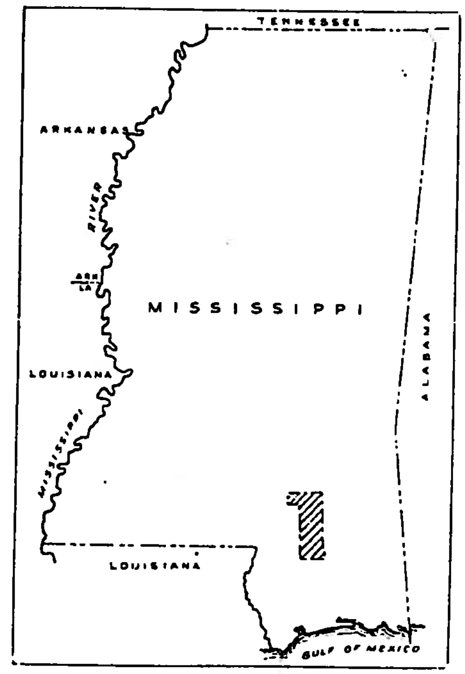


Figure 1.—Map showing location of Forrest County.

The entire county lies within the drainage area of the Leaf-Pascagoula River. The major streams all traverse the county in a southeasterly direction in strikingly parallel courses which follow approximately along the strike of the underlying formations. Named in succession, beginning with the most northeasterly, they are: Tallahala Creek, Leaf River, Bouie River, Black Creek, and Red River. The smaller streams, tributary to those named, are less regular in their courses, but in general they follow a northerly or southerly direction.

According to the 1940 census the county had a population of 34,894, of which about 63 percent were white and the remainder negro. Hattiesburg, the county seat, having a population of 21,024, is the commercial and manufacturing center of a large agricultural and lumbering area. Most of its industrial activity is based on the processing of agricultural and forestry products. There are several establishments, however, engaged in mining or manufacture of local mineral resources. Three companies mine sand and gravel from the river terraces, one makes common brick and tile from alluvial clay, and one uses local sand and gravel as an aggregate in the manufacture of cement tile.

Hattiesburg and its suburbs are supplied with natural gas from the Jackson gas field via the pipe line of a local company, and high tension electric lines of both the Mississippi Power & Light Company and the Rural Electrification Authority traverse the county.

Forrest County is served by four railroads and three paved highways all of which intersect at Hattiesburg. No part of the county, therefore, is more than six or eight miles from both railway and highway connections. In addition to the paved highways there is a network of excellent gravel roads extending to all parts of the county. The Leaf-Pascagoula River is considered navigable as far north as Hattiesburg and, although there is no longer any commercial traffic on the river, a channel can be established and maintained if the commerce of the future is sufficient to warrant periodic dredging.

TOPOGRAPHY

CUESTAS

The entire county lies within the Pine Hills physiographic region. The topography is essentially that of a maturely dissected plain sloping gently toward the southeast. Into this plain the major streams have cut broad terraced valleys separated by cuesta-shaped divides having steep northeasterly and gentle southwesterly slopes. In Forrest County cuestas are well developed between Leaf River and Black Creek and between Black Creek and Red River. The divides between Tallahala Creek and Leaf River and between Leaf and Bouie Rivers do not exhibit the typical cuesta shape and are described in connection with the stream terraces.

The crest of the divide between Leaf River and Black Creek enters the county about five miles southwest of Hattiesburg. It passes in a general southeasterly direction through the town of McLaurin and into Perry County. Although parts of the crest rise to elevations of more than 350 feet above sea level, much of the highland has been dissected by the headwaters of numerous tributary streams, and the general elevation of the crest is probably not more than 300 feet. The northward facing slope is relatively rugged and steep in character though somewhat modified by the terraces of the Leaf River. The back-slope, on the other hand, is more gentle, the streams longer, the valleys broader, and the topography more rolling. It is essentially a dip slope and toward the southwest it merges almost imperceptibly into the high terraces of Black Creek. Along parts of their courses some streams of the back-slope follow a southeasterly course and subsidiary or secondary cuestas have been developed. Thus the major watershed is in reality a composite of a complex cuesta.

The cuesta-shaped divide between Black Creek and Red River is similar to that described above, but even more complex. The main crest, which rises to an elevation of about 330 feet above sea level, enters the county north of Elder and extends in a general southeasterly direction through a point about two miles southwest of Maxie and thence to the southeastern corner of the county. The north slopes are rather abrupt in most places, but the face of the cuesta is modified by three or more prongs, or secondary cuestas, which form the divides between Black Creek and its major tributaries from the south: Little Black Creek, Big Creek, and Beaver Dam Creek. Thus the land surface appears to rise in two or more steps from the level of Black Creek to the top of the divide. The back-slopes of the secondary cuestas are in some places so gentle as to appear almost terrace-like. The back-slope of the major divide is less modified by stream erosion than is that of the cuesta between Leaf River and Black Creek and large areas are composed of very gently rolling upland. Within the limits of Forrest County the only well developed secondary cuesta on the backslope is the divide between Double Branch and Red River which occupies an area of about nine square miles in the extreme southwestern part of the county.

TERRACES

Among the most striking topographic features of Forrest County are the valleys of Bouie and Leaf Rivers and their bordering terraces. The modern valleys average respectively about two and four miles in width including the lowermost of the high terraces (elevation about 175 feet) on which Hattiesburg is built. At least two additional terraces are present at lower altitudes. Remnants of several higher terraces may also be seen in the northern part of the county.

Between Bouie and Leaf Rivers and between Leaf River and Tallahala Creek, at elevations ranging from about 200 to 290 feet, there are two fairly large areas of flat or gently rolling terraced upland (Figure 2) bordered by somewhat lower and more highly dissected areas. The cuesta shape, so characteristic of most interstream areas in the Pine Hills region, is not developed on these divides. Although they reach elevations of 125 feet or more above the floodplains these flat uplands nevertheless lie more than 75 feet below the cuesta crests to the northeast and southwest. Furthermore, the sediments on which the high plain is developed resemble lower terrace deposits rather than the gravelly sands which cap the typical cuestas in the southern half of the county. It seems evident, therefore, that the high flat divides of northern Forrest County should be considered terrace plains formed during an old erosion-deposition cycle of the associated streams.

The terraced character of the upland is best seen between the Leaf and Bouie Rivers where it is locally known as the Eatonville Flat. Along a road southeast from the town of Eatonville at least four major terraces may be seen above the first of the low terraces and including the highest level, on which Eatonville is situated. Also, the lowermost of the high terraces appears in some places to consist of three levels, separated one from the other by six-foot and eight-foot terrace scarps (Figures 3, 4, and 5B). Remnants of the several terraces are also

Figure 2.—High Terrace on Eatonville Flat, one mile east of Eatonville (NE.1/4, Sec. 8, T.5 N., R.13 W.). March 23, 1941.

present along other parts of the two valleys, but recent erosion has interrupted their continuity and somewhat modified their character. A proper description and correlation of the terraces, therefore, are impossible in the absence of topographic maps.

Southwest of Bouie River and extending about five miles south of Hattiesburg, there is another rather large rolling highland, some parts of which reach elevations corresponding to those of the Eatonville Flat terraces, and some parts of which are covered with terrace sand and gravel. Throughout most of that area, however, the typical silty clays of the Hattiesburg formation are at or near the surface, the elevations of which are between 200 and 250 feet, and correspond roughly with that of the clay underlying the terrace deposits north of the river. Along the outer edge of this series of terraces, thick deposits of sand and gravel, containing silt and clay in the basal part, overlap the lower part of the cuesta face.

Remnants of similar deposits are to be found along the south side of the Leaf River valley from Hattiesburg southeast into Perry County. This part of the valley wall is highly dissected and the terrace character is obscured. It is extremely difficult,

Figure 3.—High Terraces on Eatonville Flat, one mile southeast of Eatonville, showing terrace scarp between second and third terraces in right background (SW.1/4, SE.1/4, Sec. 8, T.5 N., R.13 W.). March 23, 1941.

Figure 4.—Terrace scarp between Second and Third High Terraces, 0.7 mile southeast of Eatonville (SE.1/4, SW.1/4, Sec. 8, T.5 N., R.13 W.). March 23, 1941.

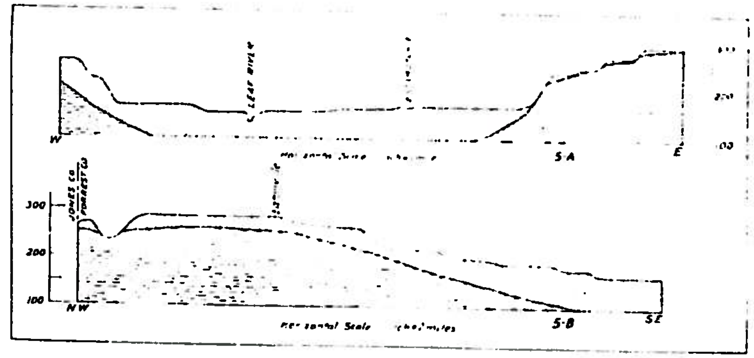


Figure 5.—Profile sections of Leaf River Valley
A. East-west section along Forrest-Jones County line.
B. Northwest-southeast section through Eatonville.

therefore, to distinguish between high terrace deposits and reworked sediments of the Citronelle formation which may have collected on the slopes as colluvium in recent times. The crests of many of the hills, however, correspond in general with the elevations of the high terraces described above, and the sediments more nearly resemble those of the high terraces than those of the Citronelle formation where the latter is undisturbed. It is believed, therefore, that most of the sand and gravel deposits which lie at elevation of less than 280 or 300 feet are remnants of former high terraces or more recent colluvium.

No attempt is made in this report to describe the terrace deposits along the other streams of the county. It is known, however, that both high and low terraces are present along Black Creek, Red River, and a few smaller streams. They closely resemble those of the Leaf and Bouie Rivers, though neither is as extensive nor as well preserved as those bordering the larger streams. Wherever the terraces were seen in the course of the present survey they are shown on the accompanying map. (Plate 1)

STRATIGRAPHIC AND AREAL GEOLOGY

GENERAL

The bedrock of Forrest County consists of a great thickness of massive blue clay, silt, and clayey fine-grained sand of Miocene age, and red gravelly sand probably Pliocene in age. The bedding is indistinct and the lithology remarkably uniform. No key beds or fossiliferous zones are known. The contact between the two Miocene formations (Hattiesburg and Pascagoula) is either covered or gradational and so obscure that it could not be definitely located. The only stratigraphic marker noted, therefore, is the unconformable contact between the Miocene clays and silts and the Pliocene sand.

Outcrops of the Miocene formations are most common on the lower slopes of the cuestas and in the deep narrow valleys which dissect the crests. The Pliocene sand crops out near the crest of the Leaf River-Black Creek divide and along the back-slope of the cuesta between Black Creek and Red River. Colluvium derived from the Pliocene and High Terrace sand extends down the slope in many places, masking the outcrops of the underlying clay.

As previously mentioned high terrace deposits of the larger streams cover the lower cuesta slopes in many places and almost completely cover the bedrock geology over large areas in the northern third of the county. Furthermore, because of the ease with which sands of the Pliocene and High Terrace deposits are eroded, the valley floors of the streams, both large and small, are commonly buried under a considerable thickness of river alluvium and low terrace deposits. For these reasons, good exposures of Miocene clay and silt are rare and of limited extent. The absence of extensive outcrops and the uniform lithology of the formations render a stratigraphic study difficult. In the descriptions which follow, therefore, considerable reliance is placed on test holes and well logs, representative examples of which are cited.

MIOCENE SYSTEM

CLASSIFICATION

That part of Mississippi's geologic section now considered to be of Miocene age was first described in 1854 by B. L. C. Wailes.[2] In his report on the agriculture and geology of Mississippi he described certain prominent ledges of sandstone which, together with associated sandy clay and siltstone, crop out in the bluffs of the Mississippi River in the vicinity of Fort Adams, Wilkinson County, and near Grand Gulf, Claiborne County. To the former he applied the name "Davion Rock," and to the latter, "Grand Gulf Sandstone." He apparently believed the rocks in the two areas of outcrop to be of the same age and traced them up the Homochitto River and its tributaries into central Franklin County and up the Big Black River and Bayou Pierre to the vicinity of Clinton and Raymond in Hinds County. Dr. Wailes did not assign an age designation to these rocks, but from his description it appears that he recognized their stratigraphic position above the limestones at Vicksburg and Jackson (now known to be Oligocene in age) and below the "Orange Sand" (Citronelle).

Dr. L. Harper in 1857[3] did not describe the rocks included in the outcrop area of "The Grand Gulf Sandstone," but erroneously considered the "Lignitic" (Eocene) and the "Orange Sand" (Eocene, Pliocene, and Pleistocene?) to be Miocene in age. The geologic map, which accompanied the report, shows rocks of Eocene age in all that part of the State now known to be underlain by younger sediments. From Dr. Harper's description of the limestones and marls of central Mississippi (Jackson and Vicksburg formations of more recent reports) it appears that he believed them to be continuous southward to the vicinity of the coast.[4]

In 1860 Dr. Eugene W. Hilgard[5] proposed the name Grand Gulf Group for the series of sandstone and sandy clay which crop out in the vicinity of Grand Gulf and Fort Adams. He traced these beds, and described numerous outcrops showing the lithologic character and stratigraphic relations as far eastward as the Chickasawhay and Pascagoula Rivers. Hilgard recognized the age equivalency, and hence the lateral gradation lithologically, of the Grand Gulf sediments at the type locality and the more clayey less consolidated sediments farther east. He also described a change in lithology from north to south. Throughout the outcrop area, his descriptions show the more northerly outcrops to consist of alternating sand or sandstone and sandy clay or siltstone, succeeded toward the south by more massive blue and gray clays, and finally, in the most southerly outcrops, by alternating layers of greenish-gray and light-gray sand or siltstone and sandy clay. Furthermore, the gentle southerly and southwesterly dips are described at a number of localities, and presumably he recognized that the more southerly outcrops were the younger. It is precisely these lithologic differences which were used by later geologists in making the threefold division of the Miocene which is followed in present day usage. Inasmuch as the only fossils found were lignitized plant remains and poorly preserved leaf prints, Hilgard did not definitely specify the age of the sediments except as being post Vicksburg and pre-Pleistocene. He suggested, however, that on the basis of the available data they might logically be considered Eocene in age.[6] Later work led him, in 1881, to suggest the Miocene age of the Grand Gulf Group.[7]

Prior to the work of L. C. Johnson in 1888 all attempts at establishing the age of the Grand Gulf were based entirely on its supposed stratigraphic relations. No fossils, other than a few poorly preserved *Unios* and plant remains of a non-diagnostic character, had been discovered in the sediments of the Grand Gulf. Furthermore, good exposures of the formation were so uncommon, and the contacts so obscured by superficial sediments, that there were those who questioned the stratigraphic relationships described by Hilgard and others. On the basis of a detailed study of stratigraphic relations in Louisiana, Mississippi, and Alabama, Johnson, in 1889, definitely established the age of the Grand Gulf as "not older than Miocene" and "as certainly not Quaternary."[8]

Johnson also discovered Miocene fossils in the section of the Grand Gulf along the lower Chickasawhay and Pascagoula Rivers. He considered these fossiliferous beds as the equivalent of the upper part or the whole of the Grand Gulf in other parts of the State and proposed that, pending the determination of their precise relation, they be called the Pascagoula formation.[9] In 1893 Johnson described the Grand Gulf sediments of Mississippi and Alabama in more detail[10] and traced them into fossiliferous beds in eastern Alabama and adjacent parts of Florida and Georgia. He proposed that in eastern Mississippi the Grand Gulf be divided, in ascending order, into the Ellisville phase, the Hattiesburg phase or formation, and the Pascagoula phase or formation. The division was made on the basis of the lithology, and boundaries described by Johnson do not everywhere include exact age equivalents. In eastern Mississippi, however, they correspond approximately with the contacts of the three Miocene formations as recognized by later authors.

Following the work of Johnson, and coincident with a study of the fossiliferous beds with which he and others had correlated the Grand Gulf, the age of these beds came into question. Dall,[11] Maury,[12] Harris,[13 14] and others considered the lower part of the section, that part lying uncomformably below the Pascagoula, to be Oligocene in age. Smith,[15] and others of the Alabama Survey, erroneously correlated the mottled clays and sands, they found overlying the Pascagoula fossiliferous beds in southern Alabama, with the "typical Grand Gulf" of Mississippi. This they considered as proof that the "Grand Gulf" was a blanket formation younger than the Pascagoula but older than the "Lafayette," and, therefore, Pliocene in age. Subsequently the name "Grand Gulf" was used with various shades of meaning by a number of authors.

Because of the confusion which existed in the use of the name to designate sediments ranging in age from Eocene in western Texas[16] to Pliocene or later in southern Alabama,[15] Veach,[17] in 1906, proposed the name Catahoula formation to replace the "typical Grand Gulf" of Dall and the "Grand Gulf proper" of Harris. The name was taken from the numerous good outcrops of the formation in Catahoula Parish, Louisiana, and special reference was made to an early description which antedated the naming of the Grand Gulf by Wailes.[2]

The term Grand Gulf Group was revived in 1940 by the Mississippi Geological Society[18] and is now used by commercial geologists of the State in much the same sense as originally defined by Hilgard. The validity of the threefold division of the Group as proposed by Johnson, Matson, and others was recognized and, in addition, certain fossiliferous beds of questionable age, lying between the Vicksburg limestone and the Catahoula sands and clays, were tentatively included with the other formations of the Grand Gulf Group. The correlation chart illustrates the changing classification of these strata and the modern usage and correlation of the Miocene formation of Mississippi.

CATAHOULA FORMATION

The Catahoula formation is not exposed at the surface in Forrest County but is reached by numerous wells at depths of 300 to 400 feet in the valleys of the Leaf and Bouie Rivers.

HATTIESBURG FORMATION

At Hattiesburg, the Hattiesburg formation, as exposed in the river bluffs, consists of thick beds of massive clays—150 or 200 feet thick—which contain some lime but very little sand. Wells in the vicinity of Hattiesburg and outcrops in the extreme northeastern corner of the county—as well as outcrops in the adjacent parts of Jones County—show that this thick clay bed is underlain by interbedded sands and clays, the sands increasing in prominence and becoming gravelly toward the base. Outcrops along the higher parts of the river bluffs at Hattiesburg and wells at Camp Shelby show that the thick clay bed is overlain by and grades upward into alternating fine-grained silty sands and clays similar to outcrops of the Pascagoula farther south. In some places this upper sand-clay zone—40 or 50 feet thick—is partly consolidated to a soft sandstone. This interval has usually been considered the uppermost member of the Hattiesburg formation and has been so mapped in the past. That is also the present conception of the oil geologists who have worked in the territory. The burning tests in the laboratory, however, show that the pyro-physical properties of this upper interval more closely resemble the burning properties of the known Pascagoula than of the underlying thick clay. Accordingly, one would be inclined to draw the Hattiesburg-Pascagoula contact at the top of the massive clay bed. However, in the absence of definite proof, it can only be stated that the contact between the two Miocene formations—the Hattiesburg and the Pascagoula—is either covered or gradational and so obscure that it cannot be definitely located.

PASCAGOULA FORMATION

Along the Pascagoula River, the type locality of the Pascagoula formation, an unconformity between the Hattiesburg formation and the overlying Pascagoula formation is supposed to be present. A search along the Pascagoula River from Pascagoula to Merrill and along the Leaf River from Hattiesburg to Beaumont failed to locate an unconformity. Although the out-

CORRELATION CHART

U. S. Geological Survey Correlation Chart Eastern Ala., 1935	Pleis.: Terrace deposits; Plio.: Citronelle form.; Miocene: Choctawhatchee formation, Alum Bluff group (Chipola formation), Tampa limestone; Oligocene: Vicksburg group, Ocala limestone; Eocene
Foster, 1941 Forrest County Miss.	Pleis.: High terraces; Plio.: Citronelle formation; Miocene: Pascagoula formation, Hattiesburg formation, Catahoula formation; Oligocene; Eocene
Miss. Geol. Society 1940	Pleis.: Coastal terraces; Plio.: Citronelle; Miocene, Grand Gulf group: Pascagoula, Hattiesburg, Catahoula; Oligocene, Vicksburg: Chickasawhay, Bucatunna, Byram marl, Glendon ls., Marianna ls., Forest Hill, Red Bluff; Eocene, Jackson group: Yazoo clay, Moodys marl
Matson, 1916 Gulf Coast	Pleis.: Coastal terraces; Plio.: Citronelle formation; Mio.: Pascagoula clay, Hattiesburg clay; Oligocene: Catahoula sandstone, Vicksburg limestone; Eocene: Jackson formation
Deussen, 1914 Texas	Pleis.: Lissie; Plio.: Uvalde; Oakville, Fleming; Catahoula sandstone; Oligocene: Vicksburg; Eocene: Jackson
Veatch, 1906 Louisiana	Pleis.: Port Hudson; Plio.: Lafayette; Plio.: Pascagoula; Fleming clay; Oligocene: Catahoula formation, Vicksburg formation; Eocene: Jackson
Smith, 1907 Alabama	Pleis.; Plio.: Lafayette, Grand Gulf; Miocene: Pascagoula in Mississippi and western Alabama correlated with marine beds in Florida and Georgia; Oligocene: Vicksburg; Eocene: Jackson
Dall, 1896 Gulf Coast	Pleis.: Columbia; Plio.: Lafayette; Miocene: Oakville beds, Pascagoula, Chesapeake; Alum Bluff beds, Oak Grove sand, Tampa beds, Chipola beds, Upper Chattahoochee, Altamaha grit; Lower Chattahoochee, Typical Grand Gulf, Hawthorn beds, Shell Bluff group (?); Oligocene, Vicksburg: Ocala group, Coral limestone, Vicksburg, Red Bluff; Eocene: Jackson, Moodys Branch beds, Yazoo [illegible]
Johnson, 1893 East Miss.	Pleis.: Terraces; Plio.: Lafayette; Miocene, Grand Gulf group: Pascagoula formation, Hattiesburg formation, Ellisville phase; Oligocene: Vicksburg; Eocene: Jackson
Hilgard, 1860 Mississippi	Pleistocene: Brown-loam Bluff, Orange sand; Miocene ?: Grand Gulf group; Eocene: Vicksburg, Jackson
Harper, 1857 Mississippi	Post-plio.: Alluvium, Loess; Plio.: Orange Sand group; Eocene: Vicksburg and Jackson Marls; Miocene ?: Lignite group
[illegible] 1854 [illegible]ippi	[illegible]

crops are few and usually obscured by terrace deposits, all consist from top to bottom of interbedded fine-grained silty sands, silts, and sandy clays similar to the outcrops of the Pascagoula near Brooklyn in Forrest County. In contrast to the typical Hattiesburg clay, which is blue at or near the surface and light chocolate in the deeper test holes, the Pascagoula clay is more nearly sky blue and commonly has a somewhat greenish tint. Furthermore, the clays of the Pascagoula are more sandy, and sand beds several feet in thickness are not uncommon.

PLIOCENE SYSTEM

CLASSIFICATION

Because of the confusion in the use of all prior names, Matson in 1916, proposed the name Citronelle formation for those beds of sand, gravel, and clay which disconformably overlie the Miocene sediments of southern Alabama and Mississippi and are in turn disconformably overlain by the coastal terrace deposits. The name was derived from typical exposures in the vicinity of Citronelle, Mobile County, Alabama.

CITRONELLE (?) FORMATION

In Forrest County most of the material formerly mapped as Citronelle is, in reality, River Terrace. Possibly the entire formation, with the exception of one or two outcrops, could logically be referred to terrace deposits—as in Louisiana where the name Citronelle has been abandoned. In Forrest County, one or two outcrops of interbedded sand and clay unconformably overlie the Pascagoula and seemingly have the same regional dip as the lower formation. In appearance these outcrops are the same as those described near the type locality of the Citronelle formation. On the geologic map of Forrest County, the Citronelle is shown as capping the highest parts of the cuestas. From the character of the sediments, however, and the stratigraphic relations of these sediments, they could just as logically be considered high terrace deposits.

PLIOCENE (?) OR PLEISTOCENE (?) SYSTEM

HIGH TERRACES

As stated under the heading of "Topography" where the physiographic expression of the High Terraces was described in some detail, these high terraces may be seen best between the Bouie and Leaf Rivers where the uppermost is known as the

Eatonville flat. Along a road extending through the Village of Eatonville southeastward toward the Leaf, four major terraces including the Eatonville plain are visible above the first of the Low Terraces—and the lowest of the four major terraces consists in places of three levels, separated the one from the other by six-foot and eight-foot terrace scarps (Figure 5B). Although the underlying Hattiesburg clay was not seen on October 18, 1941, yet there is no doubt of the correctness of this Eatonville cross section by Foster, for the reason that the underlying Hattiesburg clay is well exposed beneath the terrace material along the Forrest-Jones County line section (Figure 5A), and because of spring water that pours out beneath the sand into Providence Branch near the northwestern end of the Eatonville cross section.

Material of the Eatonville terrace near the Jones County line consists in descending order of soil, subsoil, weathered sand, and fresh sand associated with which is a small amount of fine gravel—all surficial. Both the sand and the gravel are somewhat cross-bedded and otherwise irregularly bedded. Material of the second terrace consists likewise of soil, subsoil, weathered sand, fresh sand and a very small quantity of fine gravel. Both the sand and the gravel are likewise cross-bedded. Materials of each of the succeeding major terraces and minor terraces consist, so far as determinable at the surface, of soil and weathered sand subsoil.

RECENT SYSTEM

LOW TERRACES—ALLUVIUM

It may not be possible to differentiate the materials of the lower of the low terraces or even of the upper of the low terraces from the alluvium on topographic evidence, for the reason that in extreme high waters all may be flooded. Accordingly, they are, in reality, not materials of terraces but of higher bottoms of the flood plain still subjected to coverage. Perhaps it is well, therefore, to consider the material of all of them as alluvium. As alluvium, it consists of the ordinary flood plain sand and gravel, and silts and clays. Between the Bouie and the Leaf, the sands and gravels have been deposited in great thicknesses. If to the 18.5 feet of sand and gravel above the present low water (stream level) in the gravel pits be added some 40 to 60 feet of sand, gravel, and clay that are being pumped from beneath the pit water, the total thickness is 60 to 80 feet of sand and gravel.

TEST HOLE RECORDS

A total of 191 test holes were drilled within the limits of Forrest County. A part of these were drilled to assist in a study of the stratigraphic relations and areal distribution of the several geologic formations, a part were drilled in order to discover deposits of possible economic value, and a part were drilled to determine the extent of known deposits. It was not thought to be worthwhile to reproduce the records (logs) of all test holes drilled, as many encountered nothing of economic value and others served only to confirm the presence and lateral extent of beds encountered and sampled in other holes. In the several pages which follow there are reproduced the records (logs) of all test holes from which samples were tested in the laboratory. In addition there are included records of other representative test holes from virtually every part of the county. These records serve to illustrate the stratigraphic and economic geology of the county and reference is made to them by number in both the Geology and Tests sections of the report. The records (logs) of all test holes drilled within the county may be consulted in the files of the Mississippi Geological Survey at University, Mississippi.

The ceramic tests do not show significant differences in the pyrophysical characteristics of the several formations, and no attempt is made, therefore, to group the test hole records (logs) according to formations, or according to the ceramic qualities of the samples collected. Rather, the records are numbered consecutively in the order in which the test holes were drilled. The test hole numbers and sample numbers constitute a cross index between the several parts of the report.

HATTIESBURG BRICK WORKS PROPERTY

TEST HOLE 1

Location: T.5 N., R.13 W., Sec. 32, SW.1/4, SW.1/4: 250 feet east of the east side of Hattiesburg Water Works Pumping Station

Drilled: October 9, 1939

Elevation: 239 feet

Water level: 30.5 feet

No.	Depth	Thick.	Description of strata
			High Terrace (?)
1	1.0	1.0	Sand, coarse grained
			Hattiesburg formation
2	3.1	2.1	Sand, reddish brown semi-plastic medium grained clayey; C-1
3	7.3	4.2	Clay, variegated red, gray, and yellow, plastic sandy, slightly carbonaceous; P-1
4	19.5	12.2	Clay, brownish gray semi-plastic sandy, slightly carbonaceous; P-2
5	33.0	13.5	Clay, dark gray semi-plastic sandy, carbonaceous, slightly limey, very silty; C-2
6	40.5	7.5	Clay, light gray and yellow semi-plastic silty, carbonaceous; C-3

HATTIESBURG BRICK WORKS PROPERTY

TEST HOLE 1A

Location: T.5 N., R.13 W., Sec. 32, SW.1/4, SW.1/4: 250 feet east of the east side of Hattiesburg Water Works Pumping Station

Drilled: October 9, 1939

Elevation: 239 feet

Water level: 30.5 feet

No.	Depth	Thick.	Description of strata
			High Terrace (?)
1	1.0	1.0	Sand, brownish gray
			Hattiesburg formation
2	3.7	2.7	Sand, reddish brown semi-plastic clayey
3	50.6	46.9	Clay, light gray sandy, slightly micaceous, slightly limey; mottled with red and yellow limonite stains; P-1

Hattiesburg Brick Works Property

Test Hole 2A

Location: T.5 N., R.13 W., Sec. 32, NW.1/4, SW.1/4; 350 feet north and 40 feet east of the northeast corner of the Hattiesburg Water Works Pumping Station

Drilled: October 5, 1939

Elevation: 204 feet

Water level: 40.5 feet

No.	Depth	Thick.	Description of strata
			Hattiesburg formation
1	1.6	1.6	Clay, light brown and gray plastic silty
2	13.9	12.3	Silt, light gray semi-plastic clayey, slightly micaceous, slightly carbonaceous; C-1
3	59.1	45.2	Clay, light gray silty, micaceous; P-1

Remarks: Intervals 1 and 2 correspond to the lower part of interval 3 in Test Hole 1A.

Hattiesburg Brick Works Property

Test Hole 3

Location: T.5 N., R.13 W., Sec. 32, NW.1/4, SW.1/4; 125 feet north of Test Hole 2A

Drilled: March 15, 1939

Elevation: 156 feet

Water level: 12.0 feet

No.	Depth	Thick.	Description of strata
			Hattiesburg formation
1	36.0	36.0	Clay, light gray to dark bluish gray plastic silty, limonitic, slightly limey; P-1
2	47.5	11.5	Clay, dark bluish gray plastic silty, carbonaceous; interbedded with white limey clay; P-2
3	66.0	18.5	Clay, same as interval 2; P-3
4	67.8	1.8	Sand, light bluish gray fine grained semi-plastic clayey; slightly micaceous

Remarks: Sample F-3A-P-1 is a composite sample of intervals 1, 2, and 3.

A. R. Sumrall Property

Test Hole 5

Location: T.5 N., R.13 W., Sec. 31, NW.1/4, SE.1/4; 75 feet east of residence

Drilled: October 17, 1939

Elevation: 267 feet

Water level: 20.1 feet

No.	Depth	Thick.	Description of strata
			High Terrace
1	1.3	1.3	Topsoil
2	24.0	22.7	Sand, variegated red, brown, and yellow, fine grained lignite; C-1
			Hattiesburg formation
3	43.0	19.0	Clay, gray plastic sandy, carbonaceous; upper part stained with limonite; 5A-P-1
4	60.5	17.5	Clay, same as interval 3

Remarks: Sample F-5-P-1 is a composite sample of intervals 3 and 4.

Mrs. J. T. Burch Property

Test Hole 6

Location: T.5 N., R.14 W., Sec. 25, SW.1/4, SE.1/4; 450 feet southeast of highway crossing and 30 feet east of the center line of the road

Drilled: March 17, 1939

Elevation: 225 feet

Water level: 54.0 feet

No.	Depth	Thick.	Description of strata
			High Terrace (?)
1	3.1	3.1	Topsoil
2	4.2	1.1	Sand, variegated light gray, orange, and red, clayey; C-1
3	12.3	8.1	Clay, light gray and brown semi-plastic; P-1
4	77.2	64.9	Sand and silt, fine grained clayey, micaceous

Mississippi Southern College Property

Test Hole 7

Location: T.4 N., R.13 W., Sec. 7, NW.1/4, NW.1/4; 500 feet northwest of bridge crossing the Mississippi Central Railroad and 70 feet south of the railroad

Drilled: March 22, 1939

Elevation: 247 feet

Water level: 24.4 feet

No.	Depth	Thick.	Description of strata
			Hattiesburg formation (?)
1	0.5	0.5	Topsoil
2	7.0	6.5	Clay, reddish brown and gray sandy; contains scattered small chert gravels embedded in clay; C-1
3	55.5	48.5	Clay, light gray slightly sandy, carbonaceous slightly limey; contains a few scattered quartz and chert pebbles as large as 0.5 inches in diameter; P-1

A. R. Sumrall Property

Test Hole 8

Location: T.5 N., R.13 W., Sec. 31, NE.1/4, SW.1/4; 175 feet southeast of Mixon Creek bridge and 30 feet west of Highway U. S. 49 center line

Drilled: October 11, 1939

Elevation: 211 feet

Water level: 50.5 feet

No.	Depth	Thick.	Description of strata
			Hattiesburg formation (?)
1	0.2	0.2	Topsoil
2	2.7	2.5	Clay, gray-brown plastic slightly sandy, slightly carbonaceous; C-1
3	50.8	48.1	Silt, light gray plastic clayey; limey carbonaceous; P-1
4	51.8	1.0	Sand, light bluish gray coarse grained

Markie E. Stevens Property

Test Hole 12A

Location: T.4 N., R.13 W., Sec. 6, NW.1/4, NE.1/4; 0.4 mile south of Highway U. S. 49 and 80 feet east of center line of north-south road

Drilled: October 16, 1939

Elevation: 215 feet

Water level: 28.2 feet

No.	Depth	Thick.	Description of strata
			Hattiesburg formation
1	0.8	0.8	Topsoil
2	43.6	42.8	Clay, light gray carbonaceous, limey, silty, micaceous; stained with limonite; P-1

J. J. Newman Lumber Co. Property

Test Hole 14A

Location: T.5 N., R.14 W., Sec. 27, NW.1/4, NE.1/4; 0.4 mile west of road junction at section corner and 30 feet south of section line

Drilled: October 12, 1939

Elevation: 238 feet

Water level: Dry

No.	Depth	Thick.	Description of strata
			Hattiesburg formation (?)
1	0.7	0.7	Topsoil
2	4.8	4.1	Sand, light brown and gray very fine grained; contains pea-gravel
3	44.8	40.0	Clay, light gray to light brown plastic sandy, carbonaceous; contains scattered pea-gravel; P-1

McCaughey and Calhoun Property

Test Hole 20

Location: T.5 N., R.14 W., Sec. 11, SE.1/4, SE.1/4; 0.95 mile north of Bouie River bridge and 50 feet west of road

Drilled: April 17, 1939

Elevation: 240 feet

Water level: 19.3 feet

No.	Depth	Thick.	Description of strata
			Low Terrace (?)
1	0.7	0.7	Topsoil
2	5.0	4.3	Clay, dark reddish brown sandy; contains scattered pea-gravel; C-1
3	13.0	8.0	Sand, reddish brown semi-plastic clayey, gravelly; C-2
4	19.3	6.3	Sand, red, brown, and gray, clayey; C-3
			Hattiesburg formation
5	42.0	22.7	Clay, light gray plastic carbonaceous, very sandy; contains scattered pea-gravel; P-1

Tatum Lumber Co. Property

Test Hole 43

Location: T.4 N., R.13 W., Sec. 29, SW.1/4, SW.1/4; 0.9 mile south of Southern Railway overpass on Highway U. S. 11 and 60 feet west of pavement

Drilled: May 3, 1939

Water level: 20.0 feet

Elevation: 251 feet

No.	Depth	Thick.	Description of strata
			Hattiesburg formation
1	0.7	0.7	Topsoil
2	5.8	5.1	Sand, light brown and red slightly clayey
3	13.4	7.6	Clay, light brown and gray sandy; stained with limonite; P-1
4	26.1	12.7	Clay, gray plastic carbonaceous, limey; C-2

J. S. Turner Property

Test Hole 46A

Location: T.3 N., R.13 W., Sec. 6, SW.1/4, SW.1/4; 0.7 mile south of Highway U. S. 11 at road intersection and 50 feet west of road

Drilled: October 18, 1939

Water level: 15.4 feet

Elevation: 353 feet

No.	Depth	Thick.	Description of strata
			Citronelle formation (?)
1	1.2	1.2	Topsoil
2	13.0	11.8	Sand, dark brown fine grained, contains scattered pea gravel; C-1
			Hattiesburg formation (?)
3	47.3	34.3	Clay, variegated red and gray plastic sandy; contains scattered gravel; P-1

W. J. Morris Property

Test Hole 47

Location: T.4 N., R.13 W., Sec. 20, NW.1/4, NE.1/4; 800 feet north of road junction on Highway U. S. 11 and 100 feet east of the highway

Drilled: May 11, 1939

Water level: 16.6 feet

Elevation: 217 feet

No.	Depth	Thick.	Description of strata
			High Terrace (?)
1	0.8	0.8	Topsoil
2	5.9	5.1	Sand, light brown and gray coarse grained slightly clayey; contains scattered gravel; C-1
3	11.1	5.2	Sand, light gray fine grained very clayey; limonite stained; C-2
			Hattiesburg formation
4	18.7	7.6	Clay, light gray to light brown semi-plastic sandy, micaceous; P-1
5	35.2	16.5	Clay, light brown carbonaceous, limey; P-2
6	45.1	9.9	Clay, same as interval 5; P-3

P. B. Johnson Property

Test Hole 51

Location: T.4 N., R.13 W., Sec. 34, SW.1/4, SE.1/4; 0.8 mile south of road junction with Highway U. S. 49 and 300 feet west of the highway

Drilled: May 17, 1939

Water level: 21.4 feet

Elevation: 188 feet

No.	Depth	Thick.	Description of strata
			Hattiesburg formation
1	0.2	0.2	Topsoil
2	14.5	14.3	Clay, light gray sandy limonitic; P-1
3	30.4	15.9	Clay, light gray lignitic, limey; C-1

Mrs. M. L. Rogers Property

Test Hole 57

Location: T.3 N., R.13 W., Sec. 11, SE.1/4, SW.1/4; 0.4 mile south of road junction with Highway U. S. 11 and 70 feet west of the highway

Drilled: May 24, 1939

Elevation: 207 feet

Water level: 11.6 feet

No.	Depth	Thick.	Description of strata
			High Terrace
1	0.4	0.4	Topsoil
2	3.2	2.8	Sand, red clayey, gravelly; C-1
			Hattiesburg formation
3	11.6	8.4	Clay, light brown sandy, micaceous; mottled with red, yellow, and gray; C-2
4	12.5	0.9	Sand, light gray fine grained clayey, micaceous
5	13.7	1.2	Clay, red silty; interlaminated with gray clay; C-3
6	27.6	13.9	Clay, light gray plastic sandy; P-1

City of Hattiesburg Property

Test Hole 86

Location: T.4 N., R.13 W., Sec. 14, SW.1/4, SW.1/4; 80 feet north of gravel pit road at Mississippi Central Railroad spur and 40 feet west of the track

Drilled: June 19, 1939

Elevation:

Water level: 8.2 feet

No.	Depth	Thick.	Description of strata
			Low Terrace
1	1.4	1.4	Topsoil
2	2.6	1.2	Sand, light brown fine grained, grit-bearing
3	8.2	5.6	Sand and gravel, light yellow and white coarse grained; the pebbles range in size upward to about 0.7 inch; C-2. Sample P-1 is a sample of the washed sand from the pit

Remarks: Hole drilled on banks of gravel pit said to be 40 or 50 feet in depth. Drilling below the water level was not feasible with hand tools. It is estimated that between 1,500,000 and 2,000,000 cubic yards of the washed sand are available.

The Dixie Tung Empire Corp. Property

Test Hole 90

Location: T.1 S., R.12 W., Sec. 4, NW.1/4, SW.1/4; 0.25 mile north of overpass at abandoned railroad grade and 100 feet west of Highway U. S. 49

Drilled: June 20, 1939

Elevation: 215 feet

Water level: 4.8 feet

No.	Depth	Thick.	Description of strata
			Alluvium
1	0.6	0.6	Topsoil
2	7.4	6.8	Sand, light brown to white very fine grained; C-1
3	32.7	25.3	Clay, light gray to blue-gray plastic very sandy; contains isolated quartz and chert pebbles and fragments of white chalky material; P-1

Luther Lovett Property

Test Hole 91

Location: T.5 N., R.14 W., Sec. 3, NE.1/4, NW.1/4; west side of gravel pit road, 0.3 mile north of Gulf and Ship Island Railroad crossing

Drilled: June 20, 1939

Elevation:

Water level: 7.1 feet

No.	Depth	Thick.	Description of strata
			Low Terrace of Bouie River
1	0.7	0.7	Topsoil
2	2.3	1.6	Sand, light yellow to gray very fine grained silty, limonitic; C-1
3	6.5	4.2	Sand, light gray very fine grained silty; limonitic in part; C-2
4	7.7	1.2	Sand, gray to white coarse grained, gravel bearing; C-3. Sample P-1 is from the washed sand.

Remarks: Hole drilled near edge of gravel pit. It is estimated that a minimum of 1,000,000 to 1,500,000 cubic yards of the washed sand are available in the old pit.

Forrest County Sand and Gravel Co. Property

Test Hole 93

Location: T.5 N., R.13 W., Sec. 33, NE1/4, SE1/4; 0.35 mile southeast of road junction at Hickory Grove Church and on the eastern bank of the gravel pit

Elevation:

Drilled: June 20, 1939

Water level: 21.6 feet

No.	Depth	Thick.	Description of strata
			River alluvium
1	0.2	0.2	Topsoil
2	2.3	2.1	Clay, dark red sandy, contains scattered pea gravel
3	9.1	6.8	Sand and gravel, very clayey; C2
4	25.2	16.1	Sand and gravel, very clayey; C3. Sample P1 is from the washed sand in the old pit

Remarks: It is estimated that 3,500,000 to 4,000,000 cubic yards of the washed sand are available.

U. S. Forestry Service Property

Test Hole 100

Location: T.2 N., R.12 W., Sec. 20, SW1/4, SE1/4; 1.6 miles south of bridge, 37987 and 300 feet east of Highway U. S. 49

Elevation:

Drilled: July 6, 1939

Water level: 8.3 feet

No.	Depth	Thick.	Description of strata
			Pascagoula formation
1	0.6	0.6	Clay, light gray slightly sandy
2	1.8	1.2	Clay, dark brown sandy
3	17.1	15.3	Clay, dark to light gray plastic sandy, micaceous, carbonaceous, lower 2.0 feet stained with limonite; P1
4	25.9	8.8	Sand, light red to gray clayey, micaceous, limonitic

Tatum Lumber Co. Property

Test Hole 102

Location: T.4 N., R.13 W., Sec. 20, NE1/4, SW1/4; 190 feet west of road intersection and 40 feet east of road

Elevation: 235 feet

Drilled: July 11, 1939

Water level: 10.6 feet

No.	Depth	Thick.	Description of strata
			Hattiesburg formation (?)
1	0.6	0.6	Topsoil
2	4.6	4.0	Clay, gray semi-plastic, sandy; C1
3	19.6	15.0	Clay, variegated gray and red slightly carbonaceous; grades downward to light gray; P1
4	20.5	0.9	Clay, variegated gray and red very plastic slightly sandy; C2
5	21.5	1.0	Clay, variegated red and gray limey, sandy

Tatum Lumber Co. Property

Test Hole 105

Location: T.4 N., R.13 W., Sec. 20, SE1/4, SW1/4; 0.2 mile west of road junction with Highway U. S. 11 and 70 feet south of road

Elevation: 231 feet

Drilled: July 14, 1939

Water level: 12.0 feet

No.	Depth	Thick.	Description of strata
			Hattiesburg formation (?)
1	0.4	0.4	Topsoil
2	12.0	11.6	Sand, brown, gray, and white slightly clayey; C1
3	17.5	5.5	Clay, light gray sandy; contains scattered small pebbles, in part consists of interbedded sand and clay; C2
4	33.6	16.1	Clay, light brown and gray sandy, carbonaceous, limonitic; contains scattered gravel as large as 2 x 2½ inches; P1
5	44.9	11.3	Clay, same as interval 4; C3

Tatum Lumber Co. Property

Test Hole 106A

Location: T 4 N., R.13 W., Sec. 20, NE 1/4, SW 1/4, 0.4 mile north of Southern Railway overpass and 60 feet west of Highway U. S. 11

Elevation: 214 feet

Drilled: October 4, 1939

Water level: 30.0 feet

No.	Depth	Thick.	Description of strata
			Hattiesburg formation
1	0.5	0.5	Topsoil
2	6.7	6.2	Clay, light gray and brown plastic slightly sandy, limonitic
3	21.7	15.0	Silt, variegated red, brown, yellow, and gray, plastic clayey, micaceous
4	25.5	3.8	Clay, light gray plastic sandy, limonitic
5	41.6	16.1	Silt, light gray clayey, limonitic
6	65.5	23.9	Clay, light bluish gray to brown carbonaceous, sandy, limonitic; some parts semi-consolidated; P-1

Tatum Lumber Co. Property

Test Hole 108

Location: T 4 N., R.13 W., Sec. 21, NW.1/4, SW.1/4, 100 feet south of Bonhomie, Hattiesburg and Southern Railroad and 150 feet east of gravel road

Elevation: 202 feet

Drilled: July 19, 1939

Water level: 32.0 feet

No.	Depth	Thick.	Description of strata
			Hattiesburg formation
1	0.6	0.6	Topsoil
2	32.0	31.4	Clay, light gray sandy, limey; mottled with brown limonitic stains, P-1
3	52.3	20.3	Clay, light gray plastic carbonaceous, very sandy; P-2
4	61.5	9.2	Clay, gray plastic sandy; partly limonite stained; C-1

John B. Burkett Property

Test Hole 117

Location: T 4 N., R.12 W., Sec. 29, NW 1/4, SE 1/4, 0.25 mile southeast of Carter's Creek bridge and [illegible] feet northeast of gravel road

Elevation [illegible]

Drilled: July 25, 1939

Water level: Dry

No.	Depth	Thick.	Description of strata
			High Terrace
1	1.2	1.2	Topsoil
2	6.7	5.5	Sand, brownish gray fine grained clayey; grades downward to clay
3	8.8	2.1	Clay, variegated gray, red, and yellow, sandy
4	28.6	19.8	Sand, variegated light brown and white; contains pea gravel; P-1

Mississippi Southern College Property

Test Hole 121

Location: T 4 N., R.13 W., Sec. 7, SE.1/4, NW 1/4; 0.5 mile west of Administration Building at Mississippi Southern College and 90 feet south of road center

Elevation: 232 feet

Drilled: July 26, 1939

Water level: 30.4 feet

No.	Depth	Thick.	Description of strata
			Hattiesburg formation
1	1.0	1.0	Topsoil
2	6.6	5.6	Sand, light brownish gray semi-plastic limonitic; grades downward to clay; C-1
3	30.4	23.8	Clay, gray plastic sandy; stained red, purple, and light brown with limonite; P-1
4	31.3	0.9	Sand, gray clayey
5	37.6	6.3	Clay, gray semi-plastic sandy; C-2
6	49.8	12.2	Clay, gray and light brown hard massive sandy; P-2
7	57.5	7.7	Clay, same as interval 6, C-3
8	60.7	3.2	Clay, same as interval 6

MISSISSIPPI SOUTHERN COLLEGE PROPERTY

TEST HOLE 121A

Location: T.4 N., R.13 W., Sec. 7, SE.1/4, NW.1/4; 5.0 feet east of Test Hole 121

Drilled: October 26, 1939

Elevation: 232 feet

Water level: 26.5 feet

No.	Depth	Thick.	Description of strata
			Hattiesburg formation
1	0.6	0.6	Topsoil
2	10.4	9.8	Sand, gray and brown slightly clayey; C-1
3	30.1	19.7	Clay, light gray to light brown very sandy, micaceous; P-1
4	36.4	6.3	Sand, light gray coarse grained clayey, micaceous; C-2
5	61.4	25.0	Clay, light gray very sandy, carbonaceous; P-2

W. J. MORRIS PROPERTY

TEST HOLE 155

Location: T.4 N., R.13 W., Sec. 20, NW.1/4, NE.1/4; 800 feet north of road junction on Highway U. S. 11 and 400 feet east of the highway

Drilled: Sept. 20, 1939

Elevation: 217 feet

Water level: 6.0 feet

No.	Depth	Thick.	Description of strata
			High Terrace
1	0.8	0.8	Topsoil
2	11.4	10.6	Sand and gravel, light brown and gray clayey
3	27.7	16.3	Clay, light gray plastic very sandy; bears scattered small pebbles and limonite stains throughout; P-1
4	35.8	8.1	Clay, same as interval 3; P-2

W. J. MORRIS PROPERTY

TEST HOLE 156

Location: T.4 N., R.13 W., Sec. 20, NW.1/4, NE.1/4; 950 feet north of road junction on Highway U. S. 11 and 100 feet east of highway

Drilled: Sept. 21, 1939

Elevation: 231 feet

Water level: 18.5 feet

No.	Depth	Thick.	Description of strata
			High Terrace (?)
1	0.6	0.6	Topsoil
2	9.4	8.8	Sand, light brown slightly clayey
3	17.4	8.0	Clay, light gray semi-plastic silty, very limonitic; P-1
4	20.5	3.1	Sand, light gray coarse grained; stained with limonite
5	29.0	8.5	Clay, light gray plastic sandy, gravel-bearing; P-2
6	48.7	19.7	Clay, light brown, same as interval 5; P-3
7	58.8	10.1	Clay, brown, same as interval 6; P-4

TATUM LUMBER CO. PROPERTY

TEST HOLE 157

Location: T.4 N., R.13 W., Sec. 20, NE.1/4, SW.1/4; 0.2 mile north of Southern Railway overpass and 60 feet west of Highway U. S. 11

Drilled: Sept. 20, 1939

Elevation: 216 feet

Water level: Dry

No.	Depth	Thick.	Description of strata
			Hattiesburg formation
1	0.5	0.5	Topsoil
2	3.7	3.2	Silt, light gray and brown semi-plastic
3	37.3	33.6	Clay, bluish gray and brown massive plastic very silty, sandy, limey; P-1

W. J. MORRIS PROPERTY

TEST HOLE 158

Location: T.4 N., R.13 W., Sec. 20, NE.1/4, NW.1/4; 800 feet north of road junction on Highway U. S. 11 and 200 feet west of the highway

Drilled: Sept. 22, 1939

Elevation: 219 feet

Water level: 22.8 feet

No.	Depth	Thick.	Description of strata
			High Terrace
1	2.0	2.0	Topsoil
2	3.2	1.2	Sand, light brown clayey
3	41.0	37.8	Clay, interlaminated red, yellow, and gray, plastic sandy; contains a few scattered gravel in upper part; P-1

TATUM LUMBER CO. PROPERTY

TEST HOLE 159

Location: T.4 N., R.13 W., Sec. 20, NE.1/4, SW.1/4, 0.4 mile north of Southern Railway overpass on Highway U. S. 11 and 185 feet west of the highway

Elevation: 220 feet — Drilled: Sept. 21, 1939 — Water level: 18.0 feet

No.	Depth	Thick.	Description of strata
			Hattiesburg formation
1	1.3	1.3	Topsoil
2	18.5	17.2	Clay, light gray semi-plastic carbonaceous, slightly limey, sandy; limonite stained throughout; grades downward to sand; P-4

TATUM LUMBER CO. PROPERTY

TEST HOLE 160

Location: T.4 N., R.13 W., Sec. 20, SE.1/4, SW.1/4; 250 feet north of Highway U. S. 11 underpass

Elevation: 211 feet — Drilled: Sept. 25, 1939 — Water level: 19.5 feet

No.	Depth	Thick.	Description of strata
			Hattiesburg formation
1	0.5	0.5	Topsoil
2	3.5	3.0	Silt, light gray very sandy, limonite stained
3	15.2	11.7	Clay, reddish brown and gray semi-plastic sandy; P-4
4	29.2	14.0	Clay, gray; same as interval 3; P-2
5	32.7	3.5	Clay, same as interval 4
6	37.5	4.8	Sand, light gray fine grained clayey, limonitic

W. J. MORRIS PROPERTY

TEST HOLE 161

Location: T.4 N., R.13 W., Sec. 20, NW.1/4, NE.1/4, 0.1 mile north of road junction on Highway U. S. 11 and 100 feet east of the highway

Elevation: 221 feet — Drilled: Sept. 25, 1939 — Water level: 14.3 feet

No.	Depth	Thick.	Description of strata
			Hattiesburg formation (?)
1	0.8	0.8	Topsoil
2	14.7	13.9	Sand, light brown and gray fine grained clayey
3	28.2	13.5	Clay, light gray plastic silty, stained with limonite; contains scattered small gravel; P-4

TATUM LUMBER CO. PROPERTY

TEST HOLE 162

Location: T.4 N., R.13 W., Sec. 21, NW.1/4, SW.1/4, 100 feet south of Bonhomie, Hattiesburg and Southern Railroad and 150 feet west of gravel road

Elevation: — Drilled: Sept. 26, 1939 — Water level: Dry

No.	Depth	Thick.	Description of strata
			Hattiesburg formation
1	0.9	0.9	Topsoil
2	6.9	6.0	Clay, reddish brown semi-plastic sandy; P-4
3	30.5	23.6	Clay, light gray semi-plastic slightly limey; P-2
4	43.7	13.2	Clay, same as interval 3; P-3

TATUM LUMBER CO. PROPERTY

TEST HOLE 163

Location: T.4 N., R.13 W., Sec. 29, NW.1/4, NE.1/4; 0.3 mile south of Southern Railway overpass on Highway U. S. 11 and 225 feet east of the highway

Elevation: 236 feet — Drilled: Oct. 2, 1939 — Water level: 15.8 feet

No.	Depth	Thick.	Description of strata
			High Terrace
1	0.9	0.9	Topsoil
2	10.3	9.4	Sand, light brown and white clayey, limonitic; gravel-bearing in lower part
			Hattiesburg formation (?)
3	45.7	35.4	Clay, light gray plastic micaceous, slightly sandy; limonite stained in part; contains scattered gravel; P-4

G. SARTIN PROPERTY

TEST HOLE 164

Location: T.4 N., R.13 W., Sec. 17, SW.1/4, NW.1/4; 0.7 mile south of Hardy Street at road intersection and 90 feet east of section line road between Sections 17 and 18

Elevation: — Drilled: Sept. 27, 1939 — Water level: Dry

No.	Depth	Thick.	Description of strata
			Hattiesburg formation
1	1.4	1.4	Topsoil
2	4.5	3.1	Sand, reddish brown very fine grained
3	37.5	33.0	Clay, variegated brown and gray, massive semi-plastic sandy; P-4
4	53.0	15.5	Clay, same as interval 3; P-3

W. J. Morris Property

Test Hole 165

Location: T.4 N., R.13 W., Sec. 20, NE 1/4, NW 1/4; 0.45 mile west along road crossing Highway U. S. 11 and 0.15 mile south of road

Elevation:

Drilled: Oct. 4, 1939

Water level: 14.0 feet

No.	Depth	Thick.	Description of strata
			High Terrace
1	0.9	0.9	Topsoil
2	6.8	5.9	Sand, light brown fine grained grit bearing, clayey
3	9.3	2.5	Clay, light gray plastic sandy, limonitic
4	10.1	0.8	Sand, light brown grit-bearing
			Hattiesburg formation
5	49.2	39.1	Clay, light gray plastic carbonaceous, slightly sandy; P-1

Tatum Lumber Co. Property

Test Hole 166

Location: T.4 N., R.13 W., Sec. 29, NE.1/4, NW.1/4; 0.25 mile south of Southern Railway overpass and 50 feet west of Highway U. S. 11

Elevation: 237 feet

Drilled: Oct. 24, 1939

Water level: 40.0 feet

No.	Depth	Thick.	Description of strata
			Hattiesburg formation
1	0.7	0.7	Topsoil
2	2.2	1.5	Sand, light brown slightly clayey; C-1
3	76.1	73.9	Clay, bluish gray massive plastic and semi-plastic slightly carbonaceous, slightly limey, limonitic; P-1
4	105.6	29.5	Clay, same as interval 3; P-2
5	120.6	15.0	Clay, brown and gray, same as interval 4

Tatum Lumber Co. Property

Test Hole 167

Location: T.4 N., R.13 W., Sec. 29, NE.1/4, NW.1/4, 0.35 mile south of Southern Railway underpass and 50 feet west of Highway U. S. 11

Elevation: 242 feet

Drilled: Oct. 6, 1939

Water level: 12.0 feet

No.	Depth	Thick.	Description of strata
			Hattiesburg formation
1	0.2	0.2	Topsoil
2	63.9	63.7	Clay, light gray plastic sandy; upper few feet are streaked and mottled with limonite stains; P-1

Tatum Lumber Co. Property

Test Hole 168

Location: T.4 N., R.13 W., Sec. 29, SE.1/4, NW.1/4; 0.5 mile south of Southern Railway overpass and 200 feet west of Highway U. S. 11

Elevation: 244 feet

Drilled: Oct. 3, 1939

Water level: 24.6 feet

No.	Depth	Thick.	Description of strata
			Hattiesburg formation (?)
1	0.9	0.9	Topsoil
2	3.5	2.6	Clay, light brown plastic sandy, limonitic; P-1
3	15.8	12.3	Sand, light gray and brown clayey
4	23.3	7.5	Clay, light brown plastic sandy, limonitic, P-2
5	34.5	11.2	Sand, light gray grit bearing, clayey, limonitic

A. R. Sumrall Property

Test Hole 169

Location: T.5 N., R.13 W., Sec. 31, SE.1/4, SW.1/4; 0.3 mile west of Hilltop House Nite Club and 30 feet south of gravel road

Elevation:

Drilled: Oct. 17, 1939

Water level: Dry

No.	Depth	Thick.	Description of strata
			Hattiesburg formation
1	0.7	0.7	Topsoil
2	31.5	30.8	Clay, light gray and brown massive plastic very limey, limonitic; P-1
3	53.8	22.3	Silt, light bluish gray semi-plastic clayey, slightly micaceous; C-1

A. R. Sumrall Property

Test Hole 170

Location: T.5 N., R.13 W., Sec. 31, NW.1/4, SW.1/4; 0.44 mile west of Hill-top House Nite Club and 50 feet north of gravel road

Elevation: 188 feet

Drilled: Oct. 16, 1939

Water level: 41.2 feet

No.	Depth	Thick.	Description of strata
			Hattiesburg formation
1	0.9	0.9	Topsoil
2	45.6	44.7	Clay, light gray plastic sandy, micaceous, P-1
3	48.4	2.8	Sand, light bluish gray very fine grained clayey

A. R. Sumrall Property

Test Hole 171

Location: T.5 N., R.13 W., Sec. 31, SW.1/4, SE.1/4, 0.3 mile south of road junction on Highway U. S. 49 and 80 feet east of gravel road

Drilled: Oct. 17, 1939

Elevation:

Water level: Dry

No.	Depth	Thick.	Description of strata
			Hattiesburg formation
1	0.8	0.8	Topsoil
2	49.5	48.7	Clay, variegated gray red and brown plastic sandy, slightly limey, limonitic; P-1

J. S. Turner and Sons Property

Test Hole 172

Location: T.3 N., R.13 W., Sec. 7, NW.1/4, NW.1/4; 0.8 mile south of road intersection on Highway U. S. 11 and 50 feet west of highway

Drilled: Oct. 18, 1931

Elevation:

Water level: Dry

No.	Depth	Thick.	Description of strata
			Citronelle formation
1	1.2	1.2	Topsoil
2	5.5	4.3	Sand, gray and brown gravel-bearing, clayey; C-1
			Hattiesburg formation
3	21.5	16.0	Clay, light gray and brown plastic sandy, limonitic; P-1
4	45.1	23.6	Sand, yellowish brown slightly clayey; C-2

J. S. Turner and Sons Property

Test Hole 173

Location: T.3 N., R.13 W., Sec. 6, SE.1/4, SW.1/4, 0.7 mile south of road intersection on Highway U. S. 11 and 250 feet east of highway

Drilled: Oct. 18, 1939

Elevation:

Water level: Dry

No.	Depth	Thick.	Description of strata
			Citronelle formation (?)
1	1.0	1.0	Topsoil
2	5.6	4.6	Sand, light brown gravel-bearing; C-1
3	32.8	27.2	Clay, gray and red massive plastic sandy, slightly limey; P-1
4	53.5	20.7	Sand, gray and red clayey, gravel-bearing

Tatum Lumber Co. Property

Test Hole 175

Location: T.4 N., R.13 W., Sec. 29, NE.1/4, SW.1/4, 0.8 mile south of Southern Railway overpass and 80 feet east of Highway U. S. 11

Drilled: Nov. 2, 1939

Elevation:

Water level: 25.9 feet

No.	Depth	Thick.	Description of strata
			Hattiesburg formation
1	0.4	0.4	Topsoil
2	11.5	11.1	Clay, variegated gray, red, and brown, semi-plastic, sandy; P-1
3	12.9	1.4	Silt, light gray sandy; C-1
4	39.6	26.7	Clay, light gray and brown plastic slightly sandy; P-2

W. G. Gillespie Property

Test Hole 179

Location: T.4 N., R.13 W., Sec. 7, SW.1/4, SW.1/4; 0.3 mile south of intersection of Highway U. S. 24 and 37th Avenue

Drilled: Oct. 26, 1939

Elevation:

Water level: Dry

No.	Depth	Thick.	Description of strata
			Hattiesburg formation
1	0.6	0.6	Topsoil
2	2.4	1.8	Sand, brown semi-plastic clayey
3	8.8	6.4	Clay, light gray plastic slightly sandy, limonitic; P-1
4	13.2	4.4	Sand, gray and brown clayey, limonitic; C-1
5	50.4	37.2	Clay, gray plastic carbonaceous, limonitic, slightly limey; P-1

TATUM LUMBER CO. PROPERTY

TEST HOLE 180

Location: T.4 N., R.13 W., Sec. 21, SW.1/4, SW.1/4, 0.4 mile south of Bonhomie and Hattiesburg Southern Railway crossing and 90 feet west of gravel road
Drilled: Oct. 31, 1939
Elevation:
Water level: 15.2 feet

No.	Depth	Thick.	Description of strata
			High Terrace
1	1.3	1.3	Topsoil
2	8.5	7.2	Sand, light brown and red; C-1
3	14.7	6.2	Clay, light gray semi-plastic limonitic, slightly sandy; P-1
4	16.8	2.1	Sand, pink coarse grained gravel-bearing; C-2
			Hattiesburg formation (?)
5	38.4	21.6	Clay, gray and brown plastic limonitic, slightly sandy; P-2

A. E. NORTON PROPERTY

TEST HOLE 181

Location: T.4 N., R.13 W., Sec. 7, NE.1/4, SW.1/4; 400 feet south of Highway U. S. 24 and 60 feet east of 37th Avenue
Drilled: Nov. 3, 1939
Water level: Dry
Elevation:

No.	Depth	Thick.	Description of strata
			Hattiesburg formation
1	0.7	0.7	Topsoil
2	1.8	1.1	Sand, light brown, very fine grained clayey
3	12.5	10.7	Clay, variegated gray, brown, and red, very plastic sandy; P-1

STATE OF MISSISSIPPI PROPERTY

TEST HOLE 182

Location: T.1 N., R.12 W., Sec. 16, SE.1/4, SE.1/4, 0.5 mile south of road intersection and 80 feet east of Highway U. S. 49
Drilled: Nov. 2, 1939
Water level: Dry
Elevation:

No.	Depth	Thick.	Description of strata
			Pascagoula formation
1	1.6	1.6	Topsoil
2	12.8	41.2	Clay, variegated gray, brown, and red semi-plastic sandy, very micaceous; P-1
3	13.8	1.0	Sand, light gray very fine grained limonitic

TATUM LUMBER CO. PROPERTY

TEST HOLE 183

Location: T.4 N., R.13 W., Sec. 21, SW.1/4, SW.1/4; 0.35 mile south of Bonhomie and Hattiesburg Southern Railway crossing and 80 feet west of gravel road
Drilled: Nov. 1, 1939
Elevation:
Water level: 34.5 feet

No.	Depth	Thick.	Description of strata
			Hattiesburg formation
1	1.5	1.5	Topsoil
2	3.7	2.2	Sand, brownish red fine grained clayey; C-1
3	41.5	37.8	Clay, gray plastic very limonitic, slightly sandy; P-1

STATE OF MISSISSIPPI PROPERTY

TEST HOLE 184

Location: T.1 N., R.12 W., Sec. 16, SE.1/4, SE.1/4; 100 feet north of Test Hole 182
Drilled: Nov. 3, 1939
Elevation:
Water level: 19.0 feet

No.	Depth	Thick.	Description of strata
			Pascagoula formation
1	0.7	0.7	Topsoil
2	46.8	46.1	Clay, variegated gray and brown very plastic limonitic, slightly sandy; P-1
3	49.0	2.2	Sand, light gray very fine grained limonitic

U. S. FORESTRY SERVICE PROPERTY

TEST HOLE 186

Location: T.1 N., R.12 W., Sec. 21, NE.1/4, NE.1/4; 0.7 mile south of road intersection and 80 feet east of gravel road
Drilled: Nov. 6, 1939
Water level: 27.9 feet
Elevation:

No.	Depth	Thick.	Description of strata
			Pascagoula formation
1	0.2	0.2	Topsoil
2	10.8	10.6	Clay, gray and brown plastic slightly sandy; P-1
3	26.9	16.1	Silt, light gray semi-plastic clayey; P-2
4	30.0	3.1	Sand, light gray very fine grained silty, limonitic

STATE OF MISSISSIPPI PROPERTY

TEST HOLE 187

Location: T.1 N., R.12 W., Sec. 16, SE.1/4, NE.1/4; 0.15 mile south of road intersection and 80 feet east of gravel road
Drilled: Nov. 7, 1939
Elevation:
Water level: 3.4 feet

No.	Depth	Thick.	Description of strata
			Pascagoula formation
1	0.7	0.7	Topsoil
2	31.0	30.3	Clay, gray brown and red very plastic limonitic slightly sandy; P-1
3	32.4	1.4	Sand, light gray fine grained silty, limonitic

LAURA KNOX PROPERTY

TEST HOLE 189

Location: T.3 N., R.13 W., Sec. 3, NE.1/4, SE.1/4; 200 feet northeast of Test Hole 188
Drilled: Nov. 8, 1939
Elevation:
Water level: 10.1 feet

No.	Depth	Thick.	Description of strata
			Hattiesburg formation
1	0.2	0.2	Topsoil
2	1.9	1.7	Sand, light brown fine grained semi-plastic slightly clayey; C-1
3	9.5	7.6	Clay, light brown and gray plastic slightly sandy; P-1
4	10.2	0.7	Sand, light gray very fine grained; C-2
5	34.1	23.9	Clay, light gray plastic sandy, limonitic; P-2
6	35.0	0.9	Sand, light brown fine grained silty, very micaceous

P. B. JOHNSON PROPERTY

TEST HOLE 190

Location: T.4 N., R.13 W., Sec. 34, SE.1/4, SE.1/4; 0.7 mile south of road crossing on Highway U. S. 49 and 500 feet east of highway
Drilled: Nov. 8, 1939
Elevation:
Water level: 25.0 feet

No.	Depth	Thick.	Description of strata
			Hattiesburg formation
1	1.2	1.2	Topsoil
2	37.9	36.7	Clay, light gray and brown semi-plastic slightly sandy, carbonaceous; P-1

BIBLIOGRAPHY

1. Tharp, W. E., and Spann, W. M., Soil Survey of Forrest County, Mississippi: U. S. Department of Agriculture, Bureau of Soils, 1912.
2. Wailes, B. L. C., Report on the Agriculture and Geology of Mississippi, pp. 214-219, 1854.
3. Harper, L., Preliminary report of the geology and agriculture of the state of Mississippi, 1857.
4. Harper, L., op. cit., p. 157.
5. Hilgard, Eugene W., Report on the geology and agriculture of the State of Mississippi, pp. 147-154, 1860.
6. Hilgard, Eugene W., op. cit., p. 138.
7. Hilgard, Eugene W., The later Tertiary of the Gulf of Mexico, Am. Jour. Sci., 3rd. ser. vol. 22, pp. 58-65, 1881.
8. Johnson, Lawrence C., The Grand Gulf Formation of the Gulf States, Am. Jour. Sci., 3rd ser. vol. 38, pp. 213-216, 1889.
9. McGee, W. J., The Lafayette Formation, U. S. Geological Survey, 12th Annual Report, Pt. 1, p. 409, 1891.
10. Johnson, Lawrence C., The Miocene Group of Alabama, Science, vol. 21, No. 524, pp. 90-91, Feb. 17, 1893.
11. Dall, William H., A Table of North American Tertiary Horizons, U. S. Geol. Survey, 18th Annual Report, Pt. II, p. 334, 1898.
12. Maury, Carlotta Joaquina, A comparison of the Oligocene of Western Europe and the Southern United States, Bull. Am. Pal. Vol. III, No. 15, pp. 43, 70, and 74-76, June, 1902.
13. Harris, Gilbert D., and Veach, A. C., A preliminary report on the geology of Louisiana, La. State Exp. Sta., Geol. and Agrl. La., Part V, pp. 98-99, 1899.
14. Harris, Gilbert D., The Tertiary Geology of the Mississippi Embayment, La. State Exp. Sta., Geol. and Agrl. La., Pt. VI, pp. 28-32, 1902.
15. Smith, Eugene A., and Aldrich, Truman H., The Grand Gulf formation, Science, N.S., vol. XVI, pp. 835-837, Nov. 21, 1902.
16. Dumble, E. T., Geology of southwestern Texas; Trans. Am. Inst. Mining Eng., vol. 23, p. 922, 1903.
17. Veach, A. C., Geology and underground water resources of northern Louisiana and southern Arkansas; U. S. Geological Survey, Prof. Paper 46, pp. 42-43, 1906.
18. Darby, Williams, A geological description of the state of Louisiana, Philadelphia, pp. 45-46, 1816.
19. Wailes, B. L. C., op. cit., pp. 246-253, 1854.
20. Harper, L., op. cit., pp. 162, 182-240, 1857.
21. Safford, Jas. M., A geological reconnaissance of the state of Tennessee, Nashville, Tenn., p. 162, 1856.
22. Hilgard, Eugene A., op. cit., pp. 4-29, 1860.
23. McGee, W. J., loc. cit., 1891.

Reference 14

WATER FOR INDUSTRIAL DEVELOPMENT IN

Forrest, Greene, Jones, Perry, and Wayne Counties Mississippi

A COOPERATIVE STUDY SPONSORED JOINTLY BY
WATER RESOURCES DIVISION, U. S. GEOLOGICAL SURVEY
and
Mississippi Research and Development Center
JACKSON, MISSISSIPPI

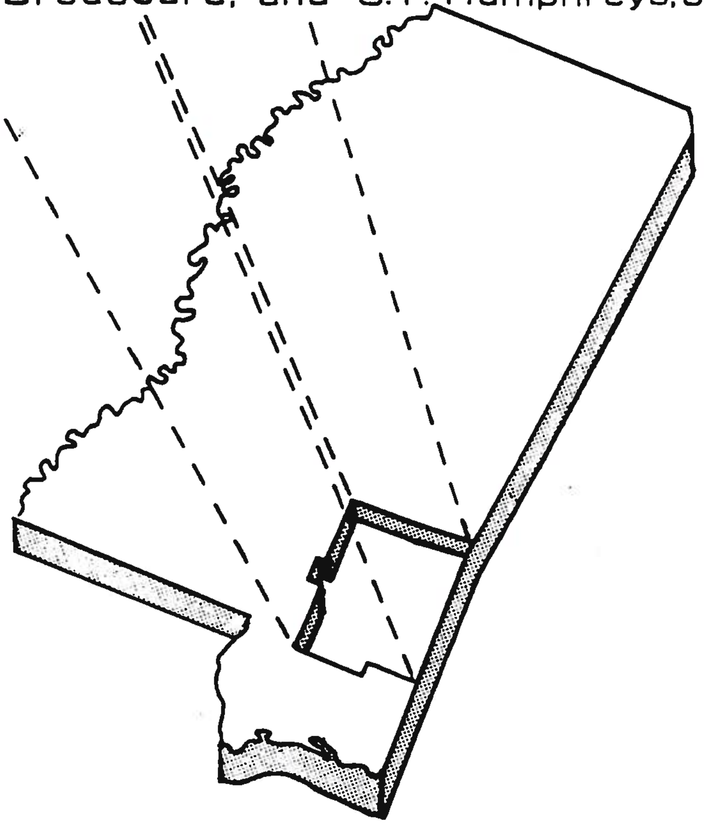
WATER FOR INDUSTRIAL DEVELOPMENT

in

Forrest, Greene, Jones, Perry, and Wayne Counties, Mississippi

By

T. N. Shows, W. L. Broussard, and C. P. Humphreys, Jr.



Prepared by
WATER RESOURCES DIVISION
U. S. GEOLOGICAL SURVEY
1966

many municipal and industrial water managers, well ow s, water-well contractors, and oil compa rsonnel. The Mississippi Power Comp plied daily temperature readings on the River at Hattiesburg.

HYDROLOGIC SETTING

Climate

The climate of southeastern Mississippi is humid and semitropical. Average annual rainfall ranges from 56 inches in the northwest corner of the five-county area to 64 inches in southern Forrest and Perry Counties. Average annual runoff from the numerous streams in the area ranges from 18 inches in the north to 26 inches in the south (fig. 1). The remainder of the precipitation seeps into the ground or is dissipated by evapotranspiration. The mean annual temperature in the five-county area is about 66° F; the mean monthly temperature ranges from 82° F in July to 51° F in January at Hattiesburg. On the average, Hattiesburg has 106 days annually with temperatures equal to or greater than 90° F, and only 41 days annually with temperatures equal to or less than 32° F.

Geology and Topography

The study area is within the Pascagoula River basin in the East Gulf Coastal Plain. Exposed rocks are of sedimentary deposition and most are unconsolidated. The exposed sediments range in age from late Eocene to Recent with Miocene and younger sediments forming the majority of the exposed sediments (fig. 3). The geologic units containing fresh-water aquifers range in age from early Eocene to Recent alluvial deposits. Most geologic units are traceable from the surface deep into the subsurface (figs. 2 and 20).

The geologic units have a regional southwestward dip of 20-45 feet per mile (fig. 23 and 24). The dip of the beds is steep (40-45 feet per mile) in Wayne and Jones Counties, but it flattens (20-25 feet per mile) in Greene, Perry, and Forrest Counties owing to the major structural uplift of the Wiggins anticline south of the study area.

Several shallow piercement salt domes in the area locally affect the dip, strike, and thickness of formations. The formations display gentle arching or uplifting across these structures. Caution should be exercised in drilling wells in the vicinity of the shallow domes, especially near the shallow Richton dome (depth of caprock 497 feet, fig. 32) because the base of fresh water is shallow over some of these domes.

One recognizable subsurface fault (figs. 2, 23, and 24) is in southern Forrest County. It is an east-west trending fault associated with the Wiggins anticline, which is south of Forrest County in Stone County. The fault causes an offset in the deep beds but no movement is apparent in the shallower Miocene deposits.

Lithology varies between geologic units, but typically consist of interbedded clay, sand, and gravel. Sand and clay in various proportions constitute most of the sediments; however a few consolidated limestone layers occur in some units, particularly in the Vicksburg Group. The formations thicken downdip to the west and south toward the Mississippi River and the Gulf of Mexico.

The deposits, particularly Miocene and younger, are lenticular (figs. 21 and 22), and lithology changes in short distances. The sands, which are irregular and thicken or thin in short distances, are difficult to trace down the dip. Most of the water bearing units were deposited in a deltaic environment.

Topography reflects the geology and drainage of the region and results from erosion of the gently dipping unconsolidated sedimentary beds. The landform is characterized by low, dissected, rounded hills and a few large streams in wide, flat valleys. Swamps are common in the lowland areas adjacent to the larger streams. There are many small man-made stock ponds in the area.

Elevation in the area ranges from less than 100 feet above sea level in the southern part along the Leaf River to 430 feet in western Jones County. Local relief is gentle; elevations vary only a small amount in short distances.

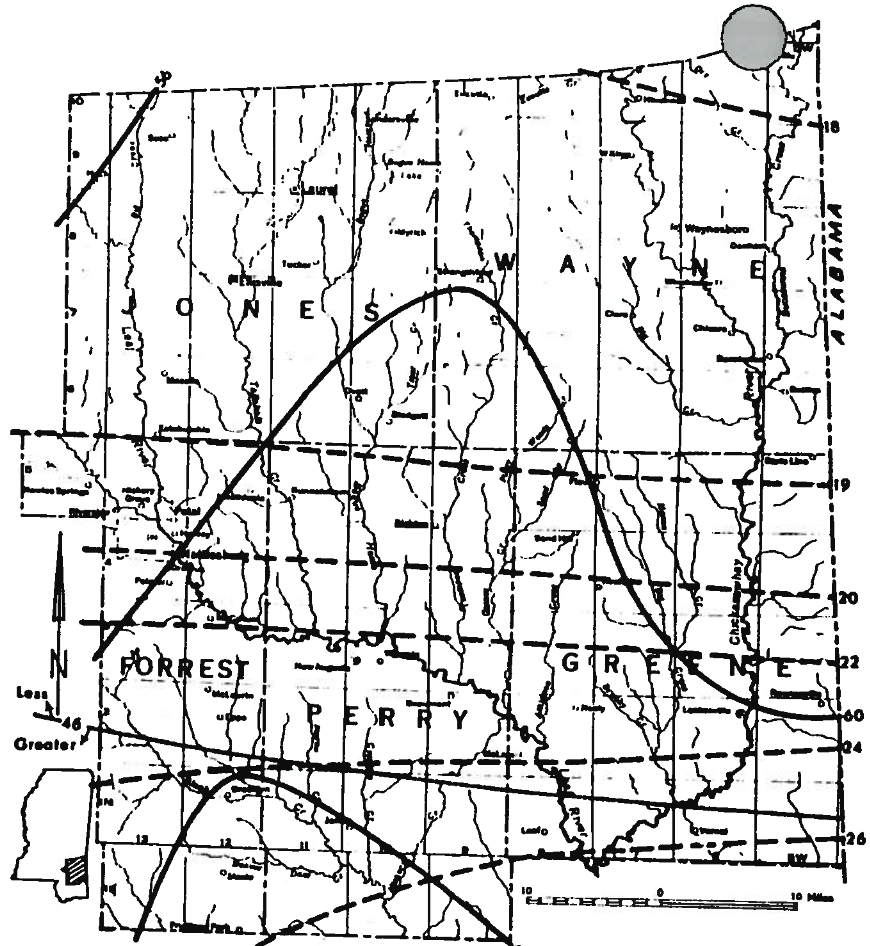
Drainage

The five-county area lies within the central part of the Pascagoula River basin. The major sub-basins in the area are the Leaf River, Chickasawhay River, and Black Creek (fig. 3). The Leaf River enters northwestern Jones County and flows generally southward to the vicinity of Hattiesburg in northern Forrest County, thence southeastward to meet the Chickasawhay River south of the Greene County line to form the main stem of the Pascagoula River. The Chickasawhay River drains the eastern parts of Wayne and Greene Counties. Black Creek flows through southern Forrest and Perry Counties and enters the Pascagoula River south of the study area. The streams are typical of those found in the southern United States, having winding meanders, broad, wooded flood plains, and many oxbow lakes along the larger rivers.

Occurrence of Ground Water

Ground water is any water in the ground that is in the zone of saturation. An aquifer is any water-bearing unit capable of yielding water to wells; in the study area most aquifers are composed of sand and gravel. The unconsolidated sediments have openings, or voids, between grains which are saturated with water below the water table. The shape, size, assortment, and degree of compaction of the grains determines the ease with which water moves through the material.

Water enters the permeable geologic units in their areas of outcrop (fig. 3) and moves generally southwestward in the direction of the dip toward areas of discharge which may be wells, springs, seeps, or adjacent permeable



EXPLANATION

——— 60
Average annual precipitation, in inches.
Extracted from U.S. Weather Bureau, 1959, "Climates of the States." Based on period 1931-55.

— — — —19
Average annual runoff from streams, in inches.
Based on streamflow records for period 1939-1960.

.... 46
Average annual lake evaporation, in inches.
Extracted from U.S. Weather Bureau Tech. Paper No. 37. Based on period 1946-55.

Fig. 1. Map showing annual precipitation, evaporation, and run-off

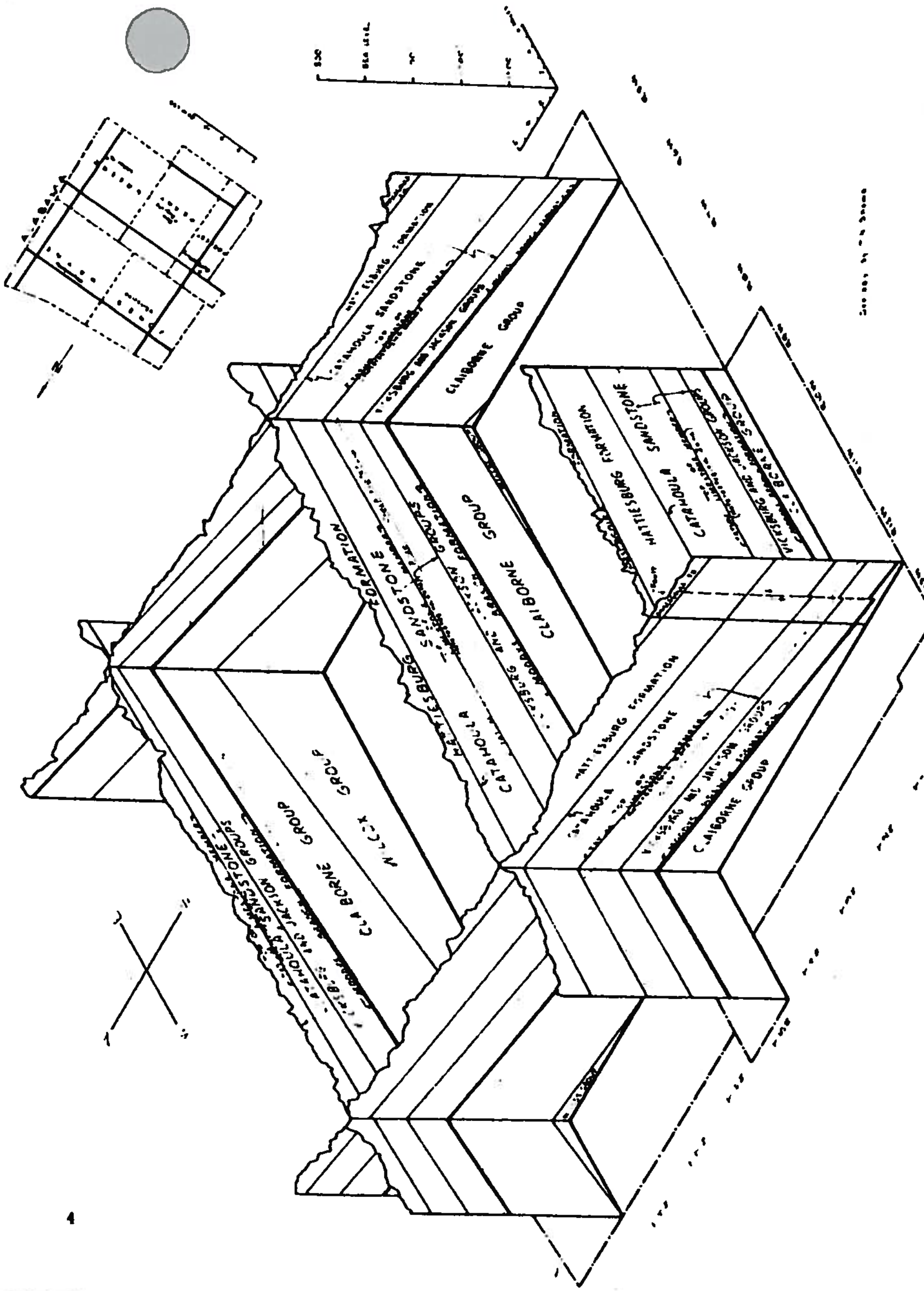


Fig. 2. Fence diagram showing geology of area

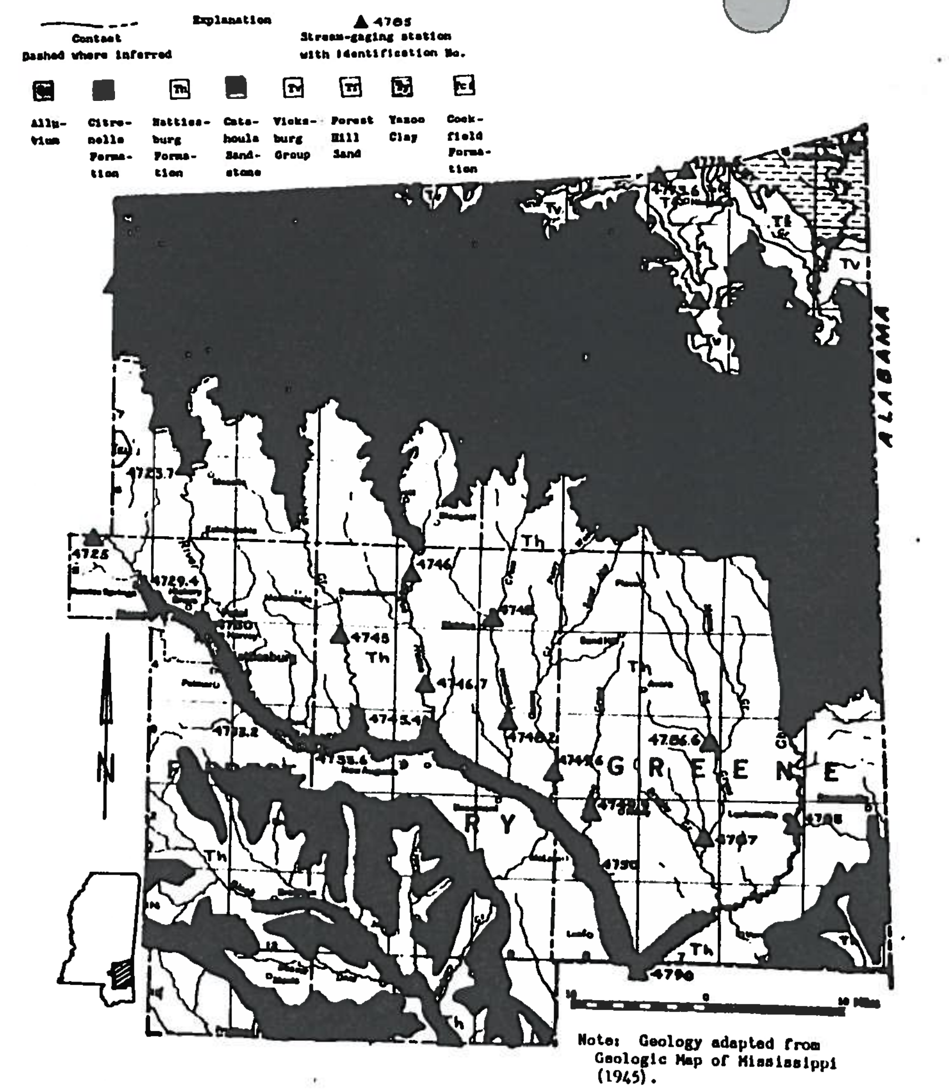


Fig. 3. Geologic map showing principal streams and gaging stations

Table 1.—Stratigraphic column and water resources in Forrest, Greene, Jones, Perry, and Wayne Counties, Miss.

System	Series	Group	Formation	Thickness (ft)	Lithology	Water resources
Quaternary	Recent		Alluvium	[illegible]	Clay, sand, and gravel in the larger stream valleys, particularly in Forrest, Greene, and Perry Counties.	Important aquifer at certain locations in the larger stream valleys, as at Hattiesburg on the Leaf River. Supplies domestic wells along the streams.
	Pleistocene		Terrace deposits	[illegible]	Red and gray sand and gravel with clay lens. Deposits on the hills and low terraces along the streams.	Not an important aquifer, except for shallow dug wells.
Tertiary	Pliocene		Citronelle	[illegible]	Clay, sand, gravel, and ferruginous layers. [illegible] Deposits on the higher hills in the area, particularly in the southern counties.	Not an important aquifer. Supplies shallow domestic wells, particularly in southern part of area.
	Miocene		Pascagoula	[illegible]	Clay, sandy clay, sand, and gravel, with some thin ferruginous layers. Sand beds occur at various horizons and vary in thickness from thin layers to 200 feet. A thin zone of limestone (Fatum Limestone Member) occurs in the lower half of the unit.	An important source of water in the extreme southern part of Forrest, Greene, and Perry Counties. Sands capable of supplying large quantities of water.
			Hattiesburg	[illegible]		An important source of water in Forrest, Greene, and Perry Counties. Sands and gravels capable of yielding large amounts of water.
	Miocene(?)		Catahoula Sandstone	[illegible]		An important source of water in all but northern third of area. Majority of wells throughout the area are completed in the Catahoula. Large yielding wells are possible in most locations from the thick sands.
	Oligocene	Vicksburg	Undifferentiated	[illegible]	Limestone beds alternating with clay sand and clay beds. Thick sand layers, 30-40 feet, occur locally at Waynesboro and Sandersville.	Generally not an aquifer. A fair aquifer in certain locations such as Waynesboro and Sandersville, where there are beds of sand up to 40 feet thick. The clay interval yields water to domestic wells in central Wayne and northeastern Jones Counties.
			Forest Hill Sand	[illegible]	Thin sand and clay layers with silt.	Not used as an aquifer, except for shallow domestic wells near outcrop.
	Eocene	Jackson	Yazoo Clay	[illegible]	Clay and calcareous sand with thin limestone layers. The Cocoa Sand Member, near the bottom, is generally 10 to 15 feet thick and composed of clay sand. In eastern Wayne County, the unit is about 40 feet thick and composed of sand with thin layers of limestone.	Not an aquifer, except in eastern Wayne County, where the Cocoa Sand Member is an important local source of water supply. The Cocoa Sand Member supplies domestic wells and one community water system in the vicinity of Buckatunna.
			Moodys Branch	[illegible]	Glauconitic, fossiliferous marl and sand. Indurated beds occur near the outcrop.	Not an aquifer.
		Claiborne	Cockfield	[illegible]	Sand and clay with lignite. This is thick beds of sand alternating with clay. Lignite is common but not as prominent as in the Sparta. Sand beds are 50 feet thick in southeastern Wayne County and 70 feet thick at Laurel.	A potential important source of water in northern Wayne and Jones Counties. Several large industrial wells tap this aquifer at Laurel. Water is colored except near outcrop in northern Wayne County.
			Cook Mountain		Shale, clay, limestone, and sandstone. Top of formation is usually a limestone and bottom is a clay or shale.	Not an aquifer.
			Sparta Sand		Sand, sandy clay and clay, with lignitic layers. Sand thickness ranges from 45 feet in eastern Wayne County to 80 feet in central Jones County. Lithology in southern counties is primarily clay and differentiation from the underlying Zilpha Clay is difficult.	An important source of water in parts of northern Jones and Wayne Counties. Colored water is common in this aquifer.
			Zilpha Clay		Shale and brown clay, with glauconite.	Not an aquifer.
			Winona Sand		Calcareous sandstone and clay with thin beds of sand.	Not an aquifer.
			Tallahatta		Brittle clay and sandstone (buhrstone). Thick sand occurs near bottom of section.	Not an aquifer, except for lower sand (Meridian Sand Member) which is usually not differentiated from the underlying Wilcox. The Meridian Sand Member is unused but is potentially an important source of water in the northern third of Wayne and Jones Counties.
		Wilcox	Undifferentiated	[illegible]	Sand, sandy shale, clay and shale. Beds of lignite occur in the sand and clay. Sand beds compose 10 percent of the unit. Sands are micaceous, medium to coarse-grained. Sand thickness ranges from 190 to 290 feet in northern Wayne County.	Potentially an important source of water in northern third of Wayne County but is untapped in study area. Best aquifers are probably in lower third of the unit.

beds. Water levels are lowered in the aquifers in the vicinity of discharge, and the lower water levels change the direction of ground-water movement. Some of the geologic units are relatively impermeable (aquicludes) and allow little movement of water. Permeability (Glossary) within an aquifer is usually greater horizontally than vertically because of horizontal stratification.

Aquifers are classified as water-table or artesian depending on whether the water level is within the aquifer and unconfined or whether it is confined. Water in a water-table well stands at about the same level as in the aquifer outside the well. Water-table aquifers receive recharge from local precipitation. Discharge from water-table aquifers supplies most of the base flow of the streams, especially during droughts. Water in the terrace and alluvial aquifers in most places occurs under water-table conditions.

In artesian aquifers the water-bearing material is confined by impermeable beds and water is confined under hydrostatic pressure or head; thus, water in wells will rise above the top of the water-bearing material. Water in the majority of aquifers in the study area occurs under artesian conditions, except for small areas in the outcrops.

Changes in quality of water occur as the water moves down the dip from the outcrop to areas of discharge. Dissolved-solids content usually increases down the dip (fig. 20) and the type of the water changes from calcium to sodium bicarbonate. The deeper water is usually softer because the calcium and magnesium content has been decreased by ionic exchange for sodium. The pH of the water increases down the dip, and iron problems are reduced.

The temperature of shallow ground water is about 66° F, which is the mean annual temperature of the air. The temperature of the water increases 1° F for each additional 65 to 100 feet of depth in the five-county area. Ground water temperature, except in shallow water-table wells, does not vary with seasonal changes in air temperature.

PRESENT WATER USE

Total water use in the five-county area is estimated to be 152 mgd (million gallons per day); ground-water use is 28 mgd and surface water use is 124 mgd. Most water is used for cooling purposes, and only a small percentage is actually consumed. All municipal and most industrial supplies are obtained from wells (fig. 4). The Mississippi Power Company and the Hercules Powder Company at Hattiesburg use both ground and surface water. These two plants use an estimated 124 mgd of surface water for industrial cooling.

The heaviest withdrawal of ground water occurs in the Hattiesburg (9.3 mgd) and Laurel (12.5 mgd) areas. Most other areas are rural with no appreciable concentration of water withdrawal, except for public supply in the smaller towns. The many rural water systems that have been installed or proposed will cause an increase in the use of ground water in the rural areas.

Ground water is used for irrigation at two tree seedling nurseries, one near Waynesboro and the other near Brooklyn. Surface water is used for crop irrigation along a few of the streams, but the total surface-water withdrawal for irrigation is small and restricted to infrequent dry periods.

Geiger Lake at Paul B. Johnson State Park, 12 miles south of Hattiesburg, is a 300-acre lake operated by the Mississippi Park Commission for recreational purposes. The Mississippi Game and Fish Commission operates Lake Bogue Homo, a 1,500-acre lake 5½ miles east of Laurel. The Leaf, Bowie, and Chickasawhay Rivers and many oxbow lakes along the Leaf and Chickasawhay are also used extensively for boating and fishing. Numerous private lakes and farm ponds throughout the area afford private fishing areas. The U. S. Department of Agriculture has developed scenic float routes on reaches of Black Creek and its tributaries in De Soto National Forest. The Pat Harrison Waterway District, in cooperation with other agencies, is planning several projects in southeastern Mississippi which include facilities for swimming, fishing, and boating.

At present there is no commercial water traffic, but it has long been the aim of local interests to link the cities of Meridian, Hattiesburg, and Laurel with the Gulf of Mexico through a system of barge canals. The Pat Harrison Waterway District is empowered by legislative act to develop plans for such navigation facilities in conjunction with Federal or State agencies.

SURFACE WATER

An abundant supply of surface water of good quality suitable for most industries is available. During an average year, more than two trillion gallons of water flows from the Leaf and Chickasawhay River basins. This large volume of water flows at an average rate of about 9,600 cfs (cubic feet per second), [illegible]200 mgd, past a gaging station (No. 4790) [illegible] Pascagoula River just downstream fr[illegible] confluence of the Leaf and Chickasawha[illegible]ers. The quantity and quality of streamflow, however, vary with time and place and this variability requires the collection and interpretation of a mass of data to appraise adequately the surface-water resources of the five-county area.

Water shortages that will increase the pollution problem and adversely affect recreational interests can occur at some locations on various streams. Often the period of deficient flow coincides with a time of maximum water demand. On the other hand, too much water during floods may cause loss of life and property damage and create many problems in transportation, commerce, and agriculture. Streamflow and water-quality data have been collected and analyzed from a network of continuous-record gaging stations supplemented by partial-record sites (fig. 3 and table 2).

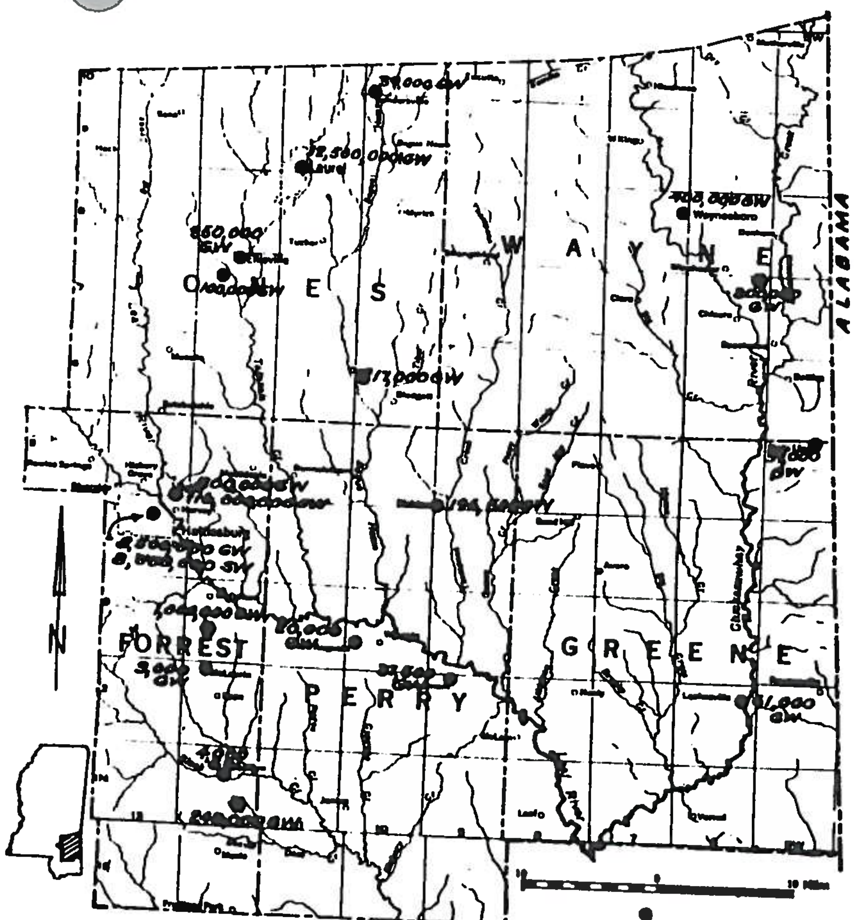
Flow Duration

Flow duration data for continuous-record gaging stations were computed from the daily discharges by the total-period method. A flow-duration curve based on these data shows, without regard to chronological order, the flow variability of a stream. Estimates of the duration of flows at short-time continuous-record stations were obtained by using methods described by Searcy (1959).

A tabulation of flow-duration data, adjusted to base period October 1928-September 1957, for stations in the area is shown in table 3. These data can be plotted on logarithmic-probability paper if graphical presentation is desired. The data in table 3 are reliable long-term predictions of the future flow patterns of the streams in the area if no unusual climatological or man-made changes occur; however, values for individual years will deviate, sometimes considerably, from the long-term period.

Flow-duration data may be used for comparing flow characteristics of different streams. If the effect of drainage-area size is removed (by dividing discharge by drainage area) a direct comparison may be made. Flow-duration curves for Bowie Creek at U. S. Highway 49 near Hattiesburg, Leaf River near McLain, Pascagoula River at Merrill, Chickasawhay River at Leakesville, and Tallahala Creek at Laurel are shown on figure 5. These stations were selected to illustrate the variation in base flow of streams in the area. Bowie Creek has a much higher low-flow yield per square mile than the other streams on figure 5. The slope of the lower end of the flow-duration curve for Bowie Creek is flatter than those of the low-yielding streams. Slope of the duration curve is a measure of the variability of that stream.

Although the information in figure 5 is expressed as discharge per square mile, it does not imply that each drainage basin internally has uniform yield. The streamflow yields of



Average daily withdrawal, in gallons

GW - ground water
SW - surface water

Seasonal daily withdrawal, in gallons

GW - ground water
SW - surface water

Fig. 4. Map showing major water withdrawals

Table 2.--Stream-gaging stations and water-sampling sites

[Type of record: 1, continuous-record gaging station; 2, low-flow partial-record station; 3, daily sampling site; 4, periodic sampling site; 5, continuous conductivity site; 6, DO and BOD sampling site; 7, sediment sampling site.]

Identification No.	Station	Drainage area (sq mi)	Period of streamflow record	Type of record: Streamflow	Type of record: Chemical quality	Location
024720	Leaf River near Collins	757	Sept. 1938-	1	4	NW¼ sec. 11, T. 9 N., R. 14 W., at bridge on U.S. Highway 84, 9½ miles northeast of Collins.
024721	Pig Creek near Laurel	a 100	1947-61 1951 1953-56 1958 1960 1963-	2	--	SW¼ sec. 4, T. 8 N., R. 11 W., at bridge on U.S. Highway 84, 10½ miles west of Laurel.
024721.5	Leaf River near Ellisville	a 910	1953-56 1958 1960 1963-	2	--	Sec. 12, T. 8 N., R. 11 W., at bridge on State Highway 588, 8 miles west of Ellisville.
024721.7	Leaf River near Moselle	1,030	1963-	2	4	NW¼ sec. 9, T. 6 N., R. 13 W., at bridge on Interstate Route 59, 1 mile west of Moselle.
024725	Bowie Creek near Hattiesburg	306	Sept. 1938-	1	4,6,7	Sec. 5, T. 5 N., R. 14 W., at bridge on U.S. Highway 49, 10 miles northwest of Hattiesburg.
024729.4	Bowie River at Hattiesburg	656	1963-	2	--	Sec. 10, T. 5 N., R. 13 W., at bridge on Interstate Route 59, 1½ miles north of intersection of U.S. Highway 49 and 11 in Hattiesburg.
024730	Leaf River at Hattiesburg	b1,740	Sept. 1938-	1	b3,b6,7	NW¼ sec. 2, T. 4 N., R. 13 W., at bridge on U.S. Highway 11, at eastern city limits of Hattiesburg.
024731.2	Leaf River at McCallum	b1,890	1963-	2	4,6	NW¼ sec. 10, T. 3 N., R. 12 W., at county highway bridge, 1 mile east of McCallum.
024731.6	Leaf River near Mahned	b1,880	1963-	2	4,5,6,7	NE¼ sec. 15, T. 3 N., R. 11 W., at county highway bridge, 1½ miles north of Mahned.
024735	Tallahala Creek at Laurel	213	1938-40 1944-	1	6	NE¼ sec. 6, T. 8 N., R. 11 W., at bridge on State Highway 15 and ¼ mile southeast of Laurel.
024743	Tallahoma Creek near Laurel	a 170	1954-56 1958 1960 1963-	2	--	NE¼ sec. 26, T. 9 N., R. 12 W., at bridge on county highway, 2 miles northeast of Laurel.
024745	Tallahala Creek near Runnelstown	612	Oct. 1938-	1	4,6	NW¼ sec. 8, T. 4 N., R. 11 W., at county highway bridge between Sunrise and Runnelstown, 3 miles south of Runnelstown.
024745.6	Tallahala Creek near Mahned	640	1963-	2	4,6	SE¼ sec. 10, T. 3 N., R. 11 W., at bridge on county highway, 2 miles north of Mahned.
024746	Bogue Homo near Richton	191	1941 1954 1956 1963-	2	--	NE¼ sec. 17, T. 5 N., R. 10 W., at bridge on county highway, 7 miles northwest of Richton.
024748	Thompson Creek near Richton	a 186	1947-48 1951-56 1958 1960 1961 1963-	2	--	NW¼ sec. 12, T. 5 N., R. 9 W., at bridge on State Highway 42, ½ mile east of Richton.
024748.2	Thompson Creek near Hintonville	a 212	1963-	2	--	SW¼ sec. 11, T. 4 N., R. 9 W., at county highway bridge, 1½ miles east of Hintonville.
024749.6	Gaines Creek near Beaumont	a 132	1963-	2	--	SW¼ sec. 25, T. 3 N., R. 9 W., at county highway bridge, 5 miles east of Beaumont.
024749.9	Atkinson Creek near McLain	a 55	1963-	2	--	NW¼ sec. 16, T. 2 N., R. 8 W., at county highway bridge, 1 miles north of McLain.
024750	Leaf River near McLain	b3,510	Oct. 1938-	1	4,6,7	SW¼ sec. 29, T. 2 N., R. 8 W., at bridge on U.S. Highway 98, 1½ miles east of McLain.
024771.1	Shubuta Creek near Shubuta	95	1939 1963-	2	--	NW¼ sec. 15, T. 1 N., R. 15 E., at county highway bridge, 1½ miles northwest of Shubuta.
024771.5	Chickasawhay River at Shubuta	b1,460	1941 1953 1963-	2	--	On line between secs. 9 and 10, T. 10 N., R. 7 W., at bridge on U.S. Highway 45, 1 mile southeast of Shubuta.
024771.6	Furutta Creek near Shubuta	a 30	1963-	2	--	NE¼ sec. 18, T. 10 N., R. 7 W., at bridge on county highway, 3 miles southeast of Shubuta.
024774.9	Yellow Creek at Waynesboro	a 90	1963-	2	--	SE¼ sec. 31, T. 9 N., R. 7 W., at bridge on county highway, ½ mile northwest of Waynesboro.
024775	Chickasawhay River near Waynesboro	b1,660	c1939-50 1957-58 1963-	1,2	3,4,6,7	NW¼ sec. 10, T. 8 N., R. 7 W., at bridge on U.S. Highway 84, 2 miles west of Waynesboro.
024776	Patton Creek near Waynesboro	a 10	1956 1958 1960 1963-	2	--	SW¼ sec. 18, T. 8 N., R. 6 W., at bridge on U.S. Highway 45, 1¼ miles southeast of Waynesboro.
024780	Buckatunna Creek at Denham	448	c1938-49 1952-56 1958 1960 1963-	1,2	--	SE¼ sec. 18, T. 6 N., R. 5 W., at bridge on county highway, 0.1 mile east of Denham.
024780.2	Big Red Creek near Buckatunna	a 40	1963-	2	--	NW¼ sec. 31, T. 7 N., R. 5 W., at bridge on county highway, 1 miles northeast of Buckatunna.

able time, as specified by the Board in its authorization, to the stream at a point downstream [illegible] the place of withdrawal. This appropriation [illegible] be made only if the Board shall find that [illegible] action will not result in any substantial detriment to property owners affected thereby or to the public interest.

Average minimum flows calculated for streams in the area are presented in table 11. Data for the period 1941-60 were used for the determinations of the average minimum flows.

The law states that the Board has authority to enter into compacts and agreements concerning the State's share of water flowing in streams, where parts of such water courses are contained within the territorial limits of a neighboring state.

GROUND WATER

Location, Extent, and Lithology of Aquifers

Fresh-water aquifers in the five county area are mostly beds of sand or zones of sandy beds. The beds dip gently to the southwest and contain fresh water as much as 40 miles from the outcrops and as much as 3,000 feet below land surface. Aquifers of Miocene age are available in practically the entire area, except in the northern third of Jones and Wayne Counties (fig. 19), but no single geologic unit contains fresh water throughout the five counties. Aquifers in Claiborne and Wilcox groups are available in the northern third of the area, but the great depth (1,200-3,000 feet) of the Wilcox has limited its use owing to the higher cost of deep wells. Shallow alluvial deposits in the larger stream valleys are potentially important aquifers in the three southern counties.

Lithology and thickness of aquifers is shown in table 1 and in a northeast-southwest cross-section (fig. 20) parallel to the general dip of the beds. Detailed sections through Laurel and Hattiesburg show the lenticular bedding of the Miocene beds (figs. 21 and 22). Depth and thickness of aquifers can be estimated from the sections for places in the vicinity of the sections, but structure contour maps drawn on mappable geologic horizons are useful for estimating aquifer depths at any place in the area. Because the Moodys Branch Formation is thin (15-20 feet), a contour map showing the configuration of the top of the mappable Moodys Branch Formation (fig. 23) is essentially the top of the Cockfield Formation. Another contour map, showing the configuration of the base of the Catahoula Sandstone (fig. 24), can be used to determine the depth of a well necessary to penetrate the Catahoula.

Thickness of geologic units increase from the outcrop toward the southwest in the direction of the center of deposition. The thickness of the Sparta Sand ranges from 110 feet in northeastern Wayne County to 190 feet in north central Jones County. Thickness of the Cockfield Formation ranges from 80 feet in northern Wayne County to 150 feet in north-central Jones County. Miocene beds range in thickness from about 100 feet in northern Jones County to about 2,000 feet in southern Forrest County. The alluvium underlying the major flood plains in the area is as much as 125 feet thick, as in the Leaf River flood plain at Hattiesburg.

Most of the aquifers are composed of sand or gravel mixed with varying proportions of silt and clay. Lignite is common in the Claiborne and Wilcox Groups. The alluvium is composed mostly of unstratified coarse sand and gravel. The beds of sand in the Miocene sediments, the principal source of ground water in the area, may be thinner than 2 feet or thicker than 200 feet. Commonly there are several beds of sand in each water-bearing geologic unit.

The marine Vicksburg Groups and Cocoa Sand are more uniform in lithology than most of the other water bearing units. The Cocoa Sand in eastern Wayne County is about 60 feet thick and is composed of thin layers (2-10 feet) of fine- to medium-grained sand alternating with thin layers (4-8 feet) of calcareous sandstone and limestone. The Vicksburg is generally composed of limestone beds alternating with thin beds (2-4 feet) of limy sand and clay. The Vicksburg at particular locations, as at Waynesboro and Sandersville, is composed of relatively thick sand beds (30-50 feet) interspersed with thin layers (1-2 feet) of limestone. The limestone or limy sand section of the Vicksburg (known locally as "Honeycomb rock") yields water to domestic wells across central Wayne and northeastern Jones Counties.

Prediction of aquifer thickness and lithology is difficult because of the lenticular bedding of most units. Lithologic changes occur in short distances and individual sands are difficult to trace, especially along the dip of the beds (figs. 21 and 22); sand beds in the Miocene are characteristically lens shaped or wedge shaped. Construction of a well where water is needed may be a problem because of the lenticular bedding of most sands, and test drilling is recommended to determine the depth, thickness, and character of aquifers underlying a particular site.

The depth of drilled water wells ranges from 20 to 1,316 feet (table 12). A well at Laurel is 1,316 feet deep, but most wells are less than 800 feet deep. At most places more than one aquifer is available.

Aquifer and Well Hydraulics

Transmissibility, Permeability, and Storage

Aquifers vary considerably in their ability to transmit and store water. Transmission and storage of water by an aquifer depends on the porosity (Glossary), size of open spaces between grains of the aquifer material, and interconnection of the open spaces; all of which are related to the depositional history of the aquifer. Coefficients of permeability and transmissibility (Glossary) are measures of the ability of an aquifer to transmit water. The coefficient of

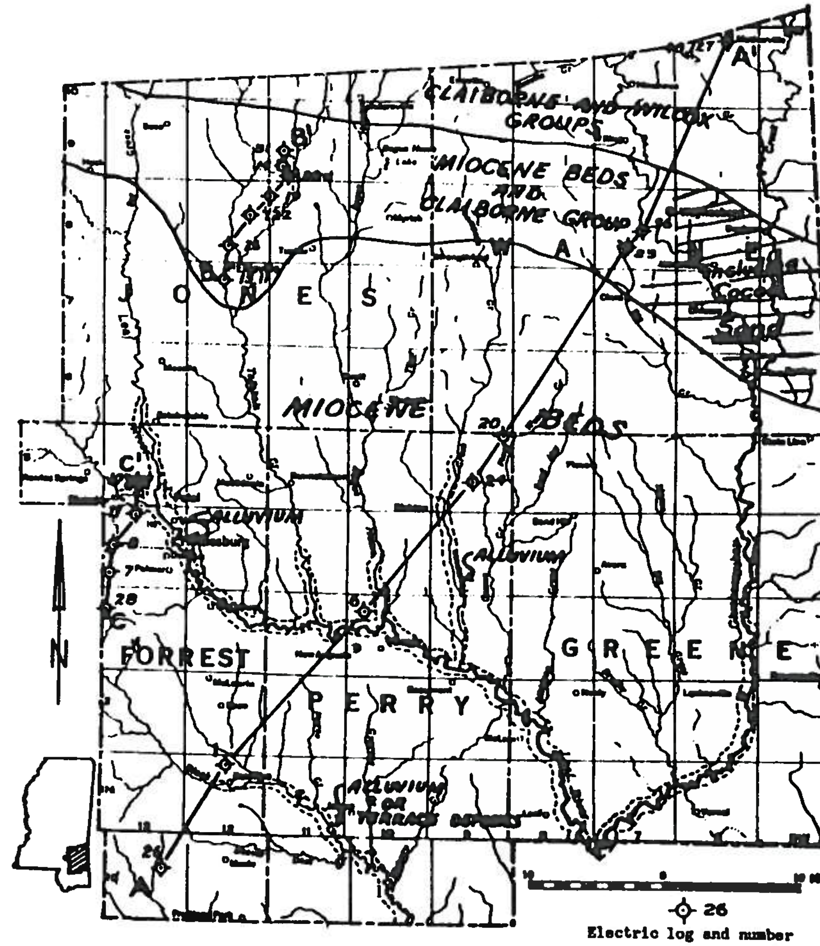


Fig. 19. Map showing distribution of fresh-water aquifers and location of geohydrologic sections

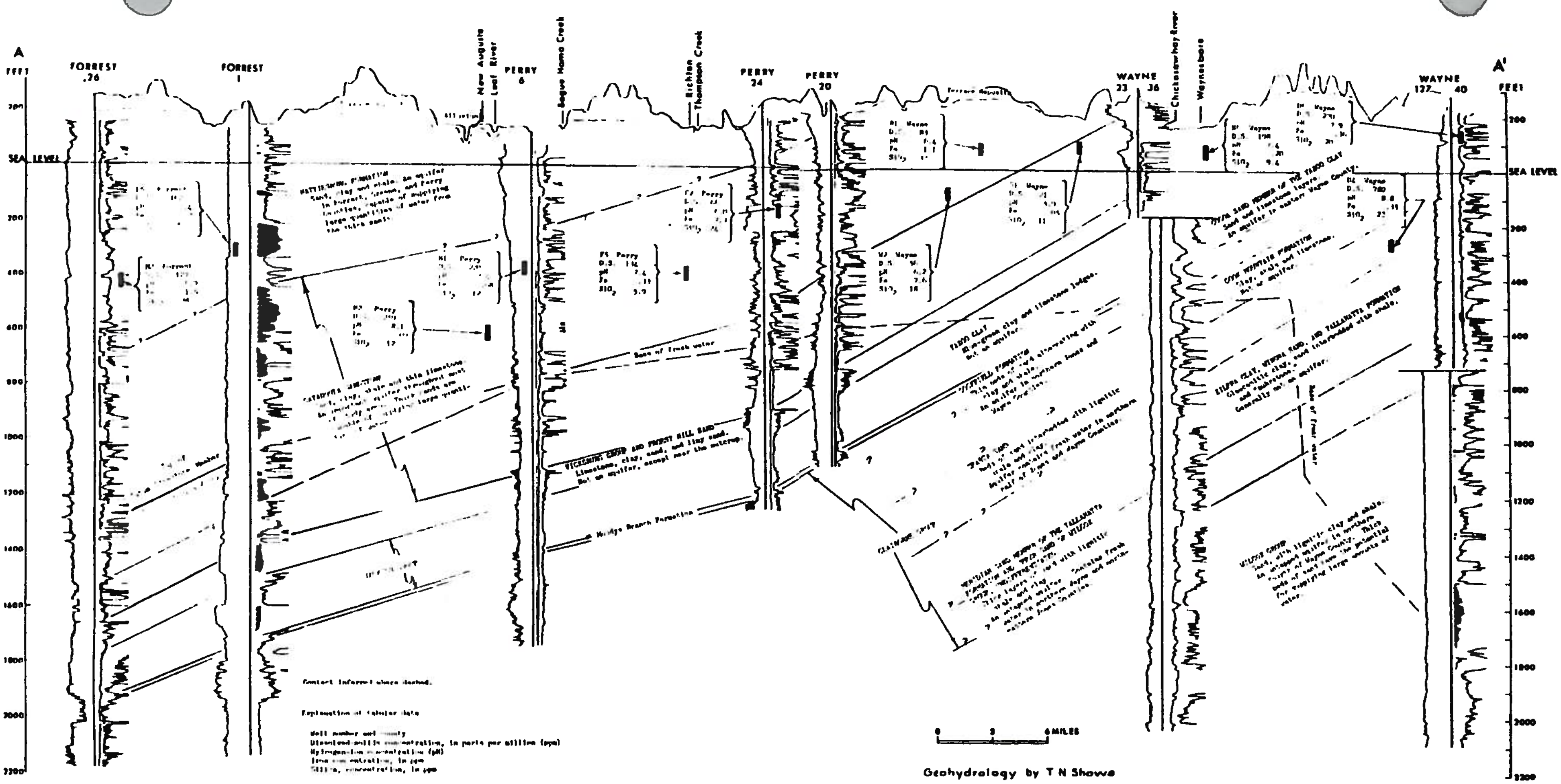


Fig. 20. Geohydrologic section (A-A') from southwestern Forrest County to northeastern Wayne County

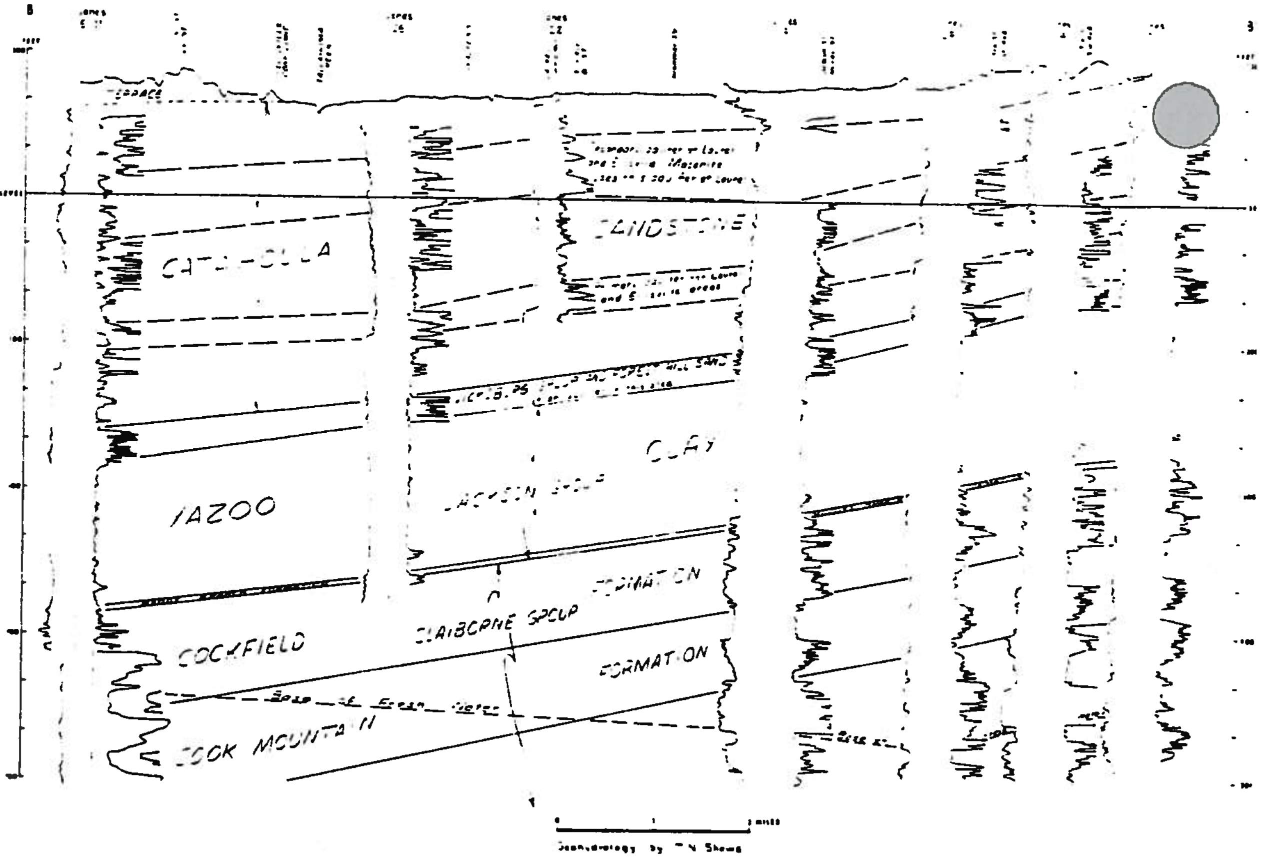


Fig. 21. Geohydrologic section (B-B') from Ellisville to Laurel

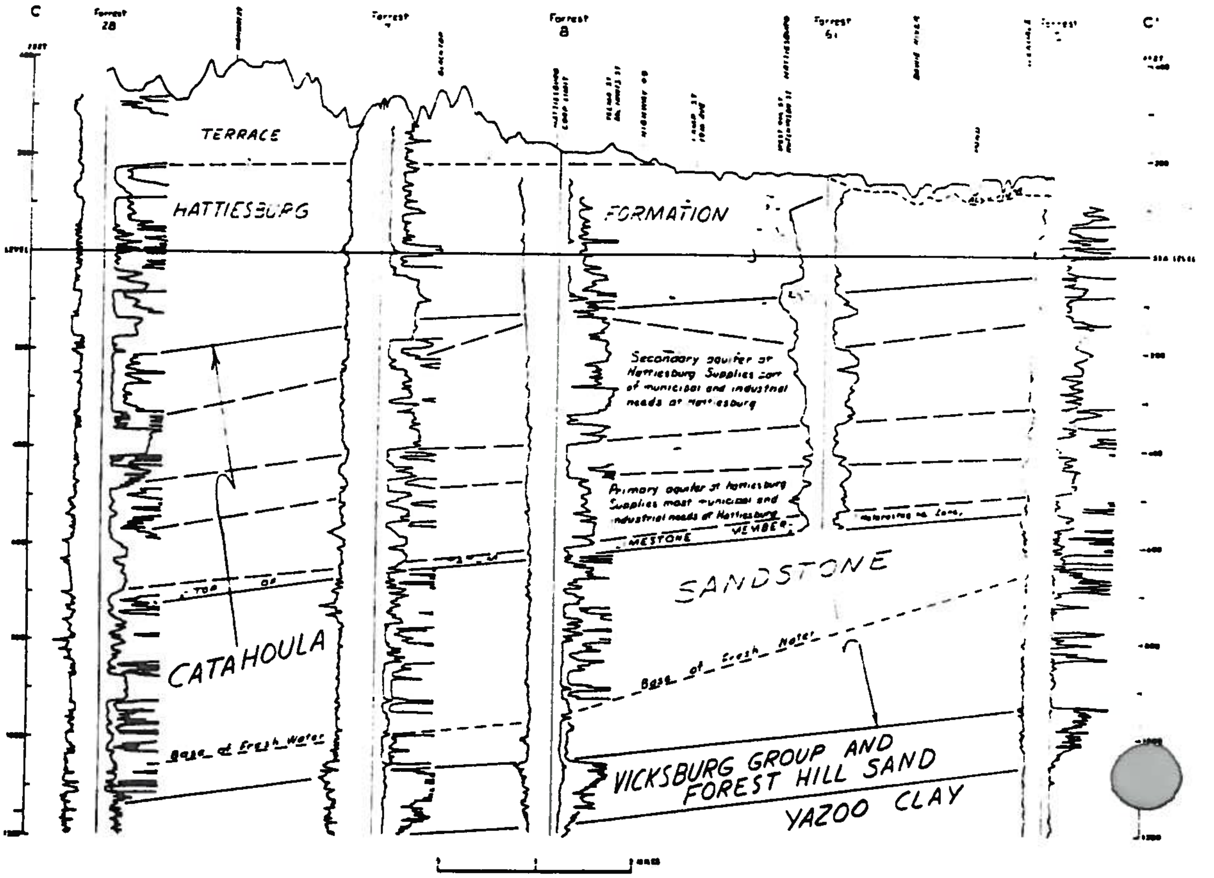
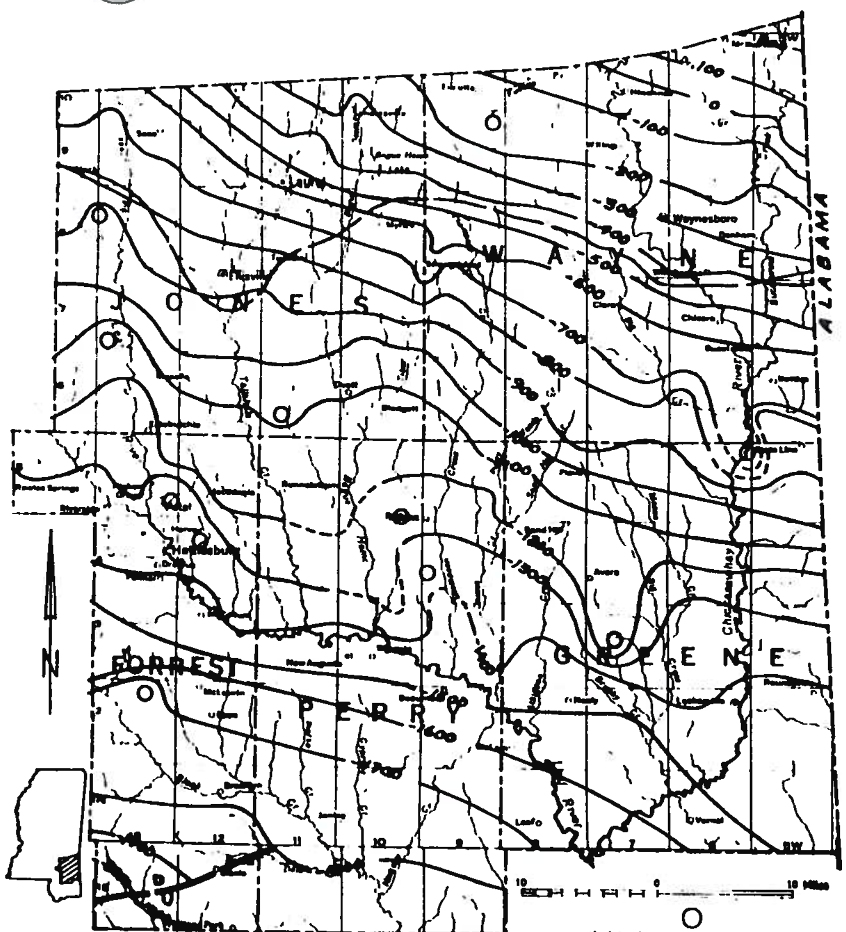


Fig. 22. Geohydrologic section (C-C') through the Hattiesburg area



Approximate limit of fresh water in Cockfield Formation.

Approximate location of fault.

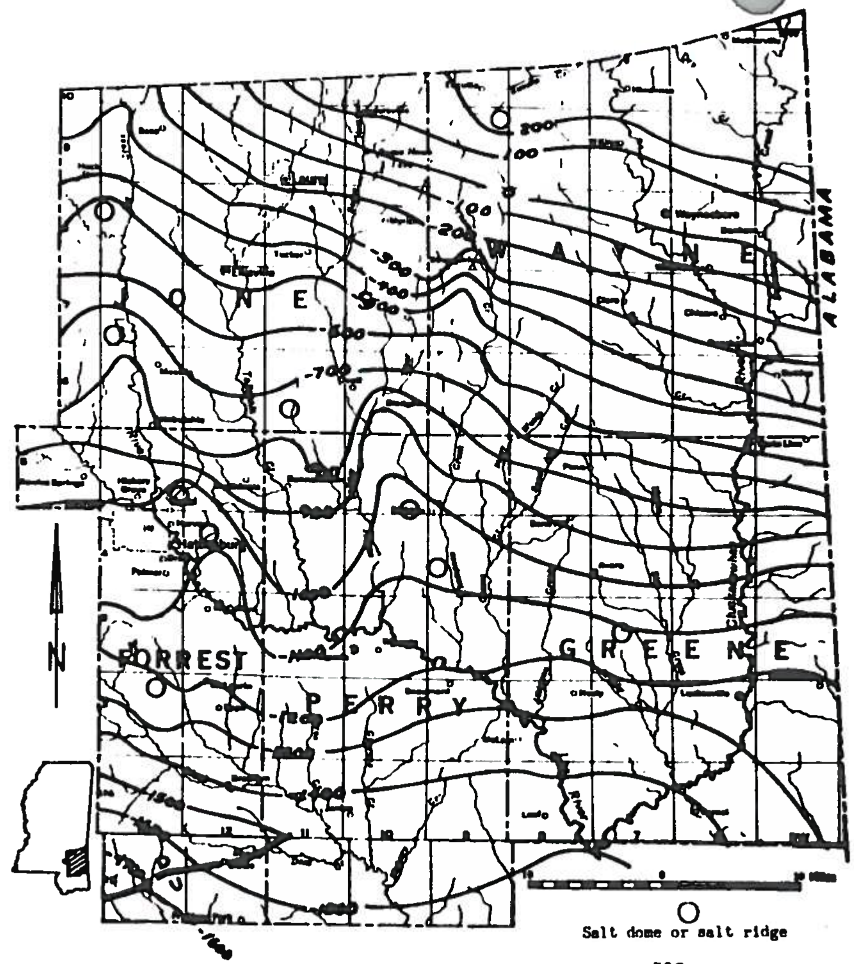
Salt dome or salt ridge

-200

Structure contour, dashed where inferred.

Contour interval 100 feet, datum is mean sea level.

Fig. 23. Contour map showing configuration of the top of the Moodys Branch Formation



Approximate location of fault

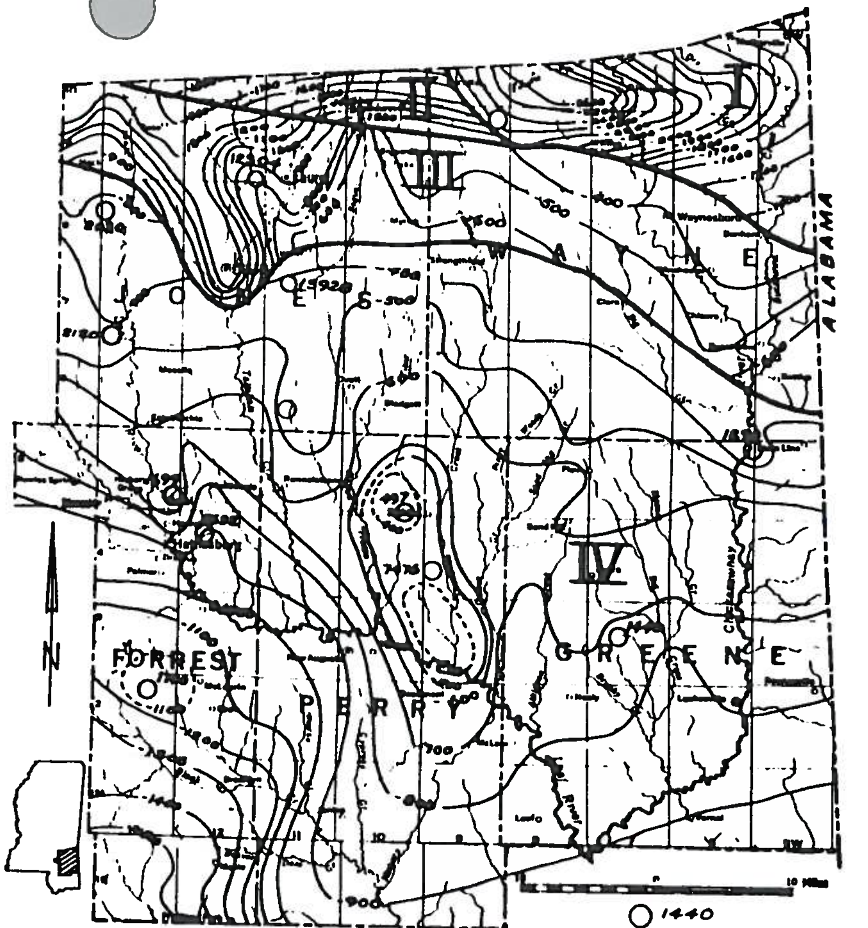
Salt dome or salt ridge

-500

Structure contour

Contour interval 100 feet, datum is mean sea level.

Fig. 24. Contour map showing configuration of the base of the Catahoula Sandstone



Area I.--Deepest fresh water is in the lower part of Wilcox Group.

Area II.--Deepest fresh water is in the upper part of Wilcox Group.

Area III.--Deepest fresh water is in Claiborne and Jackson Groups.

Area IV.--Deepest fresh water is in Miocene deposits.

○ 1440 Salt dome or salt ridge with depth to top of caprock below land surface.

—400— Contour on base of fresh water, dashed where inferred. Contour interval 100 feet, datum is mean sea level.

Line of abrupt change in base of fresh water.

Fig. 32. Contour map showing configuration of the base of the fresh-water section

are several fresh-water-bearing sands (fig. 20, 21, and 22) above the base of fresh water.

Ground-water quality varies with locality and is affected by contact with the sediments through which it slowly moves. Chemical composition of the sediments are different between zones of an individual aquifer and from one aquifer to another. Consequently the chemical quality of water pumped from a well is the result of many environmental factors. Water moves down dip in a southwesterly direction through aquifers containing clay, sand, gravel and other sedimentary material of varying size, compaction, and mineral content from which it dissolves various concentrations of the different mineral constituents. Time of contact of the water with the aquifer materials affects the amounts of the different minerals that are dissolved. In general, water from wells screened in highly permeable sands contain less dissolved solids than water from wells screened in sands with low permeabilities, if the wells are the same depth.

As water moves down the dip it exchanges calcium to the aquifer material for sodium, and changes from a moderately hard water having low dissolved solids near the outcrop areas to soft water having higher sodium and dissolved-solids concentrations at greater distance down dip. The change in water type and the increase in sodium concentration at greater distance down the dip of the Catahoula Sandstone is shown in figure 33.

Water percolating through the soil zone gathers carbon dioxide from organic matter in exchange for oxygen dissolved from the air. Most shallow wells (less than 125 feet deep) and some deeper wells in the Miocene contain water having sizable carbon dioxide concentrations (0-80 ppm) which acidify the water and render it corrosive to most metals. This corrosive water dissolves iron when in contact with iron-bearing minerals or with iron in the well system. Wells screened in the Sparta Sand, Cockfield Formation, Vicksburg Group, and Cocoa Sand member of the Yazoo Clay, in northern Wayne and Jones Counties, produce water having lower iron concentrations (0.00-0.42 ppm) than found in other formations of the study area. Iron concentrations in water from Miocene wells range from 0.00 ppm (03 Perry, 320-foot well near Janice) to 32 ppm (D5 Jones, 126-foot well near Sandersville). Treatment of iron-bearing ground water usually consists of aeration to remove carbon dioxide and to raise the pH; followed by settling and filtration to remove the iron precipitates.

Ground water usually contains higher silica concentrations than surface water because it remains in contact with silicate minerals under conditions favorable to solution for a longer period of time. Measured silica concentrations in the Miocene sediments range from 3 to 71 ppm. Silica concentrations measured in other aquifers of the study area ranged from ppm with approximately 90 percent of [illegible]ples having concentrations less than 40 ppm.

Ground water which contains anaerobic bacteria or decaying vegetation has a reducing effect upon minerals if there is no oxygen supply. The unpleasant taste and smell of hydrogen sulfide gas noted in water from the 564-foot sand at Richton and the Cockfield at Waynesboro indicate that sulfate minerals have been reduced to sulfides at these places. Hydrogen sulfide can be removed successfully by aeration of waters with a low pH or by chlorination of waters having a pH greater than 7.

Passage of water through decaying vegetation (including lignite beds) imparts color to the water. Color of water from the Cockfield Formation ranges from 5 to 240 units and color of water from one well screened in the Sparta Sand was 450 units. About 95 percent of the wells in the Miocene sediments show color of 20 units and less. Color may be removed by pH adjustment and coagulation by alum. Chemical analyses and well depths (table 14 and 15) and a map showing well locations (fig. 27) can be used to locate ground water of desirable quality.

None of the water samples collected from wells during the study indicated pollution by man's activity. Analysis of spring water in the vicinity of a brine disposal pit in the Chaprell Oil Field, Wayne County, indicated seepage of brine into the shallow ground water in that area. Potential hazard of pollution by chemicals and bacteria exists in wells screened in shallow aquifers. This hazard could be controlled by proper well location and design.

Water-Supply Potential

The water-supply potential is generally good; the largest potential supplies are in several formations of Miocene age and in the Wilcox Group. Aquifers of Miocene age underlie the southern two-thirds of the area and the Wilcox contains important aquifers in the northern one-third (fig. 19). Beds of Miocene age and the Claiborne Group contain important aquifers in the northern parts of Jones and Wayne Counties, but nearly all water supplies are obtained from the shallow beds of Miocene age. This band of shallow Miocene and deep Claiborne beds has less water-supply potential than other areas, partly because the water in the deeper aquifers is moderately mineralized (500 to 1,000 ppm dissolved solids). The water-supply potential for most municipal localities is summarized in appendix II.

Multiple aquifers underlie most places in the five-county area, and usually one or more of these aquifers will yield more than 2,000 gpm (2.9 mgd) to properly constructed wells. The mean transmissibility of the aquifers in the area as determined by 40 pumping tests is about 50,000 gpd per foot. The following well field layout in an average aquifer is used to illustrate the im-

Table 12.--Records of selected wells in Forrest, Greene, Jones, Perry, and Wayne Counties--Continued

Well No.	Owner	Year completed	Depth (ft)	Casing diameter (in)	Water-bearing unit	Elevation of land surface datum (ft)	Water level: Above (+) or below land surface (ft)	Water level: Date of measurement	Method of lift	Use	Yield: Gallons per minute	Yield: Date	Temperature (°F)	Remarks
	FORREST COUNTY--Continued													
J1	Johnson State Park	1960	111	4,4	Hattiesburg	215	50	1960	T	D	--	--	--	C
J2	Town of McLaurin, No. 2	1959	181	4	do	155	170 ±	10- 9-64	T	P	--	--	60	--
J3	do No. 1	1954	189	4	do	160	110	1954	T	P	--	--	60	C
J5	Johnson State Park	1952	115	4	do	230	60	--	T	D	--	--	--	--
J6	Shelby State Park	1961	115	2	do	215	70	1961	J	D,S	--	--	73	C
J7	Johnson State Park	1960	112	4	do	240	60	1960	P	S	--	--	--	--
L2	U.S. Forest Service (Ashe Nursery)	1936	725	8	Catahoula	280	153	1936	T	Ir	100	1936	--	--
L3	do	1957	717	10,8	do	277	153	1962	T	Ir	--	--	--	--
L5	South Forrest Attendance Center	1962	525	6	Hattiesburg	155	20	1962	T	D,S	50	1966	73	C
L17	Brooklyn Water Assoc.	1967	401	8,6	do	210	80	5- 6-66	S	P	252	1966	74	P
L49	U.S. Forest Service (Ashe Nursery)	1938	720	6	do	280	142	1938	T	I	--	--	--	C
M3	Holiday School, Carnes	1952	400	4	do	125	80	1952	T	D,S	--	--	73	C
N1	Camp Tiak, Boy Scout Camp	1955	250	4	do	200	102	3- -55	T	D	--	--	72	C
N2	Marathon Oil Co	1954	539	4,4	do	240	94	1- 2-54	T	D,S	61	1954	73	C
N4	U.S. Forest Service, Black Creek Work Center	1961	117	4	do	180	43	4-21-61	S	D,S	--	--	--	--
	GREENE COUNTY													
A1	Sand Hill School	1969	575	4	Catahoula	310	180	1969	T	P	10	--	--	C
A4	Lester Brewer	1961	418	2	do	265	97	1961	J	D,S	--	--	--	C
A9	Mrs. Margie Brewer	1966	430	2	do	271	112	1966	J	D,S	--	--	60	C
A11	James C. Mills	1955	80	2	Terrace	280	40	1955	J	D,S	--	--	71	C
A15	James E. McLain	1966	450	2	Catahoula	320	140	12- -66	J	D,S	--	--	67	--
A16	Mrs. Margie Brewer	1960	28	8	Terrace	271	13.8	5-10-65	B	D,S	--	--	--	C
A17	Sandhill Teachers Home	1964	91	2	do	316	65	1964	J	D,S	--	--	--	C
A18	Mrs. Margie Brewer	1965	110	2	Catahoula	271	112	6- -65	J	--	--	--	70	C
B5	Mrs. D. D. Henderson	1962	300	2	do	190	--	--	C	D,S	--	--	--	--
C1	L. D. Clark	1957	130	1	do	90	30	1965	P	D,S	5	1965	66	C
D1	Town of State Line	1962	304	8,6	do	200	97	8- -62	T	P	40	1965	70	C,P
E3	Clifton Watson	1960	300	2	do	105	31	10- -60	J	D,S	--	--	60	C
E4	Cities Service Co., No. 12	1964	481	1	do	140	11.1	5-12-61	A	I	--	--	--	C
F2	Ray Ayers	1964	305	2	do	275	80	1964	C	D,S	--	--	--	--
F4	E. D. Dubose	1961	282	2	do	255	70	3-17-65	J	D,S	7	1965	--	C
H1	Samuel D. Sloane	1938	400	2	do	330	300	1938	C	D,S	--	--	60	C
H2	Wert Hall, Jr	1926	75	2	Terrace	265	60	1965	C	D,S	--	--	67	C
H3	J. H. Clark	1919	190	4	Catahoula	112	+ 10	6- 1-65	P	S	25	1965	60	C
H4	do	1957	155	2	do	112	+ 20	1957	P	D,S	43	1965	60	C
J1	C. G. Cox	1955	360	2	Hattiesburg	185	15	1955	C	D,S	--	--	--	--
J3	Grover Anderson	1966	151	2	Catahoula	230	50	8- 4-66	J	D,S	--	--	60	C
J6	Sam Turner	1965	177	2	do	270	84	3- -65	J	D,S	--	--	70	C
J7	Elgin Turner	1959	50	2	Terrace	155	11	1959	J	D,S	--	--	--	C
K2	Baptist Parsonage	1961	110	2	Hattiesburg	75	+ 11	5-24-64	J	D,S	--	--	--	--
L4	Shell Oil Co., Byrnes No. 1	1965	450	5	Catahoula	180	20.6	5-12-65	A	S	30	1965	--	C
N1	R. W. Buffkin, Jr.	1950	585	2	do	185	25	1950	J	D,S	--	--	70	C
N6	J. L. Freeman	1939	164	2	Hattiesburg	76	+ 4	1964	J	D,S	--	--	60	C
N10	R. W. Buffkin, Sr.	1963	420	2	do	175	65	3-24-65	J	D,S	--	--	71	C
P1	Town of Leakesville, No. 1	1962	140	6	do	100	25.2	11-17-64	S	P	100	1965	--	D,P
P2	do No. 3	1950	125	6	do	100	30	2- -65	T	D,S	131	1965	--	--
P3	do No. 2	1957	140	6	do	100	40	1957	T	P	86	1965	70	C
P11	do	1959	407	4	Catahoula	100	+ 5	11-17-64	P	P	7	1965	71	C
Q1	Leakesville Colored School	1960	160	4	Hattiesburg	70	+ 10	1960	J	P	--	--	--	--
Q2	do	1960	180	8	do	70	+ 10	1960	J	P	--	--	--	--
Q5	T. S. Cornelius	1960	304	2	do	230	40	1962	C	D,S	--	--	70	C
R1	I. J. Edwards	1958	50	2	Terrace	105	30	1958	J	D,S	--	--	60	C
	JONES COUNTY													
A3	A. J. Green, Jr.	1955	46	2	Terrace	300	30	5-25-55	J	D	--	--	70	C
A5	So-Ro Water Assoc.	1965	470	6,4	Catahoula	310	72	7-20-64	S	P	150	1965	60	C,P
B11	Dr. J. B. Altamer	--	120	1	do	290	40	9- -51	C	D	--	--	60	C
B24	Shady Grove Water Assoc.	1965	184	6,4	do	310	171	8-24-65	S	P	165	1965	60	C,P
B25	do	1964	730	6,4	do	290	111	2-19-61	S	P	162	1961	60	P
C6	Transcontinental Gas Pipe Line Corp.	1950	275	6	do	345	56	1950	T	D	31	--	--	C
C7	Henry D. Tate	1955	158	2	do	295	85	6-27-55	C	D,S	--	--	--	C
C27	B. H. Foster	1960	70	2	Terrace	300	40	1955	J	D,S	--	--	60	C
C31	City of Laurel, No. 18	1956	318	24,16	Catahoula	242	203	9- -56	T	P	700	1960	73	C
C33	do No. 26	1949	340	24,10	do	250	113	3- 5-49	B	S	--	--	--	--
C34	do No. 5	1949	301	18,12	do	236	127	10- -49	S	P	800	1960	72	C
C35	do No. 6	1949	601	18,10	do	241	136	8- -49	T	P	850	1960	--	--
C37	do No. 8	1956	361	18,12	do	275	130	8- -56	T	P	900	1960	60	C
C38	Southern United Ice Co	1946	346	10,8	do	275	136	1946	T	B	--	--	--	--
C44	Powers Water Assoc.	1965	305	6,4	do	282	148	7-20-65	S	P	--	--	60	P
C45	C. H. Beale	1963	143	2	do	293	115	5- -63	C	D,S	9	--	67	C
C46	Powers Water Assoc.	1966	305	6	do	293	142.9	6- 6-66	S	P	306	1966	--	P
C51	City of Laurel	1900	318	10	do	240	58	1949	B	N	--	--	--	--
C53	City of Laurel, No. 2	1930	310	24,10	do	277	109.5	1930	S	S	800	1960	--	C
C67	do No. 7	1949	327	18,10	do	274	113.3	1950	T	P	912	1966	--	C,P
D1	Southland Refinery	1946	640	10,6	Cockfield	301	60	6-27-55	T	Ir	175	1955	76	C
D4	C. W. McKenzie	1945	70	2	Catahoula	285	--	--	J	D	--	--	--	C
D5	Miss Dollye C. Perkins	1933	136	2	do	295	--	--	C	D	10	1955	60	C
D6	R. D. Mayo	1955	226	4	do	233	30	3- -55	C	D	1	1955	66	C
D7	C. W. McKenzie	1946	250	4	Vicksburg	300	4.8	6-20-55	P	D	--	--	72	C
D26	Magnolia Boys Town	1955	300	6	Catahoula	252	64	1956	T	D,S	--	--	--	--
D28	R. D. Mayo	1950	16	2	Terrace	235	30	3- -55	C	D,S	--	--	--	C
D29	Rogue Home School	1956	56	6	do	343	39	9- 8-56	C	D	--	--	--	C
D33	R. D. Stevens	1960	100	2	do	345	--	--	C	D,S	--	--	--	C
D34	Bill McDonald	1963	620	3	Cockfield	313	80	11-26-63	J	D,S	--	--	--	C
D35	Town of Sandersville	1963	110	10	Vicksburg	270	35	1-24-64	T	P	--	--	68	C
D37	Sinclair Oil Co., Plant No. 50	1962	826	4	Sparta	322	--	--	B	I	40	1962	--	C
D38	Humble Oil Co.	1960	80	2	Vicksburg	365	--	--	J	I	77	1962	--	C
D41	Town of Sandersville	1962	710	8	Cockfield	303	14	9- -62	S	S	116	1962	76	--

Table [illegible].--Aquifer and well characteristics determined from aquifer tests in Forrest, Greene, Jones, Perry, and Wayne Counties

Well no.	Location	Water-bearing unit	[illegible]	[illegible]	[illegible]	[illegible]	Coefficient of storage	Specific capacity (gpm/ft at the end of 1 day)
			FORREST COUNTY					
[illegible]	Hattiesburg	Catahoula	[illegible]	[illegible]	[illegible]	[illegible]	--	[illegible]
[illegible]	do	[illegible]	[illegible]	[illegible]	[illegible]	--	--	[illegible]
[illegible]	do	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.0001	[illegible]
[illegible]	do	Hattiesburg	[illegible]	[illegible]	44,000	600	.0002	--
[illegible]	do	Catahoula	[illegible]	[illegible]	[illegible]	1,080	--	40
[illegible]	do	[illegible]	[illegible]	40	[illegible]	375	.0001	13
[illegible]	[illegible]	Alluvium	[illegible]	[illegible]	[illegible]	2,400	.0005	[illegible]
[illegible]	Hattiesburg	Catahoula	[illegible]	76	14,000	190	--	7.5
[illegible]	do	do	[illegible]	[illegible]	[illegible]	[illegible]	--	[illegible]
[illegible]	Palmers Crossing	do	[illegible]	[illegible]	[illegible]	[illegible]	.0002	20
[illegible]	Hattiesburg	do	[illegible]	[illegible]	[illegible]	[illegible]	--	--
[illegible]	do	do	[illegible]	72	[illegible]	560	.0002	11
[illegible]	Camp Shelby	Hattiesburg	[illegible]	82-102	[illegible]	580-[illegible]	.0002-.0005	--
[illegible]	[illegible]	do	[illegible]	170	[illegible]	1,110	--	22
			GREENE COUNTY					
[illegible]	State Line	Catahoula	[illegible]	54	[illegible]	180	--	15
[illegible]	Leakesville	Hattiesburg	[illegible]	[illegible]	2,[illegible]	74	--	9
			JONES COUNTY					
[illegible]	[illegible]	Catahoula	[illegible]	[illegible]	[illegible]	615	--	6.8
[illegible]	[illegible]	do	[illegible]	68	12,[illegible]	1,540	0.0002	[illegible]
[illegible]	do	do	[illegible]	66	12,[illegible]	1,900	.0002	12
[illegible]	[illegible]	do	[illegible]	55	10,[illegible]	1,090	--	12
[illegible]	do	do	[illegible]	55	55,[illegible]	1,000	--	[illegible]
[illegible]	Laurel	do	[illegible]	[illegible]	[illegible]	1,180	--	21
[illegible]	do	do	[illegible]	[illegible]	[illegible]	1,100	.0001	[illegible]
[illegible]	do	do	[illegible]	54	12,[illegible]	910	.0001	15
[illegible]	[illegible]	do	[illegible]	54	[illegible]	1,020	.0002	11
[illegible]	[illegible]	do	[illegible]	[illegible]	[illegible]	150	--	8
[illegible]	do	do	[illegible]	[illegible]	[illegible]	110	--	1
[illegible]	Laurel	do	[illegible]	[illegible]	[illegible]	685	--	14
[illegible]	do	do	[illegible]	[illegible]	17,[illegible]	290	--	6.5
[illegible]	do	do	[illegible]	[illegible]	44,[illegible]	440	.0001	8.6
[illegible]	Ellisville	do	[illegible]	[illegible]	[illegible]	[illegible]	.0002	12
			PERRY COUNTY					
[illegible]	[illegible]	Catahoula	[illegible]	--	[illegible]	--	--	1.6
[illegible]	New Augusta	do	[illegible]	[illegible]	2,[illegible]	[illegible]	0.0002	1.8
[illegible]	[illegible]	do	[illegible]	148	[illegible]	[illegible]	--	76
[illegible]	do	do	[illegible]	47	2,[illegible]	[illegible]	--	[illegible]
			WAYNE COUNTY					
[illegible]	Waynesboro	Vicksburg	114	[illegible]	25,[illegible]	[illegible]	--	17
[illegible]	[illegible]	Catahoula	[illegible]	[illegible]	[illegible]	[illegible]	--	[illegible]
[illegible]	[illegible]	do	[illegible]	[illegible]	[illegible]	1,0[illegible]	.0001	21

Table 14.--Chemical analyses of water from wells in Forrest, Greene, Jones, Perry, and Wayne Counties, Miss.

Chemical constituents, in parts per million

Well no.	Water-bearing unit	Depth (feet)	Date of collection	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Hardness as $CaCO_3$: Calcium, magnesium	Hardness as $CaCO_3$: Noncarbonate	Sodium adsorption ratio	pH	Color	Temperature (°F)
											Forrest County											
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
											Greene County											
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
											Jones County											
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table 14.--Chemical analyses of water from wells in Forrest, Greene, Jones, Perry, and Wayne Counties, Miss.--Continued

Chemical constituents, in parts per million

Well no.	Water-bearing unit	Depth (feet)	Date of collection	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Hardness as $CaCO_3$: Calcium, magnesium	Hardness as $CaCO_3$: Noncarbonate	Sodium adsorption ratio	pH	Color	Temperature (°F)
											Jones County--Continued											
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
											Perry County											
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
											Wayne County											
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]