43328 Vol 2

OSM

OFFICE OF SURFACE MINING
RECLAMATION AND ENFORCEMENT
TECHNICAL REPORT/1994

INVESTIGATION OF DAMAGE TO STRUCTURES IN THE M^{c}CUTCHANVILLE-DAYLIGHT AREA OF SOUTHWESTERN INDIANA

Volume 2 of 3

Part II: Geologic and Unconsolidated Materials in the McCutchanville-Daylight Area.
Part III: Blast Design Effects on Ground Vibrations in McCutchanville and Daylight, Indiana from Blasting at the AMAX, Ayrshire Mine.
Part IV: Vibration Environment and Damage Characterization for Houses in McCutchanville and Daylight, Indiana.
Part V: Racking Response of Large Structures from Airblast, A Case Study.
Part VI: Investigation of Building Damage in the McCutchanville-Daylight, Indiana Area.

US Department of Interior
Office of Surface Mining
Reclamation and Enforcement

Kenneth K. Eltschlager
Mining/Explosives Engineer
3 Parkway Center
Pittsburgh, PA 15220

Phone 412.937.2169
Fax 412.937.3012
Keltschl@osmre.gov

March 3, 1849

U.S. Department of the Interior

Office of Surface Mining Reclamation and Enforcement

Part II

Geologic and Unconsolidated Materials in the McCutchanville-Daylight Area.

INVESTIGATION OF DAMAGE TO STRUCTURES IN THE McCUTCHANVILLE-DAYLIGHT AREA OF SOUTHWESTERN INDIANA

A FINAL REPORT

PART II: GEOLOGIC AND UNCONSOLIDATED MATERIALS IN THE McCUTCHANVILLE-DAYLIGHT, INDIANA AREA

(Summary of OSM Contract No. GR 993184)

OSM Contract No. GR 993184

Indiana Department of Natural Resources (IDNR), Geological Survey (IGS), Environmental Geology Section. Parts 1 and 2: Geologic Framework and Physical Properties of Bedrock and Lacustrine Deposits in and Around McCutchanville, Indiana; Participants: Hester, N.; Bleuer, N.; Eggert, D.; Hasenmueller, N.; Arnold, J.; Chitwood, T.; Riddle, S.; Frushour, S.; Fitch Jr., J.; and Johnson, C.; February, 1990.

1989-1990 Mid-Year Report

CONTENTS

Figures

GEOLOGIC AND UNCONSOLIDATED MATERIALS IN THE MCCUTCHANVILLE-DAYLIGHT, INDIANA AREA

Introduction

IGS through an OSM cooperative agreement provided field data and geologic background on the study area. The IGS report submitted to OSM in February 1990 is a two-volume report. Volume I contains interpretative information on unconsolidated soil materials and bedrock geology. Included are soil sample analyses, soil descriptions and natural gamma logs of shallow auger holes. Volume II contains drawings and data from a deep core hole drilled at the McCutchanville Fire Station.

This section summarizes the IGS work, with some expansion and definition of terms provided by OSM. The objective of the cooperative agreement was to establish the geologic framework and determine the physical properties of the unconsolidated material in the vicinity of McCutchanville and Daylight, Indiana.

Information on bedrock geology was collected from IGS files. Supplemental data was collected by an IGS subcontractor who drilled and logged OSM corehole 26 at the McCutchanville Volunteer Fire Station. Continuous core from OSM 26 extended from the West Franklin Limestone Member, which begins 30 feet below ground surface, through the Springfield Coal Member at 350 feet to a total depth of 354 feet. The characteristics of unconsolidated surface material were determined from auger drilling, sampling, and downhole gamma-ray logging of shallow auger holes. Seventeen of the 35 auger holes drilled are located within +/- 100 feet of structures identified as damaged by the initial field survey. The remaining auger holes are primarily along Kansas Road and County Line Road to provide crossections of the study area. Auger hole locations are shown on Figure 1.

The study area is divided into three geomorphic or landscape surfaces based on subtly differing sequences of unconsolidated materials and surface elevation: (1) The upland or upper surface, (2) a transition or middle surface and (3) a lower surface, including lake beds.

Bedrock Geology

The study area is underlain by Pennsylvanian bedrock units of the Carbondale and McLeansboro Groups. As shown in Figure 2, the bedrock consists mostly of unnamed shale and sandstone units with thin beds of limestone, clay, and coal. The coals are marker beds used in the subsurface correlation of the Carbondale Group. The four units of stratigraphic importance in the study area are shown and defined on Figure 2.

The Directory of Coal Producers in Indiana (IGS, 1986) lists the AMAX Ayrshire Surface mine as mining the Danville and Hymera coal seams. In IGS Preliminary Coal Map 5 (1954)

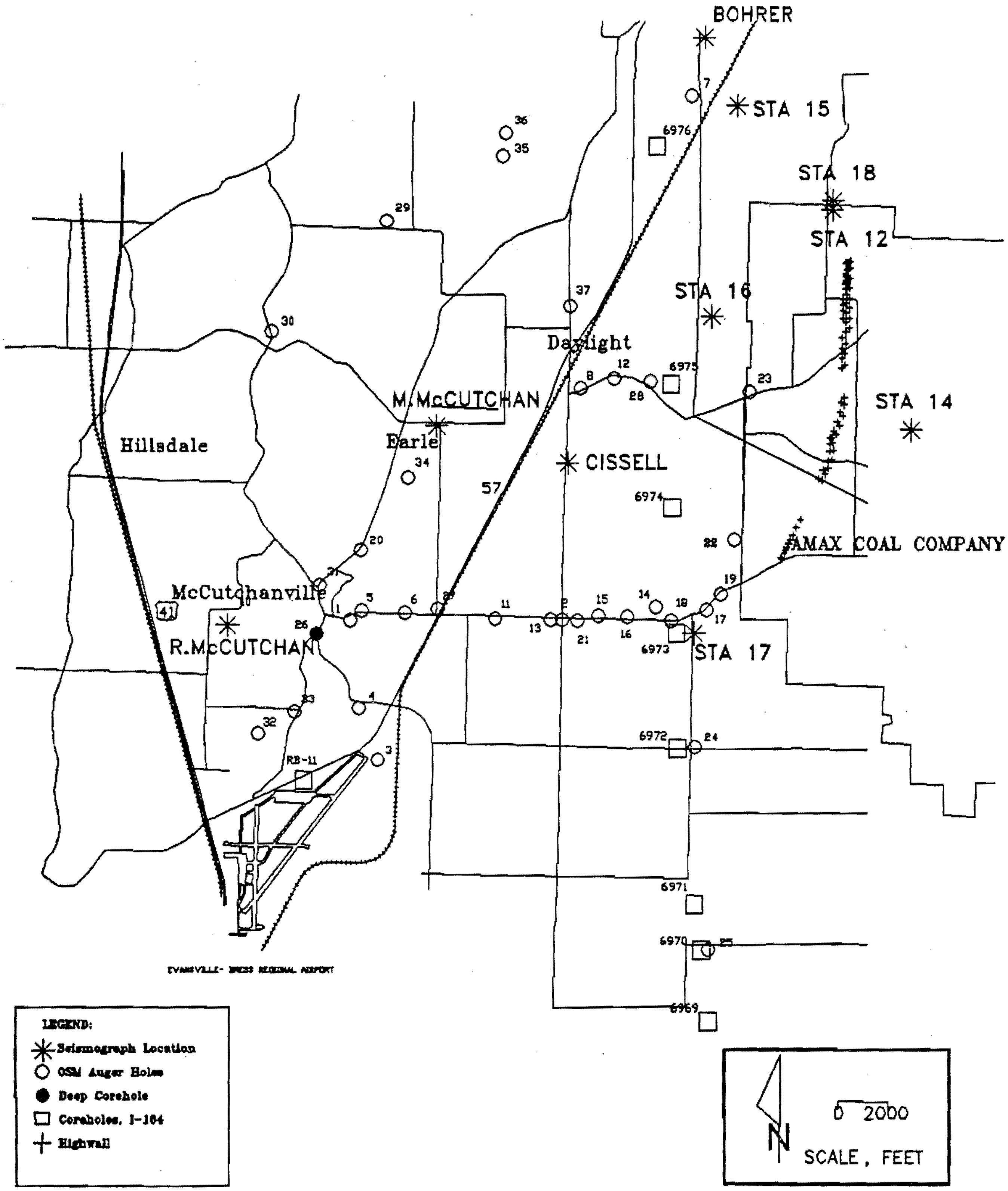
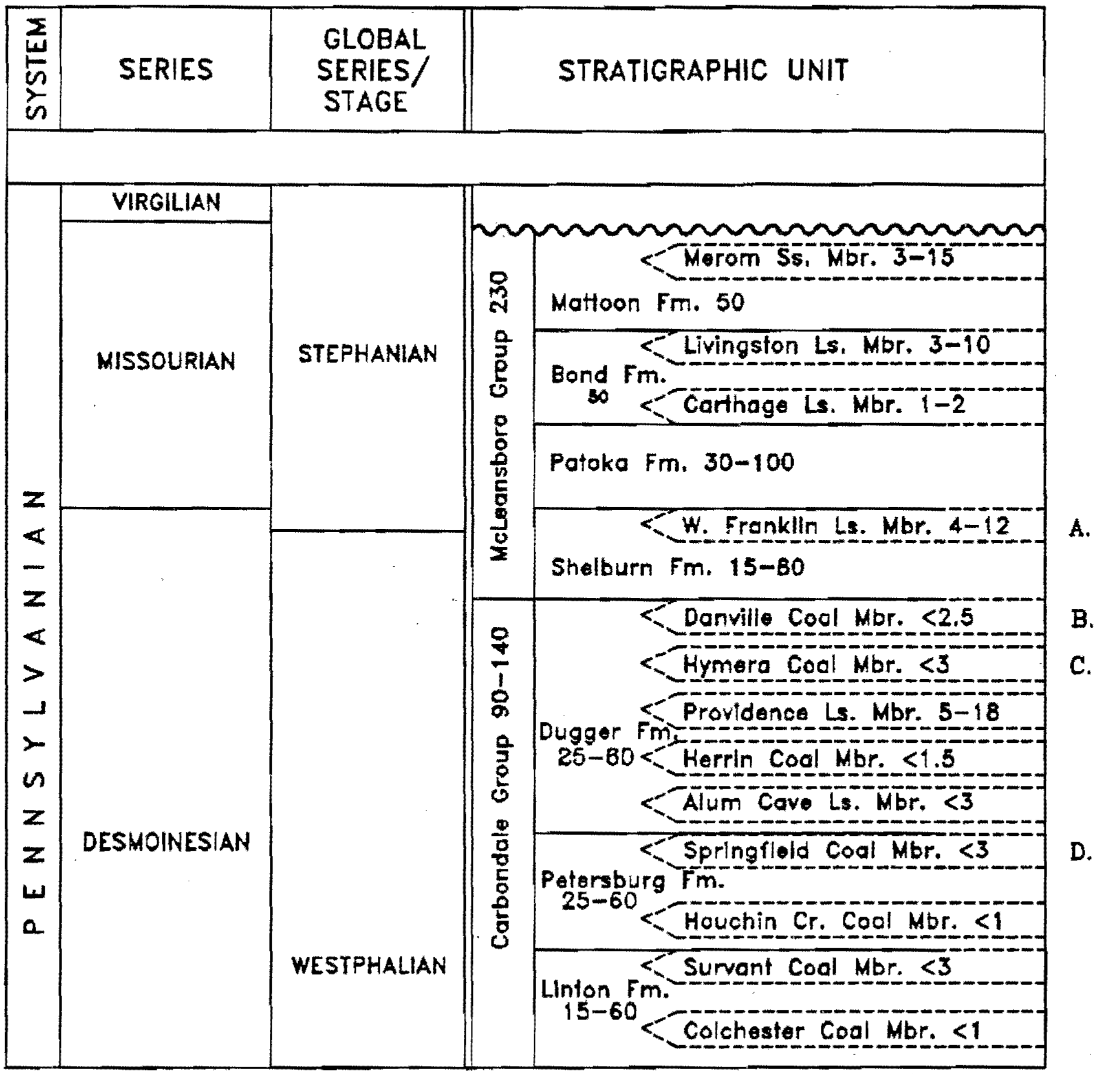


Figure 1. OSM Auger Hole and Deep Corehole Locations in the Study Area.



LEGEND

A. W. Franklin Limestone Member – Underlies upland area at a depth of less than 40 feet.
B. Danville Coal Member – Upper seam mined at the Ayrshire mine.
C. Hymera Coal Member – Lower seam mined at the Ayrshire mine.
D. Springfield Coal Member – Cored (OSM #26) at the McCutchanville fire station to the Springfield Coal Mbr. at 345 feet with a total core depth of 354 feet.

Figure 2. Pennsylvanian Stratigraphic Units in Southwestern Indiana Thickness of Units is in Meters (IGS, Gray and Others, 1985).

the Danville and Hymera coals were called the Upper Millersburg (VII) and Lower Millersburg (VI). The names Upper and Lower Millersburg, as well as the Roman numeral designations Coal VII and VI, are no longer used as official names (IGS, Chart of Paleozoic Rock-Unit Names in Indiana, 1986). Figure 3 is a generalized cross-section through the study area showing key stratigraphic units and the relative position of the coal seams mined by AMAX, unconsolidated surface material, lacustrine valley fill and reworked loess.

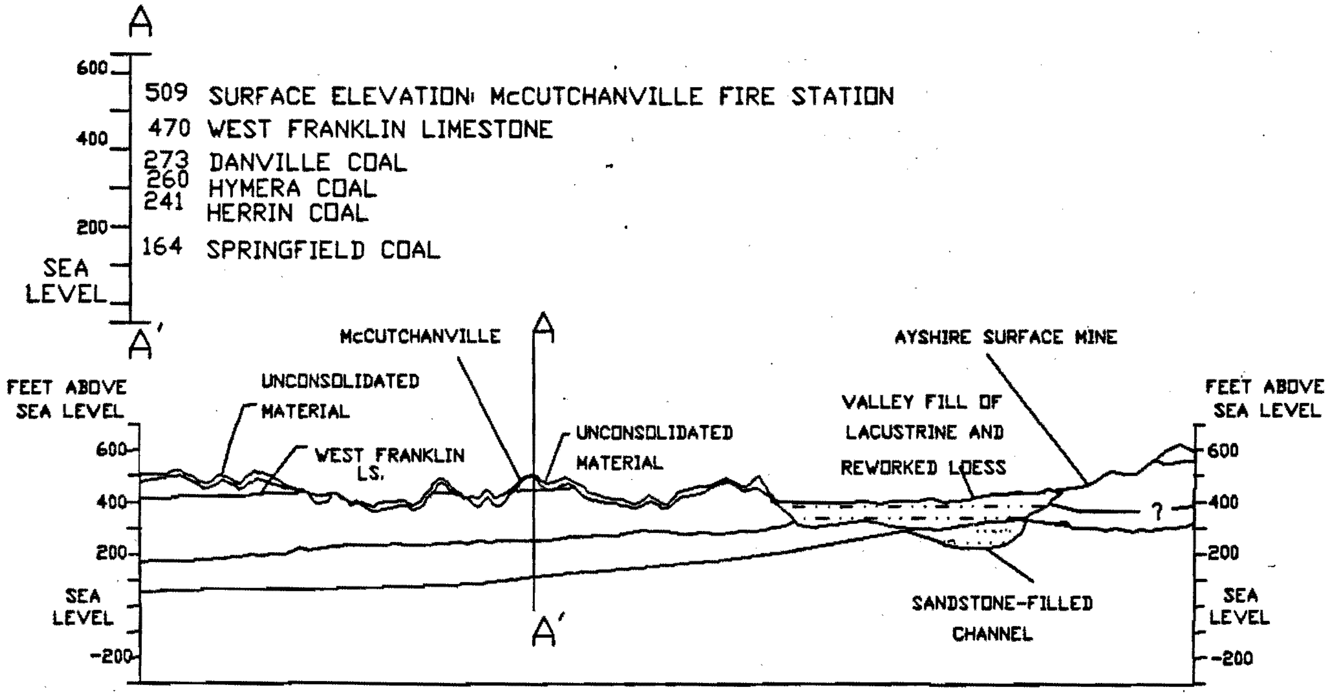
The bedrock units are fairly consistent throughout the study area. The Springfield coal seam (Figure 2) at 164 feet (mean sea level) is below the Danville and Hymeria seams mined by the Ayshire mine. The Springfield coal is present throughout the area except in an area paralleling the eastern Vanderburgh County line. A north-south river channel at a depth of 140-160 feet eroded and replaced the Springfield coal with up to 160 feet of sandstone. Shale is the predominant lithology in corehole (OSM-26) at the McCutchanville fire station. Several siltstone intervals are present in the core, and a 42-foot thick unnamed sandstone overlies the Alum Cave Limestone Member of the Dugger Formation at 338 feet. Thin beds of coal, limestone, and clay comprise the remainder of the section.

Geomorphic Surfaces

The geomorphic (landscape) surfaces include bedrock upland areas like McCutchanville, and an adjacent, broad, nearly flat-floored basin surrounding Little Bluegrass Creek. The local landscape, as shown on Figure 4, is divided into three surfaces.

The upland or upper surface lies above 450 feet in elevation and is composed of narrow ridge tops and relatively steep side slopes. The middle surface is a broader, gently sloping area flanking the upper surface; and, in some areas, a low, gently rolling upland with elevations of 400 to 450 feet. The lower surface or basin lies below 400 feet and is a "lake plain."

The upper surface generally corresponds to the presence of the West Franklin Limestone Member of the Shelburn Formation. The West Franklin Limestone is responsible for maintaining the relative steepness of the valley heads and side slopes. The middle surface is mainly underlain by shale of the Shelburn Formation and its gentle surface is characteristic of the softer lithology. The lower surface corresponds with the onlapping edge of a deep lacustrine filled basin cut into shale. These surfaces blend together with surface and buried sheetwash fan deposits at the lower reaches of the of upper and middle surfaces.



BASE ELEVATION FROM IDNR PREMININARY COAL MAPS #5 (1954) & #7 (1958).
ELEVATIONS AT A-A′ FROM DEEP CORE HOLE (OSM #26).
HASENMULLER, NANCY (1990) A PENNSYLVANIAN EROSIONAL CHANNEL IN THE ILLINOIS BASIN
ALL OTHER ELEVATIONS GENERALLIZED

Figure 3. Cross-section Through Area Showing Key Statigraphic Units.

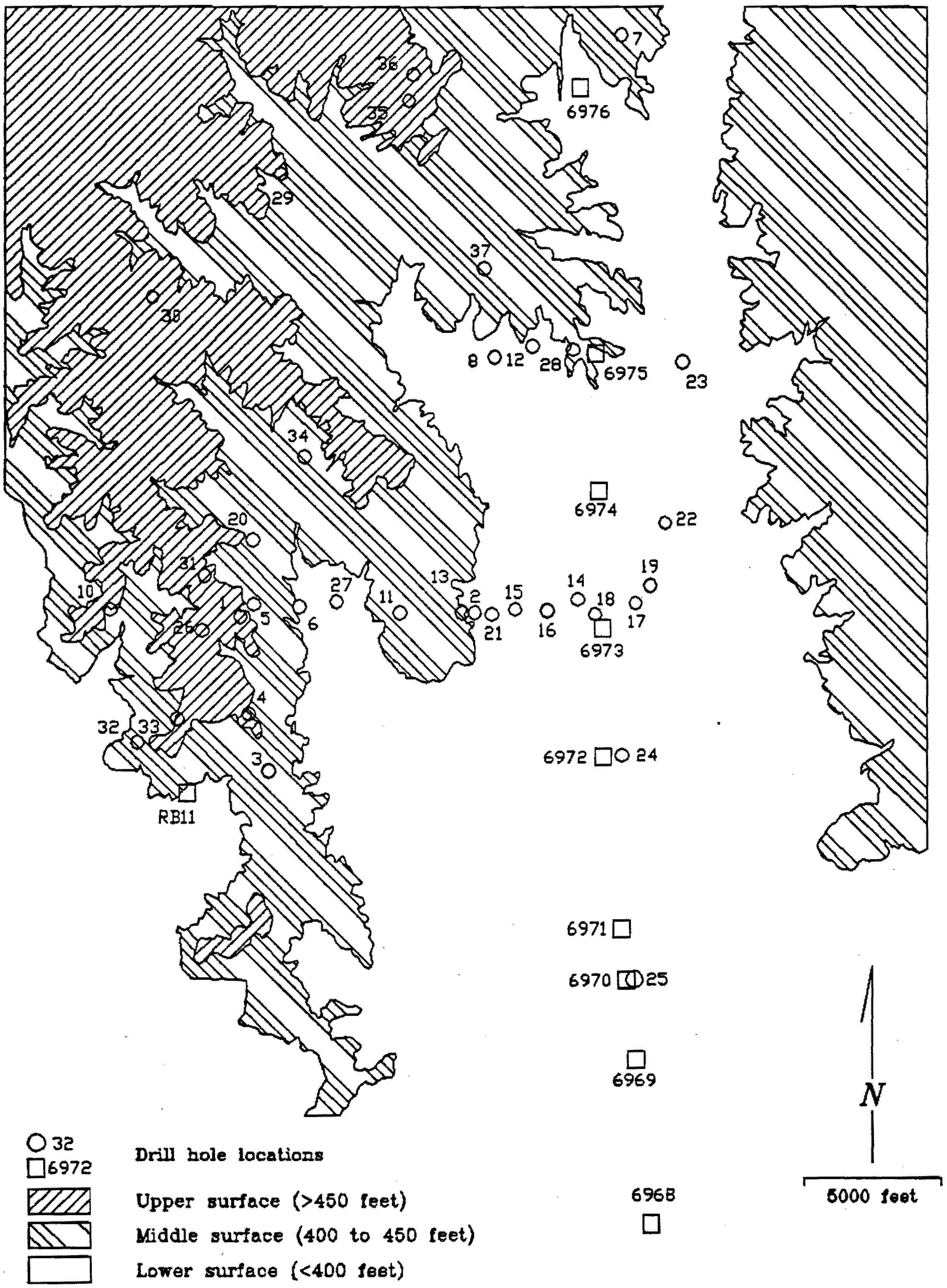


Figure 4. Geomorphic Surfaces of the Study Area.

Unconsolidated Soil Materials

The measured thickness of unconsolidated soil material depends on the definition of that material. Unconsolidated soil material is distinguished from rock based on the degree of disaggregation. IGS considers rock to be any material whose original rock structure is intact. This is important since shale is the predominant rock type forming the soil/bedrock interface. In place weathered shale that retains its original rock structure, although soft enough to be augered, is classified as bedrock.

The unconsolidated soil material ranges in thickness from less than 10 feet at some upland and side-slope positions (upper and middle surfaces) to greater than 80 feet in the eastern lake basin (lower surface). Figure 5 is an isopach map which shows the relative thickness of unconsolidated soil materials, based on data obtained during this study.

Upper and Middle Topographic Surfaces

The upper and middle topographic surfaces of the eastern half of the study have a subtly differing vertical sequence of unconsolidated materials. On the uplands of the upper surface, modern or recent soils with fragipan overlie loess.

A fragipan is a very compact horizon that is slowly to very slowly permeable to water. When dry, it is hard to very hard and has a high bulk density in comparison with the soil horizon or horizons above it. When moist, the fragipan tends to rupture if pressure is applied, rather than deform slowly. The particle size content is said to be silt or very fine sand and usually low in organic content and clay. Fragipans may or may not underlie or overlie a horizon of clay accumulation (USDA Vanderbergh County Soil Survey, 1976).

Loess is dominantly composed of silt-size particles with accessory clay and sand that were primarily deposited by wind. The loess sequence may include an upper "Peoria loess" unit overlying the "Roxana loess," shown in Figure 6. In profile descriptions, the top of the Roxana loess is commonly marked by a weak (truncated) solum, a IIB3b buried soil horizon.

The solum is the upper part of the soil profile (A and B horizons) above the parent material (C horizon). The designations IIB3b, IIIB2b and IIIB3b are soil profile sections belonging to a buried soil horizon. Roman numerals are prefixed to the master horizon and (O, A, B, C) are layer designations to indicate lithologic discontinuities either within or below the solum. Roman numeral I is understood; the second contrasting material is numbered II, and other contrasting material is numbered consecutively with depth. The symbol b is added to designate a buried genetic horizon or horizons. For example, soil nomenclature IIB3b represents the second contrasting layer below the modern solum, starting in the middle of the B horizon of a buried soil (USDA Soil Survey Manual, 1962).

In the study area, buried soil horizons grade to sandy loam suggestive of weathered

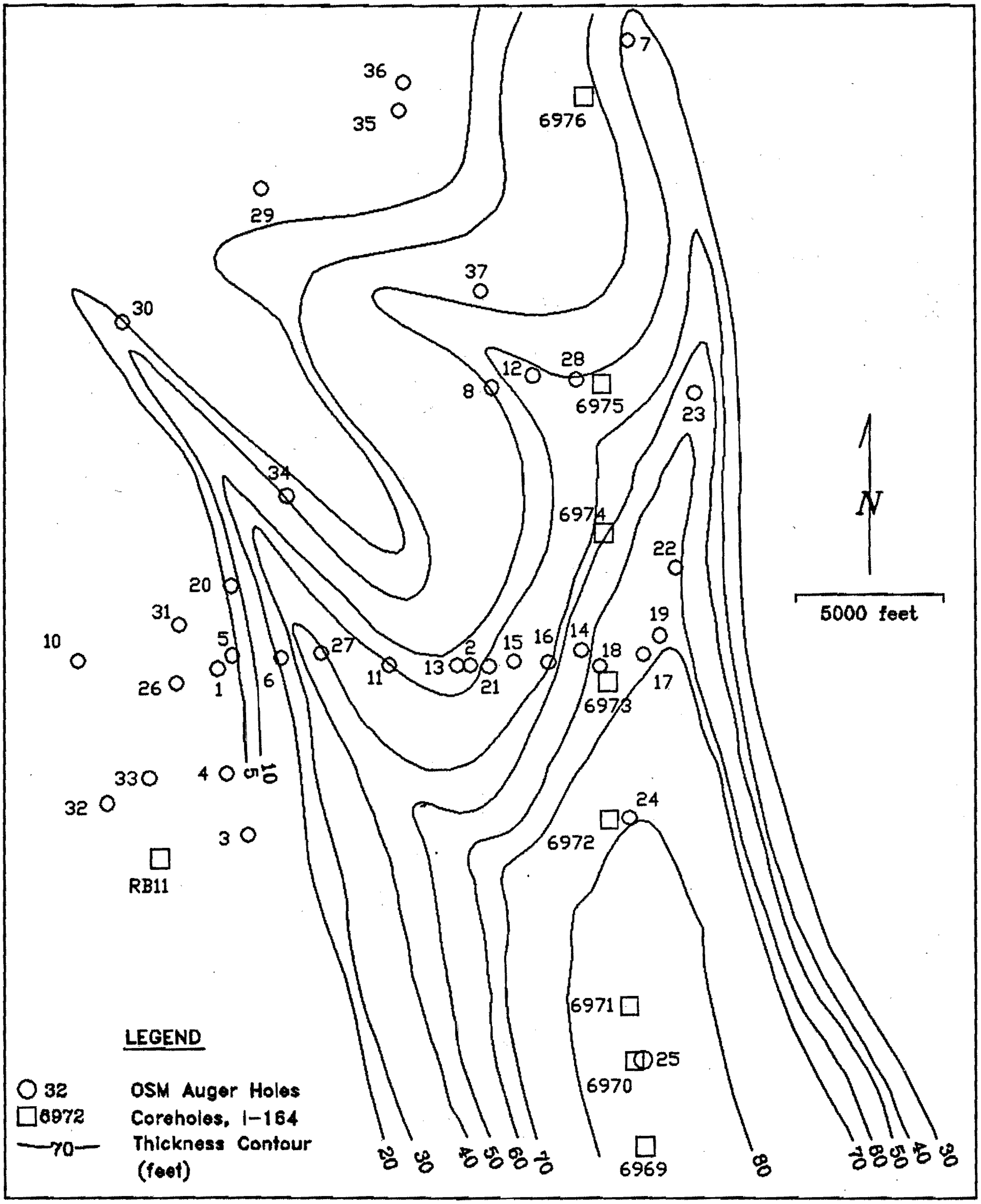


Figure 5. Thickness Contours of Unconsolidated Material in the Study Area.

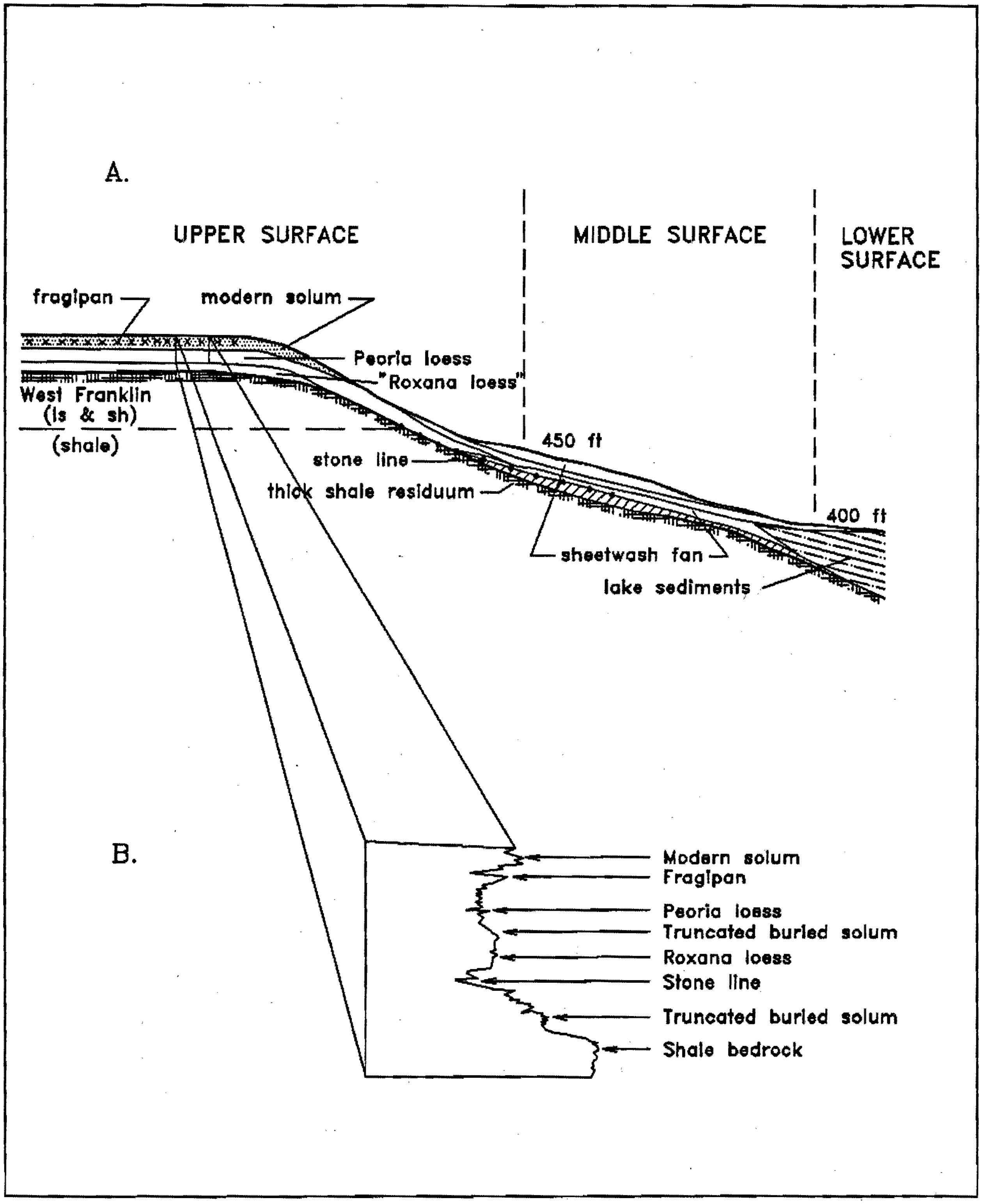


Figure 6. Cross Section Showing: A. The Relationship of Soil Materials and Geomorphic Surfaces; and B. Soil Profile Interpretations from a Natural Gamma Ray Section.

sandstone or, more commonly, shale. The transition through a IIIB2b and IIIB3b to in-situ shale that is not fragmented is commonly abrupt.

The material at and just above the shale bedrock transition are variable. The variety of material beneath the loesses appears to correspond with the variable West Franklin bedrock interval, although sandy material (found at other locations) was not encountered in the OSM borehole 26 core. The sharp contact may reflect the erosion that is presumed to have occurred on the uppermost slopes and a lack of colluvial or other forms of deposition.

On the middle surface, thicker, lower (Roxana) loess and a thicker weathered bedrock (shale) transition zone occurs. This represents an interpretive thickening wedge of sheetwash sediment at the toe of the middle slope. In holes OSM-5 and OSM-6, for instance, this unit becomes thick and contains sandy and pellet shaped manganese detritus. This suggests multiple erosional-depositional events. The thick shale transition consists of a matrix of fine, rounded clay pellets in an anastomosing (braided) clay-film [the III or IVB2b] grading downward to angular clasts and finally to coarsely jointed massive clay (soft shale). The thickness of the shale transition is interpreted to represent weathering in upland areas of the middle surface. The increased thickness of the material toward the lake basin is due to erosion of alluvium and angular rock fragments.

Certain elements contained in the unconsolidated soil profile can restrict drainage and cause seasonally perched water-table conditions. These elements include:

(1) A dense fragipan, occurring typically in the B3 part of the modern solum, at about 2.5 to 3 feet in depth. The B-horizon structural joints and root tubules provide drainage of water to the fragipan;

(2) A weak (truncated) IIB3b development in the lower loess/colluvium consisting of silty clay loam; massive to moderate, gleyed (formed under reducing conditions) root traces, and thick clay films;

(3) A moderate to strong (delineated) IIIB2b and IIIB3b development in shale residuum; clay loam massive to very fine subangular blocky; thick clay films on root tubules and cavities; and

(4) Shale bedrock.

The mineralogical composition in parts of the profile that might affect how the soil behaves when it changes from dry to wet are as follows:

(1) Minor amounts of smectite associated with mixed-layer clays in the modern solum; and

(2) Smectitic soil clays associated with IIIB2 above the shale residuum.

Smectite is a group name of clay minerals with varying degrees of expansive characteristics. Smectite minerals vary but have a layered structure that expand and break apart by absorption of water. The clay mineral, Montmorillonite is a Smectite group member with highly expansive characteristics.

The mineral composition of select profile depths were determined through X-ray diffraction (XRD) by both IDNR and COE. The COE also determined select engineering properties on eight samples. The results are discussed in the Engineering Properties section of Chapter 8.

Lower (Lake-Basin) Surface

The lower surface consists of a Pleistocene lacustrine (lake) plain and basin with a shoreline elevation of approximately 400 feet. The lake plain rises northward into the smaller tributaries and has a sea level elevation of about 380 feet across the southern part of the study area. The present day Little Bluegrass Creek dissects the lake plain with a low floodplain which lies about 10 feet lower than the lake plain. Coalesced fan surfaces slope onto the lake plain from the surrounding uplands particularly in northern areas. Individual fan lobes emanate from small tributaries.

Uppermost materials of the lake basin are deep, gleyed modern soils. The soil development appears to be Holocene (modern geological time) with accretionary sediments derived from the drainage basins. This late-stage accretion is suggested by a thick clayey solum seen on the Natural Gamma logs of the holes augered in this surface. Thin A-C soils cap alluvial silts within the shallow floodplain of the recent streams and cap sheetwash-fan surfaces at the toes of the middle surface.

The remaining lake basin fill consists of four unconsolidated stratigraphic units A through D. Indiana State Highway Department boring data for Interstate highway I-164 indicate that all four units within the lake basin appear to be of soft to stiff consistency, of relatively low density, and of a high water content.

The upper unit, A, is dominantly massive to weakly laminated, calcareous clay and silty clay. Unit A is interpreted as a glacial-age basin fill related to floods in the Ohio River valley during latest Wisconsinian glaciation. The massive character of the unit suggests deposition by one or more events over a relatively short time interval in contrast to a slower seasonal deposition.

The calcareous material in this unit can only have entered the basin from glacial floods in the Ohio since local basin source material is noncalcareous.
Unit B is a massive, noncalcareous silt, commonly oxidized in the top part. Unit B has the overall appearance of a loess and/or a water deposited silt. This unit may represent a pre-flood land surface composed of locally derived material. Alternatively, it could be locally derived lacustrine sediment relating to a glacial outwash dam built at the basin's mouth.

Unit C is a discontinuous fine sand. The origin of Unit C is unknown. This unit probably does not represent simple alluvial bedload from a local south-flowing stream. The basin size is relatively inadequate for the size of the sand body that lies to the south. Deposits at boreholes 24 and 25 thin suggesting the edge of the sand body. The sand did not enter the basin from the south along modern Pigeon Creek. Rather, the sand must enter the basin from the southeast. The material could represent bottom-flow deltaic sedimentation into an existing linear trough during glacial flood surges in the Ohio. Calcareous material can only have entered the basin from glacial floods in the Ohio.

Unit D is the basal unit. It is apparently a fine-grained silt, clay or silty clay possibly relating to earlier glacial cut and fill events.

A slight (5-foot) southern rise in basin floor suggests a southern source for one or more of the fill units. Samples were obtained from units A through C. Samples were not obtained from unit D.

Findings

- The study area in Vanderburgh and Warrick Counties, Indiana is underlain by Pennsylvanian bedrock units consisting mostly of unnamed shale and sandstone units with thin beds of limestone, clay, and coal.

- The geomorphic surfaces of the study area are divided into the bedrock upland or upper surface (above 450 feet), the middle surface (450 to 400 feet) and a lower lake basin (below 400 feet).

- The upper and middle surfaces of the eastern half of the area contain modern soils with a fragipan that overlie loess.

- There are at minimum two buried loess horizons representative of relic soils.

- The unconsolidated soil material within the study area range in thickness from less than 10 feet at some upland and middle surfaces and to greater than 80 feet in the eastern lake basin. The Indiana State Highway Department boring data for Interstate Highway I-164 indicate all four units within the lake basin are variable and appear to be of soft to stiff consistency, of relatively low density and of a high water content.

- The unconsolidated soil profile contains three areas that have the potential to restrict drainage and cause seasonally perched water-table conditions. These areas are the fragipan of the modern solum at approximately two to three feet below the surface, several buried "loess" soils and the weathered bedrock interface of mainly clay or shale.

- The minerals in the unconsolidated material that will affect soil behavior during wetting and drying are minor amounts of smectite (montmorillonite) associated with mixed-layer clays in the modern solum and smectitic minerals associated with the shale residue.

- The lower surface or lake basin contains, in descending order, (1) a modern waterlogged solum formed under reducing conditions, (2) glacial-age fill of calcareous clay and silty clay related to Ohio River flooding, (3) a massive, noncalcareous loess and/or alluvial silt derived from a land surface or lacustrine sediment related to a glacial outwash dam at the basin's mouth, (4) a fine sand of unknown origin and (5) a fine-grained silt or clay relating to earlier glacial cut and fill events.

References Cited

Indiana Department of Natural Resources (IDNR), Geological Survey (IGS), **Directory of Coal Producers in Indiana**, 1986.

Indiana Department of Conservation, Geological Survey (IDOC-GS), State of Indiana. **Preliminary Coal Map No. 5**. Compiled by S. A. Friedman, One sheet, April, 1954.

U. S. Department of Agriculture (DOA) in cooperation with Purdue University Agricultural Experiment Station, Soil Conservation Service. Kelly, Leo A. and Shiveley, Jerold L. **Soil Survey of Vanderburgh County, Indiana**. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1972. Issued June 1976.

U. S. Department of Agriculture (DOA). Soil Conservation Service, **Soil Survey Manual**, Supplement to Agriculture Handbook No. 18, Washington, D.C., May 1962.