Appendix F – Geotechnical Overview

REPORT OF GEOTECHNICAL OVERVIEW

I-64 TO U.S. 23 ASHLAND CONNECTOR STUDY

Item No. 9-129.00

BOYD COUNTY, KENTUCKY

PREPARED BY:

AMERICAN ENGINEERS, INC.
FIELD SERVICES CENTER
GLASGOW, KENTUCKY

August, 2008

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PROFESSIONAL ENGINEERING

AEI

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August 1, 2008

Mr. Brian Cash
Entran
400 East Vine Street
Suite 300
Lexington, KY 40507-1577

RE: Geotechnical Overview
I-64 to U.S. 23 Ashland Connector Study
Boyd County, Kentucky
Item No. 9-129.00
AEI Project No. 207-365

Dear Mr. Cash:

American Engineers, Inc. Field Services Center is pleased to submit this geotechnical overview which details the results of our research and observations performed in support of the above mentioned project.

The attached report describes the site, geology, topography, and geotechnical considerations. The Appendix to the report contains a drawing with identified coal mine locations, a landslide potential hazard map, and earthquake potential maps.

We appreciate the opportunity to be of service to you on this project and hope to provide further support on this and other projects in the future. Please contact us if you have any questions regarding this report.

Respectfully,
AMERICAN ENGINEERS, INC.

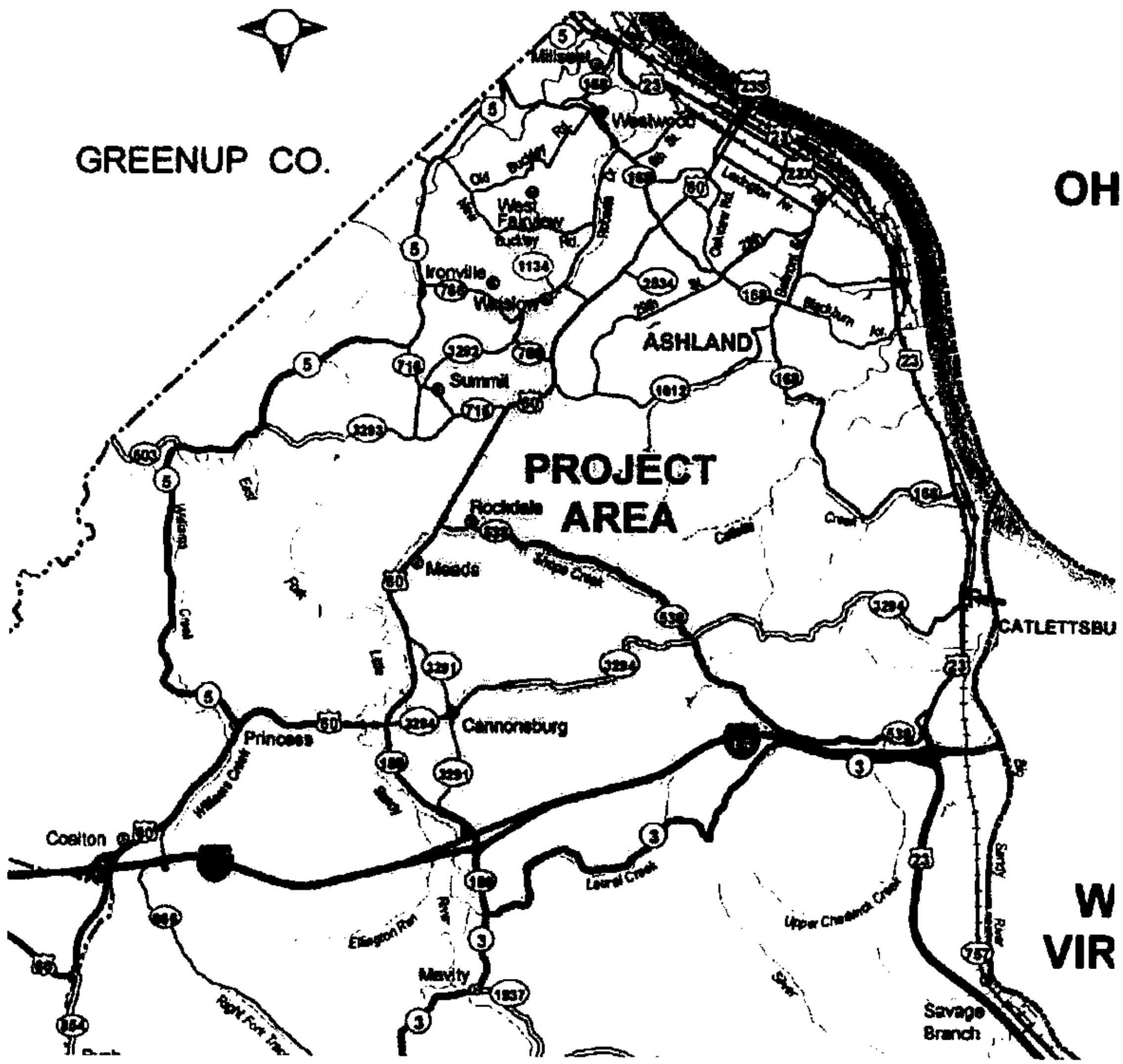
Brad High, P.G.
Project Geologist

Dennis Mitchell, P.E.
Senior Geotechnical Engineer

Geotechnical Overview

I-64 to U.S. 23 Ashland Connector Study

Boyd County, Kentucky



Geotechnical Overview
I-64 to U.S. 23 Ashland Connector Study
Boyd County, Kentucky

1. Project Description

The project corridor begins on the south at I-64 and ends on the north at Ashland, covering a length of about 11 miles. The project corridor ranges from about 5 miles wide on the southern portion of the project near I-64, and about 2 ½ to 3 miles wide throughout the remainder of the corridor. The study area lies within the Eastern Coal Field physiographic province, which includes the section of Kentucky east of the Pottsville Escarpment.

The purpose of the project is to improve traffic flow between Interstate 64 and the city of Ashland. Currently, U.S. 60 and U.S. 23 are the primary routes from Interstate 64 to downtown Ashland. High traffic volumes, crash rates, and severe traffic congestion are the primary factors for the project. Heavy truck traffic between the interstate and Ashland are also of concern to the Transportation Cabinet.

The planning study was conducted in relative accordance with a copy of Scope of Work for Geotechnical Overviews for Planning Studies provided by KYTC Planning Division, as well as Section 801 of the Kentucky Transportation Cabinet Geotechnical Manual. The study was conducted during November and December, 2007, and included field reconnaissance and geologic research of available geologic and topographic quadrangle maps, soil survey of Boyd County, Kentucky, as well as online resources available from the Kentucky Geological Survey and the United States Geological Survey. Past reports from geotechnical investigations of portions of the existing roadways and structures in the area were also reviewed in preparation of the overview.

2. *Site Geology*

The corridor lies primarily within two USGS 7.5-minute geologic quadrangle maps, 1) *Geology of the Ashland Quadrangle, Kentucky-Ohio, and the Catlettsburg Quadrangle in Kentucky,* and 2) *Geology of the Boltsfork and part of the Burnaugh Quadrangle.* The available mapping indicates that the site is underlain by, in descending order of lithology, Quaternary- aged alluvium, Tertiary and Quaternary- aged terrace deposits, the Upper Pennsylvanian Conemaugh Formation, and by the Middle Pennsylvanian Breathitt Formation. The Conemaugh and the Breathitt Formations are comprised of shale, sandstone, siltstone, limestone, underclay, and bituminous coal.

The underclays of the Breathitt Formation, and to a lesser extent non-durable shales, are responsible for the majority of landslides and slope failures in the study area. Roadway cut and embankment slopes as flat as 3H:1V which encounter these materials are at some risk for failure. Also, when water is introduced to these materials, they typically exhibit a significant reduction in bearing capacity, and behave as semi-plastic to plastic material. Where exposed to cycles of loading and unloading in construction, they tend to pump and rut. Figure 1 shows exposed shale from a construction stockpile near the southern portion of the study area which is actively weathering.

Figure 1- Weathered non-durable shale stockpile

According to the quadrangle map, *Geology of the Ashland Quadrangle, Kentucky-Ohio* engineering geology section, landslides are so prevalent in and near outcrops of the

Princess coal beds 6 and 7 that the beds can be located by failures in the roads that cross them. Several reports are available on the KYTC geotechnical reports database online which are specific to landslides in Boyd County. Of those landslide reports which discuss site specific geology, the Breathitt and Conemaugh Formations are both noted to contain materials which contributed to the slope failures. Figure 2 shows an actively eroding slope behind a store in Canonsburg, off U.S. 60.

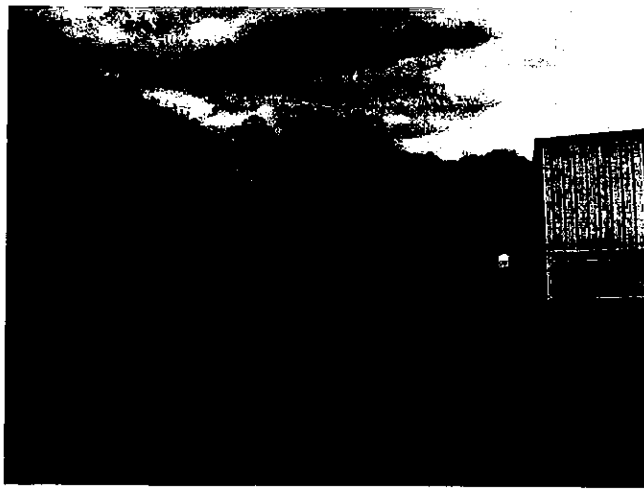


Figure 2- cut slope behind store near Canonsburg.

Landslides are relatively common throughout the region, including the study area. A copy of *Landslide Overview Map of the Conterminous United States (www.usgs.gov)* is included in the Appendix. Movement of groundwater is the most common trigger for landslides in the study area. The underclays and shales in the area are relatively impermeable, and water tends to migrate along the surface of these materials. As the water gradually saturates these materials, the amount of resisting force to movement is lowered in relation to overburden pressures and the force of gravity (driving forces). If the driving forces exceed the resisting forces, movement of the underclays and shales will occur, usually along with any overlying strata.

Terrace deposits were identified from available geologic mapping within the project area. These deposits are described as consisting of sand, silt, and gravel, and are as much as 45 feet thick in the Ashland Quadrangle. Cobbles and boulders of quartzite and chert as much as ½ to 1 foot in diameter are common. Terrace deposits such as those found within the study area were deposited by local streams and rivers during the Quaternary and Tertiary Periods in previous floodplain areas. Most streams migrate over time, especially during periods of increased energy from surface runoff over extended periods of time. After the stream alters its original course, the older deposits remain, typically at a higher elevation than the present stream level. These areas should be avoided if possible due to the heterogeneous nature of unconsolidated materials within these deposits. Much like construction within alluvial materials along existing streams, differential settlement can be expected within the limits of these materials of varying degrees.

Terrace deposits noted within the study area from available geologic mapping were predominant in and near the city of Ashland, and to a lesser extent, the southern areas of Catlettsburg. Other areas of which terrace deposits were noted included a significant area in the vicinity of the Federal Correctional Institution, and also east of U.S. 60 south of the community of Meads.

Several coal beds were identified both from geologic mapping and from field reconnaissance, most notably Princess Nos. 3, 4, 5, 6, 7, and 8, as well as several thinner and more irregular beds which intertongue with the Breathitt and Conemaugh Formations. Thickness of individual Princess Coal beds ranges typically from 1 to 4 feet based on mapped lithology of the Ashland Quadrangle. Boyd County has been mined extensively for coal through both surface and underground mining. Numerous mines were identified from available online resources (KGS, www.minemaps.ky.gov), and it is possible that several older mines exist which are not recorded. A map of approximate coal mine locations noted during the overview is included in the appendix, however it should not be considered to be all inclusive.

Coal beds within the project area are commonly underlain by moderate to highly plastic underclay layers, with relatively low permeability. The low permeability of the underclay inhibits movement of groundwater, while the bituminous coal is somewhat more permeable. As a result, when a mode of entry to a coal seam is available, water often travels along the seam to an exit point. Coal beds can often behave as aquifers and commonly discharge water at a downdip location. This discharge can undermine areas in cut slopes, especially when encountering nondurable underclays and shales. Figure 3 is a photograph of erosion beneath a thin coal bed in a cut near Canonsburg.

Figure 3- slope erosion beneath coal bed near Canonsburg.

Similarly, some sandstone beds within the area are underlain by underclay layers, and can fail in a similar manner when exposed in cuts or naturally occurring slopes. To a lesser extent, nondurable shales were noted along existing cuts and new roadway construction in the vicinity of the study area. These shales tend to break down when exposed to water, and weather rapidly, leading to potential slope failure.

Several coal mines, both active and inactive, are located within the limits of the project study area. Ground subsidence is always a risk whenever building in an area where both underground and surface mining have occurred. Settlement analyses should be performed in any mining area of which a potential corridor may cross to provide settlement estimates. Review of available permits and mapping will also aid in determining the potential for settlement in such areas. Ordinarily, the most recently reclaimed areas will have the most potential for settlement. The majority of the surface mines within the project area are west of U.S. 60 based upon a web search of the Kentucky Department for Surface Mining Reclamation and Enforcement.

3. *Topography*

Topography of the study area is typically described as rolling to mountainous, with numerous steep slopes and narrow valleys. Topographic relief throughout the study area ranges from a low of about 520 feet near the Ohio River along the eastern section of the corridor, with a high elevation of about 960 feet near portions of Interstate 64 near the southern boundary of the overview area. The study area is highly dissected by small streams and creeks, most of which ultimately drain to the Little Sandy, Big Sandy, or Ohio Rivers. Surface runoff in the study area typically drains in a dendritic pattern. Figure 4 is a photograph of typical surface drainage in Boyd County.

Figure 4- Typical drainage topography, Boyd County, Kentucky.

It is likely that if an entirely new corridor is chosen for the project, the topography will play a vital role in the route selection, such that cut and fill volumes are balanced as much as possible to minimize construction costs. Figure 5 illustrates common topography of the area.

Figure 5- Common Topography of Boyd County, Kentucky. I-64 is in the background.

4. *Geotechnical Considerations*

- Adequate drainage will be of primary concern with any design or new construction in the area. Several areas of non-durable shale and underclay were identified both in the field and from available geologic mapping, particularly in the Breathitt Formation. Landslides are relatively common in the area, often as a result of perched water on relatively impermeable layers of plastic shales and underclays.

- Subgrade soils are expected to have a CBR value typically less than 6. Non-durable shales, where utilized as roadway fill, should be expected to have a CBR value of 3 or less. Chemical treatment, such as lime application, may be desired to effectively stabilize road subgrades. In areas where rock is encountered during roadway excavations, it should be utilized as a more affordable yet effective alternative. Whenever possible, subgrade materials bearing on underclays or nondurable shales should be avoided.

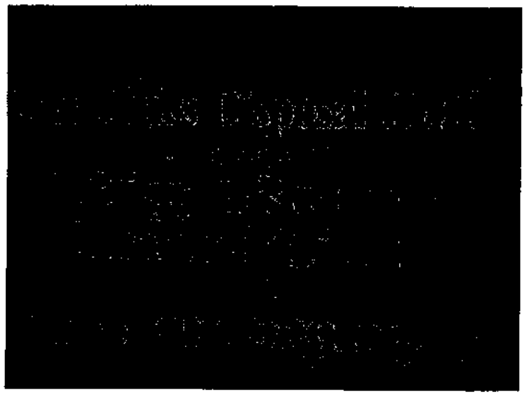
- Several small streams and creeks were identified in the study area, especially in the central and western portions of the study area. Any corridor chosen will require structures to cross these streams. Typically, the streams or creeks encountered will require only a single or double reinforced concrete box culvert to accommodate the new roadway construction. Foundations for any structure will most likely consist of shallow spread footings, which will bear on competent bedrock as identified from previous geotechnical explorations performed for structures in the area. Rock will normally be encountered near stream-crossing locations at depths of less than fifteen to twenty feet below the finished roadway grade. Foundation designs will depend upon site specific geology and engineering recommendations from geotechnical explorations performed at the potential structure locations.

- Roadway embankments and cut slopes will be required for construction of the new roadway. Based upon our prior experience with residual soils and rock types from the Conemaugh and Breathitt Formations, embankments of 3H:1V or flatter will likely provide an acceptable factor of safety for construction in the area in cuts where underclays and non-durable shales are encountered. Several existing highwalls were observed in the area, particularly along Interstate 64, which consisted primarily of massive sandstones. Based on review of the KYTC Geotechnical Manual, typical cut slope configuration for massive sandstone will vary from 1H:2V to 1H:20V. During design of cut slopes in bedrock, presence of joints, fractures, solution features, and crossbedding should be taken into consideration.

- Numerous oil and gas wells were noted in Boyd County from a search of Kentucky Geological Survey oil and gas well records database, many of which lie within the study area. Any oil or gas wells encountered during construction will need to be sealed per KYTC Standard Specifications if encountered by roadway construction.

- Water wells encountered within the construction limits of any corridor chosen will need to be sealed per the KYTC Standard Specifications. Several wells were identified from a water well records search at www.kgs.gov.

- Two (2) landfills were noted within the southwestern portion of the project area, Green Valley Landfill and Big Run Landfill, near U.S. 60 and KY State Route 5. Any potential roadway development in this area should be precluded by a study of available landfill permit records and current and past mapping.



- The study area, is located about 450 miles northeast of the city of New Madrid, Missouri, from which the New Madrid Fault derives its name. Figure-2, included in the Appendix, is an isoseismal map of the Arkansas Earthquake of December 16, 1811, and is based on the Modified Mercalli Intensity Scale. Based upon that earthquake, the damage encountered within the study area would most likely fall within the Strong category. Other available captions from www.earthquake.usgs.gov indicate that the study area would lie within an area for moderate potential for severe damage from an earthquake. An earthquake hazard map, available from the United States Geological Survey, is also included in the Appendix.

Summary

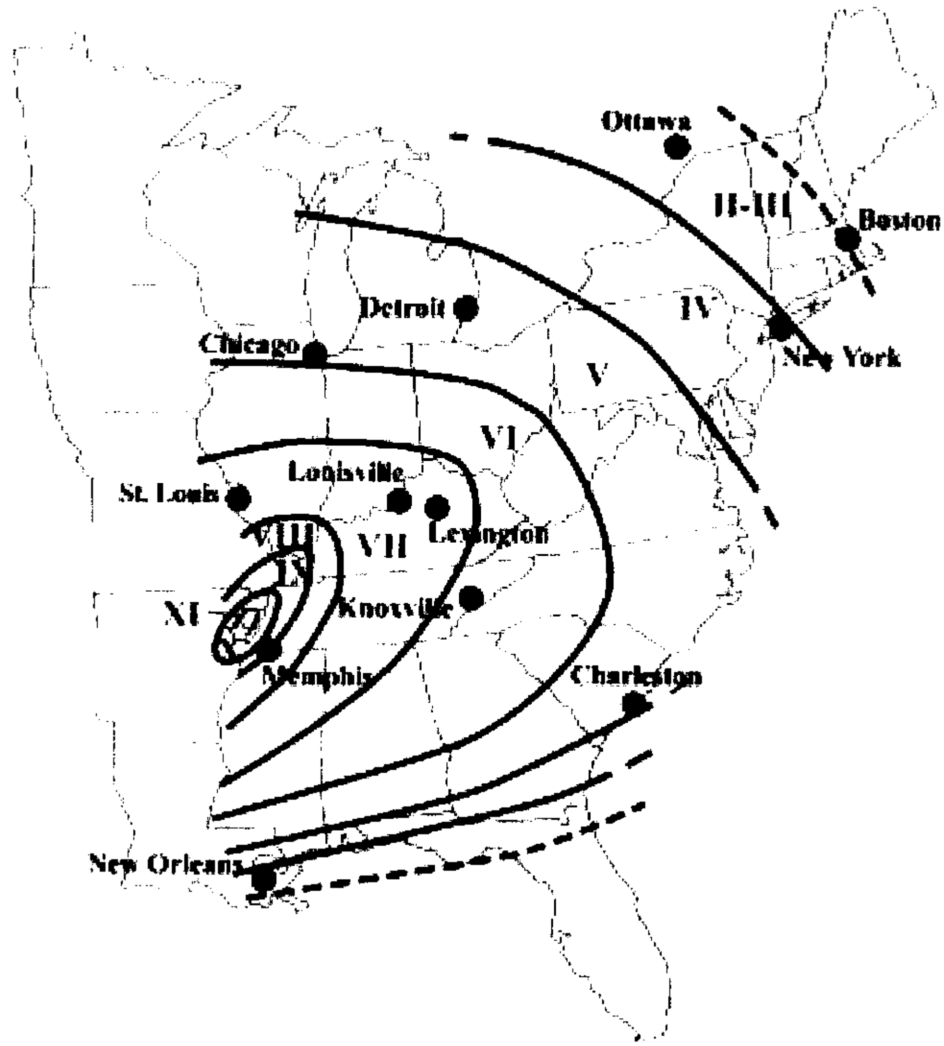
From a geotechnical perspective, several factors will be a part of selection of a new roadway alignment, or realignment of existing routes to improve traffic flow from Interstate 64 to Ashland and surrounding areas. Topographic relief will influence any new route or realignment of portions of existing roads. Generally increased topographic relief results in overall higher project costs. Additionally, the study area has been mined extensively for coal, by means of both underground and surface mining. Any corridor or realignment chosen may encounter previously mined areas, particularly in the vicinity of the Princess community, and several areas west of U.S. 60. Review of available mining records should be conducted along with settlement analyses to determine the potential for additional settlement in reclaimed areas.

Terrace deposits should be avoided as well if possible due to the heterogeneous nature and potential for settlement. Construction of a new roadway through extensive areas of terrace deposits would likely escalate project costs. Bedded materials, such as encountered in the Breathitt and Conemaugh Formations, near the surface in the region are susceptible to landslides. Measures to increase factors of safety such as flatter slopes, promotion of surface and subsurface drainage, vegetation, and construction of retaining walls will likely be required to some extent regardless of the alignment chosen to reduce maintenance costs of any potential new roadway in the area. Actual recommendations for slope geometries and means of stabilization would follow a thorough geotechnical investigation.

Appendix

- Isoseismal Map, USGS
- Earthquake Hazard Map, with %g, USGS
- Landslide Overview Map, USGS
- Approximate Mine Location Map

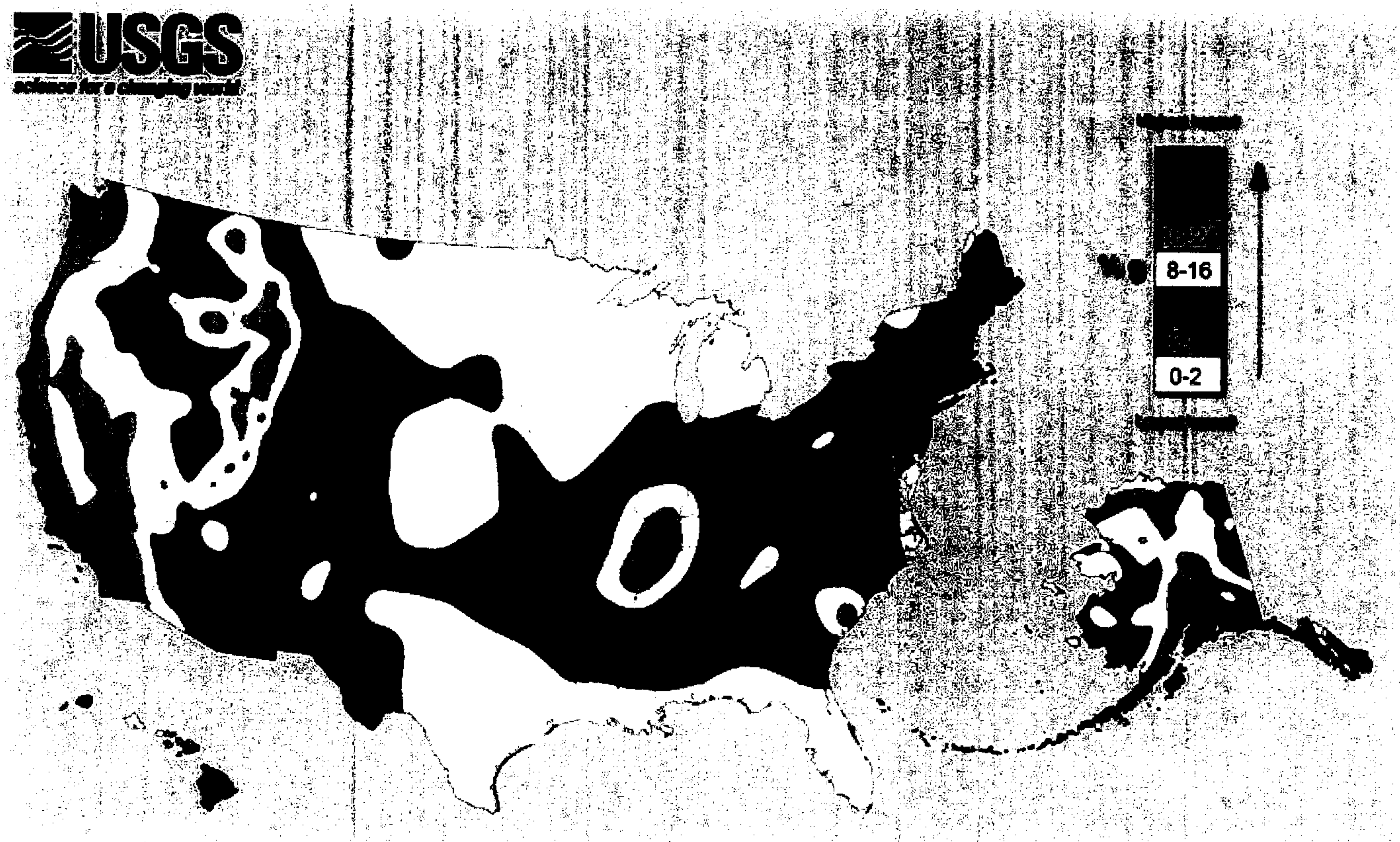
Isoseismal Map for the Arkansas Earthquake of December 16, 1811



Modified Mercalli Intensity Scale

INTENSITY		EFFECTS	AVE. PEAK ACCELERATION
VI	Strong	Felt by all. Damage slight.	0.06–0.07g
VII	Very Strong	Everybody runs outdoors. Considerable damage to poorly designed buildings.	0.10–0.15g
VIII	Destructive	Considerable damage to ordinary buildings.	0.25–0.30g
IX	Ruinous	Great damage to ordinary buildings	0.50–0.55g
X	Disastrous	Many buildings destroyed.	>0.60g
XI	Disastrous	Few, if any, structures remain standing	

(Simplified from Bolt, 1993)



USGS
science for a changing world
8-16
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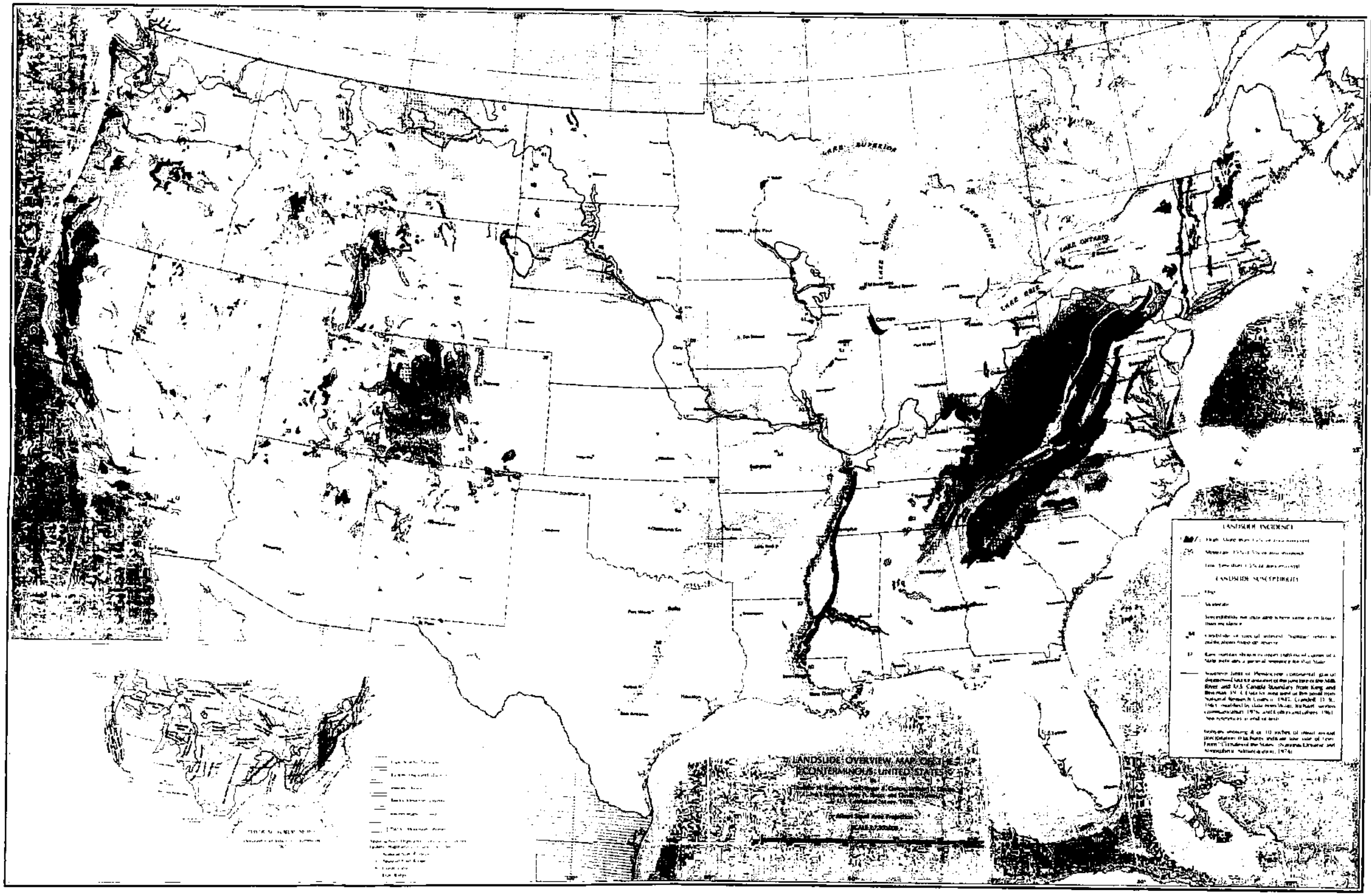
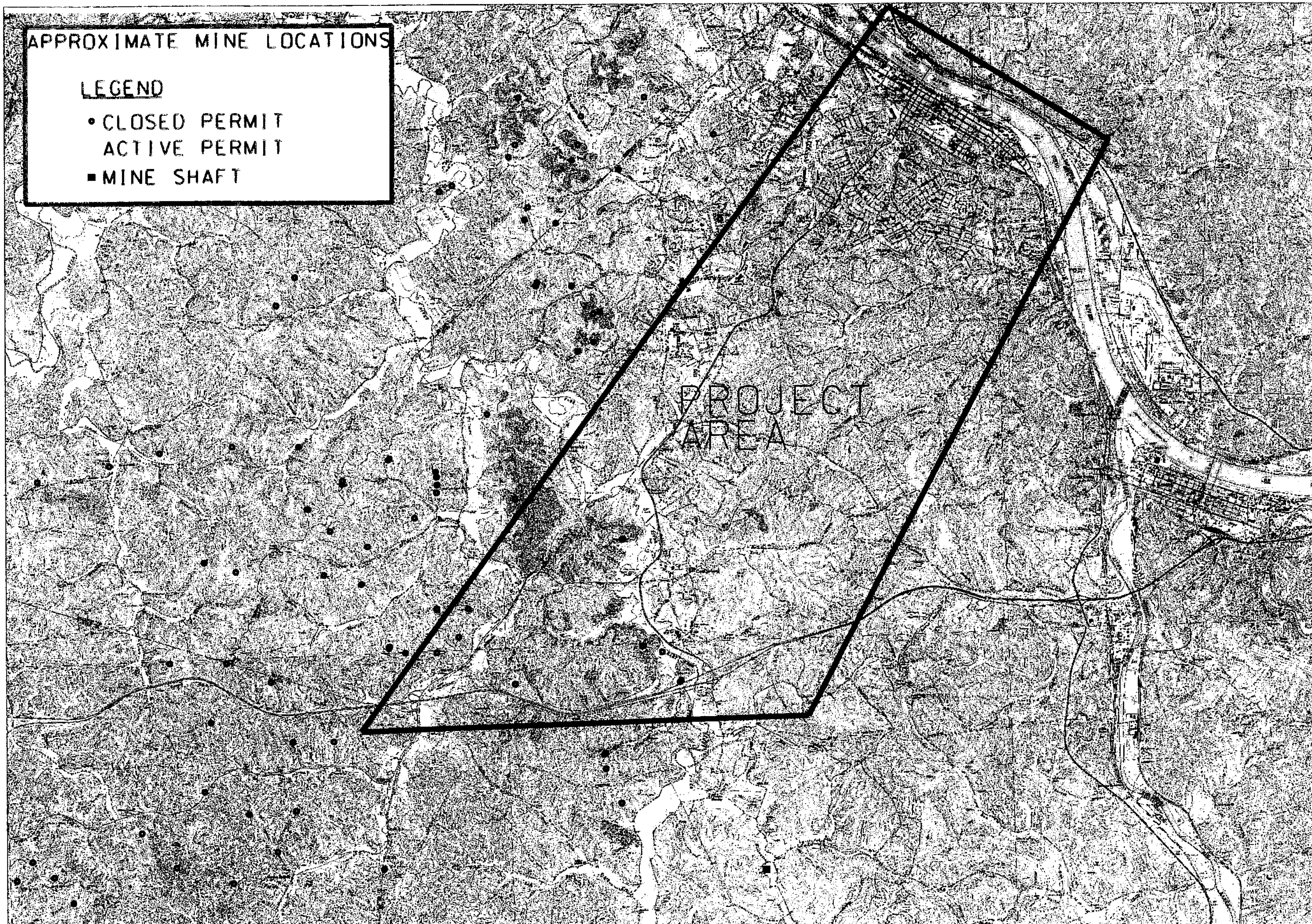
United States Department of the Interior
Geological Survey




APPROXIMATE MINE LOCATIONS
LEGEND
• CLOSED PERMIT
ACTIVE PERMIT
■ MINE SHAFT
PROJECT AREA