

Research Report
KTC-89-9

EARTHQUAKE HAZARD MITIGATION OF
TRANSPORTATION FACILITIES
FOR UNION COUNTY

by

Bobby W. Meade
Research Investigator

David L. Allen
Chief Research Engineer

and

Vincent P. Drnevich
Professor of Civil Engineering

Kentucky Transportation Center
College of Engineering
University of Kentucky
Lexington, Kentucky

in cooperation with
Transportation Cabinet
Commonwealth of Kentucky

and

Federal Highway Administration
U.S. Department of Transportation

The contents of this report reflect the views of the authors who are responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the University of Kentucky, the Kentucky Transportation Cabinet, nor the Federal Highway Administration. This report does not constitute a standard, specification, or regulation. The inclusion of manufacturer names and tradenames are for identification purposes and are not to be considered as endorsements.

May 1989

Technical Report Documentation Page

1. Report No. KTC-89-9		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle Earthquake Hazard Mitigation of Transportation Facilities for Union County			5. Report Date May 1989		
			6. Performing Organization Code		
7. Author(s) B. W. Meade, David L. Allen, Vince P. Drnevich			8. Performing Organization Report No.6 KTC-89-9		
9. Performing Organization Name and Address Kentucky Transportation Center College of Engineering University of Kentucky Lexington, KY 40506-0043			10. Work Unit No. (TRAVIS)		
			11. Contract or Grant No. KYHPR-87-116		
			13. Type of Report and Period Covered		
12. Sponsoring Agency Name and Address Kentucky Transportation Cabinet State Office Building Frankfort, KY 40622			14. Sponsoring Agency Code		
			15. Supplementary Notes Publication of this report was sponsored by the Kentucky Transportation Cabinet with the U.S. Department of Transportation, Federal Highway Administration		
16. Abstract Concern has grown in recent years over the seismic activity of the New Madrid seismic zone in Western Kentucky. Union County, Kentucky is located in this region. To permit emergency medical, supply, and equipment traffic into this area after an earthquake has occurred, the Kentucky Transportation Cabinet is interested in the possibility of keeping selected routes passable. This report lists the routes that have been investigated and recommended as being the routes in Union County that should be maintained in a passable condition. The recommended routes, US 60, KY 130, and KY 109 have been visually surveyed and all seismically significant features cataloged. These features are logged by their location on strip maps contained in Appendix A and a detailed listing of all the potentially critical features is given in Appendix B.					
17. Key Words Earthquake Alluvium Seismic Analyses Modified Mercalli Scale			18. Distribution Statement		
19. Security Classif. (of this report) Unclassified		20. Security Classif. (of this page) Unclassified		21. No. of Pages 32	
22. Price					

INTRODUCTION

An awareness of earthquakes and their possible effects upon the nation's infrastructure is critically important to the public, and in particular, to public officials. The nation's highway system is one of the most important components of the infrastructure. After the occurrence of an earthquake, the highway system is the primary mode of transporting emergency supplies and services into an affected area. Thus, it is important to catalog the important components of the highway system and attempt to anticipate the possible damage to these components from an earthquake.

Western Kentucky in general and Union County in particular are in a high risk earthquake zone. In 1811-1812, three of the most severe earthquakes in American history shook the country. The location of these quakes was not on the infamous San Andreas fault nor anywhere along the well-known fault laden Pacific coast but was near a small town on the Mississippi River where the states of Kentucky and Missouri share a border (Figure 1). It is this river town, New Madrid, Missouri, that is the namesake of a region now regarded by seismologists and disaster response planners as the most hazardous earthquake zone east of the Rocky Mountains -- the New Madrid seismic zone.

In addition to these three great earthquakes, there are several other well documented factors demonstrating the susceptibility of the New Madrid region to the recurrence of major earthquakes. Through a decade of extensive research, an ancient crustal rift has been found to underlie the relatively shallow sediments comprising the region's surface. This

type of geologic structure is prone to seismic activity. The New Madrid rift has been identified as being of sufficient size to generate major earthquakes. Further evidence of the area's seismicity is the record of over 2,000 earthquakes detected in the zone since 1974. Though most have been of a magnitude below the threshold of human perception, their existence clearly indicates the high level of seismic activity occurring in the zone.

Seismologists have calculated the probabilities of recurrence of sizeable earthquakes in the New Madrid rift zone. The probability of a magnitude 6.3 earthquake (Richter scale) within 50 years is from 86 to 97 percent. The probability (1) of that same earthquake occurring within the next 15 years is from 40 to 63 percent. For comparison, the 1971 San Fernando earthquake (magnitude 6.6) killed 58 people and caused \$480 million worth of damage. The 1988 Armenian earthquake of similar magnitude killed approximately 25,000 to 30,000 people.

The probability of a magnitude 7.6 earthquake occurring within 50 years is from 19 to 29 percent. The probability for this size earthquake occurring within 15 years drops to a range of 5.4 to 8.7 percent. On February 4, 1975, the Haicheng earthquake in China had a magnitude of 7.3 and destroyed or damaged about 90 percent of the structures in a city of 90,000 people.

When comparing historical earthquakes of similar magnitude, one must take into consideration that death totals and damage estimates will vary greatly due to the geology, population density, types of building, and quality of construction.

For a given earthquake, effects at a given location are described by the Modified Mercalli Intensity (MMI) scale (2) which ranges from I (no damage and felt only by instruments) to XII (total destruction). Details of the MMI scale are given in Table 1. Values of MMI associated with the 1811-1812 earthquakes are shown in Figure 1. The potential for damage and destruction from earthquakes in the region is significant.

In 1982, the Governor's Task Force on Earthquake Hazards and Safety was created to evaluate Kentucky's earthquake risk and to make recommendations for responding to those risks. This task force recommended increased public awareness and education programs, improved emergency response planning and training, improved building codes and seismic restraint designs, evaluation of other mitigation measures, and participation in national and regional earthquake forums and funding programs.

In 1984, Governor Collins created the Governor's Earthquake Hazards and Safety Technical Advisory Panel (GEHSTAP) to analyze scientific and engineering data regarding seismic risks in Kentucky and to make specific recommendations on mitigation, public awareness, response planning, and policy development for public health and safety. The States are dependent on their highway systems for the movement of goods and services. Due to the possible adverse effects a major earthquake could have on this system, the Earthquake Stability and Transportation Subcommittee (ESTS) of GEHSTAP was formed.

ESTS has encouraged the Kentucky Transportation Cabinet to secure

funding for generating and implementing an earthquake hazard mitigation plan in an attempt to safeguard the highway system against catastrophic earthquake failure. As a result, the Cabinet commissioned the Kentucky Transportation Center at the University of Kentucky to analyze and assess the possible effects of an earthquake on highway facilities. The study area includes the 26 western-most counties in Kentucky that are adjacent to the New Madrid seismic zone (Figure 1). To date, one of the results of that study has been the recommendation that over 1,000 miles of highways in the study area be utilized as emergency or "priority" routes. These would be the primary routes used for transporting emergency supplies and personnel after an earthquake. Also, it is anticipated that these would be the first routes repaired after an earthquake.

The initial task in identifying these priority routes was to decide where they should begin; that is, in the event of a major earthquake, the point at which the transport of goods and services would originate. Ideally, the city chosen should possess the following attributes:

1. Sufficient size to contain all necessary personnel, supplies, and facilities to respond quickly to a major emergency;
2. Proximity to the high hazard area to speed the relief effort but not so close as to suffer the same high risk potential;
3. Easy access from other major cities in the State; and
4. Sufficient routes to provide relatively direct access to all 26

high-risk counties.

The city best fitting these criteria is Bowling Green. Located at the eastern edge of the earthquake zone in Warren County, Bowling Green meets both the size criterion (population 40,450) and the accessibility criterion (Louisville and Nashville via I 65 and Lexington via the Bluegrass Parkway). Bowling Green provides access to the 26-county area via US 68/KY 80; this road was chosen as the main east-west artery because it crosses Lake Barkley and Kentucky Lake upstream from the dams impounding those bodies of water.

As a first step towards establishing an overall policy for earthquake hazard mitigation in the highway system, these priority routes have been visually surveyed and all natural and man-made features along these routes that are considered seismically significant were cataloged. With this information, a realistic and cost-effective plan for "hardening" these routes against earthquakes can be established. Such efforts are currently under way.

PRIORITY ROUTE IN UNION COUNTY

Union County is located approximately 100 miles east-northeast of the center of the New Madrid Seismic Zone. Figure 1 indicates that approximately 90 percent of Union County lies in the IX band of the MMI scale and the remainder lies in the X band. This indicates considerable damage could occur in Union County in the event of a major earthquake.

US 60, KY 130, and KY 109 have been designated as the priority routes in Union County. US 60 starts at the

Union County-Crittenden County line and travels east 26.10 miles to the Henderson County line. KY 130 begins at the Morganfield City limits and travels north 5.65 miles to the city of Uniontown. KY 109 begins at the Webster County line and travels west 1.50 miles to a junction with US 60.

A number of features along these priority routes could potentially hamper rescue and relief efforts. These features included bridges, soil fills, cut slopes, gas pipelines, power lines, radio towers, oil tanks, geologic faults, large trees, mines, and water impoundments. These features are logged by their location on strip maps contained in Appendix A and a detailed listing of all potentially critical features is given in Appendix B.

BRIDGES

Bridges are the most significant and important features on the priority routes. With few exceptions, existing highway bridges in the study area have not been designed to resist motions and forces that may be generated by earthquakes. Bridges located within the seismic zone could possibly be damaged, thus reducing their load-carrying ability. In some cases, damage could be sufficiently great to cause complete collapse. Several types of damage could occur:

1. A bridge could fail at the bearing which supports the main spans, causing the spans to fall from the bearings and possibly from the piers or abutments.
2. Failure could occur in the columns, piers, or footings which would reduce the load-carrying capacity of the bridge,

if the bridge was still in place.

- 3. An abutment could tilt allowing the entire span to fall.
- 4. Soil movement or slumping could affect the bridge approach fills, damaging the abutments or piers, or making the bridge inaccessible.

failed, this would certainly render the route impassable and immediate repairs would be necessary. The second mode of failure is a general slumping or settling of the embankment. The roadway would probably remain passable if settlement or slumping were not severe but reduced speed limits would be required for safety.

There are two bridges located on KY 130 and six bridges on US 60. The bridges are located over:

Large fills on the priority routes in Union County are located as follows:

US 60

- 1. Smith Ditch,
- 2. Cypress Creek,
- 3. Cypress Creek,
- 4. Branch Dyon Creek,
- 5. Eagle Creek, and
- 6. Branch Eagle Creek.

KY 130

- 1. Wathen Ditch, and
- 2. Lost Creek.

Current research is studying the effects that an earthquake could have on these bridges and their approach fills.

FILLS

Highway fills are particularly important because of their tendency to fail from seismically induced motions. Fills fail in one of two major modes. The first is a generalized circular or wedge-shaped failure resulting in one or both traffic lanes moving down and out. If both lanes

US 60

- 1. 0.50 mile east of Union County - Crittenden County line,
- 2. Approach fills for Smith Creek bridge,
- 3. 0.10 mile west of Cypress Creek bridge,
- 4. Approach fills for Cypress Creek bridge,
- 5. Approach fills for Cypress Creek bridge,
- 6. Approach fills for branch Dyon Creek bridge,
- 7. 0.41 mile west of Eagle Creek bridge,
- 8. Approach fills for Eagle Creek bridge,
- 9. 1.0 mile west of branch Eagle Creek bridge, and
- 10. Approach fills for branch Eagle Creek bridge.

KY 130

- 1. Approach fills for the Wathen Ditch bridge,

2. Approach fills for the Lost Creek bridge, and

3. 1.20 miles north of the KY 141 junction.

CUT SLOPES

Only one cut slope in Union County was cataloged as a problem slope. Should this slope fail, both lanes of the roadway probably would be closed. Cut slopes that have a history of failure and those that have steep slopes should be considered as problem areas.

The cut slope is located on KY 130, 0.28 mile into the Uniontown city limits.

GAS PIPELINES

Gas pipelines under or near a priority route could fail in the event of an earthquake. If a pipeline failed, an explosion might destroy a section of the priority route. Repair could be delayed by further gas leaks, fire, and/or additional explosions. It appears that most of the pipelines in Union County were constructed with little or no seismic considerations.

Gas pipelines cross under KY 130 at the Wathen Ditch bridge and at the Uniontown city limits. No gas pipelines were logged on the other priority routes in Union County.

POWER LINES

High voltage power lines also were cataloged during the route surveys. The height of the lines above the roadway were estimated visually. Power company officials speculated that a number of breaks along each power line would occur during a major

earthquake. In most cases, fallen lines would not be transmitting power because power would be automatically cut off within a few seconds in the event of a break.

Additionally, power line support towers could potentially fall across a priority route.

Power lines cross at the following locations on priority routes in Union County.

US 60

1. 0.40 mile east of KY 141 junction,
2. 1.00 mile east of city of Sturgis,
3. 0.20 mile east of KY 492 junction,
4. 0.10 mile east of KY 359 junction,
5. 0.20 mile east of KY 359 junction,
6. 1.40 miles west of KY 141 North junction, and
7. 1.45 miles west of Henderson County line.

KY 130

1. 0.17 mile north of US 60 junction,
2. 0.53 mile north of US 60 junction, and
3. 0.31 mile south of Uniontown city limits.

RADIO TOWER

A radio tower is approximately 150

feet from US 60 at milepost 14.80 or 0.90 mile west of the city of Morganfield. It is possible that the tower could fail during a major earthquake and temporarily block the priority route.

FUEL STORAGE

There are several natural gas and oil storage and distribution facilities near the priority routes in Union County. These facilities could develop leaks or rupture during an earthquake and close the priority route. These facilities are located at:

KY 130

1. Oil tanks 0.84 mile south of Wathen Ditch bridge.

US 60

1. Bulk plant 1.06 miles east of Smith Creek bridge,
2. Propane distribution center 1.61 miles east of Branch Dyon Creek bridge,
3. Propane distribution center 0.18 mile west of Branch Eagle Creek bridge, and
4. Oil tanks 0.60 mile west of Henderson County line.

GEOLOGIC FAULTS

There are numerous geologic faults (breaks in the bedrock where movement has occurred in the past) in the study area. The faults are seismically significant since a large earthquake could trigger additional movement along one or more old slip planes. There are no precautionary measures that can be taken to reduce hazards from faults except that

construction of bridges and other facilities over or near such faults requires special consideration. The faults are included for informational purposes only. Faults which cross under priority routes in Union County are listed below:

US 60

1. 0.42 mile west of the Branch Dyon Creek bridge,
2. 1.79, 1.49, 1.15, 0.58, and 0.11 miles west of Eagle Creek bridge, and
3. 0.06, 0.24, 0.46, 0.71, 1.45, and 1.60 miles east of Eagle Creek bridge.

MINES

There is only nominal mining activity near the priority routes in Union County. A strip mine, approximately 1,000 feet from US 60 and 1.41 mile west of the Smith Creek bridge, could have water impoundments that could present problems in the event of an earthquake.

WATER IMPOUNDMENTS

Small impoundments such as large farm ponds could also be a problem area. Ponds which have large earthen dams that lie above the road surface could collapse during an earthquake and wash out a section of a priority route. Ponds which lie below the road surface and are adjacent to the toe of the fill could cause failures in the fill during an earthquake due to the high moisture content.

A small pond lies adjacent to US 60 0.94 mile west of the Branch Dyon bridge.

against earthquake damage.

Future work involves training key personnel in the Transportation Cabinet in hazard mitigation and seismic safety; which includes bridge inspectors, district engineers, construction inspectors, designers, and maintenance personnel.

Following the education of key personnel, the mitigation plan proposed by the Kentucky Transportation Center will be reviewed by the Kentucky Transportation Cabinet and a program will be established for implementation. The final step involves the use of relevant seismic codes for all new construction, repair, and maintenance.

REFERENCES

1. Johnson, Arch C., "A Brief Overview of the Geology, Seismicity and Seismic Hazard of the Central Mississippi Valley Area," Proceedings, A Regional Seminar on Earthquake Fundamentals for the Mississippi Valley, Earthquake Engineering Research Institute, Memphis, Tennessee, October 29, 1985.
2. Green, N. B., "Earthquake Resistant Building Design and Construction," Third Edition, Elsevier, 1987, Page No. 179-180.
3. Keller, Edward A., "Environmental Geology," Charles E. Merrill Publishing Company, A Bell and Howell Company, 1979, Page No. 157.

Additional Information

The Commonwealth of Kentucky has prepared a State Emergency Operations Procedures (State EOP) manual that is produced by the Division of Disaster and Emergency Services (DES), Department of Military Affairs, Frankfort, 40601. Annexes H. on Transportation and DD on Earthquakes give additional information on disaster preparedness and response.

A copy of the State EOP and information on local hazard mitigation activities and response preparedness are available from the AREA 2 Office of DES which is located in Hopkinsville. The phone numbers at this office are (502) 564-8602 and (502) 885-7100.

Additional information about the study discussed in this report should be directed to David L. Allen, Project Director, at the Kentucky Transportation Center, (606) 257-4513. Requests to be placed on the mailing list for updated information should be submitted on your company or agency letterhead to the Kentucky Transportation Center at the University of Kentucky, Lexington Kentucky 40506-0043.



MMI SCALE REGIONAL INTENSITY
BOUNDARY ZONES



NEW MADRID SEISMIC
ZONE

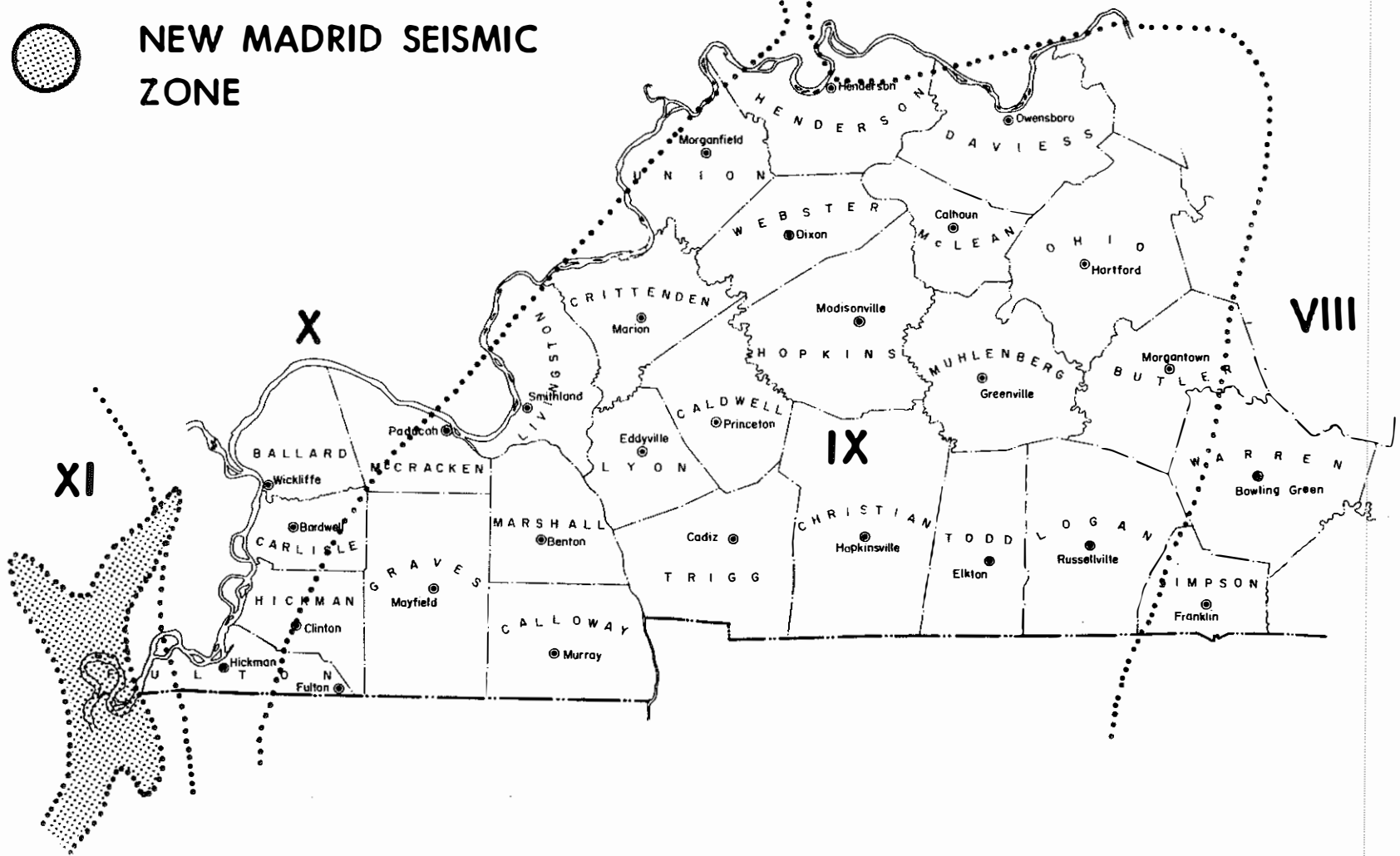


Figure 1: The twenty-six counties included in this study area.

AMPLIFICATION OF SHAKING AND DAMAGE DUE TO SHAKING

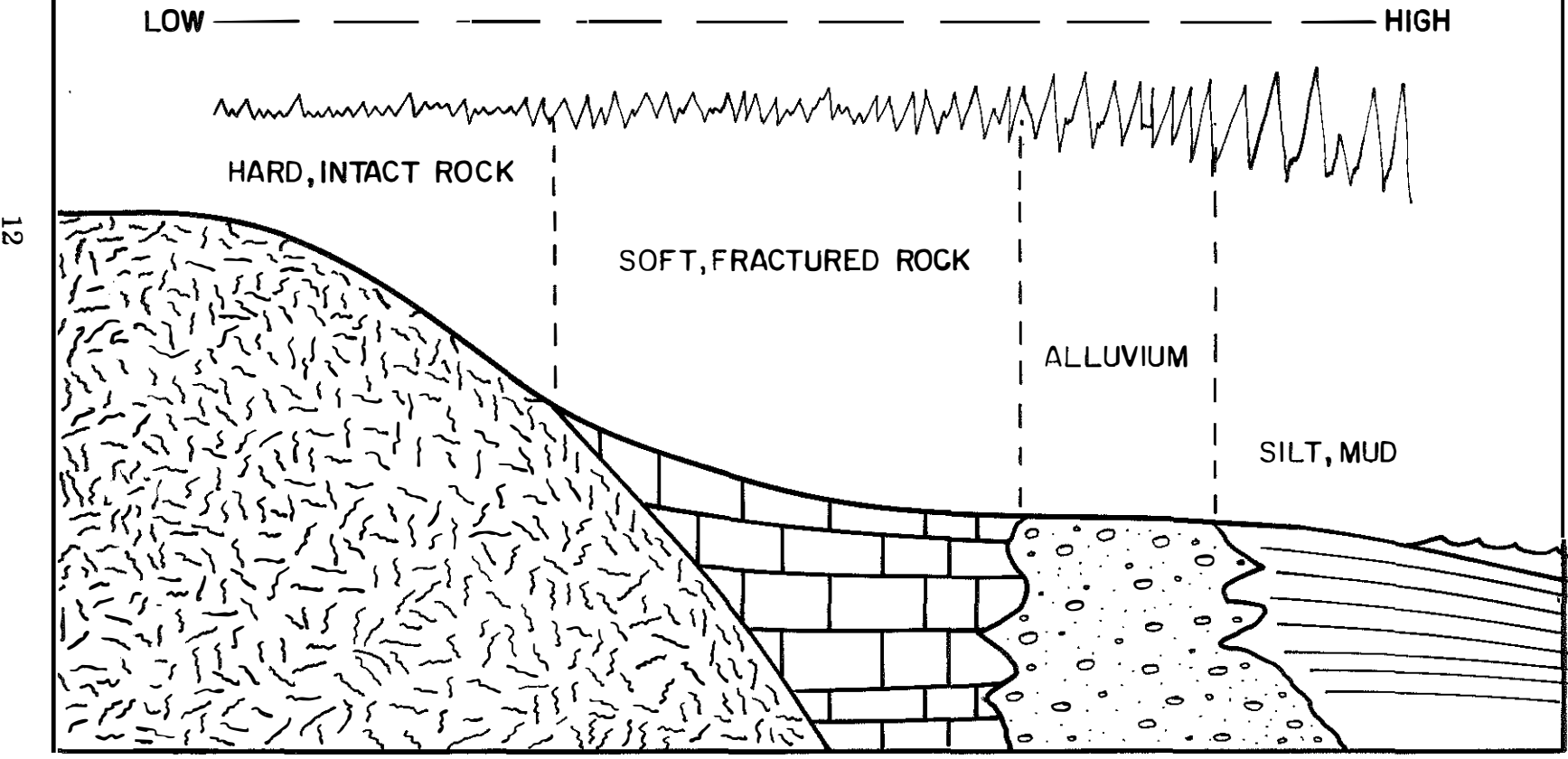


Figure 2 : Amplification of shaking in softer rock & soil during an earthquake.

Table 1: MODIFIED MERCALLI INTENSITY SCALE

Modified Mercalli Intensity Scale, 1956 Version

The following comments by Dr. Richter precede the published statement of the intensity scale:

...Each effect is named at the level of intensity at which it first appears frequently and characteristically. Each effect may be found less strongly, or in fewer instances, at the next lower grade of intensity; more strongly or more often at the next higher grade. A few effects are named at two successive levels to indicate a more gradual increase.

Masonry A, B, C, D. To avoid ambiguity of language, the quality of masonry, brick or otherwise, is specified by the following lettering.

Masonry A. Good workmanship, mortar, and design; reinforced, especially laterally, and bound together by using steel, concrete, etc.; designed to resist lateral forces.

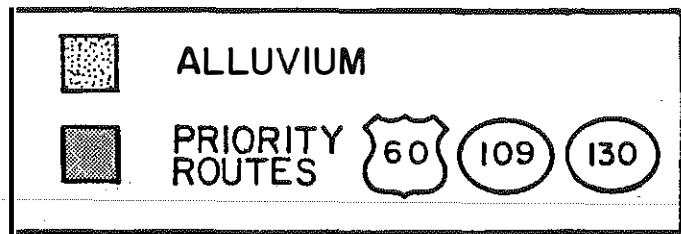



Masonry B. Good workmanship and mortar, reinforced by not designed in detail to resist lateral forces.

Masonry C. Ordinary workmanship and mortar; no extreme weakness like failing to tie corners, but neither reinforced nor designed against horizontal forces.

Masonry D. Weak materials, such as adobe; poor mortar; low standards of workmanship; weak horizontally.

The following list represents the twelve grades of the scale.

- I. Not felt. Marginal and long-period effects of large earthquakes.
- II. Felt by persons at rest, on upper floors, or favorable placed.
- III. Felt indoors, Hanging objects swing. Vibration like passing of light trucks. Duration estimated. May not be recognized as an earthquake.
- IV. Hanging objects swing. Vibration like passing of heavy trucks; or sensation of a jolt like a heavy ball striking the walls. Standing motor cars rock. Windows, dishes, doors rattle. Glasses clink. Crockery clashes. In the upper range of IV wooden walls and frame creak.
- V. Felt outdoors; direction estimated. Sleepers awakened. Liquids disturbed, some spilled. Small unstable objects displaced or upset. Doors swing, close, open. Shutters, pictures move. Pendulum clocks stop, start, change rate.
- VI. Felt by all. Many frightened and run outdoors. Persons walk unsteadily. Windows, dishes, glassware broken, Knickknacks, books, etc., off shelves. Pictures off walls. Furniture moved or overturned. Weak plaster and masonry D cracked. Small bells ring (church, school). Trees, bushes shaken.
- VII. Difficult to stand. Noticed by drivers of motor cars. Hanging objects quiver. Furniture broken. Damage to masonry D, including cracks. Weak chimneys broken at roof line. Fall of plaster, loose bricks, stones, tiles, cornices. Same cracks in masonry C. Waves on ponds; water turbid with mud. Small slides and caving in along sand or gravel banks. Large bells ring. Concrete irrigation ditches damaged.
- VIII. Steering of motor cars affected. Damage to masonry C; partial collapse. Some damage to masonry B; none to masonry A. Fall of stucco and some masonry walls. Twisting, fall of chimneys, factory stacks, monuments, towers, elevated tanks. Frame houses moved on foundation if not bolted down; loose panel walls thrown out. Decayed piling broken off. Branches broken from trees. Changes in flow or temperature of springs and wells. Cracks in wet ground and on steep slopes.
- IX. General panic. Masonry D destroyed; masonry C heavily damaged, sometimes with complete collapse; masonry B seriously damaged. Frame structures, if not bolted, shifted off foundations. Frames cracked. Serious damage to reservoirs. Underground pipes broken. Conspicuous cracks in ground. In a luviated areas sand and mud ejected, earthquake fountains, sand crater.
- X. Most masonry and frame structures destroyed with their foundations. Some well-built wooden structures and bridges destroyed. Serious damage to dams, dikes, embankments. Large land slides. Water thrown on banks of canals, river, lakes, etc. Sand and mud shifted horizontally on beaches and flat lands. Rails bent slightly.
- XI. Rails bent greatly. Underground pipelines completely out of service.
- XII. Damage nearly total. Large rock masses displaced. Lines of sight and level distorted. Objects thrown in the air.


ALLUVIUM
PRIORITY ROUTES




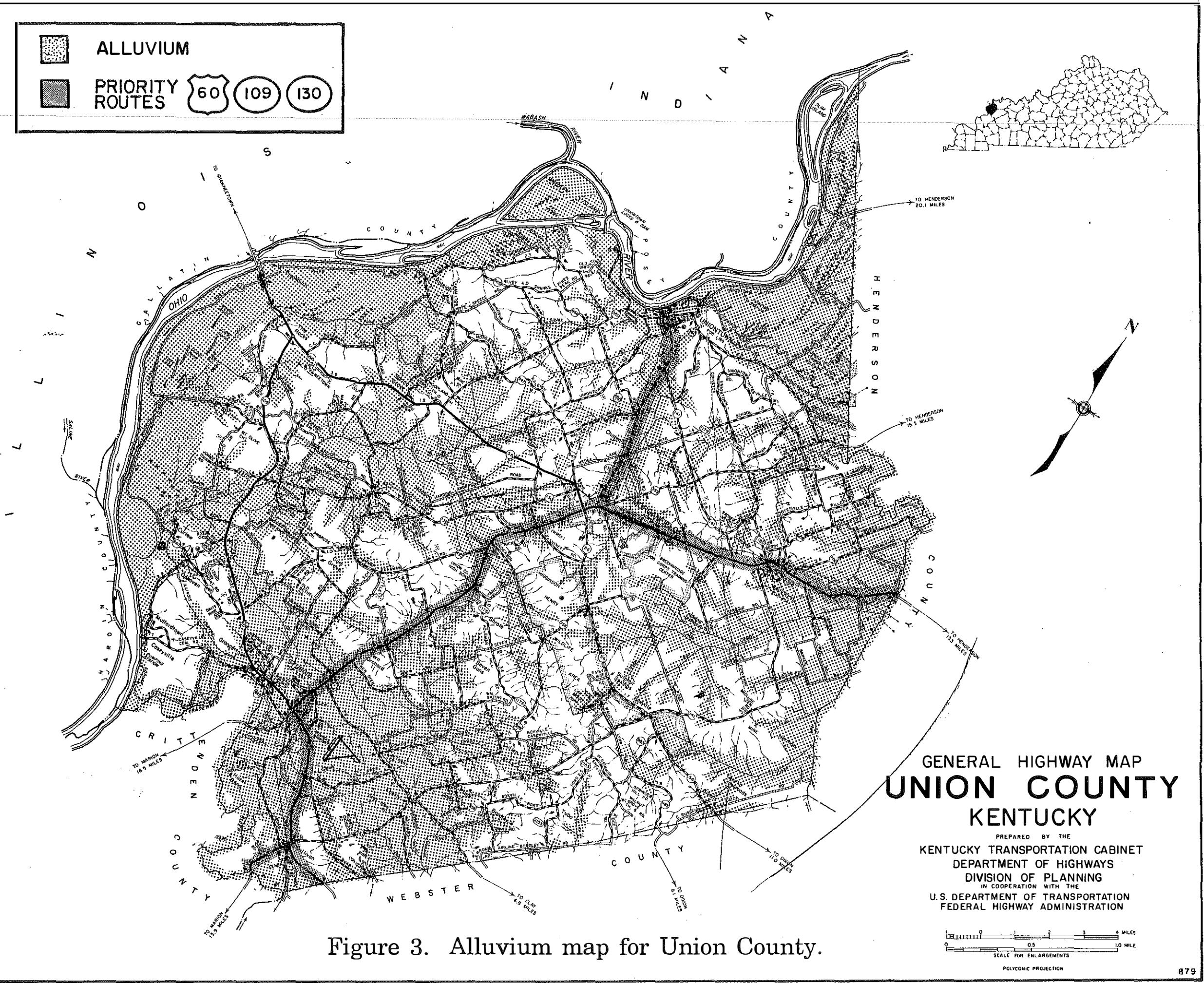
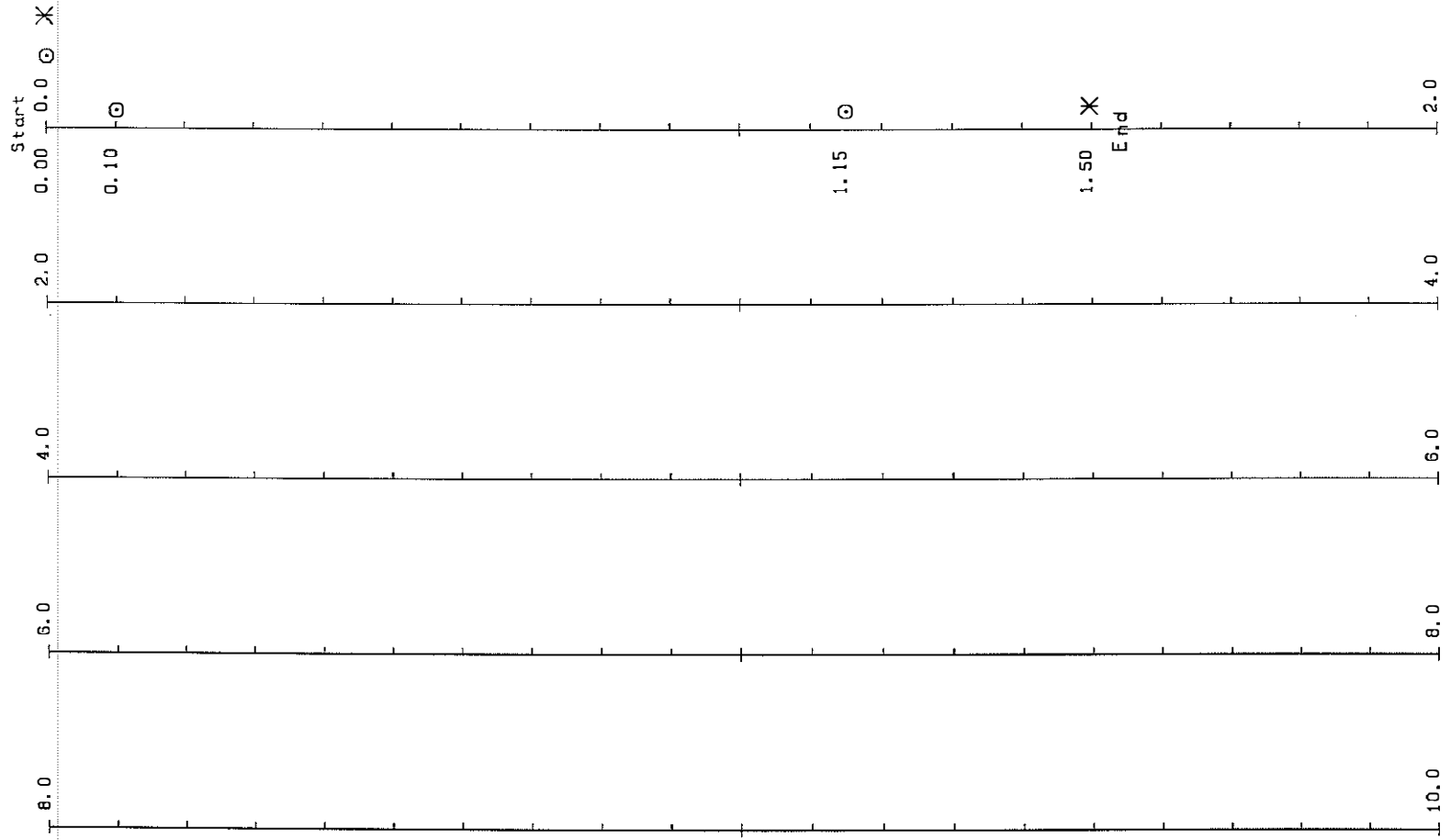


Figure 3. Alluvium map for Union County.

APPENDIX A
STRIP MAP FOR UNION COUNTY
US 60, KY 130, and KY 109

KY109

UNION



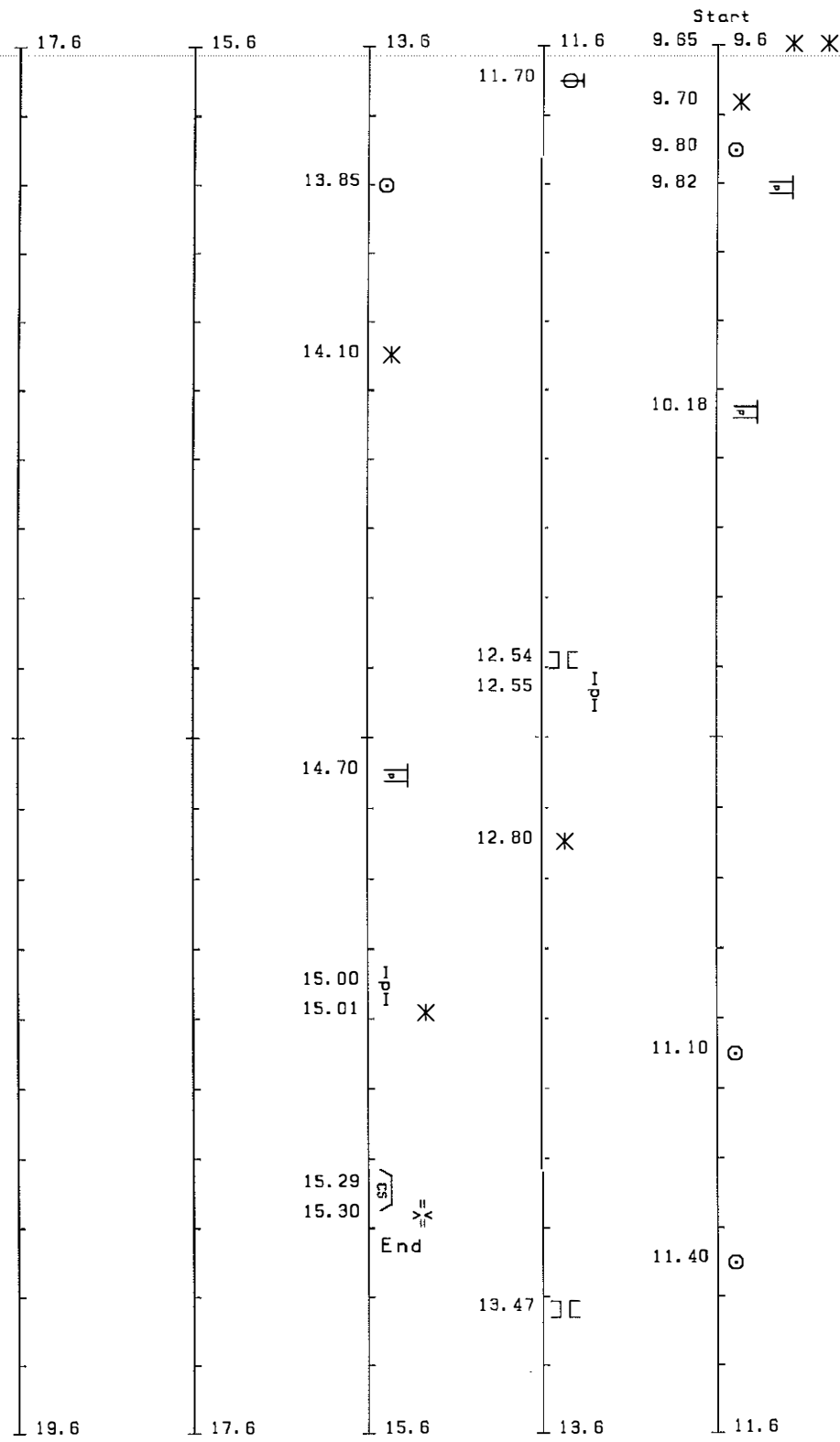
LEGEND OF FEATURES

	BRIDGE		CUT SLOPE		BUILDING		FILL		OTHER
	TREE		POWER LINE		SIGN		FAULT		
	PIPELINE		MINE		TANK		DAM		

SEE REPORT FOR DESCRIPTIONS OF OTHER

KY 130

UNION



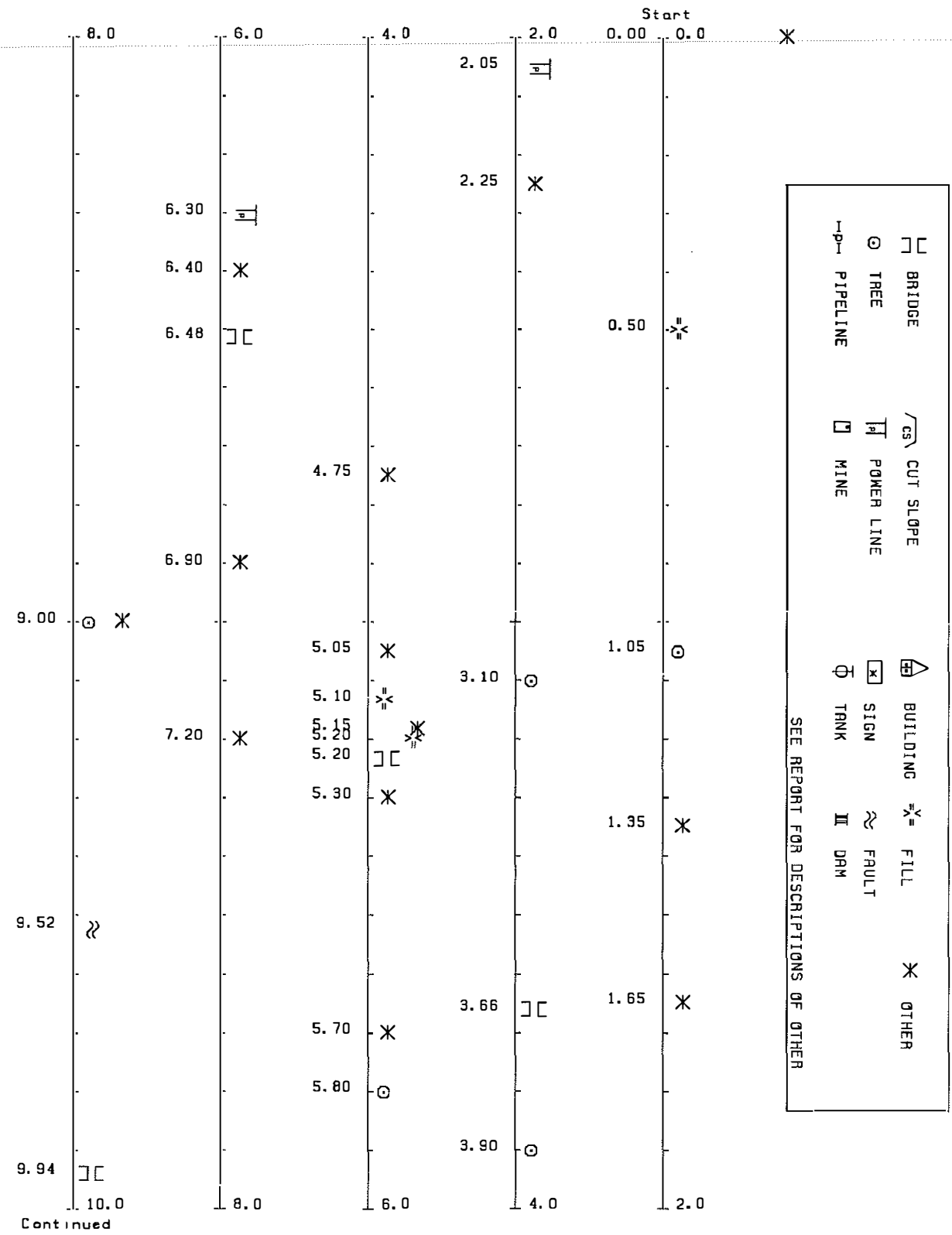
LEGEND OF FEATURES

⌈	BRIDGE	△	BUILDING	≠	FILL	✱	OTHER
⊙	TREE	⊠	SIGN	≈	FAULT		
—P—	PIPELINE	⊡	TANK	⊢	ORM		
		∕CS	CUT SLOPE				
		⌈	POWER LINE				
		⊡	MINE				

SEE REPORT FOR DESCRIPTIONS OF OTHER

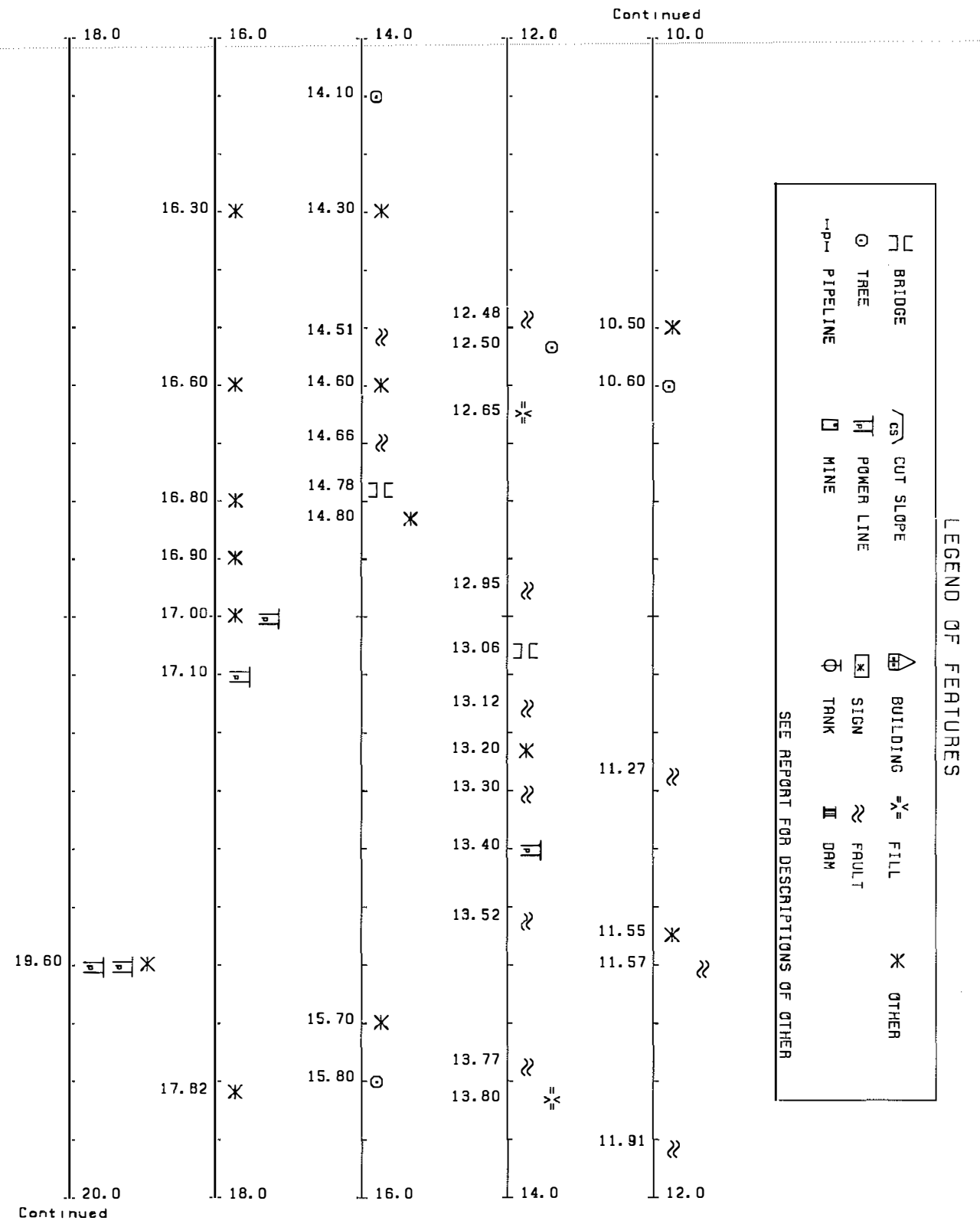
US60

UNION



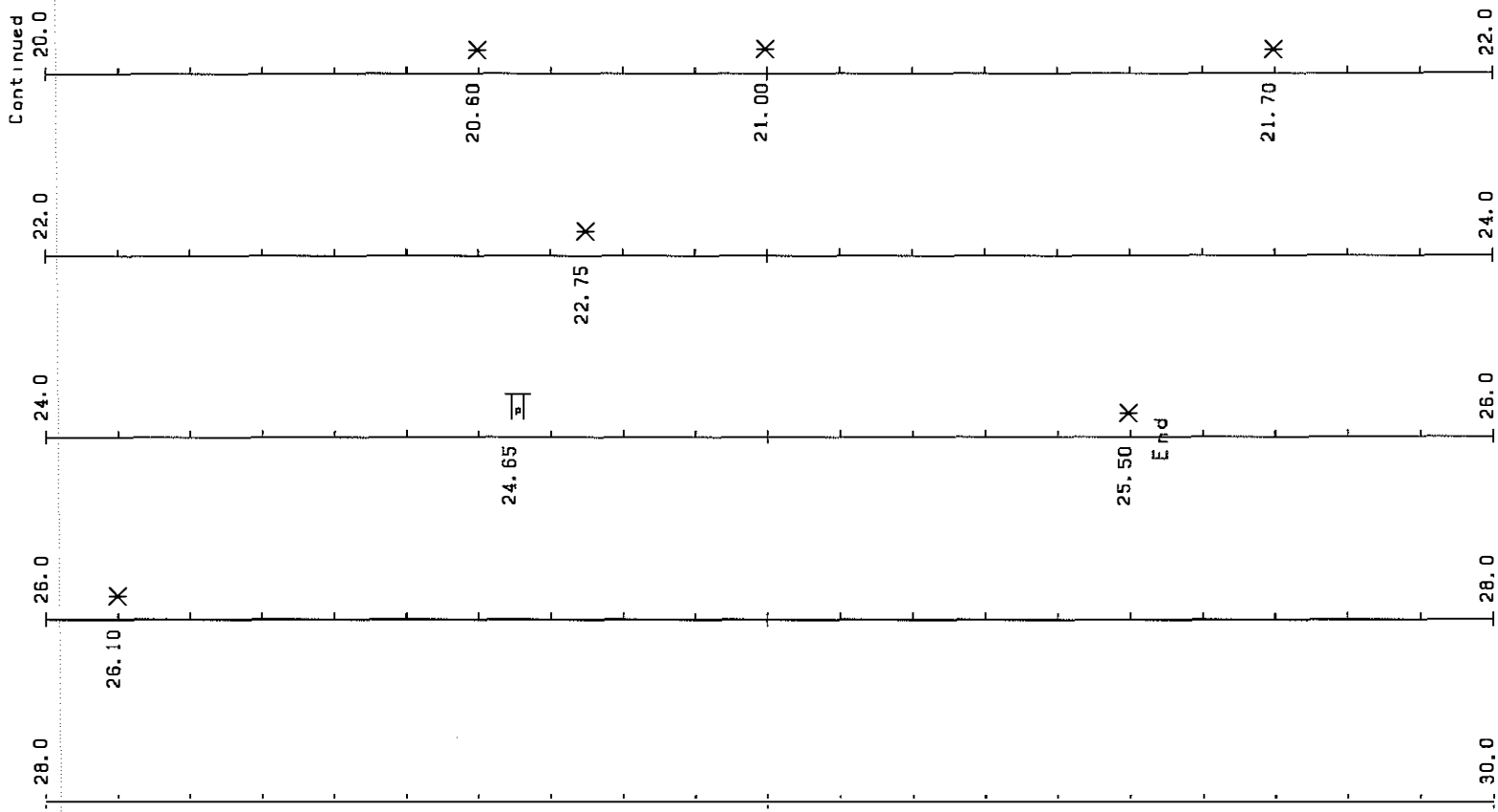
US60

UNION



US60

UNION



LEGEND OF FEATURES

	BRIDGE		CUT SLOPE		BUILDING		FILL		OTHER
	TREE		POWER LINE		SIGN		FAULT		
	PIPELINE		MINE		TANK		DAM		

SEE REPORT FOR DESCRIPTIONS OF OTHER

APPENDIX B
SEISMICALLY SIGNIFICANT FEATURES

Report by Road and Milepoint
for Union County - Kentucky
KY 109

Milepoint	Feature	Data
0.00	Trees	Number of Trees 20 Height 25 feet Diameter 24 in. Ending Milepoint 0.10 Distance From Road 7 feet Road Surface Type - Flexible
0.00	Other	Union Co - Webster Co Boundary Road Surface Type - Flexible
0.10	Trees	Number of Trees 200 Height 55 feet Diameter 24 in. Ending Milepoint 0.50 Distance From Road 15 feet Road Surface Type - Flexible
1.15	Trees	Number of Trees 10 Height 50 feet Diameter 24 in. Ending Milepoint 1.16 Distance From Road 15 feet Road Surface Type - Flexible
1.50	Other	US 60 Joins KY 109 Sullivan Road Surface Type - Flexible

Report by County and Milepoint
for Union County - Kentucky
KY 130

Milepoint	Feature	Data
9.65	Other	Morganfield City Limits Road Surface Type - Flexible
9.65	Other	Junction Us 60 Road Surface Type - Flexible
9.70	Other	Railroad Crossing Road Surface Type - Flexible
9.80	Trees	Number of Trees 20 Height 40 feet Diameter 20 in. Ending Milepoint 9.80 Distance From Road 10 feet Road Surface Type - Flexible
9.82	Power Line	Electrical Power Line 6 Lines Height 40 feet Steel Support Structure Unknown Volts Road Surface Type - Flexible
10.18	Power Line	Electrical Power Line 6 Lines Height 30 feet Wood Support Structure Unknown Volts Road Surface Type - Flexible
11.10	Trees	Number of Trees 2 Height 60 feet Diameter 24 in. Ending Milepoint 11.10 Distance From Road 18 feet Road Surface Type - Flexible
11.40	Trees	Number of Trees 1 Height 80 feet Diameter 24 in. Ending Milepoint 0.00 Distance From Road 15 feet Road Surface Type - Flexible
11.70	Tank	Oil Tank Number of Tanks 4 Total Capacity Unknown Distance From Road 50 feet Road Surface Type - Flexible

Report by County and Milepoint
for Union County - Kentucky

KY 130

Milepoint	Feature	Data
12.54	Bridge	Number of Spans 3 Overpass Concrete I-Beam End 1 Fixed Pier 1 Fixed Pier 2 Fixed End 2 Fixed Deck Type - Concrete Length 48 feet Width 25 feet Pier Type - Solid SPC Rating - C Surface Type - Flexible Expansion Type - Other End 1 Substructure - Stub End 2 Substructure - Stub Foundation Type - Unknown
12.55	Pipeline	Pipeline Type - Gas Line Road Surface Type - Flexible
12.80	Other	Junction KY 666 Road Surface Type - Flexible
13.47	Bridge	Number of Spans 3 Type Unknown Concrete T-Beam End 1 Fixed Pier 1 Fixed Pier 2 Fixed End 2 Fixed Deck Type - Concrete Length 105 feet Width 25 feet Pier Type - Open SPC Rating - C Surface Type - Flexible Expansion Type - Other End 1 Substructure - Stub End 2 Substructure - Stub Foundation Type - Unknown
13.85	Trees	Number of Trees 3 Height 65 feet Diameter 18 in. Ending Milepoint 13.85 Distance From Road 30 feet Road Surface Type - Flexible
14.10	Other	Junction KY 141 Road Surface Type - Flexible
14.70	Power Line	Electrical Power Line 3 Lines Height 30 feet Wood Support Structure Unknown Volts Road Surface Type - Flexible

Report by County and Milepoint
for Union County - Kentucky

KY 130

Milepoint	Feature	Data
15.00	Pipeline	Pipeline Type - Gas Line Road Surface Type - Flexible
15.01	Other	Uniontown City Limits Road Surface Type - Flexible
15.29	Cut Slope	Cut Slope Type - Soil Height 30 feet Length 125 feet Backslope 2:1 Road Surface Type - Flexible
15.30	Fill	Material Type - Soil Height 20 feet Side slope 2:1 Length 125 feet Crest 28 feet Type Fill - Other Road Surface Type - Flexible

Report by Road and Milepoint
for Union County - Kentucky

US 60

Milepoint	Feature	Data
0.00	Other	Union Co - Crittenden Co Boundary Road Surface Type - Flexible
0.50	Fill	Material Type - Soil Height 30 feet Side slope 2:1 Length 1,000 feet Crest 36 feet Type Fill - Other Road Surface Type - Flexible
1.05	Trees	Number of Trees 25 Height 40 feet Diameter 15 in. Ending Milepoint 1.25 Distance From Road 10 feet Road Surface Type - Flexible
1.35	Other	KY 109 Joins US 60 at Sullivan Road Surface Type - Flexible
1.65	Other	Junction KY 141 Heading North Road Surface Type - Flexible
2.05	Power Line	Electrical Power Line 3 Lines Height 40 feet Wood Support Structure Unknown Volts Road Surface Type - Flexible
2.25	Other	Strip Mine 1,000 feet from Road Road Surface Type - Flexible
3.10	Trees	Number of Trees 20 Height 45 feet Diameter 15 in. Ending Milepoint 3.55 Distance From Road 10 feet Road Surface Type - Flexible
3.66	Bridge	Number of Spans 3 Type Unknown Concrete T-Beam End 1 Fixed Pier 1 Fixed Pier 2 Fixed End 2 Fixed Deck Type - Concrete Length 140 feet Width 44 feet Pier Type - Open SPC Rating - C Surface Type - Flexible Expansion Type - Other End 1 Substructure - Full End 2 Substructure - Stub Foundation Type - Unknown

Report by County and Milepoint
for Union County - Kentucky

US 60

Milepoint	Feature	Data
3.90	Trees	Number of Trees 50 Height 50 feet Diameter 24 in. Ending Milepoint 4.10 Distance From Road 10 feet Road Surface Type - Flexible
4.75	Other	Bulk Plant 7 Tanks 125 feet from Road Road Surface Type - Flexible
5.05	Other	Gas Pipeline Road Surface Type - Flexible
5.10	Fill	Material Type - Soil Height 20 feet Side slope 2:1 Length 200 feet Crest 36 feet Type Fill - Other Road Surface Type - Flexible
5.15	Other	Flood Path to Lake Road Surface Type - Flexible
5.20	Bridge	Number of Spans 3 Type Unknown Concrete T-Beam End 1 Fixed Pier 1 Fixed Pier 2 Fixed End 2 Fixed Deck Type - Concrete Length 144 feet Width 44 feet Pier Type - Open SPC Rating - C Surface Type - Flexible Expansion Type - Other End 1 Substructure - Stub End 2 Substructure - Stub Foundation Type - Unknown
5.20	Fill	Material Type - Soil Height 20 feet Side slope 2:1 Length 200 feet Crest 36 feet Type Fill - Other Road Surface Type - Flexible
5.30	Other	City of Sturgis - Floodwall Road Surface Type - Flexible

Report by County and Milepoint
for Union County - Kentucky

US 60

Milepoint	Feature	Data
5.70	Other	US 60 Breaks from KY 109 Heading Northwest Road Surface Type - Flexible
5.80	Trees	Number of Trees 50 Height 45 feet Diameter 25 in. Ending Milepoint 6.20 Distance From Road 10 feet Road Surface Type - Flexible
6.30	Power Line	Electrical Power Line 3 Lines Height 30 feet Wood Support Structure Unknown Volts Road Surface Type - Flexible
6.40	Other	Floodwall Road Surface Type - Flexible
6.48	Bridge	Number of Spans 3 Over Stream Concrete T-Beam End 1 Fixed Pier 1 Fixed Pier 2 Fixed End 2 Fixed Deck Type - Concrete Length 134 feet Width 44 feet Pier Type - Open SPC Rating - C Surface Type - Flexible Expansion Type - Poured Compression End 1 Substructure - Stub End 2 Substructure - Stub Foundation Type - Unknown
6.90	Other	Junction KY 270 Heading East at Sturgis Road Surface Type - Flexible
7.20	Other	Junction KY 270 Heading West Road Surface Type - Flexible
9.00	Trees	Number of Trees 10 Height 30 feet Diameter 24 in. Ending Milepoint 9.00 Distance From Road 10 feet Road Surface Type - Flexible

Report by County and Milepoint
for Union County - Kentucky
US 60

Milepoint	Feature	Data
9.00	Other	Pond 20 feet Along Road (50 x 50) feet Road Surface Type - Flexible
9.52	Fault	Fault Road Surface Type - Flexible
9.94	Bridge	Number of Spans 1 Type Unknown Concrete T-Beam End 1 Fixed End 2 Fixed Deck Type - Concrete Length 27 feet Width 22 feet Pier Type - Unknown SPC Rating - C Surface Type - Flexible Expansion Type - Other End 1 Substructure - Full End 2 Substructure - Full Foundation Type - Unknown
10.50	Other	Junction KY 950 Heading Southeast Road Surface Type - Flexible
10.60	Trees	Number of Trees 2 Height 60 feet Diameter 20 in. Ending Milepoint 10.70 Distance From Road 10 feet Road Surface Type - Flexible
11.27	Fault	Rough Creek Fault Road Surface Type - Flexible
11.55	Other	Propane Distribution Center Road Surface Type - Flexible
11.57	Fault	Rough Creek Fault Road Surface Type - Flexible
11.91	Fault	Fault Road Surface Type - Flexible
12.48	Fault	Fault Road Surface Type - Flexible

Report by County and Milepoint
for Union County - Kentucky

US 60

Milepoint	Feature	Data
12.50	Trees	Number of Trees 3 Height 60 feet Diameter 20 in. Ending Milepoint 12.70 Distance From Road 10 feet Road Surface Type - Flexible
12.65	Fill	Material Type - Soil Height 10 feet Side slope 2:1 Length 1,850 feet Crest 30 feet Type Fill - Other Road Surface Type - Flexible
12.95	Fault	Fault Road Surface Type - Flexible
13.06	Bridge	Number of Spans 3 Over Stream Concrete T-Beam End 1 Fixed Pier 1 Fixed Pier 2 Fixed End 2 Fixed Deck Type - Concrete Length 107 feet Width 44 feet Pier Type - Unknown SPC Rating - C Surface Type - Flexible Expansion Type - Poured Compression End 1 Substructure - Stub End 2 Substructure - Stub Foundation Type - Unknown
13.12	Fault	Fault Road Surface Type - Flexible
13.20	Other	Junction KY 492 Heading Southwest Road Surface Type - Flexible
13.30	Fault	Rough Creek Fault Road Surface Type - Flexible
13.40	Power Line	Electrical Power Line 3 Lines Height 30 feet Wood Support Structure Unknown Volts Road Surface Type - Flexible

Report by County and Milepoint
for Union County - Kentucky
US 60

Milepoint	Feature	Data
13.52	Fault	Fault Road Surface Type - Flexible
13.77	Fault	Fault Road Surface Type - Flexible
13.80	Fill	Material Type - Soil Height 30 feet Side slope 2:1 Length 300 feet Crest 25 feet Type Fill - Other Road Surface Type - Flexible
14.10	Trees	Number of Trees 30 Height 55 feet Diameter 18 in. Ending Milepoint 14.13 Distance From Road 25 feet Road Surface Type - Flexible
14.30	Other	Water Injection Wells run to 15.28 Milepoint Road Surface Type - Flexible
14.51	Fault	Fault Road Surface Type - Flexible
14.60	Other	Propane Distribution Center Road Surface Type - Flexible
14.66	Fault	Fault Road Surface Type - Flexible
14.78	Bridge	Number of Spans 1 Type Unknown Concrete T-Beam End 1 Fixed End 2 Fixed Deck Type - Concrete Length 27 feet Width 22 feet Pier Type - Unknown SPC Rating - C Surface Type - Flexible Expansion Type - Other End 1 Substructure - Full End 2 Substructure - Full Foundation Type - Unknown

Report by Road and Milepoint
for Union County - Kentucky
US 60

Milepoint	Feature	Data
14.80	Other	Radio Tower 150 feet from Road 300 feet high Road Surface Type - Flexible
15.80	Trees	Number of Trees 200 Height 30 feet Diameter 24 in. Ending Milepoint 16.10 Distance From Road 10 feet Road Surface Type - Flexible
16.30	Other	Junction KY 56 Heading West & Southeast Road Surface Type - Flexible
16.60	Other	City of Morganfield Road Surface Type - Flexible
16.80	Other	Junction KY 130 Heading East Road Surface Type - Flexible
16.90	Other	Junction KY 359 Heading North Road Surface Type - Flexible
17.00	Other	Junction CO 2091 Heading South Road Surface Type - Flexible
17.00	Power Line	Electrical Power Line 6 Lines Height 40 feet Steel Support Structure Unknown Volts Road Surface Type - Flexible
17.10	Power Line	Electrical Power Line 3 Lines Height 40 feet Wood Support Structure Unknown Volts Road Surface Type - Flexible
17.82	Other	Bridge (Dam Reservoir 3,200 feet South) Road Surface Type - Flexible

Report by County and Milepoint
for Union County - Kentucky

US 60

Milepoint	Feature	Data
19.60	Power Line	Electrical Power Line 3 Lines Height 30 feet Wood Support Structure Unknown Volts Road Surface Type - Flexible
19.60	Other	Power Lines Parallel to Road thru 21.0 milepoint Road Surface Type - Flexible
20.60	Other	Conveyor Belt 20 feet high Road Surface Type - Flexible
21.00	Other	Junction KY 141 Heading North Road Surface Type - Flexible
21.70	Other	Junction KY 141 Heading South Road Surface Type - Flexible
22.75	Other	Gas Pipeline Road Surface Type - Flexible
24.65	Power Line	Electrical Power Line 3 Lines Height 30 feet Wood Support Structure Unknown Volts Road Surface Type - Flexible
25.50	Other	5 Oil Tanks 30 feet high 17.5 feet from Road Road Surface Type - Flexible
26.10	Other	End of Union Co - Begin Henderson Co Road Surface Type - Flexible