Research Report
KTC-89-22

EARTHQUAKE HAZARD MITIGATION OF TRANSPORTATION FACILITIES FOR TRIGG COUNTY

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16. Abstract

Concern has grown in recent years over the seismic activity of the New Madrid seismic zone in Western Kentucky. Trigg 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 Trigg County that should be maintained in a passable condition. The recommended routes, US 68/KY 80 and the Trace 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.

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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 Trigg 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 ROUTES IN TRIGG COUNTY

Trigg County is located approximately 85 miles east northeast of the center of the New Madrid Seismic Zone. Figure 1 indicates that Trigg County is in the IX band of the MMI scale. This indicates considerable damage could occur in Trigg County in the event of a major earthquake.

US 68/KY 80 and The Trace have been designated as the priority routes in Trigg County. US 68/KY 80 begins at the Marshall County line and continues east across Trigg County 28.20 miles to the Christian County line. The Trace begins at the Tennessee State line and continues north 9.10 miles to a junction with US 68/KY 80.

A number of features along priority routes could potentially hamper rescue and relief efforts. These features included bridges, soil fills, cut slopes, gas pipelines, power lines, power lines, water towers, geologic faults, large trees, mines, water impoundments, and swamps. 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.

THE TRACE

The Trace (old KY 453) is a connector route between US 79 in Tennessee and US 68/KY 80 in Trigg County. This route follows the countour of the terain and thus has small cuts and fills. In addition there are no structures near the route in Trigg county and there is a wide clear zone along both shoulders. As a result, there are no logged features on this route.

BRIDGES

Bridges are the most significant and important features on the priority route. 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.

There are five bridges on US 68/KY 80. The bridges are located at:

US 68/KY 80

1. The Trace,

2. Cumberland River,

3. Hopson Creek,

4. Little River, and

5. Interstate 24.

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 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.

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

US 68/KY 80

1. 0.60, 2.00, and 2.10 miles east of the Marshall County line,

2. Approach fills for the Trace bridge,

3. 1.17 and 0.47 miles west of and the approach fills for the Cumberland River bridge,

4. 0.89 mile west of and the approach fills for the Hopson Creek bridge,

5. Approach fills for the Little River bridge, and

6. Approach fills for the Interstate 24 bridge.

CUT SLOPE

Several cut slopes were cataloged during surveys of the priority routes in Trigg County. Should a cut slope fail, both lanes of the roadway could be closed. Cut slopes that have a history of failure and those that have steep slopes should be considered as problem areas. The cut slopes are located at:

US 68/KY 80

1. 3.77, 2.27, and 0.87 miles west of the Cumberland River bridge,

2. 1.60 miles east of the KY 1489 junction, and

3. 0.19 mile west of the Little River bridge.

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.

In addition to the potential problem of live power lines, power line support towers could fall across and block a priority route. Power lines cross the priority routes at the following locations:

US 68/KY 80

1. 1.50 miles east of the Trace,

2. 0.50 mile east of the KY 1489 junction, and

3. In the City of Cadiz.

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 Trigg County are listed below:

US 68/KY 80

1. 1.60, 1.32, 0.98 and 0.83 miles west of the Cumberland River bridge, and

2. 0.03 mile west of the KY 1489 junction.

WATER

US 68/KY 80 in Trigg County crosses several streams and travels along lake backwater areas. As a result of this there are some instances where the highway fills impound water on one or both sides. The saturated soils, both foundation and fill material, would likely fail during an earthquake. Failures would probably result in significant displacement, vertical and horizontal, and closure of the priority route. These impoundments are located at:

US 68/KY 80

1. 1.17 miles west of the Cumberland River, and

2. Approaches for the Cumberland River.

MINES

There is a gravel quarry 1.86 miles east of the Trace and an abandoned quarry on the east side of the Little

River. A large earthquake could collapse portions of quarry walls and temporarily block or destroy a section of the priority route. Further inspection should be conducted to determine if these mines constitute a probable threat to the priority routes.

TREES

The behavior of trees during an earthquake depends upon many factors including their condition, type, height, and size. Local soil conditions, geometry of the ground surface, and characteristics of the earthquake can also be important. Violent ground motions accompanied by surface rupture and perhaps permanent displacement of the soil surface produce sudden surface accelerations of the ground which can snap and uproot large trees (3).

Trees are so numerous that, if many of them fell, the priority routes could effectively be blocked for several hours or days before emergency crews could clear the debris. Groups of large trees are located near the road at the following sites:

US 68/KY 80

1. 1.07 and 1.60 miles east of the Marshall County line,

2. 1.34 miles east of the Trace bridge,

3. 0.12, 1.36, 2.30, and 3.46 miles east of the Hopson Creek bridge,

4. 0.01, 0.60, 0.80, 1.60, 1.78, and 1.90 miles east of the KY 1489 junction,

5. 0.31 mile east of the Little River bridge, and

6. 2.21 and 1.40 miles west of the KY 276 junction.

SINKHOLES

Trigg County is located in a karst topographic region. In this region there are numerous sinkholes, caverns, and underground streams. A major earthquake could cause additional and/or rapid subsidence along the priority routes. Sinkholes located under the priority routes in Trigg County are located at;

US 68/KY 80

1. 0.11 mile west of the KY 274 (northwest) junction, and

2. 3.08, 2.70, and 1.96 miles west and 2.37 mile east of the Interstate 24 bridges.

ALLUVIUM

Soil maps for Trigg County indicate that there are large amounts of alluvium present throughout the county. Alluvium is a loose, fine-grain soil which is deposited by flowing water such as creeks and rivers. Due to the nature of the alluvium, ground motions at the surface of the soil can be many times greater than those within the underlying bedrock and temporary liquefaction can occur (Figure 2). An alluvium map for Trigg County is shown in Figure 3.

CONCLUSIONS

In 1984, ESTS developed a fivefold plan of action for formulating and implementing a seismic mitigation policy for the western Kentucky seismic zone. To date, the Kentucky

Transportation Center has established priority routes for all 26 counties in the western Kentucky seismic zone and developed seismic risk maps of all natural and man-made features that are susceptible to earthquake damage that could jeopardize the priority routes.

Current work is being conducted to analyze these features and make recommendations for hardening them 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.

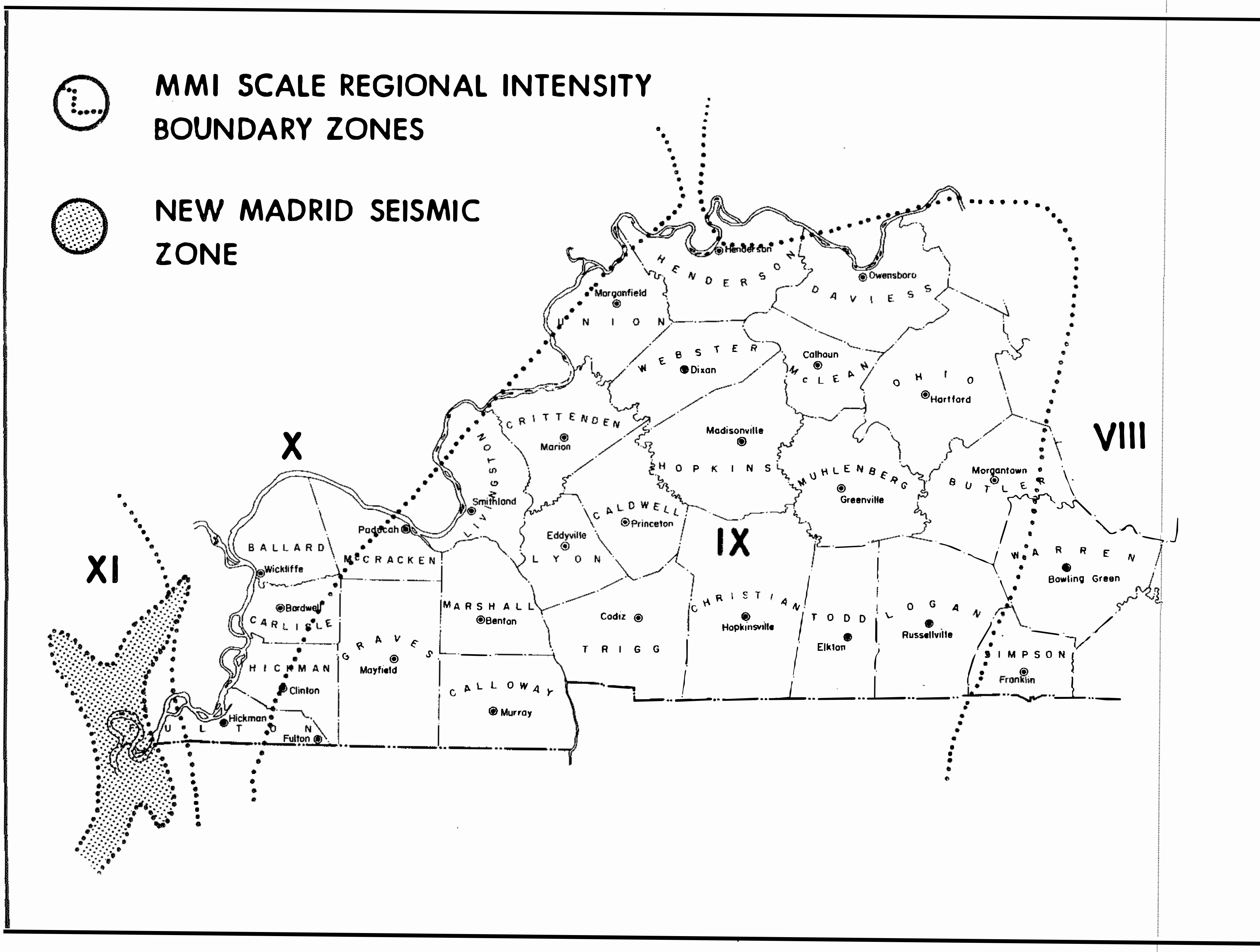


Figure I: The twenty-six counties included in this study area.

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 alluviated areas sand and mud ejected, earthquake fountains, sand crater.

X. Most masonry and frame structures destroyed with their foundations. Some will-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.

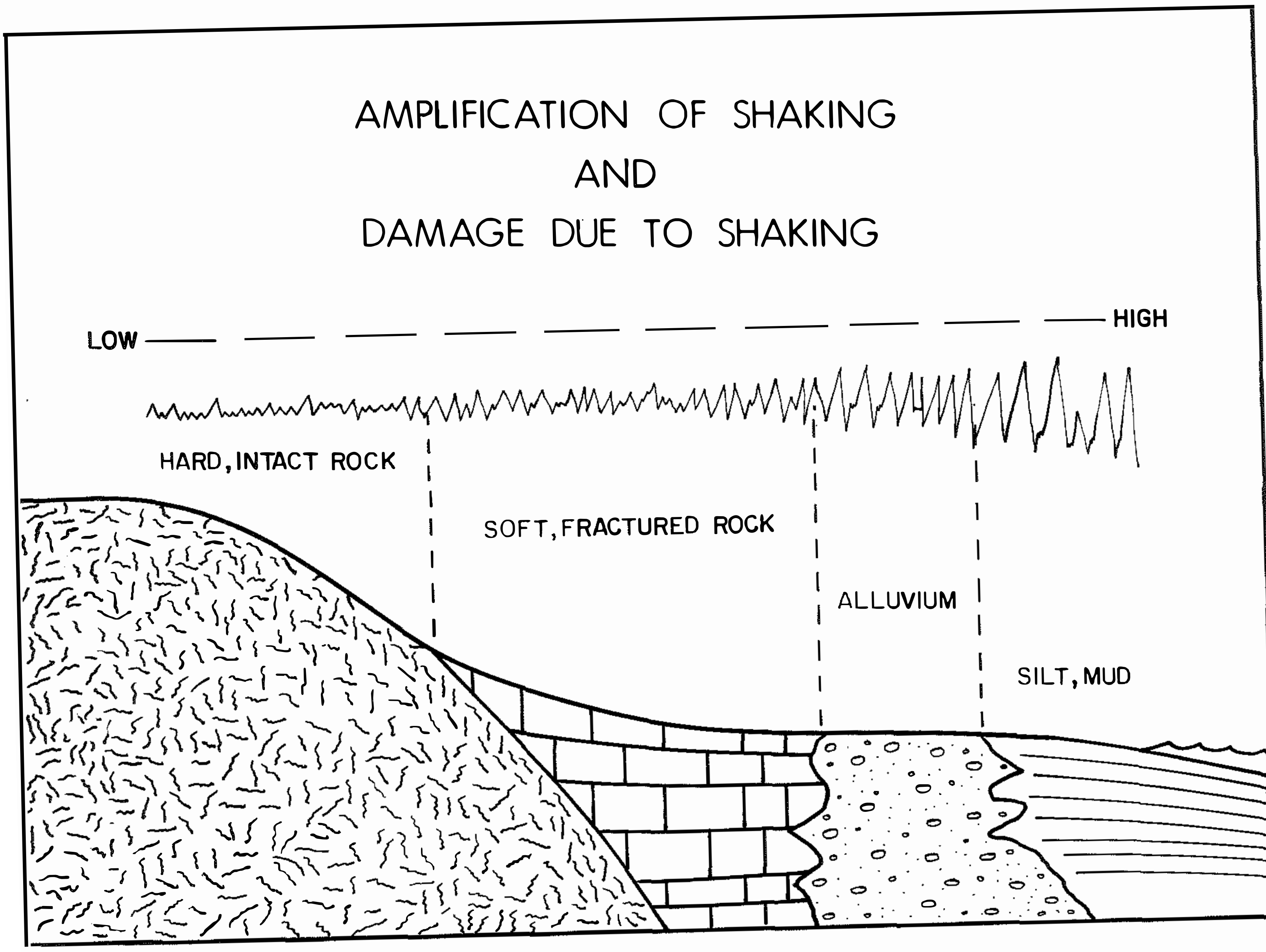


Figure 2: Amplification of shaking in softer rock & soil during an earthquake.

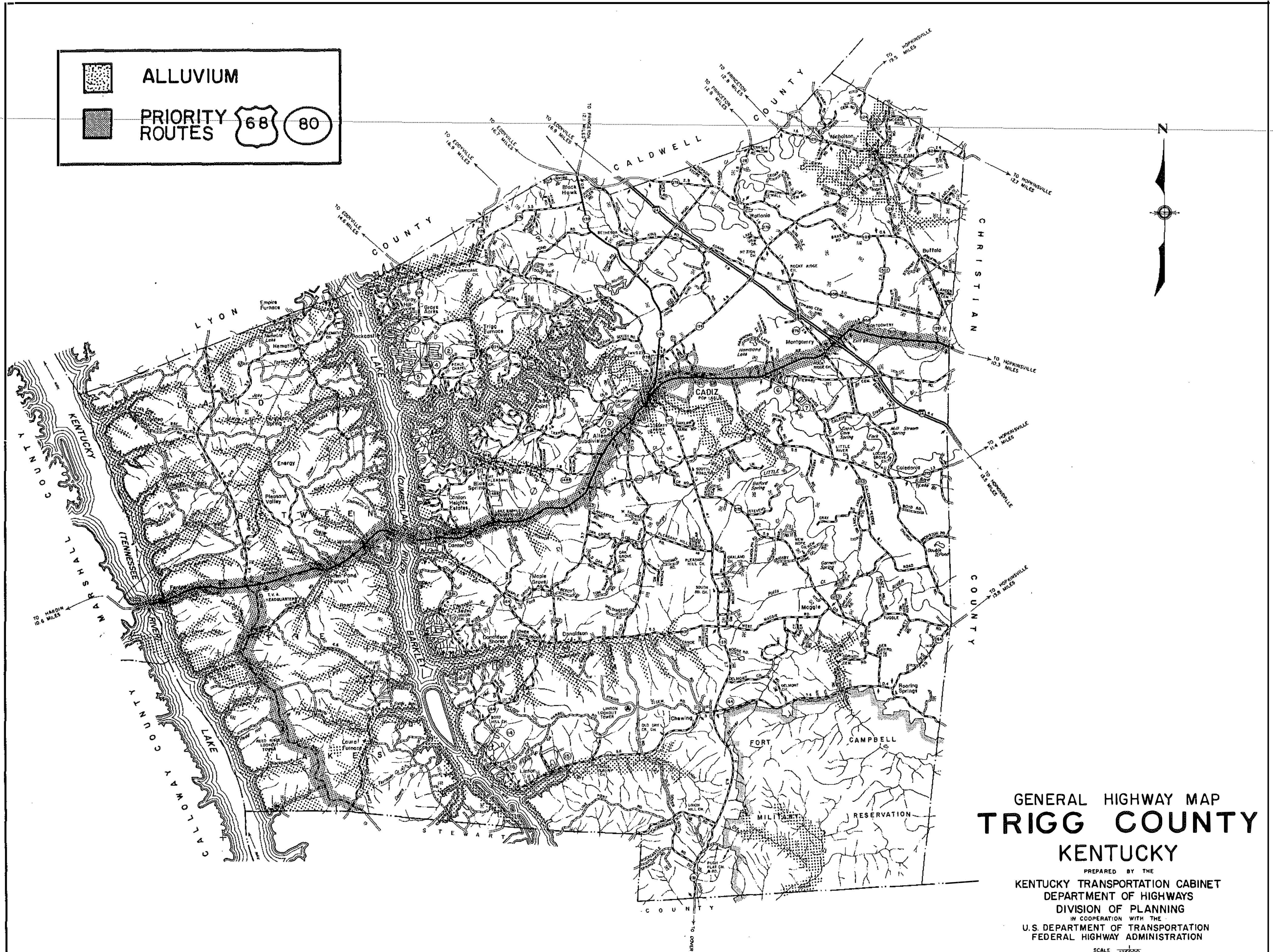


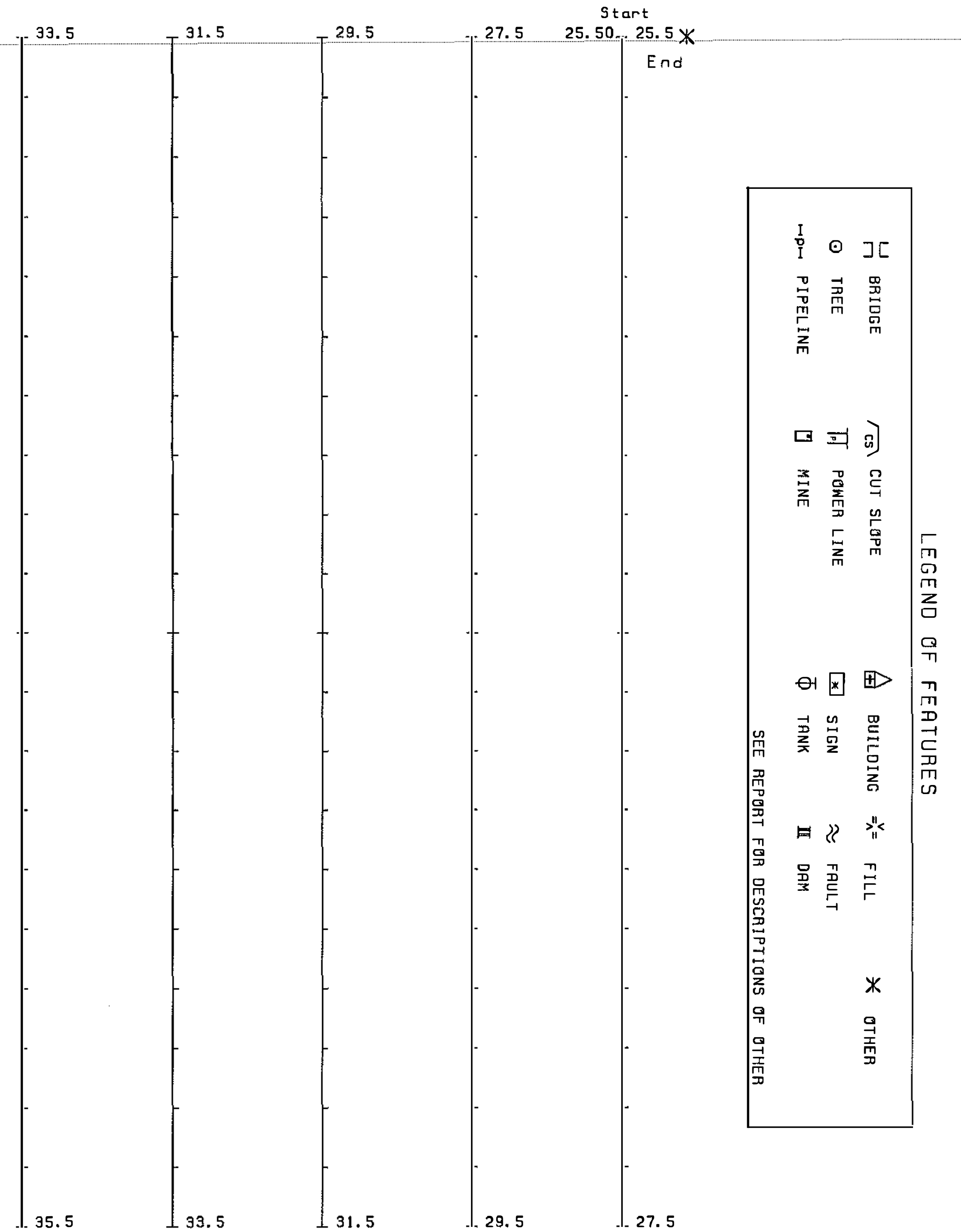
Figure 3. Alluvium map for Trigg County.

APPENDIX A

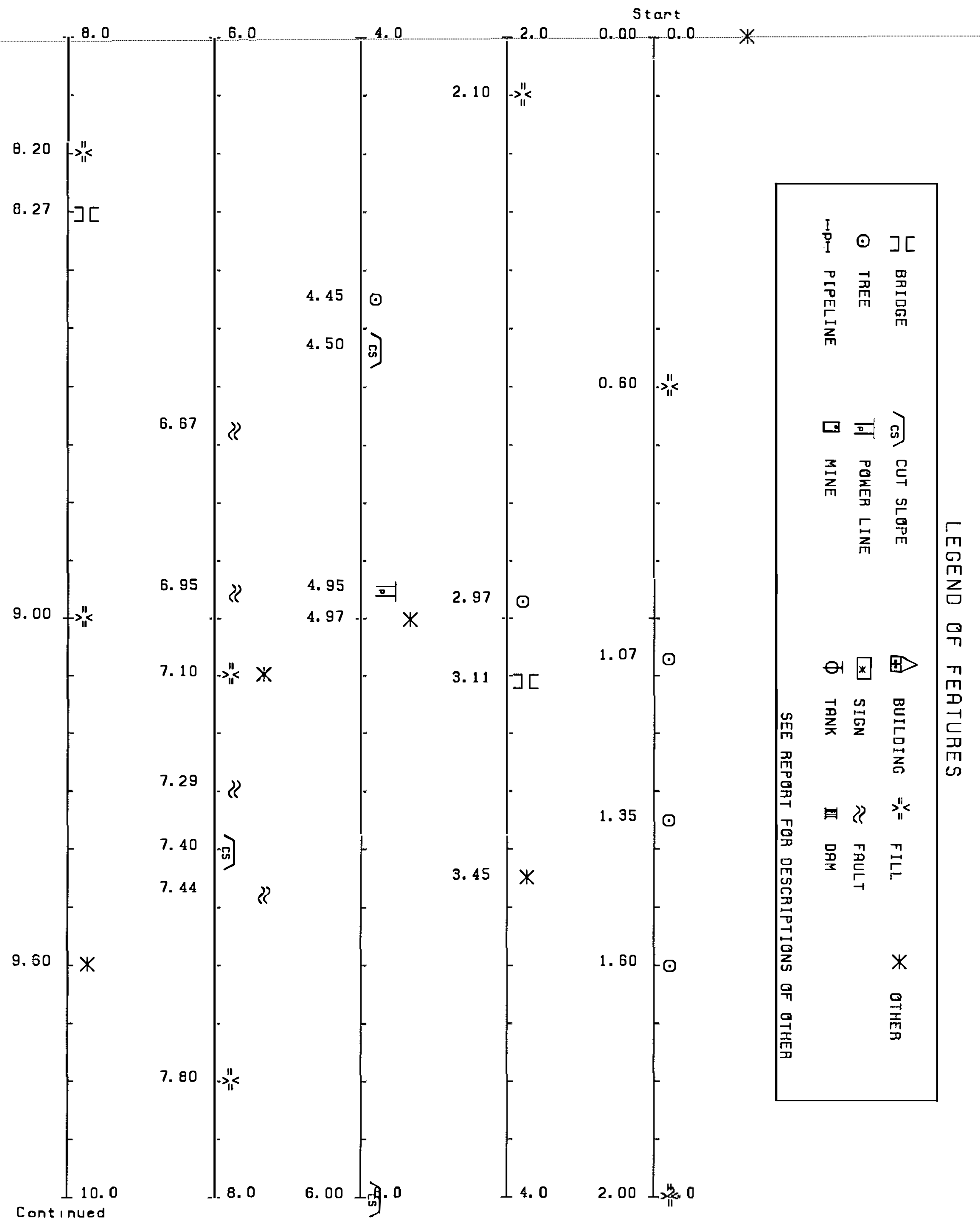
STRIP MAP FOR TRIGG COUNTY

US 62, KY 109, US 41, KY 1751, and US 41A

TRACE TRIGG


Start
33.5
31.5
29.5
27.5
25.50
25.5
End
35.5
33.5
31.5
29.5
27.5
LEGEND OF FEATURES
BRIDGE
CUT SLOPE
BUILDING
FILL
OTHER
TREE
POWER LINE
SIGN
FAULT
PIPELINE
MINE
TANK
DAM
SEE REPORT FOR DESCRIPTIONS OF OTHER

US68KY80 TRIGG



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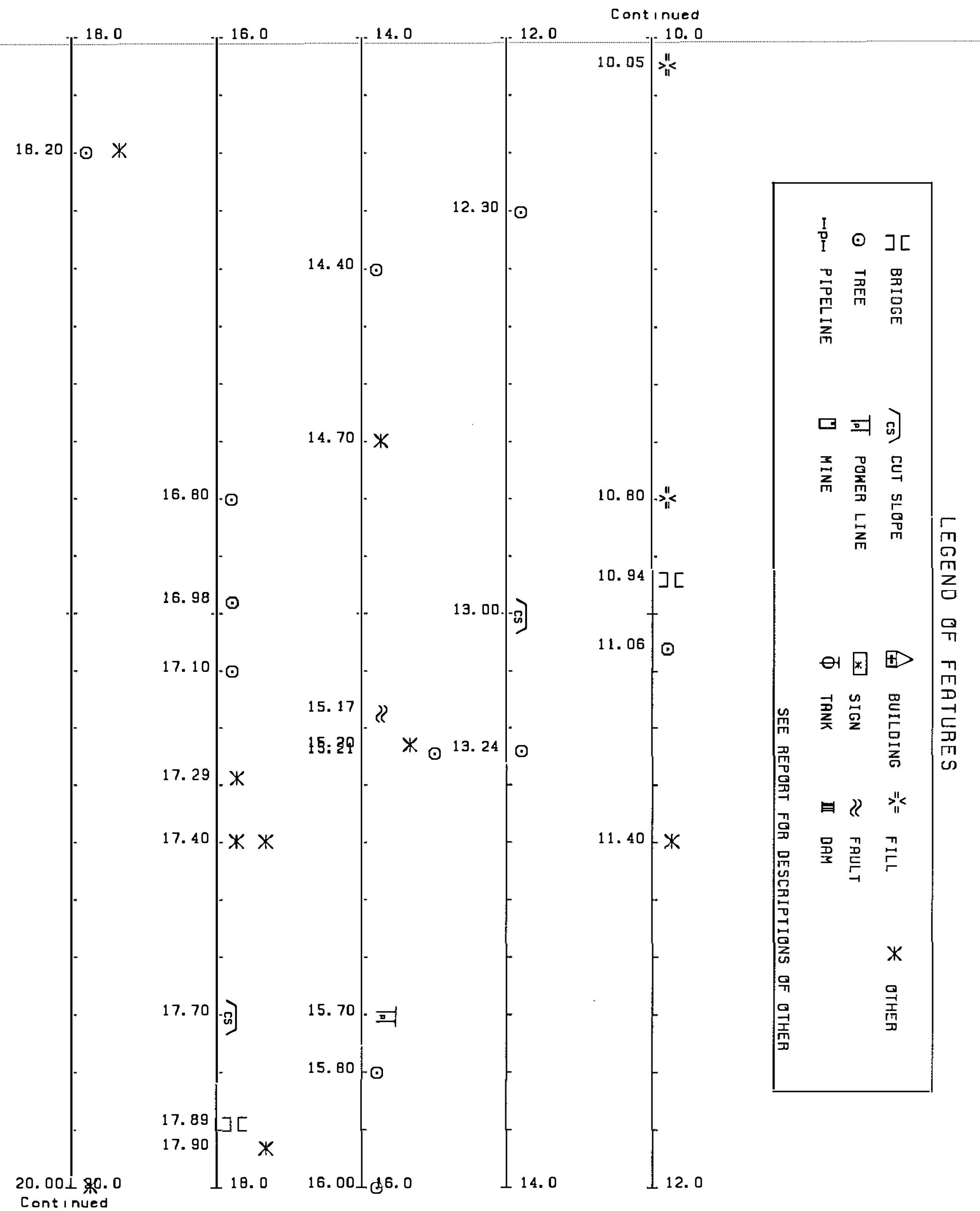

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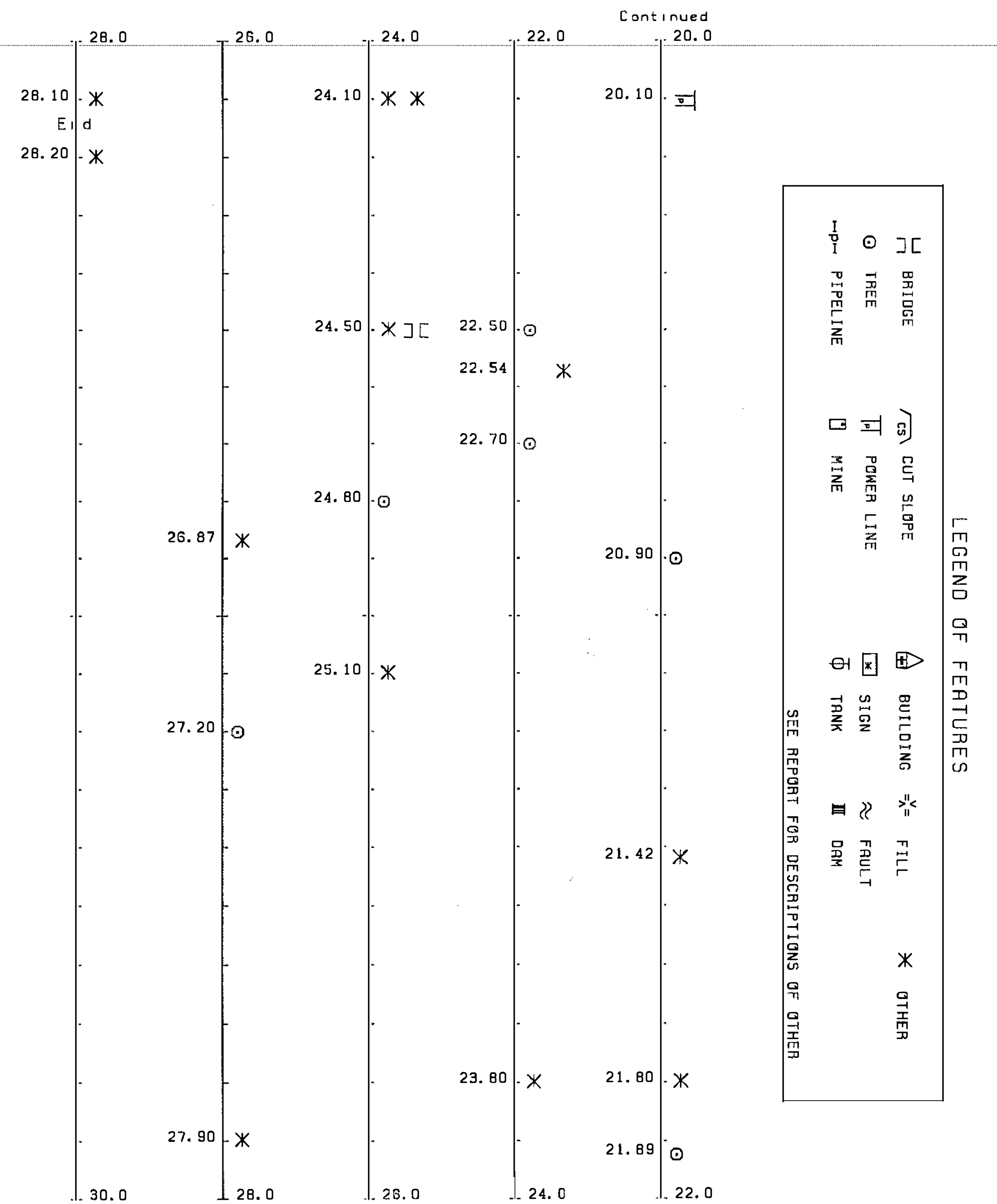

APPENDIX B

SEISMICALLY SIGNIFICANT FEATURES

Report by Road and Milepoint
for Trigg County - Kentucky
The Trace

Milepoint	Feature	Data
25.50	Other	Junction US 68 and KY 80 Road Surface Type - Flexible

US 68 / KY 80

Milepoint	Feature	Data
0.00	Other	Trigg Co - Marshall Co Boundary Road Surface Type - Flexible
0.60	Fill	Material Type - Soil Height 30 feet Side slope 2:1 Length 1,000 feet Crest 40 feet Type Fill - Other Road Surface Type - Composite
1.07	Trees	Number of Trees 25 Height 40 feet Diameter 18 in. Ending Milepoint 1.20 Distance From Road 20 feet Road Surface Type - Composite
1.35	Trees	Number of Trees 1 Height 50 feet Diameter 24 in. Ending Milepoint 1.35 Distance From Road 15 feet Road Surface Type - Flexible
1.60	Trees	Number of Trees 5 Height 45 feet Diameter 18 in. Ending Milepoint 1.64 Distance From Road 10 feet Road Surface Type - Flexible
2.00	Fill	Material Type - Soil Height 30 feet Side slope 3:2 Length 700 feet Crest 40 feet Type Fill - Side Hill Road Surface Type - Composite
2.10	Fill	Material Type - Soil Height 20 feet Side slope 3:2 Length 200 feet Crest 40 feet Type Fill - Other Road Surface Type - Rigid
2.97	Trees	Number of Trees 1 Height 40 feet Diameter 18 in. Ending Milepoint 2.97 Distance From Road 20 feet Road Surface Type - Rigid

Milepoint	Feature	Data
3.11	Bridge	Number of Spans 3 Overpass Concrete T-Beam End 1 Fixed Pier 1 Rocker Pier 2 Rocker END 2 Rocker Deck Type - Concrete Length 132 feet Width 44 feet Pier Type - Open SPC Rating - B Surface Type - Rigid Expansion Type - Sliding Plate End 1 Substurcture - Pile Bent End 2 Substructure - Pile Bent Foundation Type - Unknown
3.45	Other	Junction "The Trace" Heading South Road Surface Type - Flexible
4.45	Trees	Number of Trees 600 Height 30 feet Diameter 18 in. Ending Milepoint 5.90 Distance From Road 10 feet Road Surface Type - Rigid
4.50	Cut Slope	Cut Slope Type - Soil Height 20 feet Length 300 feet Backslope 1:5 Road Surface Type - Rigid
4.95	Power Line	Electrical Power Line 3 Lines Height 50 feet Wood Support Structure Unknown Volts Road Surface Type - Flexible
4.97	Other	Gravel Pit Road Surface Type - Flexible
6.00	Cut Slope	Cut Slope Type - Soil Height 20 feet Length 200 feet Backslope 1:5 Road Surface Type - Rigid
6.67	Fault	Fault Road Surface Type - Flexible

US 68 / KY 80

Milepoint	Feature	Data
6.95	Fault	Fault Road Surface Type - Flexible
7.10	Fill	Material Type - Soil Height 20 feet Side slope 2:1 Length 2,000 feet Crest 40 feet Type Fill - Other Road Surface Type - Rigid
7.10	Other	Water on Both Sides of Fill Road Surface Type - Flexible
7.29	Fault	Fault Road Surface Type - Flexible
7.40	Cut Slope	Cut Slope Type - Soil Height 40 feet Length 300 feet Backslope 2:1 Road Surface Type - Rigid
7.44	Fault	Fault Road Surface Type - Flexible
7.80	Fill	Material Type - Soil Height 20 feet Side slope 2:1 Length 600 feet Crest 40 feet Type Fill - Other Road Surface Type - Rigid
8.20	Fill	Material Type - Soil Height 20 feet Side slope 2:1 Length 800 feet Crest 40 feet Type Fill - Other Road Surface Type - Rigid
8.27	Bridge	Number of Spans 32 Steel Girder I-Beam Bridge Type - Over Stream Bridge Bearing Type Unknown Deck Type - Concrete Length 3,105 feet Width 20 feet Pier Type - Solid SPC Rating - C Surface Type - Rigid Expansion Type - Sliding Plate End 1 Substurcture - Pile Bent End 2 Substructure - Pile Bent Foundation Type - Unknown

Milepoint	Feature	Data
9.00	Fill	Material Type - Soil Height 10 feet Side slope 2:1 Length 300 feet Crest 40 feet Type Fill - Other Road Surface Type - Rigid
9.60	Other	Junction KY 164 Heading Southeast Road Surface Type - Flexible
10.05	Fill	Material Type - Soil Height 25 feet Side slope 1:1 Length 250 feet Crest 30 feet Type Fill - Other Road Surface Type - Flexible
10.80	Fill	Material Type - Soil Height 12 feet Side slope 2:1 Length 2,000 feet Crest 40 feet Type Fill - Other Road Surface Type - Rigid
10.94	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 99 feet Width 28 feet Pier Type - Open SPC Rating - C Surface Type - Rigid Expansion Type - Other End 1 Substructure - Stub End 2 Substructure - Stub Foundation Type - Unknown
11.06	Trees	Number of Trees 40 Height 40 feet Diameter 18 in. Ending Milepoint 11.15 Distance From Road 25 feet Road Surface Type - Rigid
11.40	Other	Junction KY 1489 Heading North Road Surface Type - Flexible

Milepoint	Feature	Data
12.30	Trees	Number of Trees 3 Height 35 feet Diameter 18 in. Ending Milepoint 12.30 Distance From Road 15 feet Road Surface Type - Flexible
13.00	Cut Slope	Cut Slope Type - Soil Height 15 feet Length 400 feet Backslope 1:5 Road Surface Type - Composite
13.24	Trees	Number of Trees 30 Height 40 feet Diameter 18 in. Ending Milepoint 13.60 Distance From Road 6 feet Road Surface Type - Composite
14.40	Trees	Number of Trees 50 Height 40 feet Diameter 15 in. Ending Milepoint 14.52 Distance From Road 15 feet Road Surface Type - Flexible
14.70	Other	Junction KY 272 Heading South Road Surface Type - Flexible
15.17	Fault	Fault Road Surface Type - Flexible
15.20	Other	Junction KY 1489 Heading Northwest Road Surface Type - Flexible
15.21	Trees	Number of Trees 200 Height 40 feet Diameter 12 in. Ending Milepoint 15.40 Distance From Road 15 feet Road Surface Type - Composite
15.70	Power Line	Electrical Power Line 3 Lines Height 25 feet Wood Support Structure Unknown Volts Road Surface Type - Flexible

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Milepoint	Feature	Data
15.80	Trees	Number of Trees 4 Height 40 feet Diameter 18 in. Ending Milepoint 15.80 Distance From Road 6 feet Road Surface Type - Composite
16.00	Trees	Number of Trees 12 Height 40 feet Diameter 18 in. Ending Milepoint 16.10 Distance From Road 6 feet Road Surface Type - Composite
16.80	Trees	Number of Trees 30 Height 40 feet Diameter 24 in. Ending Milepoint 16.90 Distance From Road 10 feet Road Surface Type - Composite
16.98	Trees	Number of Trees 35 Height 40 feet Diameter 24 in. Ending Milepoint 17.00 Distance From Road 8 feet Road Surface Type - Composite
17.10	Trees	Number of Trees 900 Height 60 feet Diameter 12 in. Ending Milepoint 17.90 Distance From Road 20 feet Road Surface Type - Composite
17.29	Other	Sink Road Surface Type - Flexible
17.40	Other	Junction KY 274 Heading Northwest Road Surface Type - Flexible
17.40	Other	Junction KY 1175 Heading South Road Surface Type - Flexible
17.70	Cut Slope	Cut Slope Type - Rock Height 10 feet Length 500 feet Backslope 1:1 Road Surface Type - Composite

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Milepoint	Feature	Data
17.89	Bridge	Number of Spans 6 Over Stream Concrete T-Beam End 1 Fixed Pier 1 Fixed Pier 2 Fixed Pier 3 Fixed Pier 4 Fixed Pier 5 Fixed End 2 Fixed Deck Type - Concrete Length 277 feet Width 28 feet Pier Type - Solid SPC Rating - C Surface Type - Composite Expansion Type - Poured Compression End 1 Substructure - Stub End 2 Substructure - Stub Foundation Type - Unknown
17.90	Other	Abandoned Quarry Road Surface Type - Flexible
18.20	Trees	Number of Trees 900 Height 60 feet Diameter 36 in. Ending Milepoint 18.60 Distance From Road 35 feet Road Surface Type - Composite
18.20	Other	Junction KY 139 Heading North-South Road Surface Type - Flexible
20.00	Other	City of Cadiz Road Surface Type - Flexible
20.10	Power Line	Electrical Power Line 3 Lines Height 40 feet Wood Support Structure Unknown Volts Road Surface Type - Composite
20.90	Trees	Number of Trees 5 Height 40 feet Diameter 30 in. Ending Milepoint 20.90 Distance From Road 15 feet Road Surface Type - Flexible
21.42	Other	Sink Road Surface Type - Flexible

Milepoint	Feature	Data
21.80	Other	Sink Road Surface Type - Flexible
21.89	Trees	Number of Trees 10 Height 40 feet Diameter 30 in. Ending Milepoint 21.90 Distance From Road 15 feet Road Surface Type - Flexible
22.50	Trees	Number of Trees 2 Height 50 feet Diameter 24 in. Ending Milepoint 22.50 Distance From Road 15 feet Road Surface Type - Flexible
22.54	Other	Sink Road Surface Type - Flexible
22.70	Trees	Number of Trees 7 Height 50 feet Diameter 24 in. Ending Milepoint 22.80 Distance From Road 15 feet Road Surface Type - Flexible
23.80	Other	Railroad Crossing Road Surface Type - Flexible
24.10	Other	Junction KY 276 Heading North Road Surface Type - Flexible
24.10	Other	Junction KY 1585 Heading Southeast Road Surface Type - Flexible
24.50	Bridge	Number of Spans 1 Steel Girder I-Beam Bridge Type - Underpass End 1 Rocker End 2 Rocker Deck Type - Concrete Length 75 feet Width 38 feet Pier Type - Solid SPC Rating - B Surface Type - Flexible Expansion Type - Sliding Plate End 1 Substructure - Full End 2 Substructure - Full

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Milepoint	Feature	Data
24.50	Other	East and Westbound Interstate 24 Bridges Road Surface Type - Flexible
24.80	Trees	Number of Trees 2 Height 40 feet Diameter 24 in. Ending Milepoint 24.80 Distance From Road 8 feet Road Surface Type - Flexible
25.10	Other	Junction KY 958 Heading North Road Surface Type - Flexible
26.87	Other	Sink Road Surface Type - Flexible
27.20	Trees	Number of Trees 3 Height 30 feet Diameter 12 in. Ending Milepoint 27.20 Distance From Road 10 feet Road Surface Type - Flexible
27.90	Other	Junction KY 120 Heading North Road Surface Type - Flexible
28.10	Other	Railroad Crossing Road Surface Type - Flexible
28.20	Other	Trigg Co - Christian Co Boundary Road Surface Type - Flexible