Earthquake Hazard Mitigation of Transportation Facilities for Caldwell County

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EARTHQUAKE HAZARD MITIGATION OF
TRANSPORTATION FACILITIES
FOR CALDWELL COUNTY

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in cooperation with
Transportation Cabinet
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and

Federal Highway Administration
U.S. Department of Transportation

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as endorsements.

June 1989
Concern has grown in recent years over the seismic activity of the New Madrid seismic zone in Western Kentucky. Caldwell 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 Caldwell County that should be maintained in a passable condition. The recommended routes, KY 91, KY 672, US 641 and US 62 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.
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 Caldwell 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.

**PR\_OR\_I\_T\_N\_I\_N\_G\_K\_A\_D\_D\_W\_L\_C\_C\_Y\_N\_T\_Y\_**

Caldwell County is located approximately 86 miles northeast of the center of the New Madrid Seismic Zone. Figure 1 indicates that Caldwell County is located in IX band of the MMI scale. This indicates considerable damage could occur in Caldwell County in the event of a major earthquake.

KY 91, KY 672, US 641 and US 62 have been designated as the priority routes for Caldwell County. KY 91 starts at the Caldwell County-Christian County line and continues north for 23.90 miles, ending at the junction of US 641 and KY 91 in the town of Fredonia. KY 672 starts at the junction of KY 91 and KY 672 and continues north for 9.80 miles, ending at junction of US 62 at the Caldwell County-Hopkins County line (The bridge at the Caldwell County-Hopkins County line is logged in the US 62 data). US 641 starts in the town of Fredonia and continues north for 3.19 miles, ending at the Caldwell County-Crittenden County line. US 62 starts at the Caldwell County-Lyon County line and continues east for 6.0 miles, ending at the junction of KY 91.

A number of features along the priority routes could potentially hamper rescue and relief efforts. These features included bridges, soil fills, cut slopes, gas pipelines, power lines, large trees, water impoundments, faults, a radio tower, a rail tunnel, a water tower, and a gravel conveyor. 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.

**BR\_I\_D\_G\_E\_S**

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 four bridges on KY 91, one bridge on KY 672, two bridges on US 641, and one bridge on US 62 in Caldwell County. The bridges are located at the following:

**KY 91**
1. I.C.R.R. crosses over KY 91,
2. KY 91 crosses the Western KY Parkway,
3. Tudor Creek, and
4. Skin Frame Creek.

**KY 672**
1. Montgomery Creek.

**US 641**
1. Easley Creek, and
2. Livingston Creek.

**US 62**
1. Tradewater River.

Research is currently under way 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 priority routes in Caldwell County are located as follows:

**KY 91**
1. Approach fills for the bridge over the Western KY Parkway,
Approach fills for the bridge over Tudor Creek, and
Approach fills for the bridge over Skin Frame Creek.

KY 672
1. Approach fills for the bridge over Montgomery Creek.

US 641
1. Approach fills for the Easley Creek bridge, and
2. Approach fills for the Livingston Creek bridge.

US 62
1. 0.65, 1.10, 2.00 and 3.00 miles east of the Caldwell County-Lyon County line, and
2. Approach fills for the bridge over the Tradewater River.

POWER LINES
High voltage power lines also were cataloged during the route surveys. The heights 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 priority routes at the following locations:

KY 91
1. Several power lines cross KY 91, 0.04 mile south of the bridge over Western KY Parkway,
2. 2.63 and 4.33 miles north of the bridge over Skin Frame Creek, and
3. 3.80 and 2.50 miles south of the junction of US 641 and KY 91.

US 62
1. 1.50 miles east of the Caldwell County-Lyon County line.
US 641
1. Power lines parallel the road from 0.22 to 0.92 mile west of the Caldwell County-Crittenden County line.

GAS PIPELINES
Several pipelines cross under many of the priority routes in Caldwell County. It is possible that pipe lines could fail under or near a priority route causing a temporary closure. 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 pipe lines in Caldwell County were constructed with little or no seismic considerations. Gas pipelines cross under the priority routes at the following locations:

KY 91
1. 2.11 miles north of the I.C.R.R. bridge, and
2. 2.90 and 2.80 miles south of the junction of US 641 and KY 91.

US 641
1. 0.07 mile south of the Livingston Creek bridge.

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. Numerous faults cross under KY 91 and KY 672 in Caldwell County, and are listed below:

KY 91
1. 3.71, 3.75, 3.82, 3.98, 4.18 and 4.51 miles north of the Caldwell County-Christian County line,
2. 0.52 mile north of the I.C.R.R. bridge,
3. 0.15, 0.18 and 0.24 mile north of the bridge over the Western KY Parkway,
4. 0.64 mile south of the Tudor Creek bridge, and
5. 0.71 and 3.27 miles north of the bridge over Skin Frame Creek.

KY 672
1. 1.53 and 1.74 miles north of the junction of KY 91 and KY 672,
2. 0.50 and 0.19 mile south of the junction of KY 278 and KY 672,
3. 0.90, 1.02, 1.15, 1.23, 1.43 and 1.49 miles north of the junction of KY 278 and KY 672, and
4. Under the Montgomery Creek bridge.
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 in Caldwell County 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:

**KY 91**

1. 0.20, 0.60, 1.10, 1.90 and 2.20 miles north of the Caldwell County-Christian County line,
2. 0.79, 1.29, 1.69, 2.29, 2.89 and 3.39 miles south of the I.C.R.R. bridge,
3. 0.81, 1.41, 1.71, and 2.31 miles north of the I.C.R.R. bridge,
4. At the junction of KY 278 (east) and KY 91,
5. 0.26, 0.46, 0.56, 0.66 and 0.96 mile north of the Western KY Parkway,
6. 0.08 mile north of the Tudor Creek bridge,
7. 0.07 mile south of the bridge over Skin Frame Creek,
8. 0.63, 0.93, 2.53, 3.43, 3.53, 3.73 and 5.23 miles north of the bridge over Skin Frame Creek,
9. 0.30, 0.95, 1.10, 3.00 and 3.32 miles south of the junction of KY 70 (heading northeast) and KY 91, and
10. 0.20 mile south of the junction of KY 91, KY 70, and US 641 in Fredonia.

**KY 672**

1. 0.80, 1.40, 1.60 and 2.10 miles north of the junction of KY 91 and KY 672,
2. 0.10, 1.90, 2.70 and 3.20 miles north of the junction of KY 278 (west) and KY 672, and
3. 2.68 and 0.38 miles south of the Montgomery Creek bridge.

**WATER IMPOUNDMENTS**

A section of KY 672 and US 62 are constructed downstream from Lake Beshear. If the dam failed during a major earthquake it is likely that several sections along KY 672 and US 62 would be destroyed and/or flooded for a considerable amount of time. It is likely that the Montgomery Creek bridge on KY 672, the Illinois Central Gulf Railroad tunnel under KY 672, and the Tradewater River bridge on US 62 would be effected.

Additional problems exits from large ponds which have earthen dams that lie above the road surface. The dam 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 slope could cause failures in the fill during an earthquake due to the high moisture content. A pond is located on US 62, 1.30 miles west of the junction of KY 91.

RAILROAD TUNNEL

An Illinois and Central Gulf Railroad tunnel crosses under KY 672 0.43 mile south of the Montgomery Creek bridge. It is possible that the tunnel could collapse during a major earthquake and cause rapid subsidence on KY 672.

WATER TOWER, GRAVEL CONVEYOR, and RADIO TOWER

A water tower is approximately 25 feet from US 62 at milepost 4.30. A gravel conveyor crosses over KY 91 at the milepost 9.0, and a radio tower is adjacent to KY 91 at milepost 11.8. It is possible that these features could fail during a major earthquake and temporarily block the priority routes.

ALLUVIUM

Soil maps for Caldwell County indicate that there are moderate amounts of alluvium present in 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 Caldwell 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


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 1: 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.


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. 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.


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 plastic, some bricks, stones, tiles, ornaments. Tree 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 stove and some masonry walls. Twisting, fall of chimneys, fragile stacks, monu\mments, towers, elevated tanks. Frame houses moved on foundation if not bolted down; loose panel walls thrown out. Delayed pilings 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. Masonry damage to reservoirs. Underground pipes broken. Conspicuous cracks in ground. In alluviated areas sand and mud ejected, earthquake fountains, sand craters.

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 disturbed. Objects thrown in the air.
AMPLIFICATION OF SHAKING AND
DAMAGE DUE TO SHAKING

Figure 2: Amplification of shaking in softer rock & soil during an earthquake.
Figure 3. Alluvium map for Caldwell County.
KY91  CALDWELL

LEGEND OF FEATURES

- BRIDGE
- CUL SLPT
- FRONT LINE
- FRONT
- BRIDGE
- CUL SLPT
- FRONT LINE
- FRONT

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8.0  8.0  4.0  2.0  8.0

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Continued
LEGEND OF FEATURES

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

SEE REPORT FOR DESCRIPTIONS OF OTHER
LEGEND OF FEATURES

- - - BRIDGE  - CUT SLOPE  - BUILDING  - FILL  - OTHER

TREE  POWER LINE  SIGN  FAULT

PIPELINE  MINE  TANK  DAM

SEE REPORT FOR DESCRIPTIONS OF OTHER
LEGEND OF FEATURES

- ☑️ BRIDGE
- ☑️ CUT SLOPE
- ☑️ POWER LINE
- ☑️ TREE
- ☑️ MINE
- ☑️ PIPELINE
- ☑️ BUILDING
- ☑️ FILL
- ☑️ SWALE
- ☑️ FAULT
- ☑️ TANK
- ☑️ DAM

SEE REPORT FOR DESCRIPTIONS OF OTHER
APPENDIX B
SEISMICALLY SIGNIFICANT FEATURES
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Report by Road and Milepoint
for Caldwell County - Kentucky

KY 91

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<td>Fault</td>
<td>Fault Road Surface Type - Flexible</td>
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<td>Fault</td>
<td>Fault Road Surface Type - Flexible</td>
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<tr>
<td>4.40</td>
<td>Trees</td>
<td>Number of Trees 50 Height 30 feet Diameter 18 in. Ending Milepoint 4.60 Distance From Road 10 feet Road Surface Type - Flexible</td>
</tr>
<tr>
<td>4.51</td>
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<td>Fault Road Surface Type - Flexible</td>
</tr>
<tr>
<td>4.90</td>
<td>Trees</td>
<td>Number of Trees 200 Height 45 feet Diameter 20 in. Ending Milepoint 5.10 Distance From Road 15 feet Road Surface Type - Flexible</td>
</tr>
<tr>
<td>5.50</td>
<td>Trees</td>
<td>Number of Trees 2 Height 50 feet Diameter 28 in. Ending Milepoint 5.50 Distance From Road 10 feet Road Surface Type - Flexible</td>
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<tr>
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<td>Trees</td>
<td>Number of Trees 1 Height 50 feet Diameter 25 in. Ending Milepoint 6.10 Distance From Road 10 feet Road Surface Type - Flexible</td>
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<td>Trees</td>
<td>Number of Trees 100 Height 45 feet Diameter 24 in. Ending Milepoint 6.70 Distance From Road 20 feet Road Surface Type - Flexible</td>
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## Report by Road and Milepoint for Caldwell County - Kentucky

**KY 91**

<table>
<thead>
<tr>
<th>Milepoint</th>
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<tbody>
<tr>
<td>7.00</td>
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<td>Number of Trees 100 Height 40 feet Diameter 24 in. Ending Milepoint 7.60 Distance From Road 10 feet Road Surface Type - Flexible</td>
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<tr>
<td>7.79</td>
<td>Bridge</td>
<td>Number of Spans 1 Underpass Concrete Box Beam End 1 Fixed End 2 Fixed Deck Type - Concrete Length 28 feet Width 24 feet Pier Type - Unknown SPC Rating - B Surface Type - Flexible Expansion Type - Other End 1 Substructure - Full End 2 Substructure - Full Foundation Type - Unknown</td>
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<td>Fault</td>
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<td>Trees</td>
<td>Number of Trees 200 Height 50 feet Diameter 32 in. Ending Milepoint 9.00 Distance From Road 15 feet Road Surface Type - Flexible</td>
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<tr>
<td>8.90</td>
<td>Other</td>
<td>Junction KY 128 Heading South Road Surface Type - Flexible</td>
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<td>9.00</td>
<td>Other</td>
<td>Gravel Conveyor Road Surface Type - Flexible</td>
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<tr>
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<td>Trees</td>
<td>Number of Trees 20 Height 50 feet Diameter 32 in. Ending Milepoint 9.22 Distance From Road 15 feet Road Surface Type - Flexible</td>
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<td>Trees</td>
<td>Number of Trees 40 Height 45 feet Diameter 18 in. Ending Milepoint 9.60 Distance From Road 10 feet Road Surface Type - Flexible</td>
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| 9.90      | Pipeline | Pipeline Type - Gas  
Road Surface Type - Flexible |
| 10.10     | Trees   | Number of Trees 4  Height 40 feet  
Diameter 24 in.  Ending Milepoint 10.11  
Distance From Road 15 feet  
Road Surface Type - Flexible |
| 11.30     | Other   | Junction KY 278 Heading East  
Road Surface Type - Flexible |
| 11.30     | Trees   | Number of Trees 200  Height 55 feet  
Diameter 32 in.  Ending Milepoint 11.60  
Distance From Road 20 feet  
Road Surface Type - Flexible |
| 11.80     | Other   | Radio Tower  
Road Surface Type - Flexible |
| 12.20     | Power Line | Electrical Power Line 6 Lines  Height 25 feet  
Steel Support Structure Unknown  
Volts  
Road Surface Type - Flexible |
| 12.20     | Power Line | Electrical Power Line 6 Lines  Height 20 feet  
Steel Support Structure Unknown  
Volts  
Road Surface Type - Flexible |
| 12.20     | Power Line | Electrical Power Line 3 Lines  Height 20 feet  
Wood Support Structure Unknown  
Volts  
Road Surface Type - Flexible |
| 12.24     | Bridge  | Number of Spans 4  Overpass  
Concrete T-Beam  
End 1 Rocker  
Pier 1 Rocker  
Pier 2 Rocker  
Pier 3 Rocker  
End 2 Rocker  
Deck Type - Concrete  
Length 318 feet  
Width 30 feet  
Pier Type - Open  
SPC Rating - B  
Surface Type - Flexible  
Expansion Type - Sliding Plate  
End 1 Substructure - Stub  
End 2 Substructure - Stub  
Foundation Type - Unknown |
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<th>Feature</th>
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<tr>
<td>12.42</td>
<td>Fault</td>
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<td>12.50</td>
<td>Trees</td>
<td>Number of Trees 5 Height 40 feet</td>
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<td></td>
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<td>Diameter 18 in. Ending Milepoint 12.50</td>
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<td>Distance From Road 15 feet</td>
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<td>12.70</td>
<td>Trees</td>
<td>Number of Trees 5 Height 40 feet</td>
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<td>Diameter 18 in. Ending Milepoint 12.70</td>
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<tr>
<td>12.80</td>
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<td>Number of Trees 6 Height 40 feet</td>
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<td>Diameter 18 in. Ending Milepoint 12.80</td>
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<td>Distance From Road 15 feet</td>
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<tr>
<td>12.90</td>
<td>Trees</td>
<td>Number of Trees 3 Height 40 feet</td>
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<td>Diameter 18 in. Ending Milepoint 12.90</td>
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<td>Distance From Road 15 feet</td>
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<tr>
<td>13.20</td>
<td>Trees</td>
<td>Number of Trees 15 Height 40 feet</td>
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<td></td>
<td>Diameter 18 in. Ending Milepoint 13.30</td>
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<td>Distance From Road 15 feet</td>
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Report by Road and Milepoint for Caldwell County - Kentucky

KY 91
<table>
<thead>
<tr>
<th>Milepoint</th>
<th>Feature</th>
<th>Data</th>
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| 13.24     | Fault   | Tabb Fault Area  
Road Surface Type - Flexible |
| 13.90     | Other   | Junction KY 139 Heading South  
Road Surface Type - Flexible |
| 13.92     | Bridge  | Number of Spans 1 Over Stream Concrete T-Beam  
End 1 Fixed  
End 2 Fixed  
Deck Type - Concrete  
Length 33 feet  
Width 20 feet  
Pier Type - Unknown  
SPC Rating - B  
Surface Type - Flexible  
Expansion Type - Other  
End 1 Substructure - Full  
End 2 Substructure - Full  
Foundation Type - Unknown |
| 14.00     | Trees   | Number of Trees 70  
Height 40 feet  
Diameter 18 in.  
Ending Milepoint 14.20  
Road Surface Type - Flexible |
| 14.50     | Trees   | Number of Trees 30  
Height 40 feet  
Diameter 13 in.  
Ending Milepoint 14.70  
Distance From Road 20 feet  
Road Surface Type - Flexible |
| 14.57     | Bridge  | Number of Spans 1 Over Stream Concrete T-Beam  
End 1 Fixed  
End 2 Fixed  
Deck Type - Concrete  
Length 33 feet  
Width 20 feet  
Pier Type - Unknown  
SPC Rating - B  
Surface Type - Flexible  
Expansion Type - Other  
End 1 Substructure - Full  
End 2 Substructure - Full  
Foundation Type - Unknown |
| 15.20     | Trees   | Number of Trees 20  
Height 40 feet  
Diameter 18 in.  
Ending Milepoint 15.30  
Distance From Road 15 feet  
Road Surface Type - Flexible |
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<td>Trees</td>
<td>Number of Trees 200 Height 40 feet</td>
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<td>Distance From Road 10 feet</td>
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<td>Diameter 18 in. Ending Milepoint 17.11</td>
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<td>Distance From Road 20 feet</td>
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<td>17.20</td>
<td>Power Line</td>
<td>Electrical Power Line 3 Lines Height 30 feet</td>
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<td>Wood Support Structure Unknown Volts</td>
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<td>Road Surface Type - Flexible</td>
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<td>17.84</td>
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<td>Road Surface Type - Flexible</td>
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<tr>
<td>18.00</td>
<td>Trees</td>
<td>Number of Trees 10 Height 40 feet</td>
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<td></td>
<td>Diameter 24 in. Ending Milepoint 18.01</td>
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<td>Distance From Road 5 feet</td>
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<td>18.10</td>
<td>Trees</td>
<td>Number of Trees 1 Height 60 feet</td>
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<tr>
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<td></td>
<td>Diameter 25 in. Ending Milepoint 18.10</td>
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<td>Distance From Road 10 feet</td>
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<tr>
<td>18.30</td>
<td>Trees</td>
<td>Number of Trees 20 Height 30 feet</td>
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<td></td>
<td>Diameter 24 in. Ending Milepoint 18.40</td>
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<td>Distance From Road 10 feet</td>
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<td>18.90</td>
<td>Power Line</td>
<td>Electrical Power Line 3 Lines Height 25 feet</td>
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<td>Data</td>
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<td>Trees</td>
<td>Number of Trees 5  Height 40 feet Diameter 15 in. Ending Milepoint 19.82  Distance From Road 20 feet Road Surface Type - Flexible</td>
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<td>Cut</td>
<td>Cut Slope Type - Rock  Height 5 feet  Length 50 feet  Backslope 2:1  Road Surface Type - Flexible</td>
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<tr>
<td>20.08</td>
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<td>Power Line</td>
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<td>Number of Trees 4  Height 45 feet Diameter 20 in. Ending Milepoint 20.42  Distance From Road 15 feet  Road Surface Type - Flexible</td>
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<td>Pipeline Type - Gas  Road Surface Type - Flexible</td>
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<td>Power Line</td>
<td>Electrical Power Line  3 Lines  Height 30 feet  Wood Support Structure  Unknown Volts  Road Surface Type - Flexible</td>
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<td>22.30</td>
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<td>Number of Trees 10  Height 40 feet Diameter 15 in. Ending Milepoint 22.38  Distance From Road 15 feet  Road Surface Type - Flexible</td>
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| 22.45     | Trees   | Number of Trees 15  
Height 30 feet  
Diameter 12 in.  
Ending Milepoint 22.88  
Distance From Road 15 feet  
Road Surface Type - Flexible |
| 23.10     | Trees   | Number of Trees 24  
Height 40 feet  
Diameter 15 in.  
Ending Milepoint 23.30  
Distance From Road 15 feet  
Road Surface Type - Flexible |
| 23.40     | Other   | Junction KY 70 Heading Northeast  
Road Surface Type - Flexible |
| 23.70     | Trees   | Number of Trees 50  
Height 40 feet  
Diameter 15 in.  
Ending Milepoint 24.10  
Distance From Road 10 feet  
Road Surface Type - Flexible |
| 23.90     | Other   | KY 91, KY 70, & US 641 Join in Fredonia  
Road Surface Type - Flexible |
| 23.90     | Other   | Junction US 641  
Road Surface Type - Flexible |
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<td>Begin KY 672 Quake Study Road Surface Type - Flexible</td>
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<td>Number of Trees 50 Height 45 feet Diameter 25 in. Ending Milepoint 5.90 Distance From Road 10 feet Road Surface Type - Flexible</td>
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<td>Trees</td>
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## Milepoint Feature Data

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<td>Trees</td>
<td>Number of Trees 300 Height 40 feet - Diameter 18 in - Ending Milepoint 8.50 - Distance From Road 15 feet - Flexible</td>
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<td>7.90</td>
<td>Fault</td>
<td>Fault - Flexible</td>
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<td>8.02</td>
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<td>8.15</td>
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<td>8.43</td>
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<td>Trees</td>
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<td>9.70</td>
<td>Trees</td>
<td>Number of Trees 50 Height 35 feet - Diameter 62 in - Ending Milepoint 9.80 - Distance From Road 20 feet - Flexible</td>
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<tr>
<td>10.20</td>
<td>Trees</td>
<td>Number of Trees 200 Height 30 feet - Diameter 12 in - Ending Milepoint 11.20 - Distance From Road 15 feet - Flexible</td>
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### Milepoint Report

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<td>13.90</td>
<td>Cut Slope</td>
<td>Cut Slope Type - Rock, Height 15 feet, Length 150 feet, Backslope 1:1, Road Surface Type - Flexible</td>
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<td>14.08</td>
<td>Bridge</td>
<td>Number of Spans 4, Over Stream Concrete T-Beam, End 1 Fixed, Pier 1 Fixed, Pier 2 Fixed, Pier 3 Fixed, End 2 Fixed, Deck Type - Concrete, Length 152 feet, Width 20 feet, Pier Type - Open, SPC Rating - C, Surface Type - Flexible, Expansion Type - Other, End 1 Substructure - Stub, End 2 Substructure - Stub, Foundation Type - Unknown</td>
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<td>14.08</td>
<td>Other</td>
<td>Bridge &amp; Fault - Scour Analysis, Road Surface Type - Flexible</td>
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<td>Other</td>
<td>Danger Lake Beshear, Road Surface Type - Flexible</td>
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<tr>
<td>14.20</td>
<td>Other</td>
<td>Caldwell Co - Hopkins Co, Road Surface Type - Flexible</td>
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<td>14.20</td>
<td>Other</td>
<td>Change to US 62 at County Boundary, Road Surface Type - Flexible</td>
</tr>
</tbody>
</table>
# Report by Road and Milepoint for Caldwell County - Kentucky

## Milepoint 1.43

**Bridge**
- **Number of Spans:** 1
- **Type:** Unknown
- **Concrete T-Beam**
- **End 1 Fixed**
- **End 2 Fixed**
- **Deck Type:** Concrete
- **Length:** 48 feet
- **Width:** 23 feet
- **Pier Type:** Unknown
- **SPC Rating:** B
- **Surface Type:** Flexible
- **Expansion Type:** Other
- **End 1 Substructure:** Full
- **End 2 Substructure:** Full
- **Foundation Type:** Unknown

## Milepoint 2.90

**Other**
- **Begin US 641 Near Fredonia**
- **Road Surface Type:** Flexible

## Milepoint 3.10

**Other**
- **Junction KY 902 Heading East**
- **Road Surface Type:** Flexible

## Milepoint 3.20

**Other**
- **Junction KY 902 Heading West**
- **Road Surface Type:** Flexible

## Milepoint 3.70

**Other**
- **Power Line Parallel to Road, 3 Lines, Wood**
- **Ending Milepoint:** 4.4
- **Road Surface Type:** Flexible

## Milepoint 4.55

**Pipeline**
- **Pipeline Type:** Gas
- **Road Surface Type:** Flexible

## Milepoint 4.62

**Other**
- **Caldwell Co - Crittenden Co Boundary**
- **Road Surface Type:** Flexible

## Milepoint 4.62

**Bridge**
- **Number of Spans:** 1
- **Over Stream**
- **Concrete I-Beam**
- **End 1 Neoprene**
- **End 2 Neoprene**
- **Deck Type:** Concrete
- **Length:** 98 feet
- **Width:** 40 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
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<td>Material Type - Soil Height 30 feet Side slope 2:1 Length 300 feet Crest 35 feet Type Fill - Other Road Surface Type - Flexible</td>
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<td>Fill</td>
<td>Material Type - Soil Height 20 feet Side slope 2:1 Length 500 feet Crest 40 feet Type Fill - Other Road Surface Type - Flexible</td>
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<tr>
<td>1.50</td>
<td>Power Line</td>
<td>Electrical Power Line 6 Lines Height 25 feet Steel Support Structure Unknown Volts Road Surface Type - Flexible</td>
</tr>
<tr>
<td>2.00</td>
<td>Fill</td>
<td>Material Type - Soil Height 18 feet Side slope 2:1 Length 100 feet Crest 30 feet Type Fill - Other Road Surface Type - Flexible</td>
</tr>
<tr>
<td>3.00</td>
<td>Fill</td>
<td>Material Type - Soil Height 30 feet Side slope 2:1 Length 400 feet Crest 40 feet Type Fill - Other Road Surface Type - Flexible</td>
</tr>
<tr>
<td>3.20</td>
<td>Cut Slope</td>
<td>Cut Slope Type - Rock Height 10 feet Length 300 feet Backslope 2:1 Road Surface Type - Flexible</td>
</tr>
<tr>
<td>3.20</td>
<td>Other</td>
<td>Rock Cut is 8 feet from Road Road Surface Type - Flexible</td>
</tr>
<tr>
<td>3.64</td>
<td>Other</td>
<td>Princeton City Limits Road Surface Type - Flexible</td>
</tr>
<tr>
<td>Milepoint</td>
<td>Feature</td>
<td>Data</td>
</tr>
<tr>
<td>-----------</td>
<td>---------</td>
<td>------</td>
</tr>
<tr>
<td>4.30</td>
<td>Tank</td>
<td>Water Tank, Number of Tanks 1, Capacity Unknown, Distance From Road 25 feet, Road Surface Type - Flexible</td>
</tr>
<tr>
<td>4.70</td>
<td>Other</td>
<td>Pond (100 x 50) feet, Road Surface Type - Flexible</td>
</tr>
<tr>
<td>6.00</td>
<td>Other</td>
<td>Junction Priority Route KY 91 Heading Northwest, Road Surface Type - Flexible, US 62 is not a Priority Route Between 6.00 and 18.38 Milepoints, US 62 Joins Priority Route Ky 672 Heading East</td>
</tr>
<tr>
<td>18.38</td>
<td>Bridge</td>
<td>Number of Spans 1, Over Stream, Steel Truss, Truss Type - Through, Through Type - Camel Back, End 1 Rocker, End 2 Rocker, Deck Type - Concrete, Length 80 feet, Width 18 feet, Pier Type - Unknown, SPC Rating - B, Surface Type - Flexible, Expansion Type - Other, End 1 Substructure - Stub, End 2 Substructure - Stub, Foundation Type - Unknown</td>
</tr>
</tbody>
</table>