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Multi-jurisdictional Hazard Mitigation Plan for Landslides for the Kentucky River Area Development District, Kentucky

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Kentucky
Geological Survey

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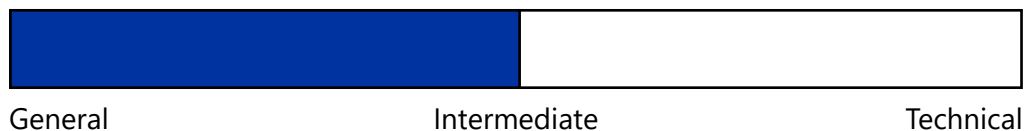
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Our Mission

The Kentucky Geological Survey (KGS) was established by the Kentucky General Assembly as a research center within the University of Kentucky. Our mission is to support the prosperity and resiliency of the Commonwealth, the vitality of its flagship land-grant university, and the welfare of its people. We accomplish this mission by conducting research in the geologic sciences, natural resources (energy, minerals, and water), and geologic hazards. We provide unbiased data and information to elected officials, decision makers, and the public and actively engage with stakeholders across Kentucky.

Technical Level



Statement of Benefit to Kentucky

Landslides are a widespread and complex geologic hazard that affects people and infrastructure. The Kentucky River Area Development District, Kentucky, sustains relatively high landslide activity that impacts several municipalities in eastern Kentucky. This hazard mitigation planning project outlines landslide hazard and risk assessments for the Kentucky River Area Development District, with information needed for each community in the region to develop mitigation strategies that will support infrastructure and development needs, land-use planning, situational awareness, and response and recovery actions for the communities.

Multi-jurisdictional Hazard Mitigation Plan for Landslides for the Kentucky River Area Development District, Kentucky

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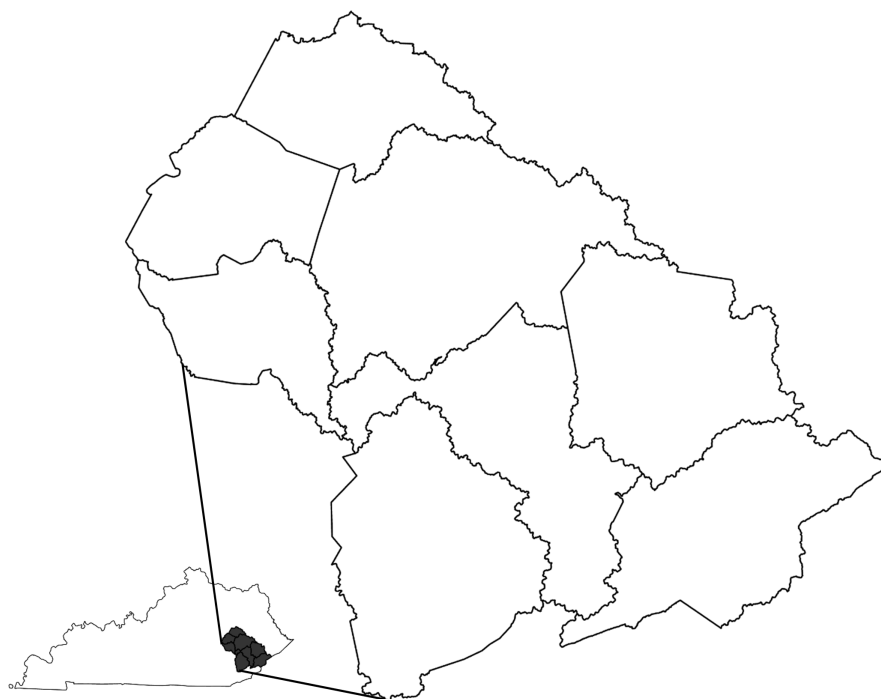
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This mitigation plan was prepared by Hudson Koch, Matthew Crawford, and Jason Dortch at the Kentucky Geological Survey in accordance with the Federal Emergency Management Agency (FEMA) Local Mitigation Planning Policy Guide. Funding support was provided through the FEMA Hazard Mitigation Grant Program (project number 4540-0013-P). For additional information on FEMA regulations and guidance for implementing hazard mitigation planning provisions, visit [this link to FEMA hazard mitigation planning guidance](#).



Introduction

Purpose

The purpose of this plan is to evaluate landslide hazards and support measures designed to mitigate risk to individuals and property in the eight counties of the Kentucky River Area Development District (KRADD), those being Breathitt, Knott, Lee, Leslie, Letcher, Owsley, Perry, and Wolfe Counties, in accordance with the Federal Emergency Management Agency (FEMA) Local Mitigation Planning Policy Guide (FEMA, 2025a). This plan contains information for communities in each county to incorporate in mitigation strategies that will support building and infrastructure needs, land-use planning, event awareness, response, and recovery actions. The plan is an inclusive process that consists of three main tasks: (1) landslide susceptibility assessment, (2) landslide risk assessment, and (3) mitigation strategy.

The landslide susceptibility and risk assessments will help to maintain and enhance the capacity of local emergency management teams in the KRADD, continuously making the region less vulnerable to hazards, improving coordination and communication with other relevant organizations, increasing public understanding, support, and demand for hazard mitigation, and reducing the high cost of recovery from hazards where economically feasible.

Areas of Governance

The KRADD is a multicounty, substate region authorized and organized pursuant to Kentucky Revised Statutes (KRS 147A). The KRADD is charged with planning, promoting, and coordinating programs for regional economic and social development. Table 1 lists the designated member jurisdictions.

Planning Process

This plan was prepared by the Kentucky Geological Survey (KGS) in accordance with the FEMA Local Mitigation Planning Policy Guide (FEMA, 2025a) and in cooperation with stakeholders in the KRADD.

While state government agencies, the KRADD Board of Directors, and the Regional Mitigation Committee were involved with the planning process, this plan is a result of and owned by KRADD residents. Through local planning and data collection, this plan is a document for the common vision of a safer region that is more prepared for emergencies associated with landslide hazards. Through the pursuit of obtaining additional information and input from the community, a detailed regional approach toward landslide hazard mitigation has been produced. This plan goes beyond minimum requirements to document landslide hazards and provide a broad risk assessment. A technical approach using updated high-resolution maps and sophisticated techniques was implemented to map landslide susceptibility.

Open Public Involvement and Participation

The planning process involved KRADD specialists, KRADD stakeholders, other planning agencies, and the public through in-person meetings and email correspondence. Participation included reaching out

Table 1. Kentucky River Area Development District (KRADD) member jurisdictions.

County		Jurisdiction	CID number
Breathitt	21025	Jackson, City of	210024
Knott	21119	Hindman, City of	210130
Knott	21119	Pippa Passes, City of	210457
Lee	21129	Beattyville, City of	210136
Leslie	21131	Hyden, City of	210137
Letcher	21133	Blackey, City of	210371
Letcher	21133	Fleming-Neon, City of	210290
Letcher	21133	Jenkins, City of	210138
Letcher	21133	Whitesburg, City of	210140
Owsley	21189	Booneville, City of	210187
Perry	21193	Buckhorn, City of	210005
Perry	21193	Hazard, City of	215188
Perry	21193	Vicco, City of	210192
Wolfe	21237	Campton, City of	210229

to emergency management directors and area managers, mayors, county judge executives, floodplain coordinators, utilities officials, and soil scientists. The in-person meetings introduced and updated stakeholders about the FEMA Hazard Mitigation Grant Program, discussed project goals, and outlined the benefits for the region. Presentations addressed the scope of work, objectives, and technical aspects of landslide susceptibility, risk assessment, and mitigation strategy. Critical stakeholder and public involvement included identification of high-hazard areas, discussions of perceptions and tolerance of risk, and what in the plan would be useful. Example landslide susceptibility and risk map results were shared with stakeholders at the in-person meetings and via email correspondence. Several suggestions regarding shared common interests and the needs of local officials were considered during map data curation and development of the final plan.

In-person meetings occurred on 5/26/2022, 3/30/2023, 9/19/2023, 3/19/2024, 9/20/2024, and 6/25/2025. These meetings included KRADD board meetings and Kentucky Association of Mitigation Managers Regional Trainings and Annual Meetings.

The subgrantees (KGS and University of Kentucky Research Foundation) provided Kentucky Emergency Management with quarterly reports documenting details of the planning process, summaries of work completed, project task updates, and anticipated activities.

Review of Technical Data and Existing Plans

The plan is consistent with and supports the existing FEMA-approved Kentucky River Area Development District 2024 Regional Hazard Mitigation Plan, as well as the Kentucky Enhanced Hazard Mitigation Plan (KYEM, 2023). The plan data support and enhance all parts of these plans, including hazard mitigation goals of reducing risk, reducing loss, protecting the public, and reducing vulnerability of the built environment. Specifically, this plan addresses the 2024 KRADD plan purpose that “The plan is designed to be used as a guide by each of the eight counties and thirteen cities within the Kentucky

River ADD region in pre-disaster and post-disaster hazard mitigation situations.”

The plan also attempts to meet requirements outlined in the FEMA Local Mitigation Planning Policy Guide (FEMA, 2025a), particularly required elements in sections 4.1, 4.2, 4.3, and 4.4.

The landslide susceptibility and risk maps generated for this plan are intended to identify areas with the potential for slope movement, support goals of reducing losses in hazard areas, and emphasize the needs for public awareness of the potential risks of landslides. Landslide susceptibility and risk data were collected for each county and associated city jurisdiction in the KRADD.

Hazard Identification

Landslides (Types, Previous Occurrences, and Extents)

Landslide is a general term for the downslope movement of rock, soil, or both under the influence of gravity. The type of movement and the resulting impact on the landscape are influenced by the rock and soil type, slope location, and the velocity of rock or soil movement. Landslides occur when the force applied to hillslope material exceeds the strength of the hillslope’s rocks or soil (Crawford et al., 2024).

A stable slope is one that balances the forces imposed (driving forces) with the strength of the soil or rock (resisting forces). A slope will fail if those conditions are disturbed by (1) an increase in the driving forces or (2) any change in resisting forces, both of which typically cause a decrease in shear strength. Landslide management, identification, and mitigation are challenging because the contributing forces vary over space and time at different scales, meaning that causal conditions and triggers of landslides may occur separately.

Examples of driving forces:

- Surcharge of weight at the top of the slope caused by adding artificial fill
- Intense and/or prolonged rainfall that increases pore-water pressure
- Removal of the toe of a slope by engineered cuts or natural stream erosion

- Earthquake-related ground shaking

Examples of changes in resisting forces:

- Increase in pore-water pressure from rainfall or rapid fall of water level along a riverbank
- Vegetation removal
- Expansion and contraction of swelling clay soils with wet-dry weather cycles
- Weathering of weak rock

Landslides occur on both natural and engineered slopes and subsequently are caused by geotechnical, geomorphic, and human-influenced processes. The most common contributing causes include bedrock geology, slope angle, slope morphology, groundwater dynamics, soil type, and slope modification. Landslide triggering mechanisms work in conjunction with the causes. Triggers are the external stimuli that can initiate slides and include rainfall, earthquake shaking, rapid groundwater change, and slope modification.

Diverse terminology and definitions among geologists, engineers, and the public reflect the complexity of landslide processes and the current lack of hazard assessment standardization at the federal level. In landslide inventories, case studies, geotechnical investigations, and casual observations, the terms landslide, mudslide, and rockslide are often used interchangeably despite distinct landslide behaviors and hazard levels. Other terms such as mass wasting, slope movement, and slope failure are also commonly used to discuss landslide phenomena. Regardless of which term is used, all landslides share physical and

mechanical (in rock and soil) processes that explain their occurrence.

Landslide Types

Landslides are classified into basic types. The classifications presented here draw from criteria by Varnes (1978) and Cruden and Varnes (1996), based primarily on the type of hillslope material and the style of movement (Fig. 1). Material in a landslide mass is either rock, soil, or a combination of both. The style of movement describes the mechanics of how the landslide mass is displaced, which is important for determining the level of hazard. Types of movement include fall, topple, slide, spread, and flow (Figs. 2–4). “Type of movement” is often synonymous with “landslide type.” Landslides have basic parts, including the surface of rupture, main scarp, landslide toe, tension cracks, and slide flanks. These parts play a role in the style of movement, velocity of the slide material, volume displaced, distance the slide might reach (extent), and any decisions regarding hazard mitigation and risk reduction.

The following descriptions are modified from Highland and Bobrowsky (2008).

Translational slides: In a translational slide, the slide mass moves down a relatively planar surface, often the contact between soil and underlying bedrock. The sliding material can be composed of fine- to

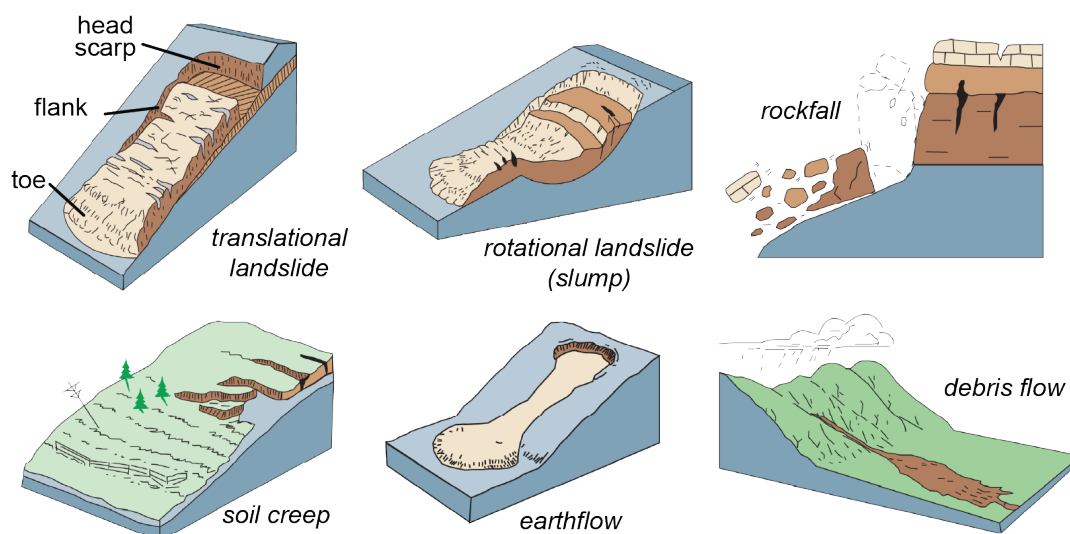


Figure 1. Relevant landslide types from Varnes (1978). Image modified from Highland (2004).



Figure 2. Home and roadway impacted by a landslide (rotational slump) in Jenkins, Letcher County. Photo by Matt Crawford.



Figure 3. Road impacted by a translational slide in Breathitt County (left) and a rockfall impacting KY 80 in Knott County (right). Photo on left by Matt Crawford. Photo on right courtesy of the Kentucky Transportation Cabinet.



Figure 4. Debris flow in Breathitt County triggered during a July 2022 storm. This debris flow measures approximately 700 feet long from up near the yellow arrow to the valley bottom. Photo from the Kentucky Division of Geographic Information and the KyFromAbove Explorer.

coarse-grained soils or rock. Slide-plane zones are typically shallow (less than 10 feet below the surface). Size can range from small (less than 100 feet long) to very large (miles wide along roadways or cutbanks in streams). Movement may initially be slow (a few centimeters a month) but can become rapid (several meters per day).

Rotational slides: Also called slumps, these slides are distinguished by an upward-curved slide plane, which causes rotational movement. Rotational slides can have multiple scarps, which create displacement that tilts back toward the headscarp and crown. Slumps often have hummocky surfaces and thick toes of displaced rock or soil. These slides usually occur in thick, unconsolidated soils, loess, and artificial fills but also may occur in weathered rock masses. Velocities of rotational slides range from slow (less than 1 foot every five years) to moderately fast (5 feet per month).

Flows: Types of flows include debris flow, debris avalanche, and earthflow. Each type is differentiated by velocity and mixture of rock and soil, which can be relatively thin or very thick accumulations of sediment. Flow sizes range from small to very large (a few

hundred feet to a few miles). Smaller earthflows are common in soils developed on shale, weathered clay-rich rocks, and fill. Debris flows and debris avalanches move rapidly (up to 34 miles/hour). They are most common on slopes where thick soils are confined to drainages or steep channels. Excessive water commonly triggers the movement of these flows. Debris flows can be very dangerous because of rapid onset and high velocity that mobilizes everything from large boulders to clay-sized sediment.

Creep: Creep is an extremely slow type of flow (less than 3 feet per decade) that is only noticeable by its effects. Shear stresses in the soil or rock are sufficient to cause movement, but soil or rock displacement is gradual. Creep often occurs seasonally with changes in moisture content and temperature. Typical damage is tilted or curved tree trunks, broken or tilted fences, tilted telephone poles, cracked foundations, and broken underground utilities. Creeps often have complex systems of rupture surfaces and have the potential to lead to more destructive, faster-moving slides or flows.

Spreads: Spreads usually occur on very gentle slopes where soft, clay-rich layers undergo lateral extension, which spreads apart overlying firmer rocks and soil. Spreads can occur in clayey lacustrine and other glacial deposits. Spread results in general subsidence into the weaker layer, and styles include block, liquefaction, and lateral spreads. Velocities range from slow (less than an inch per day) to rapid (tens of feet per day).

Rockfalls and topples: Rock material of varying size can freefall through the air from cliffs, roadcuts, or steep slopes. These failures are more likely if rocks are dipping in the same direction as the slope. Rocks can become detached from in-place bedrock by fracturing, weathering from freeze-thaw cycles, erosion of underlying material, and human activities such as road construction.

Previous Occurrences

KGS maintains a landslide inventory database that provides an overall view of landslide hazards across the state (Crawford et al., 2022a). The inventory and related map can be used to identify preexisting landslides and their extents and serve as a basis for landslide hazard and risk assessments. Inventory data

come from KGS research, published maps, state and local government agencies, the public, and media reports (Figs. 5–6).

Knowing the locations of preexisting landslides and their associated rock, soil, and geomorphic properties allows for better determination of where future landslides may occur. Landslide type is inherently related to potential landslide extent (i.e., how far and how fast a landslide might travel). Increasing development on landslide-prone slopes, coupled with changing climatic conditions that lead to more landslides, requires effective hazard and risk assessment. Effective landslide hazard assessment includes acknowledgment and consideration of changing climatic conditions and how landslide type and frequency may change. In Kentucky, annual landslide occurrence is increasing, along with statewide average cumulative rainfall (Fig. 7).

Landslides are a common occurrence in the KRADD (Fig. 6). Debris flows, translational landslides, slumps, and rockfalls all have the potential to initiate depending on the hillslope morphology, soils, bedrock geology, hillslope hydrology, and other factors. Many of these landslides are documented as points. The points represent larger landslide features that have not been mapped in detail and may fall within different parts of the slide area. In addition to

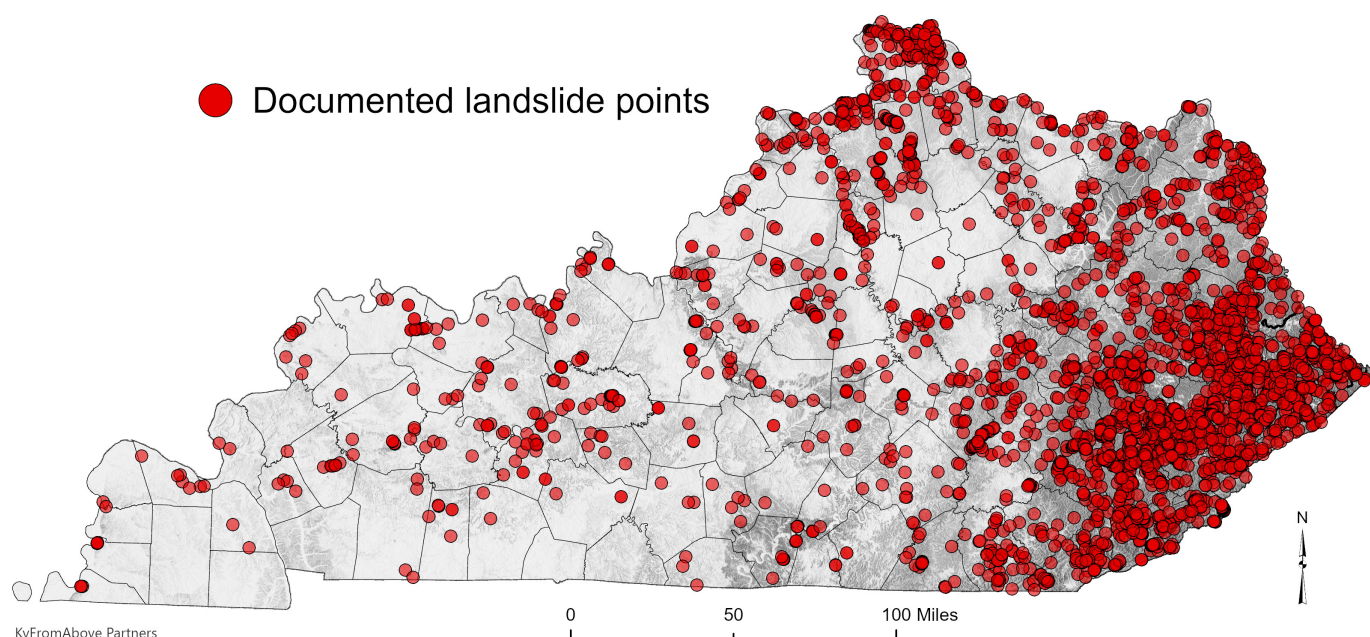


Figure 5. Documented landslide point inventory for Kentucky. These points represent landslide deposits and extents of various ages.

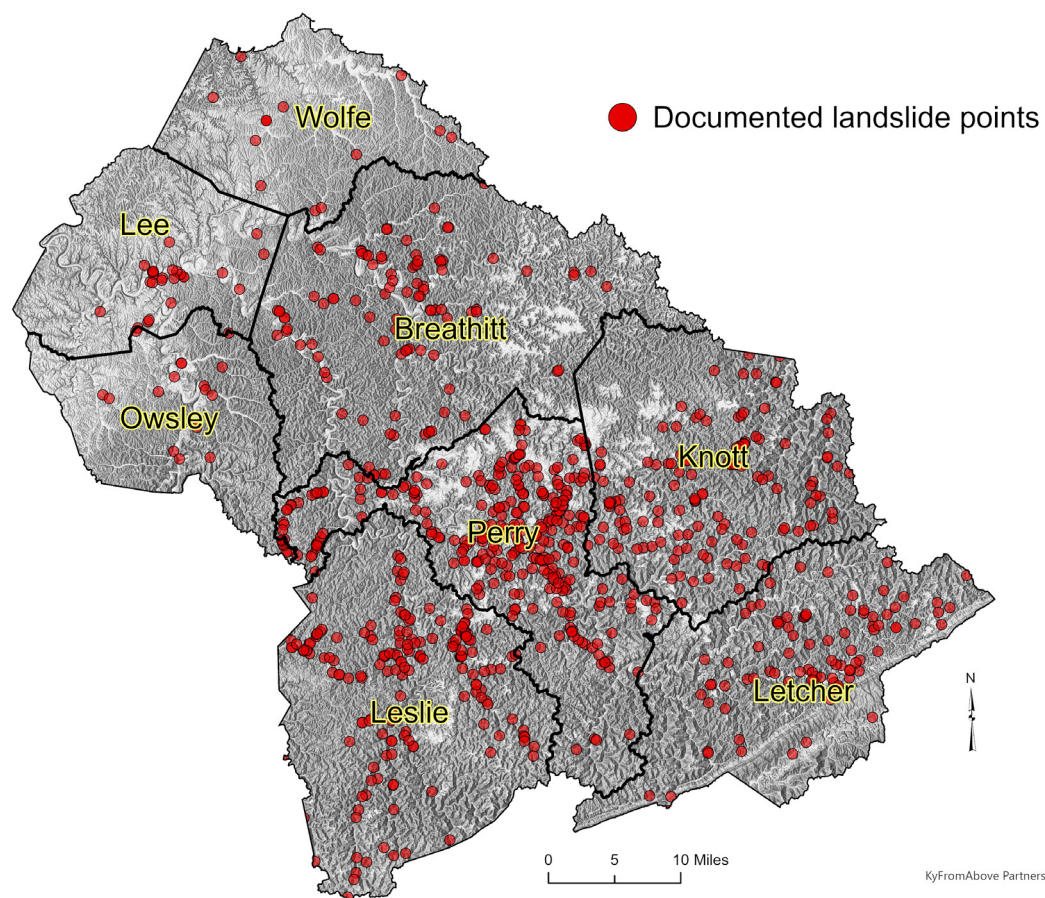


Figure 6. Landslide point inventory for the Kentucky River Area Development District.

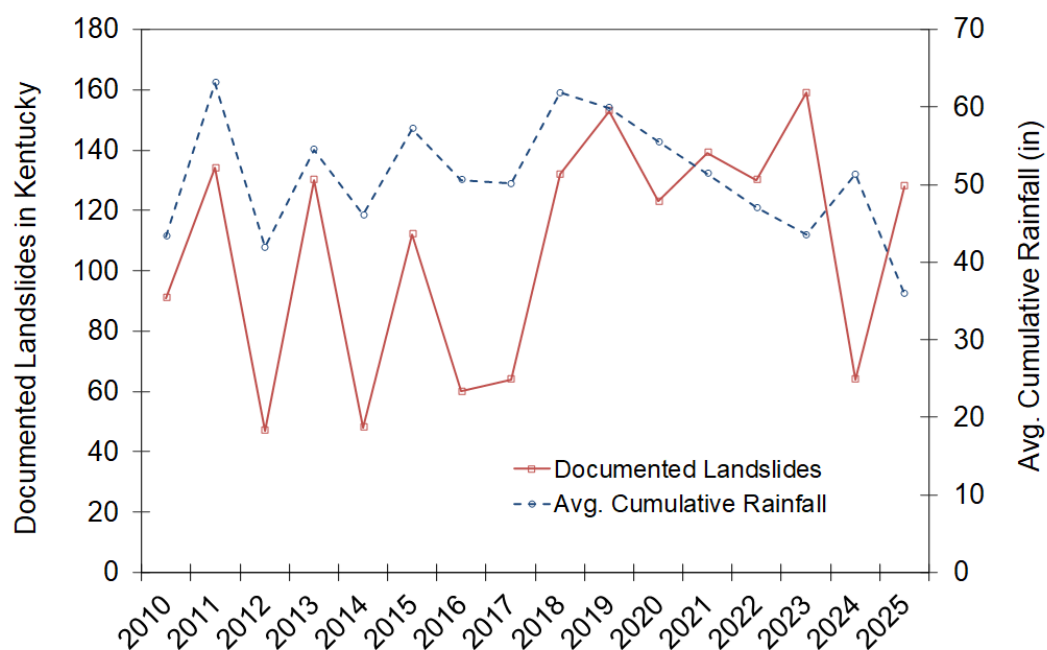


Figure 7. Documented landslides (red line) from the Kentucky Geological Survey Landslide Inventory and average cumulative rainfall data from [Kentucky Mesonet](#) (blue dashed line) in Kentucky. The 2025 values are updated through June 30, 2025.

landslide point data, other data in the KGS inventory come from a series of U.S. Geological Survey maps showing landslides and related features (discussed in Crawford, 2014). These include landslides derived from aerial photos, as well as areas identified as being susceptible to debris flows. Extent data for landslides interpreted from aerial photos are shown for each KRADD county in Table 2. The features (mapped as polygons) depict generalized slope conditions as they existed at the time of field checking (between 1977 and 1981). The data are from preliminary type maps and are suited for general planning purposes only.

KGS also mapped landslides (polygon extents) using airborne statewide lidar and lidar-derived elevation data. For the KRADD, 5,243 landslide polygons were mapped leveraging lidar and lidar-derived data (Table 3).

Landslide inventory maps can be used to identify preexisting landslides and serve as a basis for landslide hazard and risk assessments. The absence of landslides in an area does not imply that a landslide does not exist or that the ground is stable. A semi-quantitative confidence ranking was assigned to each landslide feature. Confidence rankings range from 1 (low confidence) to 8 (high confidence) and reflect the relative value of different data and the amount of information available. The full landslide inventory map and related maps can be launched from the [KGS Landslide Information Map documentation page](#). The [KGS Landslide Inventory](#) (Crawford et al., 2022a) can be downloaded from UKnowledge, the University of Kentucky's institutional repository.

Table 2. Statistics of landslides mapped by the U.S. Geological Survey. Landslides were primarily interpreted from aerial photos.

County	Number of landslides	Average area (ft ²)	Maximum area (ft ²)
Breathitt	2,192	70,576.63	1,994,219.87
Knott	476	35,164.59	637,635.04
Lee	326	19,395.41	261,543.88
Leslie	227	31,860.98	266,915.75
Letcher	135	27,573.21	121,618.24
Owsley	336	26,777.60	387,719.45
Perry	1,021	28,876.45	255,368.11
Wolfe	637	16,928.87	306,908.87

Table 3. Statistics of landslides mapped (polygon extents) using lidar and aerial imagery.

County or 7.5-min quadrangle	Number of landslides	Average area (ft ²)	Maximum area (ft ²)
Owsley	1,344	24,220.97	277,836.07
Booneville Quadrangle (Owsley)	522	28,072.97	277,836.07
Cutshin Quadrangle (Leslie)	671	28,835.52	547,864.94
Hindman Quadrangle (Knott)	1,088	67,032.09	787,220.07
Kite Quadrangle (mostly Knott)	1,851	39,628.03	330,231.95
Quicksand Quadrangle (mostly Breathitt)	469	49,786.32	509,183.88

Landslide Susceptibility

Landslide susceptibility is the relative tendency or potential for slope movement in an area (Highland and Bobrowsky, 2008; Hearn and Hart, 2019). A landslide susceptibility map classifies or ranks slope stability in categories based on relationships among factors that contribute to instability, whereas a hazard map may indicate elements of time or estimated landslide extent (National Research Council, 2004; Highland and Bobrowsky, 2008). Landslide susceptibility maps in this report identify landslide-prone areas in the KRADD, delineating probabilities of where landslides exist or are likely to occur. We classify these areas as low, low-moderate, moderate, moderate-high, or high landslide susceptibility. The following sections describe the process and data used to model landslide susceptibility and risk and ultimately to produce maps and geographic information system (GIS) datasets for the KRADD. For additional information on the methodology, see Crawford et al. (2021) and Crawford et al. (2025).

Landslide Inventory Data

To begin the process, we identified 1,344 landslides in Owsley County (Fig. 8). Landslide extents were primarily mapped by visual inspection of a multidirectional hillshade derived from a 5 ft lidar digital elevation model (DEM). Secondary maps of slope, roughness, curvature, plan curvature, contour, and traditional hillshade, as well as aerial photography, were used to help identify landslide features and constrain confidence in mapping deposit extents. Landslide extents (mapped as polygons in a GIS) are defined by the inclusion of features such as head-scarps, flanks, toe slopes, and hummocky topography (Fig. 9). A range of sizes and shapes was observed, but landslide type, age, and potential activity were not determined. The mean landslide area was approximately 24,220.97 ft², and the maximum landslide area was 277,836.07 ft². The lidar DEM used for landslide

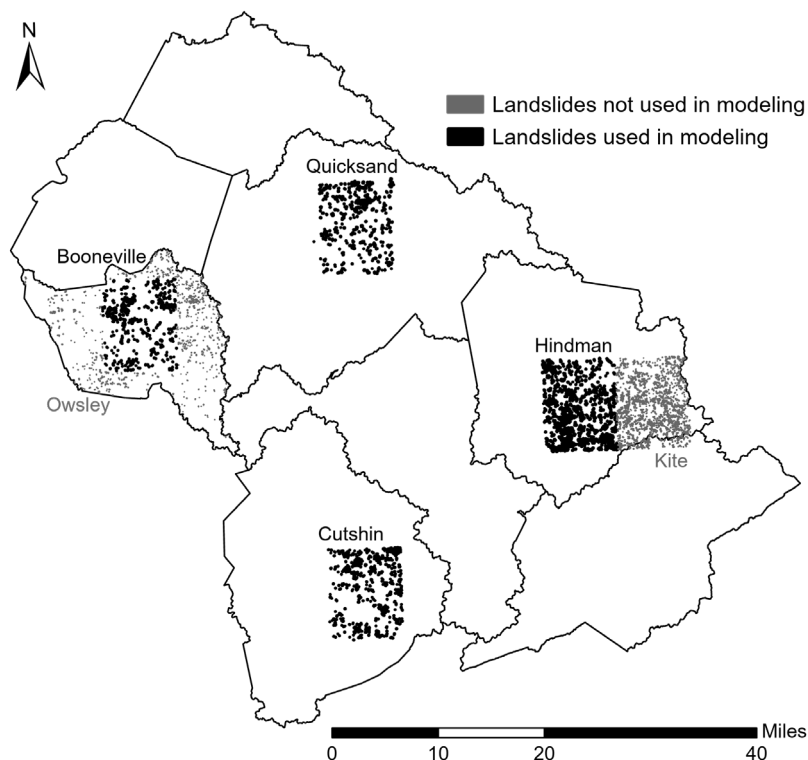


Figure 8. Locations of mapped landslide polygons in the Kentucky River Area Development District. The landslides in gray were used in landslide susceptibility modeling and map creation.

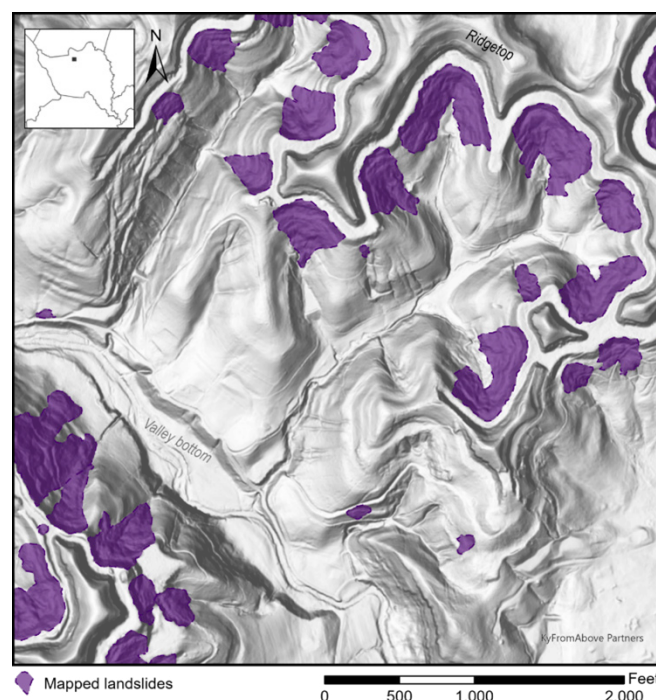


Figure 9. Zoomed-in example of a hillshade map showing specific landslide deposit extents mapped using lidar-derived data in Owsley County. The mean landslide area is approximately 24,200 ft².

identification in Owsley County was collected in 2017. New landslides likely have occurred since this compilation. In addition to the Owsley County inventory, landslides were mapped for four 7.5-minute quadrangles distributed across the KRADD: Cutshin, Hindman, Kite, and Quicksand. DEMs for these inventories were collected in 2017 (Cutshin and Quicksand), 2012 (Hindman), and 2011 (Kite). The number of landslides and the mean and maximum landslide area for each inventory are detailed in Table 2. These landslide extents serve as the data catalyst for the landslide susceptibility and risk mapping.

Geomorphic Data

Geomorphic maps of elevation, slope, terrain roughness, curvature, plan curvature, and aspect were generated from the resampled and smoothed lidar DEM (Table 4). To obtain consistent geomorphic statistics, a circular buffer was generated around the centroid point of each mapped landslide (Fig. 10). The landslide extent may, depending on the size and shape of the landslide, fall outside the buffer polygon. A buffer polygon that represents most of the landslide extent is superior to a single point in accounting for variability in landslide characteristics, however. The buffers for landslides were used to extract six statistical variables from each of the six geomorphic maps.

The GIS extraction process resulted in 36 individual statistical values for each landslide (maximum, minimum, range, mean, standard deviation, and sum of values within each buffer for each map—e.g., slope map). The buffer created for the mapped landslides had an area of ~48,000 ft² (radius of 123 ft), which corresponded to the average area of the landslides.

To prepare for susceptibility modeling, statistical data for non-landslide areas are required for the creation of the indicator, a dependent variable with a value of either 1 or 0. Non-landslide areas must also have comparable buffer shapes so that contrasting feature statistics can be gathered. The same procedure (using a 123 ft radius buffer) was followed to generate geomorphic statistics for the non-landslide areas as for the landslide areas (Fig. 10). The non-landslide locations were constrained to avoid coinciding with known landslide locations. In addition to an equal count of non-landslide points, 120 points were manually selected along cliff faces within Wolfe and Lee Counties (approximately the Red River Gorge area) and in surface mine sites across the KRADD. These areas yielded spuriously high landslide susceptibility values in preliminary models, and as such the additional non-landslide points reinforced the model to lower the susceptibility estimates in these areas. These statistics, plus the indicator variable, made up a binary dataset used in the susceptibility model applied to all eight counties.

Table 4. Geomorphic variables and maps generated from the lidar digital elevation model.

Geomorphic variable	Definition
Elevation	Vertical distance of a point above or below a reference surface, derived as a representation of the Earth's surface (meters)
Slope	Gradient or steepness from each cell of an elevation raster (degrees)
Terrain roughness	A degree of terrain irregularity calculated as surface deviation from a smoothing window; scale of landscape features is important in choosing a smoothing-window size
Curvature	The second derivative value from each cell from an elevation raster (1/100 of a z-unit)
Plan curvature	Curvature of the surface perpendicular to the direction of maximum slope (1/100 of a z-unit)
Aspect	Compass direction of a downhill-facing slope, derived for each cell of an elevation raster

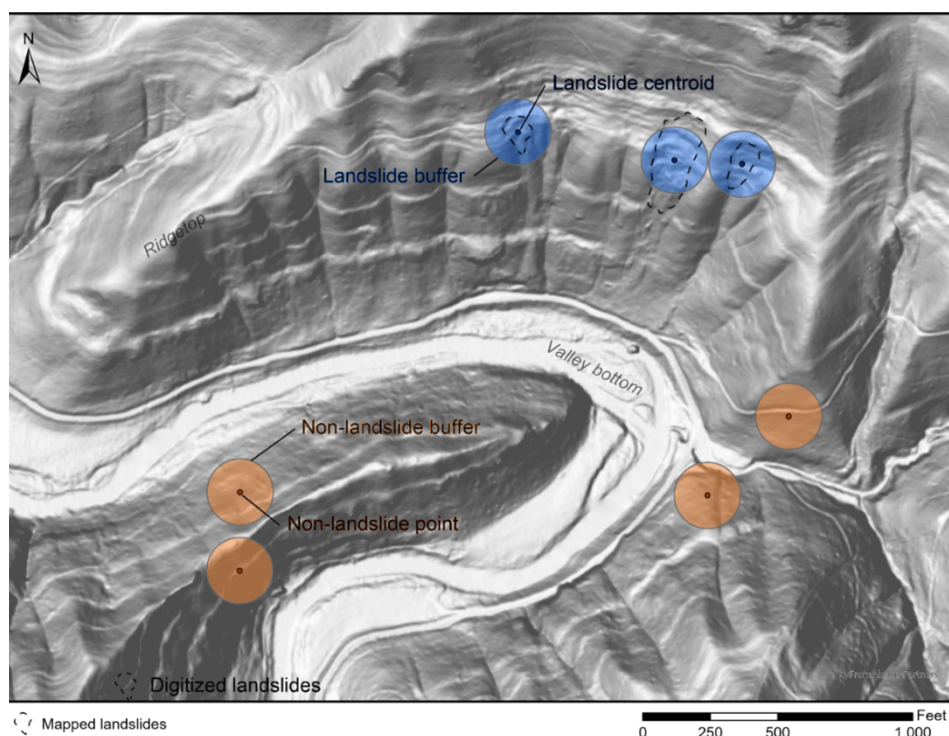


Figure 10. Landslide buffers around centroids of mapped landslides (blue) and non-landslides (orange), Leslie County.

Model and Map Output

The modeling and resulting map production were part of a two-step process involving machine learning techniques. First, variable importance was assigned using an ensemble decision tree technique referred to as bagged trees, which combines the results of many individual decision trees in order to improve model performance and reduce model overfitting. Bagged trees predicts a weighted classification using the indicator variable to return an approximation of variable importance rank. Variable importance is a prediction of relative importance based on the combination of statistical variables. The variable importance rank is used to parse important variables from the full pool of 36 variables. The threshold for parsing was determined using the mean importance value. Second, the variables selected by the bagged trees were checked for collinearity to ensure the logistic regression could determine a satisfactory fit. For the distributed inventory with additional non-landslide points, the variables removed during this stage were range of curvature and range of plan curvature.

The second step was a logistic regression technique that models the probability of an event (a

landslide) being a function of other variables and quantifies probability based on statistical analysis of existing landslides. Existing landslides are often susceptible to reactivation, which makes modeling the probability of occurrence and developing a susceptibility map with logistic regression particularly important. The value predicted is a probability of an event ranging from 0 to 1 (i.e., an estimate of the maximum likelihood that a landslide will be influenced by the statistics of observed independent variables). The two-step process avoids overly complex map results. The logistic regression indicates which modeled relationships are statistically significant and usable as inputs in map generation.

The bagged trees selected 20 variables, and 18 were used in the logistic regression model. A feature importance threshold of 1.01 was a consistent mark of separation to choose the important variables (Table 5).

We used Matlab functions [TreeBagger](#) and [fitmnr](#) (MathWorks, 2024) to conduct the bagged trees and logistic regression analysis, respectively.

In logistic regression, when the indicator variable is attributed (0, 1), the nominal response is

Table 5. Bagged trees results from highest to lowest importance. Variables with feature importance values over a threshold of 1.01 were considered important.

Geomorphic variable	Feature importance
Standard deviation plan curvature	2.02
Minimum curvature	1.57
Range aspect	1.41
Range curvature	1.34
Standard deviation elevation	1.34
Mean plan curvature	1.33
Sum plan curvature	1.28
Standard deviation curvature	1.27
Range plan curvature	1.23
Maximum plan curvature	1.17
Maximum curvature	1.15
Minimum plan curvature	1.13
Standard deviation aspect	1.12
Range elevation	1.12
Mean roughness	1.10
Standard deviation slope	1.05
Sum curvature	1.05
Sum slope	1.04
Sum roughness	1.02
Minimum slope	1.02

$$\log \left(\frac{P(y=0)}{P(y=1)} \right) = \beta_0 + \beta_1 V_1 + \beta_2 V_2 + \cdots + \beta_x V_x,$$

where β_0 is the constant intercept, V_x are the geomorphic variables, and β_x are the coefficient estimates of responses in the indicator variable. The coefficients express the effects of the predictor independent variables on the relative risk of being a landslide or not a landslide, which increases or decreases with each value of the independent variable V (i.e., the rate of change in log odds as V changes). The above equation can also be written as

$$z = \beta_0 + \beta_1 V_1 + \beta_2 V_2 + \cdots + \beta_x V_x,$$

where z is total contribution of all predictor variables, a model of relative risk of features in the landscape

being landslides or not landslides. The cumulative distribution logistic function is

$$P = \frac{1}{1 + e^z},$$

where P is the cumulative estimated output probability of an event occurring (landslide occurrence or nonoccurrence). The output probability ranges from 0 and 1. The modeled variables were assumed not to be normally distributed or to have linear relationships (Süzen and Doyuran, 2004; Nandi and Shakoor, 2010). Therefore, the logistic regression analysis worked well because the primary unknown was the relationships among the variables.

The logistic regression analysis on the 18 variables found that 8 geomorphic variables were statistically significant ($p \leq 0.05$; Table 6). Relative to a 95% confidence interval, $p \leq 0.05$ means that an extreme outcome in a set of results is unlikely under the null hypothesis, indicating statistical significance. Table 6 also shows the LogWorth, $-\log_{10}(p \text{ value})$, which is a transformation of the p value and an easier way to visualize the relative weight of each variable. The higher the variable's significance, the higher the LogWorth.

Five landslide susceptibility classifications were determined manually by creating breaks of equal intervals. Equal interval classification commonly works well even for skewed data distributions (i.e., non-normal distributions). Equal interval breaks also allow a seamless uniform scheme across county boundaries. The percent area, percent buildings, percent roads (state and local), and percent railroads that fall in each landslide susceptibility class are presented in Table 7. All infrastructure within the floodplain and mountain top removal sites were excluded from these intersection analyses, as model results were voided in those areas.

The following figures show example landslide susceptibility maps in each KRADD county and municipal jurisdiction (Figs. 11–31). The maps show susceptibility classifications derived from values of probability of an event (a landslide) being a function of other geomorphic variables. In addition to the susceptibility GIS map data, complete susceptibility maps (in .pdf format) for each KRADD county were delivered to KRADD personnel and officials.

Table 6. Logistic regression results.

Geomorphic variable	Beta coefficient	<i>p</i>	LogWorth
Intercept	1.604319	0.003183	N/A
Sum slope	−0.00050	5.43E−20	19.27
Standard deviation aspect	0.011089	2.05E−18	17.69
Range aspect	−0.00325	7.52E−14	13.12
Standard deviation plan curvature	5.123676	1.48E−11	10.83
Minimum curvature	0.558613	4.93E−05	4.31
Standard deviation slope	0.101088	0.000107	3.97
Range elevation	0.024012	0.000116	3.94
Standard deviation curvature	1.451454	0.015259	1.82

Table 7. Susceptibility model results and classes for the Kentucky River Area Development District (KRADD), the area coverage of each susceptibility class, and each class's intersections with infrastructure.

Probability	Susceptibility class	KRADD area coverage (%)	Intersection with buildings (%)	Intersection with roads (%)	Intersection with railroads (%)
0–0.2	Low	42.73	22.82	26.45	18.12
0.21–0.4	Low-moderate	33.84	31.67	36.53	36.52
0.41–0.6	Moderate	13.18	6.35	13.91	16.31
0.61–0.8	Moderate-high	2.88	0.88	4.11	3.10
0.81–1.0	High	1.35	0.01	0.18	0.12

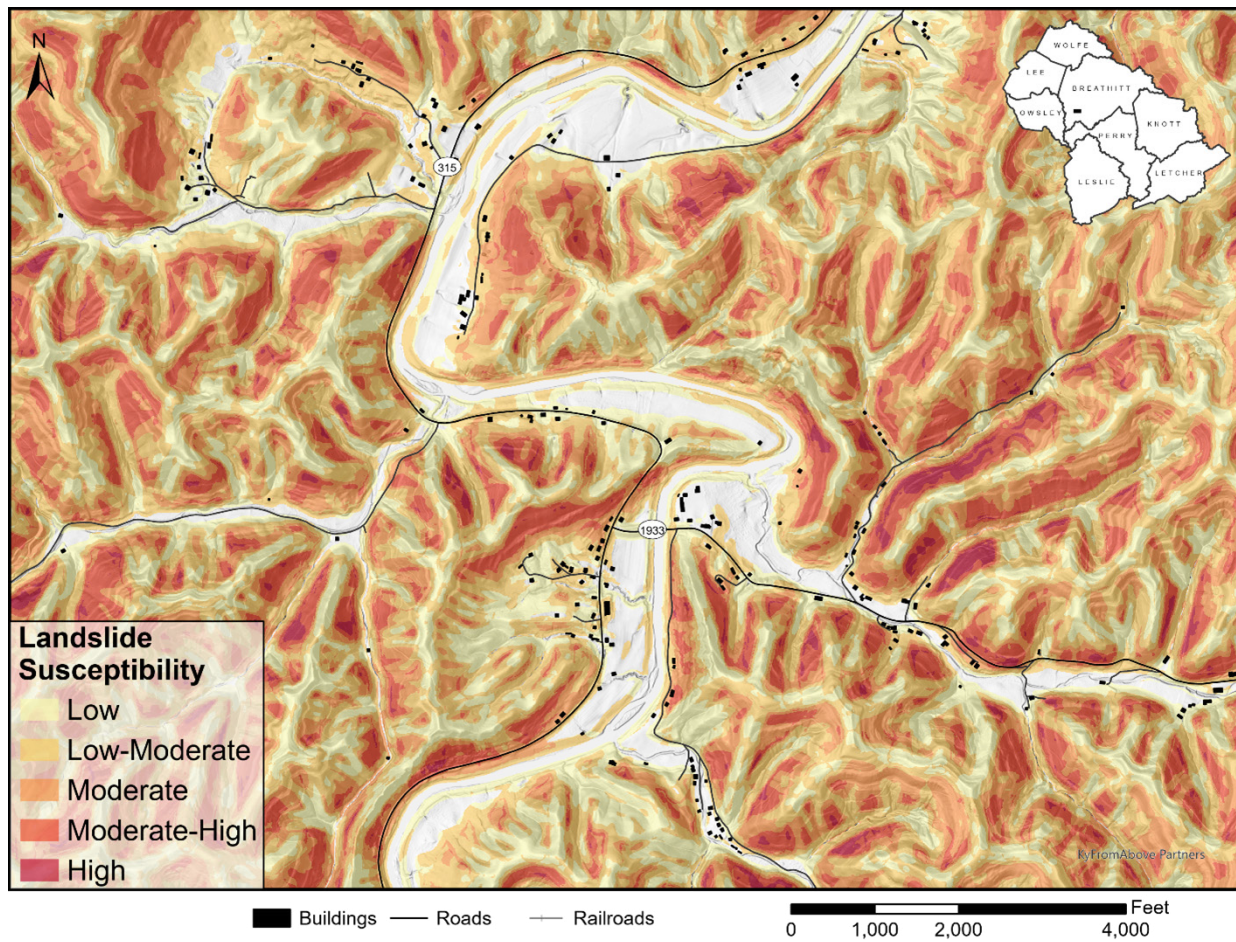


Figure 11. Landslide susceptibility in part of Breathitt County. The location of this area within Breathitt County is delineated by the black rectangle in the upper right map of the Kentucky River Area Development District.

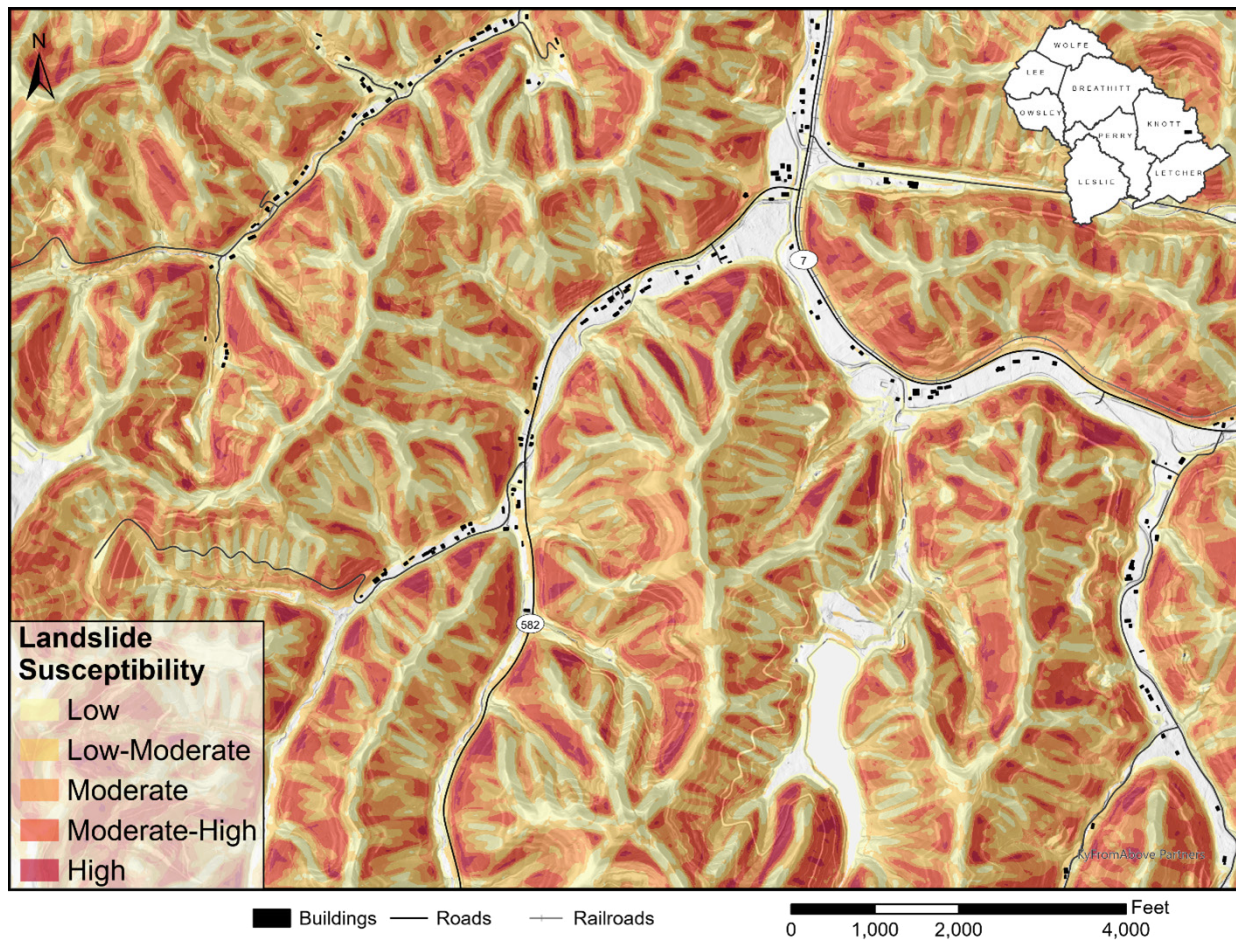


Figure 12. Landslide susceptibility in part of Knott County. The location of this area within Knott County is delineated by the black rectangle in the upper right map of the Kentucky River Area Development District.

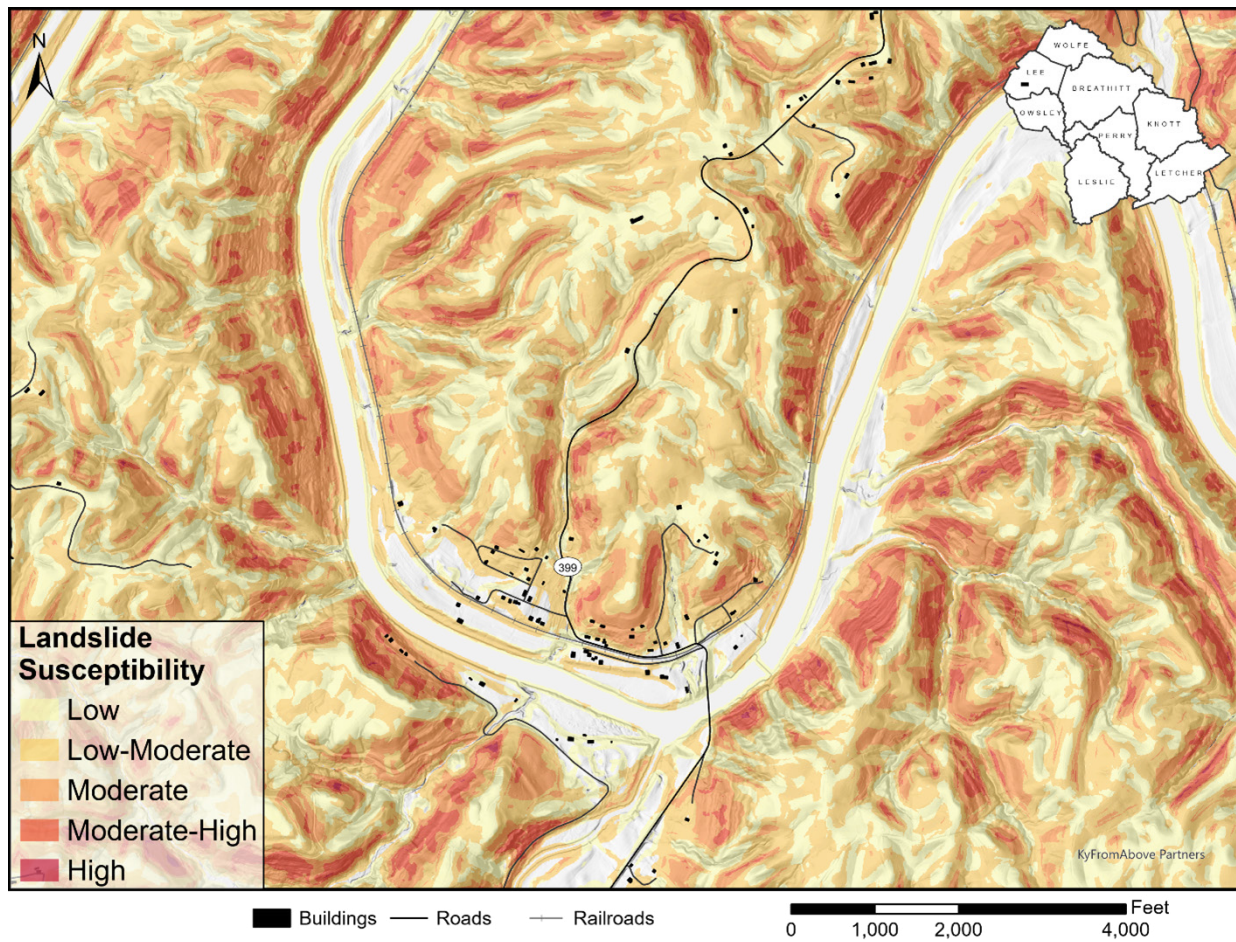


Figure 13. Landslide susceptibility in part of Lee County. The location of this area within Lee County is delineated by the black rectangle in the upper right map of the Kentucky River Area Development District.

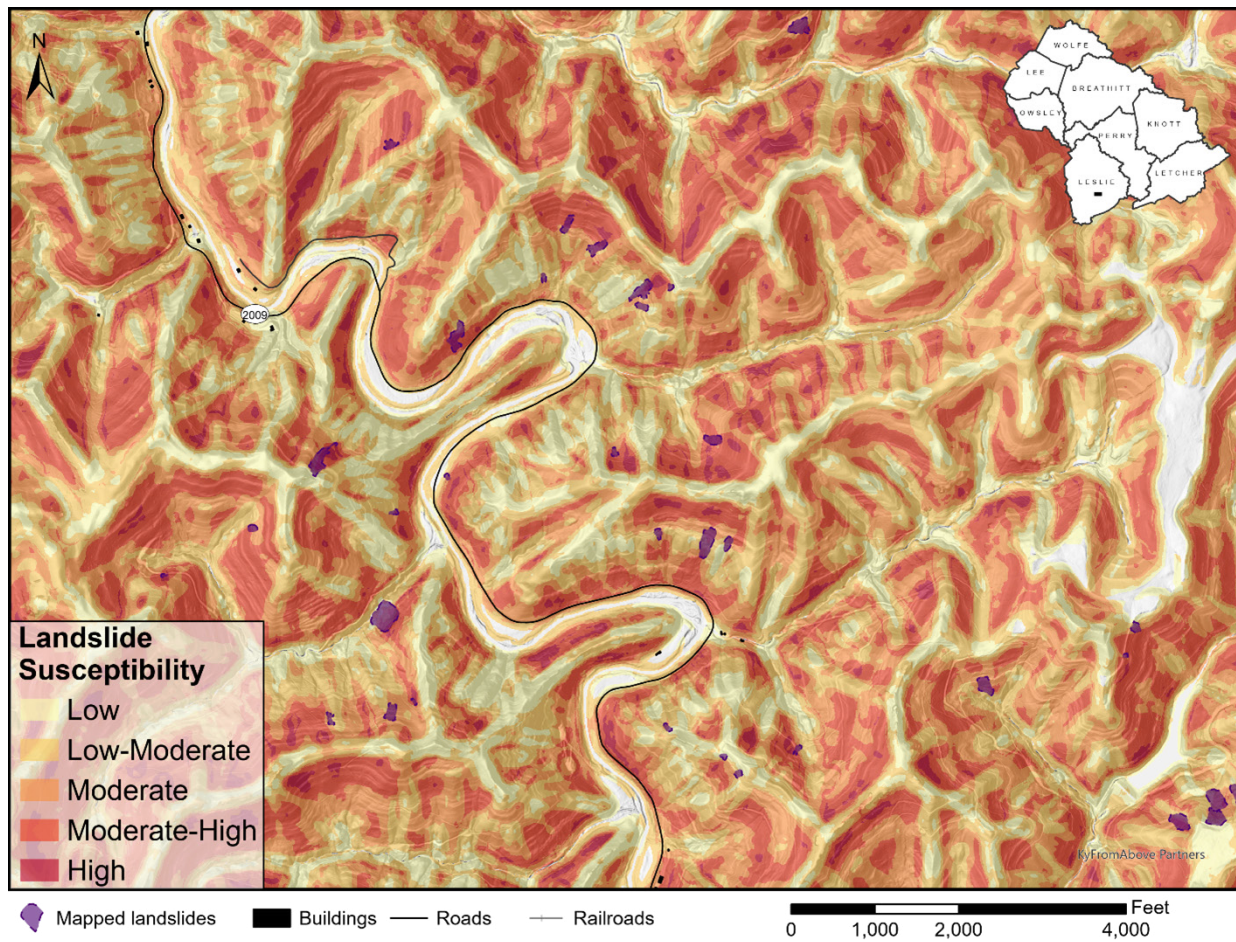


Figure 14. Landslide susceptibility in part of Leslie County. The location of this area within Leslie County is delineated by the black rectangle in the upper right map of the Kentucky River Area Development District.

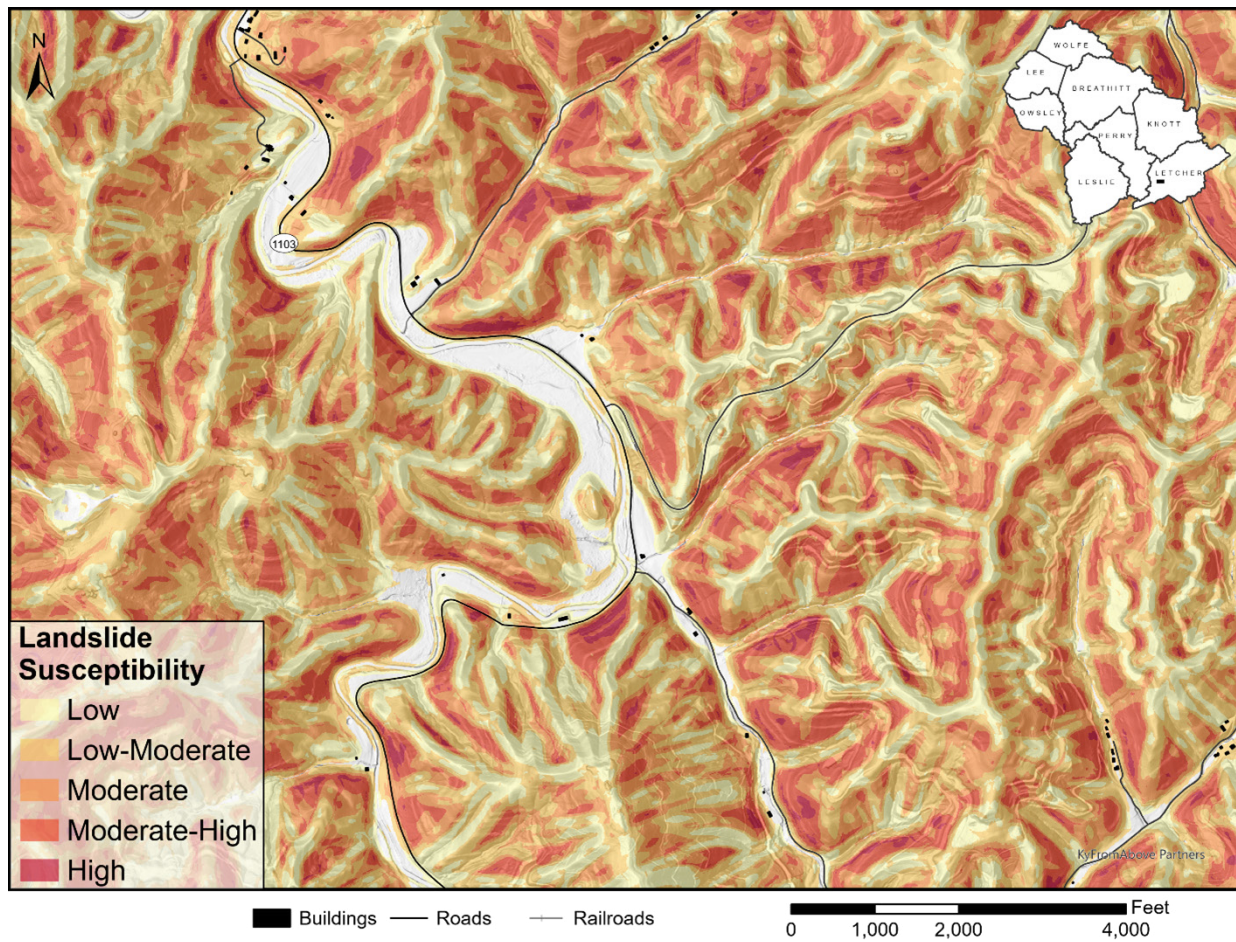


Figure 15. Landslide susceptibility in part of Letcher County. The location of this area within Letcher County is delineated by the black rectangle in the upper right map of the Kentucky River Area Development District.

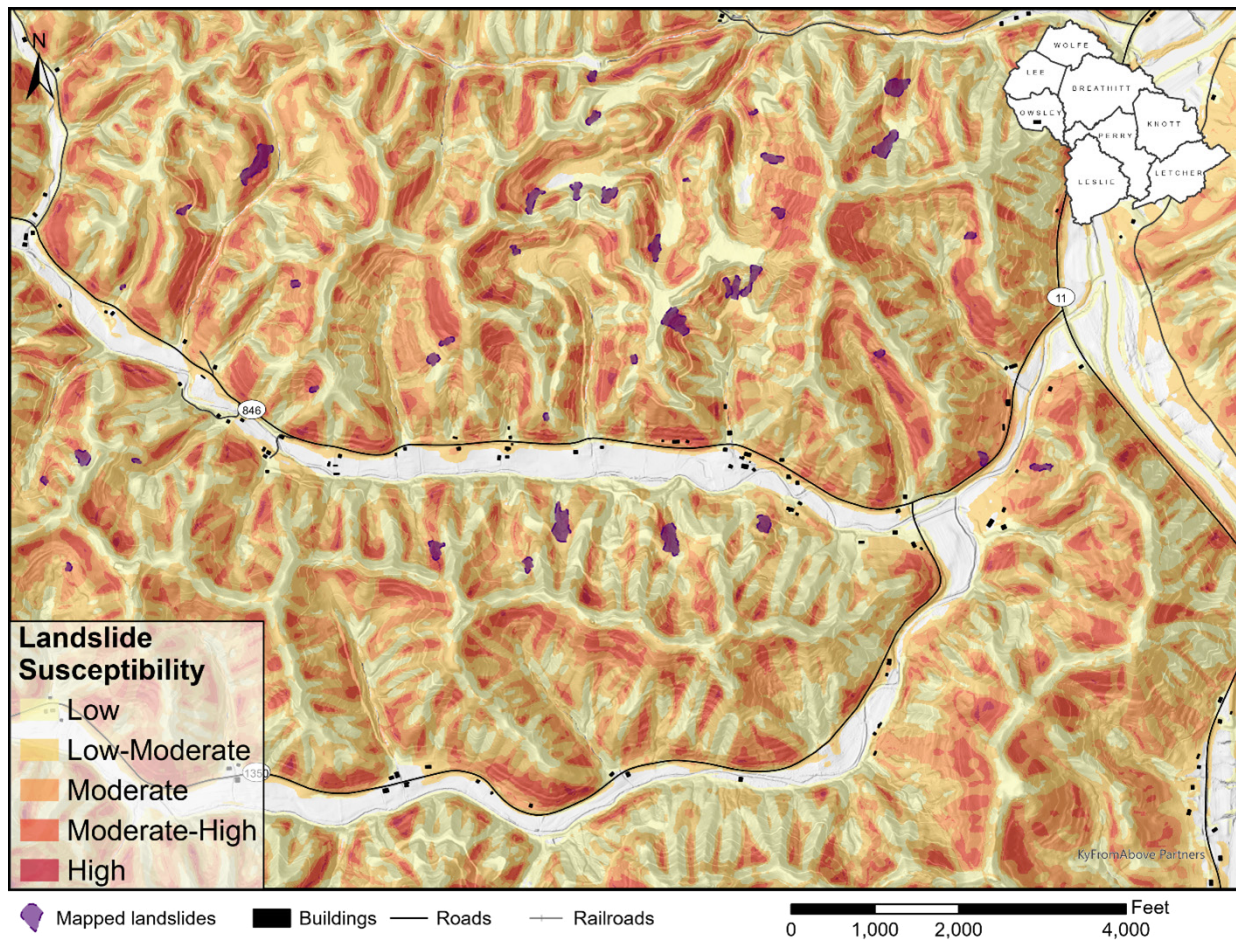


Figure 16. Landslide susceptibility in part of Owsley County. The location of this area within Owsley County is delineated by the black rectangle in the upper right map of the Kentucky River Area Development District.

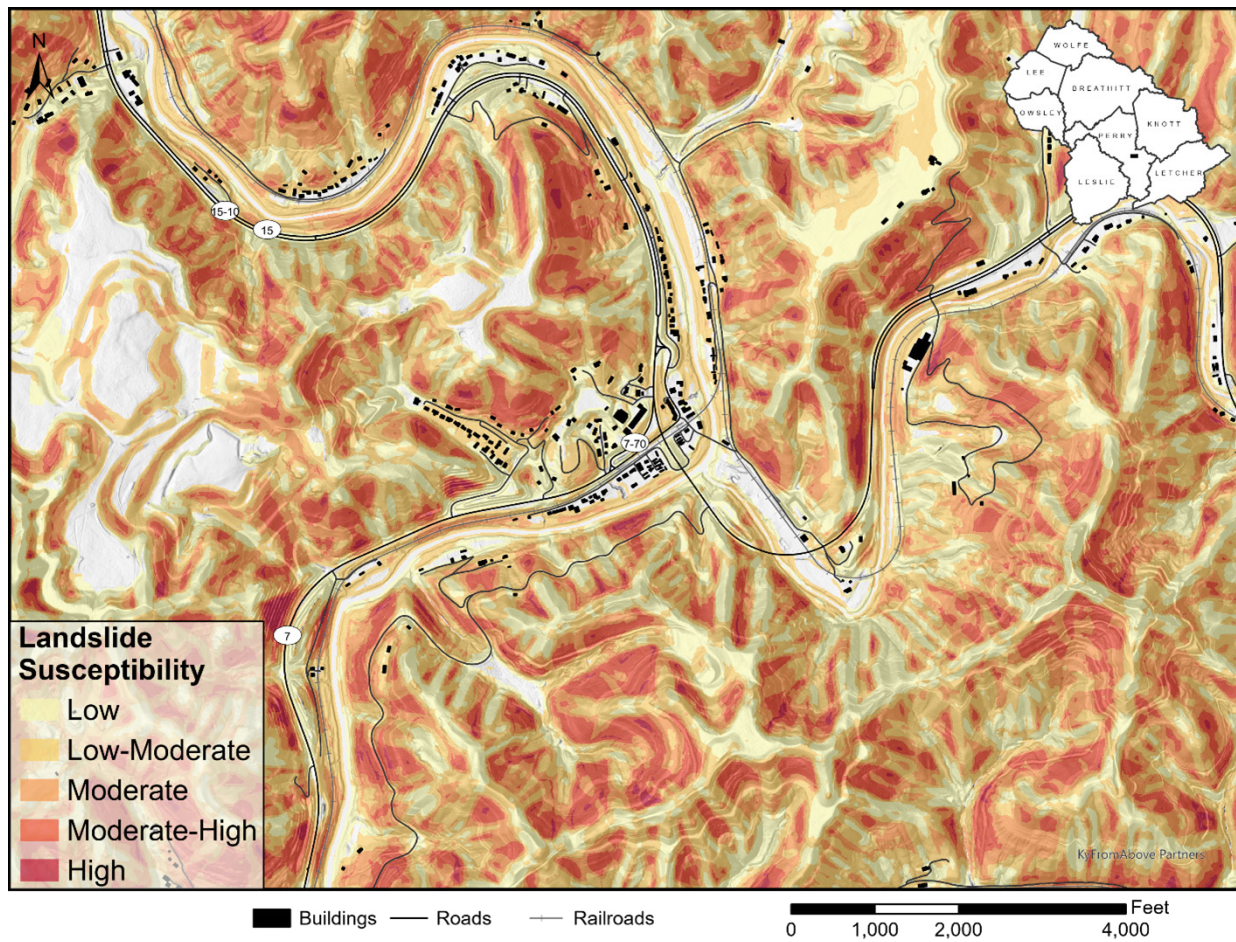


Figure 17. Landslide susceptibility in part of Perry County. The location of this area within Perry County is delineated by the black rectangle in the upper right map of the Kentucky River Area Development District.

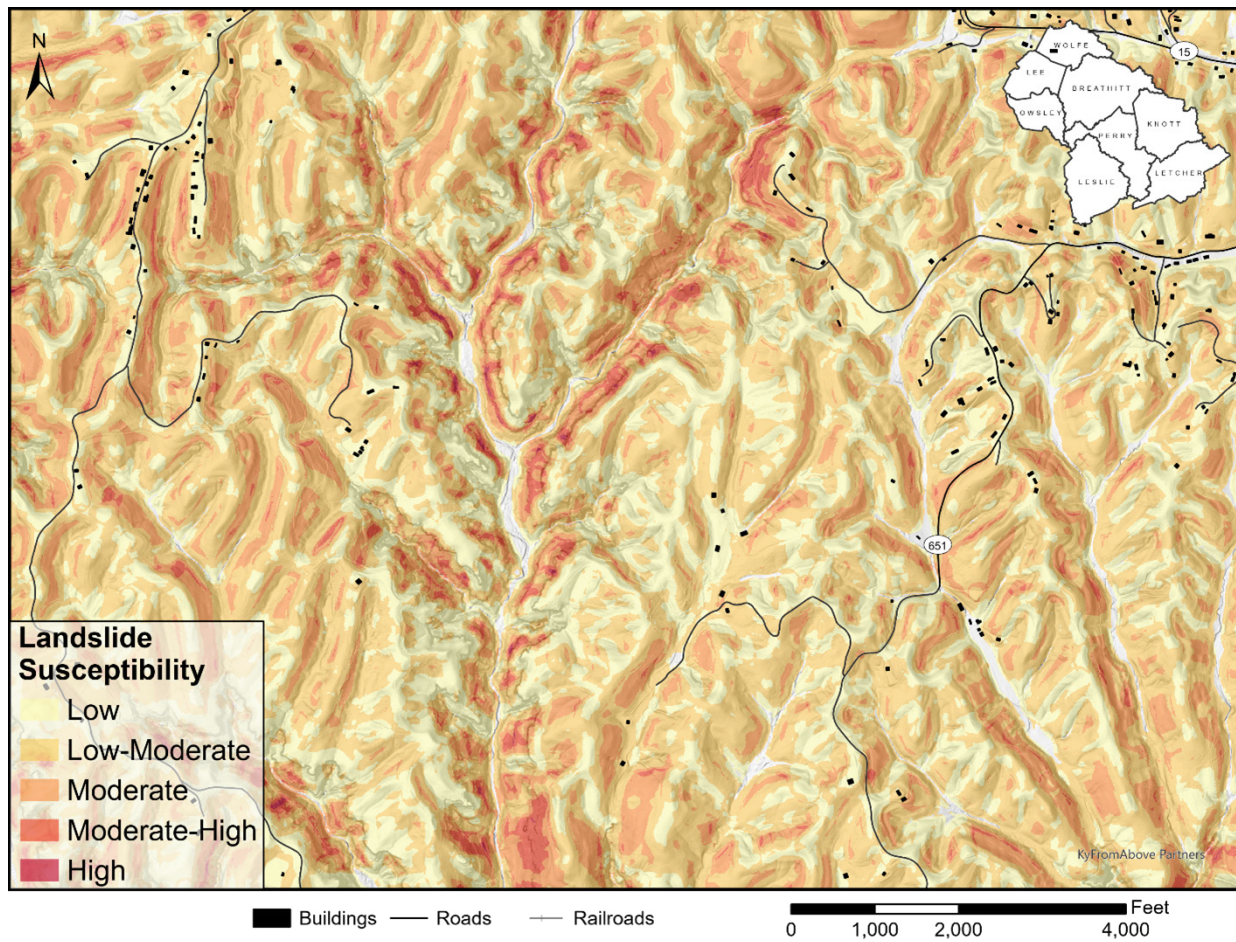


Figure 18. Landslide susceptibility in part of Wolfe County. The location of this area within Wolfe County is delineated by the black rectangle in the upper right map of the Kentucky River Area Development District.

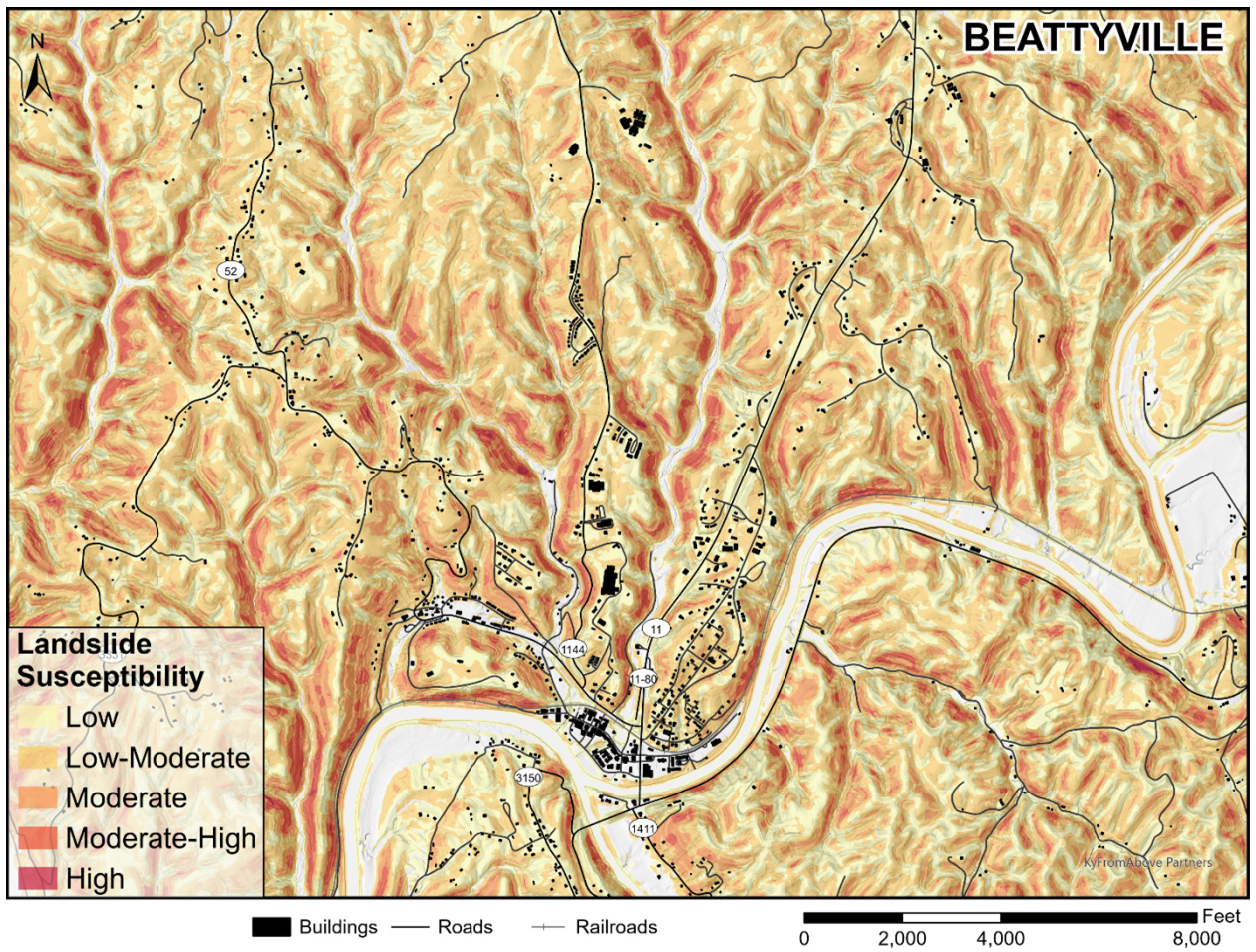


Figure 19. Landslide susceptibility in Beattyville, Lee County.

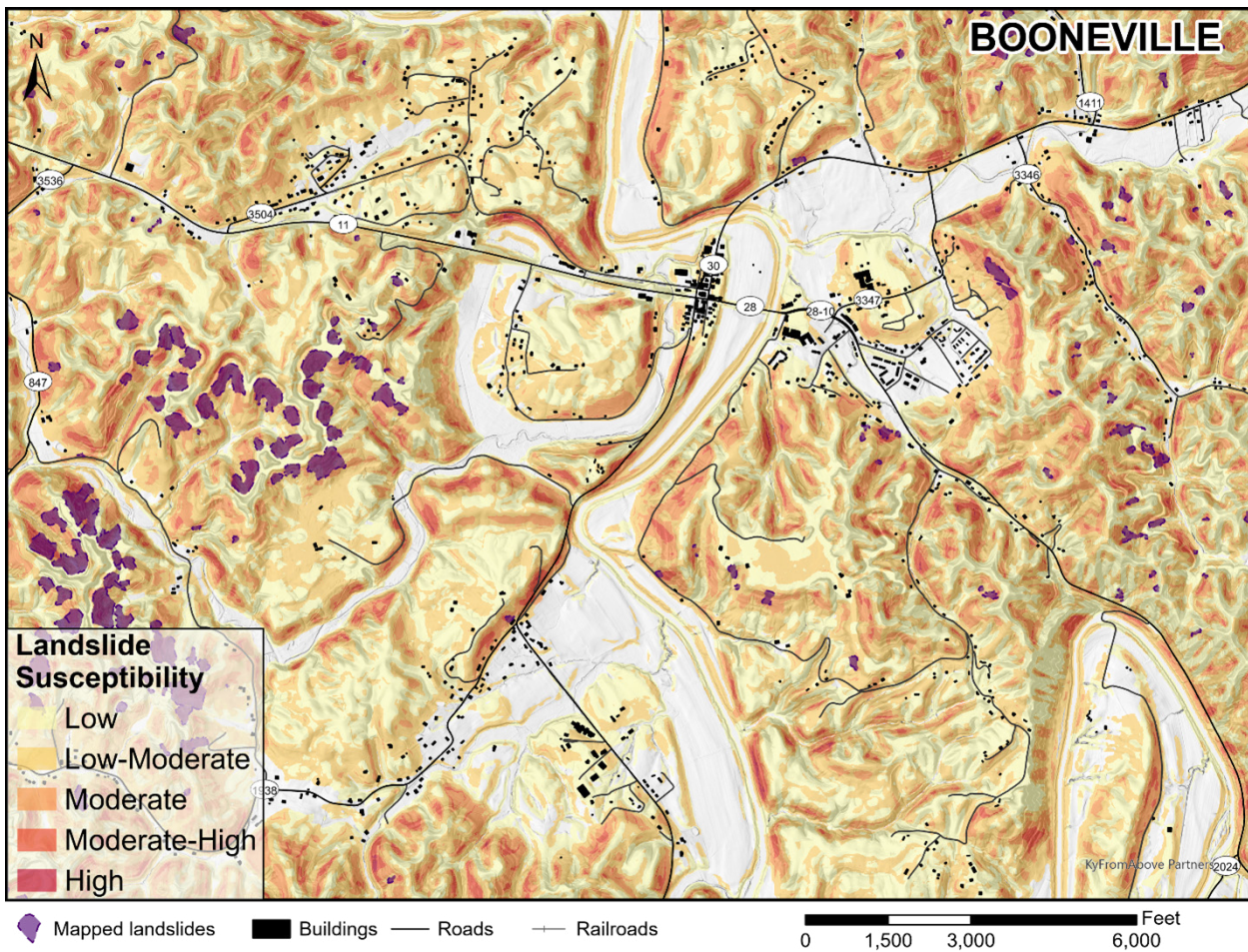


Figure 20. Landslide susceptibility in Booneville, Owsley County.

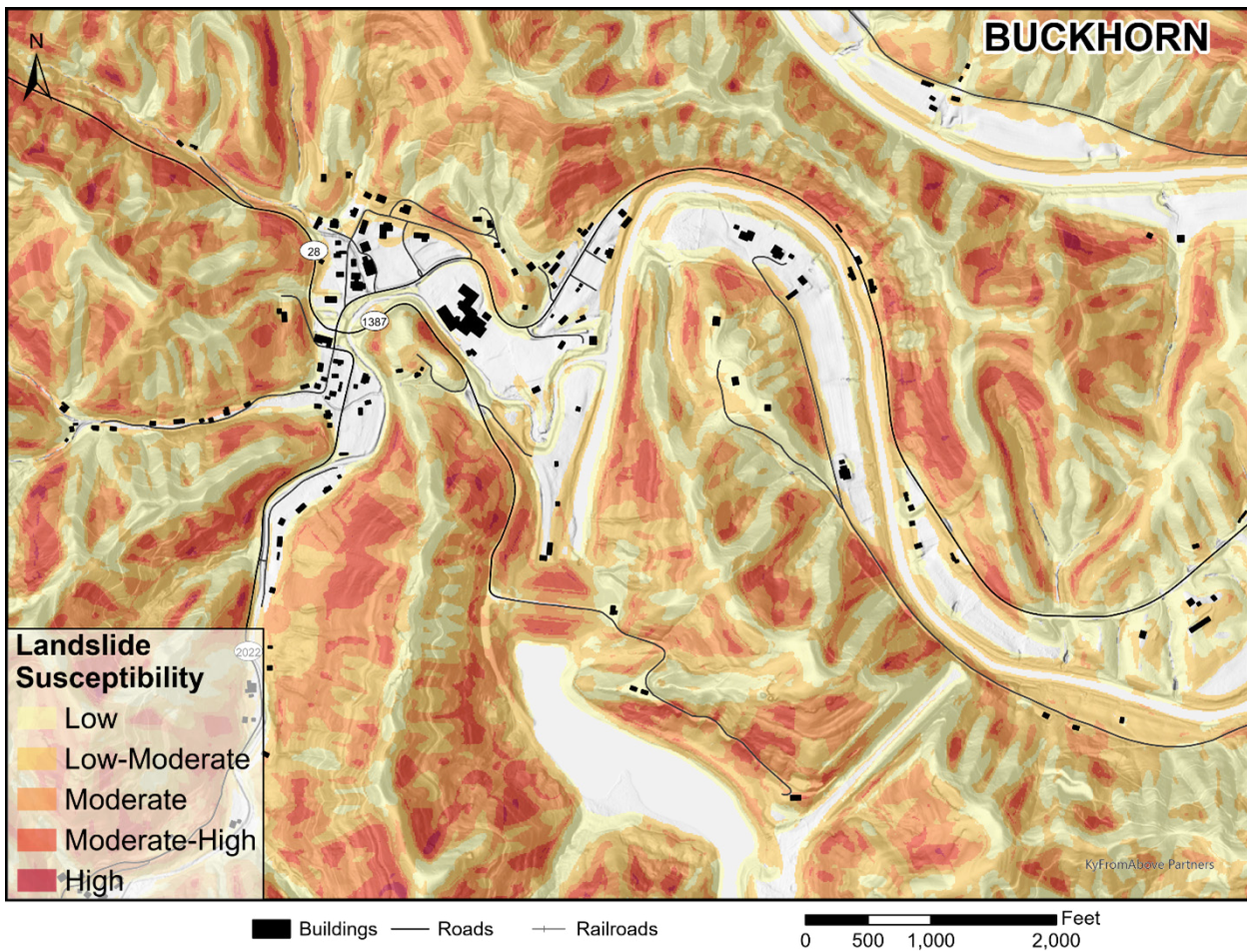


Figure 21. Landslide susceptibility in Buckhorn, Perry County.

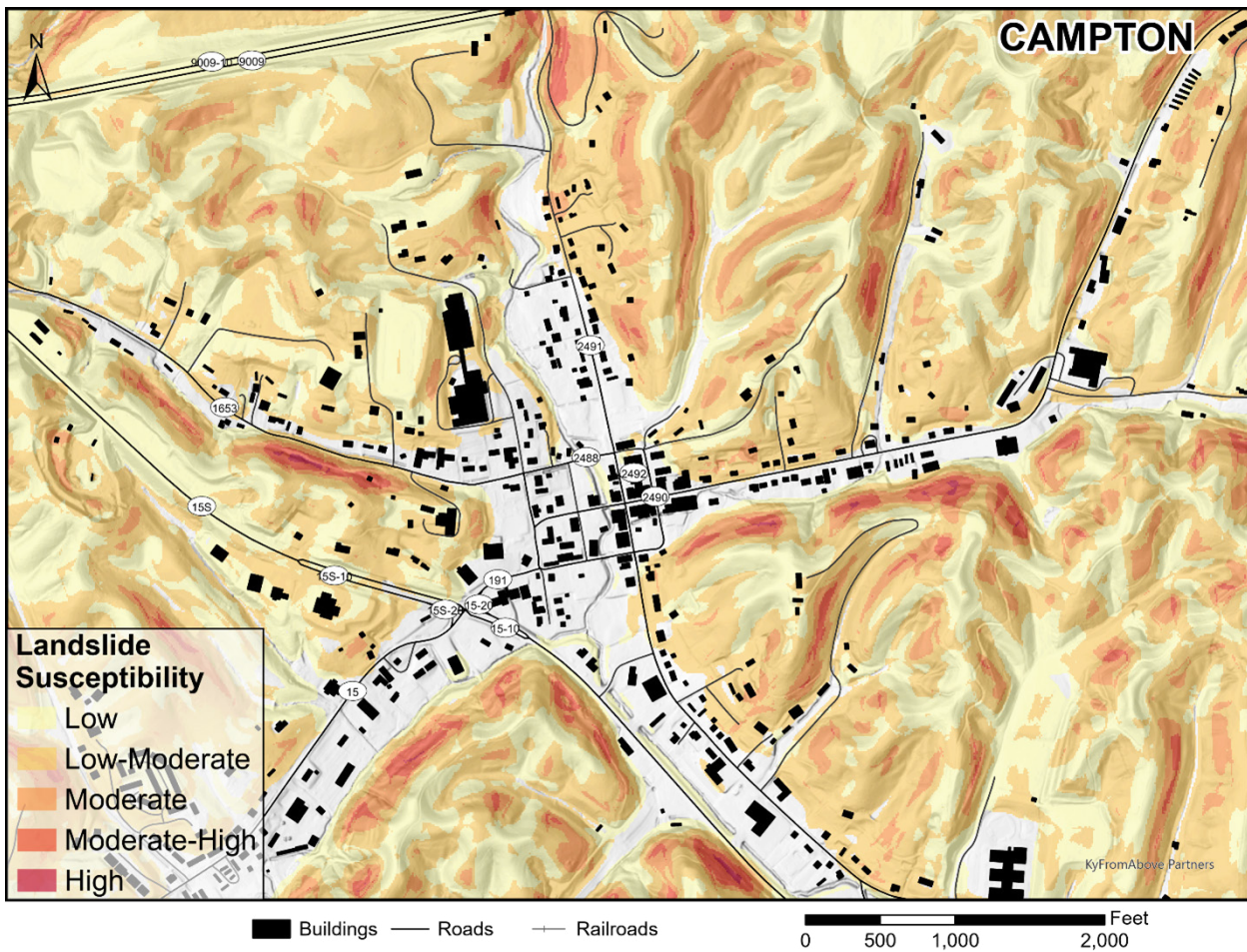


Figure 22. Landslide susceptibility in Campton, Wolfe County.

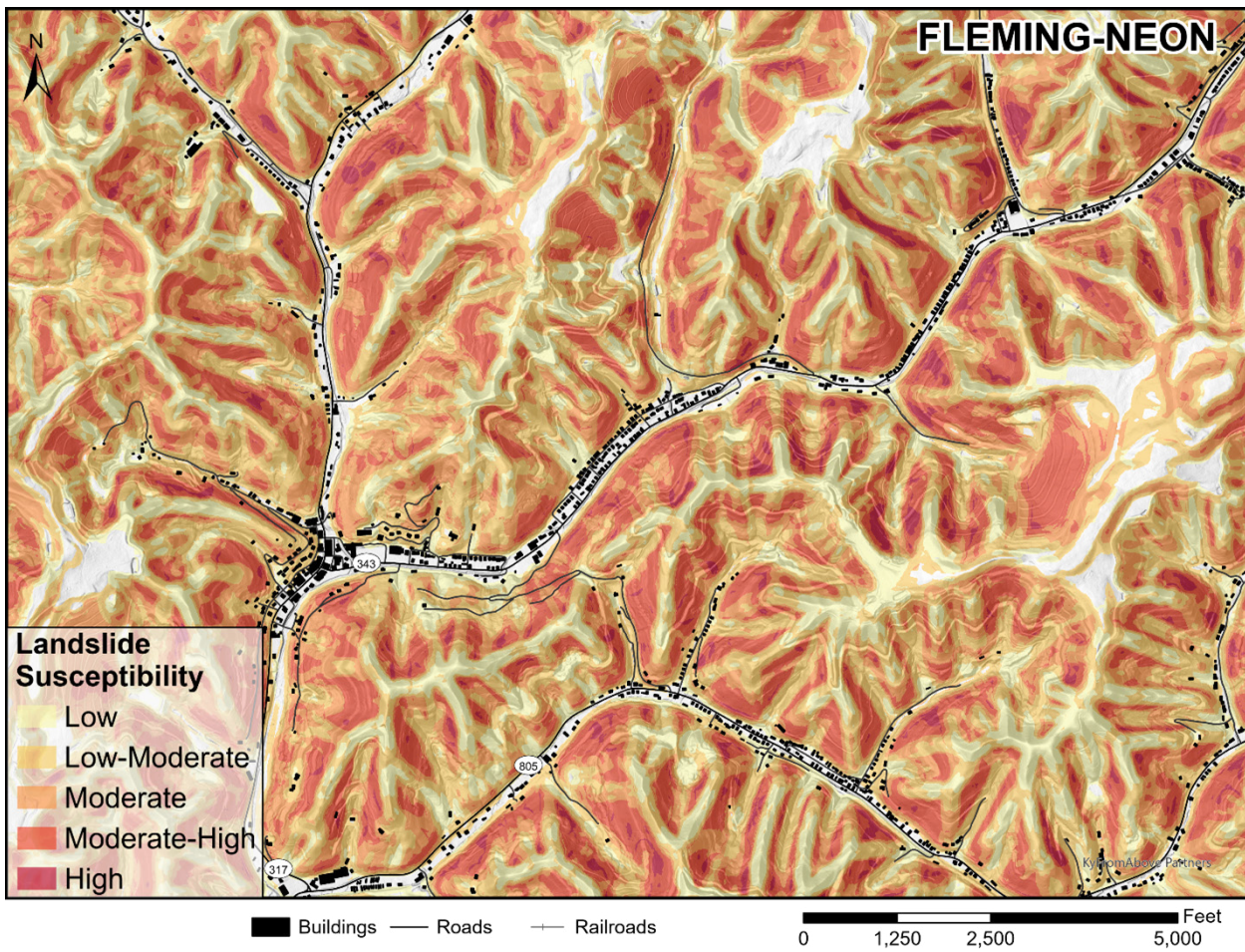


Figure 23. Landslide susceptibility in Fleming-Neon, Letcher County.

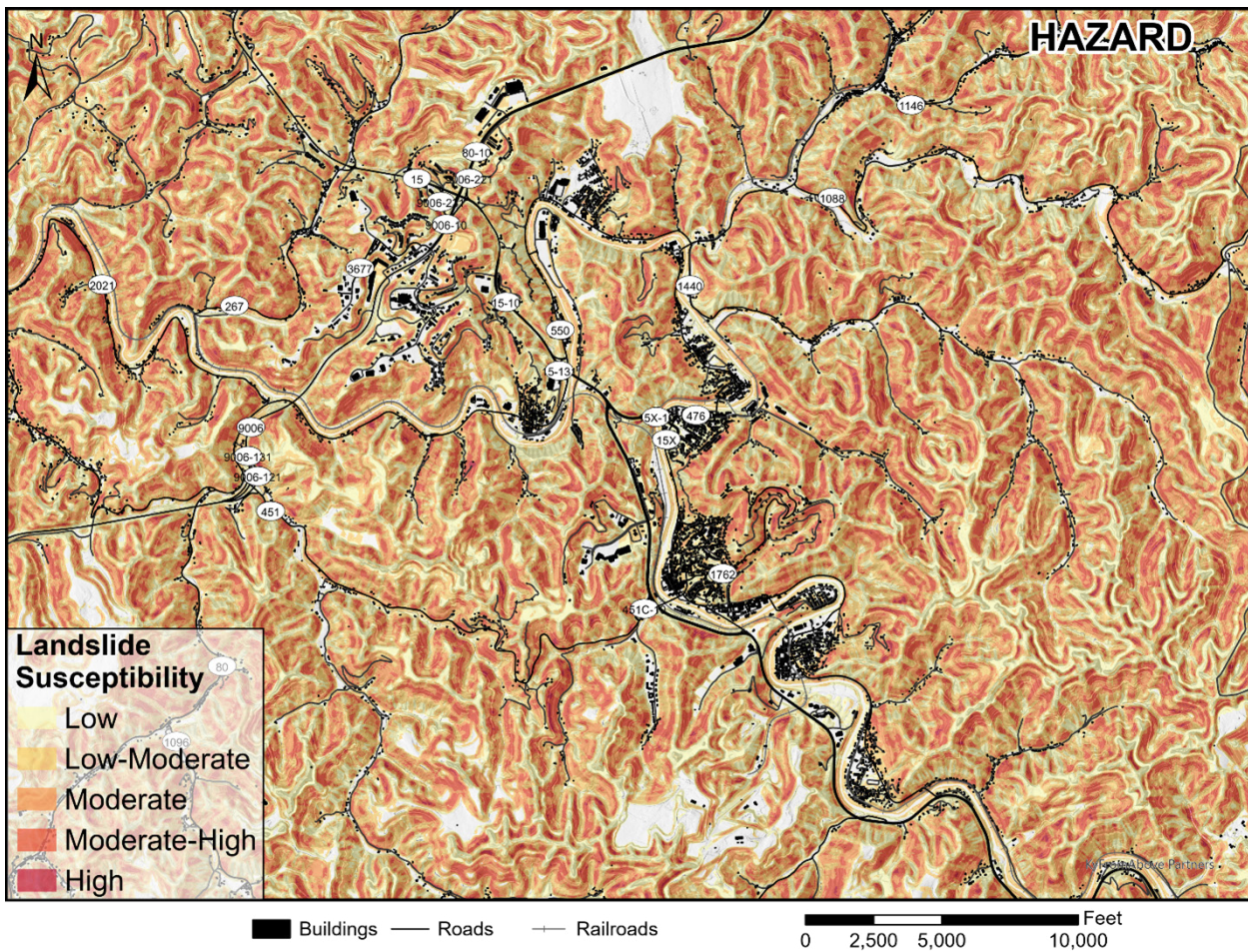


Figure 24. Landslide susceptibility in Hazard, Perry County.

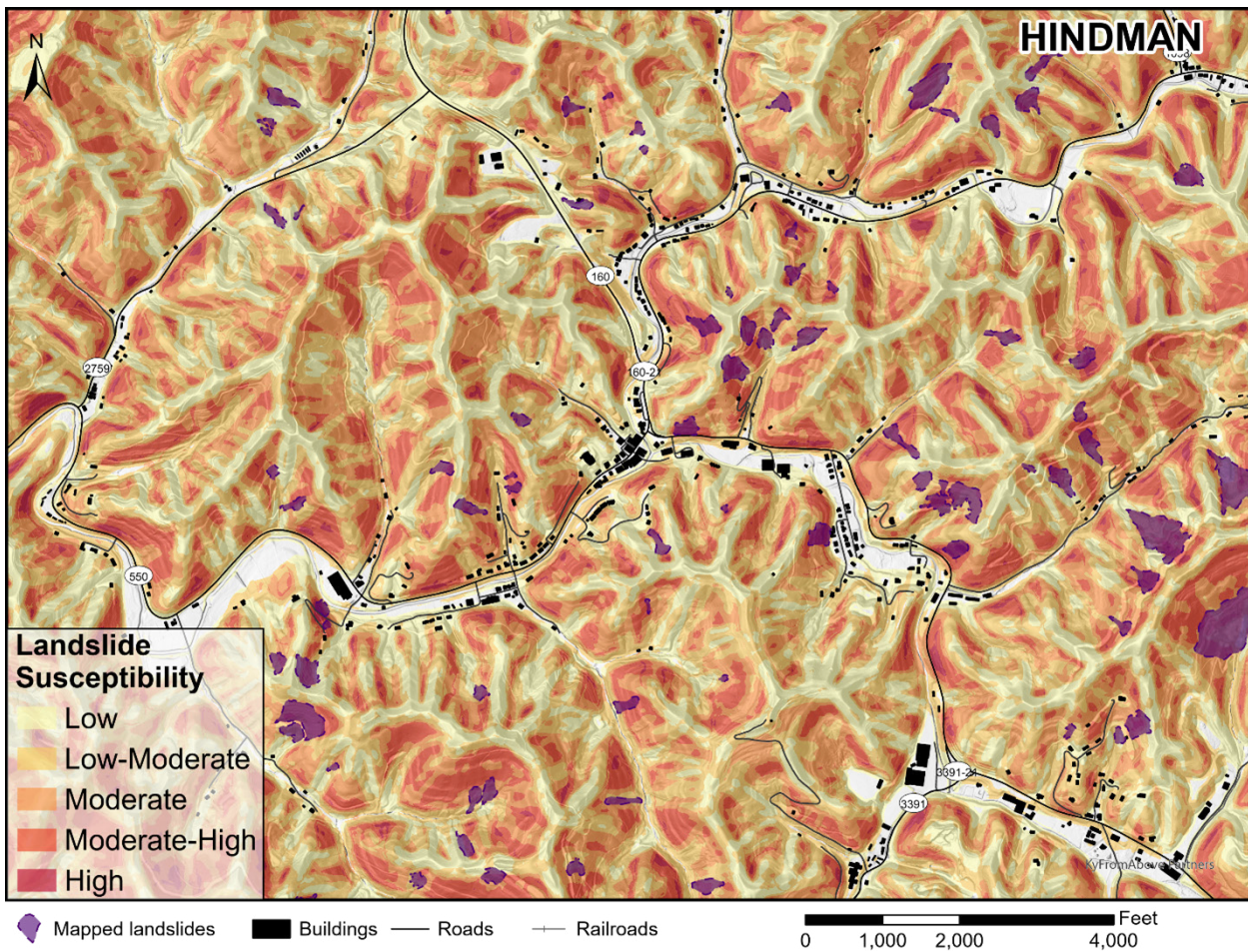


Figure 25. Landslide susceptibility in Hindman, Knott County.

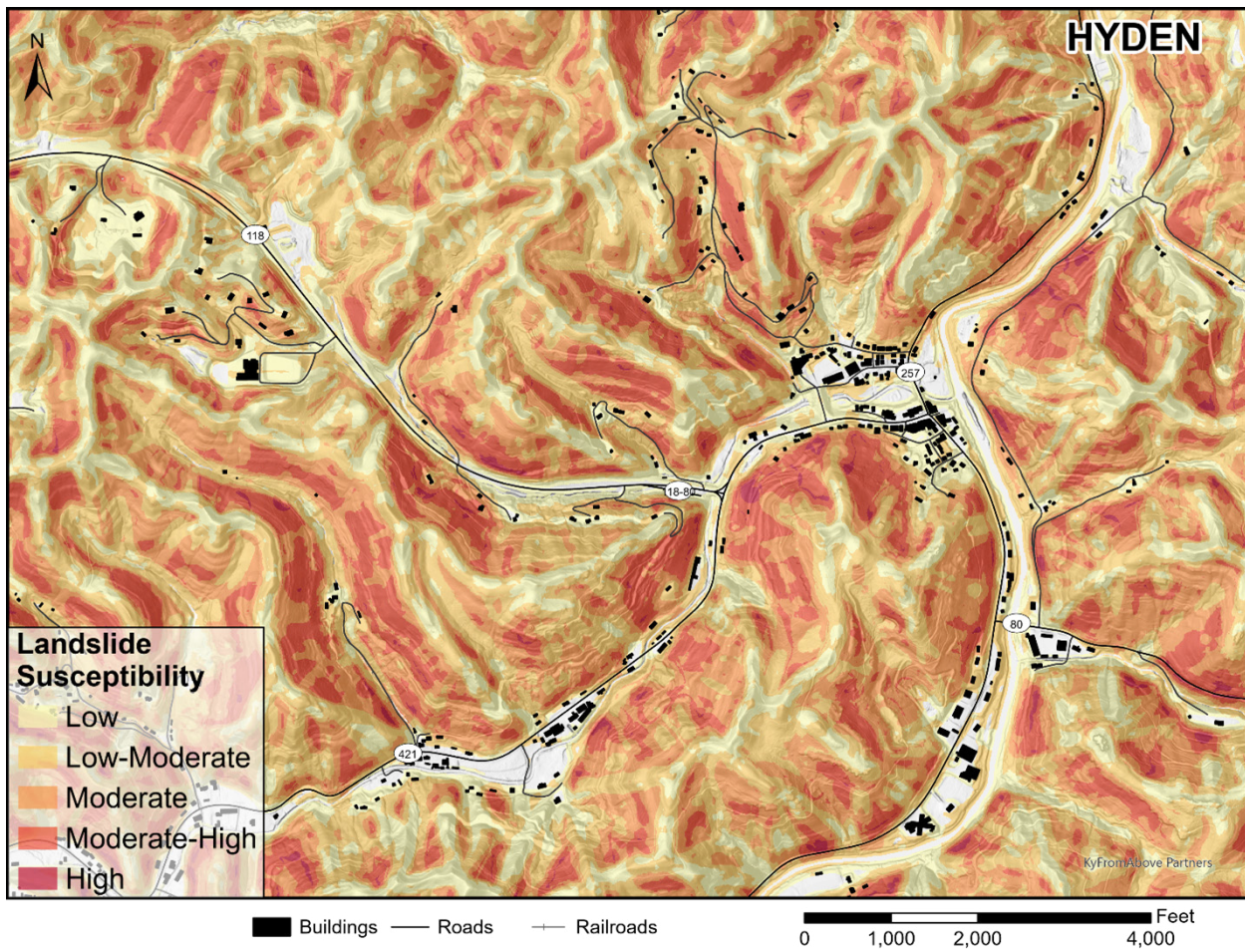


Figure 26. Landslide susceptibility in Hyden, Leslie County.

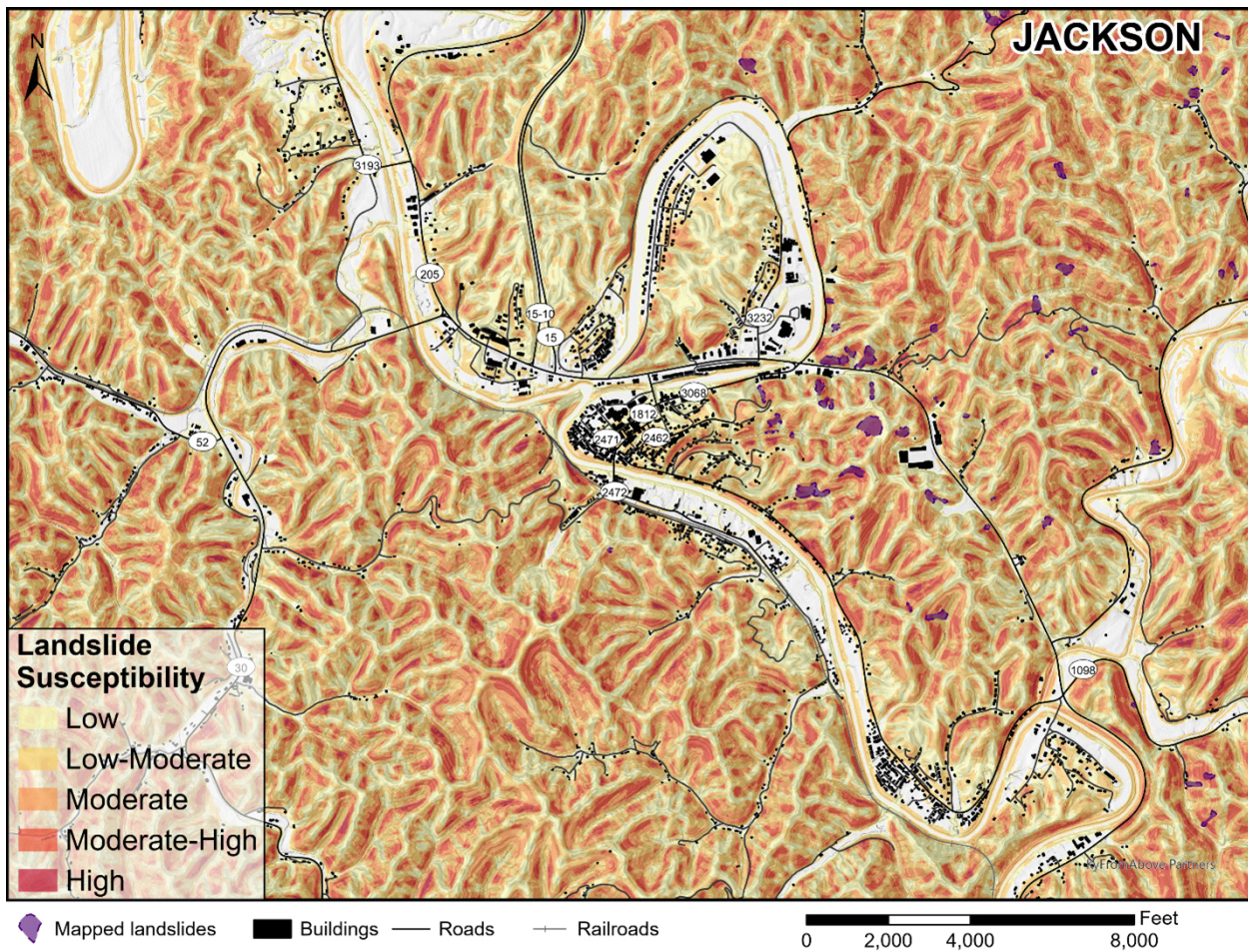


Figure 27. Landslide susceptibility in Jackson, Breathitt County.

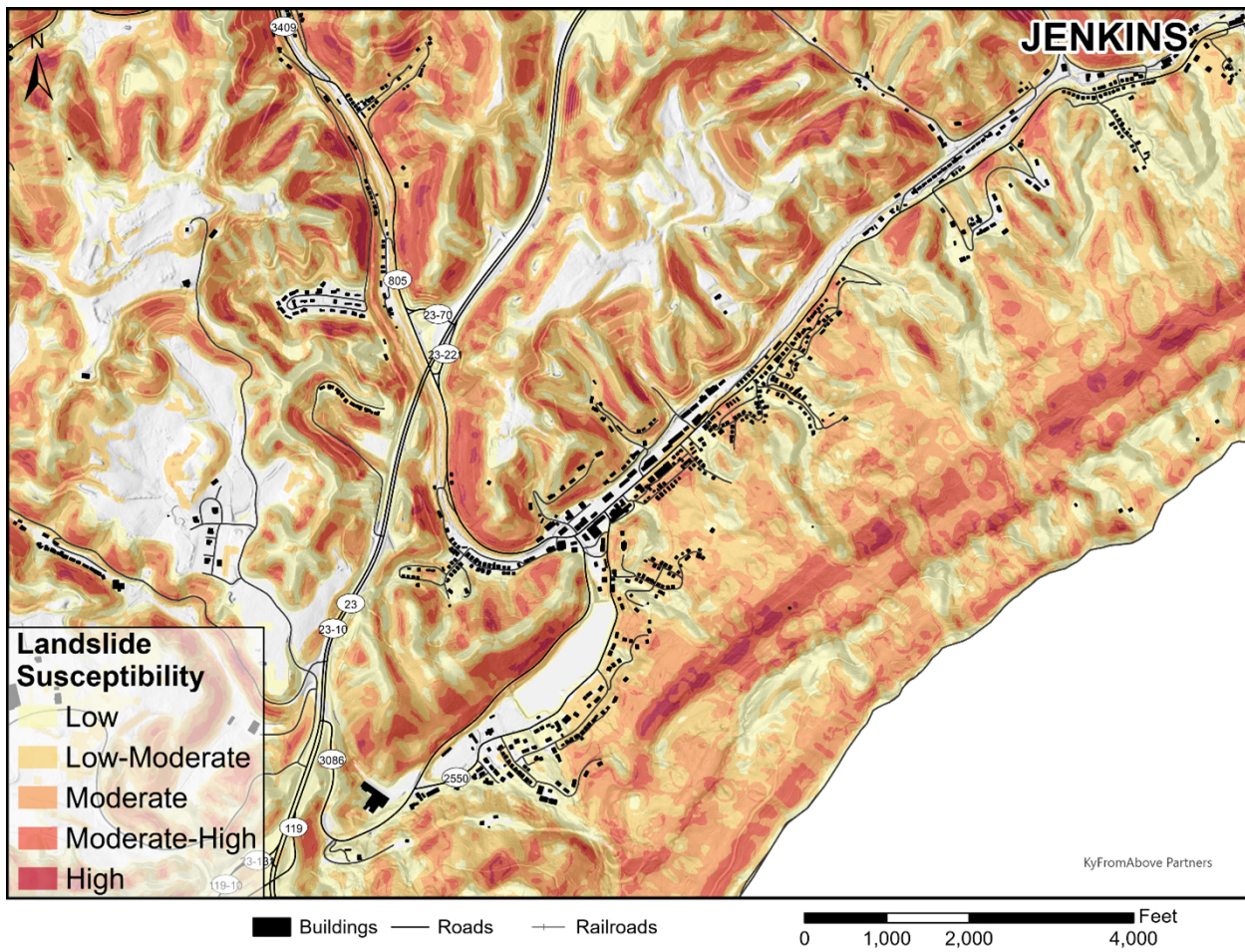


Figure 28. Landslide susceptibility in part of Jenkins, Letcher County.

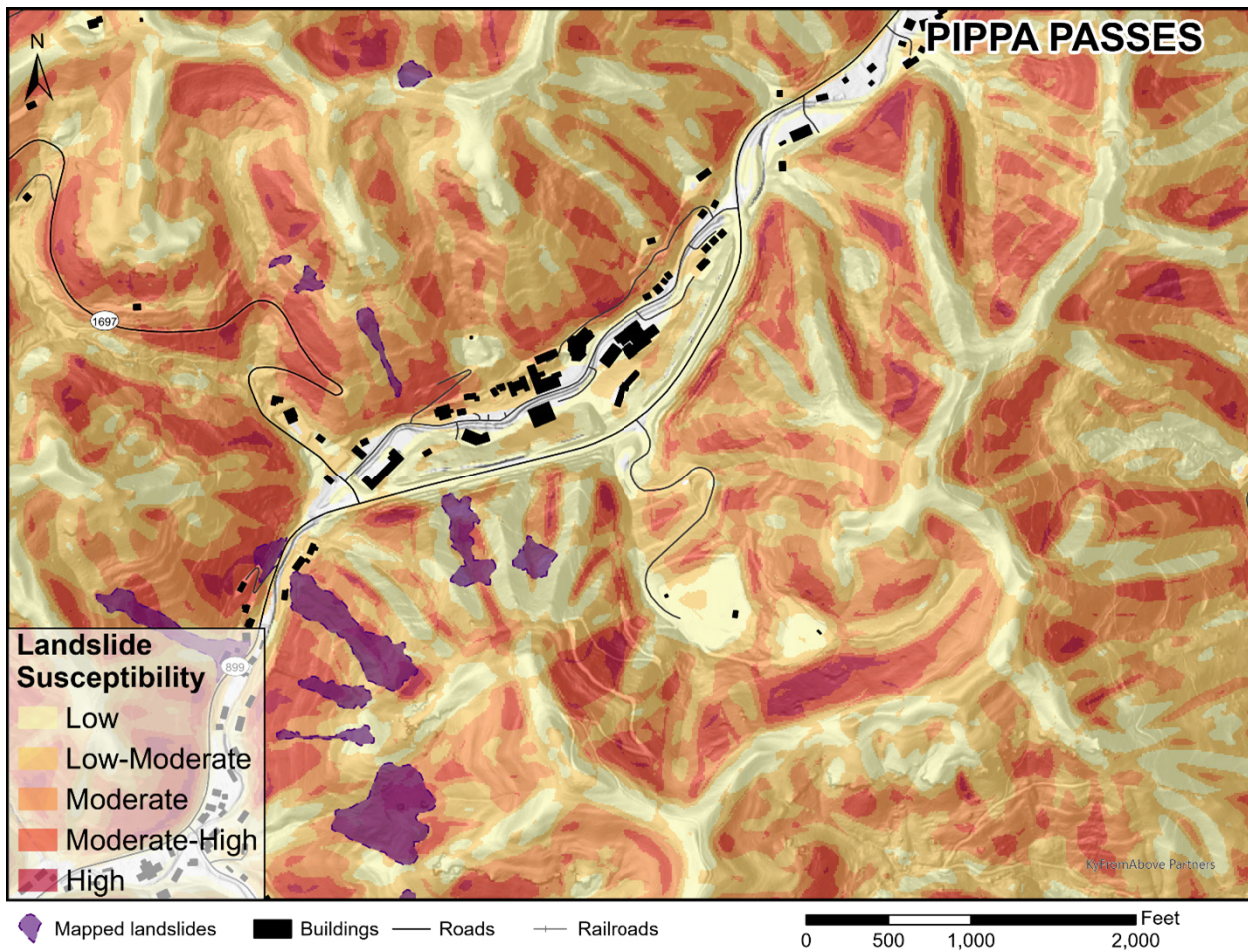


Figure 29. Landslide susceptibility in Pippa Passes, Knott County.

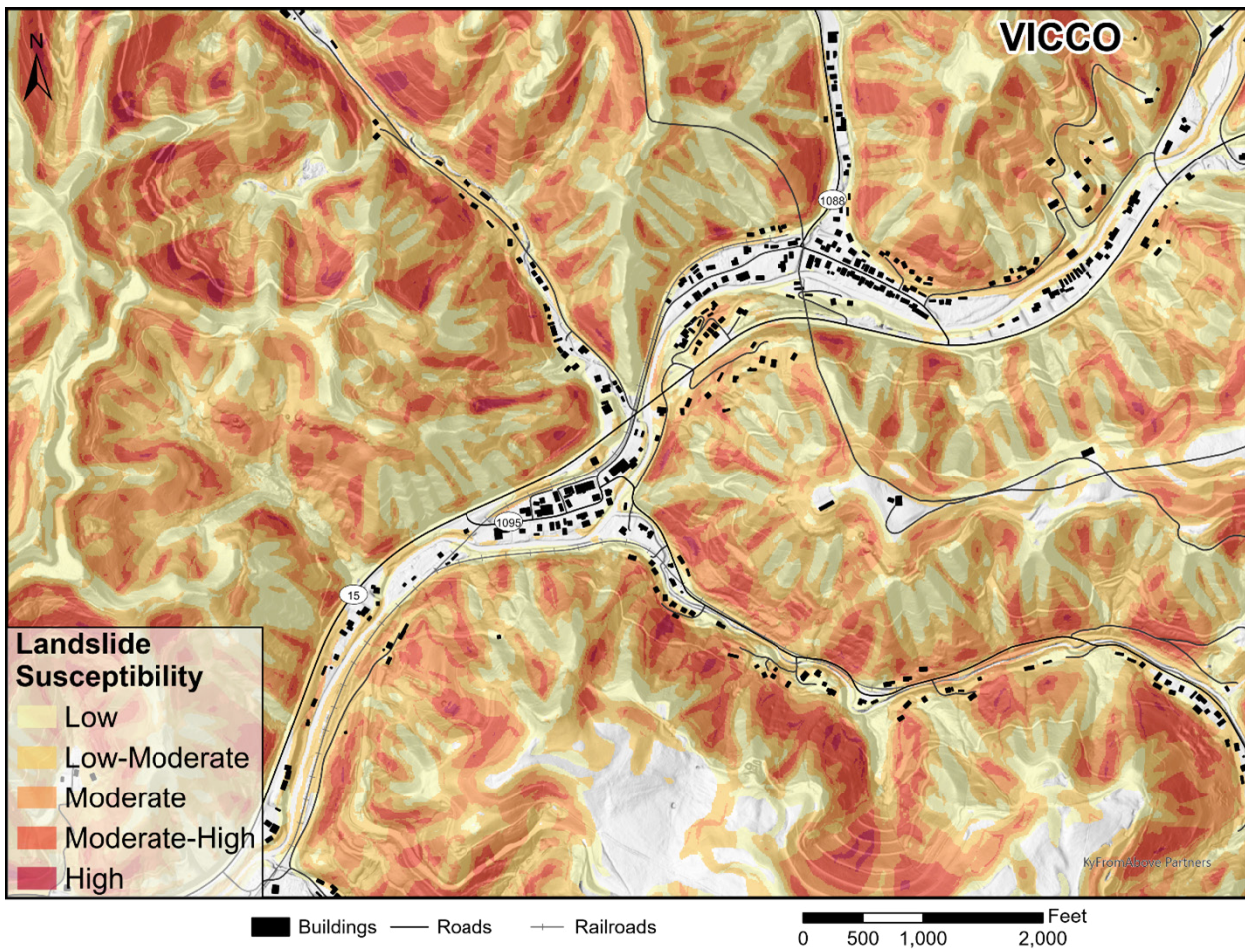


Figure 30. Landslide susceptibility in Vicco, Perry County.

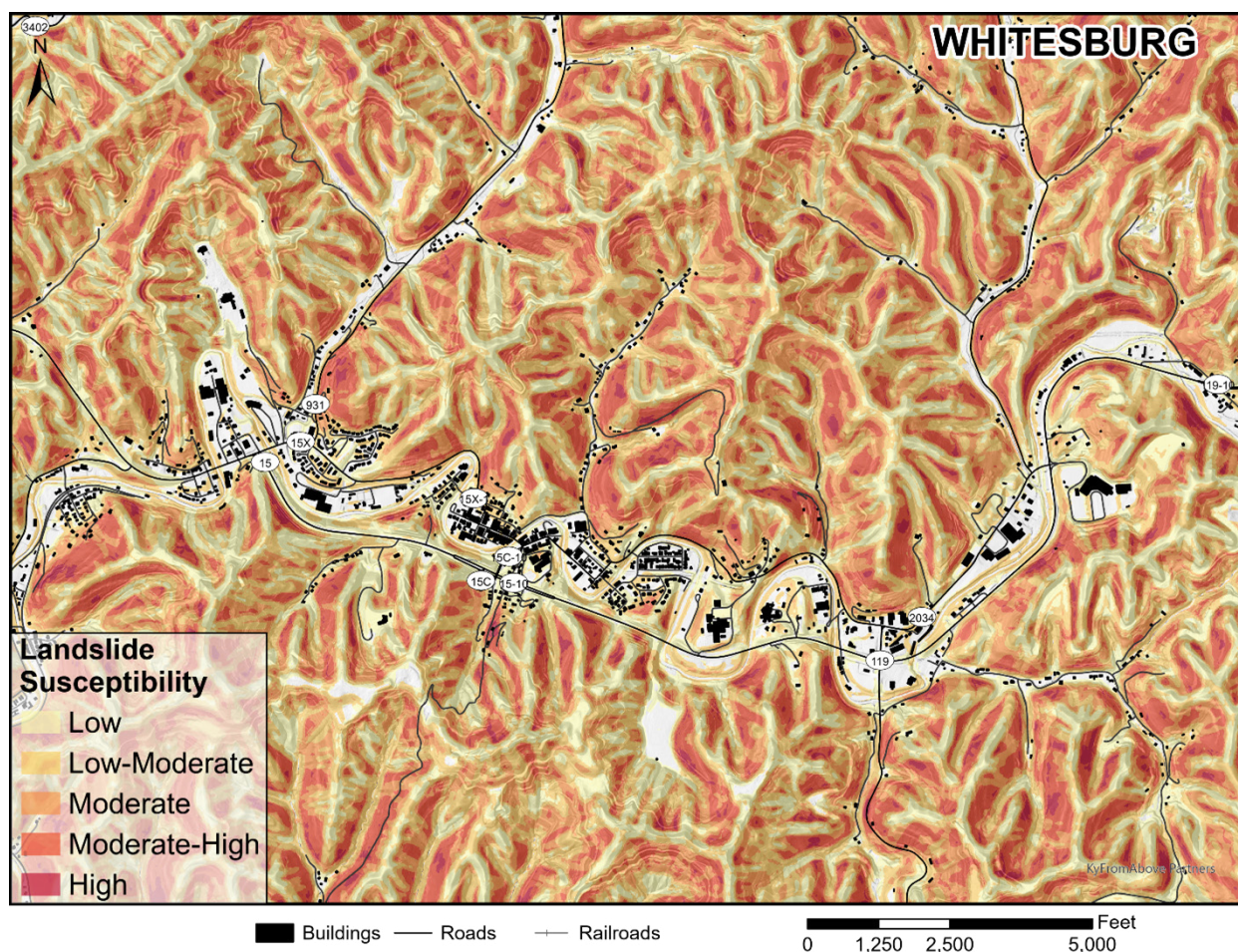


Figure 31. Landslide susceptibility in Whitesburg, Letcher County.

Susceptibility Map Validation

Landslide susceptibility models can be evaluated for general predictive success by locating recent landslides that occurred after DEM and map creation. As of May 2025, 490 landslide events are recorded in the historical landslide inventory, including those associated with the February 2025 extreme rainfall event. These point locations were buffered 123 ft

to approximate landslide area extents. The model intersections are shown in Table 8. Nearly half the landslide points (237) have a maximum value of moderate-high landslide susceptibility within the approximate landslide area.

Below are examples of model results compared to landslides that occurred after susceptibility model and map creation (Figs. 32–35).

Table 8. Intersections with historical point inventory landslides that occurred after the digital elevation model used for the landslide susceptibility model was generated.

Susceptibility class	Number of inventory landslides	Percentage of inventory
Low and low-moderate	38	7.76
Moderate	122	24.90
Moderate-high	237	48.37
High	93	18.98

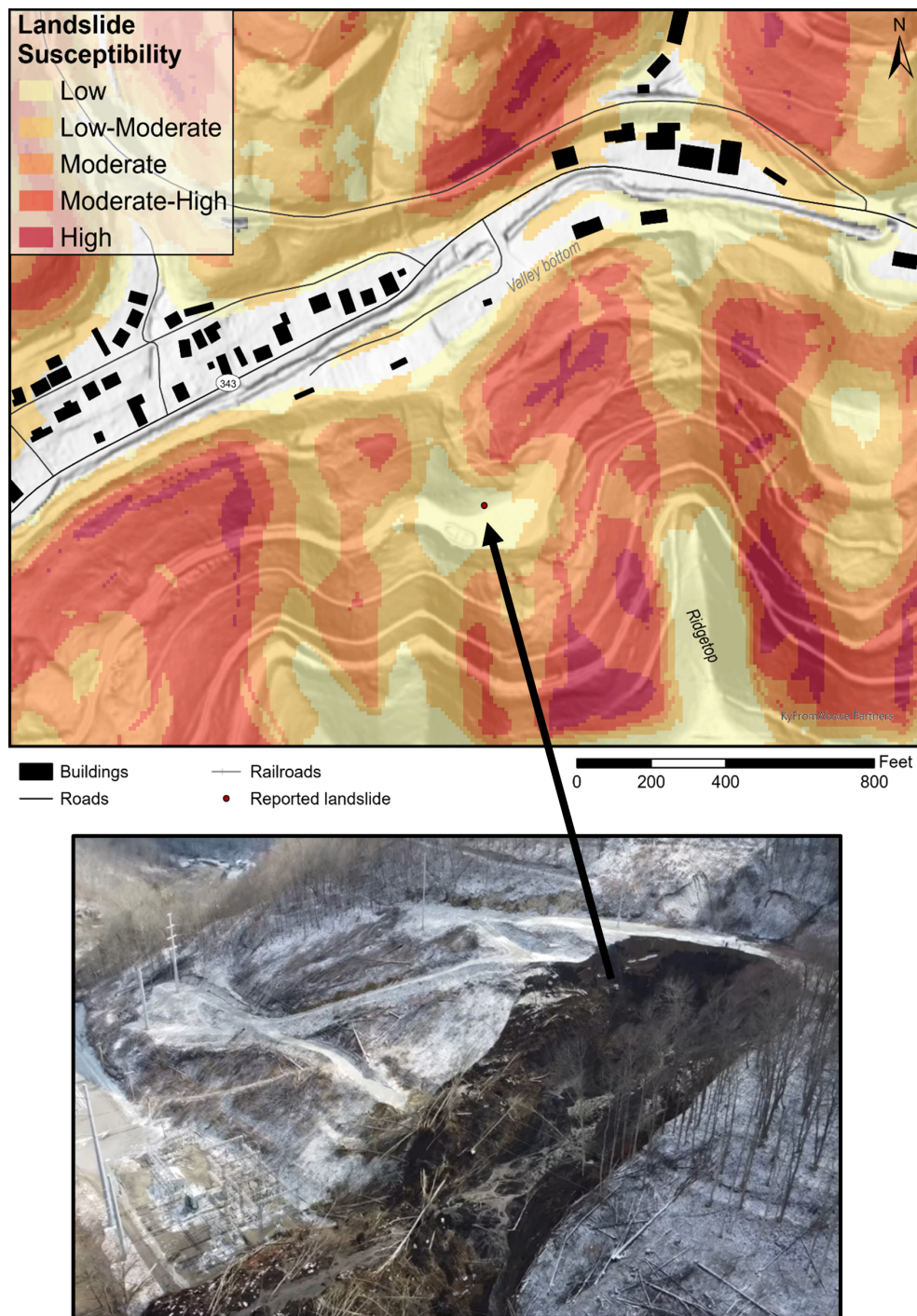


Figure 32. Landslide susceptibility map and image of a landslide that impacted Fleming-Neon, Letcher County, in February 2025. Note that the landslide initiated within a low susceptibility class, but this terrain is highly modified due to mining and other slope disturbances.

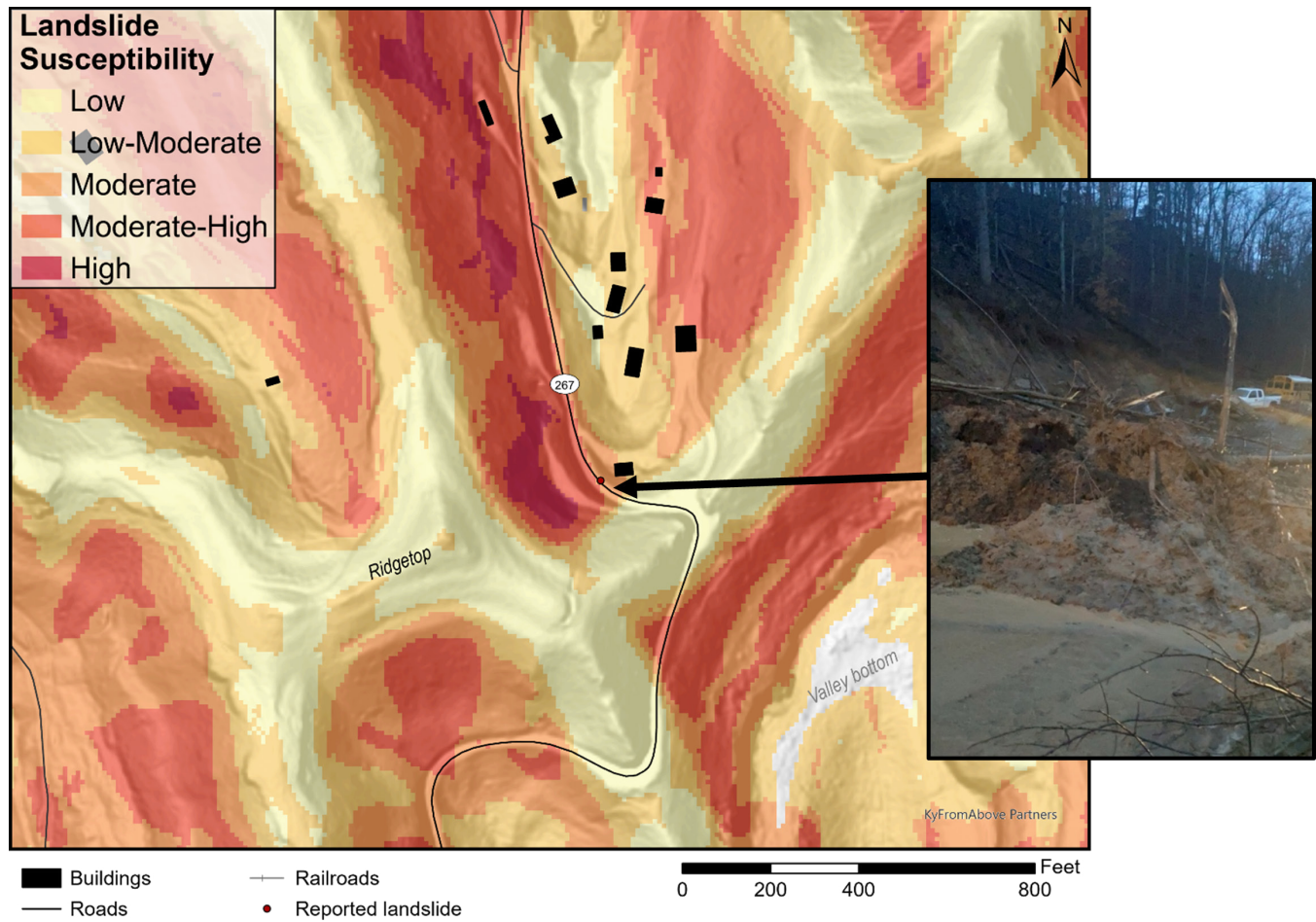


Figure 33. Landslide susceptibility map and image of a landslide that impacted KY 267, north of Hazard, Perry County, in 2025.

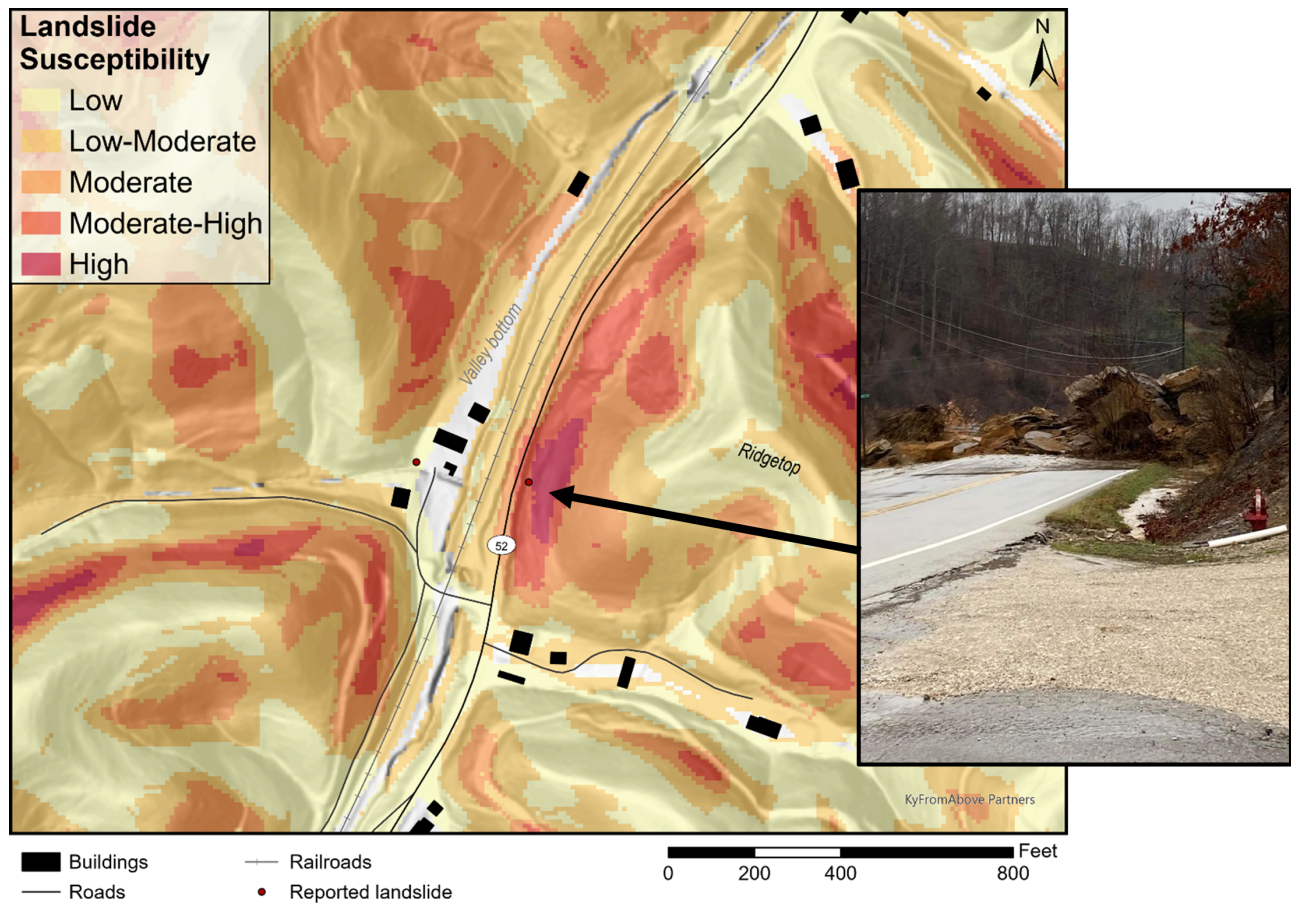


Figure 34. Landslide susceptibility map and image of a landslide that impacted KY 52, west of Jackson, Breathitt County.

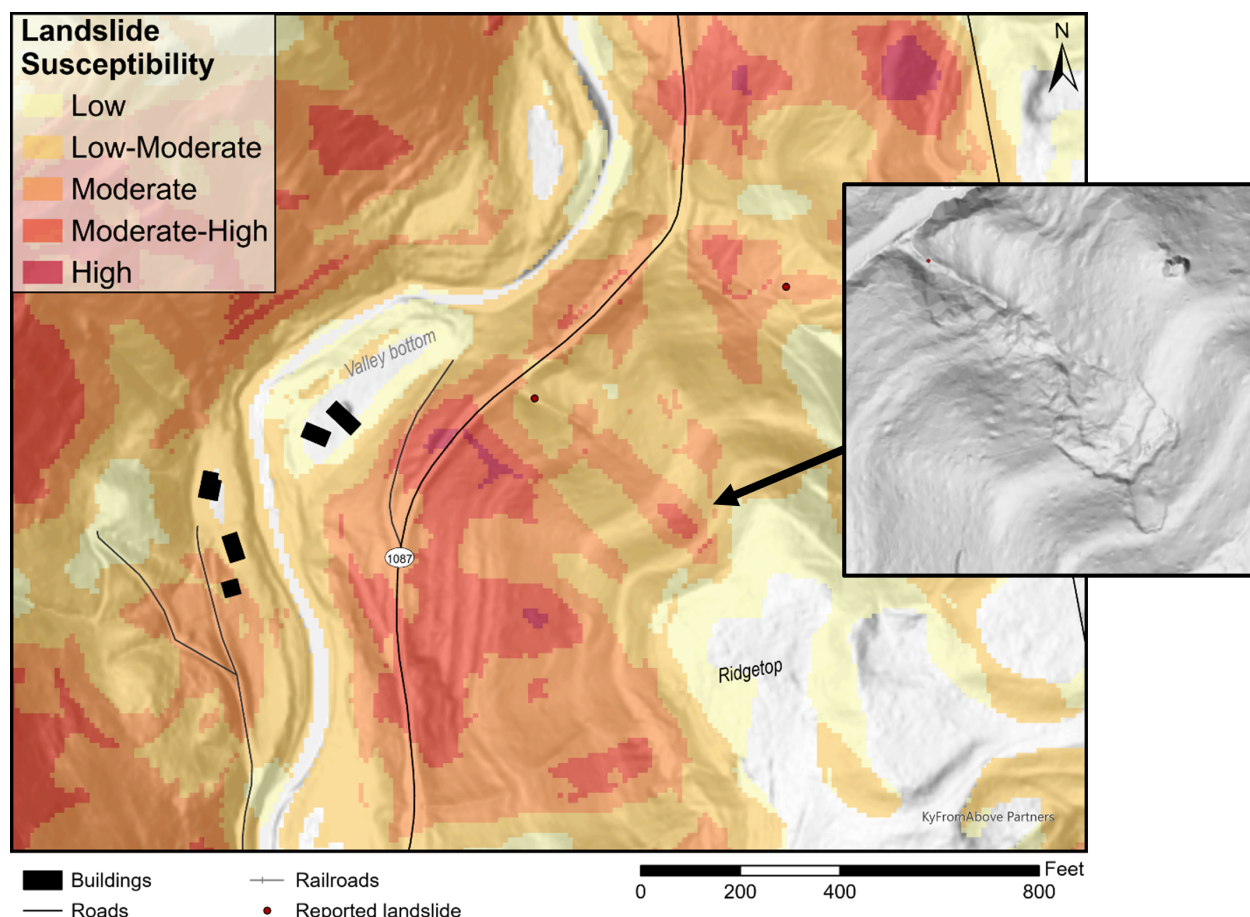


Figure 35. Landslide susceptibility map and recent lidar image of a landslide that impacted KY 1087, near the borders of Perry and Knott Counties.

Model Limitations

A statistical, geomorphic-based landslide susceptibility model tends to simplify the variables that influence landslides. Taking only those hillslope geomorphic factors that can be relatively easily mapped in an area or derived from a DEM generalizes landslide type and causal factors such as hillslope hydrologic fluctuations (van Westen et al., 2003). Using a landslide inventory as the basis for this model assumes that landslides happen under the same combination of conditions throughout the study area and through time, but in reality, environmental factors change continuously.

A more specific limitation occurred with heavily modified (primarily by roadcuts or surface mines) slopes. Often, susceptibility values are skewed for these slopes because of the artificial landscapes (see Fig. 32). In addition, the 123 ft landslide buffer used to extract the geomorphic statistics and generate the

variables resulted in occasional susceptibility map artifacts. The use of a circular buffer is reflected in some roughly circular artifacts present in areas of the resulting map. This occurs most often with heavily modified parts of the landscape (e.g., surface mine operations), where there are sharp, unnatural breaks between steep slopes and flat, modified ground. For this reason, we generated our map with additional non-landslide areas so the model could “learn” to more realistically assess landslide susceptibility in these types of landscapes.

Risk, Impacts, and Vulnerability

In the United States, landslides are widespread and occur in all 50 states and 5 inhabited territories (Highland and Bobrowsky, 2008). The societal and economic impacts of landslides are significant, and reported occurrences are underestimated globally

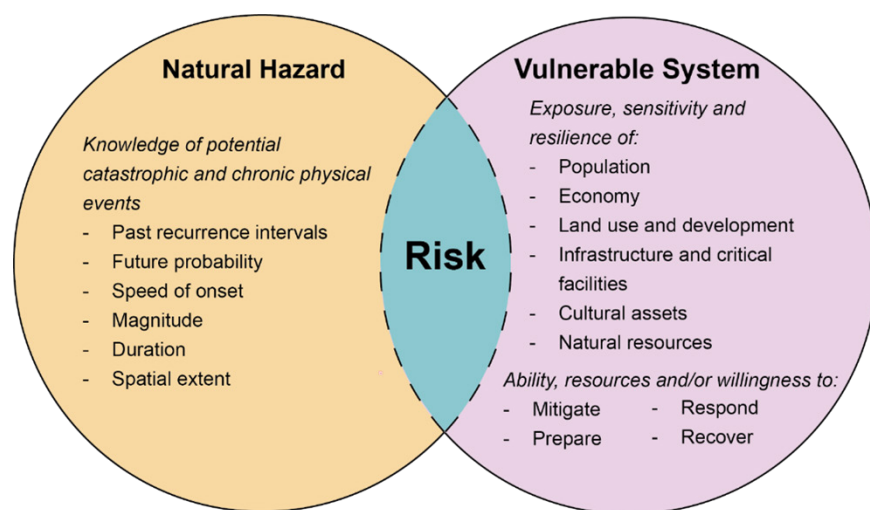


Figure 36. Schematic of the intersection between natural hazards and vulnerable elements, which equates to risk. Modified from Wood (2011).

down to the local level. Because of their wide distribution across the landscape and among different environments, landslides frequently intersect with the built environment (Lu and Godt, 2013). Compiling landslide statistics and subsequently conducting hazard assessments is challenging because landslides can be either primary or secondary hazards and often occur with a primary extreme event, such as a tropical storm or an earthquake. In the United States, landslide fatalities vary year-to-year but range from around 25 to 50 annually (Mirus et al., 2020). Economic costs from landslide damage are approximately \$3 billion annually (Spiker and Gori, 2003; Highland and Bobrowsky, 2008; Lu and Godt, 2013; Mirus et al., 2020). Although the U.S. Geological Survey maintains a national landslide inventory, delineating high- and low-hazard regions is challenging because of limited guidance for data acquisition, formatting and data management differences, and different objectives and resources across states. Any systematic catalogs of landslide occurrence or impact compiled at the state level vary in quality and consistency. Damage is poorly documented, and occurrence, costs (societal and environmental), and victims are underestimated (Mirus et al., 2020; Crawford et al., 2022b). Landslide hazards, and the resulting health and economic impacts, are compounding problems that call for not only more comprehensive landslide hazard (or susceptibility) assessment but also

socioeconomic impact or risk assessments (Crawford et al., 2024).

The International Union of Geological Sciences (IUGS) Working Group on Landslides defines landslide risk as the product of a hazard, the likelihood a landslide will occur, and exposure, the health, property, or environmental assets that might be affected by landslide occurrence. However, a range of complex risk modeling equations exist because there are numerous combinations of spatial and temporal inputs for modeling risk (Fig. 36).

To contextualize the work in this report and convey the importance of the landslide hazards in Kentucky, we

evaluated the FEMA National Risk Index, which scores 18 natural hazards, including landslides. The index rating score represents a community's relative risk for landslides in U.S. counties (Fig. 37) based on expected annual loss, social vulnerability, and community resilience (FEMA, 2025b). Considering increasing landslide occurrence, the social vulnerability component of the FEMA National Risk Index evaluates the susceptibility of social groups to the adverse impacts of natural hazards (Zuzak et al., 2023). The social vulnerability score is calculated as a consequence-enhancing risk component of the National Risk Index (FEMA, 2025b).

Many of the jurisdictions that are the most vulnerable to landslides also range from moderate to very high on FEMA's Social Vulnerability Index, particularly in eastern Kentucky (Fig. 38). Areas of lowest resilience to natural hazards also are statistically related to vulnerability, often corresponding to areas of high vulnerability (Cutter et al., 2014).

Landslides and Climate Change

Climate and its influence on the variables that cause landslides, primarily rainfall and temperature, is changing. Many scientists are investigating whether the warming temperatures and changing rainfall patterns will trigger more landslides (Palmer, 2020). Not only will more landslides be inevitable, but changes in the occurrence rates of certain types

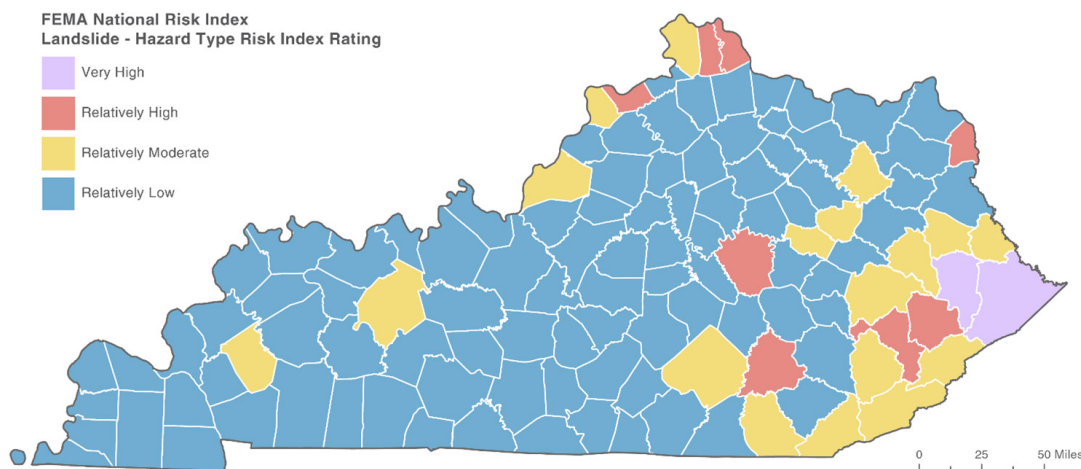


Figure 37. Federal Emergency Management Agency (FEMA) National Risk Index Landslide Hazard Risk Index Ratings for Kentucky counties (source data: FEMA, 2025b).

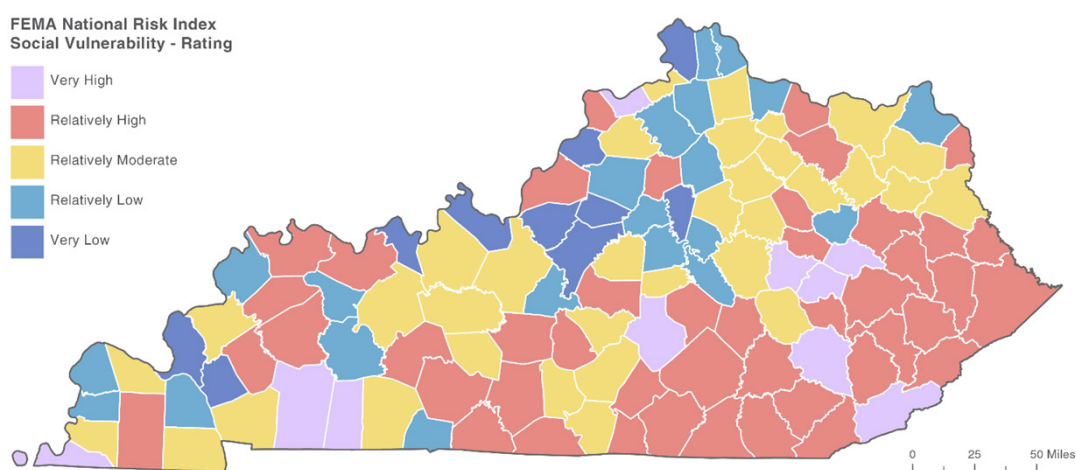


Figure 38. Federal Emergency Management Agency (FEMA) National Risk Index Social Vulnerability Ratings for Kentucky counties (source data: FEMA, 2025b).

of landslides, such as dangerous debris flows and earthflows, will occur. In addition to more frequent rainfall events capable of triggering landslides, many of those storms will be intense (more rain in less time) and perhaps concentrated in months of the year not normally associated with heavy rainfall (Gariano and Guzzetti, 2016). One way to gauge changing precipitation patterns is to calculate precipitation change using the U.S. Climate Normals (NCEI, 2023). Generated by the National Oceanic and Atmospheric Administration's National Centers for Environmental Information and the Cooperative Institute for Satellite Earth System Studies, the U.S. Climate Normals are derived from weather and climate observations captured by weather stations. Comparison of annual precipitation data from two 30-year periods (1981–2010

and 1991–2020) indicates an estimated 5 to 12% increase in annual precipitation in the southeastern United States (Fig. 39). According to the State Climate Summary for Kentucky, the total annual precipitation in Kentucky exhibits an overall upward trend, with approximately 7.4 inches above the long-term average since 2011 (Runkle et al., 2022; Fig. 40).

Landslide Risk Assessment

Generally, risk is a measure of the probability of the severity of an adverse effect to health, property, or the environment (IUGS, 1997). There are many working definitions of landslide risk, and assessments are often based on mixtures of information that range

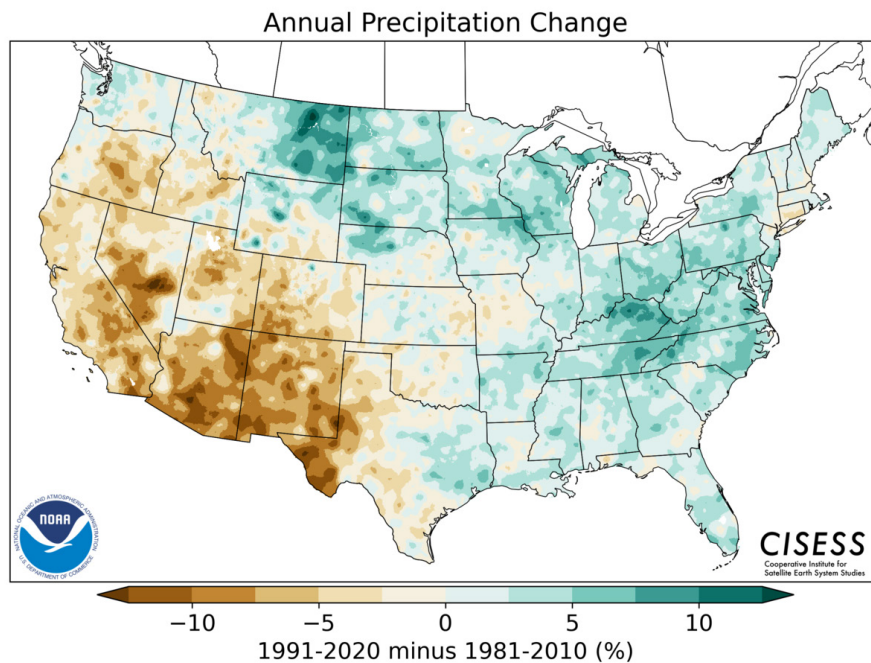


Figure 39. Annual precipitation change (1991–2020 U.S. Climate Normals minus the 1981–2010 U.S. Climate Normals) in the United States. Map from the National Centers for Environmental Information (NCEI, 2023).

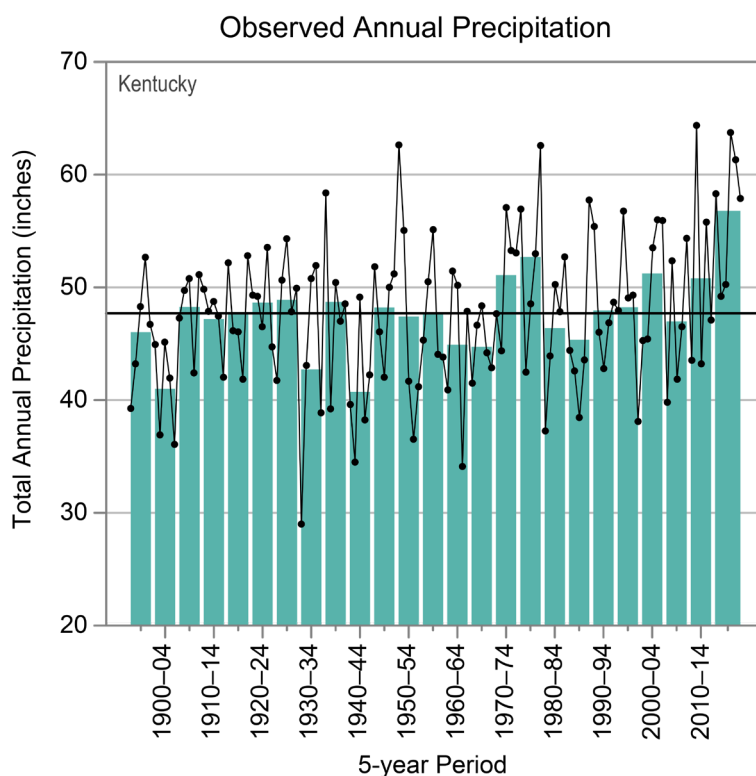


Figure 40. Total annual precipitation for Kentucky from 1900 to 2020. Figure from Runkle et al. (2022).

from well-established knowledge to broad assumptions due to lack of data (Lee, 2016). Landslide risk assessments attempt to estimate the product of hazard and consequences, finding the most useful combination of landslide susceptibility and risk components. Modeling reliable risk results is challenging due to the complexity of the many aspects of landslide hazards and the vulnerability of the built environment to landslides. Hindering factors include quantitative heterogeneity of vulnerability of different elements at risk for qualitatively similar landslide mechanisms and variability in temporal vulnerability (van Westen et al., 2006; Uzielli et al., 2008).

The risk assessment presented here considers static socioeconomic risk; specifically, this assessment is not scenario-specific or time-dependent, as spatial and temporal components were not considered (Crawford et al., 2024). The spatial distribution of elements at risk (assets) used in the risk calculation and the resulting map can be used as decision-making tools and general guides for public safety.

This risk approach was defined by Risk = Hazard × Vulnerability × Consequence, or

$$R = H \times V \times C,$$

where hazard, H , refers to the probability a threat will occur; vulnerability, V (expressed on a scale of 0 to 1), refers to the possible impact the threat could have on a given element; and consequence, C , refers to the elements at risk of being affected, including people (often referred to as societal), infrastructure and its value (referred to as economic), and environment (or ecosystem).

Consequence was split into separate components: societal (population kernel density maps) and economic (infrastructure and land monetary value maps). No specific environmental risk component was considered. The elements at risk considered within the consequence component of the risk equation were population,

roads, railroads, building footprints, and general land class. Kernel density maps were generated for population, roads, and railroads. A kernel density map is a smoothed raster estimation of the number of occurrences or density per unit area (here square feet) of a point or line feature, produced by replacing each discrete point or line with a smooth continuous function. To generate the population kernel density map, 2020 U.S. Census Block group population values were used (Fig. 41). We evenly divided these block group populations among the building footprints contained within each census block. Although not all building footprints are inhabited homes, and occupants are not equally distributed across buildings, calculating a population density by assigning fractions of the population to building footprint centroids provided a more realistic spatial distribution than assigning the entire population to the block group's single centroid. The kernel density for roads and railroads was generated based on units of line length per square map unit. For population, roads, and railroads, we used a search radius of approximately 1,000 ft (radius

within which to calculate density) in the kernel density tool in ArcGIS Pro (Esri, 2025). This search radius accounted for the true footprint of assets, which represents adjacent properties that may be at risk.

To assign monetary values to the roads and railroads, we rasterized those assets by buffering the line data. Local roads received 20 ft and 10 ft buffers for county and private roads, respectively. State roads received 9 m buffers and the U.S. highways received 100 ft buffers. Railroads received 10 ft buffers. We obtained economic value estimates for state roads, local roads, railroads, developed land, and undeveloped land from several government and industry sources (Table 9; Crawford et al., 2022b, 2024). We determined the undeveloped land values using information from the University of Kentucky College of Agriculture, Food, and Environment (Halich and Pulliam, 2013) and area coverages through the National Landcover Dataset (USGS, 2024). We converted elements-at-risk datasets to dollars-per-pixel rasters (10 ft cells) for model input consistency. For example, dollars per acre in land value was converted to a value per 10 ft by 10 ft pixel (Fig. 42).

Property values used for developed land were taken from the Federal Housing Finance Agency (Davis et al., 2021), and the values are an average of a very small sample ($n = 8$) of quarter acre values for lots in Perry County. The value is around \$111,933 per acre. This coarser survey was used instead of Property Valuation Administration (PVA) data for parity with other risk assessments in the region (Crawford et al., 2022b, 2024) as well as the vast range of PVA values observed in the county datasets. However, through analysis of the provided PVA data for seven of the eight KRADD counties, \$112,000 per acre is a reasonable approximation of general property values. In order to maintain the influence of all asset data in the risk calculation and to avoid skewing the risk assessment

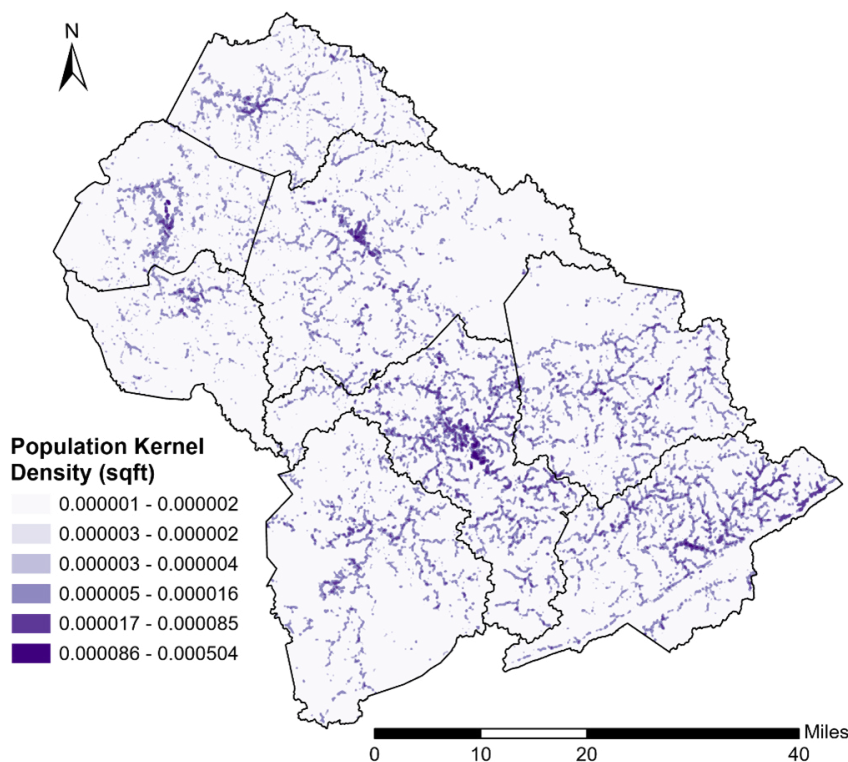


Figure 41. Population kernel density for the Kentucky River Area Development District. The numbers are small in order to match the per square foot data of the other assets, but this generally conveys where there is more or less population density in the area.

Table 9. Infrastructure used in the consequence element of the risk assessment along with associated values and information sources. KYTC = Kentucky Transportation Cabinet, UK Agriculture = University of Kentucky College of Agriculture, Food, and Environment, FHFA = Federal Housing Finance Agency, ACW = Aberdeen Carolina and Western Railway.

Infrastructure	Value (USD)	Source
Major road	24,000,000 per mile	KYTC
Local road	14,000,000 per mile	KYTC
Developed land	112,000 per acre	FHFA
Open land	1,800 per acre	UK Agriculture
Railway	1,000,000 per mile	ACW Railway

towards the most expensive asset, we categorized the values of roads, railroads, and land classes into order-of-magnitude bins. These binned consequence elements were combined and then multiplied by hazard and vulnerability values to calculate a risk (R) value for each raster.

To produce a landslide risk map, the elements at risk were multiplied by the hazard and vulnerability components. The hazard input is the logistic regression landslide susceptibility results. The vulnerability is the probability of damage to an element from the

threat on a scale of zero for no damage to one for complete destruction. Due to the lack of comprehensive vulnerability data such as landslide behavior and building resistance, vulnerability received a value of one, assuming total loss. With these components, the risk equation is

$$\text{Risk} = H \times V \times (C_1 + C_2 + C_3),$$

where H is the landslide susceptibility model, V is 1 (total loss assumed), and C is a unitless socio-economic consequence, which is the sum of the eco-

nomic value bins multiplied by binned population kernel density (C_1), binned road kernel density (C_2), and binned railroad kernel density (C_3). For less jagged and noisy results, the risk maps were smoothed radially 50 ft. All data inputs were normalized prior to calculating risk. Therefore, risk is unitless, and we consider the result a risk factor score with a theoretical range of 0–1. Due to the highly skewed data, the breaks for classification were chosen using standard deviations on a log scale, yielding a risk factor distribution of 0–0.02 (excluded), 0.021–0.04 (low risk), 0.041–0.09 (moderate risk), and 0.091–0.34 (high risk; Table 10). Figures 43–63 show risk model results for areas and municipalities within the KRADD.

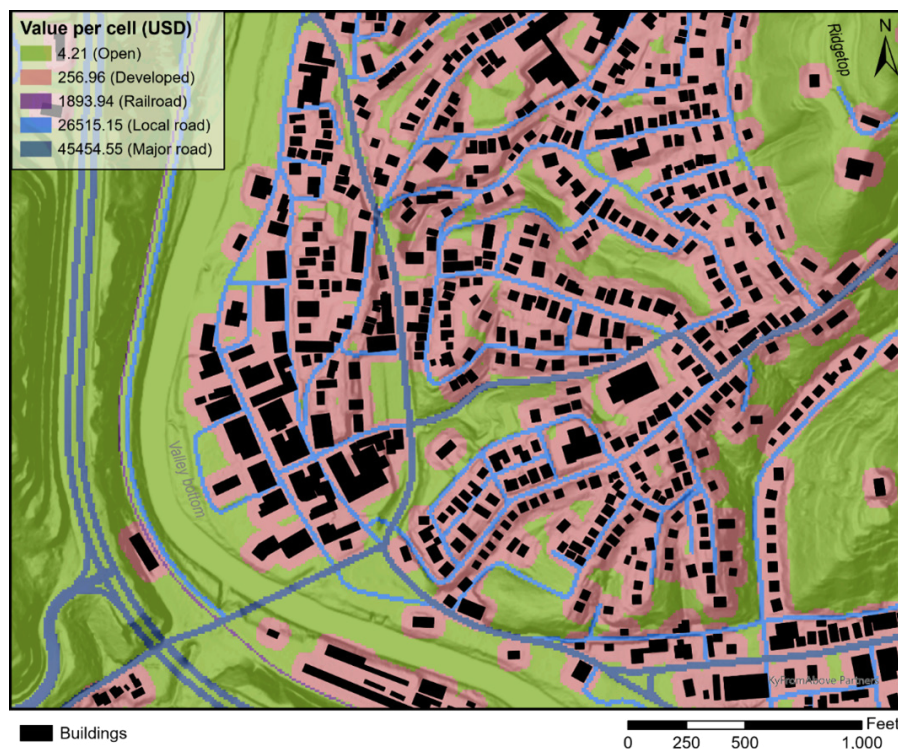


Figure 42. Dollar values per 10 square feet (per raster map pixel) used for the economic consequence layer of the risk assessment. This figure is focused on downtown Hazard, Perry County.

Table 10. Risk classes for the Kentucky River Area Development District (KRADD), the area coverage of each risk class, and each class's intersections with infrastructure.

Risk factor	Risk class	KRADD area coverage (%)	Intersection with Buildings (%)	Intersection with Roads (%)	Intersection with Railroads (%)
0–0.02	Excluded	85.89	6.39	23.88	0.06
0.021–0.04	Low	8.60	25.55	34.41	0.34
0.041–0.09	Moderate	2.63	41.94	29.52	2.13
0.091–0.34	High	0.25	10.55	7.83	71.64

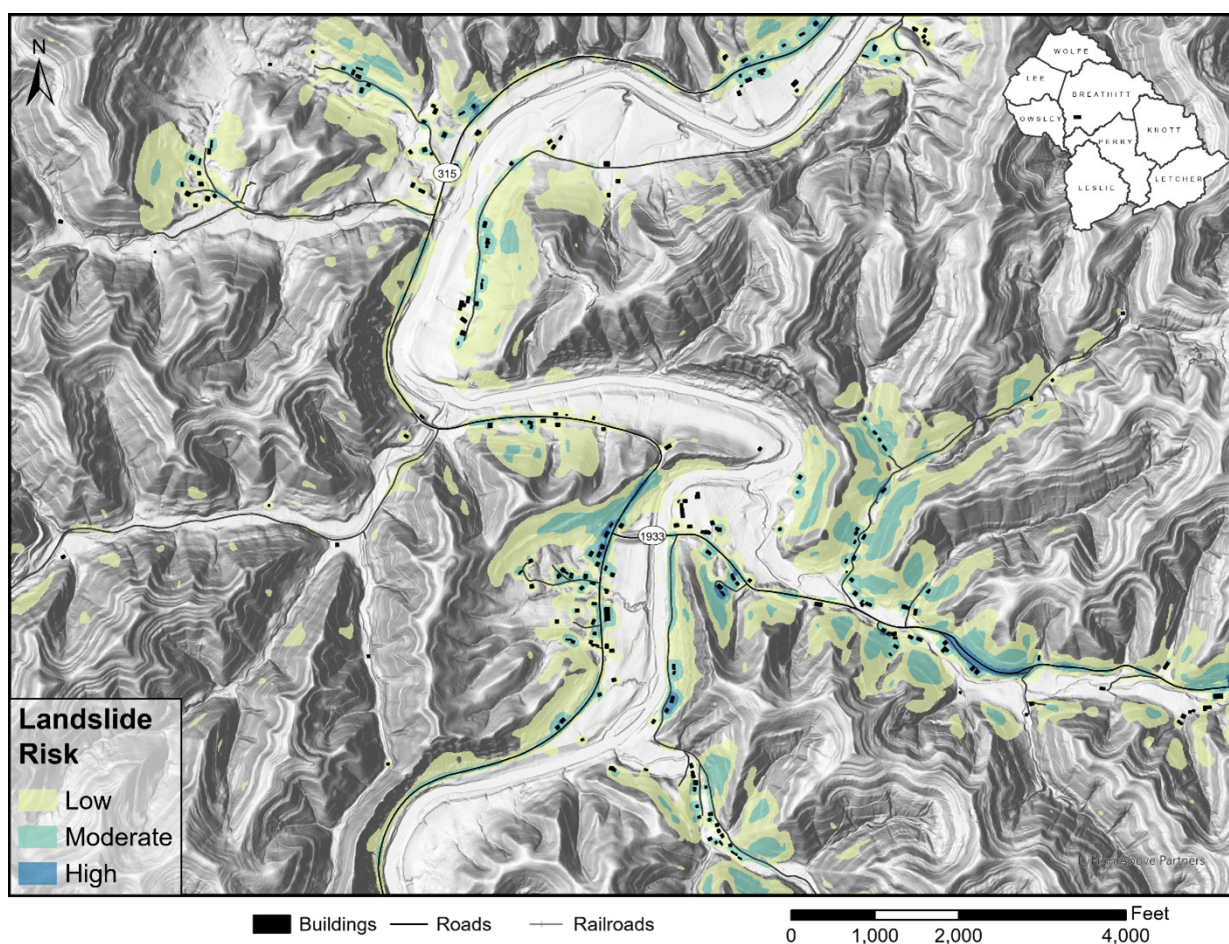


Figure 43. Landslide risk in part of Breathitt County. The location of this area within Breathitt County is delineated by the black rectangle in the upper right map of the Kentucky River Area Development District.

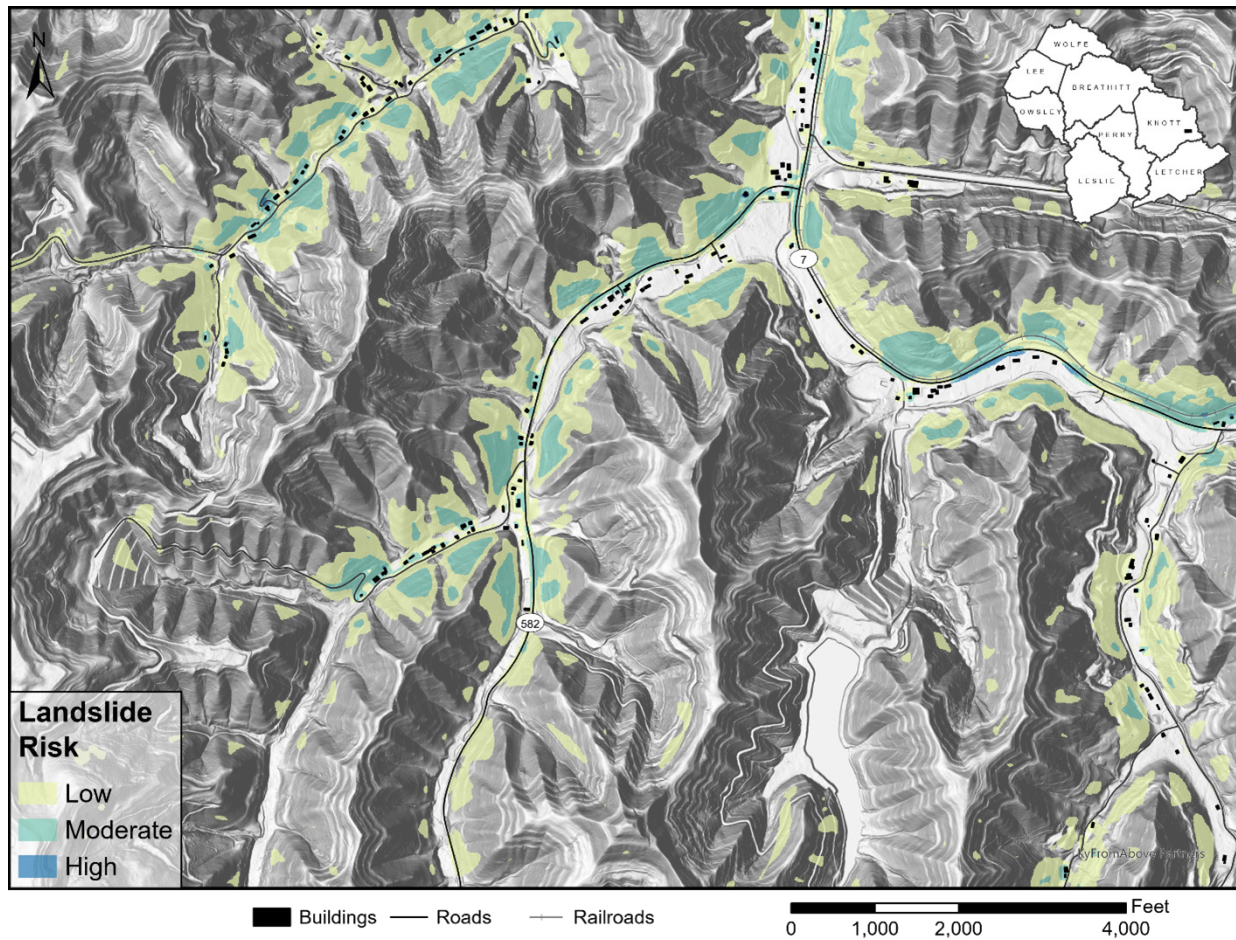


Figure 44. Landslide risk in part of Knott County. The location of this area within Knott County is delineated by the black rectangle in the upper right map of the Kentucky River Area Development District.

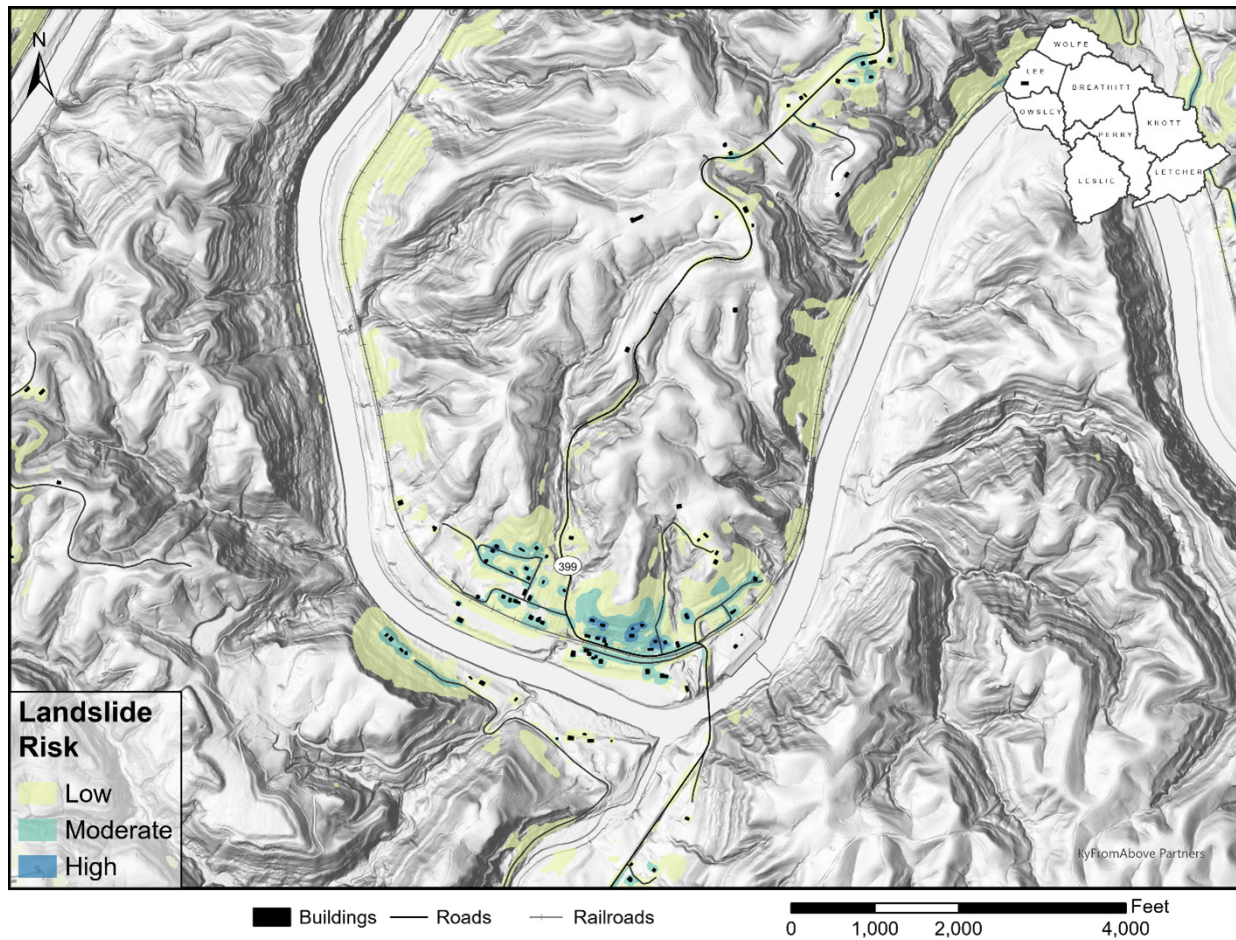


Figure 45. Landslide risk in part of Lee County. The location of this area within Lee County is delineated by the black rectangle in the upper right map of the Kentucky River Area Development District.

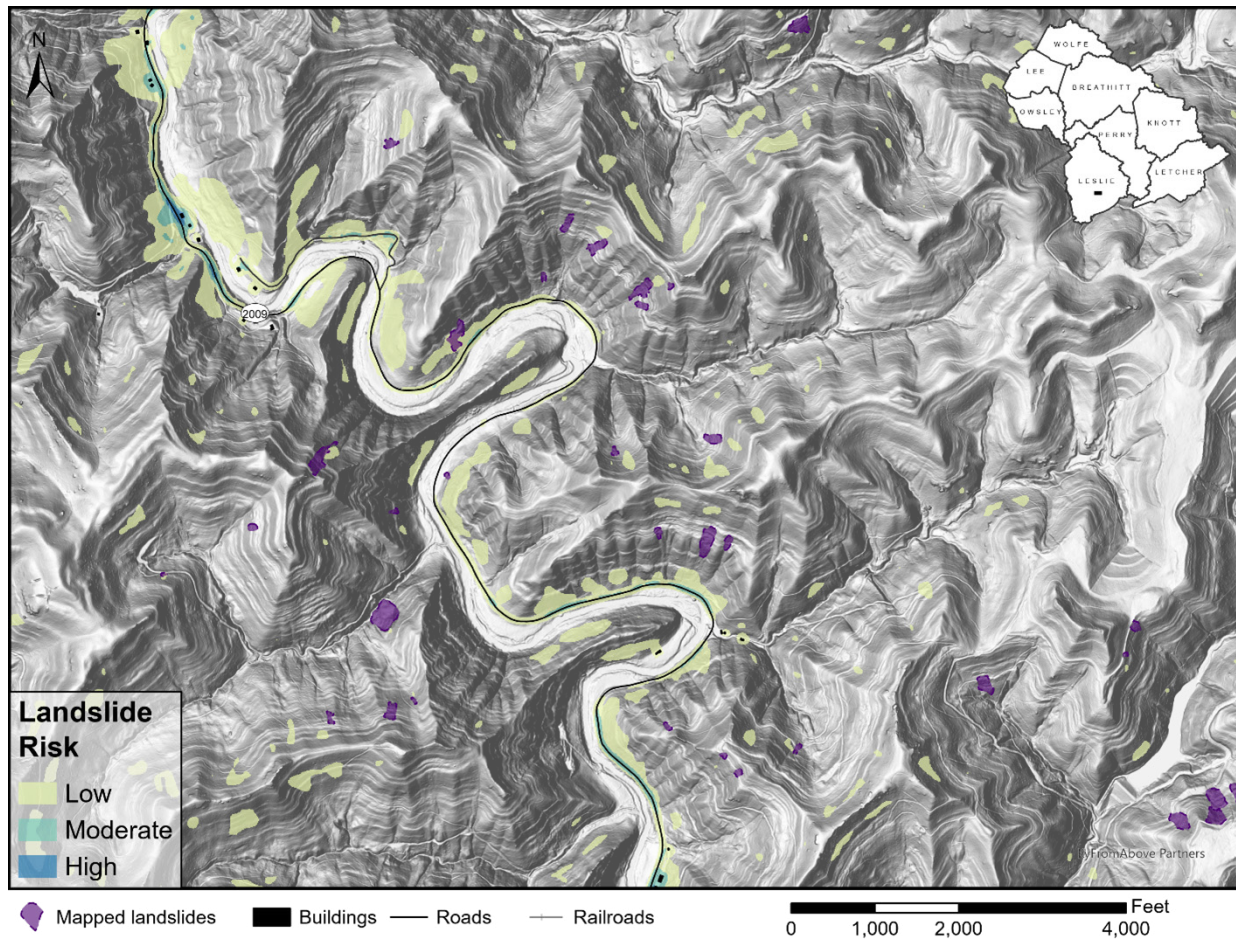


Figure 46. Landslide risk in part of Leslie County. The location of this area within Leslie County is delineated by the black rectangle in the upper right map of the Kentucky River Area Development District.

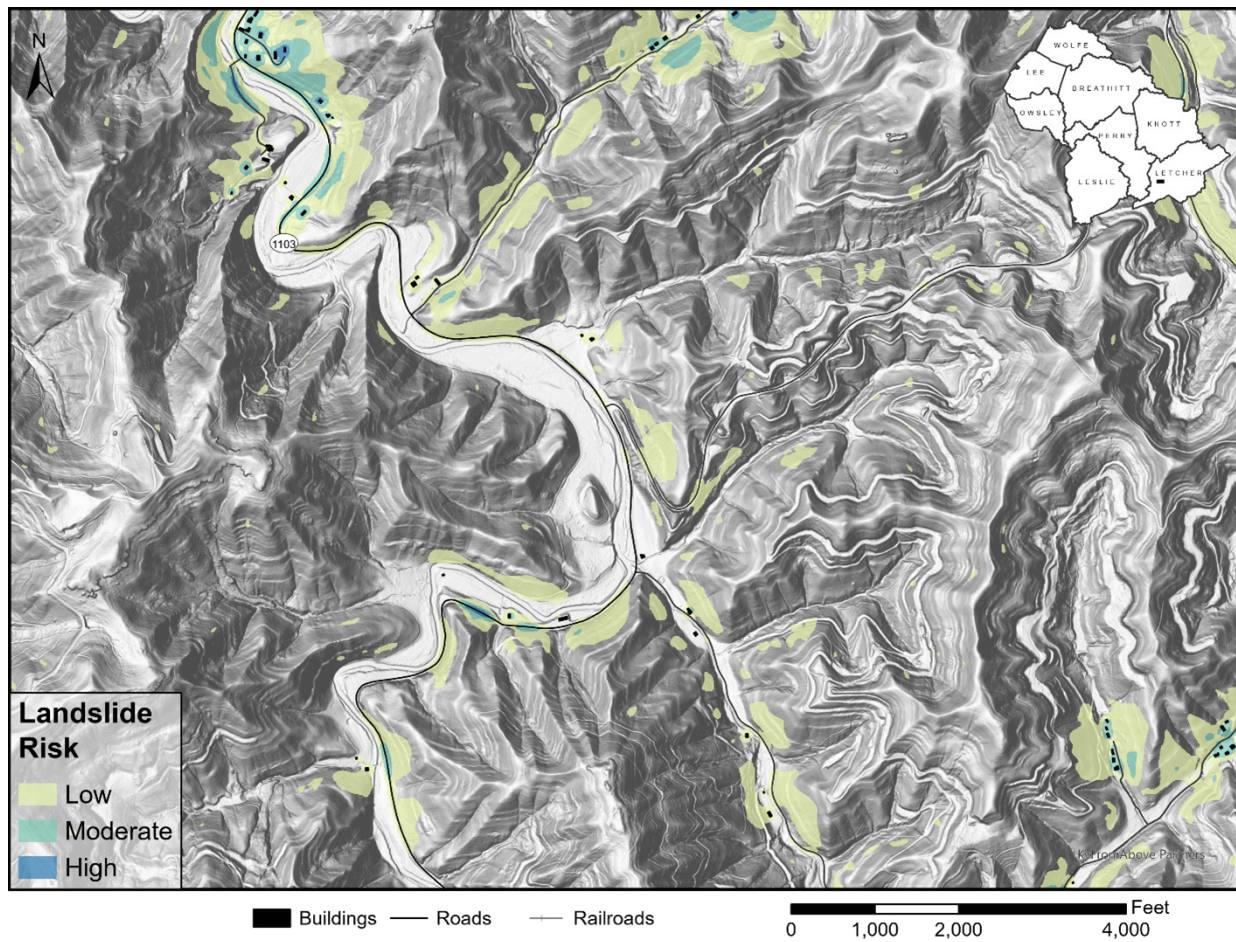


Figure 47. Landslide risk in part of Letcher County. The location of this area within Letcher County is delineated by the black rectangle in the upper right map of the Kentucky River Area Development District.

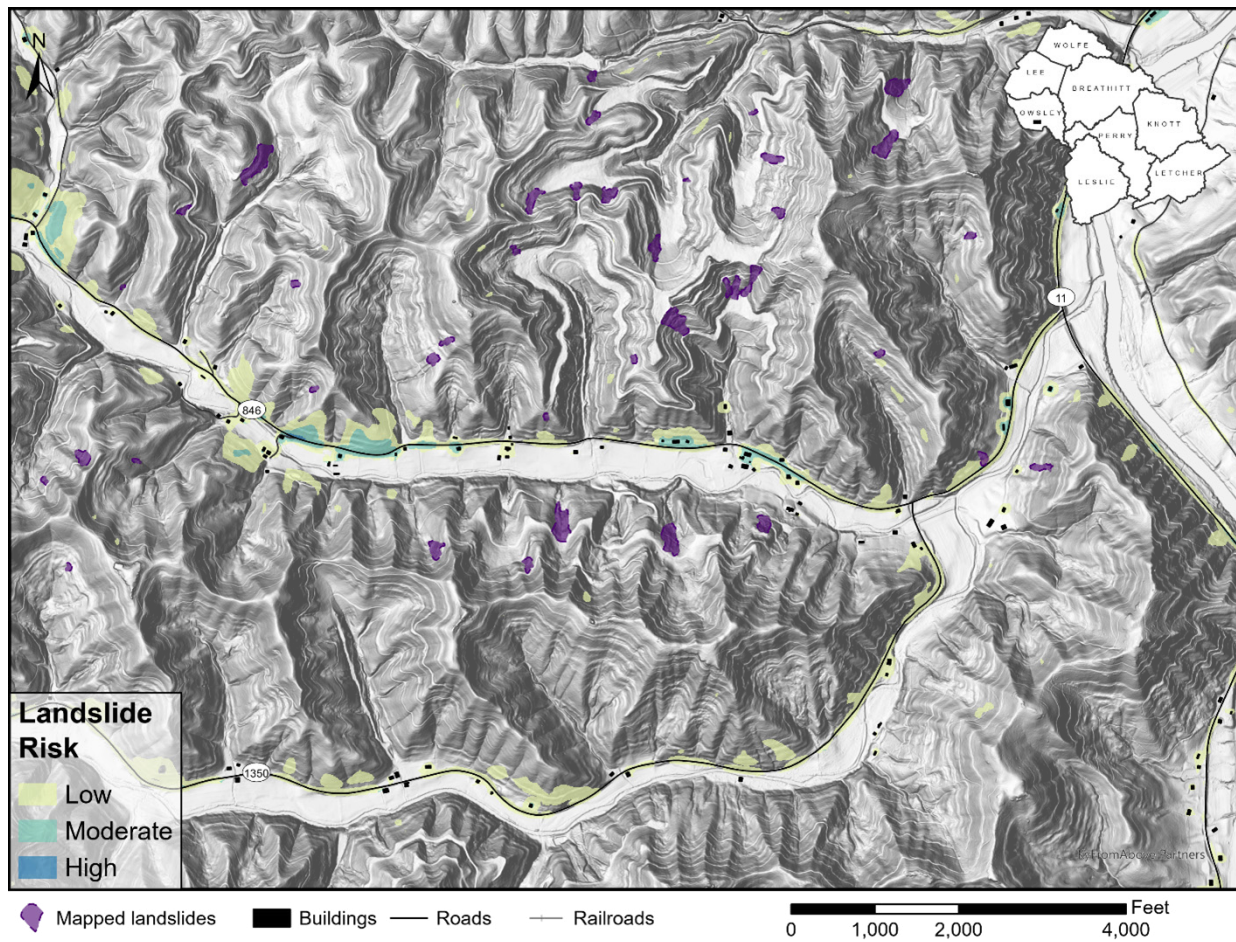


Figure 48. Landslide risk in part of Owsley County. The location of this area within Owsley County is delineated by the black rectangle in the upper right map of the Kentucky River Area Development District.

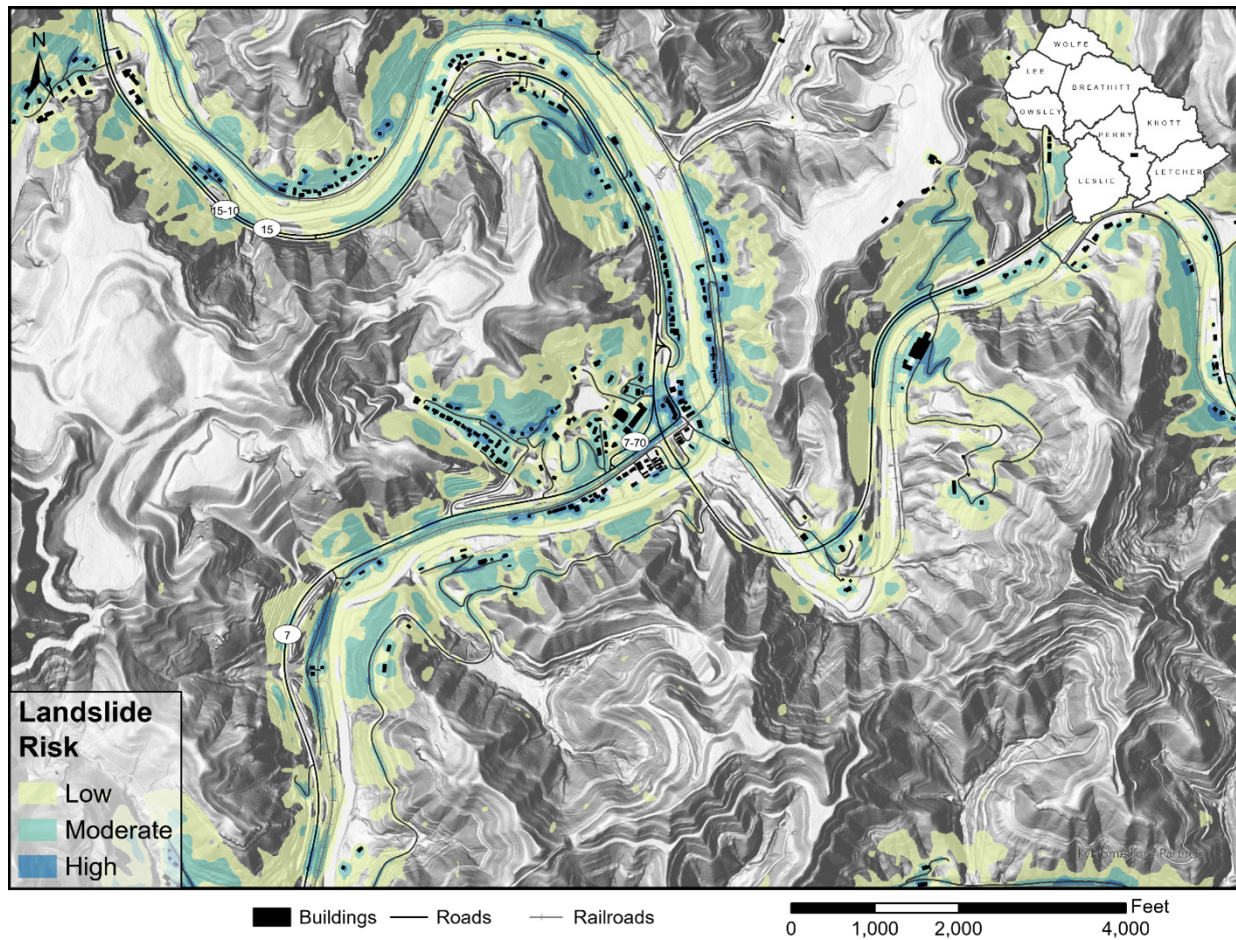


Figure 49. Landslide risk in part of Perry County. The location of this area within Perry County is delineated by the black rectangle in the upper right map of the Kentucky River Area Development District.

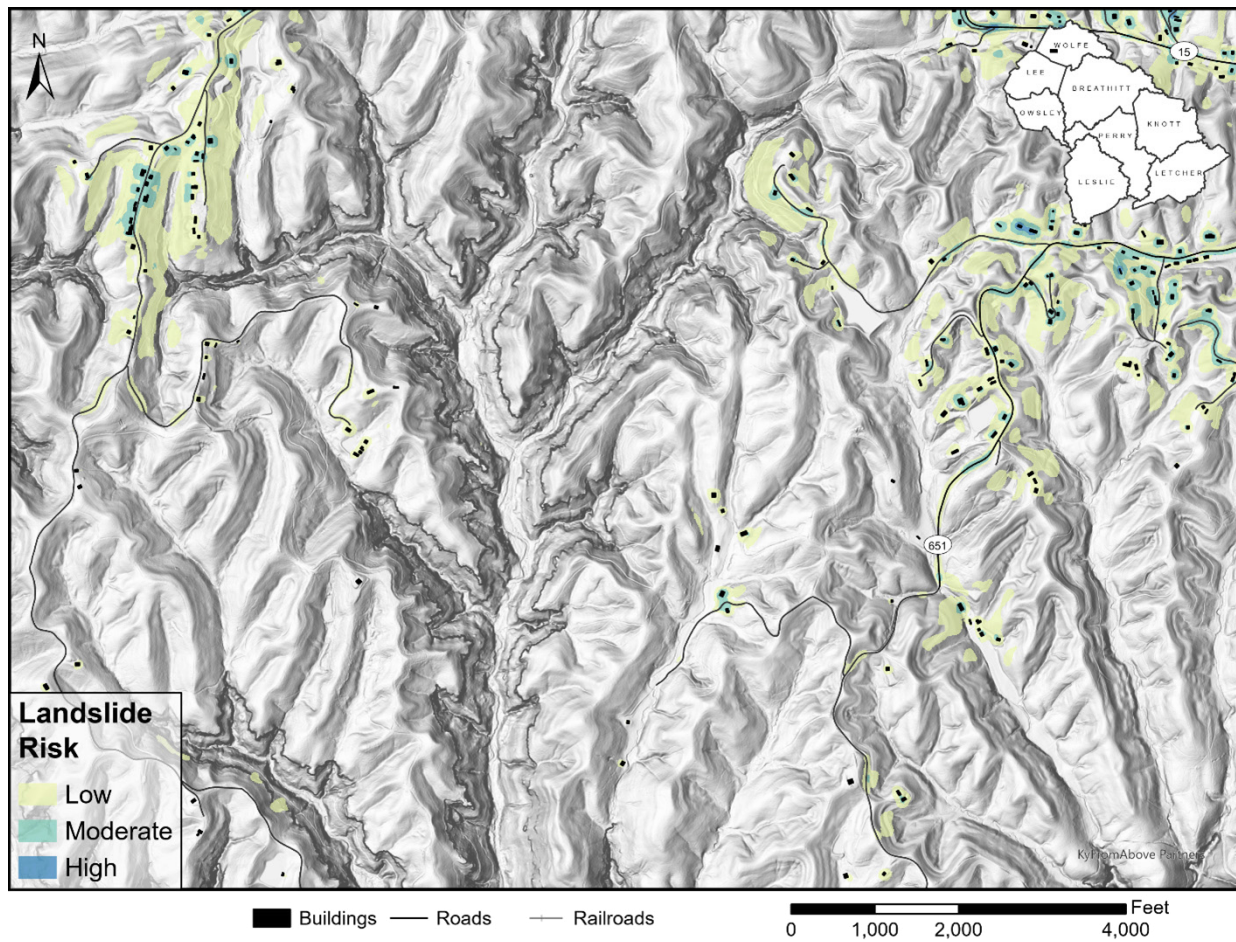


Figure 50. Landslide risk in part of Wolfe County. The location of this area within Wolfe County is delineated by the black rectangle in the upper right map of the Kentucky River Area Development District.

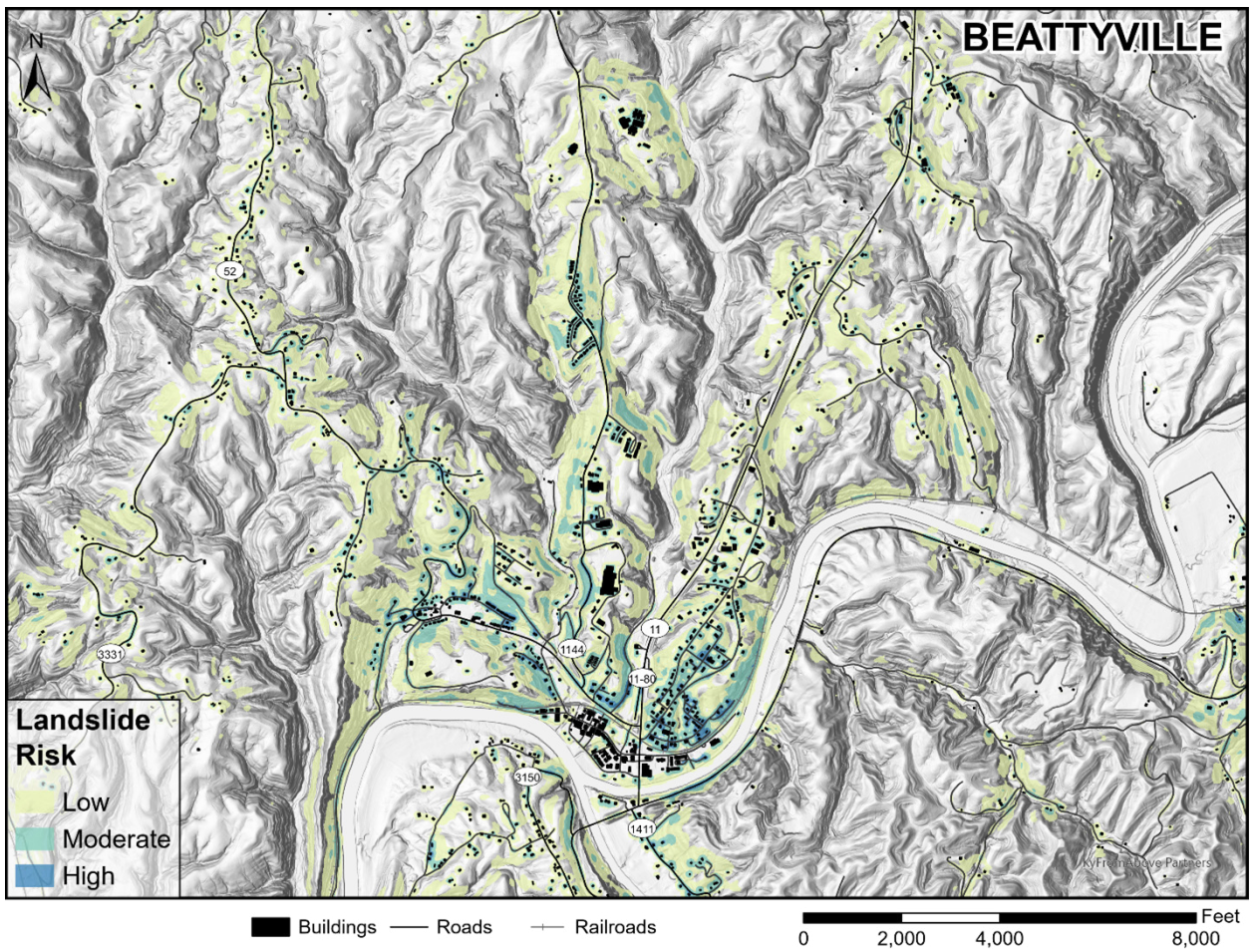


Figure 51. Landslide risk in Beattyville, Lee County.

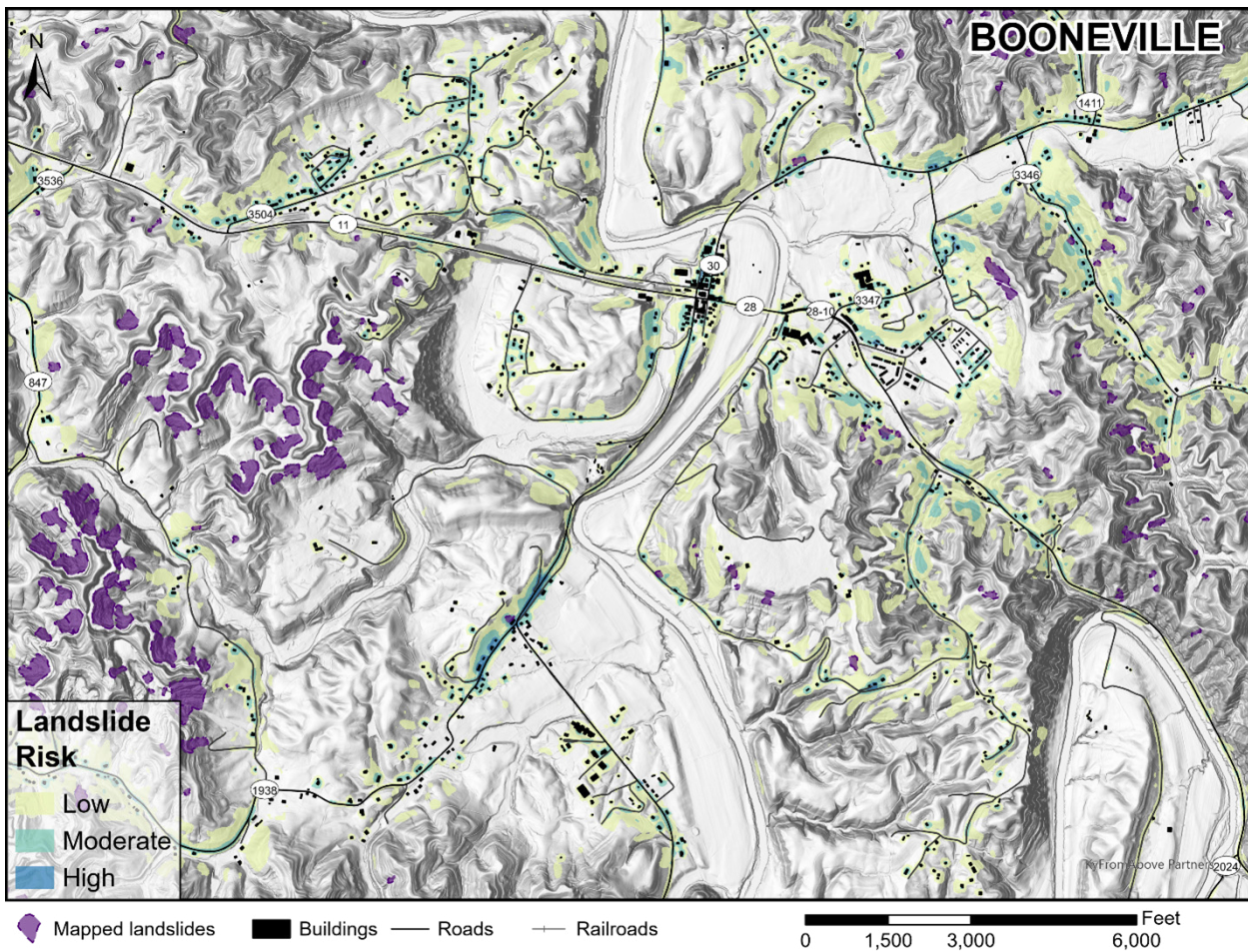


Figure 52. Landslide risk in Booneville, Owsley County.

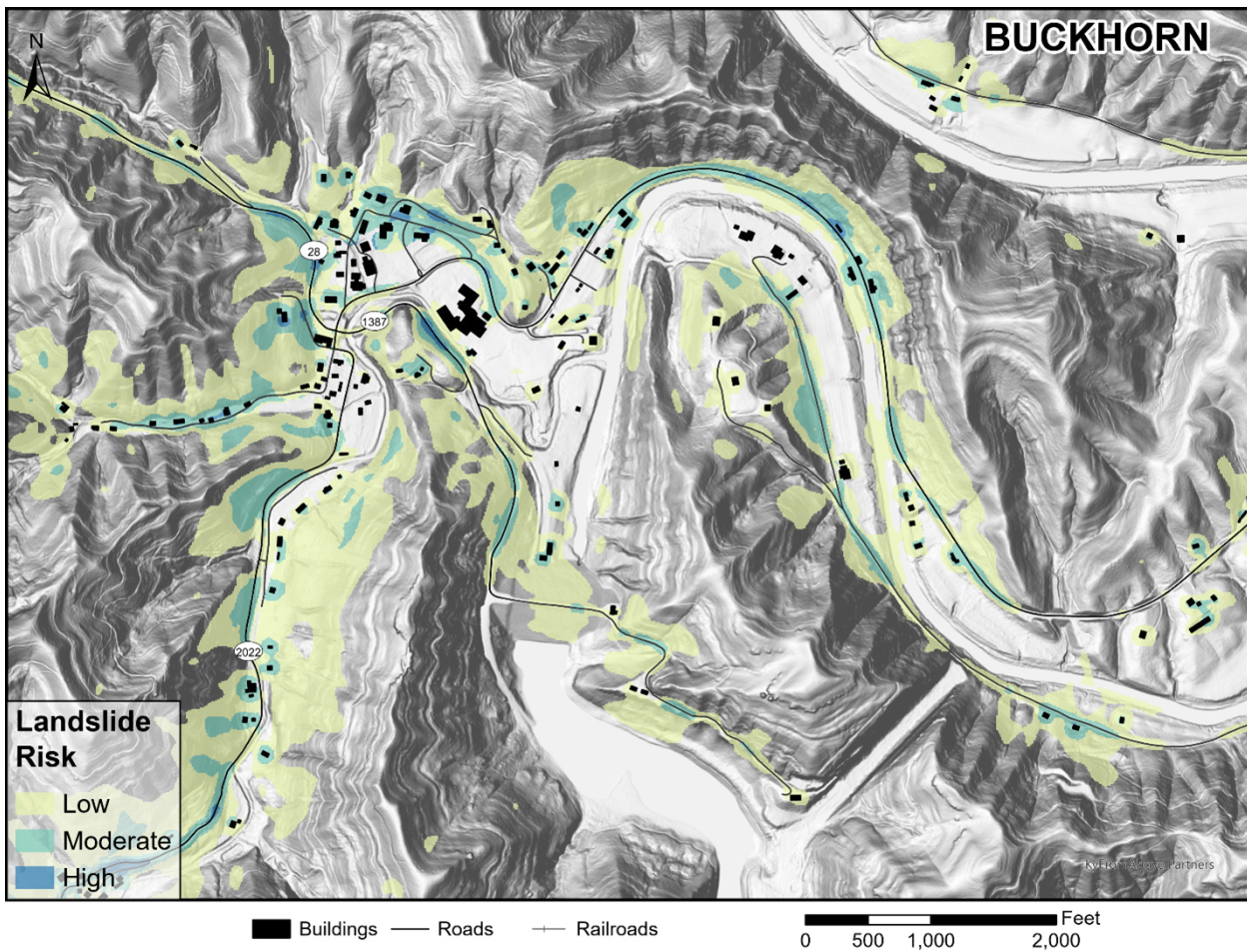


Figure 53. Landslide risk in Buckhorn, Perry County.

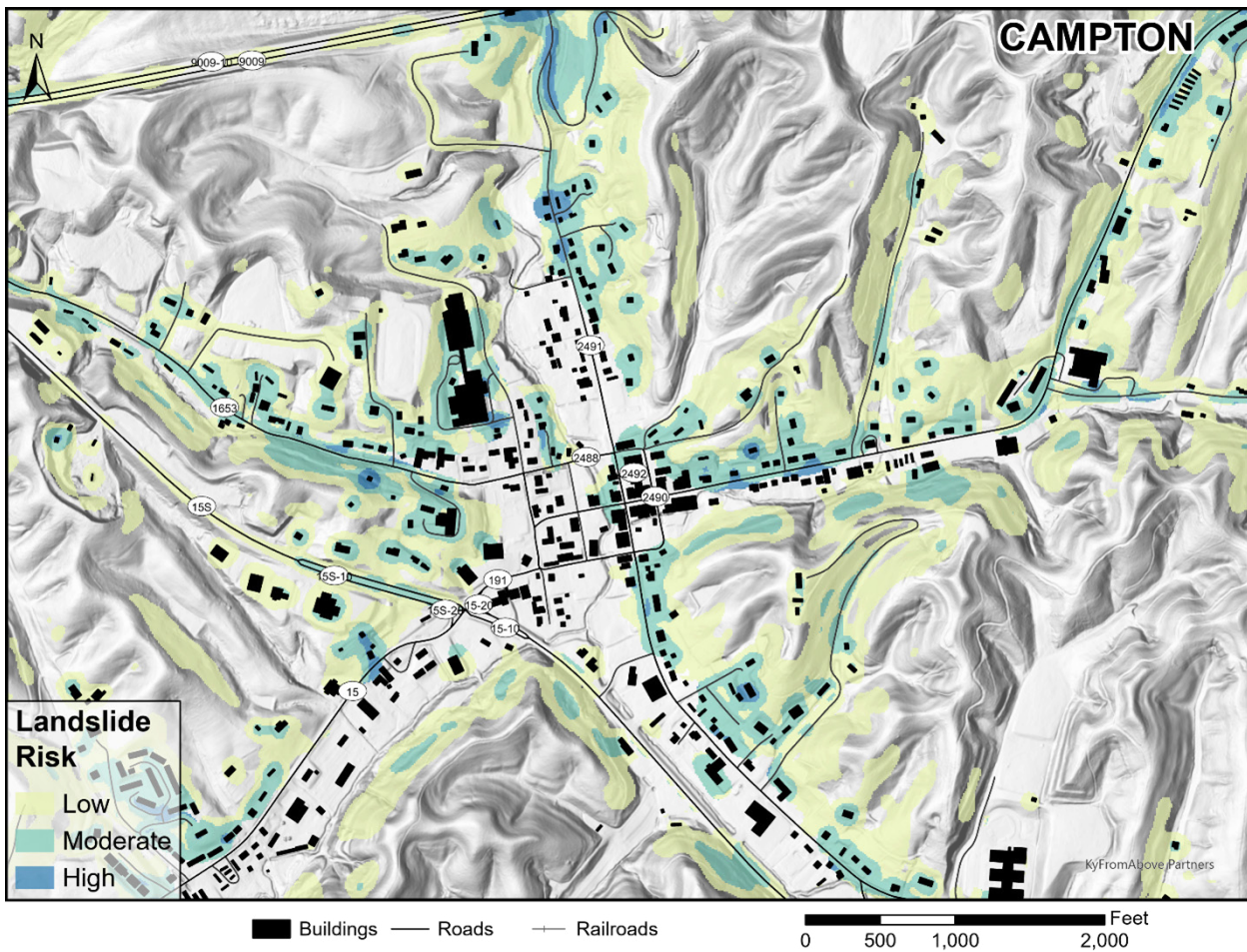


Figure 54. Landslide risk in Campton, Wolfe County.

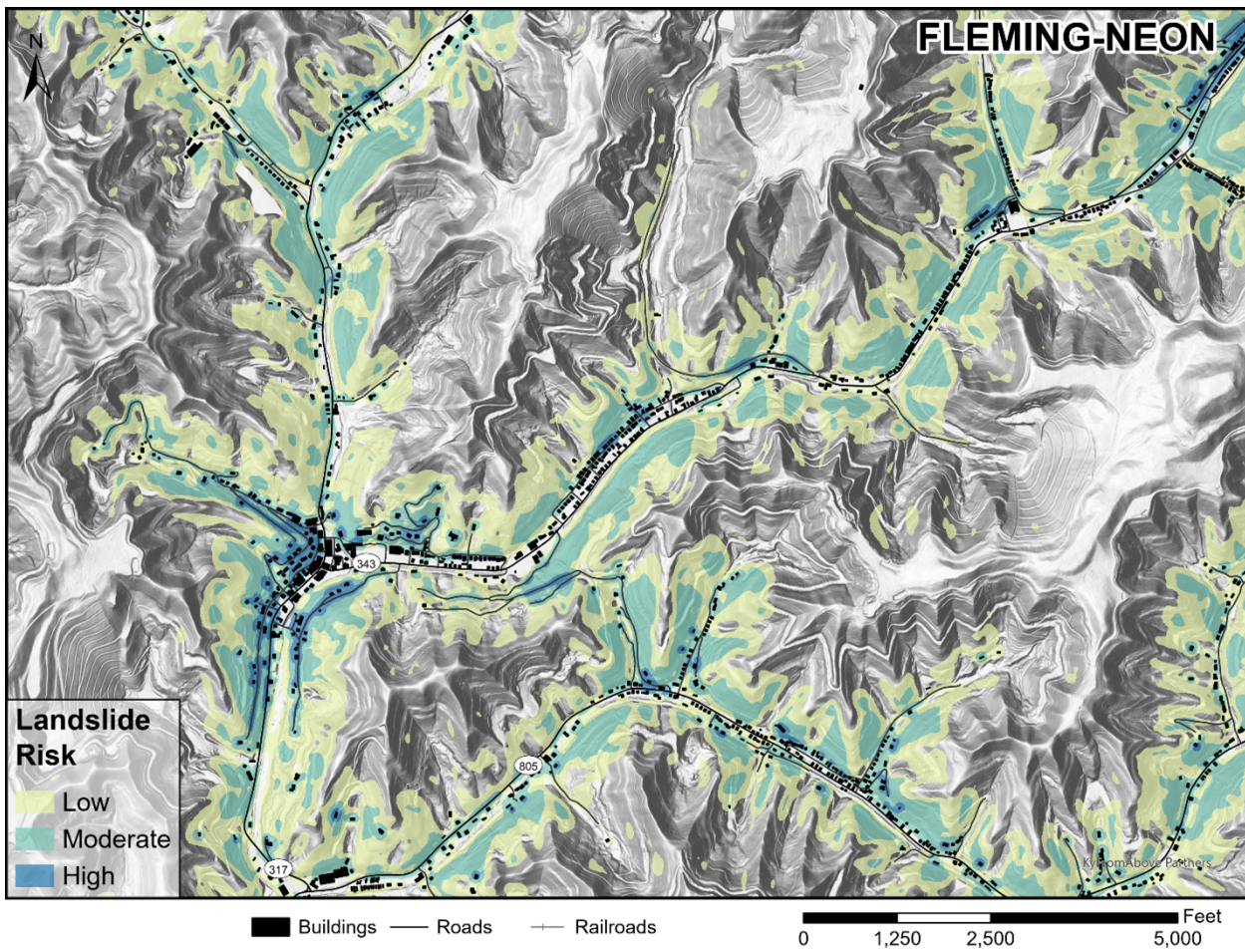


Figure 55. Landslide risk in Fleming-Neon, Letcher County.

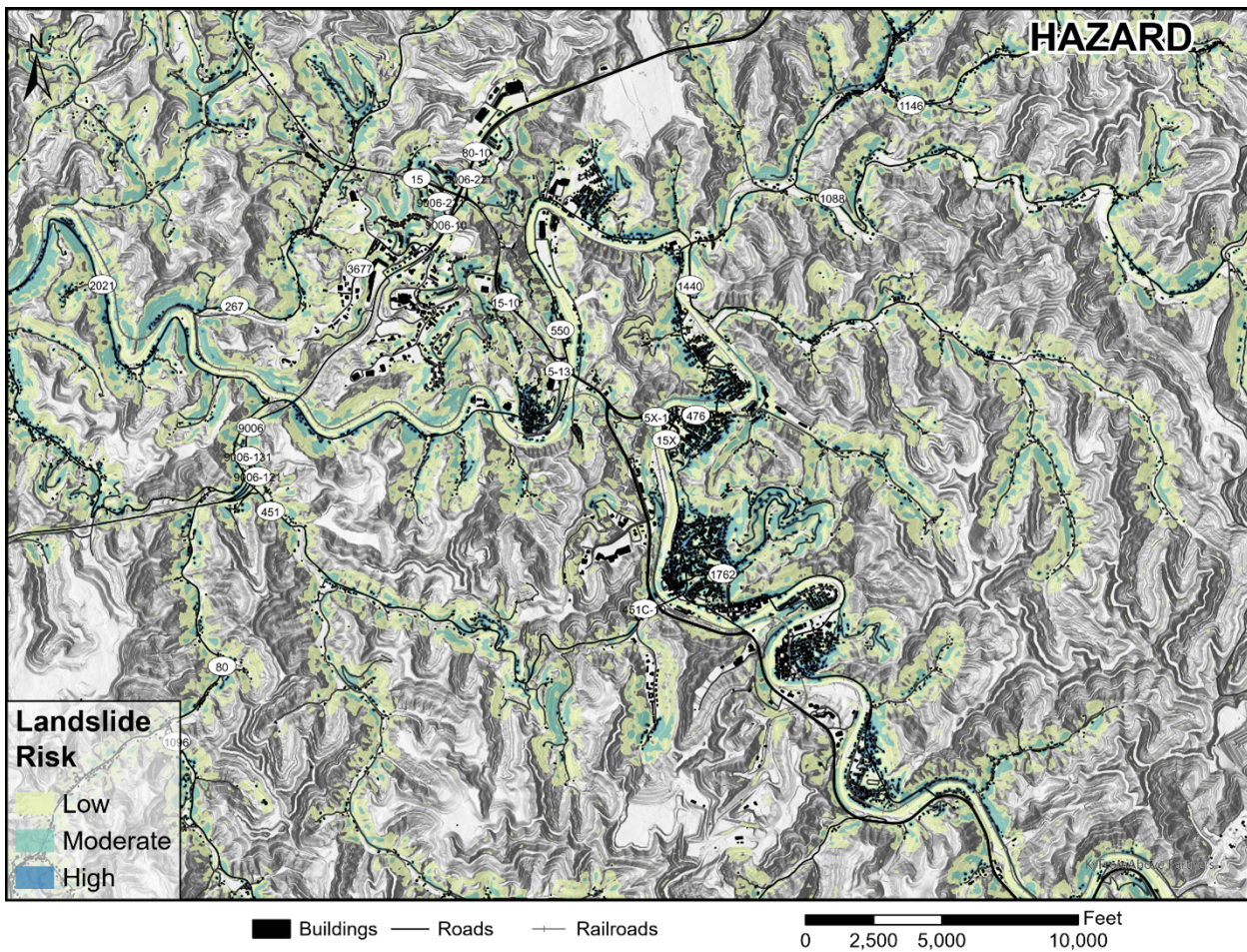


Figure 56. Landslide risk in Hazard, Perry County.

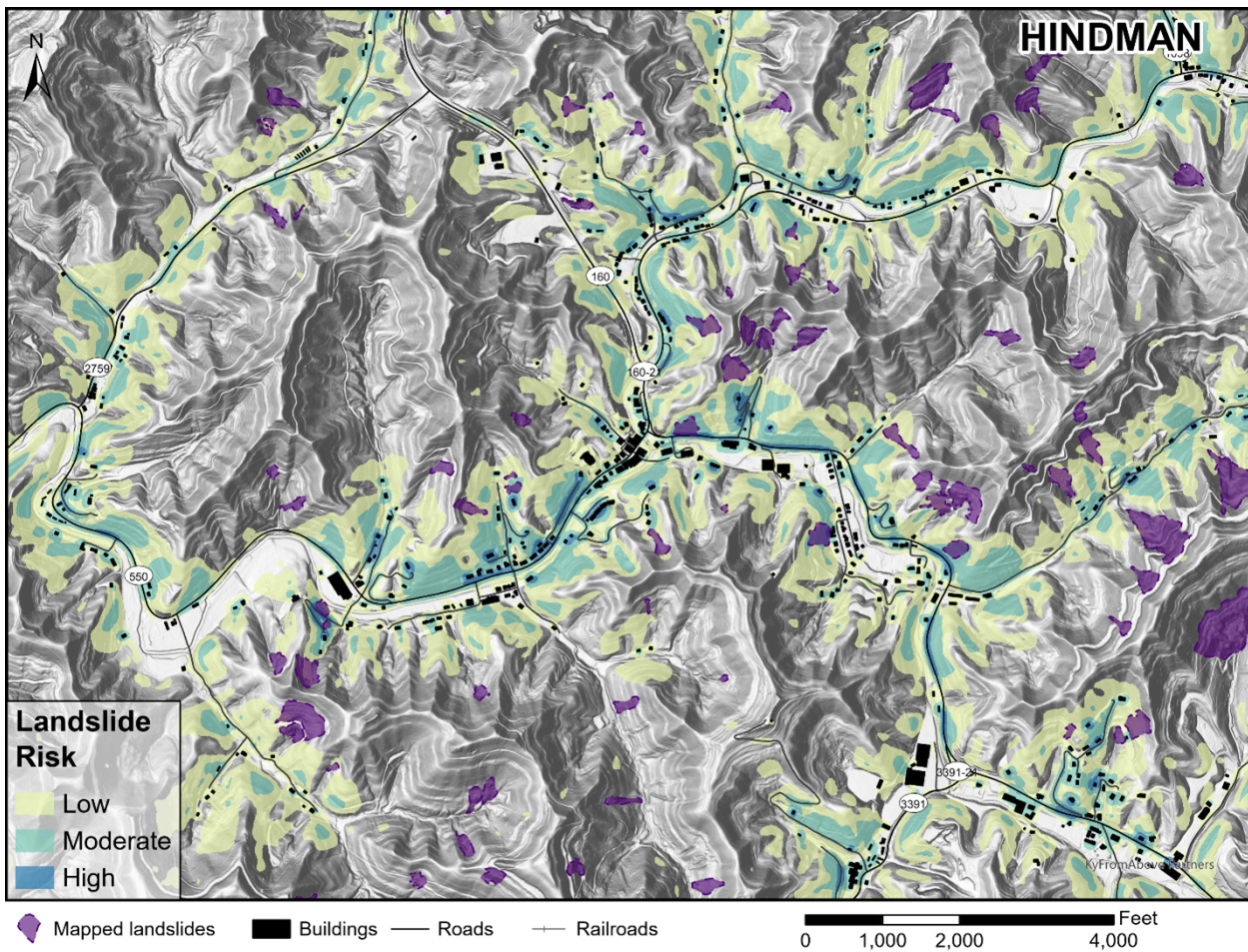


Figure 57. Landslide risk in Hindman, Knott County.

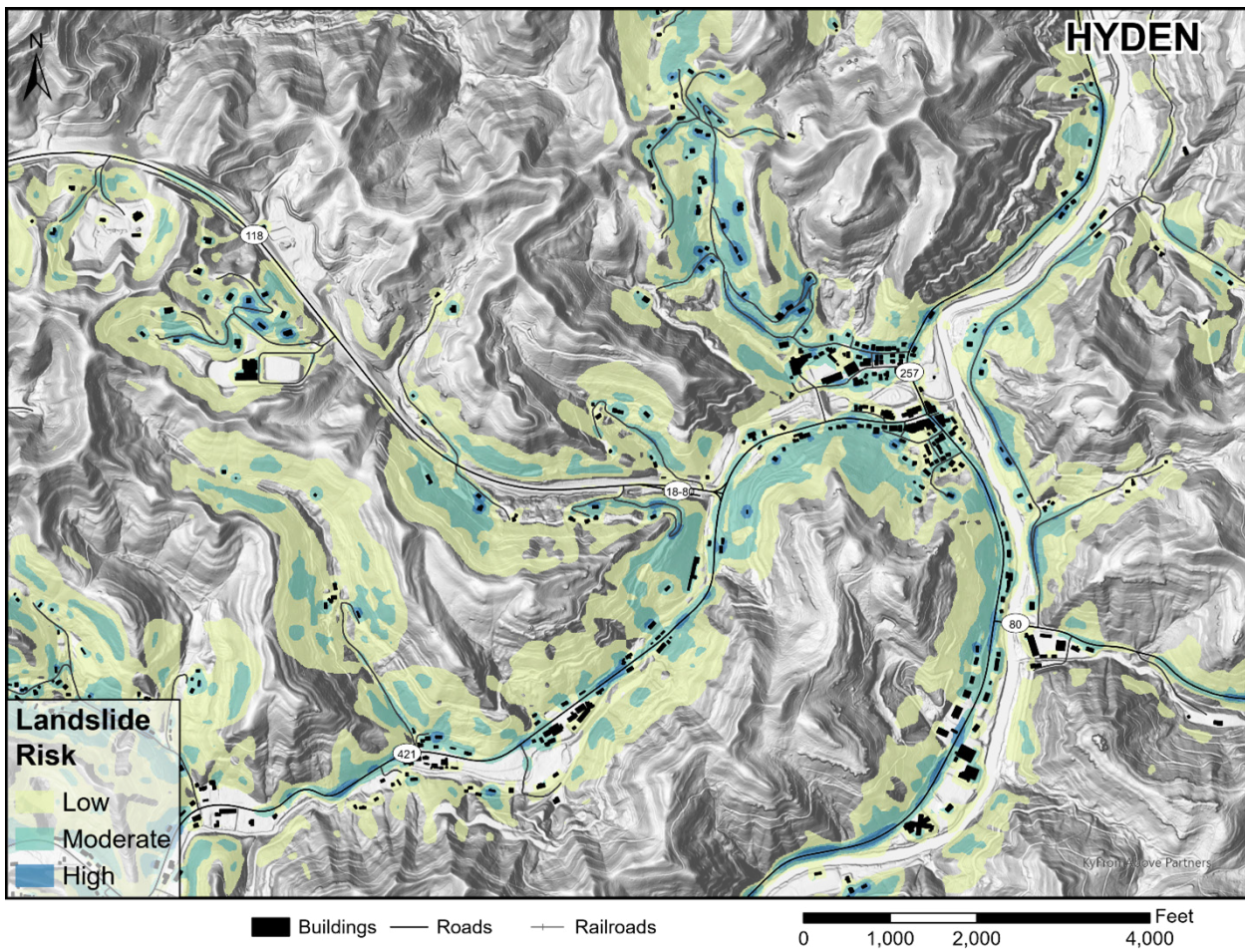


Figure 58. Landslide risk in Hyden, Leslie County.

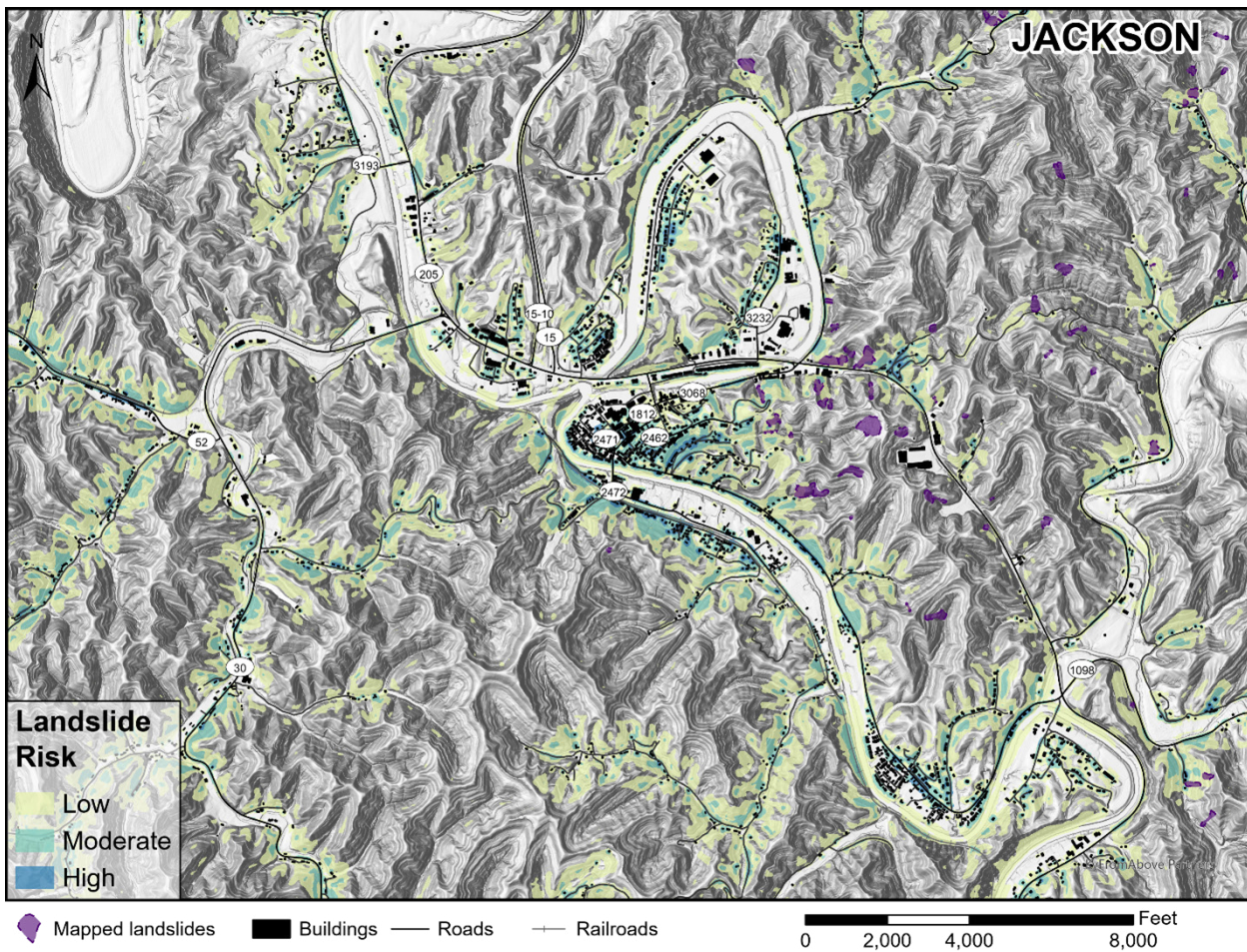


Figure 59. Landslide risk in Jackson, Breathitt County.

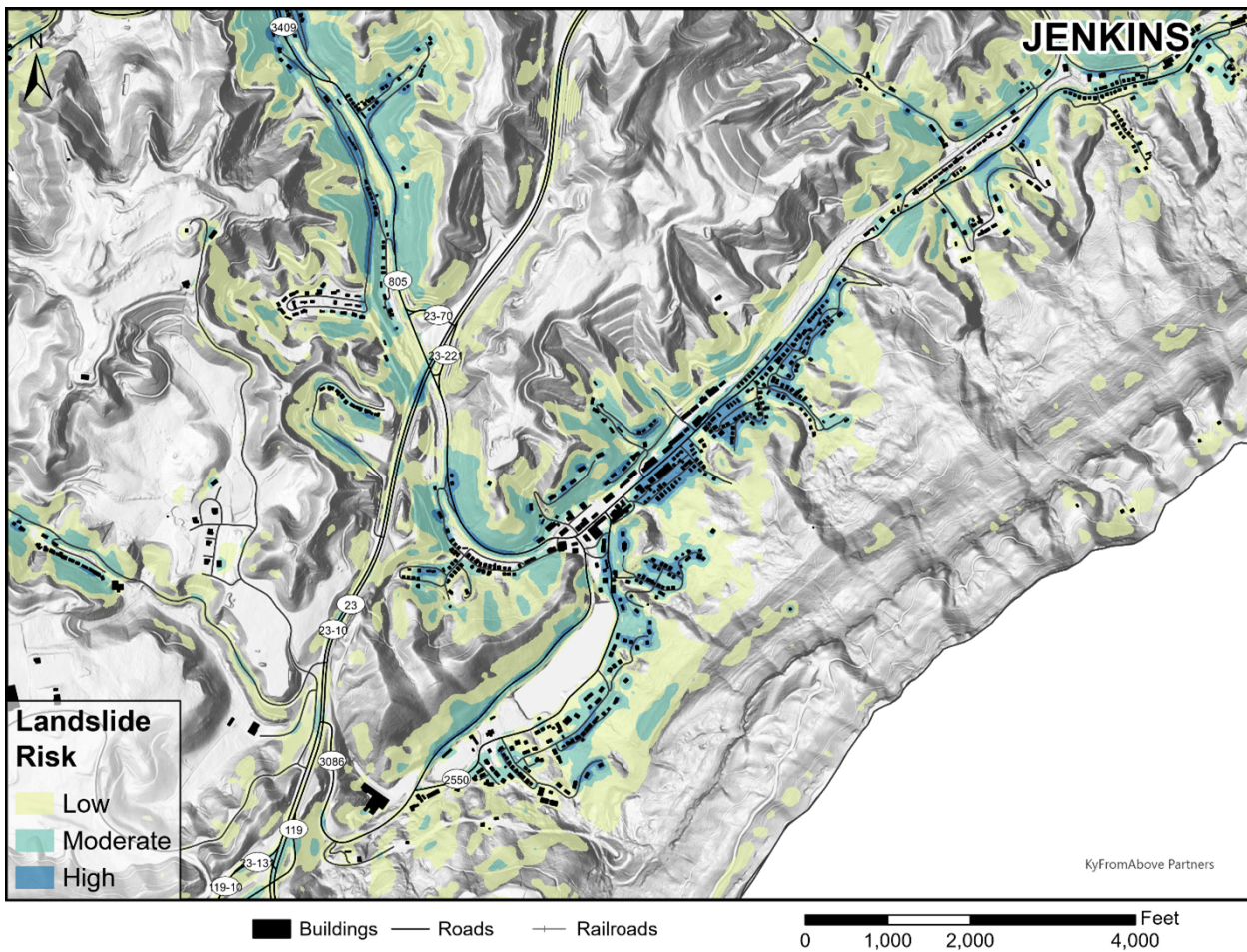


Figure 60. Landslide risk in part of Jenkins, Letcher County.

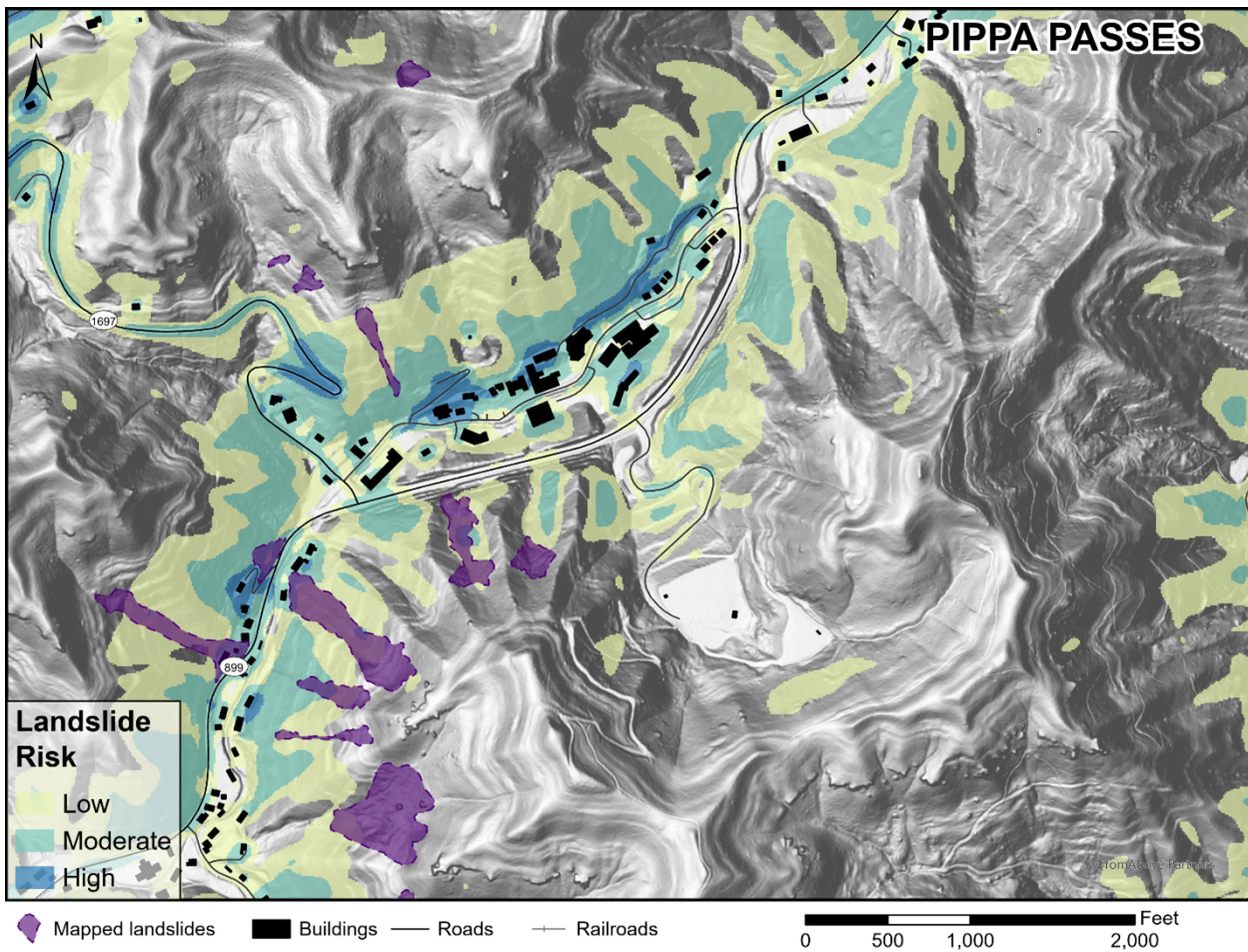


Figure 61. Landslide risk in Pippa Passes, Knott County.

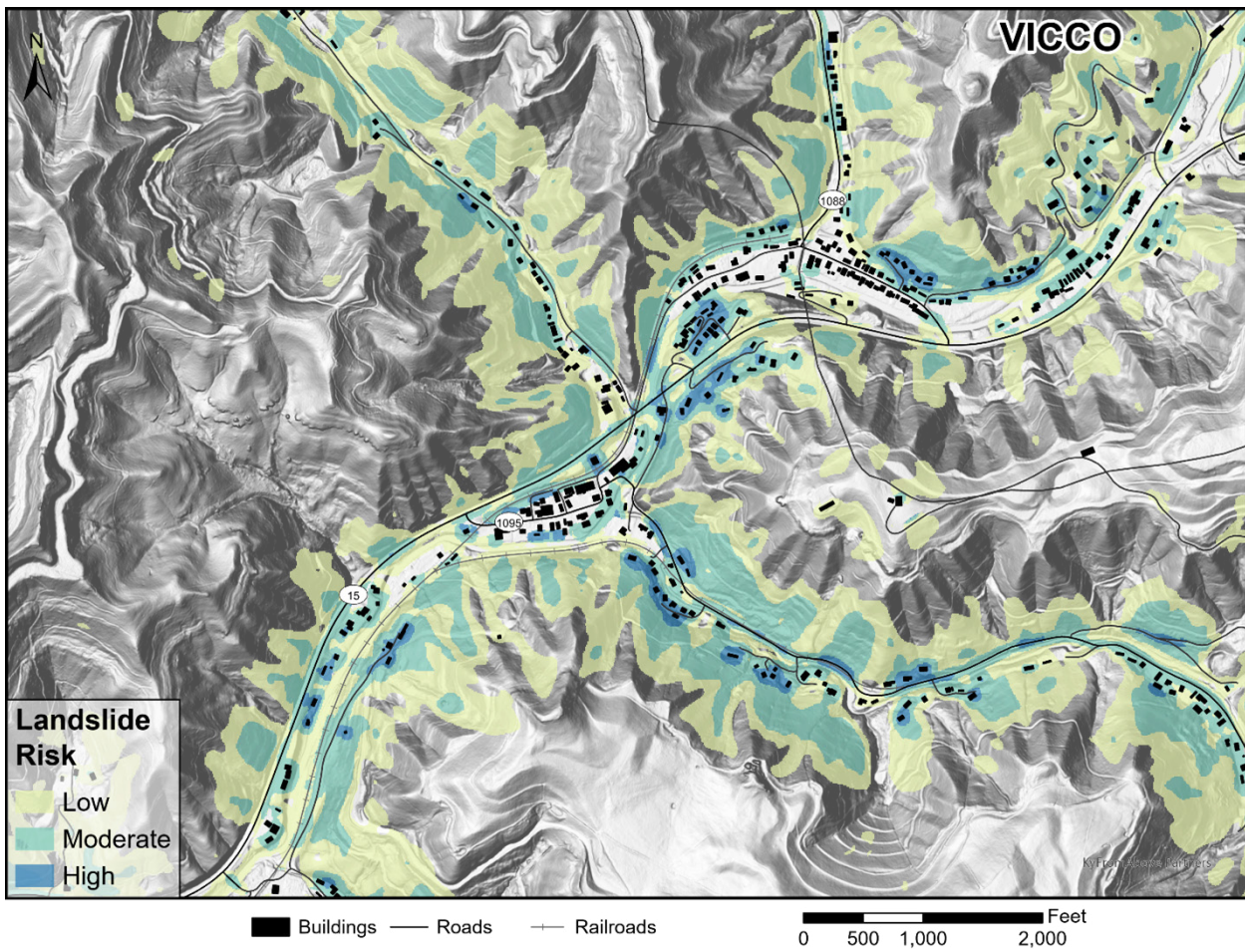


Figure 62. Landslide risk in Vicco, Perry County.

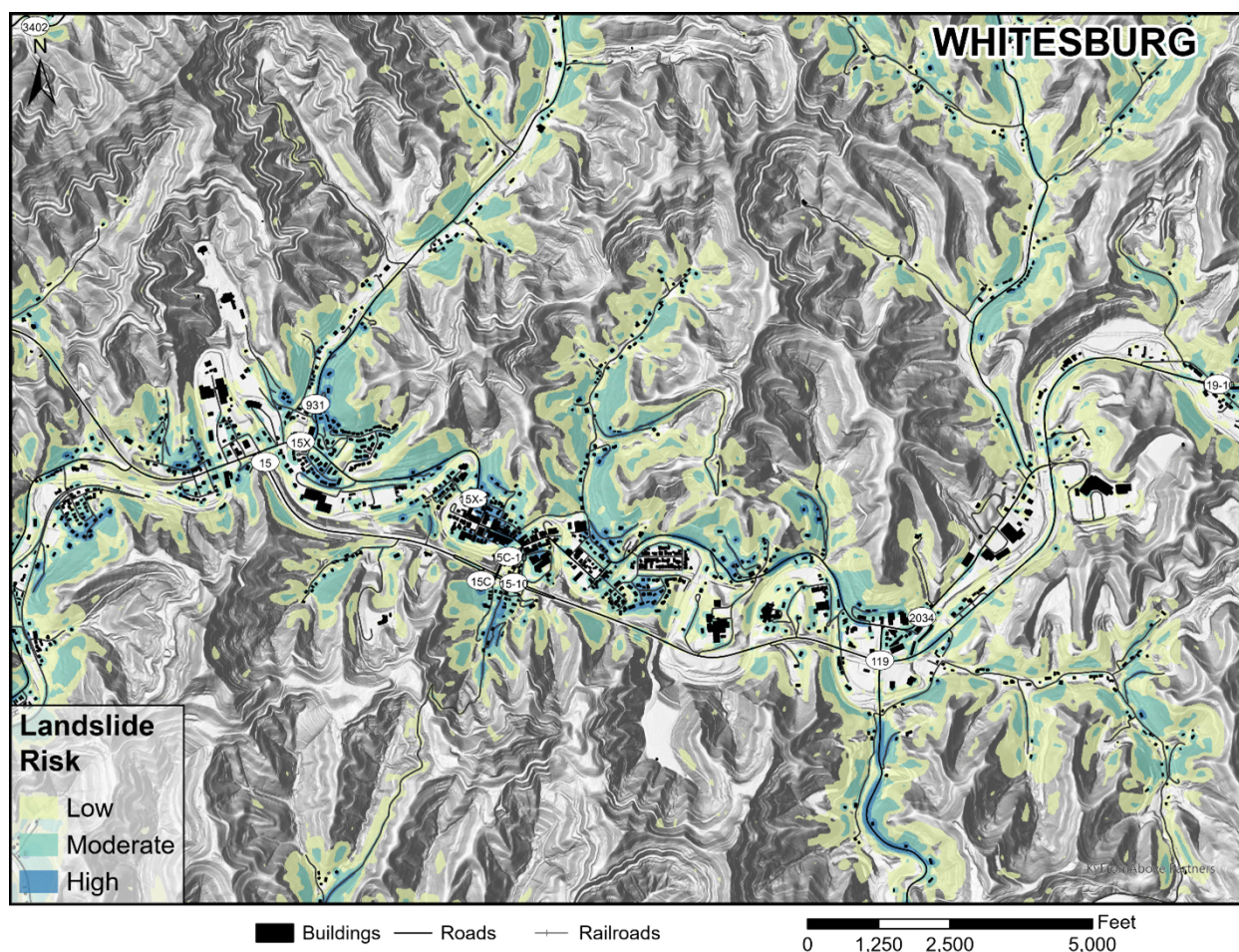


Figure 63. Landslide risk in Whitesburg, Letcher County.

Impacts and Vulnerability

Landslides occur across Kentucky, costing the Commonwealth approximately \$10 to \$20 million annually in direct costs from damage to homes, commercial property, and transportation infrastructure (Crawford et al., 2022b). Indirect costs (e.g., road closures, decreased property values, and utility interruption) are also significant but are much more challenging to quantify. Table 11 lists documented landslides in the KGS inventory that have associated costs. The sources of the annual direct cost estimates are from the Kentucky Transportation Cabinet, Kentucky Emergency Management, and the FEMA Landslide Loss Reduction guide (Wold and Jochim, 1989). The state and local government agencies that

respond to landslides vary in their approaches to landslide data collection, evaluation, and mitigation. Much of the economic loss and public cost is endured by federal, state, and local agencies responsible for disaster assistance and highway repair. Private costs involve mainly damage to land and homes, often resulting in financial ruin for homeowners. Damage from landslides is typically not covered by homeowner insurance policies.

To further quantify both direct and indirect risk, consequence layers not used in the risk model were intersected with the risk map. PVA data were collected for all KRADD counties except Letcher. These datasets detailed specific values for nearly all parcels in each county (Fig. 64).

Table 11. Landslides from the historical point inventory with associated costs.

County	Route	Failure year	Failure location	Slope angle (degrees)	Cost (USD)
Breathitt	Pond Branch Rd	2009	Natural slope	23.6	4,500.00
Breathitt	KY 15	2022	Below road, stream at bottom	37.2	819,762.00
Knott	KY 80	—	General road embankment	2.3	300,000.00
Knott	KY 15	—	Bridge embankment	1.2	2,160,000.00
Knott	KY 160	2022	Below road	33.9	496,086.40
Knott	KY 2029	2023	Below road, stream at bottom	24.4	105,981.20
Perry	KY 28	2022	Below road, stream at bottom	21.8	376,037.30
Perry	KY 484	2023	Below road, stream at bottom	32.8	61,738.55
Perry	KY 2446	2023	Below road, stream at bottom	26.2	112,941.00
Perry	KY 267	2023	Below road, stream at bottom	14.8	240,600.00
Perry	KY 484	2023	Below road, stream at bottom	20.2	94,243.00
Perry	KY 484	2023	Below road, stream at bottom	35.4	118,553.00
Perry	KY 484	2023	Below road, stream at bottom	27.8	88,495.00
Leslie	KY 118	—	Above road	27.8	375,000.00
Leslie	KY 257	2024	Below road, stream at bottom	35.6	567,576.01
Leslie	US 421	2022	Below road, stream at bottom	39.5	263,012.00
Leslie	US 421	2022	Below road, stream at bottom	38.2	373,499.60
Leslie	US 421	2022	Below road, stream at bottom	37.8	331,138.80
Leslie	KY 1482	2022	Below road, stream at bottom	25.7	276,378.00
Letcher	KY 932	2023	Below road, stream at bottom	43.4	123,955.35
Letcher	KY 805	2022	Below road, stream at bottom	24	296,747.10
Letcher	KY 7	2023	Below road, stream at bottom	43.8	161,074.50

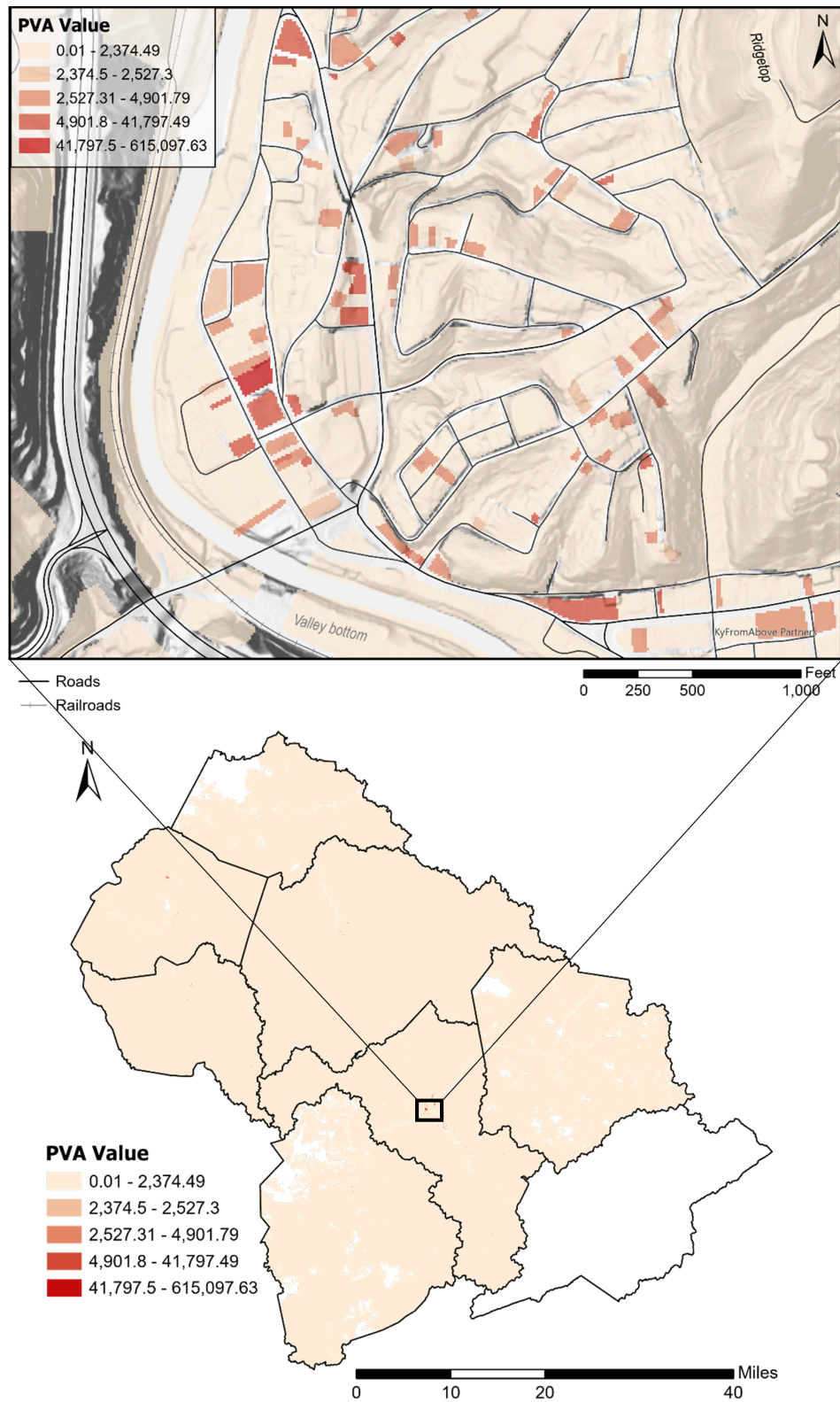


Figure 64. Property Value Administration (PVA) value map showing dollars per 10 square feet (i.e., per raster map pixel), similar to Figure 42. The inset is around downtown Hazard, Perry County.

These parcel values were converted into 10×10 ft cell equivalents and intersected with the risk and susceptibility models to determine the total economic parcel value for each risk/susceptibility class. This direct intersection avoided difficult normalization and binning strategies needed for more complicated spatial assessment techniques. The total at-risk costs for each risk class are shown in Table 12, and intersections with the susceptibility classes are shown in Table 13.

Direct intersection is approximate, as the landslide susceptibility/risk models do not include runoff, so the risk represented is static.

To address more indirect costs, specifically those from impacted roadways, we leveraged roadway datasets of traffic counts (TFC) and centrality provided by the Kentucky Transportation Center, a department within the University of Kentucky, and the Kentucky Transportation Cabinet (Zhang and Chen, 2025). TFC refers to surveys in which the total number of vehicles passing certain points over a certain time frame were counted. These traffic count studies were only performed on state-maintained roadways. Centrality, or betweenness centrality (BC), is a route metric that quantifies origin-destination pairs based on one-hour travel time. Using geometric/exponential binning, these TFC and BC values were classed into five groups, shown in Table 14.

BC and TFC groups were combined as a proxy for critical roadways (Fig. 65). This combined layer has values ranging from 2 to 10, where higher values correspond to large BC and TFC scores.

Risk model results were intersected with BC + TFC groups 7–10, which are considered the most critical roadways based on the higher BC and TFC rankings. These intersections indicate that 11% by area of the critical roadways are in the high-risk class (Table 15). Note that these intersections are approximate, much like the PVA data, as the risk models do not consider any runoff factors.

Mitigation Strategies

Hazard mitigation is any sustained action taken to reduce or eliminate the long-term risk to human life and property from hazards (FEMA, 2025b). The intent

Table 12. Total Property Value Administration dollar values for each risk class for the Kentucky River Area Development District.

Risk class	Total value (USD)
Low	803,808,110.00
Moderate	605,426,264.00
High	133,729,115.00
Total	1,542,963,489.00

Table 13. Total Property Value Administration dollar values for each susceptibility class for the Kentucky River Area Development District.

Susceptibility class	Total value (USD)
Low	841,077,707.00
Low-moderate	1,085,100,000.00
Moderate	386,763,096.00
Moderate-high	147,134,915.00
High	7,058,456.00
Total	2,467,134,174.00

Table 14. Traffic count (TFC) and betweenness centrality (BC) values and their corresponding groups.

Group	TFC	BC
1	6–186	0–0.001
2	187–741	0.002–0.006
3	742–2,448	0.007–0.027
4	2,449–7,706	0.028–0.1
5	7,707–23,887	0.11–0.47

of mitigation planning is to maintain a process that leads to hazard mitigation actions. Mitigation plans identify the natural hazards that impact communities, identify actions to reduce losses from those hazards, and establish a coordinated process to implement the plan. Integration of landslide hazard data and risk information into a multi-jurisdictional plan should revolve around goals of establishing resilience as a value of the community, providing the opportunity to

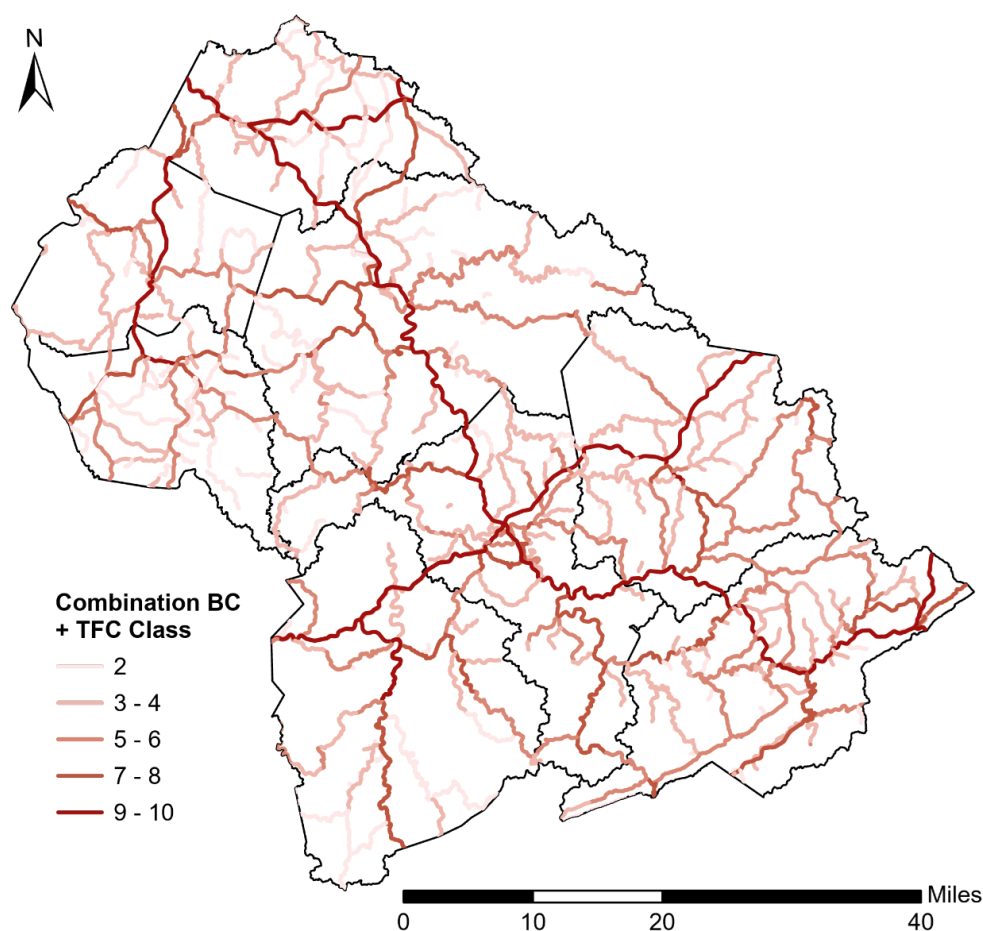


Figure 65. Combined betweenness centrality (BC) and traffic count (TFC) data for the Kentucky River Area Development District.

Table 15. Risk class area percentages for the most critical roadways in the Kentucky River Area Development District, defined as those in combined betweenness centrality and traffic count groups 7–10.

Risk class	Critical roadway coverage (%)
Excluded	23.18
Low	30.03
Moderate	30.95
High	11.04

manage development that does not lead to increased hazard vulnerability, and strengthening the safety of citizens. Landslide hazard identification, landslide

susceptibility, and landslide risk are the basis for a strategy that considers the following values within plan goals, projects, and plan maintenance of the [FEMA guidelines](#).

The primary goal of the maps and data presented in this plan is to provide the information needed to mitigate potential losses identified in the landslide susceptibility and risk assessments and to reduce the built environment's overall vulnerability to landslides. A key component of achieving these goals is communicating and disseminating a consistent message that reflects the landslide data, susceptibility and risk methods, and results. The plan content can serve as a framework for hazard mitigation actions, decision-making, and guide a workflow that satisfies the goals of mitigation action development, as well as plan maintenance and updates (Fig. 66).

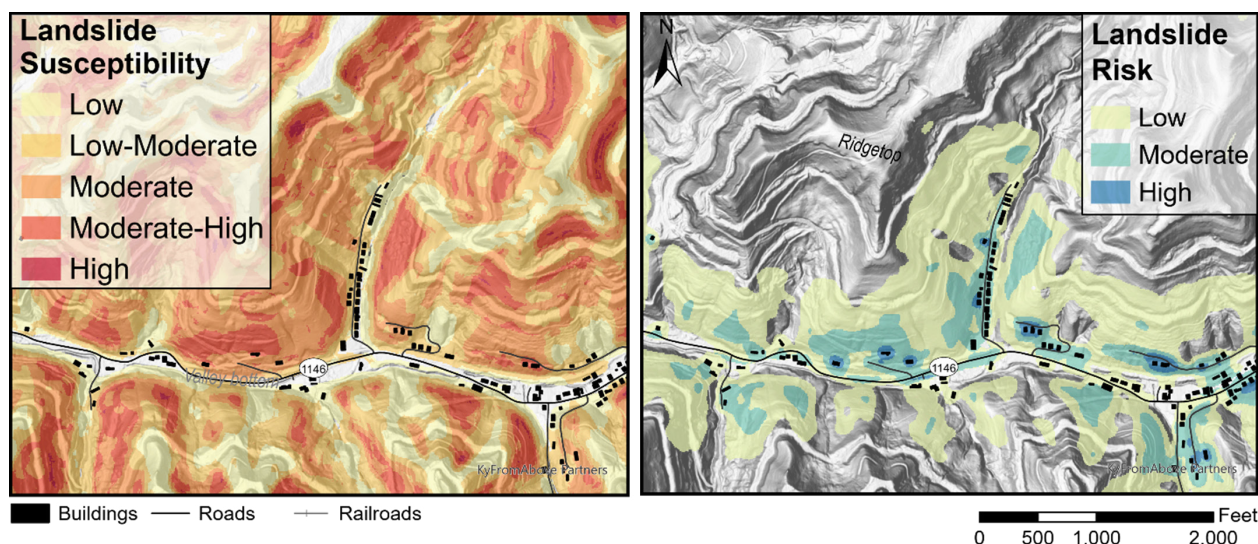


Figure 66. Landslide susceptibility (left) and landslide risk (right) north of Hazard, Perry County. Note the differences in where the moderate to high hazards occur on slopes versus the moderate to high-risk areas.

Specific Ideas/Projects

Spatial assessment of landslide hazard and vulnerability:

- Improve physical maps and GIS data, as well as the accessibility of the KGS Landslide Inventory
- Evaluate areas where landslides may occur to highlight potentially hazardous areas
- Complete an inventory of critical facilities vulnerable to landslides
- Evaluate and establish tolerable risk criteria
- Develop and maintain a database to track community vulnerability to landslides
- Establish effective communication avenues to discuss the landslide hazard and risk assessment process and limitations
- Establish frequent workshops or symposiums that convene to discuss mitigation strategies, hazard and risk assessment data and maps, other resources for stakeholders, and future work

Manage development:

- Create a plan to implement reinforcement measures in high-susceptibility and high-risk areas
- Define steep-slope/high-risk areas in land use and comprehensive plans and create guidelines or restrict new development in those areas
- Create or increase setback limits on parcels near high-susceptibility and high-risk areas

- Locate utilities outside of landslide areas to decrease the risk of service disruption
- Incorporate economic development activity restrictions in high-susceptibility and high-risk areas

Prevent impact to roads:

- Evaluate state and local roads that intersect high-susceptibility areas (Fig. 67, Table 14); spatial overlays (of road costs or susceptibility data, for example) are a good foundation for mitigation strategy goals, as well as for implementing specific projects
- Implement monitoring mechanisms/procedures (i.e., visual inspection or electronic monitoring systems)
- Apply soil stabilization measures, such as planting soil-stabilizing vegetation on steep, publicly owned slopes
- Use debris-flow mitigation measures that may reduce damage in sloping areas, such as stabilization, energy dissipation, and flow control measures
- Establish setback requirements and use large setbacks when building roads near slopes of marginal stability
- Install catch-fall nets for rocks on steep slopes and roadcuts near roadways

Disclaimer and Data Limitations

The information and data for this plan were compiled by researchers at the Kentucky Geological Survey. For more information on geologic hazards, current research projects, and further reading, visit [the KGS website](#). The figures and printed maps are smaller-scale representations of the digital spatial data that have been generated for use in a geographic information system (GIS). The data are best used in a GIS at larger scales. These landslide susceptibility and risk maps are not intended to be substitutes for site-specific investigations by licensed geologists or geotechnical engineers. The maps and GIS data do show intersections between potentially hazardous areas and infrastructure; at these intersections, investigations of slope stability or other mitigation efforts may be appropriate prior to slope disturbance.

Acknowledgments

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Appendix A. Kentucky River Area Development District landslide data selected from the Kentucky Geological Survey Landslide Inventory. Not all documented landslides have impact information (failure year and location, movement type, track dimensions, and damage), as this information is not always recorded. Landslides with associated cost estimates are listed in Table 10.

County	7.5-min quadrangle	Route	Failure year	Movement type	Track length (ft)	Width (ft)	Failure location	Slope angle (degrees)	Damage
Breathitt	Quicksand	Hensley Cemetery Rd	—	—	—	—	—	4.8	—
Breathitt	Quicksand	KY 1098	—	—	—	—	—	2.7	—
Breathitt	Quicksand	KY 1098	—	—	—	—	—	37	—
Breathitt	Quicksand	KY 1098	—	—	—	—	—	24.2	—
Breathitt	Quicksand	KY 1098	—	—	—	—	—	35.4	—
Breathitt	Quicksand	KY 1098	—	—	—	—	—	1.2	—
Breathitt	Haddix	KY 15	—	—	—	—	—	26.1	—
Breathitt	Jackson	KY 3193	—	—	—	—	—	6.5	—
Breathitt	Jackson	KY 378	—	—	—	—	—	2	—
Breathitt	Jackson	KY 541	—	—	—	—	—	2.7	—
Breathitt	Jackson	KY 541	—	—	—	—	—	14.8	—
Breathitt	Jackson	KY 30	—	—	—	—	—	12.4	—
Breathitt	Jackson	Stray Branch Rd	—	—	—	—	—	6.5	—
Breathitt	Jackson	Fire Trail Rd	—	—	—	—	—	23.4	—
Breathitt	Jackson	KY 3193	—	—	—	—	—	2.1	—
Breathitt	Jackson	KY 378	—	—	—	—	—	4.6	—
Breathitt	Jackson	Buzzard Hollow Rd	—	—	—	—	—	35.9	—
Breathitt	Jackson	KY 15	—	—	—	—	—	26.3	—
Breathitt	Jackson	KY 52	—	—	—	—	—	3.8	—
Breathitt	Jackson	Shacks Branch Rd	—	—	—	—	—	11.5	—
Breathitt	Jackson	KY 15	—	—	—	—	General road embankment	18.1	Y
Breathitt	Jackson	KY 15	—	—	—	—	—	36.2	—
Breathitt	Jackson	—	—	—	—	—	—	20.6	—
Breathitt	Guage	—	—	—	—	—	—	26.3	—

Appendix A (continued)

County	7.5-min quadrangle	Route	Failure year	Movement type	Track length (ft)	Width (ft)	Failure location	Slope angle (degrees)	Damage
Breathitt	Jackson	—	—	—	—	—	—	30.4	—
Breathitt	Canoe	—	—	—	—	—	—	25.7	—
Breathitt	Guage	—	—	—	—	—	—	32.8	—
Breathitt	Haddix	—	—	—	—	—	—	1.9	—
Breathitt	Haddix	KY 15	—	—	—	—	—	33.4	Y
Breathitt	Canoe	KY 2469	2017	—	—	—	Above and below road	27.1	—
Breathitt	Buckhorn	KY 1110	2018	—	—	—	Above and below road	23.4	Y
Breathitt	Lee City	KY 378	2018	—	—	—	—	25.6	Y
Breathitt	Haddix	KY 1110	2018	—	—	—	Above road	32.3	Y
Breathitt	Buckhorn	KY 1110	—	—	—	—	—	38.1	—
Breathitt	Buckhorn	KY 28	2018	—	—	—	—	25.4	—
Breathitt	Canoe	KY 315	2019	—	—	—	—	21.9	Y
Breathitt	Haddix	KY 1110	2020	—	—	—	—	36	Y
Breathitt	Haddix	KY 1110	2020	—	—	—	Above road	38.9	Y
Breathitt	Canoe	KY 1110	2022	—	—	—	Below road	34.7	Y
Breathitt	Haddix	KY 1278	2022	—	—	—	Below road	34	Y
Breathitt	Guage	KY 542	2022	—	—	—	Below road, stream at bottom	32.3	Y
Breathitt	Tiptop	KY 542	2022	—	—	—	Below road, stream at bottom	26.8	Y
Breathitt	Tiptop	KY 542	2022	—	—	—	Below road, stream at bottom	28.9	Y
Breathitt	Quicksand	KY 1098	2022	—	—	—	General road embankment	34.6	Y
Breathitt	Haddix	KY 1278	2022	—	—	—	Below road, stream at bottom	23.3	Y
Breathitt	Haddix	KY 1278	2022	—	—	—	General road embankment	31.6	Y
Breathitt	Haddix	KY 1278	2022	—	—	—	General road embankment	24.6	Y
Breathitt	Haddix	KY 1278	2022	—	—	—	Below road, stream at bottom	30.5	Y
Breathitt	Buckhorn	KY 1388	2022	—	—	100	Below road, stream at bottom	40.5	Y
Breathitt	Quicksand	KY 1812	2022	—	—	100	Below road	18.1	Y

Appendix A (continued)

County	7.5-min quadrangle	Route	Failure year	Movement type	Track length (ft)	Width (ft)	Failure location	Slope angle (degrees)	Damage
Breathitt	Quicksand	KY 1812	2022	—	—	320	Below road	40.2	Y
Breathitt	Canoe	KY 1933	2022	—	—	115	Below road, stream at bottom	31.5	Y
Breathitt	Canoe	KY 1933	2022	—	—	210	Below road, stream at bottom	40.4	Y
Breathitt	Jackson	—	2022	—	—	—	—	17.6	—
Breathitt	Buckhorn	KY 28	2025	—	—	—	Above road	—	Y
Breathitt	Quicksand	KY 1098	2025	—	—	—	Below road, stream at bottom	—	Y
Breathitt	Buckhorn	KY 1388	2025	—	—	—	Below road	—	Y
Breathitt	Jackson	KY 3193	2025	—	—	—	Below road, stream at bottom	—	Y
Breathitt	Haddix	KY 15	—	—	—	—	—	—	—
Breathitt	Haddix	KY 15	—	—	—	—	—	—	—
Breathitt	Cowcreek	KY 28	2025	—	—	—	Above road	—	—
Breathitt	Quicksand	KY 1098	—	General slide	—	—	—	0.8	—
Breathitt	Quicksand	Smith Branch Rd	—	General slide	—	—	Natural slope	33.2	—
Breathitt	Quicksand	Cabin Hill Rd	—	General slide	30	10	Below road	9.3	Y
Breathitt	Quicksand	KY 1812	—	General slide	—	—	Below road	8.8	Y
Breathitt	Quicksand	KY 1812	—	General slide	—	—	Above road	7.3	—
Breathitt	Quicksand	KY 2436	—	General slide	—	—	Below road	8.4	Y
Breathitt	Jackson	Pond Branch Rd	2009	General slide	—	—	Natural slope	23.6	Y
Breathitt	Tallega	Bryants Creek Rd	—	General slide	—	—	Natural slope, stream at bottom	38.3	—
Breathitt	Tallega	KY 2469	—	General slide	50	—	Above road	39	Y
Breathitt	Tallega	KY 2469	—	General slide	—	—	Above road, stream at bottom	28	Y
Breathitt	Tallega	KY 2469	—	General slide	—	—	Above road, stream at bottom	6.8	—
Breathitt	Tallega	KY 2469	—	General slide	—	—	Below road, stream at bottom	37	Y
Breathitt	Quicksand	KY 540	—	General slide	—	—	—	27.5	—
Breathitt	Quicksand	KY 2436	—	General slide	—	—	Below road	31.4	Y
Breathitt	Quicksand	KY 2436	—	General slide	—	—	Below road	32	Y

Appendix A (continued)

County	7.5-min quadrangle	Route	Failure year	Movement type	Track length (ft)	Width (ft)	Failure location	Slope angle (degrees)	Damage
Breathitt	Quicksand	KY 30	—	General slide	—	—	—	40.2	—
Breathitt	Quicksand	KY 30	—	General slide	—	—	Below road, stream at bottom	2.8	Y
Breathitt	Quicksand	KY 1812	—	General slide	—	—	—	14.5	—
Breathitt	Noble	Clemons Fork Rd	—	General slide	—	—	—	38.1	Y
Breathitt	Buckhorn	Baker Dr	2011	General slide	—	—	—	2.3	Y
Breathitt	Quicksand	KY 30	—	General slide	—	—	Below road, stream at bottom	23.3	Y
Breathitt	Quicksand	Cabin Hill Rd	—	General slide	—	—	Above and below road	6.4	—
Breathitt	Quicksand	KY 30	—	General slide	—	—	Below road, stream at bottom	3.3	Y
Breathitt	Haddix	KY 1110	2013	General slide	—	—	Above road, stream at bottom	31.6	Y
Breathitt	Quicksand	KY 30	2013	General slide	—	—	Above road	72.2	Y
Breathitt	Jackson	—	2014	General slide	—	—	Natural slope	23.6	—
Breathitt	Lee City	KY 378	2015	General slide	—	—	Above and below road	34.7	Y
Breathitt	Tallega	KY 2469	2015	General slide	—	—	—	37.6	—
Breathitt	Cowcreek	KY 2469	2015	General slide	—	—	—	24.6	—
Breathitt	Buckhorn	Miller Branch Barwick Rd	2015	General slide	—	—	Above and below road	30.9	Y
Breathitt	Tallega	KY 2469	2015	General slide	—	—	Above road, stream at bottom	32.5	Y
Breathitt	Canoe	KY 30	2015	General slide	—	—	Above road	10	—
Breathitt	Noble	Clemons Fork	2015	General slide	—	—	—	34.7	Y
Breathitt	Jackson	Blue Jay Rd	2014	General slide	—	—	—	2.9	Y
Breathitt	Jackson	KY 3193 (Wolverine Rd)	2016	General slide	—	—	—	41.2	Y
Breathitt	Canoe	KY 397	2023	General slide	—	—	Above road	36.2	—
Breathitt	Haddix	KY 15	2022	General slide	—	380	Below road, stream at bottom	37.2	Y
Breathitt	Jackson	KY 15	—	Rockfall	—	—	Above road	4.1	Y
Breathitt	Quicksand	KY 15	2015	Rockfall	—	40	Mine highwall	3.5	Y
Breathitt	Canoe	KY 3237	2018	Rockfall	—	—	Above road	52.6	—
Breathitt	Guage	KY 30	2020	Rockfall	—	—	—	28.1	Y

Appendix A (continued)

County	7.5-min quadrangle	Route	Failure year	Movement type	Track length (ft)	Width (ft)	Failure location	Slope angle (degrees)	Damage
Breathitt	Canoe	—	2016	Rockslide	—	—	Natural slope, stream at bottom	40.9	Y
Breathitt	Jackson	KY 52	2023	Rockslide	—	—	Above road	33.1	Y
Breathitt	Tallega	KY 2469	—	Rotational slide	—	—	Below road	12.4	Y
Knott	Handshoe	Rt 1098	—	—	—	—	—	28.9	—
Knott	Carrie	KY 80	—	—	—	—	General road embankment	2.3	—
Knott	Hindman	KY 550	—	—	—	—	—	5	—
Knott	Blackey	KY 15	—	—	—	—	Bridge embankment	1.2	—
Knott	Hindman	KY 550	—	—	—	—	—	47.6	—
Knott	Hindman	KY 80	—	—	—	—	General road embankment	2	—
Knott	Kite	KY 582	—	—	—	—	—	48.1	—
Knott	Wayland	KY 550	2004	—	—	—	—	27.4	—
Knott	Kite	Puncheon Rd	2010	—	—	—	—	36	—
Knott	Hindman	—	—	—	—	—	—	2.3	—
Knott	Kite	—	—	—	—	—	—	4.7	—
Knott	Carrie	—	—	—	—	—	—	19.4	—
Knott	Blackey	—	—	—	—	—	—	39.6	—
Knott	Hindman	—	—	—	—	—	—	0.9	—
Knott	Hindman	—	—	—	—	—	—	2.1	—
Knott	Hindman	—	—	—	—	—	—	30.3	—
Knott	Carrie	—	—	—	—	—	—	22.2	—
Knott	Hindman	—	—	—	—	—	—	41.7	—
Knott	Hindman	—	—	—	—	—	—	27.2	—
Knott	Blackey	—	—	—	—	—	—	35.6	—
Knott	Kite	—	—	—	—	—	—	11.8	—
Knott	Carrie	—	—	—	—	—	—	28.8	—
Knott	Carrie	—	—	—	—	—	—	23.3	—

Appendix A (continued)

County	7.5-min quadrangle	Route	Failure year	Movement type	Track length (ft)	Width (ft)	Failure location	Slope angle (degrees)	Damage
Knott	Hindman	—	—	—	—	—	—	29.8	—
Knott	Hindman	—	—	—	—	—	—	23	—
Knott	Carrie	—	—	—	—	—	—	26.2	—
Knott	Carrie	—	—	—	—	—	—	5.9	—
Knott	Carrie	—	—	—	—	—	—	29.2	—
Knott	Carrie	—	—	—	—	—	—	35.4	—
Knott	Hindman	—	—	—	—	—	—	24.8	—
Knott	Blackey	—	—	—	—	—	—	16.8	—
Knott	Kite	—	—	—	—	—	—	21.7	—
Knott	Carrie	—	—	—	—	—	—	58.8	—
Knott	Handshoe	—	—	—	—	—	—	45.4	—
Knott	Hindman	—	—	—	—	—	—	21.3	—
Knott	Kite	—	—	—	—	—	—	2	—
Knott	Handshoe	—	—	—	—	—	—	20.7	—
Knott	Hindman	—	—	—	—	—	—	26.8	—
Knott	Blackey	—	—	—	—	—	—	3.2	—
Knott	Carrie	—	—	—	—	—	—	29	—
Knott	Carrie	—	—	—	—	—	—	40.4	—
Knott	Kite	—	—	—	—	—	—	38.1	—
Knott	Carrie	—	—	—	—	—	—	2.3	—
Knott	Carrie	—	—	—	—	—	—	7.2	—
Knott	Carrie	—	—	—	—	—	—	1.9	—
Knott	Carrie	—	—	—	—	—	—	34.9	—
Knott	Kite	—	—	—	—	—	—	41.4	—
Knott	Kite	—	—	—	—	—	—	49.3	—
Knott	Carrie	—	—	—	—	—	—	34.9	—

Appendix A (continued)

County	7.5-min quadrangle	Route	Failure year	Movement type	Track length (ft)	Width (ft)	Failure location	Slope angle (degrees)	Damage
Knott	Hindman	—	—	—	—	—	—	24.5	—
Knott	Kite	—	—	—	—	—	—	37.6	—
Knott	Carrie	—	—	—	—	—	—	6.2	—
Knott	Carrie	—	—	—	—	—	—	36.6	—
Knott	Hindman	—	—	—	—	—	—	30.8	—
Knott	Carrie	—	—	—	—	—	—	33.2	—
Knott	Kite	—	—	—	—	—	—	1.4	—
Knott	Kite	—	—	—	—	—	—	29.1	—
Knott	Blackey	—	—	—	—	—	—	37.8	—
Knott	Kite	KY 582	2016	—	—	—	—	41	Y
Knott	Carrie	KY 1102	—	—	—	—	Stream at bottom	2	Y
Knott	Kite	KY 899	2017	—	—	—	—	24.8	Y
Knott	Kite	—	2015	—	280	75	—	36.2	Y
Knott	Handshoe	KY 1087	2017	—	—	—	—	15.2	—
Knott	Handshoe	Pinetree Hollow	2018	—	—	—	Above road	27.7	Y
Knott	Hindman	KY 160	2018	—	—	—	—	30.2	—
Knott	Wayland	Ky 7	—	—	—	—	—	32.2	Y
Knott	Carrie	KY 721	2019	—	—	—	—	19.5	—
Knott	Carrie	KY 550	2019	—	—	—	—	35	Y
Knott	Blackey	KY 1410	2019	—	—	—	—	35.5	Y
Knott	Carrie	KY 550	2019	—	—	—	—	25.2	Y
Knott	Hindman	KY 550	2019	—	—	—	—	17.3	—
Knott	Hindman	KY 1231	2019	—	—	—	—	26.1	—
Knott	Kite	74 Bessie Hall Ln	2019	—	—	—	—	28.4	—
Knott	Hindman	KY 550	2019	—	—	—	—	18.6	—
Knott	Kite	KY 582	2019	—	—	—	—	9.6	Y

Appendix A (continued)

County	7.5-min quadrangle	Route	Failure year	Movement type	Track length (ft)	Width (ft)	Failure location	Slope angle (degrees)	Damage
Knott	Handshoe	KY 1087	2020	—	—	—	—	35.7	Y
Knott	Hindman	KY 550	2019	—	—	—	—	24.4	—
Knott	Hindman	KY 1697	2021	—	—	—	—	6.8	—
Knott	Handshoe	KY 1098	2022	—	—	—	Above and below road	37.2	Y
Knott	Carrie	KY 3392	2022	—	—	—	—	2.2	—
Knott	Blackey	KY 1410	2022	—	—	250	Below road, stream at bottom	47.1	Y
Knott	Carrie	225 Lowerfield Hollow Rd	2022	—	—	—	—	36.6	—
Knott	Carrie	KY 1088	2022	—	—	—	—	55.9	Y
Knott	Hindman	KY 3391	2024	—	—	—	Below road, stream at bottom	29.6	Y
Knott	Hindman	KY 3391	2024	—	—	—	Below road, stream at bottom	35.9	Y
Knott	Carrie	KY 721	2024	—	—	—	Below road, stream at bottom	29	Y
Knott	Carrie	KY 721	2024	—	—	—	Below road, stream at bottom	42.8	Y
Knott	Carrie	KY 721	2024	—	—	—	Below road, stream at bottom	29.1	Y
Knott	Hindman	KY 1697	2024	—	—	—	Below road, stream at bottom	42	Y
Knott	Hindman	KY 1697	2024	—	—	—	Below road	39.4	Y
Knott	Hindman	KY 1697	2024	—	—	—	Below road, stream at bottom	46.5	Y
Knott	Hindman	KY 1697	2024	—	—	—	Below road, stream at bottom	29.9	Y
Knott	Hindman	KY 1697	2024	—	—	—	Below road, stream at bottom	40	Y
Knott	Hindman	KY 1697	2024	—	—	—	Below road	39	Y
Knott	Hindman	KY 1697	2024	—	—	—	Below road	34.7	Y
Knott	Carrie	KY 2102	2024	—	—	—	Below road, stream at bottom	10.6	Y
Knott	Carrie	KY 2102	2024	—	—	—	General road embankment	41.6	Y
Knott	Carrie	KY 2102	2024	—	—	—	General road embankment	38.6	Y
Knott	Hindman	KY 3391	2022	—	—	—	Below road, stream at bottom	36	Y
Knott	Hindman	KY 160	2022	—	—	350	Below road	33.9	Y
Knott	Hindman	KY 3391	2024	—	—	—	Below road, stream at bottom	23.4	Y

Appendix A (continued)

County	7.5-min quadrangle	Route	Failure year	Movement type	Track length (ft)	Width (ft)	Failure location	Slope angle (degrees)	Damage
Knott	Blackey	KY 1410	2022	—	—	504	Below road, stream at bottom	43.5	Y
Knott	Kite	KY 582	2024	—	—	—	Above road	59.7	—
Knott	Vest	KY 1087	2025	—	—	—	Above road	—	—
Knott	Blackey	KY 15	2025	—	—	—	Above road	—	—
Knott	Carrie	KY 476	2025	—	—	—	Above road	—	Y
Knott	Vicco	KY 15	2025	—	—	—	Above road	—	Y
Knott	Carrie	KY 1102	2025	—	—	—	Above road	—	Y
Knott	Carrie	KY 80	2025	—	—	—	—	—	Y
Knott	Handshoe	KY 1087	2025	—	—	—	Below road, stream at bottom	—	Y
Knott	Handshoe	KY 550	2020	Debris flow	—	—	—	33.5	Y
Knott	Wayland	KY 550	—	General slide	—	—	—	39.4	—
Knott	Wayland	KY 550	—	General slide	—	—	—	30.8	—
Knott	Handshoe	KY 80	—	General slide	—	—	Above and below road, stream at bottom	38	Y
Knott	Handshoe	Shiloh Dr	—	General slide	—	—	—	28	—
Knott	Hindman	KY 582	2011	General slide	—	—	Above road, stream at bottom	24.2	Y
Knott	Kite	Puncheon Rd	2011	General slide	—	—	—	25.5	Y
Knott	Vicco	KY 15	2012	General slide	—	—	Above road	73.1	Y
Knott	Handshoe	Yellow Mountain Rd	—	General slide	85	—	Above road	29.3	—
Knott	Wayland	KY 7	2013	General slide	—	—	Above road, stream at bottom	1.2	Y
Knott	Carrie	KY 1088	2013	General slide	—	—	—	1.9	Y
Knott	Handshoe	KY 1087	2013	General slide	—	—	Above road	19.4	Y
Knott	Kite	KY 899	2015	General slide	—	—	Above road	37.8	—
Knott	Hindman	KY 550	2016	General slide	—	—	—	31.7	Y
Knott	Handshoe	98 Hoot Owl Hollow	2019	General slide	—	—	—	14.2	Y
Knott	Wayland	KY 7	2022	General slide	—	—	Above road	37.5	—
Knott	Hindman	KY 2759	2022	General slide	—	—	Road cut	63.7	—

Appendix A (continued)

County	7.5-min quadrangle	Route	Failure year	Movement type	Track length (ft)	Width (ft)	Failure location	Slope angle (degrees)	Damage
Knott	Vest	KY 1087	2024	General slide	—	—	Above road	35.3	—
Knott	Handshoe	KY 2029	2023	General slide	—	92	Below road, stream at bottom	24.4	Y
Knott	Handshoe	KY 2029	2024	General slide	—	—	Below road, stream at bottom	39.8	Y
Knott	Carrie	KY 80	2018	Rockfall	—	—	Above road	78.7	Y
Knott	Blackey	KY 15	2020	Rockfall	—	—	Road cut	68	Y
Knott	Carrie	KY 1088	—	Rockslide	—	—	Above road	51.5	Y
Knott	Handshoe	White Oak Flats	2009	Translational slide	—	—	—	2.2	—
Lee	Beattyville	KY 52	—	—	—	—	—	17.4	—
Lee	Beattyville	KY 1144	—	—	—	—	—	25.9	—
Lee	Tallega	KY 708	—	—	—	—	—	1.6	—
Lee	Beattyville	KY 52	—	—	—	—	—	4.1	—
Lee	Heidelberg	—	—	—	—	—	—	17.9	—
Lee	Beattyville	—	—	—	—	—	—	29.7	—
Lee	Beattyville	—	—	—	—	—	—	2.3	—
Lee	Beattyville	KY 52	—	—	—	—	—	6.3	Y
Lee	Beattyville	KY 1144	2018	—	—	—	—	33.5	Y
Lee	Tallega	KY 52	2018	—	—	—	Above road	31.8	Y
Lee	Beattyville	KY 3150	2020	—	—	—	Above road	46.9	Y
Lee	Beattyville	—	—	—	—	—	Above and below road	27.2	Y
Lee	Tallega	KY 2017	2021	—	—	—	Below road	43.9	Y
Lee	Beattyville	KY 52	2021	—	—	—	—	19.3	Y
Lee	Beattyville	KY 1411	2025	—	—	—	—	—	Y
Lee	Beattyville	KY 52	—	General slide	—	—	Above road	1.3	—
Lee	Beattyville	KY 52	2013	General slide	—	—	—	22	Y
Lee	Beattyville	KY 1411	2014	General slide	—	—	Above road	30.4	Y
Lee	Beattyville	Pleasant Flat Rd	1984	General slide	—	—	—	25.9	—

Appendix A (continued)

County	7.5-min quadrangle	Route	Failure year	Movement type	Track length (ft)	Width (ft)	Failure location	Slope angle (degrees)	Damage
Lee	Tallega	KY 708	2015	General slide	—	—	—	21.9	Y
Lee	Beattyville	KY 3332	2023	General slide	—	—	Below road	22.5	Y
Lee	Beattyville	Silver Creek Rd	2011	Rockfall	—	—	Below road, stream at bottom	27	Y
Lee	Beattyville	KY 3150	2013	Rockfall	—	—	—	4.2	—
Lee	Beattyville	KY 52	2019	Rockfall	—	—	—	40	—
Lee	Beattyville	KY 52	—	Rotational slide	—	—	Above road	27.2	—
Leslie	Hoskinston	KY 406	—	—	—	—	—	9.3	—
Leslie	Hyden East	KY 1807	—	—	—	—	—	6.5	—
Leslie	Hyden East	US 421	—	—	—	—	—	4.1	—
Leslie	Hyden West	KY 118	—	—	—	—	—	8.2	—
Leslie	Hyden East	KY 1807	—	—	—	—	—	39.9	—
Leslie	Hyden East	KY 80	—	—	—	—	—	22	—
Leslie	Hyden West	KY 118	—	—	80	—	Above road	27.8	—
Leslie	Hyden East	KY 1807	—	—	—	—	—	30.4	—
Leslie	Hyden East	KY 1807	—	—	—	—	—	49.4	—
Leslie	Helton	—	—	—	—	—	—	39.4	—
Leslie	Hyden East	—	—	—	—	—	—	24.5	—
Leslie	Hyden East	—	—	—	—	—	—	29.8	—
Leslie	Hyden East	—	—	—	—	—	—	27.1	—
Leslie	Cutshin	—	—	—	—	—	—	26.6	—
Leslie	Hyden East	—	—	—	—	—	—	25.7	—
Leslie	Hyden East	—	—	—	—	—	—	15.8	—
Leslie	Helton	—	—	—	—	—	—	28.4	—
Leslie	Hoskinston	—	—	—	—	—	—	19.8	—
Leslie	Helton	—	—	—	—	—	—	24.1	—
Leslie	Cutshin	—	—	—	—	—	—	39.9	—

Appendix A (continued)

County	7.5-min quadrangle	Route	Failure year	Movement type	Track length (ft)	Width (ft)	Failure location	Slope angle (degrees)	Damage
Leslie	Cutshin	—	—	—	—	—	—	34.9	—
Leslie	Hyden West	—	—	—	—	—	—	18.8	—
Leslie	Beverly	—	—	—	—	—	—	26.1	—
Leslie	Hoskinston	—	—	—	—	—	—	32.8	—
Leslie	Hazard South	—	—	—	—	—	—	3.9	—
Leslie	Hyden West	—	—	—	—	—	—	36.7	—
Leslie	Big Creek	—	—	—	—	—	—	34.4	—
Leslie	Hoskinston	—	—	—	—	—	—	17.7	—
Leslie	Hyden West	—	—	—	—	—	—	19.3	—
Leslie	Hyden West	—	—	—	—	—	—	27.8	—
Leslie	Hyden West	—	—	—	—	—	—	6.6	—
Leslie	Hyden West	—	—	—	—	—	—	24.6	—
Leslie	Cutshin	—	—	—	—	—	—	4.2	—
Leslie	Hyden West	—	—	—	—	—	—	28.2	—
Leslie	Hyden West	—	—	—	—	—	—	12.8	—
Leslie	Big Creek	—	—	—	—	—	—	9.1	—
Leslie	Hyden West	—	—	—	—	—	—	39.9	—
Leslie	Big Creek	—	—	—	—	—	—	32.6	—
Leslie	Big Creek	—	—	—	—	—	—	34.7	—
Leslie	Hyden West	—	—	—	—	—	—	29.3	—
Leslie	Helton	—	—	—	—	—	—	21.5	—
Leslie	Hyden East	—	—	—	—	—	—	27.9	—
Leslie	Hyden East	—	—	—	—	—	—	2.4	—
Leslie	Hyden East	—	—	—	—	—	—	5.2	—
Leslie	Hyden East	—	—	—	—	—	—	31.1	—
Leslie	Hyden West	—	—	—	—	—	—	62	—

Appendix A (continued)

County	7.5-min quadrangle	Route	Failure year	Movement type	Track length (ft)	Width (ft)	Failure location	Slope angle (degrees)	Damage
Leslie	Hyden West	—	—	—	—	—	—	5.1	—
Leslie	Hyden West	—	—	—	—	—	—	28.4	—
Leslie	Hyden West	—	—	—	—	—	—	4.8	—
Leslie	Hyden East	—	—	—	—	—	—	39.4	—
Leslie	Hyden East	—	—	—	—	—	—	48.6	—
Leslie	Cutshin	—	—	—	—	—	—	45	—
Leslie	Cutshin	—	—	—	—	—	—	3.7	—
Leslie	Hyden West	—	—	—	—	—	—	1.3	—
Leslie	Hyden West	—	—	—	—	—	—	20	—
Leslie	Hyden West	—	—	—	—	—	—	33.2	—
Leslie	Hyden East	—	—	—	—	—	—	27.2	—
Leslie	Hyden East	—	—	—	—	—	—	0.9	—
Leslie	Hyden East	—	—	—	—	—	—	1.8	—
Leslie	Hoskinston	US 421	2016	—	—	—	Above road	18.3	Y
Leslie	Hyden East	KY 257	—	—	—	100	Above road	27.5	Y
Leslie	Hyden East	KY 2057	—	—	—	—	Above road	15.6	Y
Leslie	Helton	—	—	—	—	—	—	7.7	Y
Leslie	Leatherwood	KY 699	2017	—	—	—	—	14.1	Y
Leslie	Hoskinston	KY 1780	2018	—	—	—	Above road	28.8	—
Leslie	Hoskinston	KY 406	—	—	—	145	—	37.2	—
Leslie	Hyden West	KY 257	2018	—	—	—	Above road, stream at bottom	30.6	Y
Leslie	Manchester	KY 421	2019	—	—	—	—	25.6	Y
Leslie	Leatherwood	10034 Cutshia Rd	—	—	—	—	—	26.7	Y
Leslie	Hyden West	US 421	2019	—	—	—	—	31.5	—
Leslie	Hyden West	US 421	2020	—	—	—	—	35.3	Y
Leslie	Helton	KY 1780	2020	—	—	—	—	26	Y

Appendix A (continued)

County	7.5-min quadrangle	Route	Failure year	Movement type	Track length (ft)	Width (ft)	Failure location	Slope angle (degrees)	Damage
Leslie	Hoskinston	US 421	2019	—	—	—	—	24.7	—
Leslie	Hyden West	US 421	2019	—	—	—	—	39.3	—
Leslie	Helton	KY 1780	2019	—	—	—	—	25.8	—
Leslie	Hyden East	KY 1807	2019	—	—	—	—	52.8	—
Leslie	Cutshin	KY 2009	2019	—	—	—	—	38.6	—
Leslie	Cutshin	KY 2009	2019	—	—	—	—	3	—
Leslie	Hyden East	KY 699	2019	—	—	—	—	25.3	—
Leslie	Cutshin	KY 699	2019	—	—	—	—	31.8	—
Leslie	Hoskinston	KY 406	2019	—	—	—	—	26.3	—
Leslie	Hyden East	KY 2057	2019	—	—	—	—	48.4	—
Leslie	Cutshin	KY 3427	2019	—	—	—	—	2.3	—
Leslie	Hyden East	KY 3427	2019	—	—	—	—	28.2	—
Leslie	Hyden East	CR 1029	2019	—	—	—	—	17.8	—
Leslie	Helton	KY 1780	2019	—	—	—	—	54.6	—
Leslie	Hoskinston	KY 1780	2019	—	—	—	—	31.6	—
Leslie	Buckhorn	KY 257	2019	—	—	—	—	29	—
Leslie	Hyden West	KY 3424	2019	—	—	—	—	30.6	—
Leslie	Cutshin	KY 2009	2019	—	—	—	—	23.8	—
Leslie	Hyden East	KY 699	2019	—	—	—	—	43.2	—
Leslie	Cutshin	KY 699	2019	—	—	—	—	28.6	—
Leslie	Hyden West	KY 257	2021	—	—	—	—	27.9	—
Leslie	Hyden West	KY 257	2021	—	—	—	—	45.5	—
Leslie	Buckhorn	KY 257	2021	—	—	—	—	52.1	—
Leslie	Leatherwood	KY 699	2021	—	—	—	—	37.7	—
Leslie	Leatherwood	KY 699	2021	—	—	—	—	3.8	—
Leslie	Leatherwood	KY 699	2021	—	—	—	—	39.3	—

Appendix A (continued)

County	7.5-min quadrangle	Route	Failure year	Movement type	Track length (ft)	Width (ft)	Failure location	Slope angle (degrees)	Damage
Leslie	Leatherwood	KY 699	2021	—	—	—	—	43.3	—
Leslie	Hyden East	KY 80	2021	—	—	—	—	9.2	—
Leslie	Hyden West	KY 3424	2021	—	—	—	—	19.8	—
Leslie	Leatherwood	KY 3427	2021	—	—	—	—	7.4	—
Leslie	Hazard South	KY 2057	2021	—	—	—	—	1.8	—
Leslie	Helton	KY 1780	2021	—	—	—	—	9.9	—
Leslie	Hoskinston	KY 1780	2021	—	—	—	—	11.4	—
Leslie	Hyden East	KY 1807	2021	—	—	—	—	18.7	—
Leslie	Hyden East	KY 699	2021	—	—	—	—	16.8	—
Leslie	Hoskinston	US 421	2021	—	—	—	—	31.7	—
Leslie	Hyden West	US 421	2021	—	—	—	—	23.8	—
Leslie	Hyden West	US 421	2021	—	—	—	—	35	—
Leslie	Hoskinston	US 421	2021	—	—	—	—	20.4	—
Leslie	Hyden West	US 421	2021	—	—	—	—	33.1	—
Leslie	Hyden West	US 421	2021	—	—	—	—	37.3	—
Leslie	Hyden East	KY 80	2021	—	—	—	—	18.4	—
Leslie	Hyden East	KY 80	2021	—	—	—	—	39.7	—
Leslie	Hyden West	KY 257	2020	—	—	—	—	41.2	—
Leslie	Helton	KY 2058	2020	—	—	—	—	35.1	—
Leslie	Hyden East	KY 80	2020	—	—	—	—	28	—
Leslie	Hyden West	KY 257	2020	—	—	—	—	19.9	—
Leslie	Creekville	KY 66	2020	—	—	—	—	23	—
Leslie	Hyden West	KY 257	2020	—	—	—	—	32	—
Leslie	Hyden West	KY 257	2020	—	—	—	—	39	—
Leslie	Hyden East	KY 257	2020	—	—	—	—	26.9	—
Leslie	Cutshin	KY 2009	2020	—	—	—	—	10.5	—

Appendix A (continued)

County	7.5-min quadrangle	Route	Failure year	Movement type	Track length (ft)	Width (ft)	Failure location	Slope angle (degrees)	Damage
Leslie	Hoskinston	KY 406	2020	—	—	—	—	4.5	—
Leslie	Hyden East	KY 80	2020	—	—	—	—	6.3	—
Leslie	Hyden East	KY 80	2020	—	—	—	—	16.3	—
Leslie	Hyden West	US 421	2020	—	—	—	—	42.5	—
Leslie	Bledsoe	KY 2009	2020	—	—	—	—	37.7	—
Leslie	Cutshin	KY 699	2023	—	—	—	Artificial fill slope	28.6	N
Leslie	Hyden West	KY 257	2022	—	—	—	Below road	21.2	Y
Leslie	Hyden West	US 421	2022	—	—	—	Below road, stream at bottom	14.2	Y
Leslie	Big Creek	KY 1482	2022	—	—	—	Below road	22.6	Y
Leslie	Hyden East	KY 80	2022	—	—	—	Below road	28.1	Y
Leslie	Big Creek	KY 1482	2022	—	—	—	Below road	40.7	Y
Leslie	Big Creek	KY 1482	2022	—	—	—	Below road, stream at bottom	42	Y
Leslie	Hyden West	KY 1482	2023	—	—	—	Below road, stream at bottom	40.2	Y
Leslie	Hyden West	KY 1482	2023	—	—	—	Below road	5.1	Y
Leslie	Hyden West	KY 1482	2023	—	—	—	Below road	25.4	Y
Leslie	Hyden West	KY 1482	2023	—	—	—	Below road	33.7	Y
Leslie	Hyden East	KY 1807	2023	—	—	—	Below road	38.2	Y
Leslie	Hyden East	KY 1807	2023	—	—	—	Below road	33.6	Y
Leslie	Hyden East	KY 1807	2023	—	—	—	Below road	26.7	Y
Leslie	Hoskinston	US 421	2022	—	—	—	Below road, stream at bottom	12.4	Y
Leslie	Big Creek	US 421	2022	—	—	250	Below road, stream at bottom	39.5	Y
Leslie	Big Creek	US 421	2022	—	—	—	Below road	39.3	Y
Leslie	Big Creek	US 421	2022	—	—	—	Below road	47.1	Y
Leslie	Big Creek	US 421	2022	—	—	288	Below road, stream at bottom	38.2	Y
Leslie	Hoskinston	KY 406	2022	—	40	70	Below road, stream at bottom	35.1	Y
Leslie	Hyden East	KY 699	2022	—	—	—	Below road, stream at bottom	41.6	Y

Appendix A (continued)

County	7.5-min quadrangle	Route	Failure year	Movement type	Track length (ft)	Width (ft)	Failure location	Slope angle (degrees)	Damage
Leslie	Big Creek	US 421	2022	—	—	364	Below road, stream at bottom	37.8	Y
Leslie	Hyden West	KY 1482	2022	—	—	230	Below road, stream at bottom	25.7	Y
Leslie	Hyden East	KY 80	2022	—	—	—	Below road, stream at bottom	30.2	Y
Leslie	Hoskinston	KY 1780	2025	—	—	—	Above road	—	—
Leslie	Hyden West	KY 257	2025	—	—	—	Above road	—	Y
Leslie	Hoskinston	KY 1780	2025	—	—	—	Above road	—	Y
Leslie	Hoskinston	US 421	2025	—	—	—	Above road	—	Y
Leslie	Hoskinston	US 421	2025	—	—	—	Above road	—	Y
Leslie	Hyden East	KY 421	2025	—	—	—	Above road	—	Y
Leslie	Big Creek	KY 484	2025	—	—	—	Above road	—	Y
Leslie	Leatherwood	KY 699	2024	—	—	—	Below road, stream at bottom	—	Y
Leslie	Cutshin	KY 2009	2025	—	—	150	Below road, stream at bottom	—	Y
Leslie	Cutshin	KY 3427	2025	—	—	75	Below road, stream at bottom	—	Y
Leslie	Hyden West	Bowling Branch Rd	2025	—	—	—	—	—	Y
Leslie	Hyden East	Fawn Drive	2025	—	—	—	Above road	—	—
Leslie	Hoskinston	John Morgan Memorial Rd	—	General slide	—	—	—	1.1	—
Leslie	Hyden East	KY 1807	—	General slide	150	—	Above and below road, stream at bottom	33.6	—
Leslie	Hyden East	KY 80	—	General slide	450	—	Below road	4.5	—
Leslie	Hyden East	KY 699	—	General slide	—	180	Below road	10.9	—
Leslie	Hyden East	KY 80	—	General slide	—	—	Below road	33.3	—
Leslie	Hyden West	KY 3424	2014	General slide	—	—	—	28.5	—
Leslie	Hyden East	US 421	—	General slide	—	—	—	36.5	—
Leslie	Hoskinston	KY 421	—	General slide	—	—	—	11.5	—
Leslie	Cutshin	KY 699	2015	General slide	—	—	—	5.7	—
Leslie	Hoskinston	US 421	2015	General slide	—	—	—	32.3	Y

Appendix A (continued)

County	7.5-min quadrangle	Route	Failure year	Movement type	Track length (ft)	Width (ft)	Failure location	Slope angle (degrees)	Damage
Leslie	Hoskinston	US 421	2015	General slide	—	—	—	23.8	Y
Leslie	Hyden East	KY 257	2023	General slide	—	—	Below road, stream at bottom	33.6	Y
Leslie	Helton	KY 1780	2023	General slide	19.15	—	Below road, stream at bottom	31.8	Y
Leslie	Hyden East	KY 257	2024	General slide	—	320	Below road, stream at bottom	35.6	Y
Leslie	Hoskinston	KY 2009	2009	Rockfall	—	—	Above road	31.4	Y
Leslie	Hoskinston	KY 2009	2011	Rockfall	—	—	Above road	3.3	Y
Leslie	Hyden East	KY 1807	2014	Rockfall	—	—	Above road	3.2	Y
Letcher	Roxana	KY 588	—	—	—	—	—	37.8	—
Letcher	Whitesburg	US 119	—	—	—	—	—	0.5	—
Letcher	Roxana	KY 588	—	—	—	—	—	6.2	—
Letcher	Blackey	Doty Creek Rd	2012	—	—	—	—	21.5	—
Letcher	Whitesburg	—	—	—	—	—	—	11.4	—
Letcher	Mayking	—	—	—	—	—	—	47.2	—
Letcher	Blackey	—	—	—	—	—	—	12.7	—
Letcher	Jenkins West	—	—	—	—	—	—	33.9	—
Letcher	Jenkins West	—	—	—	—	—	—	10.1	—
Letcher	Louellen	—	—	—	—	—	—	31.1	—
Letcher	Mayking	—	—	—	—	—	—	21.4	—
Letcher	Roxana	—	—	—	—	—	—	29.1	—
Letcher	Mayking	—	—	—	—	—	—	20.1	—
Letcher	Mayking	—	—	—	—	—	—	10	—
Letcher	Mayking	—	—	—	—	—	—	32.1	—
Letcher	Roxana	—	—	—	—	—	—	17.6	—
Letcher	Mayking	—	—	—	—	—	—	31.2	—
Letcher	Mayking	—	—	—	—	—	—	9.5	—
Letcher	Jenkins West	—	—	—	—	—	—	23.2	—

Appendix A (continued)

County	7.5-min quadrangle	Route	Failure year	Movement type	Track length (ft)	Width (ft)	Failure location	Slope angle (degrees)	Damage
Letcher	Jenkins West	—	—	—	—	—	—	41.2	—
Letcher	Mayking	—	—	—	—	—	—	34.7	—
Letcher	Whitesburg	—	—	—	—	—	—	33.4	—
Letcher	Jenkins West	—	—	—	—	—	—	39.4	—
Letcher	Jenkins East	—	—	—	—	—	—	22.3	—
Letcher	Mayking	—	—	—	—	—	—	34.9	—
Letcher	Blackey	—	—	—	—	—	—	39.7	—
Letcher	Blackey	—	—	—	—	—	—	27.4	—
Letcher	Blackey	—	—	—	—	—	—	33.4	—
Letcher	Roxana	—	—	—	—	—	—	17	—
Letcher	Whitesburg	—	—	—	—	—	—	37.5	—
Letcher	Mayking	—	—	—	—	—	—	39	—
Letcher	Mayking	—	—	—	—	—	—	24.5	—
Letcher	Jenkins West	—	—	—	—	—	—	26.7	—
Letcher	Jenkins West	—	—	—	—	—	—	26.7	—
Letcher	Mayking	—	—	—	—	—	—	24.2	—
Letcher	Mayking	—	—	—	—	—	—	7	—
Letcher	Jenkins West	—	—	—	—	—	—	7	—
Letcher	Roxana	—	—	—	—	—	—	2.1	—
Letcher	Mayking	—	—	—	—	—	—	2.1	—
Letcher	Whitesburg	—	—	—	—	—	—	22.9	—
Letcher	Roxana	—	—	—	—	—	—	23.7	—
Letcher	Roxana	—	—	—	—	—	—	21.4	—
Letcher	Whitesburg	—	—	—	—	—	—	10.8	—
Letcher	Mayking	—	—	—	—	—	—	3.7	—
Letcher	Jenkins West	—	—	—	—	—	—	4.4	—

Appendix A (continued)

County	7.5-min quadrangle	Route	Failure year	Movement type	Track length (ft)	Width (ft)	Failure location	Slope angle (degrees)	Damage
Letcher	Whitesburg	—	—	—	—	—	—	29.4	—
Letcher	Whitesburg	—	—	—	—	—	—	38.4	—
Letcher	Mayking	—	—	—	—	—	—	31.7	—
Letcher	Mayking	—	—	—	—	—	—	20.3	—
Letcher	Mayking	—	—	—	—	—	—	29.4	—
Letcher	Jenkins West	—	—	—	—	—	—	4.5	—
Letcher	Jenkins West	—	—	—	—	—	—	19.4	—
Letcher	Mayking	—	—	—	—	—	—	30.9	—
Letcher	Whitesburg	—	—	—	—	—	—	46.8	—
Letcher	Mayking	—	—	—	—	—	—	2.6	—
Letcher	Jenkins West	—	—	—	—	—	—	30.1	—
Letcher	Jenkins West	—	—	—	—	—	—	2.2	—
Letcher	Jenkins West	—	—	—	—	—	—	12.7	—
Letcher	Whitesburg	Solomon Rd	2016	—	—	—	—	28.8	Y
Letcher	Mayking	KY 1148	2017	—	—	—	General road embankment	4.2	Y
Letcher	Whitesburg	US 119	2018	—	—	—	Above road	7.8	Y
Letcher	Roxana	KY 588	2018	—	—	—	—	33.8	Y
Letcher	Roxana	KY 160	—	—	—	—	—	35.9	—
Letcher	Mayking	KY 1862	—	—	—	—	—	28.9	Y
Letcher	Roxana	KY 1103	2019	—	—	—	—	4	Y
Letcher	Whitesburg	KY 931	2019	—	—	—	—	25.3	Y
Letcher	Mayking	KY 931	2019	—	—	—	—	33.9	—
Letcher	Roxana	KY 1103	2019	—	—	—	—	33.6	—
Letcher	Jenkins West	Haymond Hill Rd	2019	—	—	—	—	24.8	—
Letcher	Jenkins West	KY 317	2019	—	—	—	—	2.8	—
Letcher	Louellen	KY 160	2019	—	—	—	—	35.6	—

Appendix A (continued)

County	7.5-min quadrangle	Route	Failure year	Movement type	Track length (ft)	Width (ft)	Failure location	Slope angle (degrees)	Damage
Letcher	Whitesburg	US 119	2019	—	—	—	—	28.5	—
Letcher	Mayking	KY 2034	2022	—	—	—	Above and below road	20.1	Y
Letcher	Whitesburg	KY 15	2022	—	—	—	General road embankment	27.7	Y
Letcher	Whitesburg	KY 3401	2023	—	—	—	Below road, stream at bottom	11.9	Y
Letcher	Flat Gap	KY 932	2023	—	140	102	Below road, stream at bottom	43.4	Y
Letcher	Whitesburg	KY 15	2023	—	—	—	Below road, stream at bottom	6.3	Y
Letcher	Whitesburg	KY 3410	2024	—	—	—	Below road, stream at bottom	24.9	Y
Letcher	Whitesburg	KY 3410	2024	—	—	—	Below road, stream at bottom	20.5	Y
Letcher	Jenkins West	KY 805	2022	—	50	127	Below road, stream at bottom	24	Y
Letcher	Blackey	KY 7	2023	—	—	75	Below road, stream at bottom	43.8	Y
Letcher	Mayking	KY 931	2024	—	—	—	Below road	41.1	Y
Letcher	Jenkins West	KY 343	2025	—	—	—	Above road	—	Y
Letcher	Mayking	KY 931	2016	General slide	—	—	—	34.6	Y
Letcher	Whitesburg	US 119	2019	General slide	—	—	—	20	—
Letcher	Jenkins West	KY 3409	2022	General slide	—	—	Above road	16.7	—
Letcher	Blackey	KY 15	2022	General slide	78	30	Artificial fill slope	34.6	—
Letcher	Roxana	KY 160	2019	Rockfall	—	—	Above road	53.4	Y
Letcher	Mayking	U 9999	—	Translational slide	—	—	—	1.1	Y
Owsley	Booneville	KY 846	—	—	—	—	—	2.8	—
Owsley	Sturgeon	KY 847	—	—	—	—	—	1.5	—
Owsley	Booneville	KY 30	—	—	—	—	—	0	—
Owsley	Booneville	KY 11	—	—	—	—	—	1.5	—
Owsley	Beattyville	KY 11	—	—	—	—	—	4.5	—
Owsley	Booneville	KY 30	—	—	—	—	—	0	—
Owsley	Booneville	—	—	—	—	—	—	23.5	—
Owsley	Booneville	—	—	—	—	—	—	13.3	—

Appendix A (continued)

County	7.5-min quadrangle	Route	Failure year	Movement type	Track length (ft)	Width (ft)	Failure location	Slope angle (degrees)	Damage
Owsley	Cowcreek	KY 2024	2020	—	—	—	—	19.7	—
Owsley	Booneville	KY 28	2019	—	—	—	—	27.7	—
Owsley	Booneville	KY 28	2019	—	—	—	—	40.8	—
Owsley	Booneville	KY 28	2021	—	—	—	Above and below road	57.9	Y
Owsley	Booneville	KY 11	2020	—	—	—	—	27.6	—
Owsley	Beattyville	KY 11	2020	—	—	—	—	29.8	—
Owsley	Mistletoe	KY 2022	2023	—	—	—	Below road, stream at bottom	38.4	Y
Owsley	Mistletoe	KY 2022	2023	—	—	140	Below road	39.6	Y
Owsley	Mistletoe	KY 2022	2023	—	—	—	Below road, stream at bottom	15.6	Y
Owsley	Mistletoe	KY 2022	2023	—	—	—	Below road, stream at bottom	32.4	Y
Owsley	Mistletoe	KY 2022	2023	—	—	—	Below road	9.9	Y
Owsley	Mistletoe	KY 2022	2023	—	—	—	Below road	35.6	Y
Owsley	Mistletoe	KY 2022	2023	—	—	—	Below road	38.2	Y
Owsley	Oneida	KY 11	2025	—	—	160	Below road, stream at bottom	—	Y
Owsley	Oneida	KY 11	2025	—	—	160	Below road	—	Y
Owsley	Booneville	KY 11	2025	—	—	108	Below road, stream at bottom	—	Y
Owsley	Booneville	KY 11	2025	—	—	490	Below road, stream at bottom	—	Y
Owsley	Booneville	KY 28	2025	—	—	275	Below road, stream at bottom	—	Y
Owsley	Tallega	KY 708	2013	General slide	—	—	—	3.4	Y
Owsley	Sturgeon	KY 847	—	General slide	—	—	—	20.6	—
Owsley	Booneville	KY 1938	2015	General slide	—	—	Below road, stream at bottom	21.5	Y
Perry	Hazard North	KY 80	—	—	—	—	—	27.7	—
Perry	Krypton	KY 15	—	—	—	—	—	20.6	—
Perry	Hazard North	Happy Valley Ln	—	—	—	—	—	27.7	—
Perry	Hazard North	KY 80	—	—	—	—	—	38.3	—
Perry	Krypton	HR 9006	—	—	—	—	—	19.2	—

Appendix A (continued)

County	7.5-min quadrangle	Route	Failure year	Movement type	Track length (ft)	Width (ft)	Failure location	Slope angle (degrees)	Damage
Perry	Krypton	KY 28	—	—	—	—	—	5.3	—
Perry	Buckhorn	KY 28	—	—	—	—	—	15.6	—
Perry	Tilford	KY 699	—	—	—	—	—	14.6	—
Perry	Krypton	KY 28	—	—	—	—	—	22.4	—
Perry	Noble	KY 476	—	—	—	—	—	8.8	—
Perry	Vicco	KY 7	—	—	—	—	—	1.9	—
Perry	Hazard South	KY 451	—	—	—	—	—	8.6	—
Perry	Hazard South	KY 1165	—	—	—	—	—	6.5	—
Perry	Vicco	KY 1165	—	—	—	—	—	11.6	—
Perry	Vicco	KY 1165	—	—	—	—	—	32.4	—
Perry	Hazard North	KY 476	—	—	—	—	—	24	—
Perry	Noble	KY 476	—	—	—	—	—	42.2	—
Perry	Krypton	KY 451	2013	—	—	—	—	37.8	—
Perry	Noble	KY 476	2013	—	—	—	—	3.1	Y
Perry	Krypton	—	—	—	—	—	—	24.3	—
Perry	Hazard North	—	—	—	—	—	—	4.6	—
Perry	Hazard North	—	—	—	—	—	—	26.6	—
Perry	Hazard North	—	—	—	—	—	—	14.5	—
Perry	Hazard North	—	—	—	—	—	—	32.4	—
Perry	Vicco	—	—	—	—	—	—	14.5	—
Perry	Hazard North	—	—	—	—	—	—	34.7	—
Perry	Hazard North	—	—	—	—	—	—	22.4	—
Perry	Hazard North	—	—	—	—	—	—	10.3	—
Perry	Krypton	—	—	—	—	—	—	28.8	—
Perry	Vicco	—	—	—	—	—	—	3.1	—
Perry	Vicco	—	—	—	—	—	—	7.6	—

Appendix A (continued)

County	7.5-min quadrangle	Route	Failure year	Movement type	Track length (ft)	Width (ft)	Failure location	Slope angle (degrees)	Damage
Perry	Hazard North	—	—	—	—	—	—	11	—
Perry	Vicco	—	—	—	—	—	—	35.3	—
Perry	Hazard North	—	—	—	—	—	—	22.6	—
Perry	Hazard South	—	—	—	—	—	—	15.3	—
Perry	Hazard South	—	—	—	—	—	—	31.8	—
Perry	Hazard North	—	—	—	—	—	—	12.9	—
Perry	Krypton	—	—	—	—	—	—	27.4	—
Perry	Hazard North	—	—	—	—	—	—	6.2	—
Perry	Hazard South	—	—	—	—	—	—	11.4	—
Perry	Hazard North	—	—	—	—	—	—	4.5	—
Perry	Vicco	—	—	—	—	—	—	41	—
Perry	Krypton	—	—	—	—	—	—	19.2	—
Perry	Hazard South	—	—	—	—	—	—	3.1	—
Perry	Hazard North	—	—	—	—	—	—	41.7	—
Perry	Hazard South	—	—	—	—	—	—	5.1	—
Perry	Hazard North	—	—	—	—	—	—	16.2	—
Perry	Hazard North	—	—	—	—	—	—	4.3	—
Perry	Tilford	—	—	—	—	—	—	22.5	—
Perry	Hazard North	—	—	—	—	—	—	4.5	—
Perry	Vicco	—	—	—	—	—	—	16.9	—
Perry	Hazard North	—	—	—	—	—	—	28.9	—
Perry	Krypton	—	—	—	—	—	—	9.4	—
Perry	Hazard North	—	—	—	—	—	—	4.8	—
Perry	Hazard North	—	—	—	—	—	—	27.9	—
Perry	Krypton	—	—	—	—	—	—	25.5	—
Perry	Hazard South	—	—	—	—	—	—	14.7	—

Appendix A (continued)

County	7.5-min quadrangle	Route	Failure year	Movement type	Track length (ft)	Width (ft)	Failure location	Slope angle (degrees)	Damage
Perry	Hazard North	—	—	—	—	—	—	0.6	—
Perry	Vest	—	—	—	—	—	—	17.9	—
Perry	Krypton	—	—	—	—	—	—	35.9	—
Perry	Hazard North	—	—	—	—	—	—	23.9	—
Perry	Hazard North	—	—	—	—	—	—	35.3	—
Perry	Hazard North	—	—	—	—	—	—	22.3	—
Perry	Hazard North	—	—	—	—	—	—	1.1	—
Perry	Krypton	—	—	—	—	—	—	28.3	—
Perry	Hazard South	—	—	—	—	—	—	0.9	—
Perry	Hazard North	—	—	—	—	—	—	14	—
Perry	Hazard South	—	—	—	—	—	—	35.5	—
Perry	Hazard North	—	—	—	—	—	—	19.1	—
Perry	Hazard South	—	—	—	—	—	—	32.9	—
Perry	Hazard South	—	—	—	—	—	—	23.9	—
Perry	Hazard North	—	—	—	—	—	—	3.8	—
Perry	Hazard North	—	—	—	—	—	—	19.7	—
Perry	Hazard North	—	—	—	—	—	—	28.3	—
Perry	Vicco	—	—	—	—	—	—	0.9	—
Perry	Hazard North	—	—	—	—	—	—	30.5	—
Perry	Hazard North	—	—	—	—	—	—	32.5	—
Perry	Hazard South	—	—	—	—	—	—	12	—
Perry	Hazard North	—	—	—	—	—	—	22.2	—
Perry	Buckhorn	—	—	—	—	—	—	40.8	—
Perry	Krypton	—	—	—	—	—	—	23	—
Perry	Krypton	—	—	—	—	—	—	38.9	—
Perry	Vicco	—	—	—	—	—	—	0.5	—

Appendix A (continued)

County	7.5-min quadrangle	Route	Failure year	Movement type	Track length (ft)	Width (ft)	Failure location	Slope angle (degrees)	Damage
Perry	Hazard North	—	—	—	—	—	—	11.7	—
Perry	Hyden East	—	—	—	—	—	—	34.2	—
Perry	Hazard North	—	—	—	—	—	—	3.3	—
Perry	Vicco	—	—	—	—	—	—	36.1	—
Perry	Hazard North	—	—	—	—	—	—	23.6	—
Perry	Hazard North	—	—	—	—	—	—	39.1	—
Perry	Krypton	—	—	—	—	—	—	23.1	—
Perry	Hazard South	—	—	—	—	—	—	17.9	—
Perry	Hazard North	—	—	—	—	—	—	18.9	—
Perry	Hazard North	—	—	—	—	—	—	25.2	—
Perry	Vicco	—	—	—	—	—	—	33.7	—
Perry	Hazard North	—	—	—	—	—	—	21.4	—
Perry	Hazard South	—	—	—	—	—	—	13.3	—
Perry	Hazard South	—	—	—	—	—	—	23	—
Perry	Hazard South	—	—	—	—	—	—	17.7	—
Perry	Hazard North	—	—	—	—	—	—	13.3	—
Perry	Hazard South	—	—	—	—	—	—	12.7	—
Perry	Hyden East	—	—	—	—	—	—	32.4	—
Perry	Hazard North	—	—	—	—	—	—	32.7	—
Perry	Krypton	—	—	—	—	—	—	15.8	—
Perry	Hazard South	—	—	—	—	—	—	26.3	—
Perry	Vicco	—	—	—	—	—	—	34	—
Perry	Vicco	—	—	—	—	—	—	20.2	—
Perry	Hazard North	—	—	—	—	—	—	26.3	—
Perry	Hazard South	—	—	—	—	—	—	37.9	—
Perry	Vicco	—	—	—	—	—	—	57.5	—

Appendix A (continued)

County	7.5-min quadrangle	Route	Failure year	Movement type	Track length (ft)	Width (ft)	Failure location	Slope angle (degrees)	Damage
Perry	Hazard North	—	—	—	—	—	—	14.3	—
Perry	Hazard South	—	—	—	—	—	—	27.9	—
Perry	Krypton	—	—	—	—	—	—	21	—
Perry	Hazard North	—	—	—	—	—	—	6.7	—
Perry	Hazard South	—	—	—	—	—	—	26.6	—
Perry	Hazard South	—	—	—	—	—	—	5.6	—
Perry	Hazard North	—	—	—	—	—	—	4.8	—
Perry	Hazard North	—	—	—	—	—	—	29.5	—
Perry	Hazard North	—	—	—	—	—	—	11.5	—
Perry	Hazard North	—	—	—	—	—	—	8.3	—
Perry	Hazard North	—	—	—	—	—	—	6	—
Perry	Hazard North	—	—	—	—	—	—	3.4	—
Perry	Hazard North	—	—	—	—	—	—	24.6	—
Perry	Hazard North	—	—	—	—	—	—	27.1	—
Perry	Hazard South	—	—	—	—	—	—	4.3	—
Perry	Hazard North	—	—	—	—	—	—	42.7	—
Perry	Hazard North	—	—	—	—	—	—	18.1	—
Perry	Hazard North	—	—	—	—	—	—	29.2	—
Perry	Krypton	—	—	—	—	—	—	36.1	—
Perry	Hyden East	—	—	—	—	—	—	16.2	—
Perry	Krypton	—	—	—	—	—	—	9	—
Perry	Hazard North	—	—	—	—	—	—	28	—
Perry	Hazard South	—	—	—	—	—	—	37.2	—
Perry	Hazard North	—	—	—	—	—	—	23.4	—
Perry	Hazard North	—	—	—	—	—	—	46.7	—
Perry	Hazard North	—	—	—	—	—	—	31.6	—

Appendix A (continued)

County	7.5-min quadrangle	Route	Failure year	Movement type	Track length (ft)	Width (ft)	Failure location	Slope angle (degrees)	Damage
Perry	Krypton	—	—	—	—	—	—	38.3	—
Perry	Hazard North	—	—	—	—	—	—	30.6	—
Perry	Vicco	—	—	—	—	—	—	26.2	—
Perry	Krypton	—	—	—	—	—	—	21.9	—
Perry	Hazard North	—	—	—	—	—	—	20	—
Perry	Krypton	—	—	—	—	—	—	18.5	—
Perry	Hazard North	—	—	—	—	—	—	9.7	—
Perry	Hazard North	—	—	—	—	—	—	3.2	—
Perry	Krypton	—	—	—	—	—	—	15.5	—
Perry	Hazard North	—	—	—	—	—	—	3.6	—
Perry	Hazard North	—	—	—	—	—	—	20	—
Perry	Hazard North	—	—	—	—	—	—	5	—
Perry	Hazard North	—	—	—	—	—	—	25.2	—
Perry	Hazard South	—	—	—	—	—	—	40.8	—
Perry	Hazard North	—	—	—	—	—	—	5.8	—
Perry	Hazard South	Hank St	2017	—	—	—	Above and below road, stream at bottom	59.9	Y
Perry	Hazard North	KY 476	2017	—	—	—	—	40.6	Y
Perry	Hyden East	KY 80	2018	—	—	—	—	37.4	Y
Perry	Vicco	KY 7	2018	—	—	—	—	37.8	Y
Perry	Hyden West	Saul Mud Lick Branch	2018	—	—	—	Above road	29.5	Y
Perry	Hazard North	KY 476	2018	—	—	—	—	30.8	Y
Perry	Krypton	Hickory Gap Rd	2018	—	—	—	—	29.7	Y
Perry	Hazard North	KY 451	2018	—	—	—	—	13.4	—
Perry	Hazard North	Sun Valley Terrace	2018	—	—	—	—	31.7	Y
Perry	Leatherwood	Clover Fork Rd	2018	—	—	—	Natural slope	34.4	Y
Perry	Hazard South	KY 1166	2019	—	—	—	—	17	—

Appendix A (continued)

County	7.5-min quadrangle	Route	Failure year	Movement type	Track length (ft)	Width (ft)	Failure location	Slope angle (degrees)	Damage
Perry	Hyden East	KY 80	2019	—	—	—	—	28.2	Y
Perry	Vicco	KY 15	2019	—	—	—	—	39.6	—
Perry	Hazard South	KY 451	2019	—	—	—	—	22.5	—
Perry	Hazard North	KY 476	2019	—	—	—	—	27.9	Y
Perry	Hazard North	KY 3351	—	—	—	—	—	0.9	—
Perry	Krypton	KY 451	2019	—	—	—	—	33.3	Y
Perry	Hazard South	KY 1165	2020	—	—	—	—	16.9	Y
Perry	Noble	KY 267	2020	—	—	—	—	36.7	Y
Perry	Hazard North	Hull School Rd	2020	—	—	—	—	30	Y
Perry	Hazard North	KY 15	2020	—	—	—	—	17.4	Y
Perry	Hazard North	KY 476	2020	—	—	—	Above and below road	32.4	Y
Perry	Krypton	KY 2021	2020	—	—	—	Above and below road, stream at bottom	38.3	—
Perry	Vicco	KY 1165	2020	—	—	—	—	31.7	Y
Perry	Vicco	KY 1165	2020	—	—	—	Below road	35.1	Y
Perry	Mistletoe	KY 2022	2021	—	—	—	Below road	32.5	Y
Perry	Vest	KY 1087	2021	—	—	—	—	25.6	Y
Perry	Hazard North	Darb Creek Rd	2021	—	—	—	—	25	Y
Perry	Vicco	KY 7	2022	—	—	—	Above road	41.7	Y
Perry	Krypton	KY 9006	2021	—	—	—	—	4.3	—
Perry	Krypton	KY 2021	2021	—	—	—	—	0.8	—
Perry	Hazard South	KY 1165	2020	—	—	—	—	7.5	—
Perry	Buckhorn	KY 28	2020	—	—	—	—	5.3	—
Perry	Hazard North	KY 476	2020	—	—	—	—	4.9	—
Perry	Hazard North	332 Hiner Rd	2023	—	—	—	—	31.6	y
Perry	Hazard North	KY 267	2019	—	—	—	Above and below road	34.8	Y
Perry	Noble	KY 1087	2022	—	—	—	Below road	28.5	Y

Appendix A (continued)

County	7.5-min quadrangle	Route	Failure year	Movement type	Track length (ft)	Width (ft)	Failure location	Slope angle (degrees)	Damage
Perry	Krypton	KY 451	2022	—	—	—	Below road, stream at bottom	42.5	Y
Perry	Hazard North	KY 267	2022	—	—	—	Below road, stream at bottom	15.8	Y
Perry	Hazard North	KY 267	2022	—	—	—	Below road	17.4	Y
Perry	Hazard North	KY 267	2022	—	—	—	Below road, stream at bottom	26.6	Y
Perry	Hazard North	KY 267	2022	—	—	—	Below road, stream at bottom	47.4	Y
Perry	Hazard North	KY 267	2022	—	—	—	Below road	42.9	Y
Perry	Krypton	KY 451	2022	—	—	—	Below road	38.8	Y
Perry	Krypton	KY 451	2022	—	—	—	Below road, stream at bottom	36	Y
Perry	Krypton	KY 451	2022	—	—	—	Below road, stream at bottom	23.7	Y
Perry	Krypton	KY 2021	2022	—	—	—	Below road, stream at bottom	25.9	Y
Perry	Hazard North	KY 1067	2022	—	—	—	Below road, stream at bottom	24.5	Y
Perry	Hazard North	KY 1067	2022	—	—	—	Below road, stream at bottom	43.6	Y
Perry	Noble	KY 1087	2022	—	—	—	Below road, stream at bottom	41	Y
Perry	Hazard North	KY 1440	2022	—	—	—	Below road, stream at bottom	24.4	Y
Perry	Hazard North	KY 1440	2022	—	—	—	Below road, stream at bottom	38.6	Y
Perry	Buckhorn	KY 2022	2022	—	—	—	Below road, stream at bottom	32.1	Y
Perry	Buckhorn	KY 2022	2022	—	—	—	Below road	37.3	Y
Perry	Buckhorn	KY 2022	2022	—	—	—	Below road	27.9	Y
Perry	Hazard North	KY 1146	2022	—	—	—	Below road	37.5	Y
Perry	Hazard North	KY 1146	2022	—	—	—	Below road, stream at bottom	42	Y
Perry	Hazard North	KY 1146	2022	—	—	—	Below road	33.2	Y
Perry	Hazard North	KY 1146	2022	—	—	—	Below road	32.7	Y
Perry	Hazard North	KY 267	2022	—	—	—	Below road, stream at bottom	36.2	Y
Perry	Hazard North	KY 267	2022	—	—	—	Below road	11.7	Y
Perry	Hazard North	KY 267	2022	—	—	—	Below road	36.2	Y
Perry	Hazard North	KY 267	2022	—	—	—	Below road, stream at bottom	35.4	Y

Appendix A (continued)

County	7.5-min quadrangle	Route	Failure year	Movement type	Track length (ft)	Width (ft)	Failure location	Slope angle (degrees)	Damage
Perry	Buckhorn	KY 2022	2022	—	—	—	Below road, stream at bottom	29.8	Y
Perry	Buckhorn	KY 2022	2022	—	—	—	Below road, stream at bottom	42.1	Y
Perry	Mistletoe	KY 2022	2022	—	—	—	Below road	43.3	Y
Perry	Mistletoe	KY 2022	2022	—	—	—	Below road, stream at bottom	36.9	Y
Perry	Mistletoe	KY 2022	2022	—	—	—	Below road, stream at bottom	43.7	Y
Perry	Mistletoe	KY 2022	2022	—	—	—	Below road, stream at bottom	39.1	Y
Perry	Mistletoe	KY 2022	2022	—	—	—	Below road	38.1	Y
Perry	Noble	KY 267	2023	—	—	—	Below road, stream at bottom	26.1	Y
Perry	Buckhorn	KY 2022	2022	—	—	—	Below road	27.4	Y
Perry	Hazard North	KY 476	2022	—	—	—	Road cut	40.7	Y
Perry	Haddix	KY 2446	2023	—	93	28	Below road, stream at bottom	23.3	Y
Perry	Haddix	KY 2446	2023	—	—	75	Below road, stream at bottom	26.2	Y
Perry	Mistletoe	KY 2022	2023	—	60	70	Below road, stream at bottom	49.1	Y
Perry	Mistletoe	KY 2022	2023	—	—	—	Below road, stream at bottom	53.2	Y
Perry	Mistletoe	KY 2022	2023	—	—	—	Below road	24.6	Y
Perry	Krypton	KY 2021	2023	—	41	50	Below road, stream at bottom	27.7	Y
Perry	Krypton	KY 2021	2023	—	20	13	Below road, stream at bottom	32.3	Y
Perry	Krypton	KY 2021	2023	—	—	—	Below road, stream at bottom	37.1	Y
Perry	Hazard North	KY 1146	2023	—	—	—	Below road, stream at bottom	31.8	Y
Perry	Hazard North	KY 267	2023	—	—	—	Below road, stream at bottom	14.8	Y
Perry	Hazard North	KY 267	2023	—	—	—	Below road, stream at bottom	7.9	Y
Perry	Hazard North	KY 267	2023	—	—	—	Below road, stream at bottom	27.8	Y
Perry	Hazard North	KY 267	2023	—	—	—	Below road, stream at bottom	19.3	Y
Perry	Krypton	KY 451	2023	—	—	—	Below road	48.3	Y
Perry	Krypton	KY 451	2023	—	—	—	Below road	39.4	Y
Perry	Krypton	KY 451	2023	—	—	—	Below road	12.6	Y

Appendix A (continued)

County	7.5-min quadrangle	Route	Failure year	Movement type	Track length (ft)	Width (ft)	Failure location	Slope angle (degrees)	Damage
Perry	Krypton	KY 451	2023	—	—	—	Below road, stream at bottom	29.1	Y
Perry	Krypton	KY 451	2023	—	—	—	General road embankment	42.1	Y
Perry	Mistletoe	KY 484	2023	—	—	—	Below road	29.4	Y
Perry	Mistletoe	KY 484	2023	—	—	—	Below road, stream at bottom	33.6	Y
Perry	Buckhorn	KY 484	2023	—	—	80	Below road, stream at bottom	20.2	Y
Perry	Buckhorn	KY 484	2023	—	30	80	Below road, stream at bottom	35.4	Y
Perry	Buckhorn	KY 484	2023	—	—	—	Bridge embankment	36.9	Y
Perry	Buckhorn	KY 484	2023	—	30	90	Below road, stream at bottom	36.3	Y
Perry	Buckhorn	KY 484	2023	—	—	85	Below road, stream at bottom	27.8	Y
Perry	Buckhorn	KY 484	2023	—	—	—	Below road, stream at bottom	36.6	Y
Perry	Buckhorn	KY 484	2023	—	—	—	Below road, stream at bottom	33	Y
Perry	Hazard North	KY 1440	2023	—	—	—	Below road, stream at bottom	23.9	Y
Perry	Krypton	KY 28	2022	—	—	237	Below road, stream at bottom	21.8	Y
Perry	Buckhorn	KY 484	2023	—	—	65	Below road, stream at bottom	32.8	Y
Perry	Krypton	Barwick Rd	—	—	—	—	Above and below road	—	—
Perry	Krypton	Barwick Rd	—	—	—	—	Above and below road	—	—
Perry	Hazard North	KY 1088	2025	—	—	—	Above road	—	Y
Perry	Hazard North	KY 267	2025	—	—	—	Above road	—	Y
Perry	Vicco	KY 3197	2025	—	—	—	—	—	—
Perry	Vicco	KY 3197	2025	—	—	—	—	—	—
Perry	Vicco	KY 7	2024	—	—	475	Below road, stream at bottom	—	Y
Perry	Hyden East	KY 80	2025	—	—	200	—	—	Y
Perry	Hazard North	Upper Second Creek Rd	2025	—	—	—	Natural slope	—	—
Perry	Hazard North	KY 80	2025	—	—	195	Below road, stream at bottom	—	Y
Perry	Hazard North	KY 1440	2025	—	—	—	Below road, stream at bottom	—	Y
Perry	Hazard North	KY 3351	2025	—	—	—	Below road, stream at bottom	—	Y

Appendix A (continued)

County	7.5-min quadrangle	Route	Failure year	Movement type	Track length (ft)	Width (ft)	Failure location	Slope angle (degrees)	Damage
Perry	Hazard North	KY 476	2025	—	—	—	Below road, stream at bottom	—	Y
Perry	Buckhorn	KY 1833	2025	—	—	—	Below road, stream at bottom	—	Y
Perry	Krypton	KY 451	2025	—	—	—	Below road, stream at bottom	—	Y
Perry	Krypton	KY 451	2025	—	—	—	Below road, stream at bottom	—	Y
Perry	Tilford	KY 3348	2025	—	—	—	Below road, stream at bottom	—	Y
Perry	Hazard North	KY 476	2025	—	—	—	Below road, stream at bottom	—	Y
Perry	Tilford	KY 3348	2025	—	—	—	Below road, stream at bottom	—	Y
Perry	Buckhorn	KY 28	2025	—	—	—	Below road	—	Y
Perry	Hazard South	KY 1166	2025	—	—	47	Below road, stream at bottom	—	Y
Perry	Mistletoe	KY 2022	2025	—	—	—	Below road, stream at bottom	—	Y
Perry	Hazard North	KY 3351	2025	—	—	—	Below road, stream at bottom	—	Y
Perry	Krypton	KY 2021	2025	—	—	—	Below road, stream at bottom	—	Y
Perry	Hazard South	Browns Fork Rd	—	General slide	—	—	Above road	15.2	—
Perry	Hazard South	KY 1166	—	General slide	—	—	Above road	30.5	—
Perry	Hazard South	KY 1096	—	General slide	—	—	—	32.1	—
Perry	Hazard South	Browns Fork Rd	—	General slide	—	—	—	20.9	—
Perry	Hazard South	KY 1096	—	General slide	—	—	Natural slope	29.2	—
Perry	Hazard South	KY 1165	—	General slide	—	—	—	17.5	—
Perry	Tilford	KY 699	2006	General slide	—	—	Above road	43.4	Y
Perry	Buckhorn	KY 1833	2015	General slide	—	—	Above road	11.2	Y
Perry	Buckhorn	Lakeview Dr	2009	General slide	—	—	Natural slope	37.4	Y
Perry	Hazard North	Grand Oak Ln	—	General slide	—	—	—	18.4	Y
Perry	Hazard North	Jordan St	2011	General slide	—	—	—	4.1	Y
Perry	Krypton	William Baker Ln	2011	General slide	—	—	—	11.3	Y
Perry	Krypton	KY 451	2011	General slide	—	—	—	13	Y
Perry	Krypton	Krypton Lick Branch Rd	2011	General slide	—	—	—	8.3	—

Appendix A (continued)

County	7.5-min quadrangle	Route	Failure year	Movement type	Track length (ft)	Width (ft)	Failure location	Slope angle (degrees)	Damage
Perry	Hazard South	Anderson Fork Rd	—	General slide	—	—	—	5.3	—
Perry	Krypton	Hall Rogers Pkwy	—	General slide	—	240	Above and below road, stream at bottom	7.1	—
Perry	Hazard South	—	2012	General slide	—	—	Above road	4.6	Y
Perry	Buckhorn	Cam Johnson Branch Rd	2014	General slide	—	—	—	29.8	Y
Perry	Buckhorn	KY 28	—	General slide	—	—	Below road	34.1	—
Perry	Hazard North	Faulkner St	2015	General slide	—	—	Above and below road	30.8	Y
Perry	Hazard North	KY 1146 (Hardburly Rd)	2016	General slide	—	—	—	34.2	Y
Perry	Hazard South	KY 451	2019	General slide	—	—	—	35.7	Y
Perry	Hazard North	KY 267	2022	General slide	—	—	Above road	36.6	—
Perry	Krypton	Briar Fork Circle Rd	2010	Rockfall	—	—	—	3.3	—
Perry	Carrie	KY 80	2013	Rockfall	—	—	Above road	3.7	Y
Perry	Buckhorn	KY 28	2015	Rockfall	—	—	Above road	18.5	Y
Perry	Hazard North	KY 550	2015	Rockslide	—	—	Above road, stream at bottom	46.3	—
Perry	Krypton	Sam Campbell Branch	—	Translational slide	120	—	Above road	3.4	—
Perry	Hazard South	KY 7	2010	—	—	—	—	43.2	—
Perry	Hazard South	KY 7	2010	—	—	—	—	25.6	—
Wolfe	Pomeroyton	KY 9000	—	—	—	—	—	10.8	—
Wolfe	Campton	KY 9009	—	—	—	—	—	9.2	—
Wolfe	Campton	KY 9009	—	—	—	—	—	4.5	—
Wolfe	Campton	KY 9000	—	—	—	—	—	15.2	—
Wolfe	Landsaw	—	—	—	—	—	—	16.3	—
Wolfe	Campton	—	—	—	—	—	—	17.6	—
Wolfe	Cannel City	KY 191	2019	—	—	—	—	18.6	—
Wolfe	Pomeroyton	KY 715	2021	—	—	—	Below road	26	Y
Wolfe	Lee City	KY 1094	2023	—	—	—	Below road, stream at bottom	29	Y
Wolfe	Lee City	KY 1094	2023	—	—	—	Below road, stream at bottom	30.2	Y

Appendix A (continued)

County	7.5-min quadrangle	Route	Failure year	Movement type	Track length (ft)	Width (ft)	Failure location	Slope angle (degrees)	Damage
Wolfe	Landsaw	KY 1812	2023	—	60	35	Below road, stream at bottom	35.2	Y
Wolfe	Campton	KY 651	2013	General slide	—	—	—	6.3	Y
Wolfe	Landsaw	KY 1261	2015	General slide	—	—	—	11	—
Wolfe	Pomeroyton	KY 746	2015	General slide	—	—	—	16.1	Y