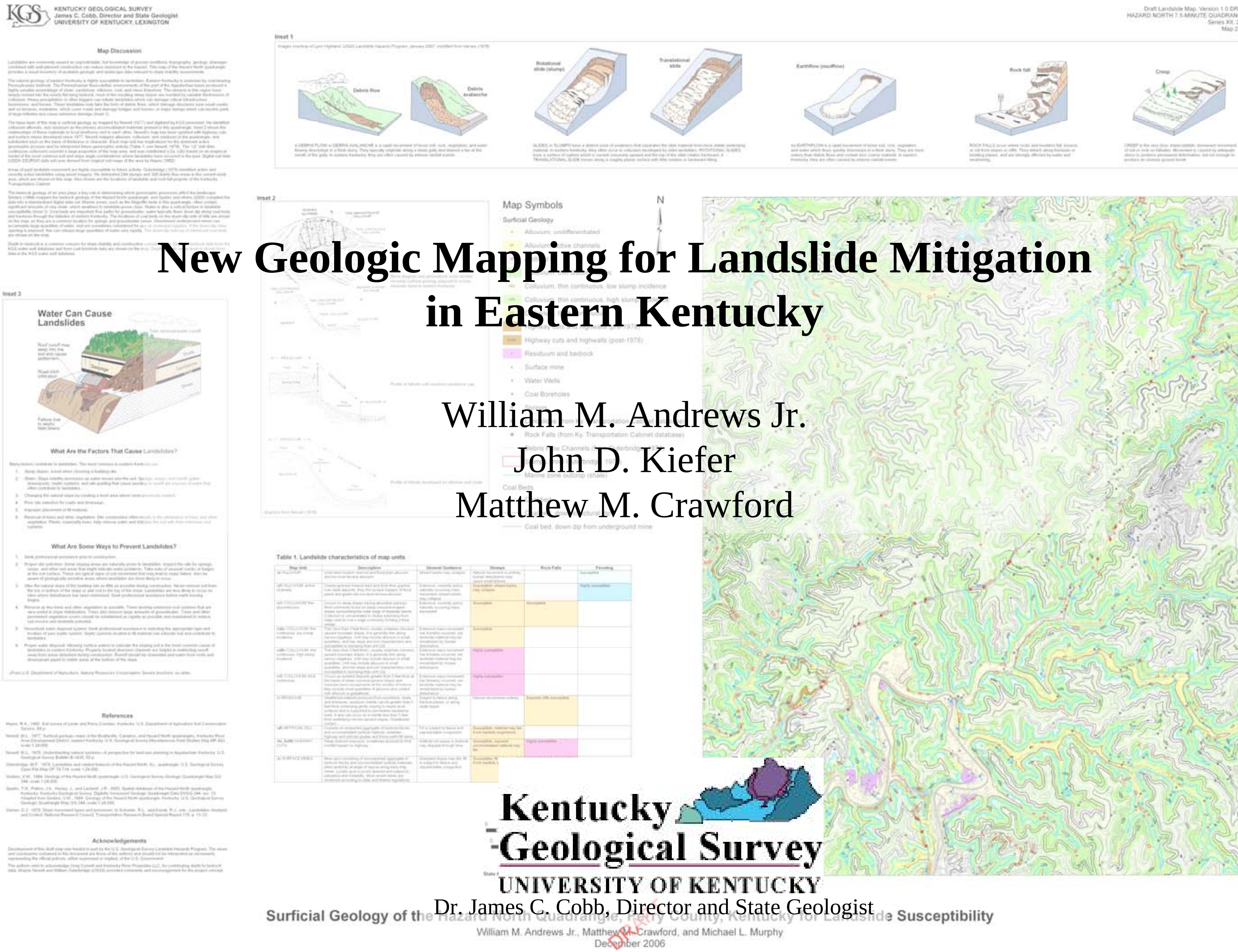


New Geologic Mapping for Landslide Mitigation in Eastern Kentucky

William M. Andrews Jr.
John D. Kiefer
Matthew M. Crawford

Kentucky Geological Survey
UNIVERSITY OF KENTUCKY

Dr. James C. Cobb, Director and State Geologist

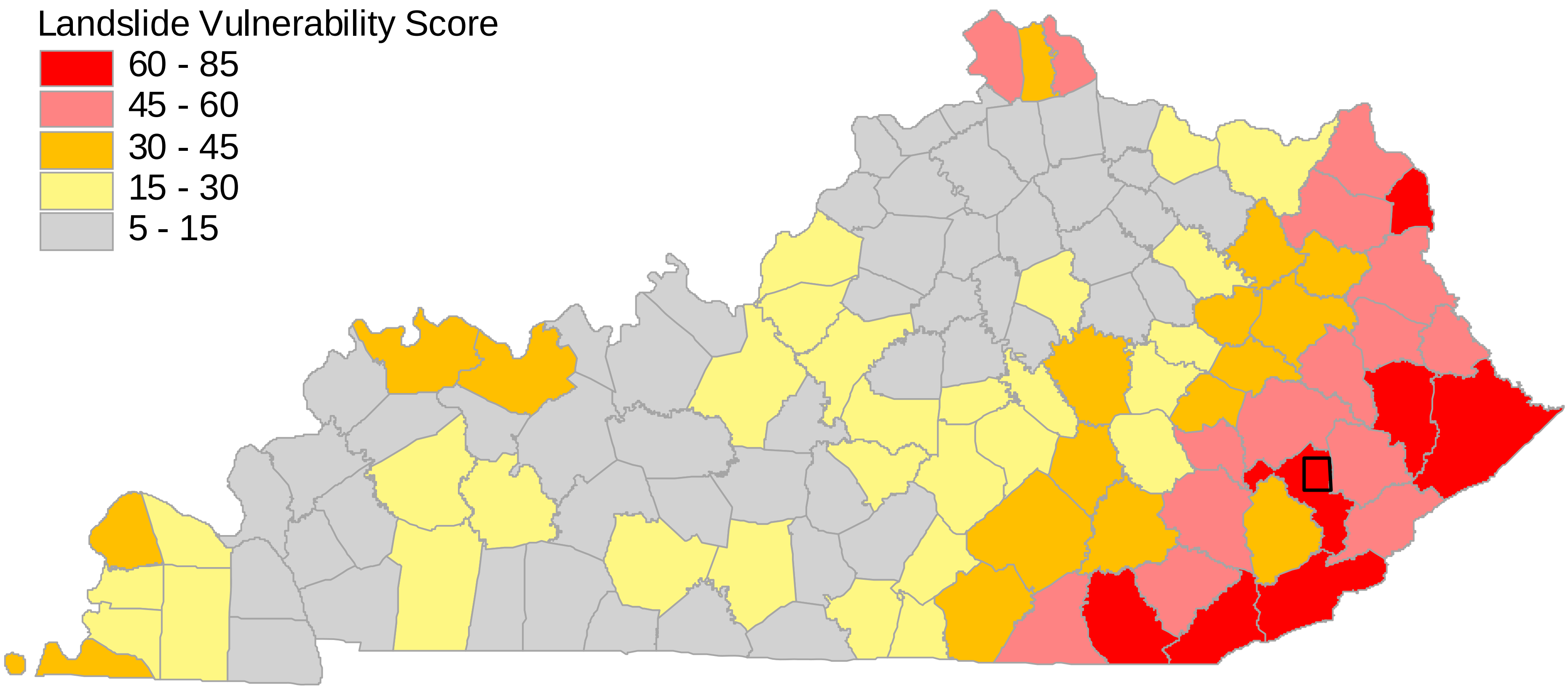
Slemp Landslide
April 2006
Perry County

Alluvial fans / debris flow fans
Johnson County

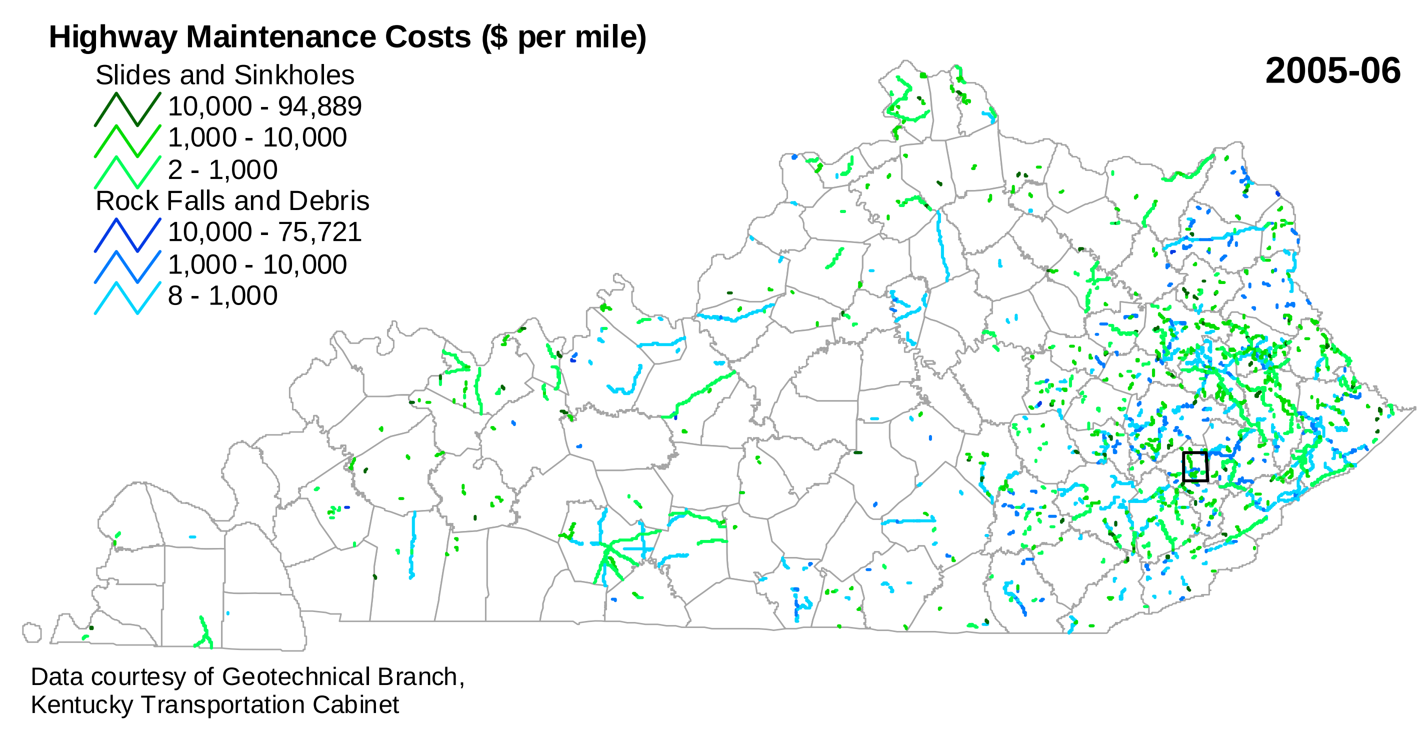
KGS

Landslide Hazards in Kentucky

Kentucky State Hazards Mitigation Plan



Data courtesy of R.J. Human, University of Louisville,
Center for Hazards Research And Policy Development



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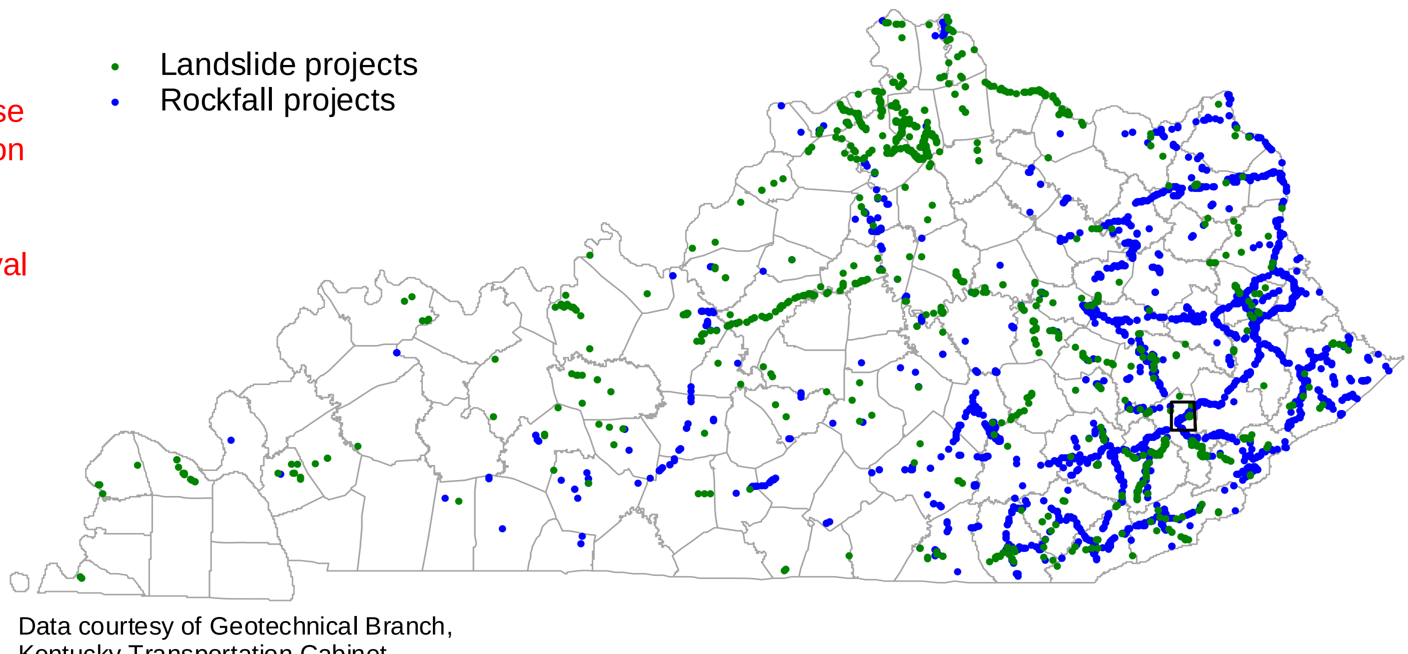


Eastern Kentucky Landslide Overview

Topography: steep, narrow, dissected

Bedrock: coal measures, laterally variable lithologies

Structure: generally flat-lying strata, regional and local fractures

Hydrology: complex, controlled by coal beds and fractures

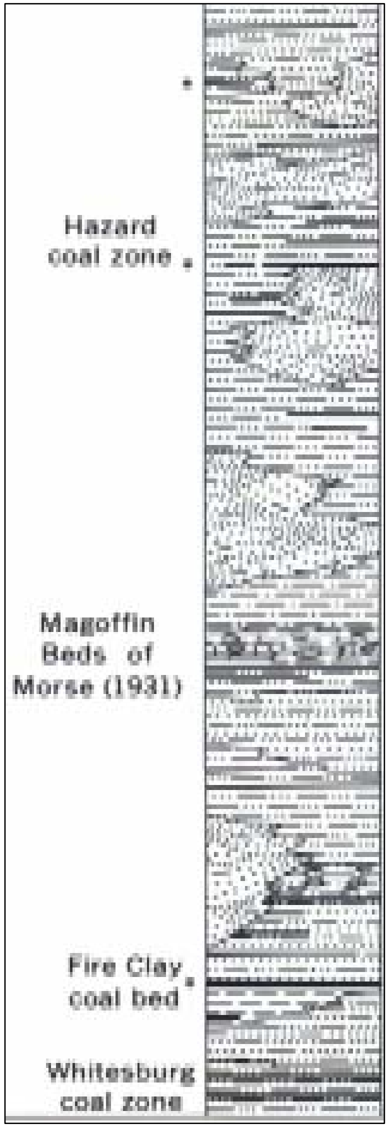
Processes: debris flows/avalanches, slides/slumps, creep, rock fall

Costs: extensive, significant, prohibitive

Eastern Kentucky landscape

Perry County

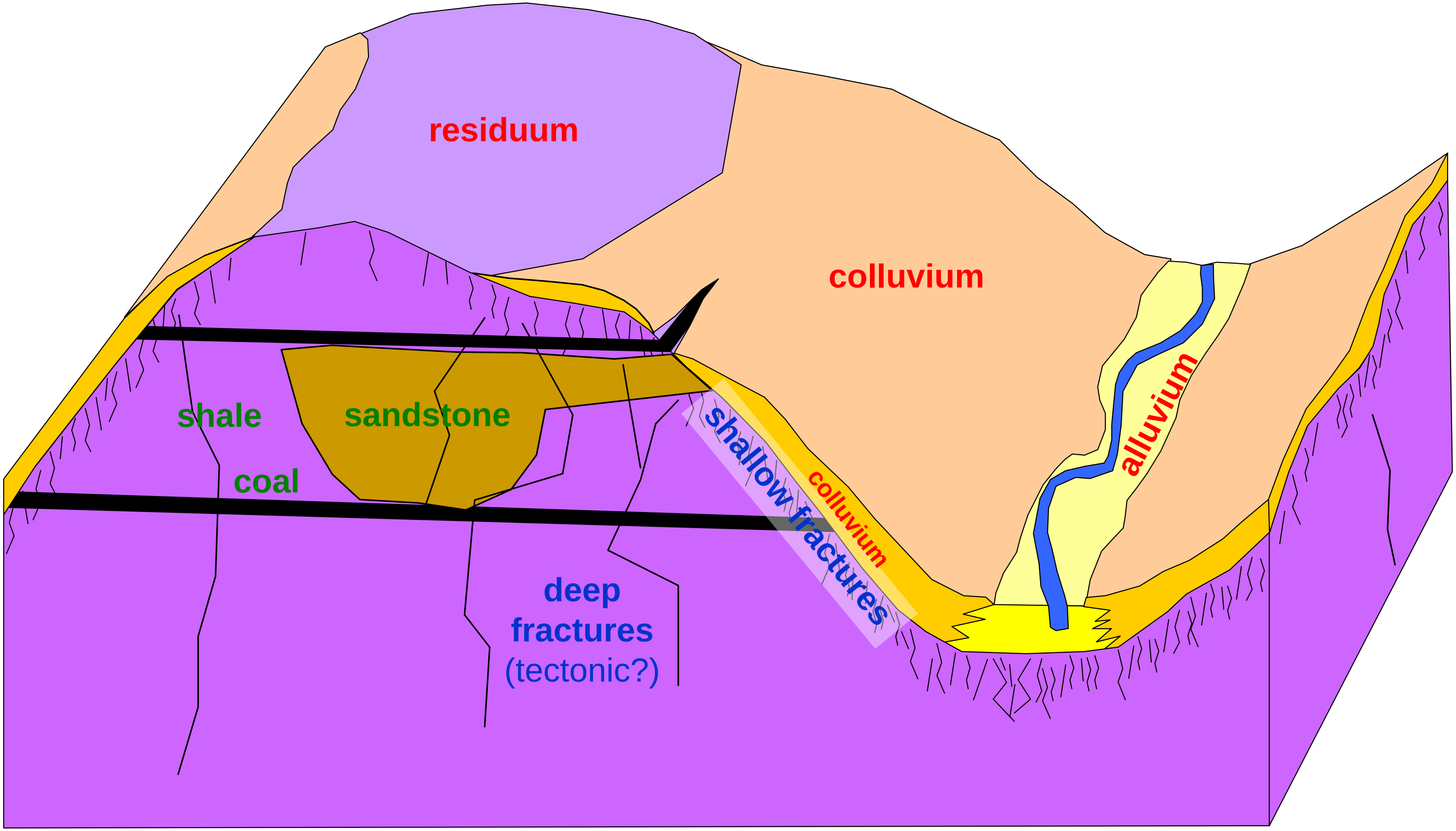
Eastern Kentucky stratigraphy



Failure along bedrock joint
Floyd County

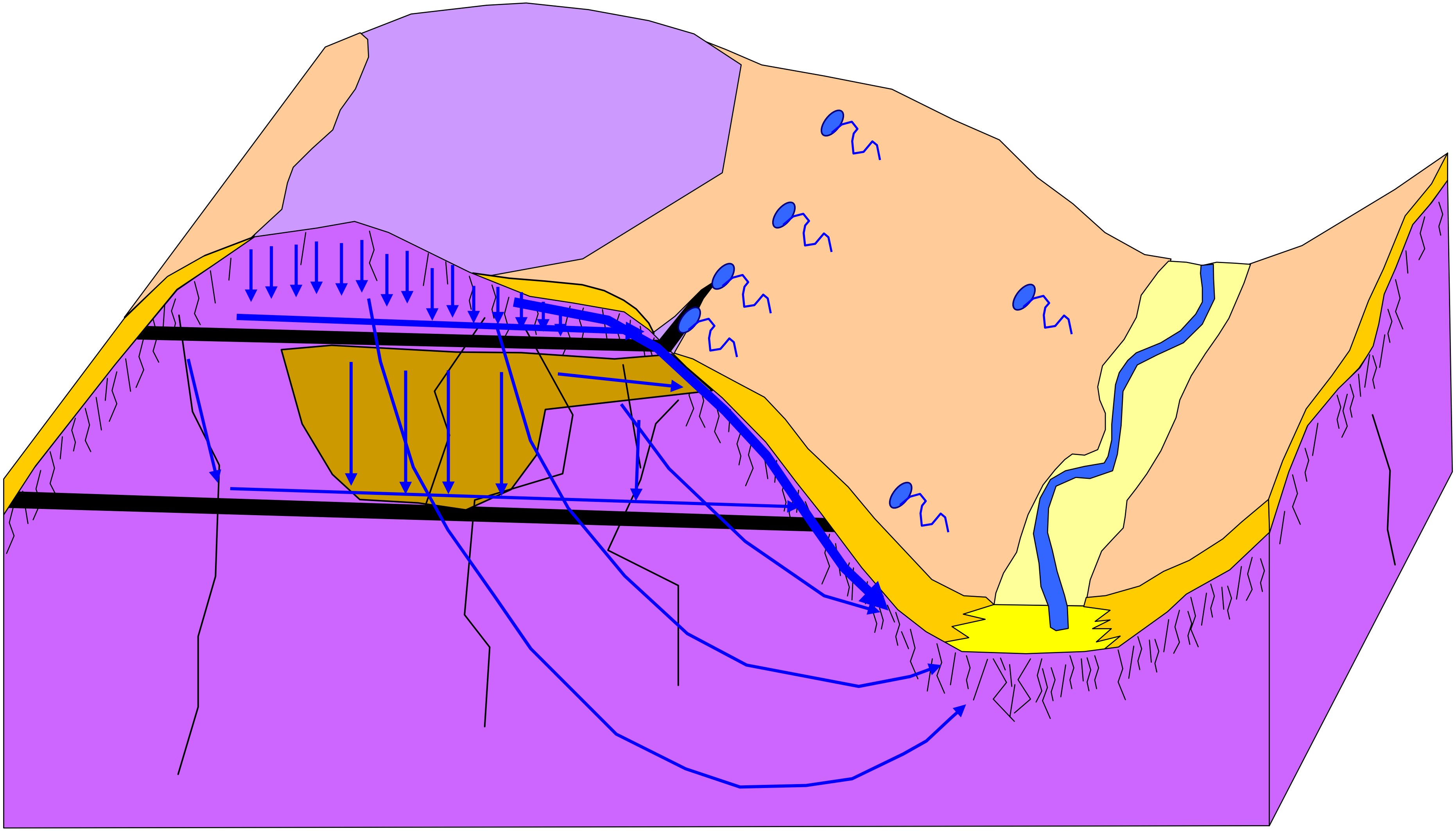
Photos courtesy of
Kentucky Transportation Cabinet

Generalized landscape model
Eastern Kentucky coal field



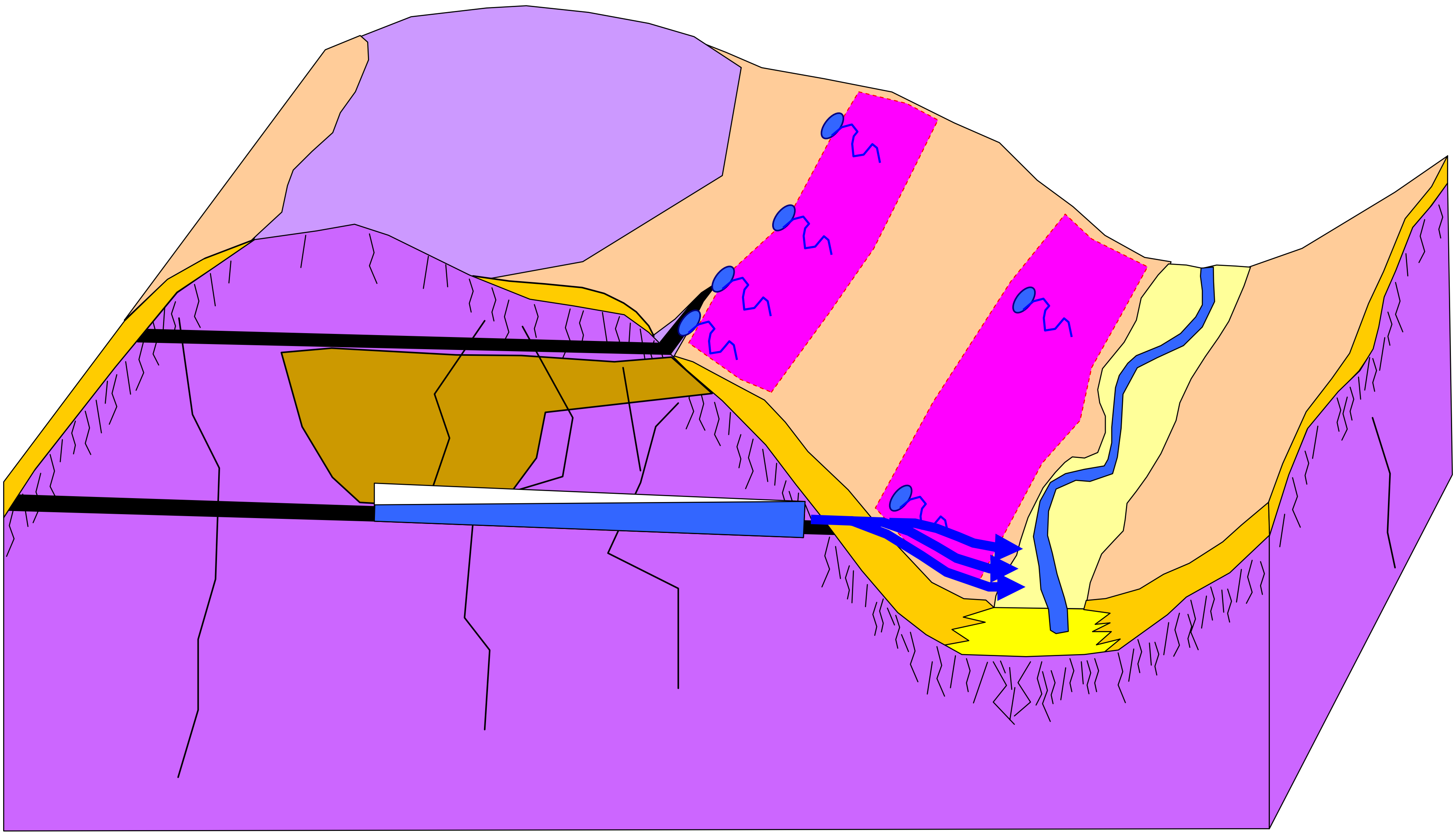
KGS

Conceptual groundwater flow
Eastern Kentucky coal field



Modified from Wunsch, 1993

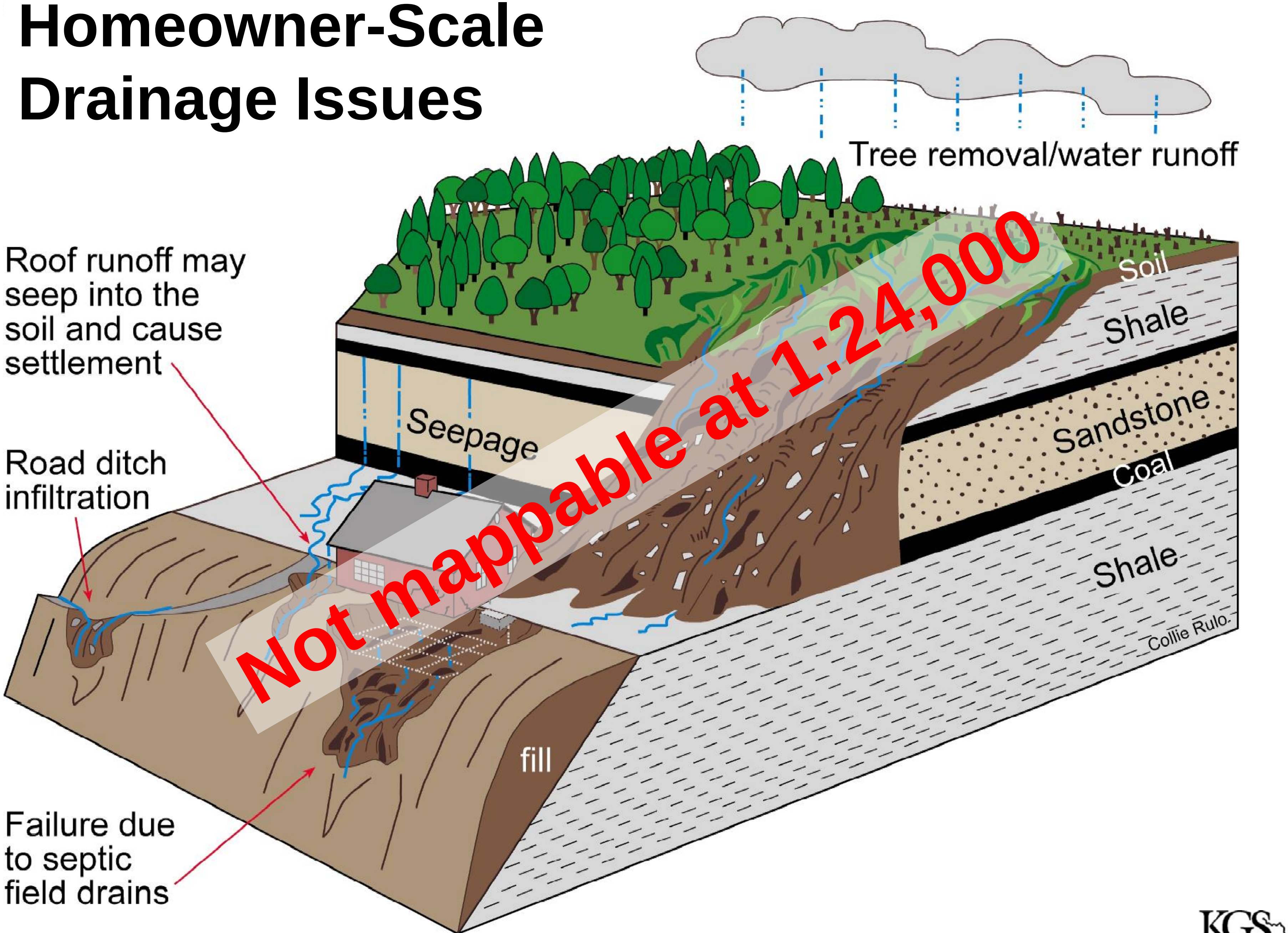
Conceptual groundwater flow
Eastern Kentucky coal field



Modified from Wunsch, 1993

KGS

Homeowner-Scale Drainage Issues



Landslide Mapping

Eastern Kentucky

Previous

Newell (1977): surficial geology

Newell (1978): application for land-use planning

Outerbridge (1979): landslide map (inventory)

New/Future

New surficial geologic mapping

Derivative maps for land-use planning

Engineering geologic map

GIS-based modeling

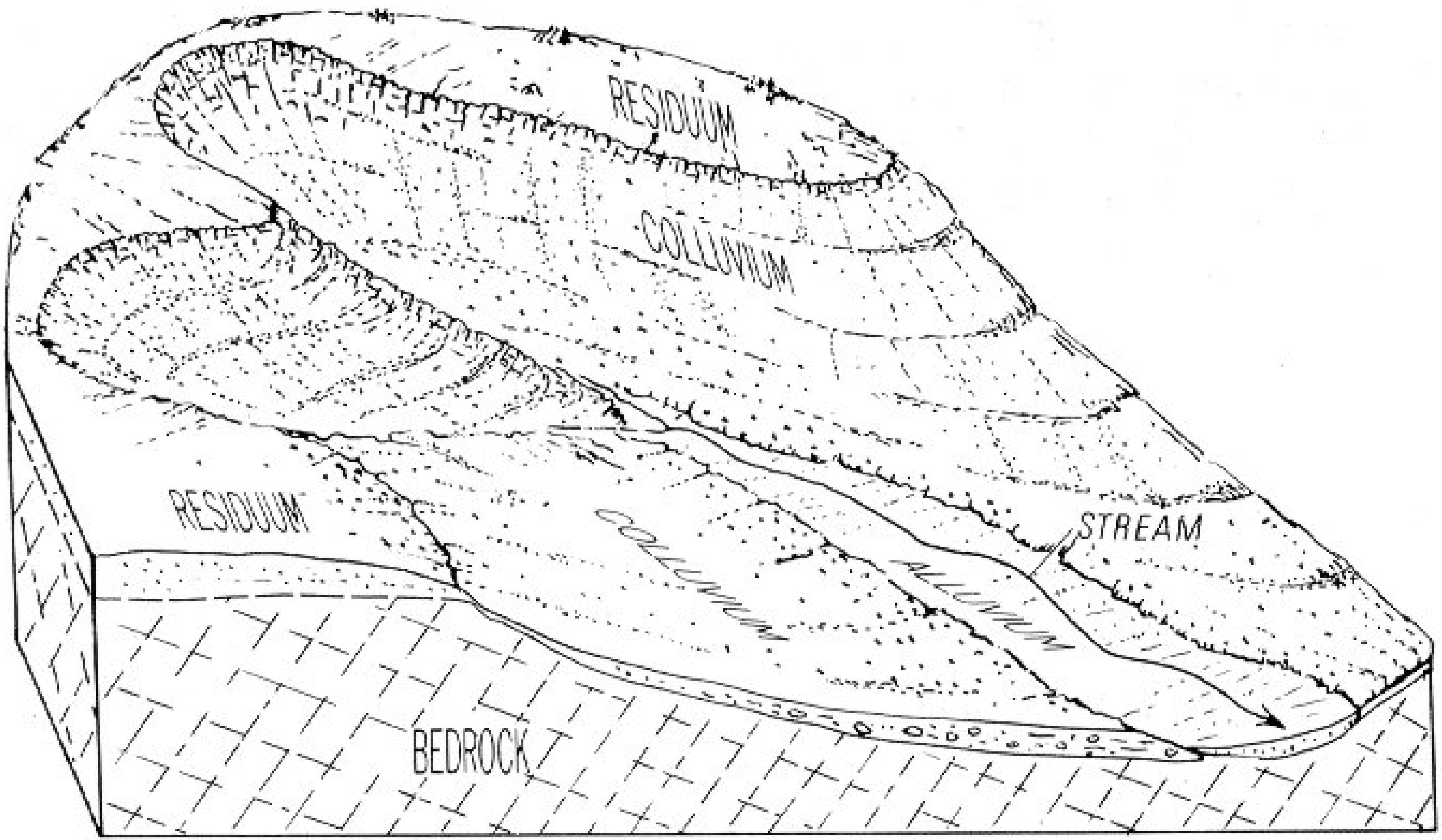
Digital data delivery

User-education workshops

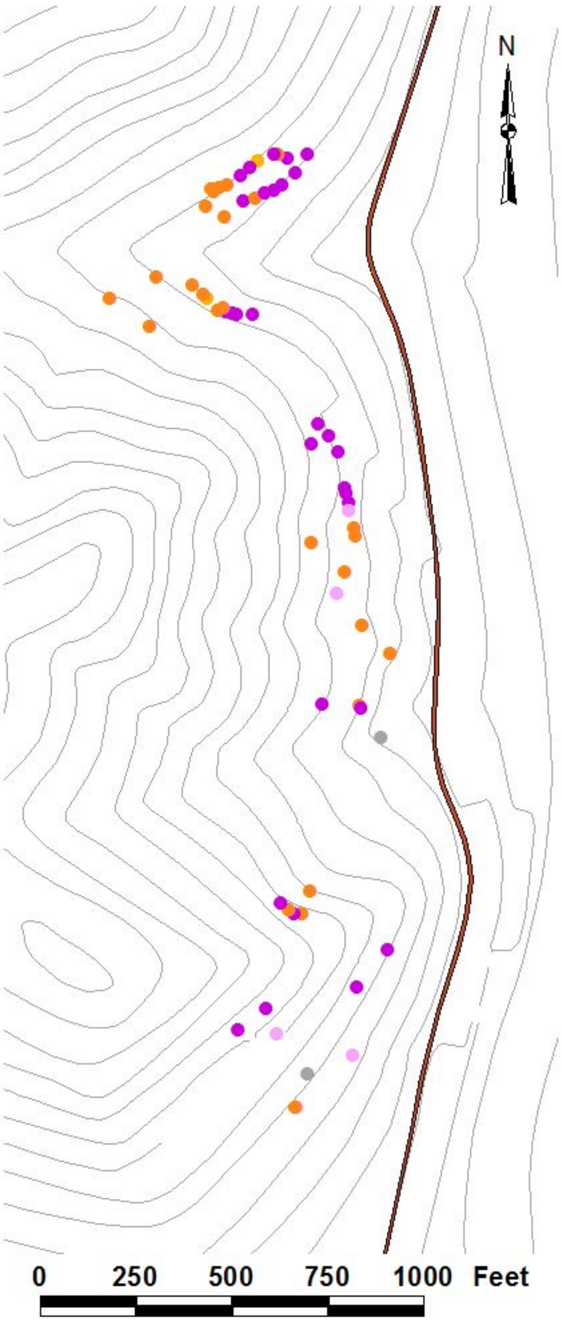
Landslide map from aerial imagery: esp. slumps, debris-flow chutes, highwalls

Outerbridge, 1979

Mapping concept of Newell (1977)



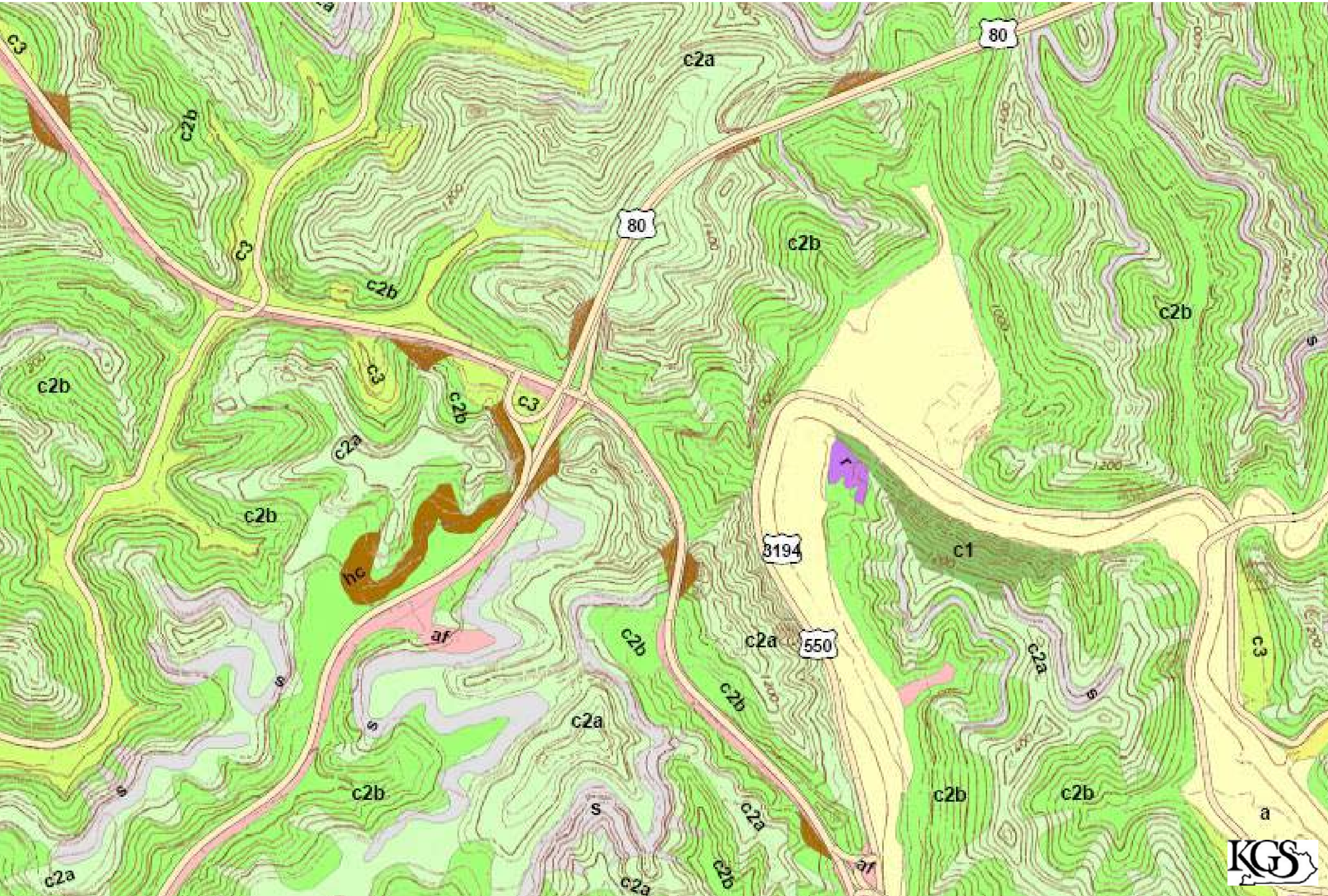
From Newell, 1978



KY Hwy 7
Depth to Bedrock study area

Surficial Geology: colluvium, alluvium, residuum, surface cuts

Updated from Newell (1977)



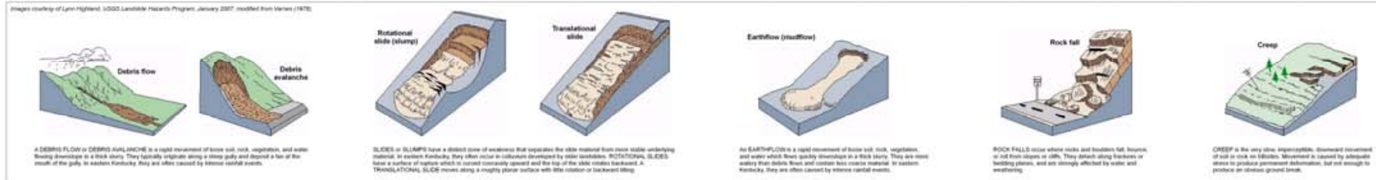
KENTUCKY GEOLOGICAL SURVEY
James C. Cobb, Director and State Geologist
UNIVERSITY OF KENTUCKY, LEXINGTON

Map for Land-Use Planning

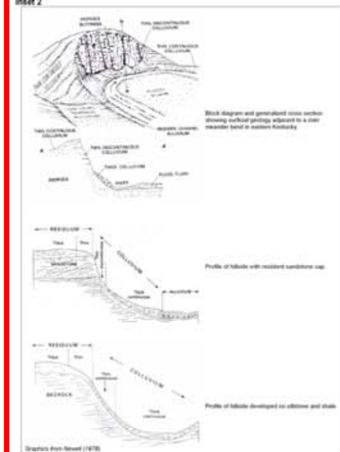
Map Discussion

Landslides are commonly viewed as unpredictable, but knowledge of ground conditions (topography, geology, drainage) combined with well-planned construction can reduce exposure to the hazard. This map of the Hazard North quadrangle provides a visual inventory of available geologic and landscape data relevant to slope stability assessments.

Inset 1



Inset 2



Graphics from Newell (1978)

Inset 3

Water Can Cause Landslides

What Are the Factors That Cause Landslides?

What Are Some Ways to Prevent Landslides?

Map Symbols

N

Surficial Geology

- Alluvium, undifferentiated
- Alluvium, active channels
- Artificial fill
- Colluvium, thin discontinuous
- Colluvium, thin continuous, low slump incidence
- Colluvium, thin continuous, high slump incidence
- Colluvium, thick continuous
- Highway cuts and highwalls (pre-1978)
- Highway cuts and highwalls (post-1978)
- Residuum and bedrock
- Surface mine
- Water Wells
- Coal Boreholes
- Springs
- Landslides (from Ky. Transportation Cabinet database)
- Rock Falls (from Ky. Transportation Cabinet database)
- Debris Flow Channels (from Outerbridge, 1979)
- Slumps (from Outerbridge, 1979)
- Marine zone outcrop (shale)

Coal Beds

- Coal bed
- Coal bed, down structural dip
- Coal bed, down dip from underground mine

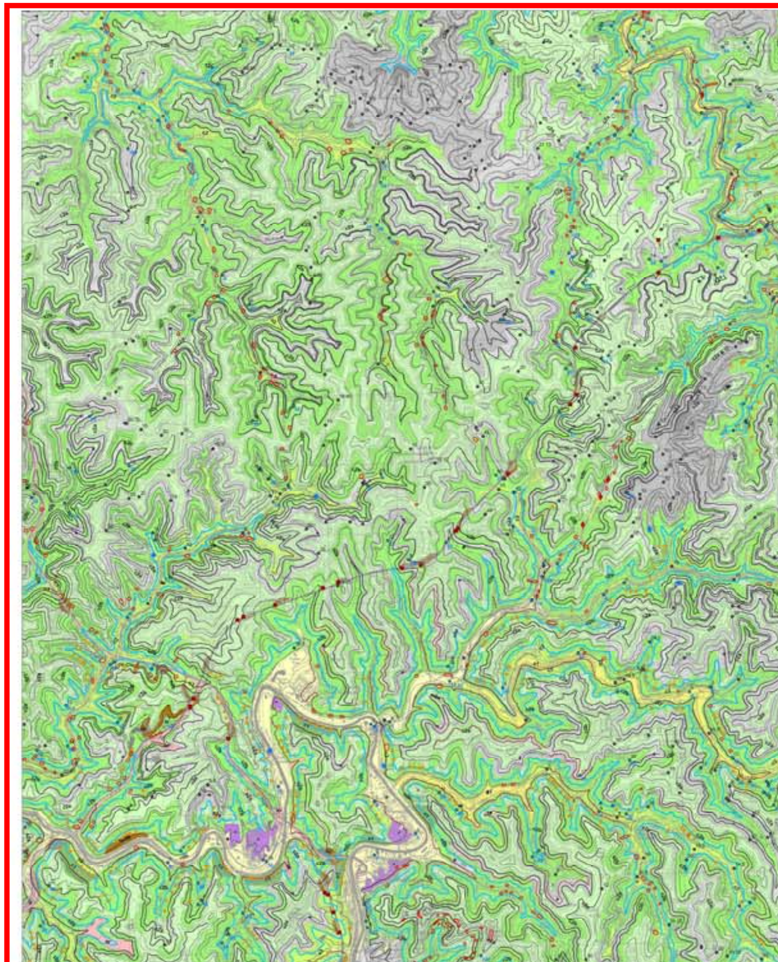


Table 1. Landslide characteristics of map units

Map Unit	Description	General Guidance	Slumps	Rock Falls	Flooding
(a) ALLUVIUM	[illegible]	[illegible]	[illegible]		Susceptible
(af) ALLUVIUM, active channels	[illegible]	[illegible]	[illegible]		Highly susceptible
(cf) COLLUVIUM, thin discontinuous	[illegible]	[illegible]	Susceptible	Susceptible	
(c2a) COLLUVIUM, thin continuous, low slump incidence	[illegible]	[illegible]	Susceptible		
(c2b) COLLUVIUM, thin continuous, high slump incidence	[illegible]	[illegible]	Highly susceptible		
(c3) COLLUVIUM, thick continuous	[illegible]	[illegible]	Highly susceptible		
(r) RESIDUUM	[illegible]	[illegible]	[illegible]	Exposed cliffs susceptible	
(af) ARTIFICIAL FILL	[illegible]	[illegible]	[illegible]		
(hc, hc08) HIGHWAY CUTS	[illegible]	[illegible]	[illegible]	Highly susceptible	
(s) SURFACE MINES	[illegible]	[illegible]	[illegible]	[illegible]	

1:24,000

0 0.25 0.5 1 1.5 2 Miles

0 1,000 2,000 4,000 6,000 8,000 Feet

0 0.25 0.5 1 1.5 Kilometers

State Plane projection, Kentucky Single Zone, 1983 North American datum

References

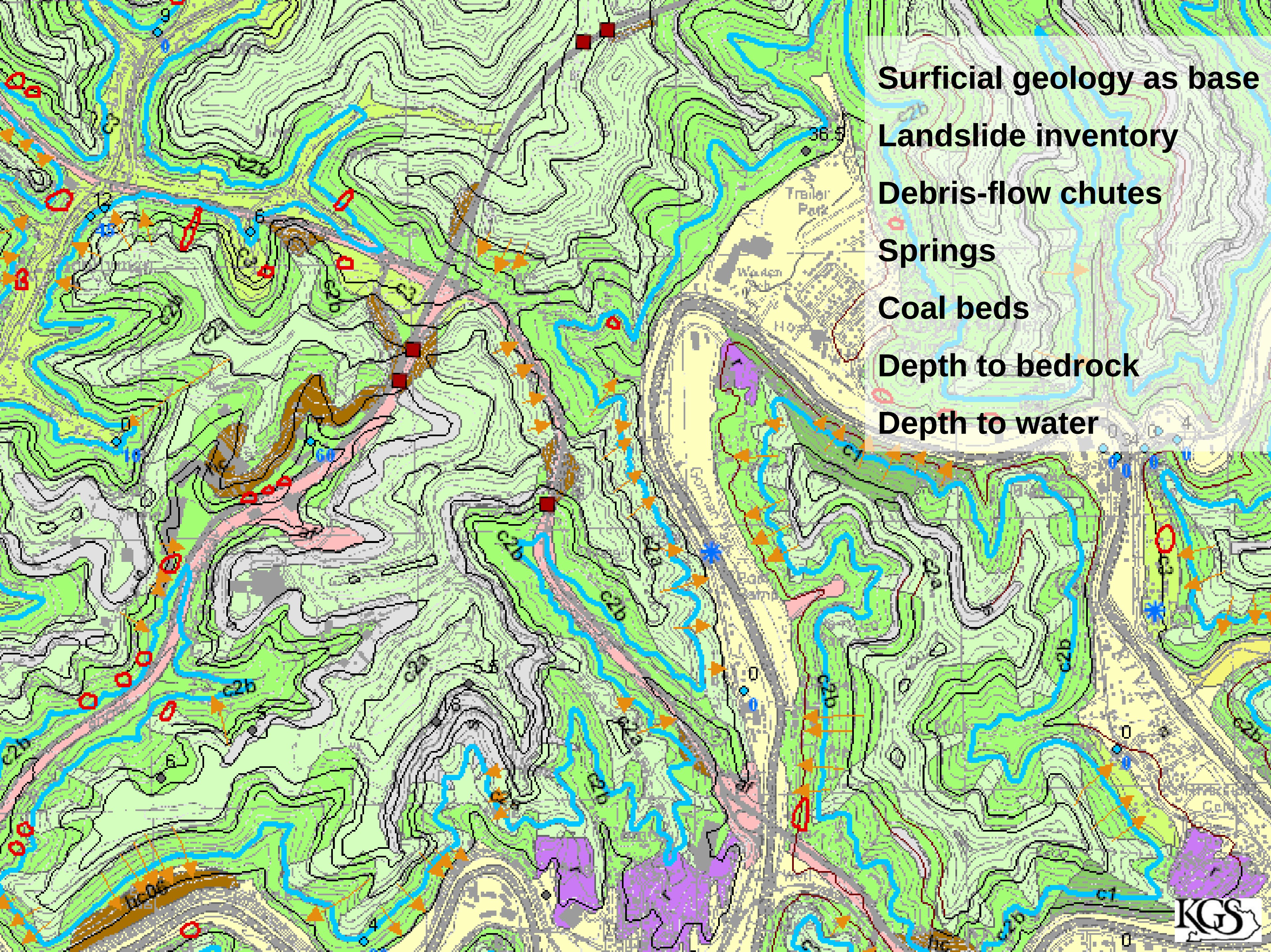
Acknowledgements

Surficial Geology of the Hazard North Quadrangle, Perry County, Kentucky for Landslide Susceptibility

William M. Andrews Jr., Matthew M. Crawford, and Michael L. Murphy

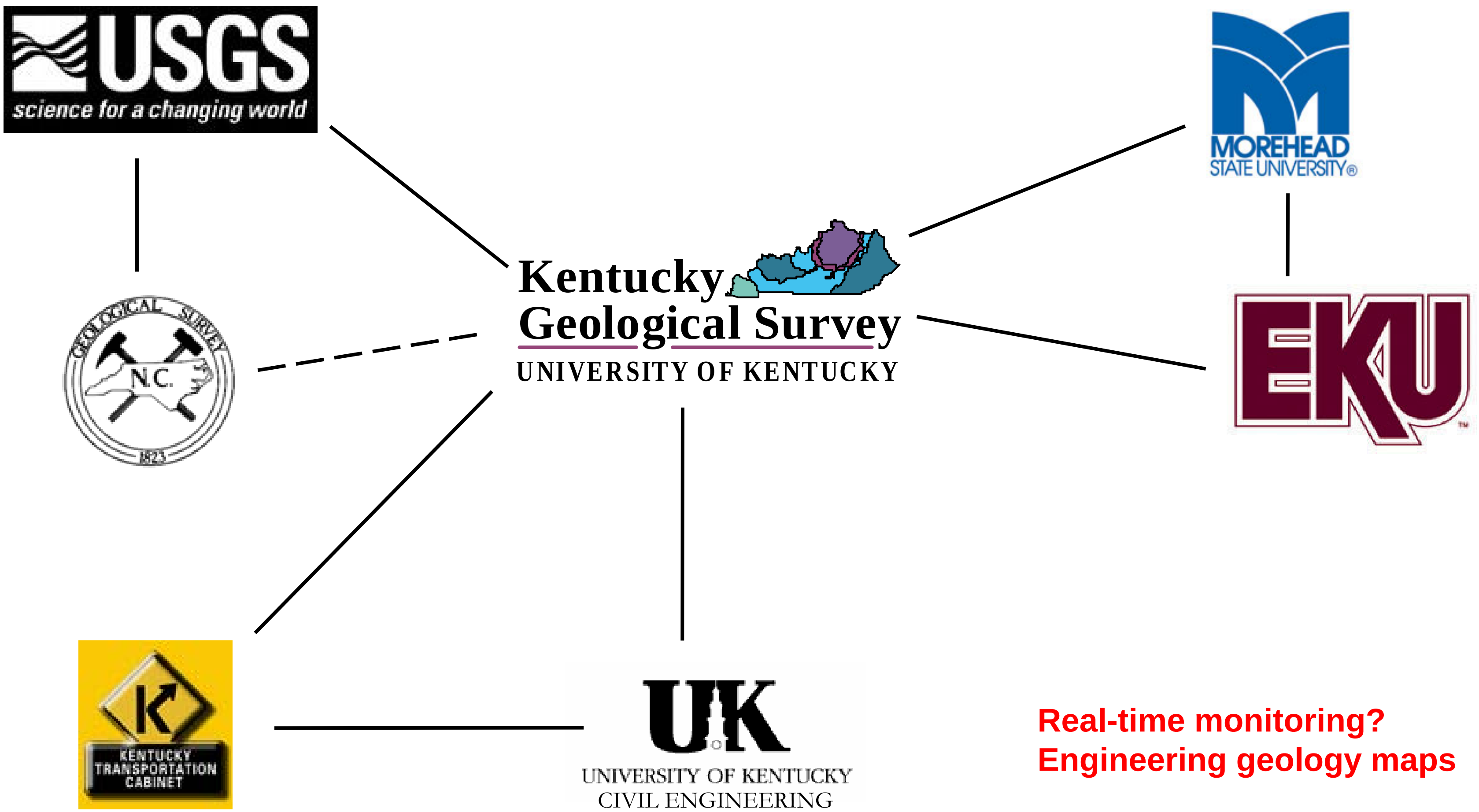
December 2006

DRAFT


Surficial geology as base
Landslide inventory
Debris-flow chutes
Springs
Coal beds
Depth to bedrock
Depth to water

Program Relationships

Surficial geologic mapping
Fracture mapping
Land-use Derivatives



Real-time monitoring?
Engineering geology maps

Eastern Kentucky landscape

Hazard, Perry County

Debris flows and slumps in the landscape: trends in location

Hazard, Perry County

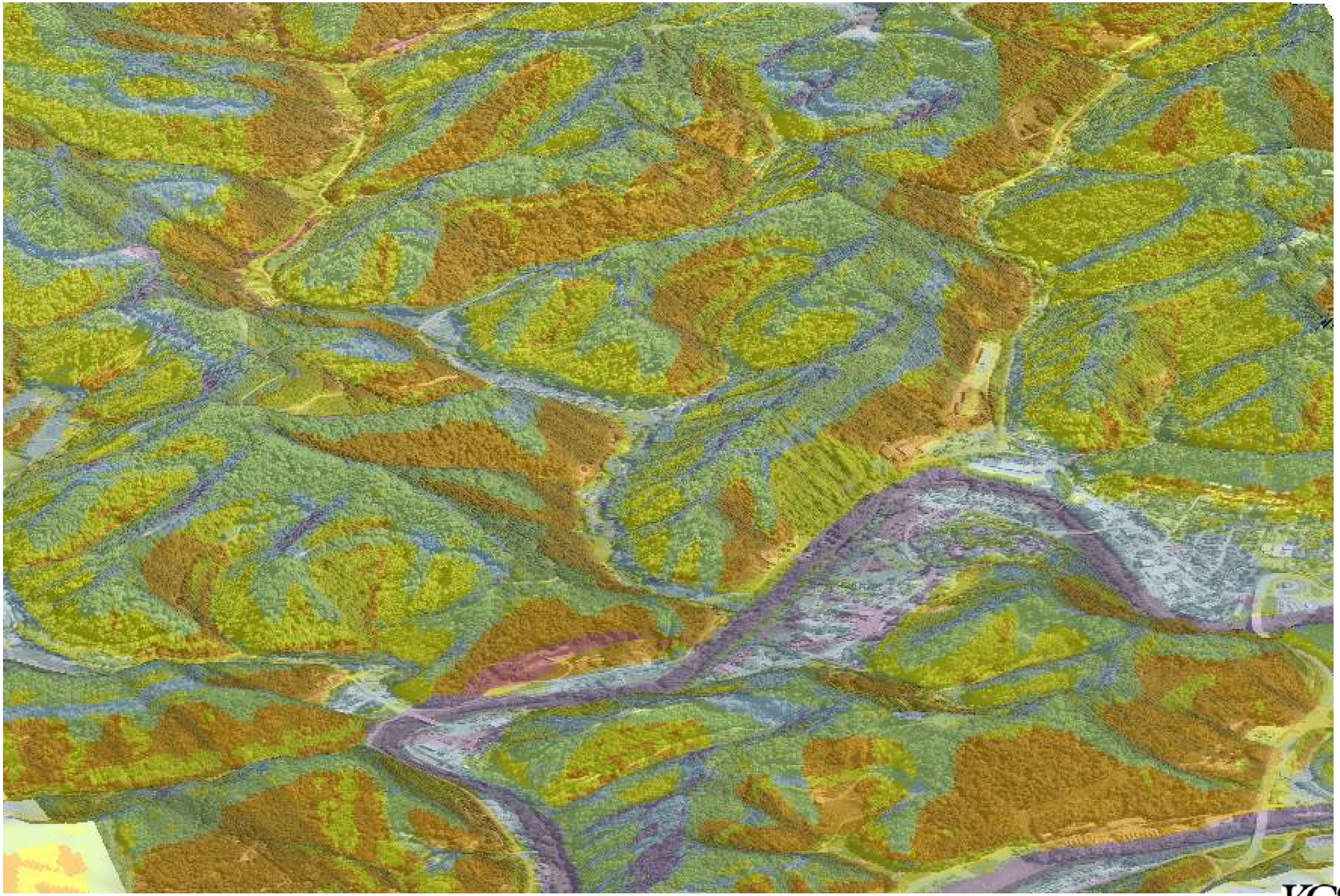
Surficial geology on landscape
Hazard, Perry County

Landslides and surficial geology

Hazard, Perry County

Empirical susceptibility model on landscape

Hazard, Perry County



Audiences and Products

Geological maps: for geologists
- Geologic quadrangles
- Surficial geology

Derivative maps: for non-geological audiences
- Engineering geology (technical audience)
- Land-use map (less technical audience)

Web Products: increased user access
- Digital delivery of data sets and static maps
- Interactive map and data servers

Questions?

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Photo courtesy of
Ky Transportation Cabinet