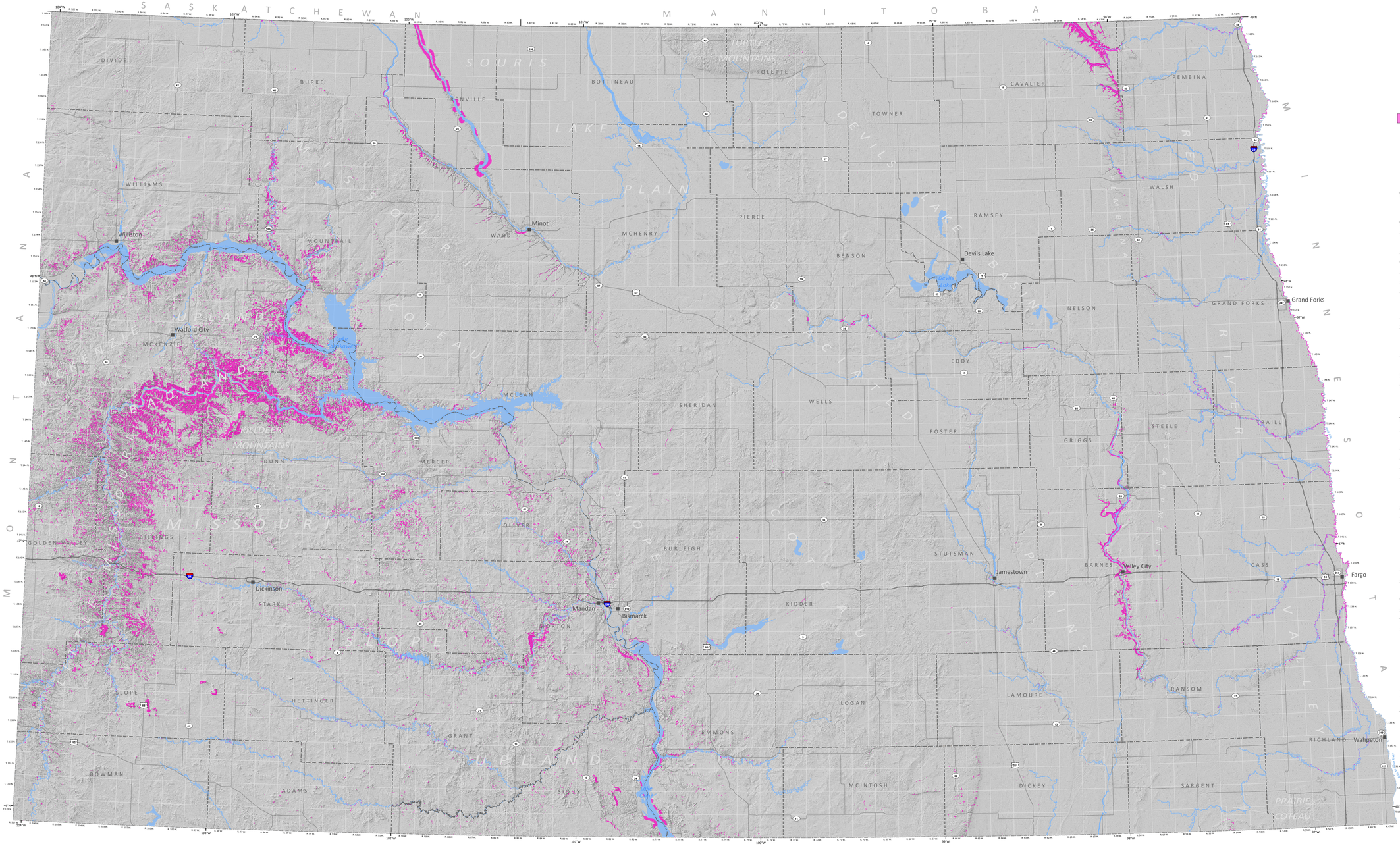
North Dakota Geological Survey
Edward C. Murphy, State Geologist

Areas of Landslides in North Dakota



Fred J. Anderson, Christopher A. Maike, Levi D. Moxness, Edward C. Murphy, Navin Thapa, Benjamin C. York

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Landslide Deposits

A mass of material that has moved downslope. Includes earth flows, slumps, and areas of soil creep.

DISCUSSION

The landslides and landslide complexes depicted on this map were delineated using historical aerial photographs, recent digital aerial imagery, and hillshade models produced from Light Detection and Ranging (LiDAR) elevation data. These landslide areas were digitally mapped between 2016 and 2023 using Geographic Information Systems (GIS) platforms at variable scales and published at a scale of 1:24,000 in 1,464 individual 7.5' quadrangle maps that cover the state. During this inventory 58,891 landslide areas were identified from their surface geomorphology captured in the most recent LiDAR collections. The actual number of individual landslide areas is likely to be somewhat higher since many of these areas were mapped as landslide complexes which may contain several individual slides.

Historical aerial photography utilized in the initial identification of landslide areas consisted of 1:20,000 paper photographs from the U.S. Department of Agriculture's flights spanning the years from 1952 to 1965. Recent aerial imagery from the National Agricultural Imagery Program (NAIP), ranging primarily from 1997 to 2022, was also reviewed when available either in the desktop mapping environment or within the Google Earth platform. NAIP high resolution satellite imagery was also overlain on assorted elevation datasets. Shaded relief (hillshade) models, created from QL2 and QL3 LiDAR digital elevation datasets collected between 2008 and 2017, were used to update previous inventory mapping where only aerial photos were used. These models served as the basemap for final inventory mapping.

Throughout the state, regardless of the surface lithology, landslides of varying sizes occur along the edges of floodplains where fluvial erosion has undermined the base of the valley walls. Slopes also become oversteepened during human earthwork, especially along old railroad and road cuts, excavations for buildings, or well pads at the base of slopes. This activity can compromise previously stable slopes or reactivate older slope failures, especially portions of larger landslides where glacial meltwater carved deep ravines into bedrock. In western North Dakota, ice age downcutting by the Missouri River and its tributaries exposed steep outcrops of Paleocene sandstone, siltstone, mudstone, and lignite. These rocks are usually weakly-cemented and prone to failure in large rotational slumps with well-defined head scarps and toes. This is common in the Little Missouri badlands, where landslide complexes can stretch uninterrupted for several miles.

In eastern North Dakota, exposures of bedrock are rare as repeated glaciations have dampened much of the topography and covered it in glacial sediment. Conversely, outburst floods cut deep meltwater trenches into Cretaceous shales in the Pembina Gorge and Sheyenne River Valley. Shale, claystone, and mudstone, as well as sediment rich in swelling clays, are the weakest and most failure-prone lithologies in the state, especially where they occur in steep slopes. Even the very moderate slopes of eastern North Dakota frequently fail where they occur in expansive glacial lake clays, mostly along rivers and streams and engineered slopes in the Red River Valley.

Landslides in North Dakota are thought to range in age from the Pleistocene to recent, although some large slumps around the major buttes in southwestern North Dakota could be older. Slump blocks become increasingly unconsolidated through time, often breaking down into complexes of smaller landslides or eventually stabilizing and becoming overprinted by colluvium (slopewash). Smaller landslides along active rivers can quickly erode away. New landslide activity continues to be identified as NDGS mapping progresses from inventory mapping into temporal analysis through the interpretation of repeat LiDAR data sets. This map represents the first comprehensive landslide mapping inventory completed for the state of North Dakota.

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Cartographic Compilation: Navin Thapa