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LANDSLIDES IN MOUNTRAIL COUNTY

Landslides are masses of rocks and sediment that have tumbled or slid down a slope under their own weight. Landslides are one of the most common geologic hazards in North Dakota and can destroy buildings, roads, railroad tracks, pipelines, transmission lines, and other types of infrastructure. Landslides are generally characterized in the field by steep, near-vertical slopes (the scarp) that are upslope from a mound of displaced rock (the body). The body of the slide may be relatively intact, or it may be severely fragmented. Recent or relatively new landslides are generally characterized by a fresh (well-exposed rock) scarp and a sparsely vegetated body. Older slides are typically more difficult to identify in the field because the topography of the scarps and bodies may be smoother and more subdued due to weathering. Landslides are most readily identifiable from Light Detection and Ranging (LiDAR) data, supplemented with aerial imagery.

Landslides in Mountrail County were mapped from LiDAR data collected from October to November 2021 along with NAIP digital imagery from 2016 to 2022 and a complete set of historical aerial photographs flown from July to August in 1958 at a scale of 1:20,000. The aerial photographs were taken when leaves were on the trees which is unfortunate because groves of leaf-bearing trees tend to obscure landslides, especially small ones. On the other hand, leaves can sometimes make it easier to identify these features as trees and bushes are often aligned within very distinct parallel-, transverse-, and/or semi-circular-depressions that generally occur within the body of the landslide. Using LiDAR elevation data allows us to see through most of the areas previously obscured by vegetation in the historical imagery and aerial photography and greatly increases our ability to identify additional landslide areas.

A total of 2,630 landslide areas were identified in Mountrail County. Some of these slide areas are complexes, consisting of multiple landslides that formed from different events. Therefore, the number of individual landslides in this county is likely somewhat higher. Collectively, these landslide areas cover 19.8 square miles (12,668 acres) or approximately one percent of the county. Most of the landslides occur within the White Earth Creek Valley in the western part of the county and the Little Knife River Valley in the south central part of the county and on the slopes of the Missouri River Valley along Lake Sakakawea. Most of the larger slide areas are landslide complexes consisting of several large, coalesced slides.

Most of the slides in Mountrail County (71%) cover less than four acres (Figure 1). On the larger side of the scale, 287 (11%) are larger than 10 acres with an average of 24 acres. Landslides are commonly concentrated along drainages, ravines, and coulees, and within areas of high local topographical relief along major creeks and valleys. All, or portions, of the head of a ravine typically fail, presumably because headward erosion causes these areas to undergo some of the fastest rates of erosion, oversteepening slopes.

Several historical abandoned mine lands (AMLs) are found in Mountrail County, mostly in the southwestern half. These small coal mines, commonly referred to as wagon mines, are found somewhat concentrated north and south of White Earth with several locations near Newtown and northwest of Parshall. No collapse features from underground voids were visible on the surface, but uncollapsed mine voids may occur in the subsurface beyond the boundaries of the known AML locations since a mine is reported to have existed at these locations, according to records compiled by the North Dakota Public Service Commission. It can be difficult to determine whether small surface irregularities along drainage slopes are old mines or slumps, further complicated as abandoned mines are susceptible to slope failure. Thus, some areas mapped as landslides may include the collapse of abandoned mine-headwalls.

Slopes fail for various reasons including the steepness or angle of the slope, rock type, bedding, and moisture content of the rocks. Most landslides in western North Dakota are rotational slumps that have a well-defined head and toe. Typically, the part of the slope that breaks apart slides down the slope as a single unit and the beds tilt back in the direction of the slope. The failed mass of rock is, however, never a cohesive unit; tension cracks generally cause the failed material to splinter into smaller portions. Successive landslides may occur at the same location. Over time, the accumulated material from multiple, adjacent landslides can cover an area that is several thousand feet wide and several miles long.

Most (90%) of Mountrail County is covered by glacial sediments of the Coleharbor Group which consists of pebbly, silty, sandy clay till. The sedimentary bedrock geology of Mountrail County, which is exposed only along major creeks and river valleys, consists of sandstone, siltstone, mudstone, claystone, limestone, and lignite deposited in rivers, floodplains, lakes, and swamps during the middle and late Tertiary. These rocks are included in the Bullion Creek (middle Paleocene), Sentinel Butte (late Paleocene), and Golden Valley (latest Paleocene to Eocene) Formations. Over half of the number of landslides in Mountrail County occur in the Sentinel Butte Formation (54%) along with the Bullion Creek (11%) and Golden Valley Formations (4%), with a sizeable number (32%) occurring within Quaternary sediments of the Coleharbor Group. It is not uncommon for landslides to occur across multiple formations and displace several units, especially where glacial sediments mantle sedimentary bedrock (Figure 2).

Small landslides, 10 acres or less in size, are common throughout the rugged topography of western North Dakota. Many of these, as well as larger landslides, can be obscured by slopewash or colluvium. Layers or blankets of slopewash typically cover the lower portion of a slope and extend horizontally from its base. Thick smooth layers of slopewash can completely obscure the broken, jumbled beds of landslide material. In some areas, smaller landslides, or landslides that are very old and have been inactive for a long period of time, are only visible if slopewash is thin or absent, or the beds are sufficiently displaced to create subtle irregularities at the surface. An area with many landslides suggests that the slopes in that area may be predisposed to future slides. Even when landslides are not identified in these types of settings, these areas often remain vulnerable to slope failure and should be evaluated prior to the development of any civil works or energy infrastructure projects and, when possible, be avoided.

LANDSLIDE AREAS IN MOUNTRAIL COUNTY, NORTH DAKOTA

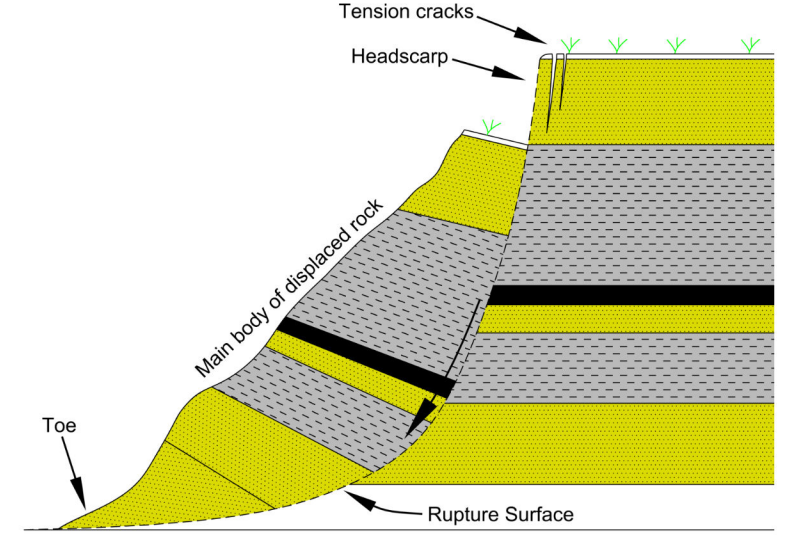
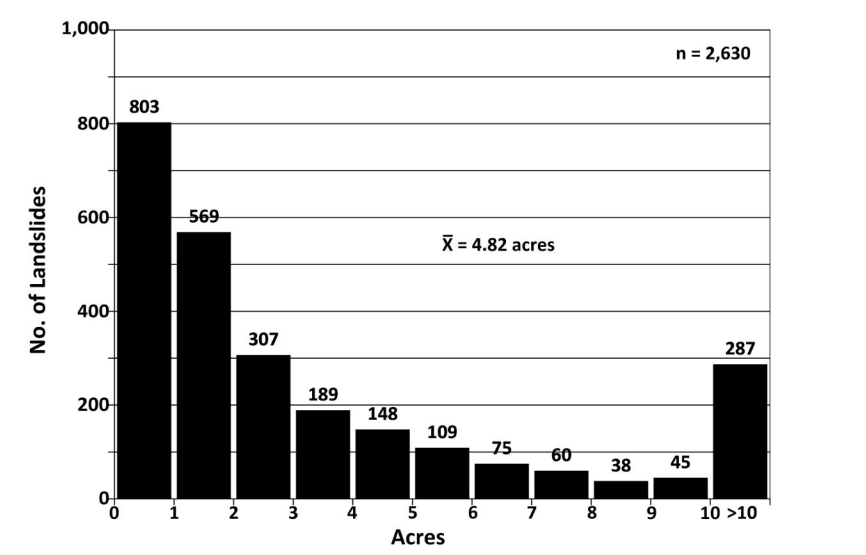
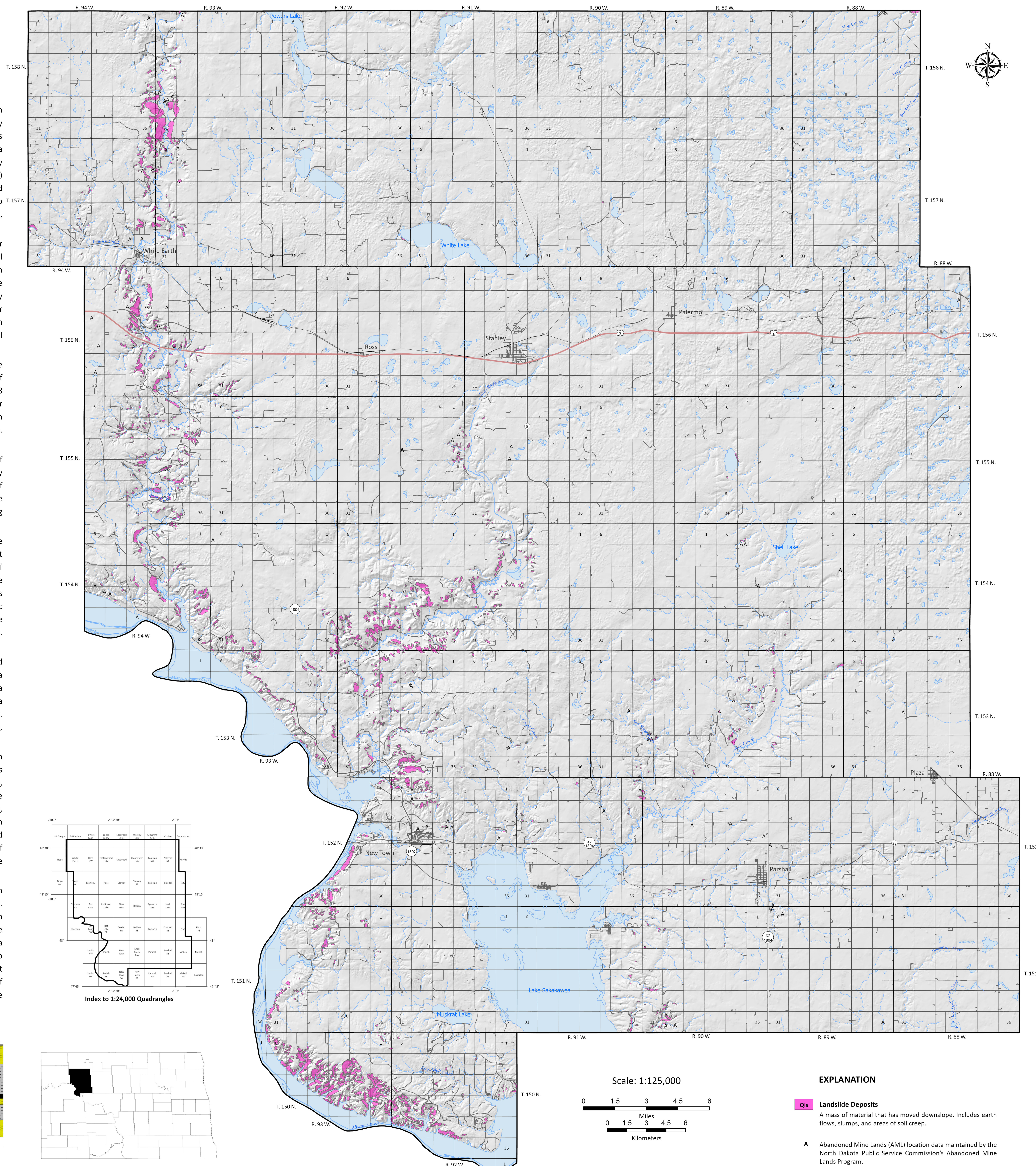
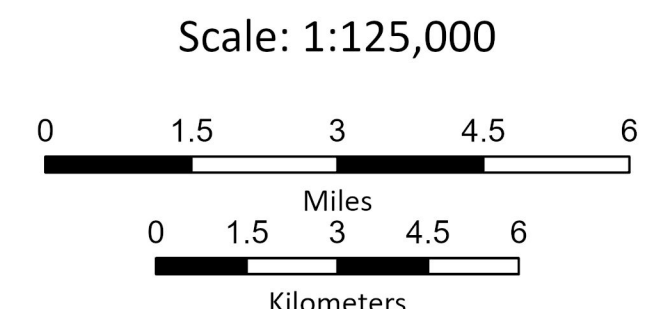
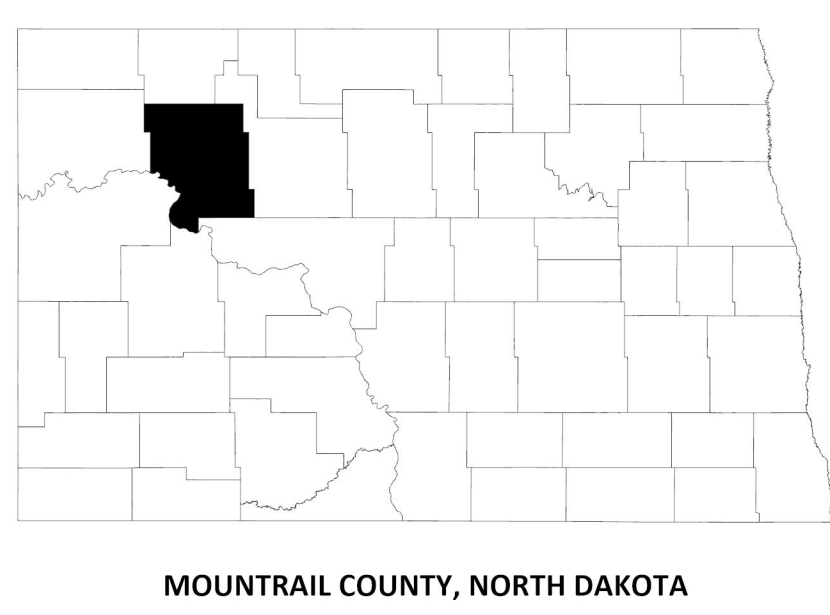


Figure 1. Distribution of landslide areas mapped in Mountrail County. Most landslide areas (71%) cover less than four acres. Some slides (11%) are over ten acres in size. The mean (X̄) landslide area size is 4.82 acres. The number of landslide areas (n) in this distribution is 2,630. Within the 287 landslide areas that are greater than 10 acres, the mean is 24 acres. The largest landslide area mapped in the county covers 266 acres.

Figure 2. Generalized diagram of a rotational bedrock slump common to the badlands terrain of western North Dakota.



EXPLANATION

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

A Abandoned Mine Lands (AML) location data maintained by the North Dakota Public Service Commission's Abandoned Mine Lands Program.