UTAH GEOLOGICAL SURVEY
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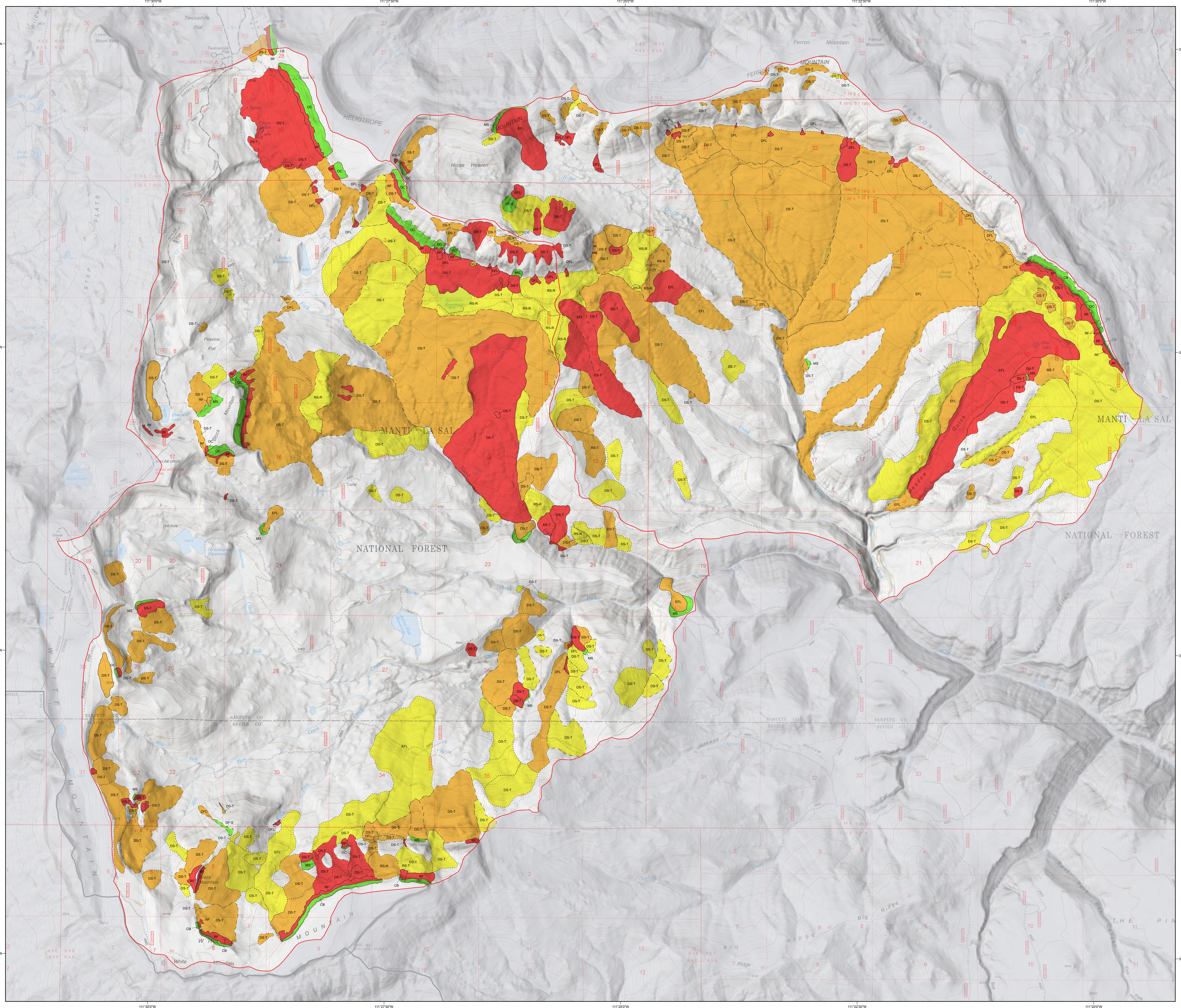

Base from 2012 USFS Woods Lake, Heliotrope Mtn, Flagstaff Peak, Water Hollow Ridge, Acord Lakes, and Emery West. 7.5' Quadrangles
Projection: UTM Zone 12
Datum: NAD 1983
Spheroid: Clarke 1866

SCALE 1:24,000

2 1 0 2 Miles

2 1 0 2 Kilometers

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

CONTOUR INTERVAL 40 FEET

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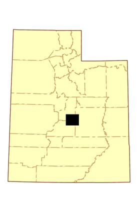
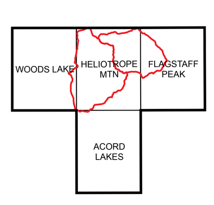


MAP LOCATION



7.5' QUADRANGLE NAMES

11° 16'
TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 2015

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LANDSLIDE INVENTORY MAP FOR THE UPPER MUDDY CREEK AREA, SANPETE AND SEVIER COUNTIES, UTAH

by
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2015

EXPLANATION

This map presents a landslide inventory for the upper Muddy Creek area, Sanpete and Sevier Counties, Utah, at a scale of 1:24,000. The purpose of the map and accompanying geodatabase is to show and characterize historical and prehistoric landslides larger than about 50 feet across their shortest dimension, and to provide information useful for managing landslide problems. The map and accompanying geodatabase were prepared by the Utah Geological Survey (UGS) as a cooperative project with the Manti–La Sal National Forest. The map covers 54 square miles of the southern part of the Wasatch Plateau, and includes two Hydrologic Unit Names and Codes in the east-southeast draining Muddy Creek headwaters: Beaver Creek (140700020201) and Horse Creek (140700020202) (Utah Automated Geographic Reference Center, 2014). We used geographic information system (GIS) software to capture, store, and display the data for each mapped landslide.

We prepared the landslide inventory by analyzing and interpreting 15 different sets of stereo and orthophoto aerial photography, acquired periodically from 1940 through 2011, which provide a 71-year history of landsliding in the map area. We cite photography dates and scales in our aerial photographs reference list. The 1984 and 1985 photo sets have limited coverage in the map area. We recorded spatial and tabular data for each mapped landslide. Spatial data include landslide deposit and source location, area, and perimeter length. Tabular data describe landslide characteristics in text or numeric form and include landslide geomorphic source type: slide and flow main scarps, rock-fall cliff bands and outcrops, and debris-flow channels. The spatial and tabular data are stored in the database and linked to the inventory map. Landslide information stored in the database includes: area, material type, movement type, landslide deposit name, landslide source name, movement activity, thickness, movement direction, approximate movement dates, bedrock unit(s) associated with the landslide, confidence in mapped boundaries, mapper name, peer reviewer name, and comments.

Manti-La Sal National Forest boundary

Hydrologic unit boundary

Landslide Classification

The characteristics used to classify landslides were observed on aerial photography of various dates, on topographic quadrangle maps, in U.S. Forest Service reports, and in the field. Our classification methodology is similar to that used by the California Geological Survey (Irvine and others, 2007) and the Oregon Department of Geology and Mineral Industries (Burns and Madin, 2009). Landslide classification is based primarily on terminology and mapping criteria of Varnes (1978), Wieczorek (1984), Cruden and Varnes (1996), Keaton and DeGraff (1996), and Haskins and others (1998). Landslide deposits are classified based on type of geologic material and type of movement. Where a landslide source could be identified and mapped, the source was classified based on the geomorphic source type. Both the landslide deposit and source are further classified based on landslide movement activity and boundary-mapping confidence. The geodatabase includes additional landslide information not shown on the map.

Landslide Deposit Materials and Movement

Each landslide deposit is assigned a two-part name based on dominant material type and movement type after Cruden and Varnes (1996). The material is classified as rock or soil, and soil is further subdivided as debris (mostly coarser than sand-sized particles) or earth (mostly sand-sized or finer particles). The observed movement types in the map area consist of falls, flows, and slides (rotational and translational). We used the following landslide names in our mapping:

RF	rock fall
RS-R	rock slide rotational
RS-T	rock slide translational
DS-T	debris slide translational
DFL	debris flow
EFL	earth flow

Landslide Source Type

Landslide source areas are classified based on geomorphic source type. Cliff bands and outcrops are typically the source areas for rock-fall deposits. Main scarps are typically the source area for slide and flow deposits. We identified the following landslide source types in our mapping:

CB	cliff band
OC	outcrop
MS	main scarp
DF-S	debris flow source area

Landslide Movement Activity

We classified landslide deposit and source activity based on landslide features observed on aerial photographs and/or in the field.

Active or historical: Landslide has documented movement or landslide features observed on aerial photography and/or in the field indicative of historical movement.

Dormant or very slow moving: Landslide deposit landforms are fresh or uneroded, but there is no evidence of historical movement. Landslide movement is suspended or at a slow rate, preventing development of sharp recognizable features associated with active movement allowing erosion to smooth existing features.

Dormant-eroded: Landslide deposit landforms are smoothed, subdued, and incised by erosion.

Landslide Mapping Confidence

The confidence of landslide mapping is based on the visual clarity of boundaries around landslide sources or deposits. Erosion or vegetation may obscure boundaries, making them difficult to map accurately.

High: The landslide boundary is clearly evident and discernable. The landslide generally shows features indicative of recent movement.

Moderate: Some, but not all parts of the boundary are clearly evident, other parts are approximate or gradational. Diagnostic landforms are generally present.

Low: The boundary is difficult to determine and is approximately located, and few diagnostic landforms may be present.

Geology and Landslides in the Upper Muddy Creek Area

The upper Muddy Creek area lies on the southern Wasatch Plateau. The rock units exposed in upper Muddy Creek consist of, from oldest to youngest: Cretaceous Blackhawk Formation, Castlegate Sandstone, and Price River Formation; Tertiary-Cretaceous North Horn Formation; and Tertiary Flagstaff Limestone (Witkind and others, 1987; Sanchez and Hayes, 1979). The Blackhawk Formation contains sandstone, shaley siltstone, shale, and coal. The Castlegate Sandstone contains massive sandstone with some conglomerate. The Price River Formation contains sandstone and shale. The North Horn Formation is primarily shale with lesser amounts of sandstone. The Flagstaff Limestone contains shale and limestone and is the cap rock of the Wasatch Plateau. Flagstaff outcrops form long linear cliffs along the south side of Heliotrope Mountain and Ferron Mountain and the north and west sides of White Mountain. The rock units are generally flat lying and, in the uppermost watershed, are cut by high-angle, small-displacement normal faults. The White Mountain area faults (Black and Hecker, 1999a) trend northwest in the westernmost part of the watershed, displace bedrock, and locally displace glacial moraines, impounding lakes behind upslope-facing escarpments. North-south trending faults at the south end of the Snow Lake graben extend south of Heliotrope Mountain into the map area (Black and Hecker, 1999b). Prominent cirques are present at upper elevations along the north and west sides of White Mountain and along the south and east sides of Heliotrope Mountain (Larson, 1996). The cirques are shallow with a cirque floor-to-headwall relief ranging up to 800 feet. The North Fork and South Fork tributaries to Muddy Creek flow across broad open valleys that transition into narrow, steep, V-shaped inner-valley bedrock gorges eroded into the Price River Formation, Castlegate Sandstone, and Blackhawk Formation.

Landsliding in the upper Muddy creek area is associated with weak, landslide-prone rock. Shale in the North Horn Formation commonly weathers to clay and typically produces more numerous and larger landslides than other rock units on the Wasatch Plateau (McDonald and Giraud, 2011). Flagstaff Limestone cliff bands and outcrops are a common source of rock fall. Our mapping shows that most of the active landslides are reactivations of pre-existing landslides and that pre-existing landslides are prone to reactivation due to their weak strength characteristics. Several post-glacial landslides displace moraines in the upper watershed. Movement of large landslides along the south sides of Heliotrope and Ferron Mountains have created small, hanging V-shaped drainages above the main scarps. Historically, landslides have had a significant impact within the watershed. Landslide movement in 1983 destroyed Brush Reservoir (U.S. Forest Service [USFS], 1983). The 2-mile-long Meadow Gulch landslide is a large active earth flow and movement in the upper part continually damages USFS road 043.

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DISCLAIMER

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