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LANDSLIDE INVENTORY MAP OF THE SEELY CREEK AND BIG BEAR CREEK DRAINAGES, SANPETE AND EMERY COUNTIES, UTAH

by

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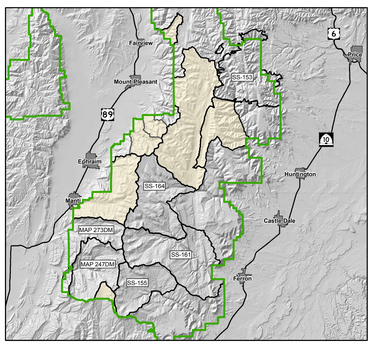
2019



UTAH GEOLOGICAL SURVEY PUBLISHED WASATCH PLATEAU AREA LANDSLIDE INVENTORY MAPS

Map 247DM — McDonald, G.N., and Giraud, R.E., 2011, Landslide inventory map of Twelvemile Canyon, Sanpete County, Utah: Utah Geological Survey Map 247DM, scale 1:24,000.

Map 273DM — Beukelman, G.S., Erickson, B.E., and Giraud, R.E., 2015, Landslide inventory map of the Sixmile Canyon and North Hollow area, Sanpete County, Utah: Utah Geological Survey Map 273DM, scale 1:24,000.

Special Study 153 — McDonald, G.N., and Giraud, R.E., 2014, Landslide inventory map of the 2012 Seeley fire area, Carbon and Emery Counties, Utah: Utah Geological Survey Special Study 153, scale 1:24,000.

Special Study 155 — McDonald, G.N., and Giraud, R.E., 2015, Landslide inventory map for the Upper Muddy Creek area, Sanpete and Sevier Counties, Utah: Utah Geological Survey Special Study 155, scale 1:24,000.

Special Study 161 — Giraud, R.E., and McDonald, G.N., 2017, Landslide inventory map of the Ferron Creek area, Sanpete and Emery Counties, Utah: Utah Geological Survey Special Study 161, scale 1:24,000.

Special Study 164 (this map) — Giraud, R.E., and McDonald, G.N., 2019, Landslide inventory map of the Seely Creek and Big Bear Creek drainages, Sanpete and Emery Counties, Utah: Utah Geological Survey Special Study 164, scale 1:24,000.

EXPLANATION

This map presents a landslide inventory for the Seely Creek and Big Bear Creek drainages, Sanpete and Emery Counties, Utah, at a scale of 1:24,000. The purpose of the map and accompanying geodatabase are 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 as a cooperative project for the Manti-La Sal National Forest. The map covers 80 square miles on the east side of the Wasatch Plateau in the Seely Creek and Big Bear Creek drainages (Utah Automated Geographic Reference Center, 2018). We used geographic information system (GIS) software to capture, store, and display the data for each mapped landslide. The landslide data is included in the *Utah Landslide Inventory Mapped Areas Database* (Utah Automated Geographic Reference Center, 2019).

Hydrologic unit boundary

Area mapped using 0.75-meter lidar

We prepared the landslide inventory by analyzing and interpreting 16 different sets of stereo and orthophoto aerial photography acquired periodically from 1940 through 2016, which provide a 76-year history of landsliding in upper Seely and Big Bear Creeks (photography dates and scale are given in our aerial photographs reference list). We also used high-resolution 0.75-meter light detection and ranging (lidar) data in the easternmost map area (Woolpert, 2014). We recorded spatial and tabular data for each mapped landslide. Spatial data pertain to landslide deposit and landslide geomorphic source type; source types include slide and flow main scarps, rockfall outcrops, and debris-flow source areas and channels. Tabular data describe landslide characteristics in text or numeric form. 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, geologic unit(s) associated with the landslide, confidence in mapped boundaries, mapper name, peer reviewer name, and comments.

Landslide Classification

The characteristics used to classify landslides were observed on aerial photography of various dates, on topographic quadrangle maps, in Manti-La Sal National Forest reports, on 0.75-meter lidar imagery where available, and in the field. Our landslide classification protocol and database schema are 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-size particles) or earth (mostly sand-size or finer particles). The observed movement types consist of falls, flows, and slides (rotational and translational). We used the following landslide names in our mapping:

RF	rockfall
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 rockfall deposits. Main scarps are typically the source area for slide and flow deposits. A debris-flow source is the eroded area above the deposit. We identified the following landslide source types in our mapping:

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, in the field, and/or on 0.75-meter lidar imagery, where available.

Active or historical: The 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 the source and the deposit. 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 Seely Creek and Big Bear Creek Drainages

The Seely Creek and Big Bear Creek drainages lie near the southern end of the Wasatch Plateau. Previous geologic mapping in the eastern part of the study area includes 1:24,000-scale coal resource-related mapping of the Ferron Canyon 7.5′ quadrangle (Ellis, 1981) and the Joes Valley Reservoir 7.5′ quadrangle (Kitzmiller, 1982). Smaller-scale mapping includes the 1:100,000-scale geologic map of the Manti 30′ x 60′ quadrangle (Witkind and others, 1987). Geologic units in the area consist of, from oldest to youngest: Cretaceous Blackhawk Formation, Castlegate Sandstone, and Price River Formation; Tertiary-Cretaceous North Horn Formation; Tertiary Flagstaff Limestone; and Quaternary deposits including till, alluvium, colluvium, and landslide debris (Ellis, 1981; Kitzmiller, 1982; Witkind and others, 1987). 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. The Flagstaff forms long, linear outcrops and cliffs along Cove Mountain, Lake Mountain, Trail Ridge, Buck Ridge, Wagon Road Ridge, Ridley Ridge, Olsen Bench, and the headwater cirques of Seely Creek and Big Bear Creek. Bedrock units are generally flat lying, except on Horseshoe Flat, Olsen Bench, and Ridley Ridge, where bedding dips several degrees to the south. The western and eastern parts of the map area are cut by high-angle, predominantly north-south-trending normal faults. The Wagon Road Ridge fault zone extends through the eastern part of the Big Bear Creek drainage (Ellis, 1981; Witkind and others, 1987). The Snow Lake graben (Foley and others, 1986; Utah Geological Survey, 2019a) extends through the western part of the upper watersheds and locally displaces glacial moraines. Both John August Lake and Snow Lake are within the graben and lie in depressions created by displacement along the east Snow Lake graben fault. The Joes Valley graben west-bounding fault cuts across lower Seely Creek west of Joes Valley Reservoir (Foley and others, 1986; Utah Geological Survey, 2019b).

Prominent east-facing cirques are present at higher elevations in the heads of Cove Creek, Lake Fork Creek, Little Bear Creek, North Fork and South Fork Big Bear Creek, Seely Creek, and Becks Creek (Larson, 1996). The cirques are wide and shallow with relief up to 1400 feet and broad, gently sloping floors. Big Bear and Cove Creeks converge above Ferron Creek and have eroded a narrow, steep, V-shaped bedrock gorge that cuts progressively down-section into the Price River Formation, Castlegate Sandstone, and Blackhawk Formation.

Weak geologic units within the Seely and Big Bear Creek drainages show evidence of widespread landsliding. Weathered shale and mudstone in the North Horn Formation produce the largest and greatest number of landslides on the Wasatch Plateau (McDonald and Giraud, 2011). The long, linear outcrops and cliffs of the Flagstaff Limestone are a common source of rockfall. Our mapping shows that most active landslides are reactivations of pre-existing landslides. Pre-existing landslides are prone to reactivation due to their weak strength characteristics.

The map area has a long history of damaging landslides. During the spring of 1983, a landslide blocked Forest Road FH8, the east-west route between Orangeville and Ephraim (U.S. Forest Service, 1983). Landslides also damaged Skyline Drive or Forest Road 150 north of Snow Lake in 2011. Numerous other small landslides occurred after melting of above-normal snowpacks in the 1980s (U.S. Forest Service, 1983) and in 2011. The Slide Lake landslide, a 1.2-mile-long earth flow, is 3 miles west of Joes Valley Reservoir. Aerial photography and field observations indicate that the Slide Lake landslide is active nearly every year and that the landslide's toe locally ponds and restricts the flow of Seely Creek. The landslide had significant movement in 1983 and released sediment into Seely Creek and downstream into Joes Valley Reservoir (Kaliser, 1989). The Slide Lake landslide and two other landslides north of Seely Creek at this location have the potential to dam the creek. Landslide dams have caused problems elsewhere on the Wasatch Plateau. A 1983 landslide dammed South Fork Twelvemile Creek and ponded water that overtopped the dam, producing a debris flow that traveled 2.4 miles downstream before burying part of Pinchot Campground (Kaliser, 1989; McDonald and Giraud, 2011).

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AERIAL PHOTOGRAPHS

Aerial photographs listed here, with the exception of ESRI imagery and the National Agriculture Imagery Program and Google orthophotos, are available online via the UGS Aerial Imagery Collection at https://geodata.geology.utah.gov/imagery/.

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SCALE 1:24,000

1 0.5 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 0.5 0 1 KILOMETER

CONTOUR INTERVAL 40 FEET

LOCATION MAP

APPROXIMATE MEAN DECLINATION, 2019

Base from 2013 USFS Ferron Canyon, Ferron Reservior, Danish Knoll, and Joes Valley Reservoir 7.5′ quadrangles
Projection: UTM Zone 12
Datum: NAD 1983
Spheroid: Clarke 1866

GIS and Cartography: Gordon E. Douglass and Lori Steadman

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