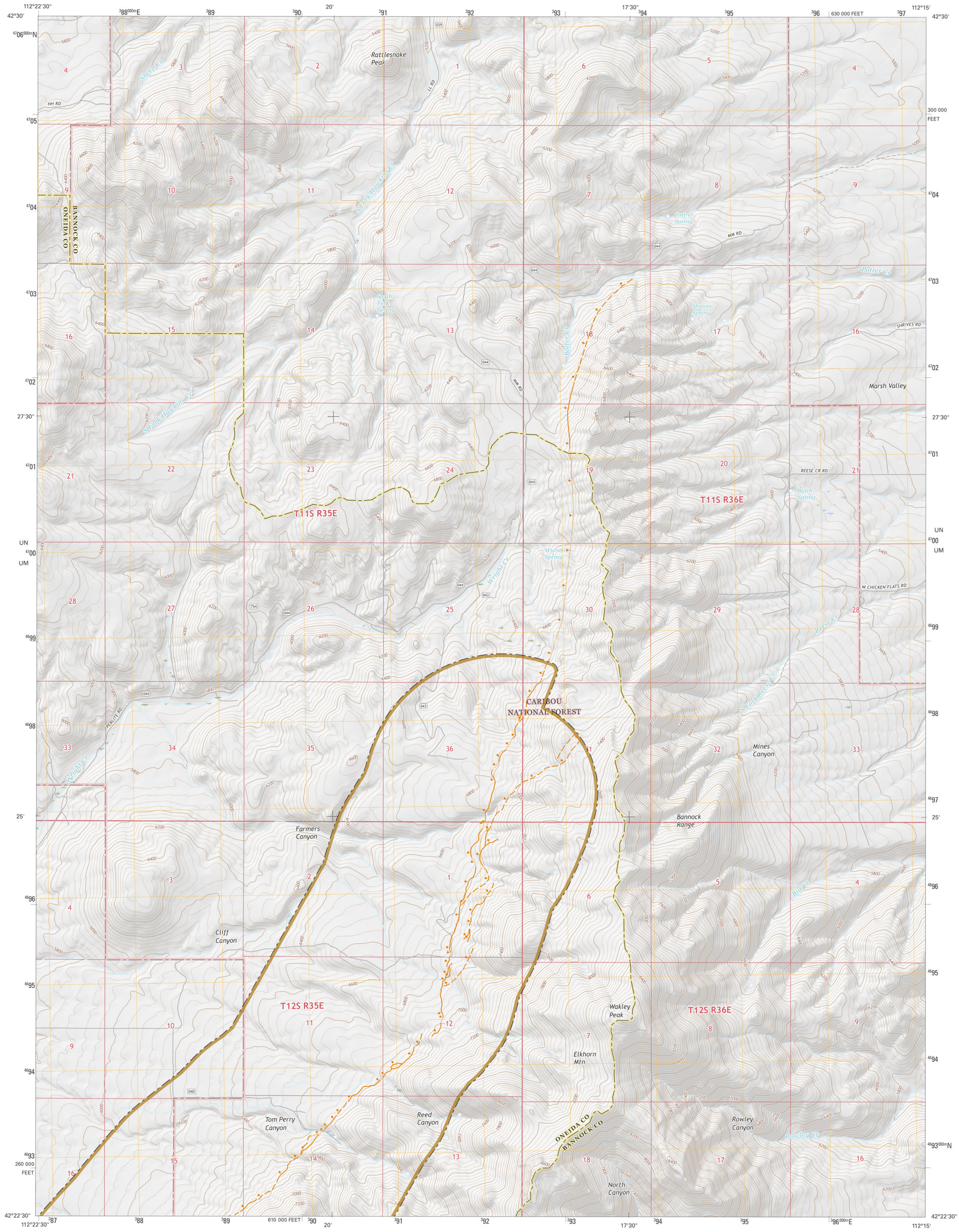

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This map is a plot of geographic information system (GIS) files created to visually represent the content of the GIS data files. This preliminary map contains features that do not meet UGS cartographic standards.

IDAHO
QUADRANGLE LOCATION

SCALE 1:24,000

1 0.5 0 1 MILE
5000 2500 0 5000 FEET
1 0.5 0 1 KILOMETER

CONTOUR INTERVAL 40 FEET

TRUE NORTH
MAGNETIC NORTH
11°57'
APPROXIMATE MEAN DECLINATION, 2018

Base from USGS Wakley Peak 7.5' Quadrangle (2017)
Projection: UTM Zone 12 N
Datum: NAD 1983

Surficial fault mapping: Greg N. McDonald
GIS and cartography: Gordon E. Douglass
Project Manager: Greg N. McDonald

Utah Geological Survey
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P.O. Box 146100, Salt Lake City, UT 84114-6100
(801) 537-3300
geology.utah.gov

SURFACE FAULT TRACE MAP OF THE WAKLEY PEAK QUADRANGLE, BANNOCK AND ONEIDA COUNTIES, IDAHO

by

Greg N. McDonald

2018

1	2	3
4		5
6	7	8

1. Bradley Mountain
2. Hawkins
3. Arimo
4. Dairy Creek
5. Downet West
6. Daniels
7. Elkhorn Peak
8. Malad Summit

EXPLANATION

2013–2014 lidar extent: 0.5-meter Wasatch Front bare earth light detection and ranging (lidar) elevation data, available from the Utah Automated Geographic Reference Center and OpenTopography.

SURFACE FAULT RUPTURE HAZARD CATEGORIES

Holocene-active fault (movement within the past 11,700 years) or suspected Holocene-active fault: Surface-fault-rupture hazard investigations recommended for all structures intended for human occupancy and all International Building Code (IBC; International Code Council, 2014) Risk Category IIa, IIb, III, and IV structures (see Lund and others, 2016). Ball and bar on downthrown side of fault. Solid line indicates well-defined fault trace, dashed line indicates moderately well defined fault trace, and dotted line indicates buried or inferred fault trace. None currently mapped within this quadrangle.

Late Quaternary-active fault (movement within the past 130,000 years) or suspected late Quaternary-active fault: Surface-fault-rupture hazard investigations recommended for all IBC Risk Category IIb, III, and IV structures (see Lund and others, 2016). Investigations for IBC Risk Category IIa and other structures for human occupancy remain prudent, but should be based on an assessment of whether risk-reduction measures are justified by weighing the probability of occurrence against the risk to lives and potential economic loss. Ball and bar on downthrown side of fault. Solid line indicates well-defined fault trace, dashed line indicates moderately well defined fault trace, and dotted line indicates buried or inferred fault trace.

Quaternary-active fault (movement within the past 2,600,000 years) or suspected Quaternary-active fault: Surface-fault-rupture hazard investigations recommended for all IBC Risk Category III and IV structures (see Lund and others, 2016). Investigations for IBC Risk Category IIb and other structures for human occupancy remain prudent because a low likelihood of surface faulting still exists. Ball and bar on downthrown side of fault. Solid line indicates well-defined fault trace, dashed line indicates moderately well-defined fault trace, and dotted line indicates buried or inferred fault trace. None currently mapped within this quadrangle.

Other lineaments, unknown activity/source: Lineaments and traces mapped using lidar and other data. None currently mapped within this quadrangle.

USING THIS MAP

This map shows potentially active faults in the Wakely Peak quadrangle along which surface faulting may occur. The UGS did not delineate special-study areas around faults for quadrangles located in Idaho. The faults are part of the Wasatch fault zone and the UGS recommends a site-specific, surface-fault-rupture hazard investigation (such as fault trenching) be performed before development following the guidelines of Lund and others (2016) for faults mapped in Utah. Site-specific geotechnical/geologic-hazard investigations can resolve uncertainties inherent in the generalized map scale and help ensure safety by identifying the need for and determine distances for fault setbacks from infrastructure. These investigations use the characteristics of past surface faulting at a site as a scientific basis for providing recommendations to reduce the risk for damage, injury, and/or death from future, presumably similar, surface faulting. Site-specific fault-trenching investigations should be preceded by a careful field evaluation of the site to identify the surface trace of the fault as well as other faults and fault-related features not evident at the mapped scale.

Aleatory (natural) variability in fault behavior cannot be reduced; therefore, predicting exactly when, where, and how much ground rupture will occur during future surface-faulting earthquakes is not possible. New faults may form, existing faults may propagate beyond their present lengths, elapsed time between individual surface-faulting earthquakes can vary by hundreds or thousands of years and be affected by clustering, triggering, and multi- or partial-segment ruptures. For these reasons, developing property in the vicinity of hazardous faults will always involve a level of irreducible, inherent risk.

This map is not intended for use at scales other than 1:24,000; it is our opinion that the inventory of potentially active faults shown on this map is likely complete at this scale where high-resolution lidar data are available. However, smaller faults may not have been detected during mapping (such as those with very small offset or surface warping) or are concealed beneath young geologic deposits. Bedrock faults having no documented Quaternary movement were not included, but could represent an unlikely source of surface-fault-rupture hazard. Additionally, concealed and approximately located faults by definition lack a clearly identifiable surface trace; therefore, their locations are approximate. Lidar-derived fault traces were mapped at 1:10,000 scale where possible; however, all traces are shown on this map at 1:24,000 scale.

We focused on mapping traces of the Wasatch fault zone and other nearby faults within the available high-resolution lidar elevation data. Additionally, we used 1970s low-sun-angle and oblique aerial photography from Woodward-Lundgren & Associates Wasatch fault investigations (Cluff and others, 1970; compiled in Bowman and others, 2015) supplemented by other aerial photography from the *UGS Aerial Imagery Collection* (https://geodata.geology.utah.gov/imagery/), and previous geologic and related mapping (Link and Stanford, 1999; and Pope and others, 2001). Fault traces outside the available lidar extents are from the *U.S. Geological Survey Quaternary Fault and Fold Database of the United States* (https://earthquake.usgs.gov/hazards/qfaults/). We encourage local governments to forward surface-fault-rupture hazard investigation reports they receive to the UGS so that fault mapping accuracy and detail for future maps can be improved. Additional information on earthquakes and other geologic hazards is available at https://geology.utah.gov/hazards/.

REFERENCES

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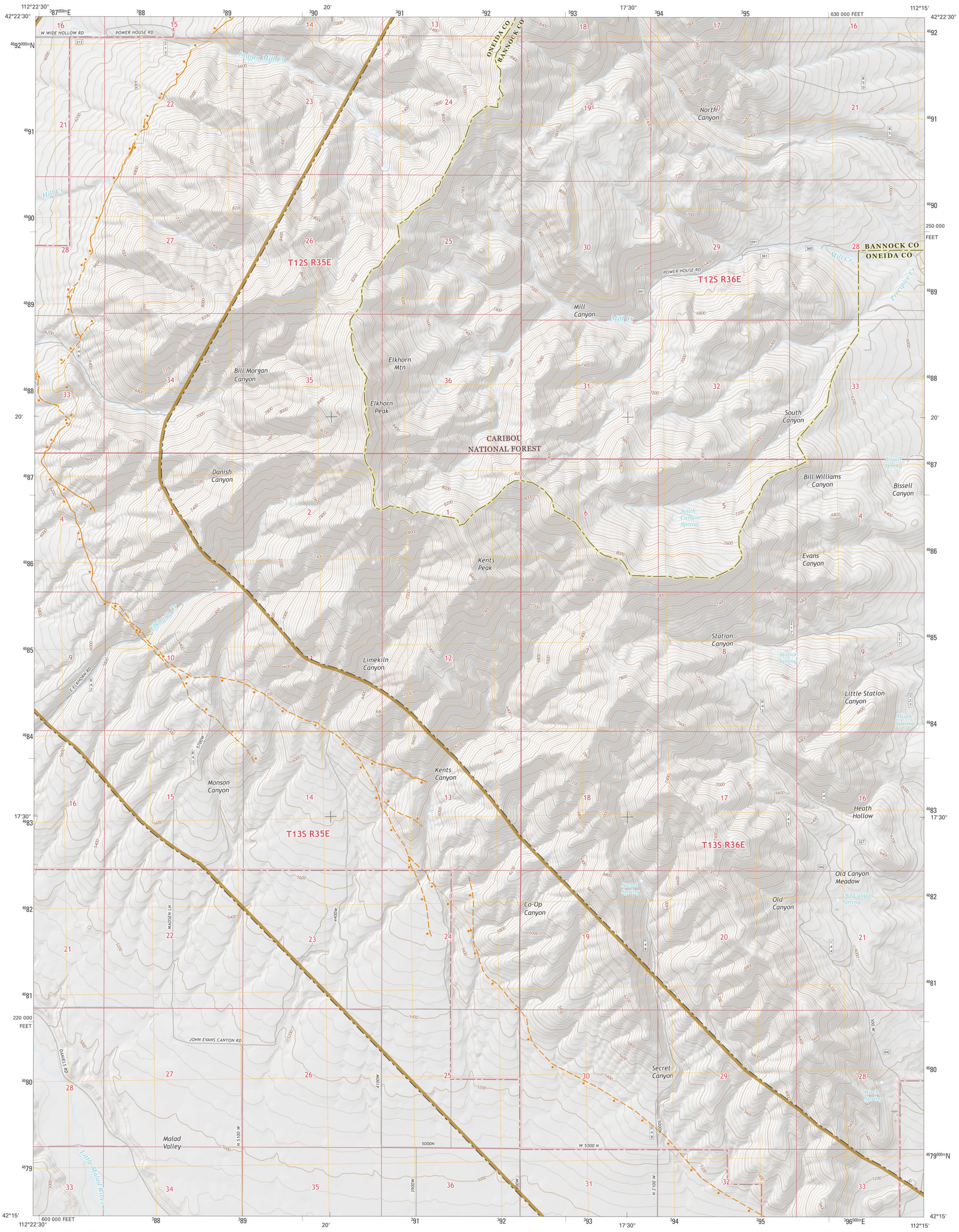
Pope, A.D., Blair, J.J., and Link, P.K., 2001, Geologic map of the Wakley Peak quadrangle, Bannock and Oneida Counties, Idaho: Idaho Geological Survey Technical Report 01-4, 1 plate, scale 1:24,000.

Utah Automated Geographic Reference Center, 2013-2014, Wasatch Front LiDAR elevation data: Online, Utah Automated Geographic Reference Center, State Geographic Information Database, https://gis.utah.gov/data/elevation-terrain-data/2013-2014-lidar/.



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IDAHO
QUADRANGLE LOCATION

SCALE 1:24,000

1 0.5 0 1 MILE
5000 2500 0 5000 FEET
1 0.5 0 1 KILOMETER

CONTOUR INTERVAL 40 FEET

TRUE NORTH
MAGNETIC NORTH
11°56'
APPROXIMATE MEAN DECLINATION, 2018

Base from USGS Wakley Peak 7.5' Quadrangle (2017)
Projection: UTM Zone 12 N
Datum: NAD 1983

Surficial fault mapping: Greg N. McDonald
GIS and cartography: Gordon E. Douglass
Project Manager: Greg N. McDonald

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SURFACE FAULT TRACE MAP OF THE ELKHORN PEAK QUADRANGLE, BANNOCK AND ONEIDA COUNTIES, IDAHO

by

Greg N. McDonald

2018

1	2	3
4		5
6	7	8

1. Dairy Creek
2. Wakley Peak
3. Downey West
4. Daniels
5. Malad Summit
6. Ireland Springs
7. Malad City West
8. Malad City East

ADJOINING 7.5' QUADRANGLE NAMES

EXPLANATION

2013-2014 lidar extent: 0.5-meter Wasatch Front bare earth light detection and ranging (lidar) elevation data, available from the Utah Automated Geographic Reference Center and OpenTopography.

SURFACE FAULT RUPTURE HAZARD CATEGORIES

Holocene-active fault (movement within the past 11,700 years) or suspected Holocene-active fault: Surface-fault-rupture hazard investigations recommended for all structures intended for human occupancy and all International Building Code (IBC; International Code Council, 2014) Risk Category IIa, IIb, III, and IV structures (see Lund and others, 2016). Ball and bar on downthrown side of fault. Solid line indicates well-defined fault trace, dashed line indicates moderately well defined fault trace, and dotted line indicates buried or inferred fault trace. None currently mapped within this quadrangle.

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Other lineaments, unknown activity/source: Lineaments and traces mapped using lidar and other data. None currently mapped within this quadrangle.

USING THIS MAP

This map shows potentially active faults in the Elkhorn Peak quadrangle along which surface faulting may occur. The UGS did not delineate special-study areas around faults for quadrangles located in Idaho. The faults are part of the Wasatch fault zone and the UGS recommends a site-specific, surface-fault-rupture hazard investigation (such as fault trenching) be performed before development following the guidelines of Lund and others (2016) for faults mapped in Utah. Site-specific geotechnical/geologic-hazard investigations can resolve uncertainties inherent in the generalized map scale and help ensure safety by identifying the need for and determine distances for fault setbacks from infrastructure. These investigations use the characteristics of past surface faulting at a site as a scientific basis for providing recommendations to reduce the risk for damage, injury, and/or death from future, presumably similar, surface faulting. Site-specific fault-trenching investigations should be preceded by a careful field evaluation of the site to identify the surface trace of the fault as well as other faults and fault-related features not evident at the mapped scale.

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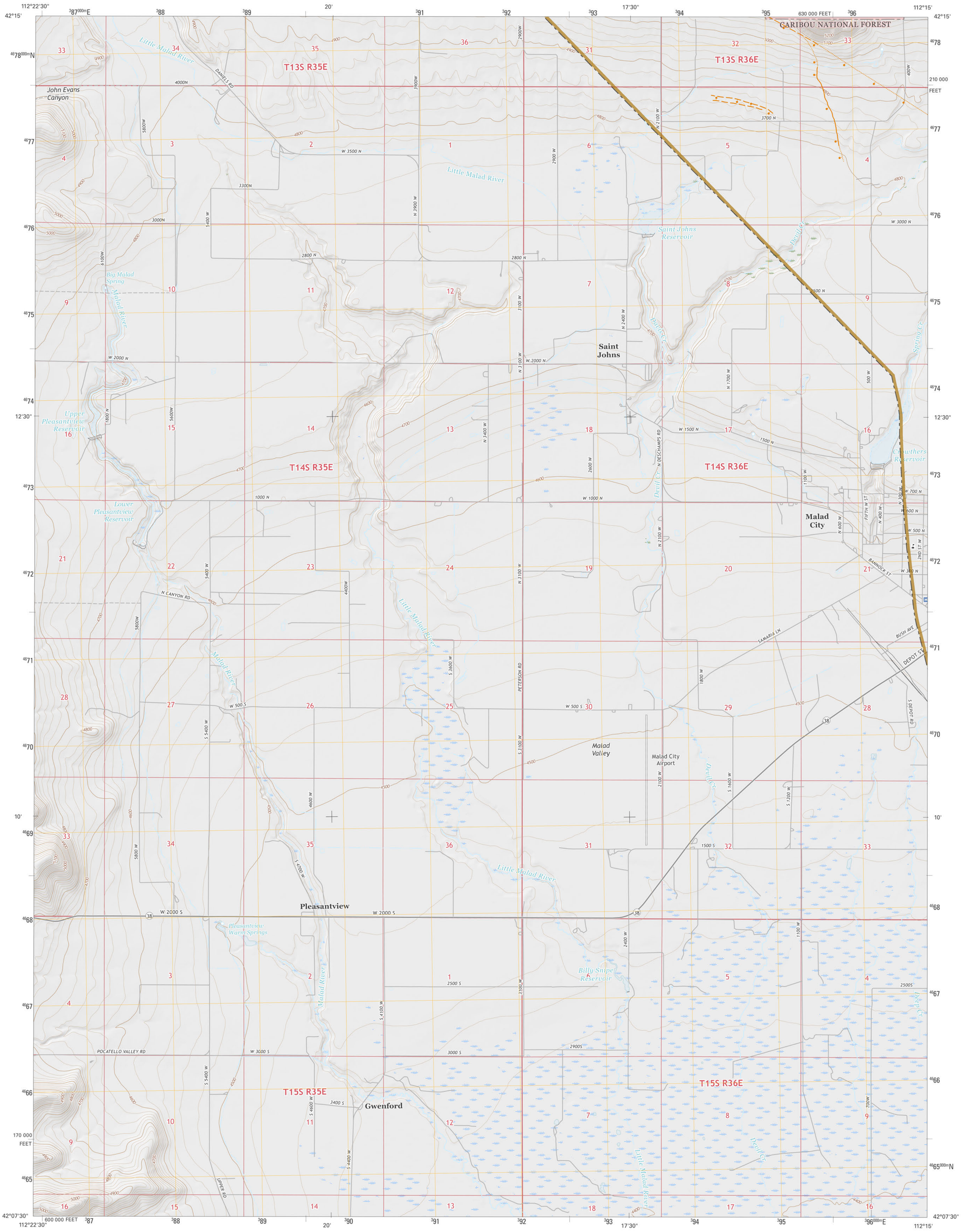
Oriel, S.S., Platt, L.B., and Allmendinger, R.W., 1991, Reconnaissance geologic map of Elkhorn Peak Quadrangle, Bannock and Oneida Counties, Idaho: U.S. Geological Survey Map MF-2162, scale 1:24,000.

Utah Automated Geographic Reference Center, 2013-2014, Wasatch Front LiDAR elevation data: Online, Utah Automated Geographic Reference Center, State Geographic Information Database, https://gis.utah.gov/data/elevation-terrain-data/2013-2014-lidar/.



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1 0.5 0 1 MILE
5000 2500 0 5000 FEET
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TRUE NORTH
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Base from USGS Wakley Peak 7.5' Quadrangle (2017)
Projection: UTM Zone 12 N
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Surficial fault mapping: Greg N. McDonald
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SURFACE FAULT TRACE MAP OF THE MALAD CITY WEST QUADRANGLE, ONEIDA COUNTY, IDAHO

by

Greg N. McDonald and Michael D. Hylland

2018

1	2	3
4		5
6	7	8

1. Daniels
2. Elkhorn Peak
3. Malad Summit
4. Ireland Springs
5. Malad City East
6. Grover Canyon
7. Samaria
8. Henderson Creek

ADJOINING 7.5' QUADRANGLE NAMES

EXPLANATION

2013–2014 lidar extent: 0.5-meter Wasatch Front bare earth light detection and ranging (lidar) elevation data, available from the Utah Automated Geographic Reference Center and OpenTopography.

SURFACE FAULT RUPTURE HAZARD CATEGORIES

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Other lineaments, unknown activity/source: Lineaments and traces mapped using lidar and other data. None currently mapped within this quadrangle.

USING THIS MAP

This map shows potentially active faults in the Malad City West quadrangle along which surface faulting may occur. The UGS did not delineate special-study areas around faults for quadrangles located in Idaho. The faults are part of the Wasatch fault zone and the UGS recommends a site-specific, surface-fault-rupture hazard investigation (such as fault trenching) be performed before development following the guidelines of Lund and others (2016) for faults mapped in Utah. Site-specific geotechnical/geologic-hazard investigations can resolve uncertainties inherent in the generalized map scale and help ensure safety by identifying the need for and determine distances for fault setbacks from infrastructure. These investigations use the characteristics of past surface faulting at a site as a scientific basis for providing recommendations to reduce the risk for damage, injury, and/or death from future, presumably similar, surface faulting. Site-specific fault-trenching investigations should be preceded by a careful field evaluation of the site to identify the surface trace of the fault as well as other faults and fault-related features not evident at the mapped scale.

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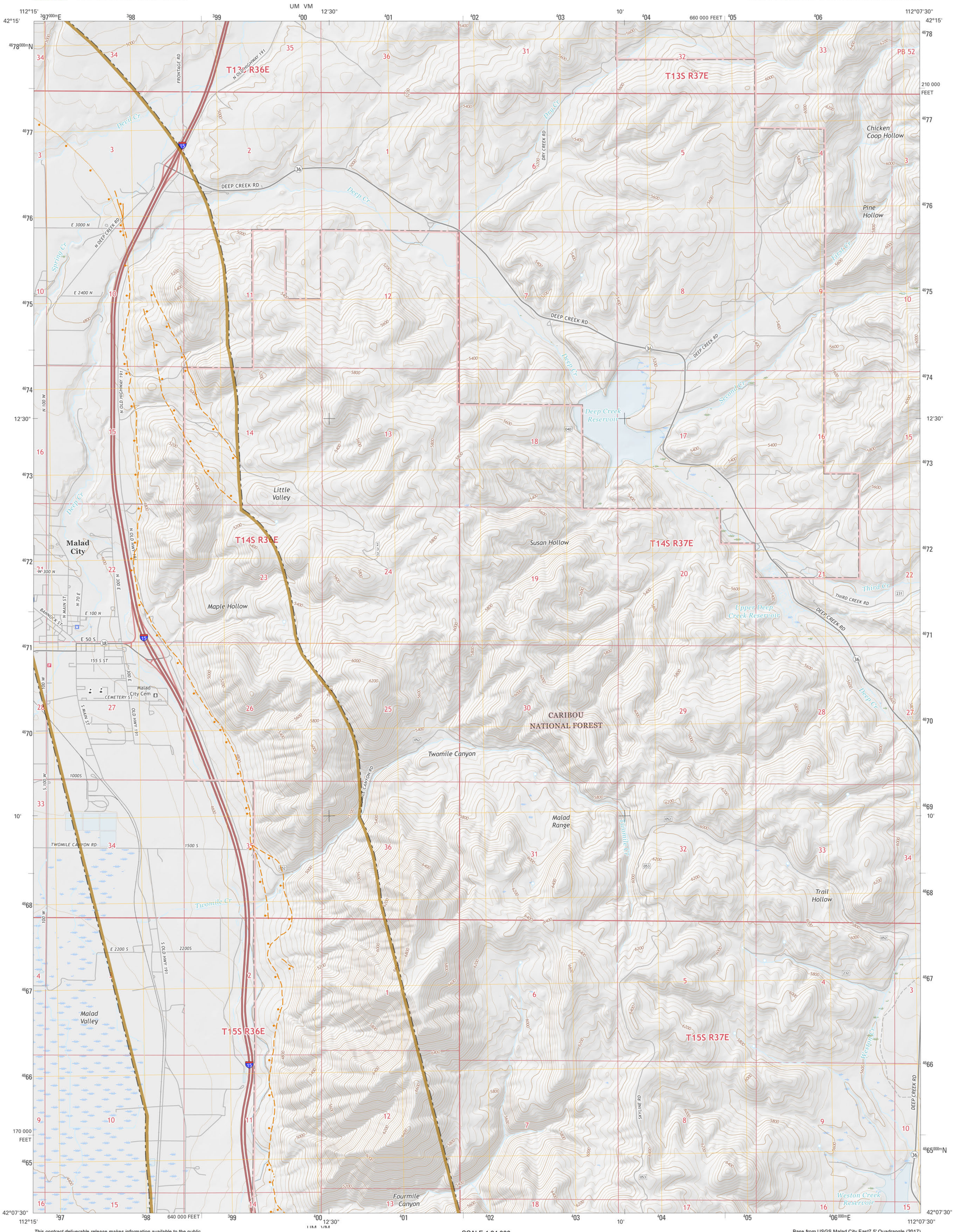

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CONTOUR INTERVAL 40 FEET

TRUE NORTH
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11°52'
APPROXIMATE MEAN DECLINATION, 2018

Base from USGS Malad City East7.5' Quadrangle (2017)
Projection: UTM Zone 12 N
Datum: NAD 1983

Surficial Fault Mapping: Greg N. McDonald
GIS and Cartography: Gordon E. Douglass
Project Manager: Greg N. McDonald

Utah Geological Survey
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(801) 537-3300
geology.utah.gov

SURFACE FAULT TRACE MAP OF THE MALAD CITY EAST QUADRANGLE, ONEIDA COUNTY, IDAHO

by

Greg N. McDonald

2018

1	2	3
4		5
6	7	8

1. Elkhorn Peak
2. Malad Summit
3. Oxford
4. Malad City West
5. Clifton
6. Samaria
7. Henderson Creek
8. Weston Canyon

ADJOINING 7.5' QUADRANGLE NAMES

EXPLANATION

2013–2014 lidar extent: 0.5-meter Wasatch Front bare earth light detection and ranging (lidar) elevation data, available from the Utah Automated Geographic Reference Center and OpenTopography.

SURFACE FAULT RUPTURE HAZARD CATEGORIES

Holocene-active fault (movement within the past 11,700 years) or suspected Holocene-active fault: Surface-fault-rupture hazard investigations recommended for all structures intended for human occupancy and all International Building Code (IBC; International Code Council, 2014) Risk Category IIa, IIb, III, and IV structures (see Lund and others, 2016). Ball and bar on downthrown side of fault. Solid line indicates well-defined fault trace, dashed line indicates moderately well defined fault trace, and dotted line indicates buried or inferred fault trace. None currently mapped within this quadrangle.

Late Quaternary-active fault (movement within the past 130,000 years) or suspected late Quaternary-active fault: Surface-fault-rupture hazard investigations recommended for all IBC Risk Category IIb, III, and IV structures (see Lund and others, 2016). Investigations for IBC Risk Category IIa and other structures for human occupancy remain prudent, but should be based on an assessment of whether risk-reduction measures are justified by weighing the probability of occurrence against the risk to lives and potential economic loss. Ball and bar on downthrown side of fault. Solid line indicates well-defined fault trace, dashed line indicates moderately well defined fault trace, and dotted line indicates buried or inferred fault trace.

Quaternary-active fault (movement within the past 2,600,000 years) or suspected Quaternary-active fault: Surface-fault-rupture hazard investigations recommended for all IBC Risk Category III and IV structures (see Lund and others, 2016). Investigations for IBC Risk Category IIb and other structures for human occupancy remain prudent because a low likelihood of surface faulting still exists. Ball and bar on downthrown side of fault. Solid line indicates well-defined fault trace, dashed line indicates moderately well-defined fault trace, and dotted line indicates buried or inferred fault trace. None currently mapped within this quadrangle.

Other lineaments, unknown activity/source: Lineaments and traces mapped using lidar and other data. None currently mapped within this quadrangle.

USING THIS MAP

This map shows potentially active faults in the Malad City East quadrangle along which surface faulting may occur. The UGS did not delineate special-study areas around faults for quadrangles located in Idaho. The faults are part of the Wasatch fault zone and the UGS recommends a site-specific, surface-fault-rupture hazard investigation (such as fault trenching) be performed before development following the guidelines of Lund and others (2016) for faults mapped in Utah. Site-specific geotechnical/geologic-hazard investigations can resolve uncertainties inherent in the generalized map scale and help ensure safety by identifying the need for and determine distances for fault setbacks from infrastructure. These investigations use the characteristics of past surface faulting at a site as a scientific basis for providing recommendations to reduce the risk for damage, injury, and/or death from future, presumably similar, surface faulting. Site-specific fault-trenching investigations should be preceded by a careful field evaluation of the site to identify the surface trace of the fault as well as other faults and fault-related features not evident at the mapped scale.

Aleatory (natural) variability in fault behavior cannot be reduced; therefore, predicting exactly when, where, and how much ground rupture will occur during future surface-faulting earthquakes is not possible. New faults may form, existing faults may propagate beyond their present lengths, elapsed time between individual surface-faulting earthquakes can vary by hundreds or thousands of years and be affected by clustering, triggering, and multi- or partial-segment ruptures. For these reasons, developing property in the vicinity of hazardous faults will always involve a level of irreducible, inherent risk.

This map is not intended for use at scales other than 1:24,000; it is our opinion that the inventory of potentially active faults shown on this map is likely complete at this scale where high-resolution lidar data are available. However, smaller faults may not have been detected during mapping (such as those with very small offset or surface warping) or are concealed beneath young geologic deposits. Bedrock faults having no documented Quaternary movement were not included, but could represent an unlikely source of surface-fault-rupture hazard. Additionally, concealed and approximately located faults by definition lack a clearly identifiable surface trace; therefore, their locations are approximate. Lidar-derived fault traces were mapped at 1:10,000 scale where possible; however, all traces are shown on this map at 1:24,000 scale.

We focused on mapping traces of the Wasatch fault zone and other nearby faults within the available high-resolution lidar elevation data. Additionally, we used 1970s low-sun-angle and oblique aerial photography from Woodward-Lundgren & Associates Wasatch fault investigations (Cluff and others, 1970; compiled in Bowman and others, 2015) supplemented by other aerial photography from the *UGS Aerial Imagery Collection* (https://geodata.geology.utah.gov/imagery/), and previous geologic and related mapping (Hanson, 1949; Link and Stanford, 1999). Fault traces outside the available lidar extents are from the *U.S. Geological Survey Quaternary Fault and Fold Database of the United States* (https://earthquake.usgs.gov/hazards/qfaults/). We encourage local governments to forward surface-fault-rupture hazard investigation reports they receive to the UGS so that fault mapping accuracy and detail for future maps can be improved. Additional information on earthquakes and other geologic hazards is available at https://geology.utah.gov/hazards/.

REFERENCES

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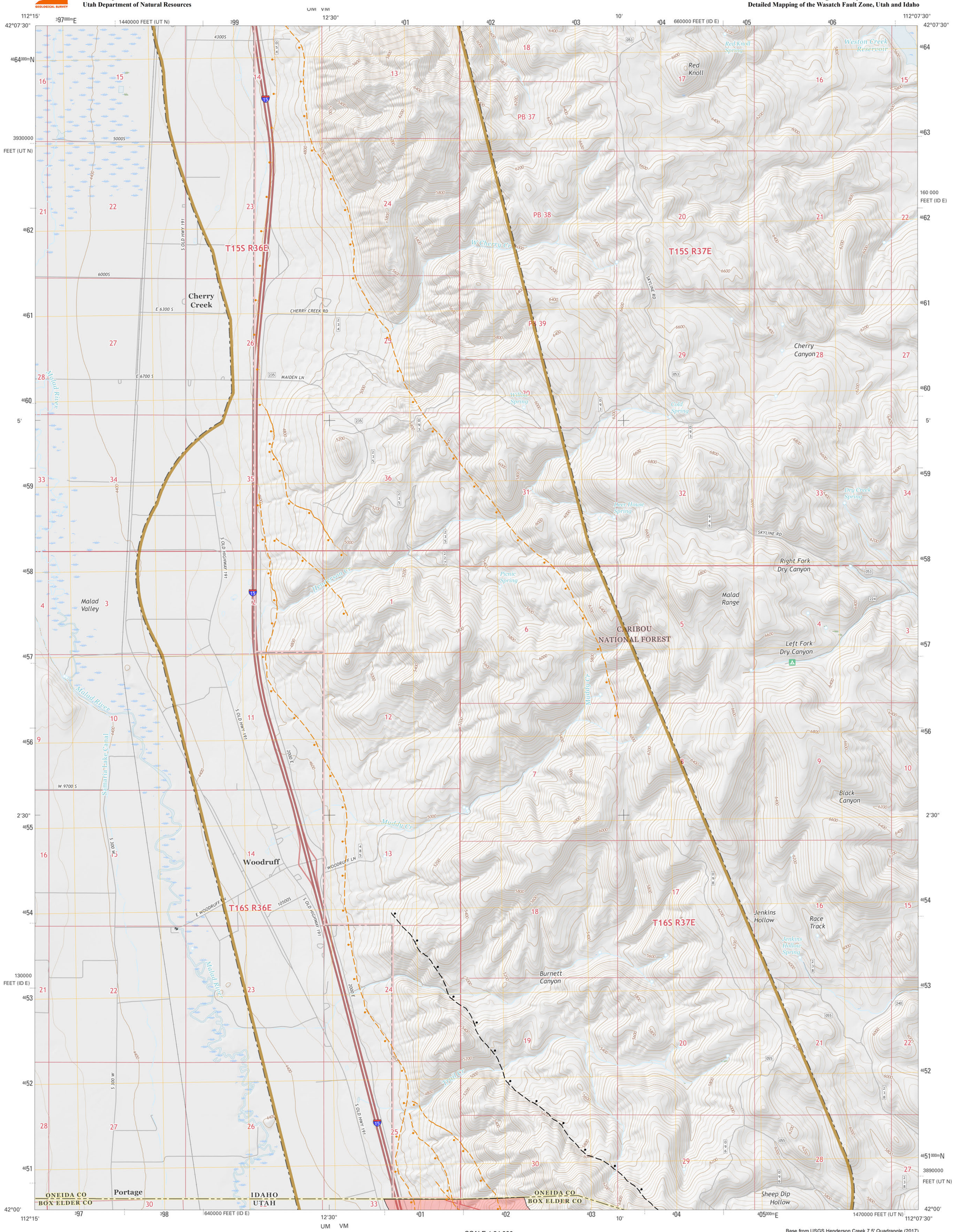
Utah Automated Geographic Reference Center, 2013-2014, Wasatch Front LiDAR elevation data: Online, Utah Automated Geographic Reference Center, State Geographic Information Database, https://gis.utah.gov/data/elevation-terrain-data/2013-2014-lidar/.



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This map is a plot of geographic information system (GIS) files created to visually represent the content of the GIS data files. This preliminary map contains features that do not meet UGS cartographic standards.

IDAHO
QUADRANGLE LOCATION

SCALE 1:24,000
1 0.5 0 1 MILE
5000 2500 0 5000 FEET
1 0.5 0 1 KILOMETER
CONTOUR INTERVAL 40 FEET

TRUE NORTH
MAGNETIC NORTH
11°50'
APPROXIMATE MEAN DECLINATION, 2018

Base from USGS Henderson Creek 7.5' Quadrangle (2017)
Projection: UTM Zone 12 N
Datum: NAD 1983

Surficial Fault Mapping: Greg N. McDonald
GIS and Cartography: Gordon E. Douglass
Project Manager: Greg N. McDonald

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1. Malad City West
2. Malad City East
3. Clifton
4. Samaria
5. Weston Canyon
6. Limekiln Knoll
7. Portage
8. Clarkston

ADJOINING 7.5' QUADRANGLE NAMES

SURFACE FAULT RUPTURE HAZARD MAP OF THE HENDERSON CREEK QUADRANGLE, ONEIDA COUNTY, IDAHO AND BOX ELDER COUNTY, UTAH

by

Greg N. McDonald

2018

EXPLANATION

2013–2014 lidar extent: 0.5-meter Wasatch Front bare earth light detection and ranging (lidar) elevation data, available from the Utah Automated Geographic Reference Center and OpenTopography.

SURFACE FAULT RUPTURE HAZARD CATEGORIES

Holocene-active fault (movement within the past 11,700 years) or suspected Holocene-active fault: Surface-fault-rupture hazard investigations recommended for all structures intended for human occupancy and all International Building Code (IBC; International Code Council, 2014) Risk Category IIa, IIb, III, and IV structures (see Lund and others, 2016). Ball and bar on downthrown side of fault. Solid line indicates well-defined fault trace, dashed line indicates moderately well defined fault trace, and dotted line indicates buried or inferred fault trace. None currently mapped within this quadrangle.

Late Quaternary-active fault (movement within the past 130,000 years) or suspected late Quaternary-active fault: Surface-fault-rupture hazard investigations recommended for all IBC Risk Category IIb, III, and IV structures (see Lund and others, 2016). Investigations for IBC Risk Category IIa and other structures for human occupancy remain prudent, but should be based on an assessment of whether risk-reduction measures are justified by weighing the probability of occurrence against the risk to lives and potential economic loss. Ball and bar on downthrown side of fault. Solid line indicates well-defined fault trace, dashed line indicates moderately well defined fault trace, and dotted line indicates buried or inferred fault trace.

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Other lineaments, unknown activity/source: Lineaments and traces mapped using lidar and other data. None currently mapped within this quadrangle.

Surface-fault-rupture hazard special-study area: For well-defined faults, special-study area extends 500 feet on the downthrown side and 250 feet on the upthrown side of each fault. For moderately well located or buried/inferred faults, special-study area extends 1000 feet on each side of the suspected trace of each fault (Lund and others, 2016). Only designated for faults in Utah. Refer to booklet for more details on special-study area designations.

USING THIS MAP

This map shows potentially active faults in the Henderson Creek quadrangle along which surface faulting may occur. The UGS did not delineate special-study areas around faults for the portion of the quadrangle located in Idaho. All the faults are part of the Wasatch fault zone and the UGS recommends a site-specific, surface-fault-rupture hazard investigation (such as fault trenching) be performed before development following the guidelines of Lund and others (2016) for the faults mapped in Utah. Site-specific geotechnical/geologic-hazard investigations can resolve uncertainties inherent in the generalized map scale and help ensure safety by identifying the need for and determine distances for fault setbacks from infrastructure. These investigations use the characteristics of past surface faulting at a site as a scientific basis for providing recommendations to reduce the risk for damage, injury, and/or death from future, presumably similar, surface faulting. Site-specific fault-trenching investigations should be preceded by a careful field evaluation of the site to identify the surface trace of the fault as well as other faults and fault-related features not evident at the mapped scale.

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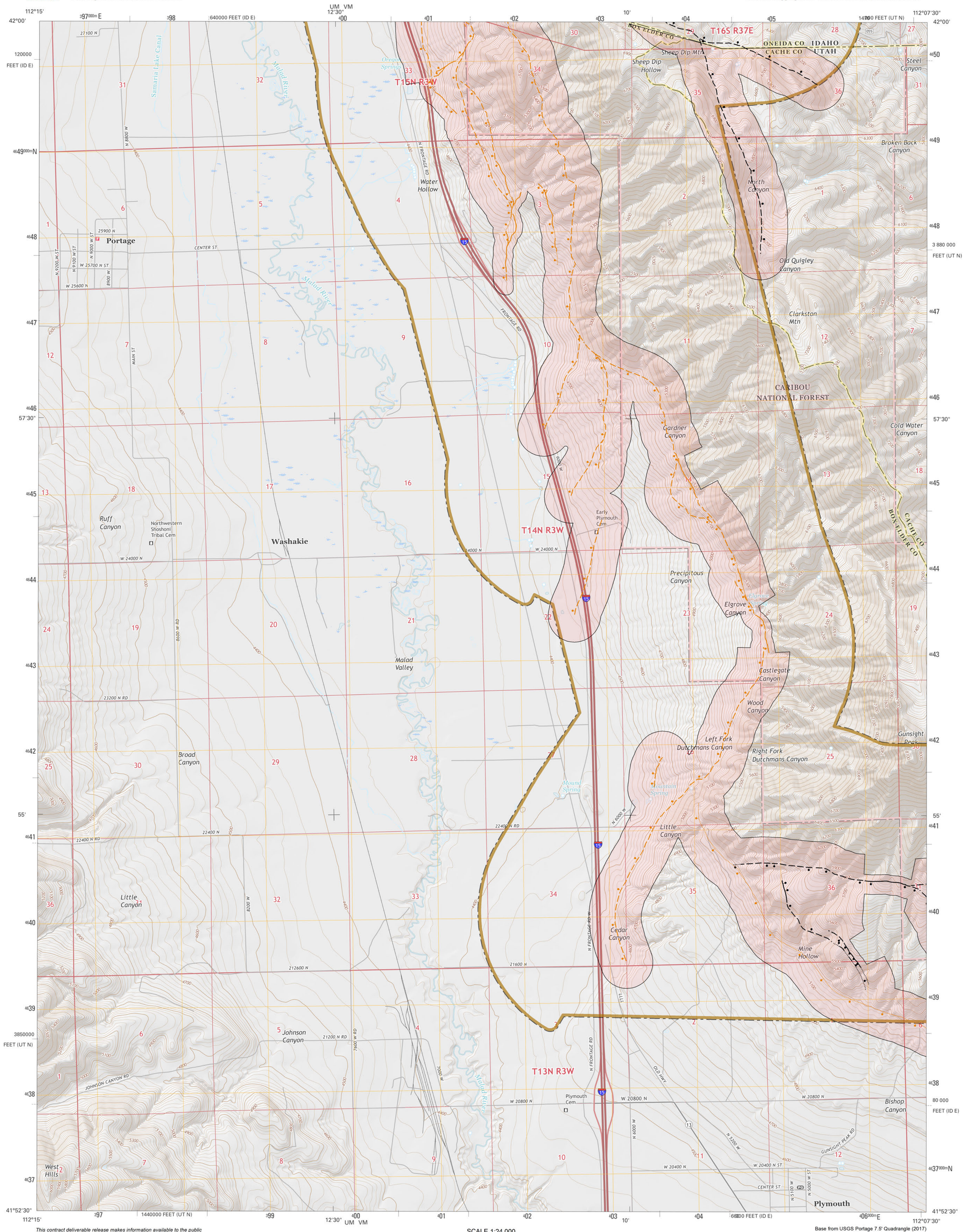
Wach, P.H., 1967, Geology of the west-central part of the Malad Range, Idaho: Logan, Utah State University M.S. thesis, 71 p., 1 plate, scale 1:24,000.



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UTAH
QUADRANGLE LOCATION

SCALE 1:24,000
1 0.5 0 1 MILE
5000 2500 0 5000 FEET
1 0.5 0 1 KILOMETER
CONTOUR INTERVAL 20 FEET

TRUE NORTH
MAGNETIC NORTH
11°49'
APPROXIMATE MEAN DECLINATION, 2018

Base from USGS Portage 7.5' Quadrangle (2017)
Projection: UTM Zone 12 N
Datum: NAD 1983

Surficial Fault Mapping: Greg N. McDonald, Adam P. McKean, and Kimm M. Harty
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1. Samaria
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5. Clarkston
6. Blind Springs
7. Riverside
8. Cutler Dam

ADJOINING 7.5' QUADRANGLE NAMES

SURFACE FAULT RUPTURE HAZARD MAP OF THE PORTAGE QUADRANGLE, BOX ELDER AND CACHE COUNTIES, UTAH AND ONEIDA COUNTY, IDAHO

by

Greg N. McDonald, Adam P. McKean, and Kimm M. Harty

2018

EXPLANATION

2013–2014 lidar extent: 0.5-meter Wasatch Front bare earth light detection and ranging (lidar) elevation data, available from the Utah Automated Geographic Reference Center and OpenTopography.

SURFACE FAULT RUPTURE HAZARD CATEGORIES

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USING THIS MAP

This map shows potentially active faults in the Portage quadrangle along which surface faulting may occur and delineated special-study areas around those faults. Within each area, the UGS recommends a site-specific, surface-fault-rupture hazard investigation (such as fault trenching) be performed before development following the guidelines of Lund and others (2016). Site-specific geotechnical/geologic-hazard investigations can resolve uncertainties inherent in the generalized map scale and help ensure safety by identifying the need for and determine distances for fault setbacks from infrastructure. These investigations use the characteristics of past surface faulting at a site as a scientific basis for providing recommendations to reduce the risk for damage, injury, and/or death from future, presumably similar, surface faulting. Site-specific fault-trenching investigations should be preceded by a careful field evaluation of the site to identify the surface trace of the fault as well as other faults and fault-related features not evident at the mapped scale.

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REFERENCES

Biek, R.F., Oaks, R.Q., Jr., Janecke, S.U., Solomon, B.J., and Swenson Barry, L.M., 2003, Geologic maps of the Clarkston and Portage quadrangles, Box Elder and Cache Counties, Utah and Franklin and Oneida Counties, Idaho: Utah Geological Survey Map 194, 41 p. pamphlet, 3 plates, scale 1:24,000.

Bowman, S.D., Hiscock, A.I., and Unger, C., 2015, Compilation of 1970s Woodward-Lundgren & Associates Wasatch fault investigation reports and low-sun-angle aerial photography, Wasatch Front and Cache Valley, Utah and Idaho: Utah Geological Survey Open-File Report 632, variously paginated, DVD.

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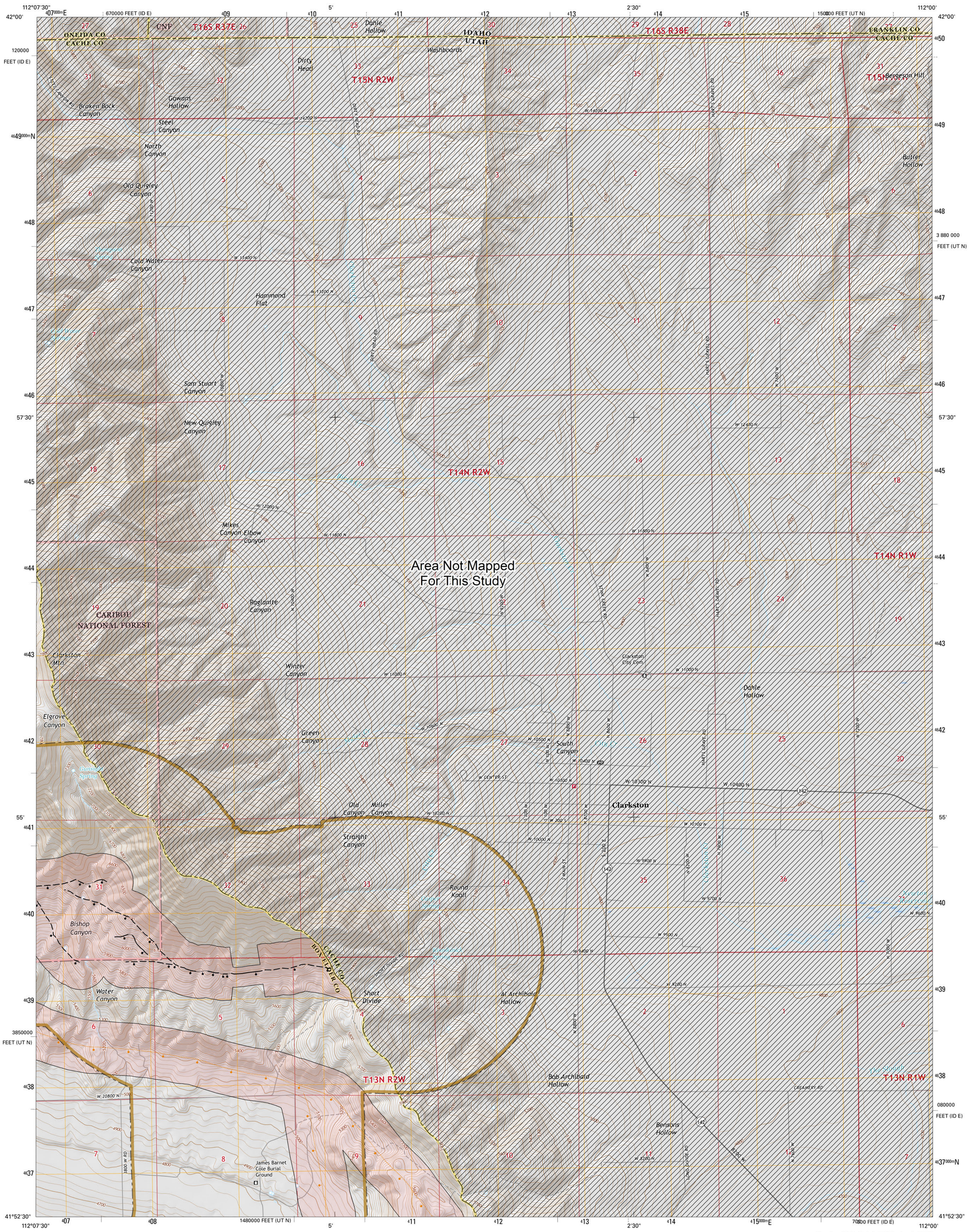

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7. Cutler Dam
8. Newton

ADJOINING 7.5' QUADRANGLE NAMES

SURFACE FAULT RUPTURE HAZARD MAP OF THE CLARKSTON QUADRANGLE, BOX ELDER AND CACHE COUNTIES, UTAH AND FRANKLIN AND ONEIDA COUNTIES, IDAHO

by

Greg N. McDonald, Adam P. McKean, and Kimm M. Harty

2018

EXPLANATION

2013–2014 lidar extent: 0.5-meter Wasatch Front bare earth light detection and ranging (lidar) elevation data, available from the Utah Automated Geographic Reference Center and OpenTopography.

SURFACE FAULT RUPTURE HAZARD CATEGORIES

Holocene-active fault (movement within the past 11,700 years) or suspected Holocene-active fault: Surface-fault-rupture hazard investigations recommended for all structures intended for human occupancy and all International Building Code (IBC; International Code Council, 2014) Risk Category IIa, IIb, III, and IV structures (see Lund and others, 2016). Ball and bar on downthrown side of fault. Solid line indicates well-defined fault trace, dashed line indicates moderately well defined fault trace, and dotted line indicates buried or inferred fault trace. None currently mapped within this quadrangle.

Late Quaternary-active fault (movement within the past 130,000 years) or suspected late Quaternary-active fault: Surface-fault-rupture hazard investigations recommended for all IBC Risk Category IIb, III, and IV structures (see Lund and others, 2016). Investigations for IBC Risk Category IIa and other structures for human occupancy remain prudent, but should be based on an assessment of whether risk-reduction measures are justified by weighing the probability of occurrence against the risk to lives and potential economic loss. Ball and bar on downthrown side of fault. Solid line indicates well-defined fault trace, dashed line indicates moderately well defined fault trace, and dotted line indicates buried or inferred fault trace.

Quaternary-active fault (movement within the past 2,600,000 years) or suspected Quaternary-active fault: Surface-fault-rupture hazard investigations recommended for all IBC Risk Category III and IV structures (see Lund and others, 2016). Investigations for IBC Risk Category IIb and other structures for human occupancy remain prudent because a low likelihood of surface faulting still exists. Ball and bar on downthrown side of fault. Solid line indicates well-defined fault trace, dashed line indicates moderately well defined fault trace, and dotted line indicates buried or inferred fault trace.

Other lineaments, unknown activity/source: Lineaments and traces mapped using lidar and other data. None currently mapped within this quadrangle.

Surface-fault-rupture hazard special-study area: For well-defined faults, special-study area extends 500 feet on the downthrown side and 250 feet on the upthrown side of each fault. For moderately well located or buried/inferred faults, special-study area extends 1000 feet on each side of the suspected trace of each fault (Lund and others, 2016). Refer to booklet for more details on special-study area designations.

USING THIS MAP

This map shows potentially active faults in the Clarkston quadrangle along which surface faulting may occur and delineated special-study areas around those faults. Within each area, the UGS recommends a site-specific, surface-fault-rupture hazard investigation (such as fault trenching) be performed before development following the guidelines of Lund and others (2016). Site-specific geotechnical/geologic-hazard investigations can resolve uncertainties inherent in the generalized map scale and help ensure safety by identifying the need for and determine distances for fault setbacks from infrastructure. These investigations use the characteristics of past surface faulting at a site as a scientific basis for providing recommendations to reduce the risk for damage, injury, and/or death from future, presumably similar, surface faulting. Site-specific fault-trenching investigations should be preceded by a careful field evaluation of the site to identify the surface trace of the fault as well as other faults and fault-related features not evident at the mapped scale.

Aleatory (natural) variability in fault behavior cannot be reduced; therefore, predicting exactly when, where, and how much ground rupture will occur during future surface-faulting earthquakes is not possible. New faults may form, existing faults may propagate beyond their present lengths, elapsed time between individual surface-faulting earthquakes can vary by hundreds or thousands of years and be affected by clustering, triggering, and multi- or partial-segment ruptures. For these reasons, developing property in the vicinity of hazardous faults will always involve a level of irreducible, inherent risk. The special-study areas were delineated to account for much of the uncertainty in fault trace location and propagation.

This map is not intended for use at scales other than 1:24,000; it is our opinion that the inventory of potentially active faults shown on this map is likely complete at this scale where high-resolution lidar data are available. However, smaller faults may not have been detected during mapping (such as those with very small offset or surface warping) or are concealed beneath young geologic deposits. Bedrock faults having no documented Quaternary movement were not included, but could represent an unlikely source of surface-fault-rupture hazard. Additionally, concealed and approximately located faults by definition lack a clearly identifiable surface trace; therefore, their locations are approximate. Lidar-derived fault traces were mapped at 1:10,000 scale where possible; however, all traces are shown on this map at 1:24,000 scale.

We focused on mapping traces of the Wasatch fault zone and other nearby faults within the available high-resolution lidar elevation data. Additionally, we used 1970s low-sun-angle and oblique aerial photography from Woodward-Lundgren & Associates Wasatch fault investigations (Cluff and others, 1970; compiled in Bowman and others, 2015) supplemented by other aerial photography from the *UGS Aerial Imagery Collection* (https://geodata.geology.utah.gov/imagery/), and previous geologic and related mapping (Biek and others, 2003). Faults east of the Wasatch fault zone were not mapped for this study. We encourage local governments to forward surface-fault-rupture hazard investigation reports they receive to the UGS so that fault mapping accuracy and detail for future maps can be improved. Additional information on earthquakes and other geologic hazards is available at https://geology.utah.gov/hazards/.

REFERENCES

Biek, R.F., Oaks, R.Q., Jr., Janecke, S.U., Solomon, B.J., and Swenson Barry, L.M., 2003, Geologic maps of the Clarkston and Portage quadrangles, Box Elder and Cache Counties, Utah and Franklin and Oneida Counties, Idaho: Utah Geological Survey Map 194, 41 p. pamphlet, 3 plates, scale 1:24,000.

Bowman, S.D., Hiscock, A.I., and Unger, C., 2015, Compilation of 1970s Woodward-Lundgren & Associates Wasatch fault investigation reports and low-sun-angle aerial photography, Wasatch Front and Cache Valley, Utah and Idaho: Utah Geological Survey Open-File Report 632, variously paginated, DVD.

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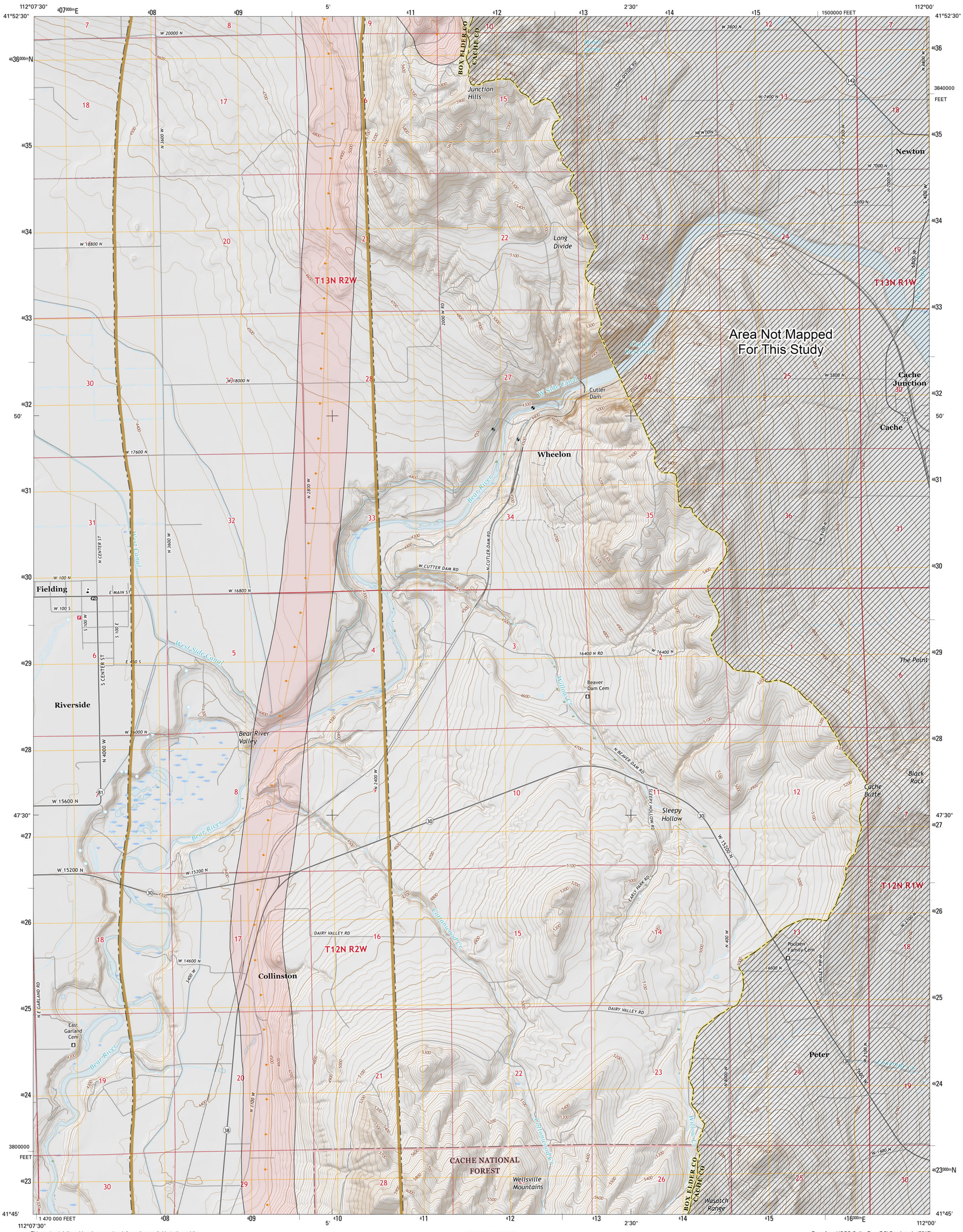
Utah Automated Geographic Reference Center, 2013-2014, Wasatch Front lidar elevation data: Online, Utah Automated Geographic Reference Center, State Geographic Information Database, https://gis.utah.gov/data/elevation-terrain-data/2013-2014-lidar/.



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This map is a plot of geographic information system (GIS) files created to visually represent the content of the GIS data files. This preliminary map contains features that do not meet UGS cartographic standards.

UTAH
QUADRANGLE LOCATION

SCALE 1:24,000
1 0.5 0 1 MILE
5000 2500 0 5000 FEET
1 0.5 0 1 KILOMETER
CONTOUR INTERVAL 20 FEET

TRUE NORTH
MAGNETIC NORTH
11°45'
APPROXIMATE MEAN DECLINATION, 2018

Base from USGS Cutler Dam 7.5' Quadrangle (2017)
Projection: UTM Zone 12 N
Datum: NAD 1983

Surficial Fault Mapping: Greg N. McDonald
GIS and Cartography: Gordon E. Douglass and Greg N. McDonald
Project Manager: Greg N. McDonald

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SURFACE FAULT RUPTURE HAZARD MAP OF THE CUTLER DAM QUADRANGLE, BOX ELDER AND CACHE COUNTIES, UTAH

by

Greg N. McDonald

2018

1	2	3
4		5
6	7	8

1. Portage
2. Clarkston
3. Trenton
4. Riverside
5. Newton
6. Tremonton
7. Honeyville
8. Wellsville

ADJOINING 7.5' QUADRANGLE NAMES

EXPLANATION

2013–2014 lidar extent: 0.5-meter Wasatch Front bare earth light detection and ranging (lidar) elevation data, available from the Utah Automated Geographic Reference Center and OpenTopography.

SURFACE FAULT RUPTURE HAZARD CATEGORIES

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USING THIS MAP

This map shows potentially active faults in the Cutler Dam quadrangle along which surface faulting may occur and delineated special-study areas around those faults. Within each area, the UGS recommends a site-specific, surface-fault-rupture hazard investigation (such as fault trenching) be performed before development following the guidelines of Lund and others (2016). Site-specific geotechnical/geologic-hazard investigations can resolve uncertainties inherent in the generalized map scale and help ensure safety by identifying the need for and determine distances for fault setbacks from infrastructure. These investigations use the characteristics of past surface faulting at a site as a scientific basis for providing recommendations to reduce the risk for damage, injury, and/or death from future, presumably similar, surface faulting. Site-specific fault-trenching investigations should be preceded by a careful field evaluation of the site to identify the surface trace of the fault as well as other faults and fault-related features not evident at the mapped scale.

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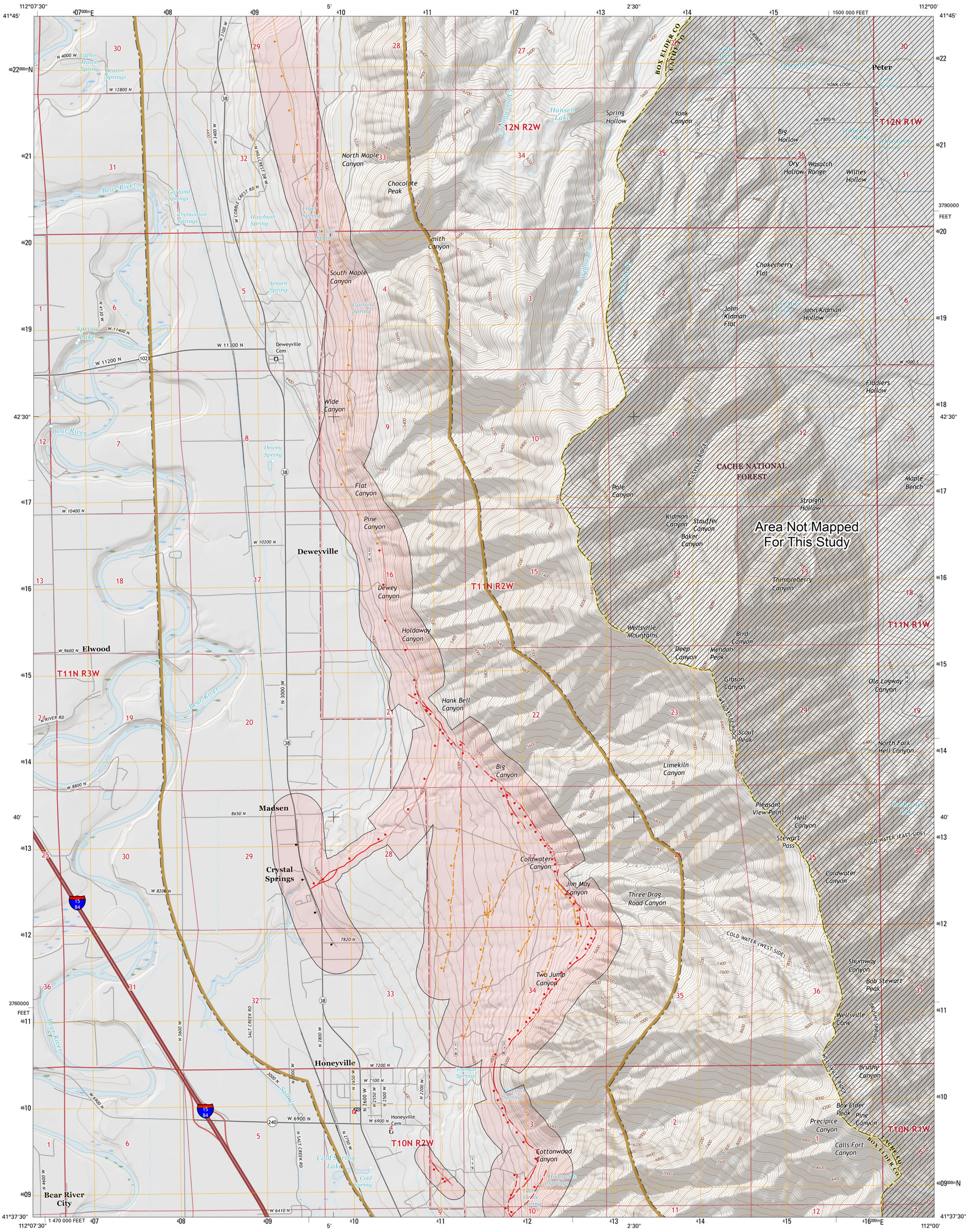
Oviatt, C.G., 1986, Geologic map of the Cutler Dam quadrangle, Box Elder and Cache Counties, Utah: Utah Geological and Mineral Survey Map 91, 7 p., scale 1:24,000.

Utah Automated Geographic Reference Center, 2013–2014, Wasatch Front LiDAR elevation data: Online, Utah Automated Geographic Reference Center, State Geographic Information Database, https://gis.utah.gov/data/elevation-terrain-data/2013-2014-lidar/.



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SCALE 1:24,000
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5000 2500 0 5000 FEET
1 0.5 0 1 KILOMETER
CONTOUR INTERVAL 20 FEET

TRUE NORTH
MAGNETIC NORTH
11°44'
APPROXIMATE MEAN DECLINATION, 2018

Base from USGS Honeyville 7.5' Quadrangle (2017)
Projection: UTM Zone 12 N
Datum: NAD 1983

Surficial Fault Mapping: Greg N. McDonald and Adam P. McKean
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SURFACE FAULT RUPTURE HAZARD MAP OF THE HONEYVILLE QUADRANGLE, BOX ELDER AND CACHE COUNTIES, UTAH

by

Greg N. McDonald and Adam P. McKean

2018

1	2	3
4		5
6	7	8

1. Riverside
2. Cutler Dam
3. Newton
4. Tremonton
5. Wellsville
6. Bear River City
7. Brigham City
8. Mount Pisgah

ADJOINING 7.5' QUADRANGLE NAMES

EXPLANATION

2013–2014 lidar extent: 0.5-meter Wasatch Front bare earth light detection and ranging (lidar) elevation data, available from the Utah Automated Geographic Reference Center and OpenTopography.

SURFACE FAULT RUPTURE HAZARD CATEGORIES

Holocene-active fault (movement within the past 11,700 years) or suspected Holocene-active fault: Surface-fault-rupture hazard investigations recommended for all structures intended for human occupancy and all International Building Code (IBC; International Code Council, 2014) Risk Category IIa, IIb, III, and IV structures (see Lund and others, 2016). Ball and bar on downthrown side of fault. Solid line indicates well-defined fault trace, dashed line indicates moderately well defined fault trace, and dotted line indicates buried or inferred fault trace.

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USING THIS MAP

This map shows potentially active faults in the Honeyville quadrangle along which surface faulting may occur and delineated special-study areas around those faults. Within each area, the UGS recommends a site-specific, surface-fault-rupture hazard investigation (such as fault trenching) be performed before development following the guidelines of Lund and others (2016). Site-specific geotechnical/geologic-hazard investigations can resolve uncertainties inherent in the generalized map scale and help ensure safety by identifying the need for and determine distances for fault setbacks from infrastructure. These investigations use the characteristics of past surface faulting at a site as a scientific basis for providing recommendations to reduce the risk for damage, injury, and/or death from future, presumably similar, surface faulting. Site-specific fault-trenching investigations should be preceded by a careful field evaluation of the site to identify the surface trace of the fault as well as other faults and fault-related features not evident at the mapped scale.

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We focused on mapping traces of the Wasatch fault zone and other nearby faults within the available high-resolution lidar elevation data. Additionally, we used 1970s low-sun-angle and oblique aerial photography from Woodward-Lundgren & Associates Wasatch fault investigations (Cluff and others, 1970; compiled in Bowman and others, 2015) supplemented by other aerial photography from the *UGS Aerial Imagery Collection* (https://geodata.geology.utah.gov/imagery/), and previous geologic and related mapping (Cluff and others, 1974; Davis, 1985; Oviatt, 1986; Personius, 1990). Faults east of the Wasatch fault zone were not mapped for this study. We encourage local governments to forward surface-fault-rupture hazard investigation reports they receive to the UGS so that fault mapping accuracy and detail for future maps can be improved. Additional information on earthquakes and other geologic hazards is available at https://geology.utah.gov/hazards/.

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Cluff, L.S., Glass, C.E., and Brogan, G.E., 1974, Investigation and evaluation of the Wasatch fault north of Brigham City and Cache Valley faults, Utah and Idaho; a guide to land-use planning with recommendations for seismic safety: Oakland, California, Woodward-Lundgren and Associates, unpublished report for U.S. Geological Survey, contract no. 14-08-001-13665, 147 p.

Davis, F.D., 1985, Geologic map of the northern Wasatch Front, Utah: Utah Geological and Mineral Survey Map-53A, scale 1:24,000.

International Code Council, 2014, International Building Code: Country Club Hills, Illinois, 700 p.

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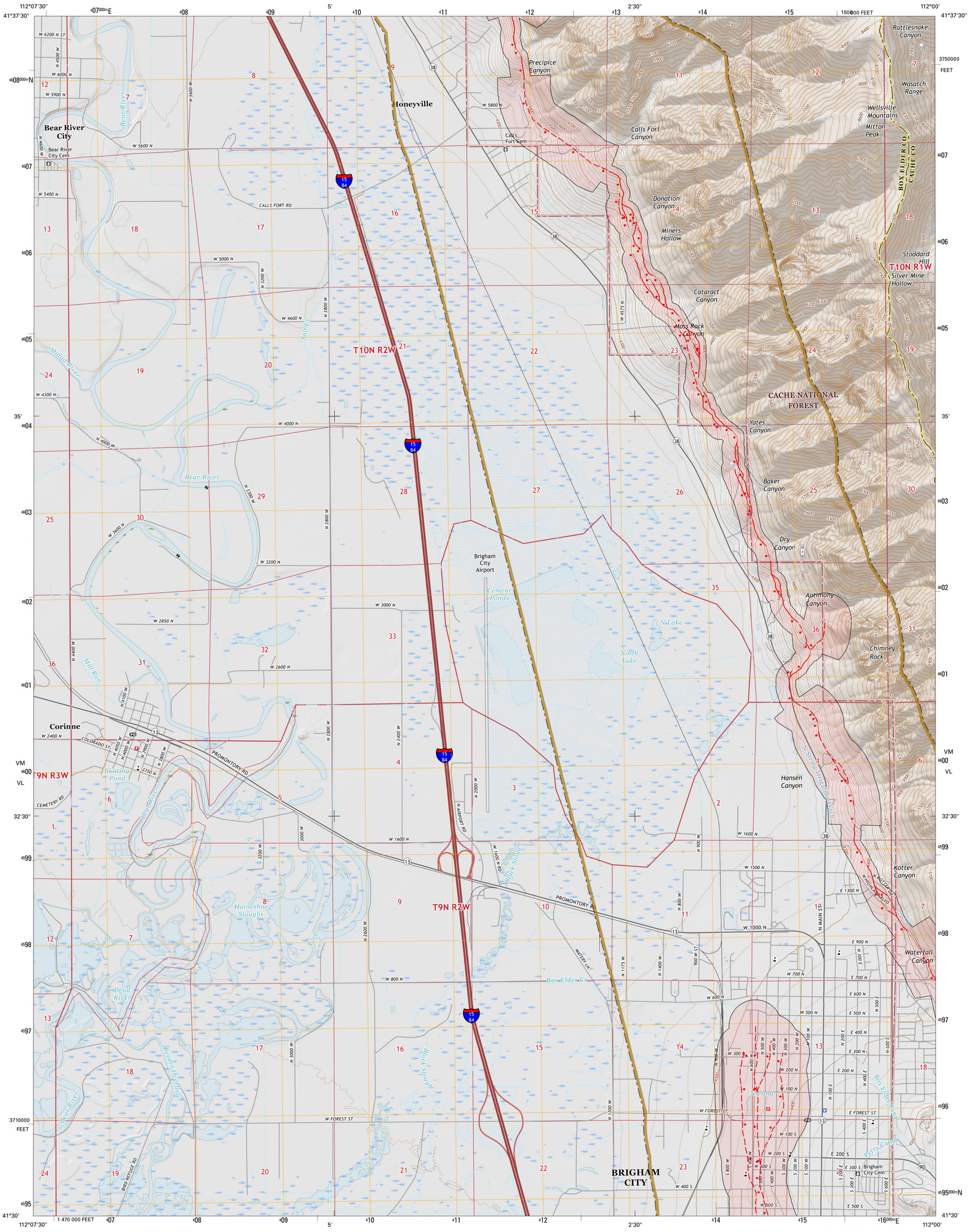
Oviatt, C.G., 1986, Geologic map of the Honeyville quadrangle, Box Elder and Cache Counties, Utah: Utah Geological and Mineral Survey Map 88, 13 p., scale 1:24,000.

Personius, S.F., 1990, Surficial geologic map of the Brigham City segment and adjacent parts of the Weber and Collinston segments, Wasatch fault zone, Box Elder and Weber Counties, Utah: U.S. Geological Survey Miscellaneous Investigations Series Map I-1979, scale 1:50,000.

Utah Automated Geographic Reference Center, 2013–2014, Wasatch Front LiDAR elevation data: Online, Utah Automated Geographic Reference Center, State Geographic Information Database, https://gis.utah.gov/data/elevation-terrain-data/2013-2014-lidar/.



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SCALE 1:24,000
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CONTOUR INTERVAL 20 FEET

TRUE NORTH
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Base from USGS Brigham City 7.5' Quadrangle (2017)
Projection: UTM Zone 12 N
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by

Greg N. McDonald

2018

1	2	3
4		5
6	7	8

1. Tremonton
2. Honeyville
3. Wellsville
4. Bear River City
5. Mount Pisgah
6. Whistler Canal
7. Willard
8. Mantua

ADJOINING 7.5' QUADRANGLE NAMES

EXPLANATION

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SURFACE FAULT RUPTURE HAZARD CATEGORIES

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Late Quaternary-active fault (movement within the past 130,000 years) or suspected late Quaternary-active fault: Surface-fault-rupture hazard investigations recommended for all IBC Risk Category IIb, III, and IV structures (see Lund and others, 2016). Investigations for IBC Risk Category IIa and other structures for human occupancy remain prudent, but should be based on an assessment of whether risk-reduction measures are justified by weighing the probability of occurrence against the risk to lives and potential economic loss. Ball and bar on downthrown side of fault. Solid line indicates well-defined fault trace, dashed line indicates moderately well defined fault trace, and dotted line indicates buried or inferred fault trace. None currently mapped within this quadrangle. None currently mapped within this quadrangle.

Quaternary-active fault (movement within the past 2,600,000 years) or suspected Quaternary-active fault: Surface-fault-rupture hazard investigations recommended for all IBC Risk Category III and IV structures (see Lund and others, 2016). Investigations for IBC Risk Category IIb and other structures for human occupancy remain prudent because a low likelihood of surface faulting still exists. Ball and bar on downthrown side of fault. Solid line indicates well-defined fault trace, dashed line indicates moderately well defined fault trace, and dotted line indicates buried or inferred fault trace. None currently mapped within this quadrangle.

Other lineaments, unknown activity/source: Lineaments and traces mapped using lidar and other data. None currently mapped within this quadrangle.

Surface-fault-rupture hazard special-study area: For well-defined faults, special-study area extends 500 feet on the downthrown side and 250 feet on the upthrown side of each fault. For moderately well located or buried/inferred faults, special-study area extends 1000 feet on each side of the suspected trace of each fault (Lund and others, 2016). Refer to booklet for more details on special-study area designations.

USING THIS MAP

This map shows potentially active faults in the Brigham City quadrangle along which surface faulting may occur and delineated special-study areas around those faults. Within each area, the UGS recommends a site-specific, surface-fault-rupture hazard investigation (such as fault trenching) be performed before development following the guidelines of Lund and others (2016). Site-specific geotechnical/geologic-hazard investigations can resolve uncertainties inherent in the generalized map scale and help ensure safety by identifying the need for and determine distances for fault setbacks from infrastructure. These investigations use the characteristics of past surface faulting at a site as a scientific basis for providing recommendations to reduce the risk for damage, injury, and/or death from future, presumably similar, surface faulting. Site-specific fault-trenching investigations should be preceded by a careful field evaluation of the site to identify the surface trace of the fault as well as other faults and fault-related features not evident at the mapped scale.

Aleatory (natural) variability in fault behavior cannot be reduced; therefore, predicting exactly when, where, and how much ground rupture will occur during future surface-faulting earthquakes is not possible. New faults may form, existing faults may propagate beyond their present lengths, elapsed time between individual surface-faulting earthquakes can vary by hundreds or thousands of years and be affected by clustering, triggering, and multi- or partial-segment ruptures. For these reasons, developing property in the vicinity of hazardous faults will always involve a level of irreducible, inherent risk. The special-study areas were delineated to account for much of the uncertainty in fault trace location and propagation.

This map is not intended for use at scales other than 1:24,000; it is our opinion that the inventory of potentially active faults shown on this map is likely complete at this scale where high-resolution lidar data are available. However, smaller faults may not have been detected during mapping (such as those with very small offset or surface warping) or are concealed beneath young geologic deposits. Bedrock faults having no documented Quaternary movement were not included, but could represent an unlikely source of surface-fault-rupture hazard. Additionally, concealed and approximately located faults by definition lack a clearly identifiable surface trace; therefore, their locations are approximate. Lidar-derived fault traces were mapped at 1:10,000 scale where possible; however, all traces are shown on this map at 1:24,000 scale.

We focused on mapping traces of the Wasatch fault zone and other nearby faults within the available high-resolution lidar elevation data. Additionally, we used 1970s low-sun-angle and oblique aerial photography from Woodward-Lundgren & Associates Wasatch fault investigations (Cluff and others, 1970; compiled in Bowman and others, 2015) supplemented by other aerial photography from the *UGS Aerial Imagery Collection* (https://geodata.geology.utah.gov/imagery/), and previous geologic and related mapping (Cluff and others, 1974; Davis, 1985; Personius, 1990; Jensen and King, 1999). Fault traces outside the available lidar extents are from the *Utah Quaternary Fault and Fold Database* (https://geology.utah.gov/apps/qfaults/). We encourage local governments to forward surface-fault-rupture hazard investigation reports they receive to the UGS so that fault mapping accuracy and detail for future maps can be improved. Additional information on earthquakes and other geologic hazards is available at https://geology.utah.gov/hazards/.

REFERENCES

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Cluff, L., Brogan, G., and Glass, C., 1970, Wasatch fault, northern portion, earthquake fault investigation & evaluation, a guide to land use planning: Oakland, California, Woodward-Clyde and Associates, unpublished consultant's report for the Utah Geological and Mineralogical Survey, variously paginated.

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Davis, F.D., 1985, Geologic map of the northern Wasatch Front, Utah: Utah Geological and Mineral Survey Map–53A, scale 1:24,000.

International Code Council, 2014, International Building Code: Country Club Hills, Illinois, 700 p.

Jensen, M.E., and King, J.K., 1999, Geologic map of the Brigham City 7.5-minute quadrangle, Box Elder and Cache Counties, Utah: Utah Geological Survey Map 173, 46 p., scale 1:24,000.

Lund, W.R., Christenson, G.E., Batatian, L.D., and Nelson, C.V., 2016, Guidelines for evaluating surface-fault-rupture hazards in Utah, *in* Bowman, S.D., and Lund, W.R., editors, Guidelines for investigating geologic hazards and preparing engineering geology reports, with a suggested approach to geologic-hazard ordinances in Utah: Utah Geological Survey Circular 122, p. 31–53.

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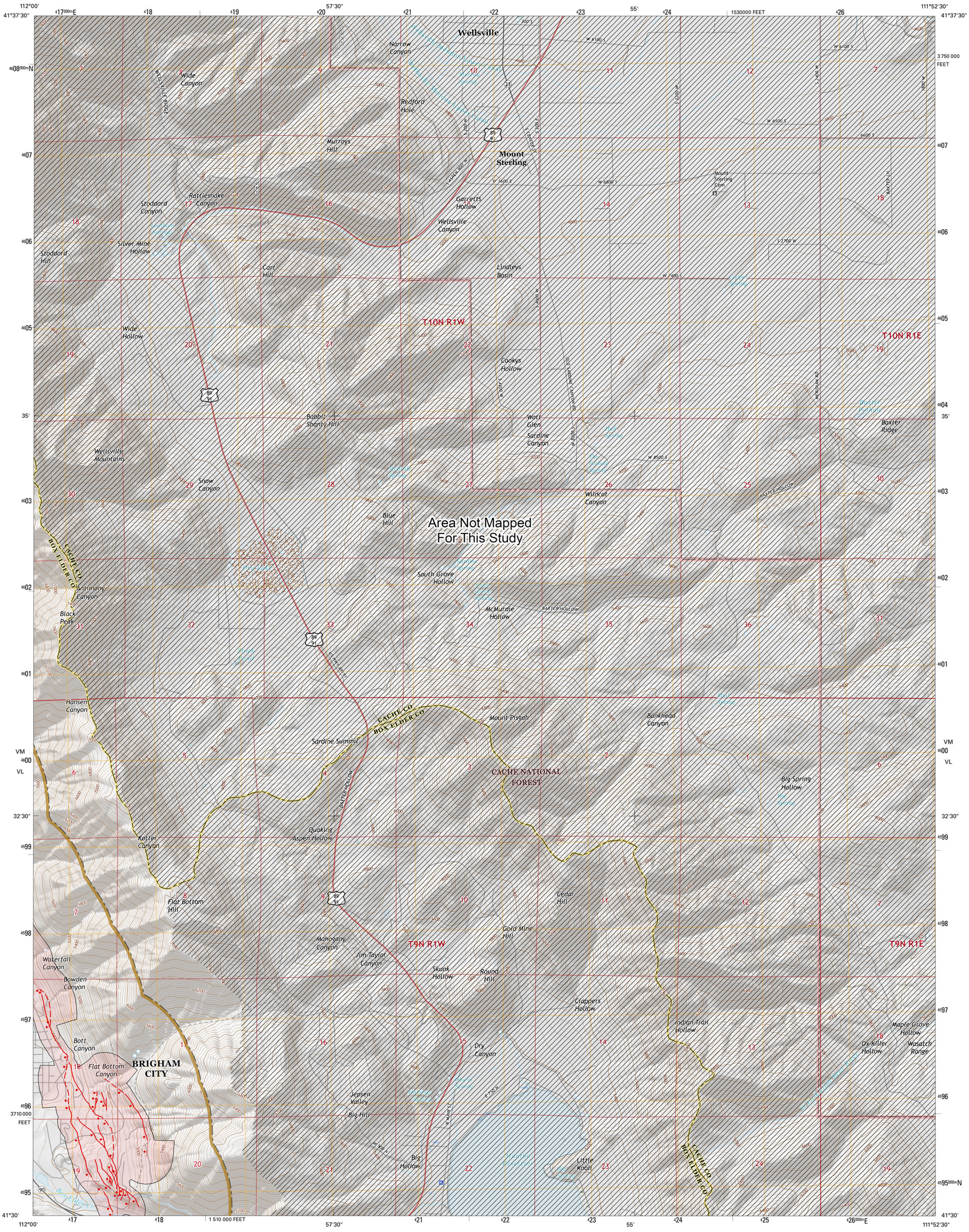

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UTAH
QUADRANGLE LOCATION

SCALE 1:24,000
1 0.5 0 1 MILE
5000 2500 0 5000 FEET
1 0.5 0 1 KILOMETER
CONTOUR INTERVAL 40 FEET

TRUE NORTH
MAGNETIC NORTH
11°40'
APPROXIMATE MEAN DECLINATION, 2018

Base from USGS Mount Pisgah 7.5' Quadrangle (2017)
Projection: UTM Zone 12 N
Datum: NAD 1983

Surficial Fault Mapping: Greg N. McDonald
GIS and Cartography: Gordon E. Douglass and Greg N. McDonald
Project Manager: Greg N. McDonald

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SURFACE FAULT RUPTURE HAZARD MAP OF THE MOUNT PISGAH QUADRANGLE, BOX ELDER AND CACHE COUNTIES, UTAH

by

Greg N. McDonald

2018

1	2	3
4		5
6	7	8

1. Honeyville
2. Wellsville
3. Logan
4. Brigham City
5. Paradise
6. Willard
7. Mantua
8. James Peak

ADJOINING 7.5' QUADRANGLE NAMES

EXPLANATION

2013–2014 lidar extent: 0.5-meter Wasatch Front bare earth light detection and ranging (lidar) elevation data, available from the Utah Automated Geographic Reference Center and OpenTopography.

SURFACE FAULT RUPTURE HAZARD CATEGORIES

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USING THIS MAP

This map shows potentially active faults in the Mount Pisgah quadrangle along which surface faulting may occur and delineated special-study areas around those faults. Within each area, the UGS recommends a site-specific, surface-fault-rupture hazard investigation (such as fault trenching) be performed before development following the guidelines of Lund and others (2016). Site-specific geotechnical/geologic-hazard investigations can resolve uncertainties inherent in the generalized map scale and help ensure safety by identifying the need for and determine distances for fault setbacks from infrastructure. These investigations use the characteristics of past surface faulting at a site as a scientific basis for providing recommendations to reduce the risk for damage, injury, and/or death from future, presumably similar, surface faulting. Site-specific fault-trenching investigations should be preceded by a careful field evaluation of the site to identify the surface trace of the fault as well as other faults and fault-related features not evident at the mapped scale.

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Davis, F.D., 1985, Geologic map of the northern Wasatch Front, Utah: Utah Geological and Mineral Survey Map-53A, scale 1:24,000.

Dover, J.H., 1995, Geologic map of the Logan 30' x 60' quadrangle, Cache and Rich Counties, Utah, and Lincoln and Uinta Counties, Wyoming: U.S. Geological Survey Miscellaneous Investigations Series Map I-2210, scale 1:100,000.

International Code Council, 2014, International Building Code: Country Club Hills, Illinois, 700 p.

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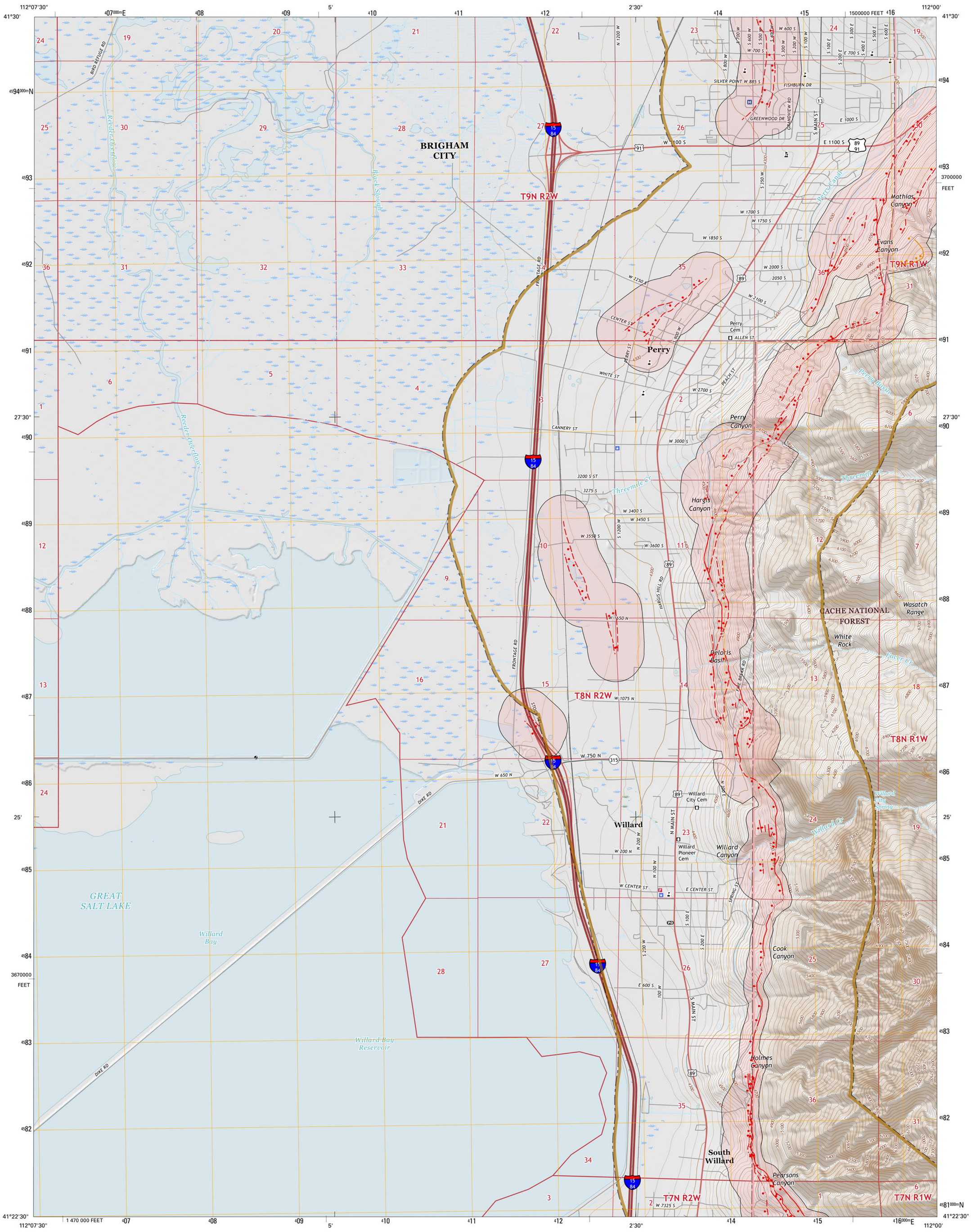

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U T A H
QUADRANGLE LOCATION

SCALE 1:24,000
1 0.5 0 1 MILE
4900 2450 0 4900 FEET
1 0.5 0 1 KILOMETER
CONTOUR INTERVAL 20 FEET

TRUE NORTH
MAGNETIC NORTH
11°41'
APPROXIMATE MEAN DECLINATION, 2018

Base from USGS Willard 7.5' Quadrangle (2017)
Projection: UTM Zone 12
Datum: NAD 1983

Surface fault mapping: Adam P. McKean and Greg N. McDonald
GIS and Cartography: Gordon E. Douglass, Adam P. McKean, and Greg N. McDonald
Project Manager: Greg N. McDonald

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(801) 537-3300

1	2	3
4		5
6	7	8

1. Bear River City
2. Brigham City
3. Mount Pisgah
4. Whistler Canal
5. Mantua
6. Plain City SW
7. Plain City
8. North Ogden

ADJOINING 7.5' QUADRANGLE NAMES

SURFACE FAULT RUPTURE HAZARD MAP OF THE WILLARD QUADRANGLE, BOX ELDER COUNTY, UTAH

by

Adam P. McKean and Greg N. McDonald

2018

EXPLANATION

2013–2014 lidar extent: 0.5-meter Wasatch Front bare earth light detection and ranging (lidar) elevation data, available from the Utah Automated Geographic Reference Center and OpenTopography.

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USING THIS MAP

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McKean, A.P., Balgord, E.A., Yonkee, W.A., and Hiscock, A.I., 2018, Geologic map of the Willard quadrangle, Box Elder County, Utah: Utah Geological Survey Map 278DM, 18 p., 2 plates, scale 1:24,000.

Personius, S.F., 1990, Surficial geologic map of the Brigham City segment and adjacent parts of the Weber and Collinston segments, Wasatch fault zone, Box Elder and Weber Counties, Utah: U.S. Geological Survey Miscellaneous Investigations Series Map I-1979, scale 1:50,000.

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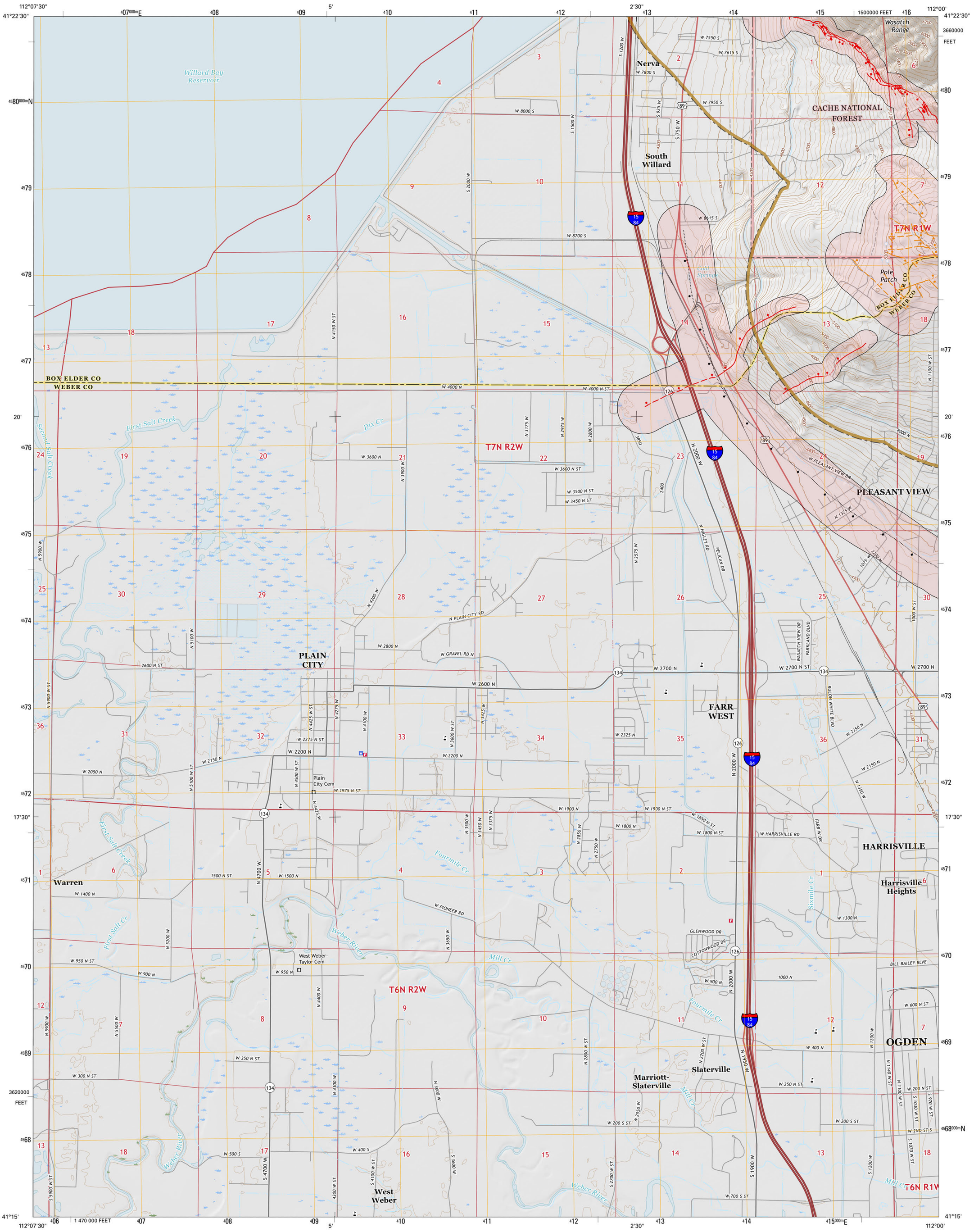

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SURFACE FAULT RUPTURE HAZARD MAP OF THE PLAIN CITY QUADRANGLE, BOX ELDER AND WEBER COUNTIES, UTAH

by

Greg N. McDonald, Kimm M. Harty and Mike Lowe

2018

1	2	3
4		5
6	7	8

1. Whistler Canal
2. Willard
3. Mantua
4. Plain City SW
5. North Ogden
6. Ogden Bay
7. Roy
8. Ogden

ADJOINING 7.5' QUADRANGLE NAMES

EXPLANATION

2013–2014 lidar extent: 0.5-meter Wasatch Front bare earth light detection and ranging (lidar) elevation data, available from the Utah Automated Geographic Reference Center and OpenTopography.

SURFACE FAULT RUPTURE HAZARD CATEGORIES

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Late Quaternary-active fault (movement within the past 130,000 years) or suspected late Quaternary-active fault: Surface-fault-rupture hazard investigations recommended for all IBC Risk Category IIb, III, and IV structures (see Lund and others, 2016). Investigations for IBC Risk Category IIa and other structures for human occupancy remain prudent, but should be based on an assessment of whether risk-reduction measures are justified by weighing the probability of occurrence against the risk to lives and potential economic loss. Ball and bar on downthrown side of fault. Solid line indicates well-defined fault trace, dashed line indicates moderately well defined fault trace, and dotted line indicates buried or inferred fault trace.

Quaternary-active fault (movement within the past 2,600,000 years) or suspected Quaternary-active fault: Surface-fault-rupture hazard investigations recommended for all IBC Risk Category III and IV structures (see Lund and others, 2016). Investigations for IBC Risk Category IIb and other structures for human occupancy remain prudent because a low likelihood of surface faulting still exists. Ball and bar on downthrown side of fault. Solid line indicates well-defined fault trace, dashed line indicates moderately well defined fault trace, and dotted line indicates buried or inferred fault trace.

Other lineaments, unknown activity/source: Lineaments and traces mapped using lidar and other data. None currently mapped within this quadrangle.

Surface-fault-rupture hazard special-study area: For well-defined faults, special-study area extends 500 feet on the downthrown side and 250 feet on the upthrown side of each fault. For moderately well located or buried/inferred faults, special-study area extends 1000 feet on each side of the suspected trace of each fault (Lund and others, 2016). Refer to booklet for more details on special-study area designations.

USING THIS MAP

This map shows potentially active faults in the Plain City quadrangle along which surface faulting may occur and delineated special-study areas around those faults. Within each area, the UGS recommends a site-specific, surface-fault-rupture hazard investigation (such as fault trenching) be performed before development following the guidelines of Lund and others (2016). Site-specific geotechnical/geologic-hazard investigations can resolve uncertainties inherent in the generalized map scale and help ensure safety by identifying the need for and determine distances for fault setbacks from infrastructure. These investigations use the characteristics of past surface faulting at a site as a scientific basis for providing recommendations to reduce the risk for damage, injury, and/or death from future, presumably similar, surface faulting. Site-specific fault-trenching investigations should be preceded by a careful field evaluation of the site to identify the surface trace of the fault as well as other faults and fault-related features not evident at the mapped scale.

Aleatory (natural) variability in fault behavior cannot be reduced; therefore, predicting exactly when, where, and how much ground rupture will occur during future surface-faulting earthquakes is not possible. New faults may form, existing faults may propagate beyond their present lengths, elapsed time between individual surface-faulting earthquakes can vary by hundreds or thousands of years and be affected by clustering, triggering, and multi- or partial-segment ruptures. For these reasons, developing property in the vicinity of hazardous faults will always involve a level of irreducible, inherent risk. The special-study areas were delineated to account for much of the uncertainty in fault trace location and propagation.

This map is not intended for use at scales other than 1:24,000; it is our opinion that the inventory of potentially active faults shown on this map is likely complete at this scale where high-resolution lidar data are available. However, smaller faults may not have been detected during mapping (such as those with very small offset or surface warping) or are concealed beneath young geologic deposits. Bedrock faults having no documented Quaternary movement were not included, but could represent an unlikely source of surface-fault-rupture hazard. Additionally, concealed and approximately located faults by definition lack a clearly identifiable surface trace; therefore, their locations are approximate. Lidar-derived fault traces were mapped at 1:10,000 scale where possible; however, all traces are shown on this map at 1:24,000 scale.

We focused on mapping traces of the Wasatch fault zone and other nearby faults within the available high-resolution lidar elevation data. Additionally, we used 1970s low-sun-angle and oblique aerial photography from Woodward-Lundgren & Associates Wasatch fault investigations (Cluff and others, 1970; compiled in Bowman and others, 2015) supplemented by other aerial photography from the *UGS Aerial Imagery Collection* (https://geodata.geology.utah.gov/imagery/), and previous geologic and related mapping (Crittenden and Sorensen, 1985; Davis, 1985; Personius, 1990; Harty and others, 2012). Fault traces outside the available lidar extents are from the *Utah Quaternary Fault and Fold Database* (https://geology.utah.gov/apps/qfaults/). We encourage local governments to forward surface-fault-rupture hazard investigation reports they receive to the UGS so that fault mapping accuracy and detail for future maps can be improved. Additional information on earthquakes and other geologic hazards is available at https://geology.utah.gov/hazards/.

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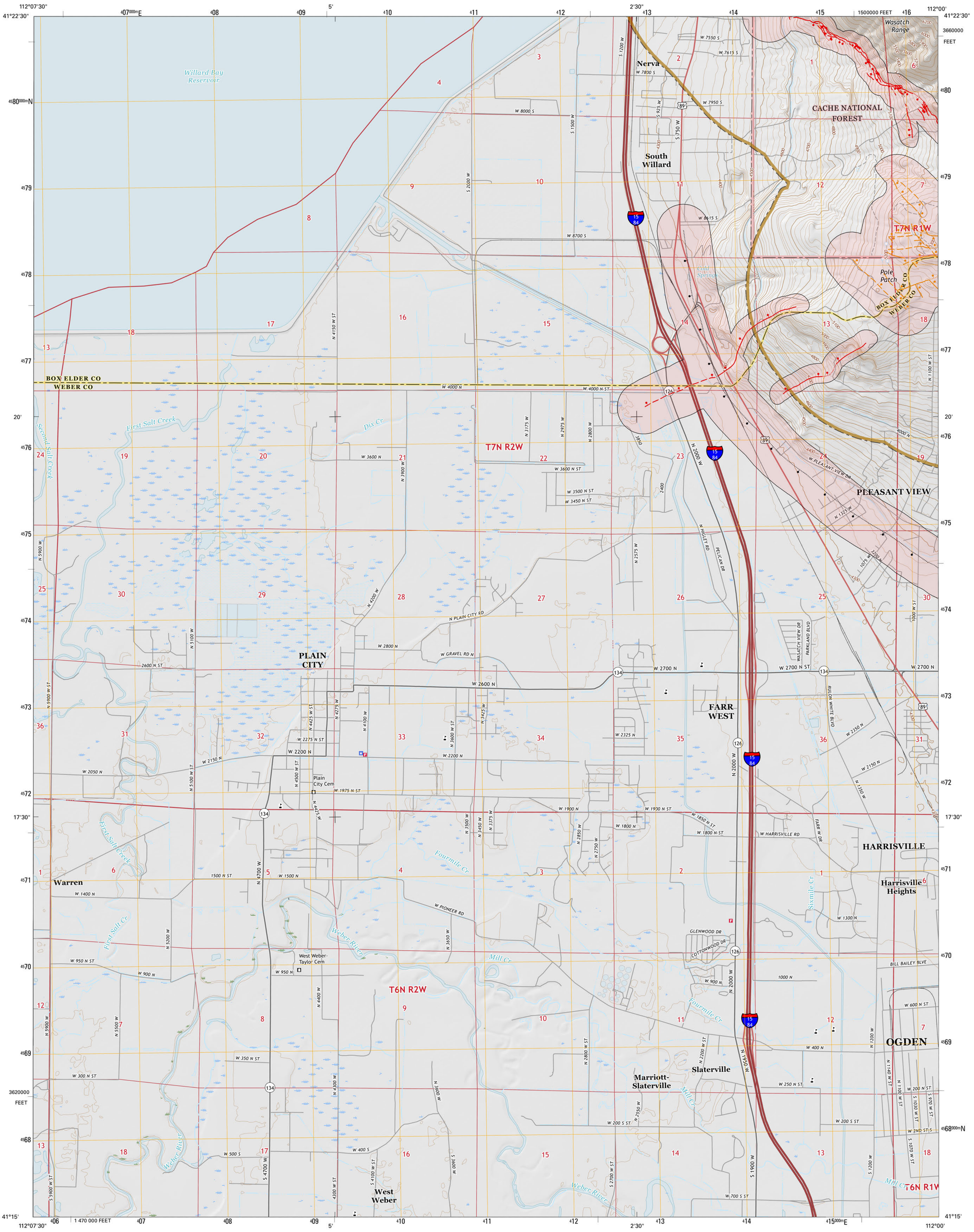

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APPROXIMATE MEAN DECLINATION, 2018

Base from USGS Plain City 7.5' Quadrangle (2017)
Projection: UTM Zone 12
Datum: NAD 1983

Surface fault mapping: Greg N. McDonald, Kimm M. Harty, and Mike Lowe
GIS and Cartography: Gordon E. Douglass, and Greg N. McDonald
Project Manager: Greg N. McDonald

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1594 West North Temple, Suite 3110
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SURFACE FAULT RUPTURE HAZARD MAP OF THE PLAIN CITY QUADRANGLE, BOX ELDER AND WEBER COUNTIES, UTAH

by

Greg N. McDonald, Kimm M. Harty and Mike Lowe

2018

1	2	3
4		5
6	7	8

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ADJOINING 7.5' QUADRANGLE NAMES

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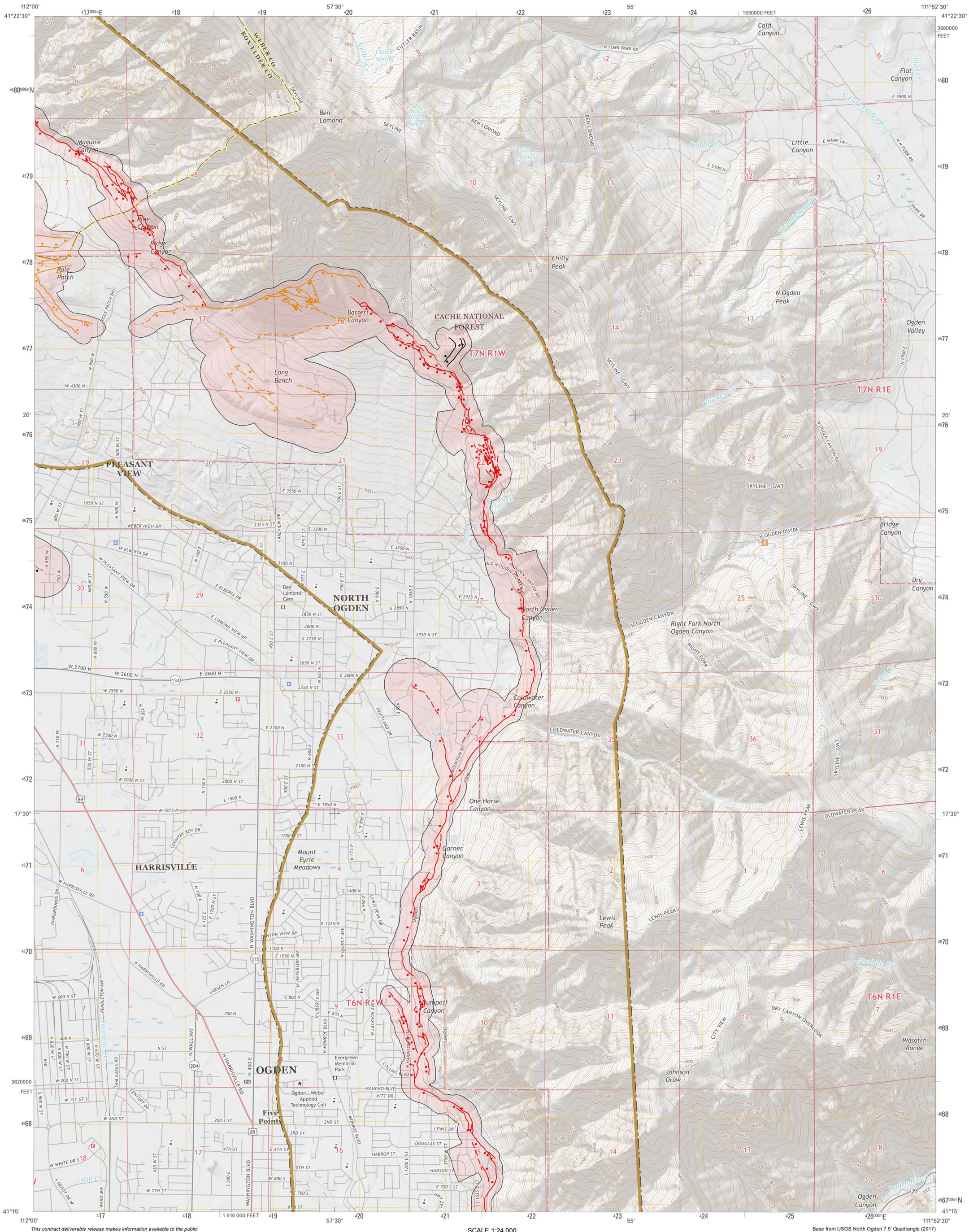

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Base from USGS North Ogden 7.5' Quadrangle (2017)
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SURFACE FAULT RUPTURE HAZARD MAP OF THE NORTH OGDEN QUADRANGLE, BOX ELDER AND WEBER COUNTIES, UTAH

by

Greg N. McDonald

2018

1	2	3
4		5
6	7	8

1. Willard
2. Mantua
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4. Plain City
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8. Snow Basin

ADJOINING 7.5' QUADRANGLE NAMES

EXPLANATION

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Coogan, C.C., and King, J.K., 2016, Interim geologic map of the Ogden 30' x 60' quadrangle, Box Elder, Cache, Davis, Morgan, Rich, and Summit Counties Utah, and Uinta County, Wyoming: Utah Geological Survey Open-File Report 633DM, 148 p., 3 plates, scale 1:100,000.

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Nelson, A.R., and Personius, S.F., 1993, Surficial geologic map of the Weber segment, Wasatch fault zone, Weber and Davis Counties, Utah: U.S. Geological Survey Miscellaneous Field Investigations Series Map I-2199, scale 1:50,000.

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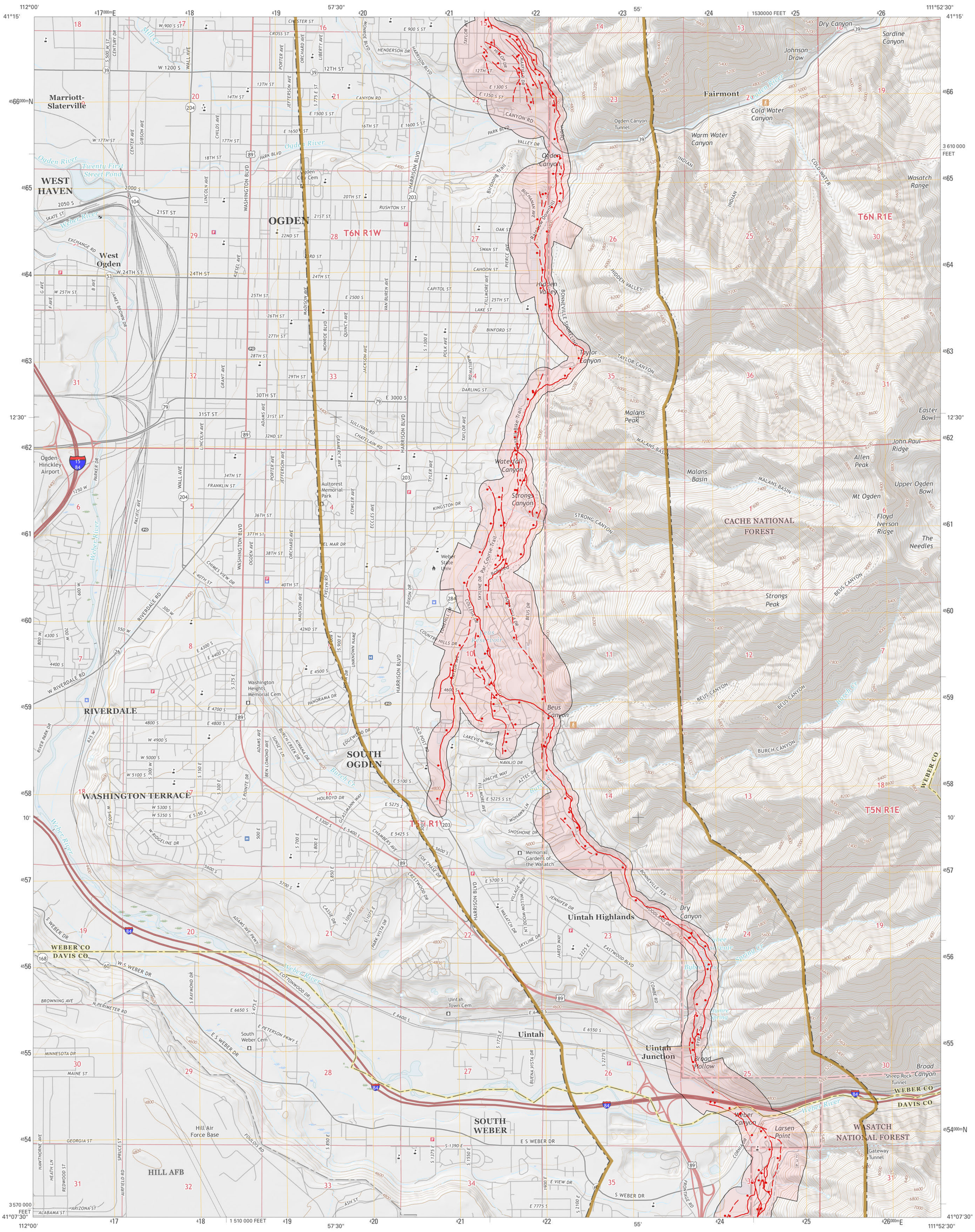

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MAGNETIC NORTH
11°36'
APPROXIMATE MEAN DECLINATION, 2018

Base from USGS Ogden 7.5' Quadrangle (2017)
Projection: UTM Zone 12 N
Datum: NAD 1983

Surficial fault mapping: Greg N. McDonald
GIS and Cartography: Gordon E. Douglass and Greg N. McDonald
Project Manager: Greg N. McDonald

Utah Geological Survey
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(801) 537-3300
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SURFACE FAULT RUPTURE HAZARD MAP OF THE OGDEN QUADRANGLE, DAVIS AND WEBER COUNTIES, UTAH

by

Greg N. McDonald

2018

1	2	3
4		5
6	7	8

1. Plain City
2. North Ogden
3. Huntsville
4. Roy
5. Snow Basin
6. Clearfield
7. Kaysville
8. Peterson

ADJOINING 7.5' QUADRANGLE NAMES

EXPLANATION

2013–2014 lidar extent: 0.5-meter Wasatch Front bare earth light detection and ranging (lidar) elevation data, available from the Utah Automated Geographic Reference Center and OpenTopography.

SURFACE FAULT RUPTURE HAZARD CATEGORIES

Holocene-active fault (movement within the past 11,700 years) or suspected Holocene-active fault: Surface-fault-rupture hazard investigations recommended for all structures intended for human occupancy and all International Building Code (IBC; International Code Council, 2014) Risk Category IIa, IIb, III, and IV structures (see Lund and others, 2016). Ball and bar on downthrown side of fault. Solid line indicates well-defined fault trace, dashed line indicates moderately well defined fault trace, and dotted line indicates buried or inferred fault trace.

Late Quaternary-active fault (movement within the past 130,000 years) or suspected late Quaternary-active fault: Surface-fault-rupture hazard investigations recommended for all IBC Risk Category IIb, III, and IV structures (see Lund and others, 2016). Investigations for IBC Risk Category IIa and other structures for human occupancy remain prudent, but should be based on an assessment of whether risk-reduction measures are justified by weighing the probability of occurrence against the risk to lives and potential economic loss. Ball and bar on downthrown side of fault. Solid line indicates well-defined fault trace, dashed line indicates moderately well defined fault trace, and dotted line indicates buried or inferred fault trace. None currently mapped within this quadrangle.

Quaternary-active fault (movement within the past 2,600,000 years) or suspected Quaternary-active fault: Surface-fault-rupture hazard investigations recommended for all IBC Risk Category III and IV structures (see Lund and others, 2016). Investigations for IBC Risk Category IIb and other structures for human occupancy remain prudent because a low likelihood of surface faulting still exists. Ball and bar on downthrown side of fault. Solid line indicates well-defined fault trace, dashed line indicates moderately well defined fault trace, and dotted line indicates buried or inferred fault trace. None currently mapped within this quadrangle.

Other lineaments, unknown activity/source: Lineaments and traces mapped using lidar and other data. None currently mapped within this quadrangle.

Surface-fault-rupture hazard special-study area: For well-defined faults, special-study area extends 500 feet on the downthrown side and 250 feet on the upthrown side of each fault. For moderately well located or buried/inferred faults, special-study area extends 1000 feet on each side of the suspected trace of each fault (Lund and others, 2016). Refer to booklet for more details on special-study area designations.

USING THIS MAP

This map shows potentially active faults on the Ogden quadrangle along which surface faulting may occur and delineated special-study areas around those faults. Within each area, the UGS recommends a site-specific, surface-fault-rupture hazard investigation (such as fault trenching) be performed before development following the guidelines of Lund and others (2016). Site-specific geotechnical/geologic-hazard investigations can resolve uncertainties inherent in the generalized map scale and help ensure safety by identifying the need for and determine distances for fault setbacks from infrastructure. These investigations use the characteristics of past surface faulting at a site as a scientific basis for providing recommendations to reduce the risk for damage, injury, and/or death from future, presumably similar, surface faulting. Site-specific fault-trenching investigations should be preceded by a careful field evaluation of the site to identify the surface trace of the fault as well as other faults and fault-related features not evident at the mapped scale.

Aleatory (natural) variability in fault behavior cannot be reduced; therefore, predicting exactly when, where, and how much ground rupture will occur during future surface-faulting earthquakes is not possible. New faults may form, existing faults may propagate beyond their present lengths, elapsed time between individual surface-faulting earthquakes can vary by hundreds or thousands of years and be affected by clustering, triggering, and multi- or partial-segment ruptures. For these reasons, developing property in the vicinity of hazardous faults will always involve a level of irreducible, inherent risk. The special-study areas were delineated to account for much of the uncertainty in fault trace location and propagation.

This map is not intended for use at scales other than 1:24,000; it is our opinion that the inventory of potentially active faults shown on this map is likely complete at this scale where high-resolution lidar data are available. However, smaller faults may not have been detected during mapping (such as those with very small offset or surface warping) or are concealed beneath young geologic deposits. Bedrock faults having no documented Quaternary movement were not included, but could represent an unlikely source of surface-fault-rupture hazard. Additionally, concealed and approximately located faults by definition lack a clearly identifiable surface trace; therefore, their locations are approximate. Lidar-derived fault traces were mapped at 1:10,000 scale where possible; however, all traces are shown on this map at 1:24,000 scale.

We focused on mapping traces of the Wasatch fault zone and other nearby faults within the available high-resolution lidar elevation data. Additionally, we used 1970s low-sun-angle and oblique aerial photography from Woodward-Lundgren & Associates Wasatch fault investigations (Cluff and others, 1970; compiled in Bowman and others, 2015) supplemented by other aerial photography from the *UGS Aerial Imagery Collection* (https://geodata.geology.utah.gov/imagery/), and previous geologic and related mapping (Crittenden an Sorensen, 1985; Davis, 1985; Nelson and Personius, 1993; Yonkee and Lowe, 2004; Coogan and King, 2016). Fault traces outside the available lidar extents are from the *Utah Quaternary Fault and Fold Database* (https://geology.utah.gov/apps/qfaults/). We encourage local governments to forward surface-fault-rupture hazard investigation reports they receive to the UGS so that fault mapping accuracy and detail for future maps can be improved. Additional information on earthquakes and other geologic hazards is available at https://geology.utah.gov/hazards/.

REFERENCES

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Crittenden, M.D., Jr., and Sorensen, M.L., 1985, Geologic map of the North Ogden quadrangle and part of the Ogden and Plain City quadrangles, Box Elder and Weber Counties, Utah: U.S. Geological Survey Miscellaneous Investigations Series Map I-1606, scale 1:24,000.

Davis, F.D., 1985, Geologic map of the northern Wasatch Front, Utah: Utah Geological and Mineral Survey Map-53A, scale 1:24,000.

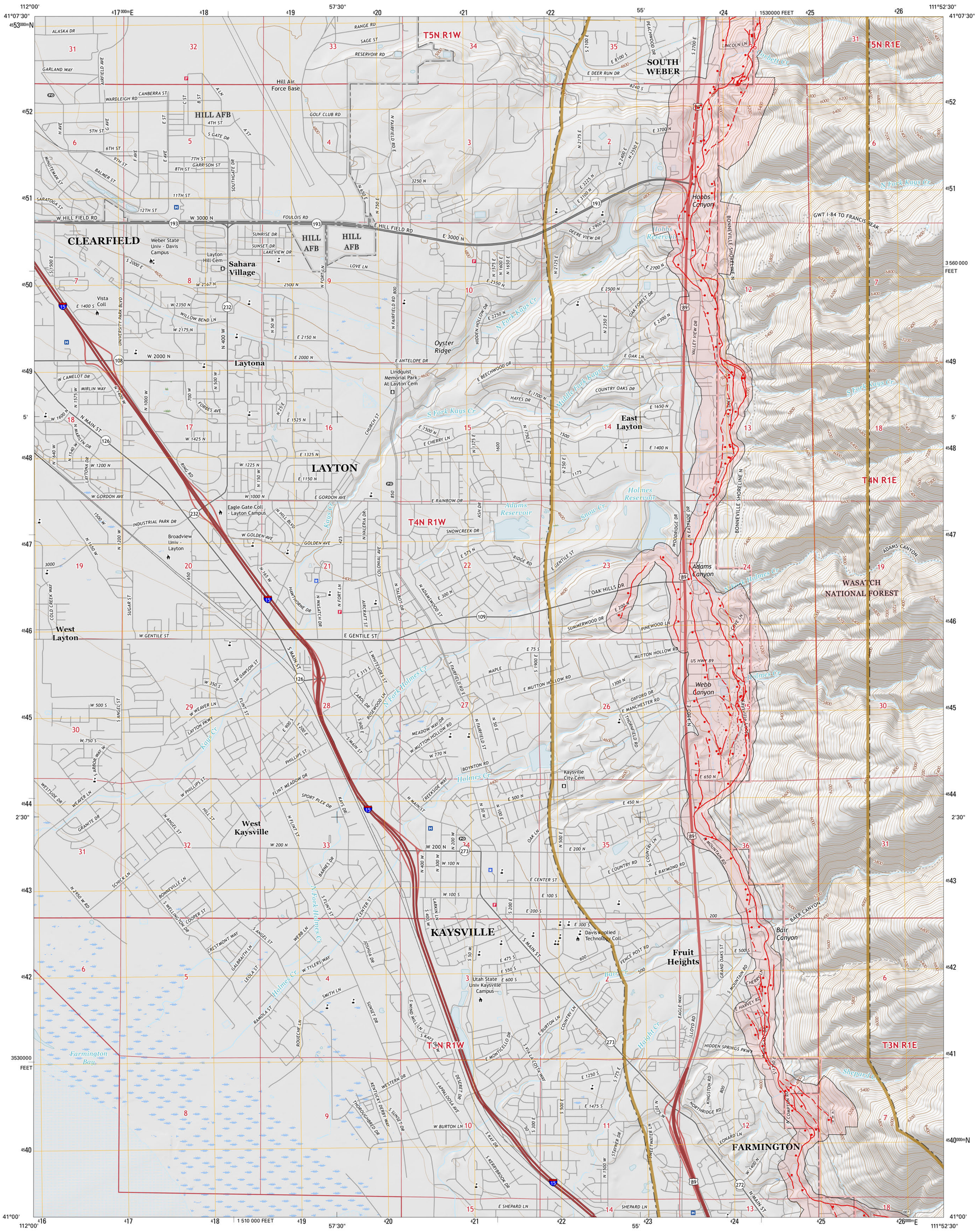
International Code Council, 2014, International Building Code: Country Club Hills, Illinois, 700 p.

Lund, W.R., Christenson, G.E., Batatian, L.D., and Nelson, C.V., 2016, Guidelines for evaluating surface-fault-rupture hazards in Utah, *in* Bowman, S.D., and Lund, W.R., editors, Guidelines for investigating geologic hazards and preparing engineering geology reports, with a suggested approach to geologic-hazard ordinances in Utah: Utah Geological Survey Circular 122, p. 31–53.

Nelson, A.R., and Personius, S.F., 1993, Surficial geologic map of the Weber segment, Wasatch fault zone, Weber and Davis Counties, Utah: U.S. Geological Survey Miscellaneous Field Investigations Series Map I-2199, scale 1:50,000.

Utah Automated Geographic Reference Center, 2013–2014, Wasatch Front LiDAR elevation data: Online, Utah Automated Geographic Reference Center, State Geographic Information Database, https://gis.utah.gov/data/elevation-terrain-data/2013-2014-lidar/.

Yonkee, W.A., and Lowe, M., 2004, Geologic map of the Ogden quadrangle, Weber and Davis Counties, Utah: Utah Geological Survey Map 200, 42 p., 2 plates, scale 1:24,000.



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This map is a plot of geographic information system (GIS) files created to visually represent the content of the GIS data files. This preliminary map contains features that do not meet UGS cartographic standards.

UTAH
QUADRANGLE LOCATION

SCALE 1:24,000
1 0.5 0 1 MILE
5000 2500 0 5000 FEET
1 0.5 0 1 KILOMETER
CONTOUR INTERVAL 40 FEET

TRUE NORTH
MAGNETIC NORTH
11°35'
APPROXIMATE MEAN DECLINATION, 2018

Base from USGS Kaysville 7.5' Quadrangle (2017)
Projection: UTM Zone 12 N
Datum: NAD 1983

Surficial fault mapping: Greg N. McDonald
GIS and Cartography: Gordon E. Douglass and Greg N. McDonald
Project Manager: Greg N. McDonald

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SURFACE FAULT RUPTURE HAZARD MAP OF THE KAYSVILLE QUADRANGLE, DAVIS COUNTY, UTAH

by

Greg N. McDonald

2018

1	2	3
4		5
6	7	8

1. Roy
2. Ogden
3. Snow Basin
4. Clarfield
5. Peterson
6. Saltair NE
7. Farmington
8. Bountiful Peak

ADJOINING 7.5' QUADRANGLE NAMES

EXPLANATION

2013–2014 lidar extent: 0.5-meter Wasatch Front bare earth light detection and ranging (lidar) elevation data, available from the Utah Automated Geographic Reference Center and OpenTopography.

SURFACE FAULT RUPTURE HAZARD CATEGORIES

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USING THIS MAP

This map shows potentially active faults on the Kaysville quadrangle along which surface faulting may occur and delineated special-study areas around those faults. Within each area, the UGS recommends a site-specific, surface-fault-rupture hazard investigation (such as fault trenching) be performed before development following the guidelines of Lund and others (2016). Site-specific geotechnical/geologic-hazard investigations can resolve uncertainties inherent in the generalized map scale and help ensure safety by identifying the need for and determine distances for fault setbacks from infrastructure. These investigations use the characteristics of past surface faulting at a site as a scientific basis for providing recommendations to reduce the risk for damage, injury, and/or death from future, presumably similar, surface faulting. Site-specific fault-trenching investigations should be preceded by a careful field evaluation of the site to identify the surface trace of the fault as well as other faults and fault-related features not evident at the mapped scale.

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We focused on mapping traces of the Wasatch fault zone and other nearby faults within the available high-resolution lidar elevation data. Additionally, we used 1970s low-sun-angle and oblique aerial photography from Woodward-Lundgren & Associates Wasatch fault investigations (Cluff and others, 1970; compiled in Bowman and others, 2015) supplemented by other aerial photography from the *UGS Aerial Imagery Collection* (https://geodata.geology.utah.gov/imagery/), and previous geologic and related mapping (Nelson and Personius, 1993; Solomon, 2007; Coogan and King, 2016). Fault traces outside the available lidar extents are from the *Utah Quaternary Fault and Fold Database* (https://geology.utah.gov/apps/qfaults/). We encourage local governments to forward surface-fault-rupture hazard investigation reports they receive to the UGS so that fault mapping accuracy and detail for future maps can be improved. Additional information on earthquakes and other geologic hazards is available at https://geology.utah.gov/hazards/.

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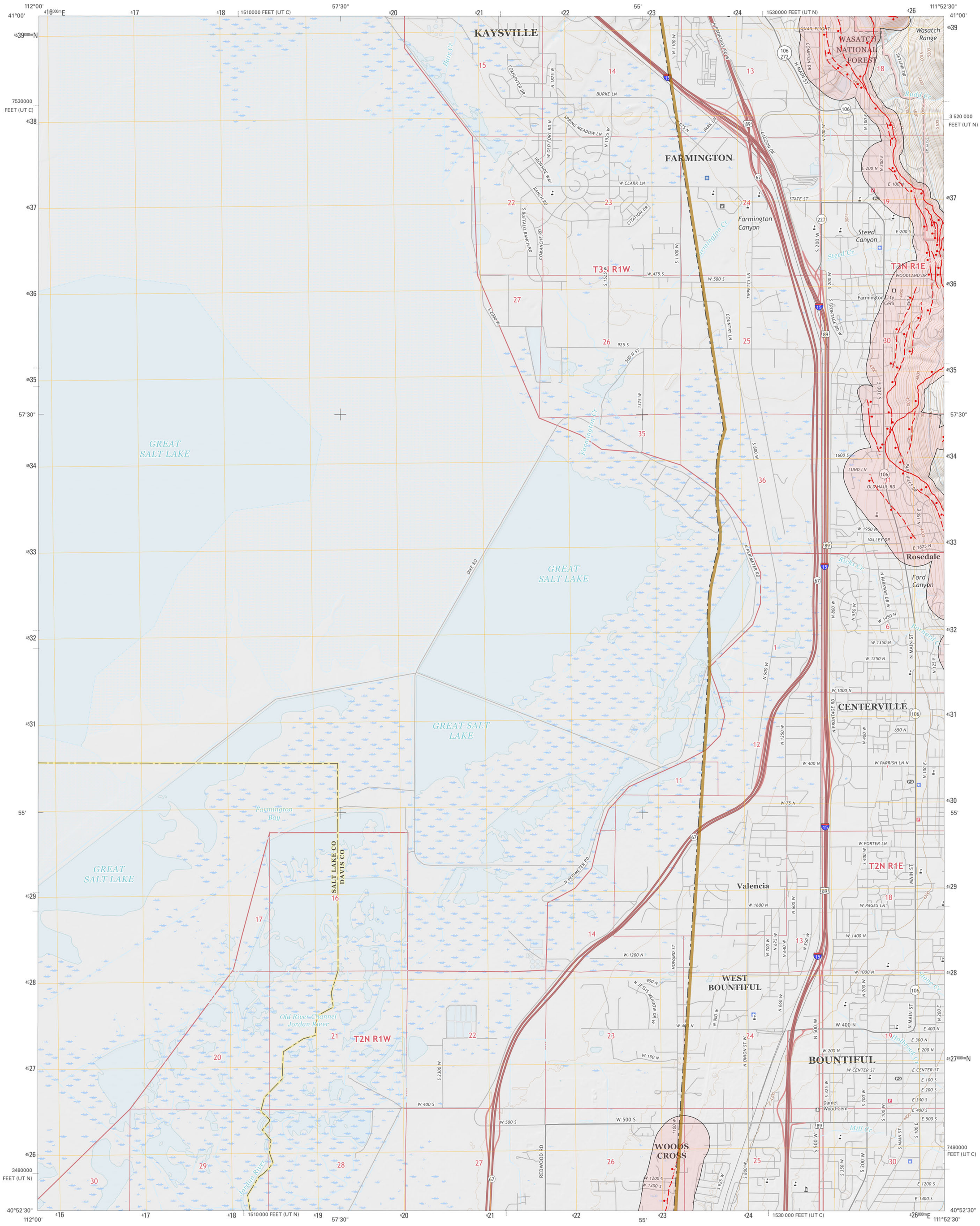
Solomon, B.J., 2007, Surficial geologic map of part of the Kaysville quadrangle, Davis County, Utah: Utah Geological Survey Map 224, scale 1:24,000.

Utah Automated Geographic Reference Center, 2013–2014, Wasatch Front LiDAR elevation data: Online, Utah Automated Geographic Reference Center, State Geographic Information Database, https://gis.utah.gov/data/elevation-terrain-data/2013-2014-lidar/.



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UTAH
QUADRANGLE LOCATION

SCALE 1:24,000
1 0.5 0 1 MILE
5000 2500 0 5000 FEET
1 0.5 0 1 KILOMETER
CONTOUR INTERVAL 20 FEET

TRUE NORTH
MAGNETIC NORTH
11°34'
APPROXIMATE MEAN DECLINATION, 2018

Base from USGS Farmington 7.5' Quadrangle (2017)
Projection: UTM Zone 12 N
Datum: NAD 1983

Surficial fault mapping: Greg N. McDonald
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SURFACE FAULT RUPTURE HAZARD MAP OF THE FARMINGTON QUADRANGLE, DAVIS AND SALT LAKE COUNTIES, UTAH

by

Greg N. McDonald

2018

1	2	3
4		5
6	7	8

1. Clearfield
2. Kaysville
3. Peterson
4. Saltair NE
5. Bountiful Peak
6. Baileys Lake
7. Salt Lake City North
8. Fort Douglas

ADJOINING 7.5' QUADRANGLE NAMES

EXPLANATION

2013–2014 lidar extent: 0.5-meter Wasatch Front bare earth light detection and ranging (lidar) elevation data, available from the Utah Automated Geographic Reference Center and OpenTopography.

SURFACE FAULT RUPTURE HAZARD CATEGORIES

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USING THIS MAP

This map shows potentially active faults on the Farmington quadrangle along which surface faulting may occur and delineated special-study areas around those faults. Within each area, the UGS recommends a site-specific, surface-fault-rupture hazard investigation (such as fault trenching) be performed before development following the guidelines of Lund and others (2016). Site-specific geotechnical/geologic-hazard investigations can resolve uncertainties inherent in the generalized map scale and help ensure safety by identifying the need for and determine distances for fault setbacks from infrastructure. These investigations use the characteristics of past surface faulting at a site as a scientific basis for providing recommendations to reduce the risk for damage, injury, and/or death from future, presumably similar, surface faulting. Site-specific fault-trenching investigations should be preceded by a careful field evaluation of the site to identify the surface trace of the fault as well as other faults and fault-related features not evident at the mapped scale.

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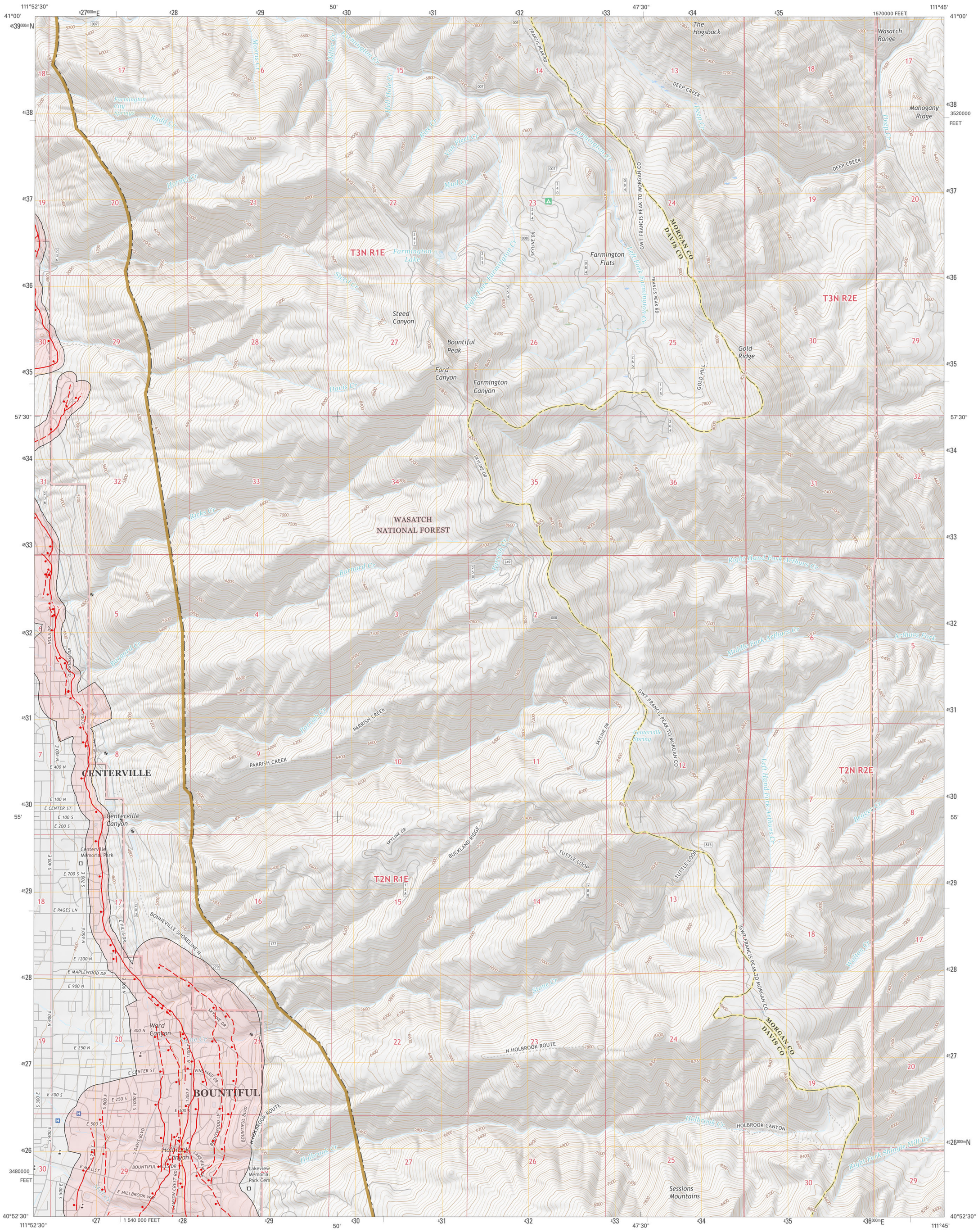

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U T A H
QUADRANGLE LOCATION

SCALE 1:24,000
1 0.5 0 1 MILE
5000 2500 0 5000 FEET
1 0.5 0 1 KILOMETER
CONTOUR INTERVAL 40 FEET

11°31'
TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 2018

Base from USGS Bountiful Peak 7.5' Quadrangle (2017)
Projection: UTM Zone 12 N
Datum: NAD 1983

Surficial fault mapping: Greg N. McDonald and Zach A. Anderson
GIS and Cartography: Gordon E. Douglass and Greg N. McDonald
Project Manager: Greg N. McDonald

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(801) 537-3300
geology.utah.gov

1	2	3
4		5
6	7	8

1. Kaysville
2. Peterson
3. Morgan
4. Farmington
5. Porterville
6. Salt Lake City North
7. Fort Douglas
8. Mountain Dell

ADJOINING 7.5' QUADRANGLE NAMES

SURFACE FAULT RUPTURE HAZARD MAP OF THE BOUNTIFUL PEAK QUADRANGLE, DAVIS AND MORGAN COUNTIES, UTAH

by

Greg N. McDonald and Zach A. Anderson

2018

EXPLANATION

2013–2014 lidar extent: 0.5-meter Wasatch Front bare earth light detection and ranging (lidar) elevation data, available from the Utah Automated Geographic Reference Center and OpenTopography.

SURFACE FAULT RUPTURE HAZARD CATEGORIES

Holocene-active fault (movement within the past 11,700 years) or suspected Holocene-active fault: Surface-fault-rupture hazard investigations recommended for all structures intended for human occupancy and all International Building Code (IBC; International Code Council, 2014) Risk Category IIa, IIb, III, and IV structures (see Lund and others, 2016). Ball and bar on downthrown side of fault. Solid line indicates well-defined fault trace, dashed line indicates moderately well defined fault trace, and dotted line indicates buried or inferred fault trace.

Late Quaternary-active fault (movement within the past 130,000 years) or suspected late Quaternary-active fault: Surface-fault-rupture hazard investigations recommended for all IBC Risk Category IIb, III, and IV structures (see Lund and others, 2016). Investigations for IBC Risk Category IIa and other structures for human occupancy remain prudent, but should be based on an assessment of whether risk-reduction measures are justified by weighing the probability of occurrence against the risk to lives and potential economic loss. Ball and bar on downthrown side of fault. Solid line indicates well-defined fault trace, dashed line indicates moderately well defined fault trace, and dotted line indicates buried or inferred fault trace. None currently mapped within this quadrangle.

Quaternary-active fault (movement within the past 2,600,000 years) or suspected Quaternary-active fault: Surface-fault-rupture hazard investigations recommended for all IBC Risk Category III and IV structures (see Lund and others, 2016). Investigations for IBC Risk Category IIb and other structures for human occupancy remain prudent because a low likelihood of surface faulting still exists. Ball and bar on downthrown side of fault. Solid line indicates well-defined fault trace, dashed line indicates moderately well defined fault trace, and dotted line indicates buried or inferred fault trace. None currently mapped within this quadrangle.

Other lineaments, unknown activity/source: Lineaments and traces mapped using lidar and other data. None currently mapped within this quadrangle.

Surface-fault-rupture hazard special-study area: For well-defined faults, special-study area extends 500 feet on the downthrown side and 250 feet on the upthrown side of each fault. For moderately well located or buried/inferred faults, special-study area extends 1000 feet on each side of the suspected trace of each fault (Lund and others, 2016). Refer to booklet for more details on special-study area designations.

USING THIS MAP

This map shows potentially active faults on the Bountiful Peak quadrangle along which surface faulting may occur and delineated special-study areas around those faults. Within each area, the UGS recommends a site-specific, surface-fault-rupture hazard investigation (such as fault trenching) be performed before development following the guidelines of Lund and others (2016). Site-specific geotechnical/geologic-hazard investigations can resolve uncertainties inherent in the generalized map scale and help ensure safety by identifying the need for and determine distances for fault setbacks from infrastructure. These investigations use the characteristics of past surface faulting at a site as a scientific basis for providing recommendations to reduce the risk for damage, injury, and/or death from future, presumably similar, surface faulting. Site-specific fault-trenching investigations should be preceded by a careful field evaluation of the site to identify the surface trace of the fault as well as other faults and fault-related features not evident at the mapped scale.

Aleatory (natural) variability in fault behavior cannot be reduced; therefore, predicting exactly when, where, and how much ground rupture will occur during future surface-faulting earthquakes is not possible. New faults may form, existing faults may propagate beyond their present lengths, elapsed time between individual surface-faulting earthquakes can vary by hundreds or thousands of years and be affected by clustering, triggering, and multi- or partial-segment ruptures. For these reasons, developing property in the vicinity of hazardous faults will always involve a level of irreducible, inherent risk. The special-study areas were delineated to account for much of the uncertainty in fault trace location and propagation.

This map is not intended for use at scales other than 1:24,000; it is our opinion that the inventory of potentially active faults shown on this map is likely complete at this scale where high-resolution lidar data are available. However, smaller faults may not have been detected during mapping (such as those with very small offset or surface warping) or are concealed beneath young geologic deposits. Bedrock faults having no documented Quaternary movement were not included, but could represent an unlikely source of surface-fault-rupture hazard. Additionally, concealed and approximately located faults by definition lack a clearly identifiable surface trace; therefore, their locations are approximate. Lidar-derived fault traces were mapped at 1:10,000 scale where possible; however, all traces are shown on this map at 1:24,000 scale.

We focused on mapping traces of the Wasatch fault zone and other nearby faults within the available high-resolution lidar elevation data. Additionally, we used 1970s low-sun-angle and oblique aerial photography from Woodward-Lundgren & Associates Wasatch fault investigations (Cluff and others, 1970; compiled in Bowman and others, 2015) supplemented by other aerial photography from the *UGS Aerial Imagery Collection* (https://geodata.geology.utah.gov/imagery/), and previous geologic and related mapping (Nelson and Personius, 1993; Anderson, in progress). Fault traces outside the available lidar extents are from the *Utah Quaternary Fault and Fold Database* (https://geology.utah.gov/apps/qfaults/). We encourage local governments to forward surface-fault-rupture hazard investigation reports they receive to the UGS so that fault mapping accuracy and detail for future maps can be improved. Additional information on earthquakes and other geologic hazards is available at https://geology.utah.gov/hazards/.

REFERENCES

Anderson, Z.W., *in progress*, Interim geologic map of the Bountiful Peak 7.5' quadrangle, Davis and Morgan Counties, Utah: Utah Geological Survey Open-File Report, scale 1:24,000.

Bowman, S.D., Hiscock, A.I., and Unger, C., 2015, Compilation of 1970s Woodward-Lundgren & Associates Wasatch fault investigation reports and low-sun-angle aerial photography, Wasatch Front and Cache Valley, Utah and Idaho: Utah Geological Survey Open-File Report 632, variously paginated, DVD.

Cluff, L., Brogan, G., and Glass, C., 1970, Wasatch fault, northern portion, earthquake fault investigation & evaluation, a guide to land use planning: Oakland, California, Woodward-Clyde and Associates, unpublished consultant's report for the Utah Geological and Mineralogical Survey, variously paginated.

International Code Council, 2014, International Building Code: Country Club Hills, Illinois, 700 p.

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Nelson, A.R., and Personius, S.F., 1993, Surficial geologic map of the Weber segment, Wasatch fault zone, Weber and Davis Counties, Utah: U.S. Geological Survey Miscellaneous Field Investigations Series Map I-2199, scale 1:50,000.

Utah Automated Geographic Reference Center, 2013–2014, Wasatch Front LiDAR elevation data: Online, Utah Automated Geographic Reference Center, State Geographic Information Database, https://gis.utah.gov/data/elevation-terrain-data/2013-2014-lidar/.

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This map is a plot of geographic information system (GIS) files created to visually represent the content of the GIS data files. This preliminary map contains features that do not meet UGS cartographic standards.

UTAH
QUADRANGLE LOCATION

SCALE 1:24,000
1 0.5 0 1 MILE
5000 2500 0 5000 FEET
1 0.5 0 1 KILOMETER
CONTOUR INTERVAL 5 FEET

TRUE NORTH
MAGNETIC NORTH
11°25'
APPROXIMATE MEAN DECLINATION, 2018

Base from USGS Baileys Lake 7.5' Quadrangle (2017)
Projection: UTM Zone 12 N
Datum: NAD 1983

Surficial fault mapping: Adam P. McKean and Michael D. Hylland
GIS and Cartography: Gordon E. Douglass and Adam I. Hiscock
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SURFACE FAULT RUPTURE HAZARD MAP OF THE BAILEYS LAKE QUADRANGLE, SALT LAKE AND DAVIS COUNTIES, UTAH

by

Adam I. Hiscock, Adam P. McKean, and Michael D. Hylland

2018

1	2	3
4		5
6	7	8

1. Antelope Island
2. Saltair NE
3. Farmington
4. Antelope Island South
5. Salt Lake City North
6. Farnsworth Peak
7. Magna
8. Salt Lake City South

ADJOINING 7.5' QUADRANGLE NAMES

EXPLANATION

2013–2014 lidar extent: 0.5-meter Wasatch Front bare earth light detection and ranging (lidar) elevation data, available from the Utah Automated Geographic Reference Center and OpenTopography.

SURFACE FAULT RUPTURE HAZARD CATEGORIES

Holocene-active fault (movement within the past 11,700 years) or suspected Holocene-active fault: Surface-fault-rupture hazard investigations recommended for all structures intended for human occupancy and all International Building Code (IBC; International Code Council, 2014) Risk Category IIa, IIb, III, and IV structures (see Lund and others, 2016). Ball and bar on downthrown side of fault. Solid line indicates well-defined fault trace, dashed line indicates moderately well defined fault trace, and dotted line indicates buried or inferred fault trace, queried where uncertain.

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Quaternary-active fault (movement within the past 2,600,000 years) or suspected Quaternary-active fault: Surface-fault-rupture hazard investigations recommended for all IBC Risk Category III and IV structures (see Lund and others, 2016). Investigations for IBC Risk Category IIb and other structures for human occupancy remain prudent because a low likelihood of surface faulting still exists. Ball and bar on downthrown side of fault. Solid line indicates well-defined fault trace, dashed line indicates moderately well defined fault trace, and dotted line indicates buried or inferred fault trace, queried where uncertain. None currently mapped within this quadrangle.

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USING THIS MAP

This map shows potentially active faults in the Baileys Lake quadrangle along which surface faulting may occur and delineated special-study areas around those faults. Within each area, the UGS recommends a site-specific, surface-fault-rupture hazard investigation (such as fault trenching) be performed before development following the guidelines of Lund and others (2016). Site-specific geotechnical/geologic-hazard investigations can resolve uncertainties inherent in the generalized map scale and help ensure safety by identifying the need for and determine distances for fault setbacks from infrastructure. These investigations use the characteristics of past surface faulting at a site as a scientific basis for providing recommendations to reduce the risk for damage, injury, and/or death from future, presumably similar, surface faulting. Site-specific fault-trenching investigations should be preceded by a careful field evaluation of the site to identify the surface trace of the fault as well as other faults and fault-related features not evident at the mapped scale.

Aleatory (natural) variability in fault behavior cannot be reduced; therefore, predicting exactly when, where, and how much ground rupture will occur during future surface-faulting earthquakes is not possible. New faults may form, existing faults may propagate beyond their present lengths, elapsed time between individual surface-faulting earthquakes can vary by hundreds or thousands of years and be affected by clustering, triggering, and multi- or partial-segment ruptures. For these reasons, developing property in the vicinity of hazardous faults will always involve a level of irreducible, inherent risk. The special-study areas were delineated to account for much of the uncertainty in fault trace location and propagation.

This map is not intended for use at scales other than 1:24,000; it is our opinion that the inventory of potentially active faults shown on this map is likely complete at this scale where high-resolution lidar data are available. However, smaller faults may not have been detected during mapping (such as those with very small offset or surface warping) or are concealed beneath young geologic deposits. Bedrock faults having no documented Quaternary movement were not included, but could represent an unlikely source of surface-fault-rupture hazard. Additionally, concealed and approximately located faults by definition lack a clearly identifiable surface trace; therefore, their locations are approximate. Fault traces were mapped at 1:24,000 scale where possible.

We focused on mapping traces of the Wasatch fault zone and other nearby faults within the available high-resolution lidar elevation data. Additionally, we used aerial photography from the *UGS Aerial Imagery Collection* (https://geodata.geology.utah.gov/imagery/), and previous geologic and related mapping (Personius and Scott, 1992; McKean and Hylland, 2013). Fault traces outside the available lidar extents are from the *Utah Quaternary Fault and Fold Database* (https://geology.utah.gov/apps/qfaults/). We encourage local governments to forward surface-fault-rupture hazard investigation reports they receive to the UGS so that fault mapping accuracy and detail for future maps can be improved. Additional information on earthquakes and other geologic hazards is available at https://geology.utah.gov/hazards/.

REFERENCES

International Code Council, 2014, International Building Code: Country Club Hills, Illinois, 700 p.

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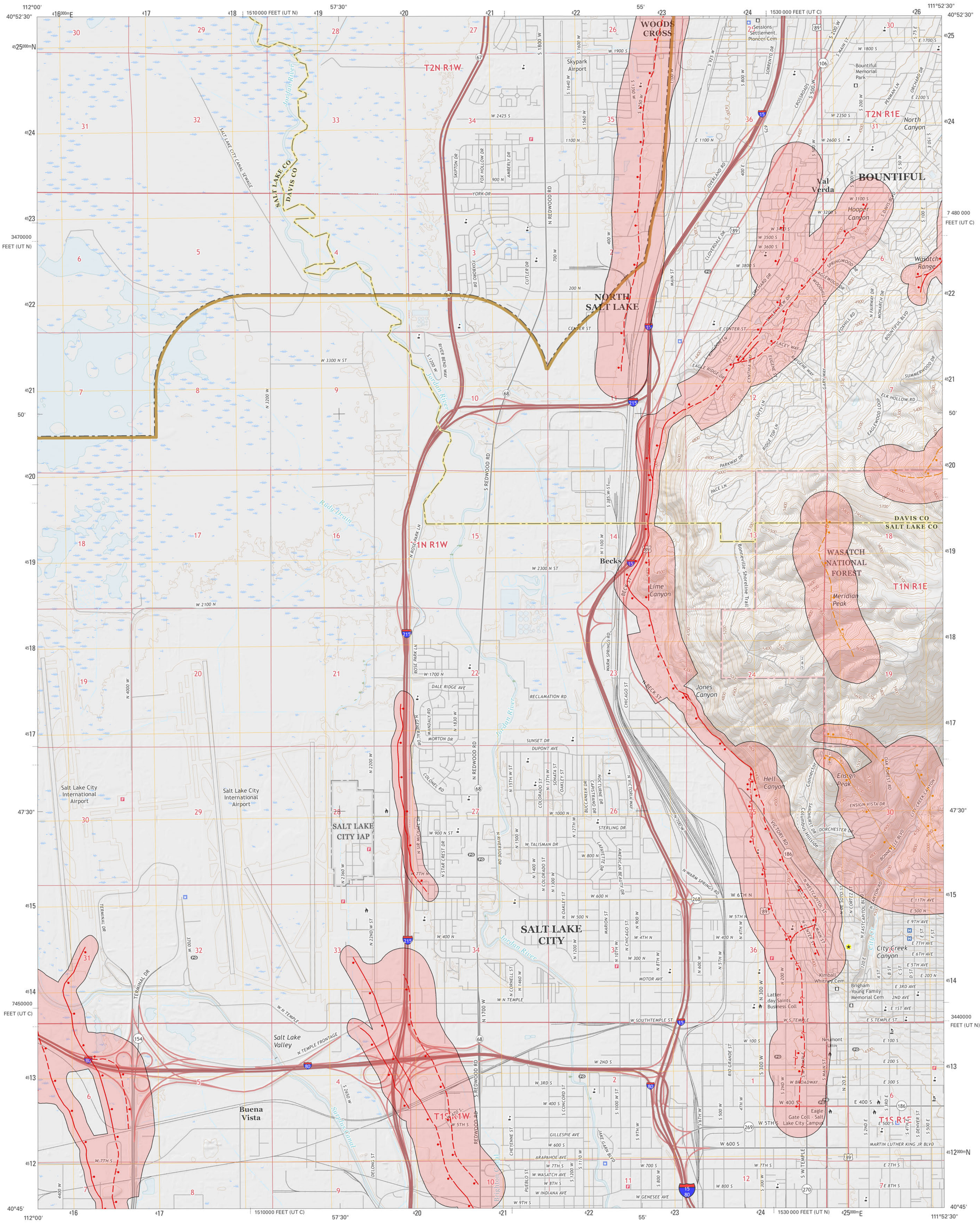
McKean, A.P., and Hylland, M.D., 2013, Interim geologic map of the Baileys Lake quadrangle, Salt Lake and Davis Counties, Utah: Utah Geological Survey Open-File Report 624, 17 p., 1 plate, scale 1:24,000.

Personius, S.F., and Scott, W.E., 1992, Surficial geologic map of the Salt Lake City segment and parts of adjacent segments of the Wasatch fault zone, Davis, Salt Lake, and Utah Counties, Utah: U.S. Geological Survey Miscellaneous Investigations Series Map I-2106, scale 1:50,000.

Utah Automated Geographic Reference Center, 2013–2014, Wasatch Front LiDAR elevation data: Online, Utah Automated Geographic Reference Center, State Geographic Information Database, https://gis.utah.gov/data/elevation-terrain-data/2013-2014-lidar/.



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UTAH
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SCALE 1:24,000
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CONTOUR INTERVAL 20 FEET

TRUE NORTH
MAGNETIC NORTH
11°25'
APPROXIMATE MEAN DECLINATION, 2018

Base from USGS Salt Lake City North 7.5' Quadrangle (2017)
Projection: UTM Zone 12 N
Datum: NAD 1983

Surficial fault mapping: Adam P. McKean
GIS and Cartography: Gordon E. Douglass, Adam I. Hiscock, and Adam P. McKean
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SURFACE FAULT RUPTURE HAZARD MAP OF THE SALT LAKE CITY NORTH QUADRANGLE, SALT LAKE AND DAVIS COUNTIES, UTAH

by

Adam I. Hiscock and Adam P. McKean

2018

1	2	3
4		5
6	7	8

1. Saltair NE
2. Farmington
3. Bountiful Peak
4. Baileys Lake
5. Fort Douglass
6. Magna
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8. Sugar House

ADJOINING 7.5' QUADRANGLE NAMES

EXPLANATION

2013–2014 lidar extent: 0.5-meter Wasatch Front bare earth light detection and ranging (lidar) elevation data, available from the Utah Automated Geographic Reference Center and OpenTopography.

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Holocene-active fault (movement within the past 11,700 years) or suspected Holocene-active fault: Surface-fault-rupture hazard investigations recommended for all structures intended for human occupancy and all International Building Code (IBC; International Code Council, 2014) Risk Category IIa, IIb, III, and IV structures (see Lund and others, 2016). Ball and bar on downthrown side of fault. Solid line indicates well-defined fault trace, dashed line indicates moderately well defined fault trace, and dotted line indicates buried or inferred fault trace, queried where uncertain.

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USING THIS MAP

This map shows potentially active faults in the Salt Lake City North quadrangle along which surface faulting may occur and delineated special-study areas around those faults. Within each area, the UGS recommends a site-specific, surface-fault-rupture hazard investigation (such as fault trenching) be performed before development following the guidelines of Lund and others (2016). Site-specific geotechnical/geologic-hazard investigations can resolve uncertainties inherent in the generalized map scale and help ensure safety by identifying the need for and determine distances for fault setbacks from infrastructure. These investigations use the characteristics of past surface faulting at a site as a scientific basis for providing recommendations to reduce the risk for damage, injury, and/or death from future, presumably similar, surface faulting. Site-specific fault-trenching investigations should be preceded by a careful field evaluation of the site to identify the surface trace of the fault as well as other faults and fault-related features not evident at the mapped scale.

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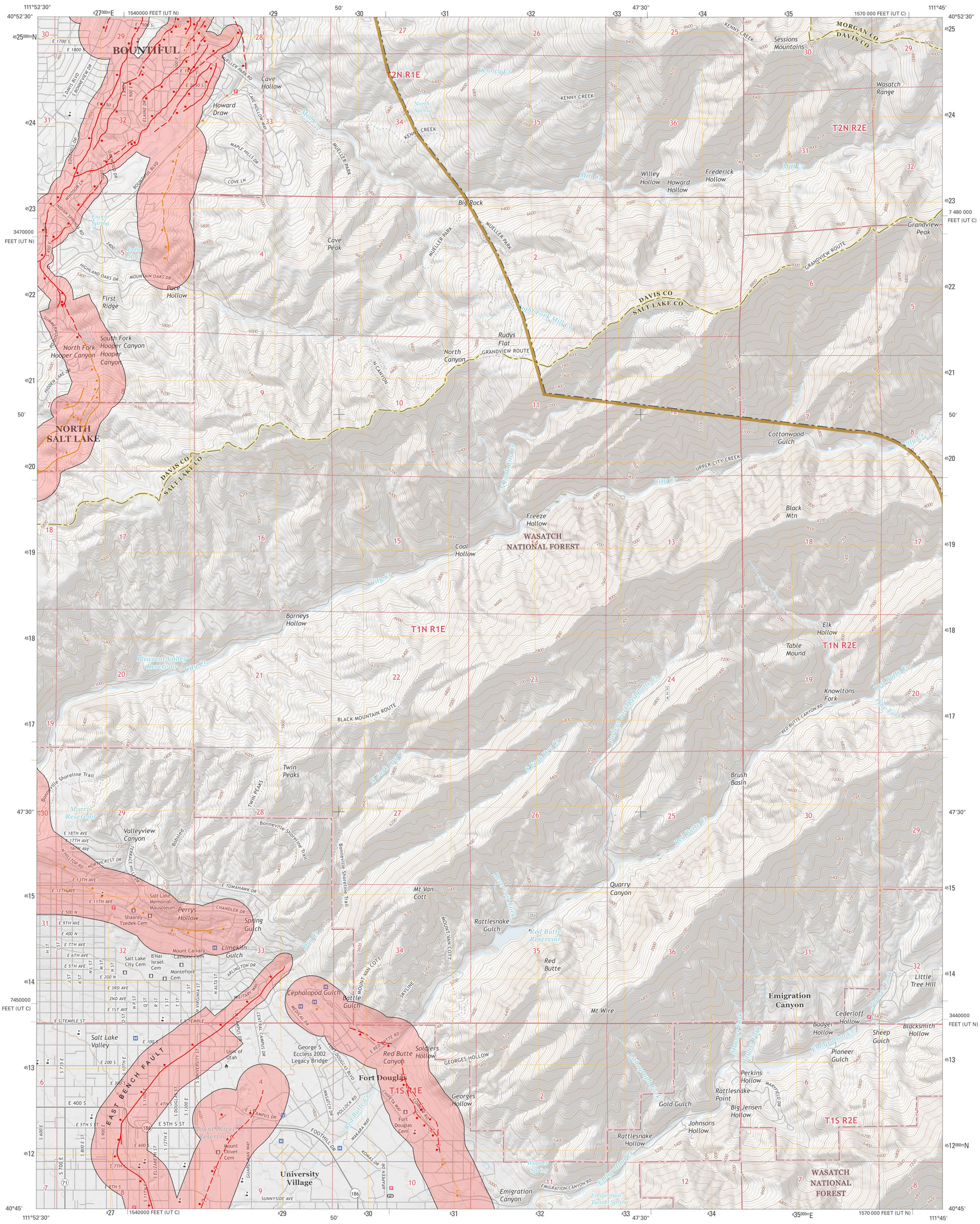

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U T A H

QUADRANGLE LOCATION

SCALE 1:24,000

1 0.5 0 1 MILE

5000 2500 0 5000 FEET

1 0.5 0 1 KILOMETER

CONTOUR INTERVAL 40 FEET

11°39'
TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 2018

Base from USGS Fort Douglas 7.5' Quadrangle (2017)
Projection: UTM Zone 12 N
Datum: NAD 1983

Surficial fault mapping: Zach A. Anderson, Adam P. McKean and Greg N. McDonald
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by

Greg N. McDonald, Zach W. Anderson, Adam P. McKean, and Adam I. Hiscock

2018

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SURFACE FAULT RUPTURE HAZARD CATEGORIES

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Late Quaternary-active fault (movement within the past 130,000 years) or suspected late Quaternary-active fault: Surface-fault-rupture hazard investigations recommended for all IBC Risk Category IIb, III, and IV structures (see Lund and others, 2016). Investigations for IBC Risk Category IIa and other structures for human occupancy remain prudent, but should be based on an assessment of whether risk-reduction measures are justified by weighing the probability of occurrence against the risk to lives and potential economic loss. Ball and bar on downthrown side of fault. Solid line indicates well-defined fault trace, dashed line indicates moderately well defined fault trace, and dotted line indicates buried or inferred fault trace, queried where uncertain.

Quaternary-active fault (movement within the past 2,600,000 years) or suspected Quaternary-active fault: Surface-fault-rupture hazard investigations recommended for all IBC Risk Category III and IV structures (see Lund and others, 2016). Investigations for IBC Risk Category IIb and other structures for human occupancy remain prudent because a low likelihood of surface faulting still exists. Ball and bar on downthrown side of fault. Solid line indicates well-defined fault trace, dashed line indicates moderately well defined fault trace, and dotted line indicates buried or inferred fault trace, queried where uncertain. None currently mapped within this quadrangle.

Other lineaments, unknown activity/source: Lineaments and traces mapped using lidar and other data. None currently mapped within this quadrangle.

Surface-fault-rupture hazard special-study area: For well-defined faults, special-study area extends 500 feet on the downthrown side and 250 feet on the upthrown side of each fault. For moderately well located or buried/inferred faults, special-study area extends 1000 feet on each side of the suspected trace of each fault (Lund and others, 2016). Due to the height of the East Bench fault scarp (labeled on map), the special-study area extends for 1000 feet on each side of the fault trace. Refer to booklet for more details on special-study area designations.

USING THIS MAP

This map shows potentially active faults in the Fort Douglas quadrangle along which surface faulting may occur and delineated special-study areas around those faults. Within each area, the UGS recommends a site-specific, surface-fault-rupture hazard investigation (such as fault trenching) be performed before development following the guidelines of Lund and others (2016). Site-specific geotechnical/geologic-hazard investigations can resolve uncertainties inherent in the generalized map scale and help ensure safety by identifying the need for and determine distances for fault setbacks from infrastructure. These investigations use the characteristics of past surface faulting at a site as a scientific basis for providing recommendations to reduce the risk for damage, injury, and/or death from future, presumably similar, surface faulting. Site-specific fault-trenching investigations should be preceded by a careful field evaluation of the site to identify the surface trace of the fault as well as other faults and fault-related features not evident at the mapped scale.

Aleatory (natural) variability in fault behavior cannot be reduced; therefore, predicting exactly when, where, and how much ground rupture will occur during future surface-faulting earthquakes is not possible. New faults may form, existing faults may propagate beyond their present lengths, elapsed time between individual surface-faulting earthquakes can vary by hundreds or thousands of years and be affected by clustering, triggering, and multi- or partial-segment ruptures. For these reasons, developing property in the vicinity of hazardous faults will always involve a level of irreducible, inherent risk. The special-study areas were delineated to account for much of the uncertainty in fault trace location and propagation.

This map is not intended for use at scales other than 1:24,000; it is our opinion that the inventory of potentially active faults shown on this map is likely complete at this scale where high-resolution lidar data are available. However, smaller faults may not have been detected during mapping (such as those with very small offset or surface warping) or are concealed beneath young geologic deposits. Bedrock faults having no documented Quaternary movement were not included, but could represent an unlikely source of surface-fault-rupture hazard. Additionally, concealed and approximately located faults by definition lack a clearly identifiable surface trace; therefore, their locations are approximate. Fault traces were mapped at 1:24,000 scale where possible.

We focused on mapping traces of the Wasatch fault zone and other nearby faults within the available high-resolution lidar elevation data. Additionally, we used 1970s low-sun-angle and oblique aerial photography from Woodward-Lundgren & Associates Wasatch fault investigations (Cluff and others, 1970; compiled in Bowman and others, 2015) supplemented by other aerial photography from the *UGS Aerial Imagery Collection* (https://geodata.geology.utah.gov/imagery/), and previous geologic and related mapping (VanHorn and Crittenden, 1987; Personius and Scott, 1992; and Anderson and others, in preparation). Fault traces outside the available lidar extents are from the *Utah Quaternary Fault and Fold Database* (https://geology.utah.gov/apps/qfaults/). We encourage local governments to forward surface-fault-rupture hazard investigation reports they receive to the UGS so that fault mapping accuracy and detail for future maps can be improved. Additional information on earthquakes and other geologic hazards is available at https://geology.utah.gov/hazards/.

REFERENCES

Anderson, Z.W., McKean, A.P., and Yonkee, W.A., in preparation, Interim geologic map of the Fort Douglas quadrangle, Salt Lake and Davis Counties, Utah: Utah Geological Survey Open-File Report, booklet, scale 1:24,000.

Bowman, S.D., Hiscock, A.I., and Unger, C., 2015, Compilation of 1970s Woodward-Lundgren & Associates Wasatch fault investigation reports and low-sun-angle aerial photography, Wasatch Front and Cache Valley, Utah and Idaho: Utah Geological Survey Open-File Report 632, variously paginated, DVD.

Cluff, L., Brogran, G., and Glass, C., 1970, Wasatch fault, northern portion, earthquake fault investigation & evaluation, a guide to land use planning: Oakland, California, Woodward-Clyde and Associates, unpublished consultant's report for the Utah Geological and Mineralogical Survey, variously paginated.

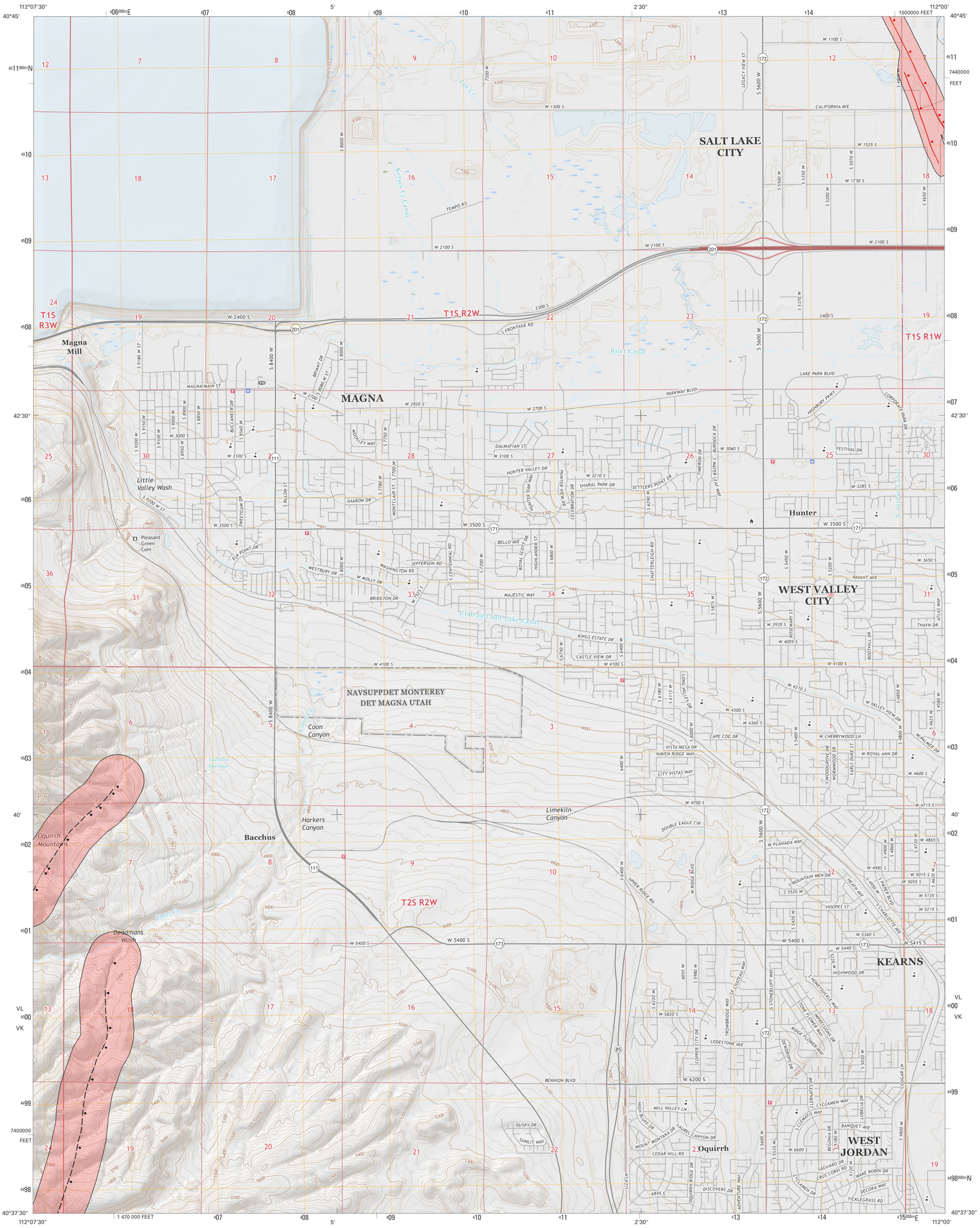
International Code Council, 2014, International Building Code: Country Club Hills, Illinois, 700 p.

Lund, W.R., Christenson, G.E., Batatian, L.D., and Nelson, C.V., 2016, Guidelines for evaluating surface-fault-rupture hazards in Utah, *in* Bowman, S.D., and Lund, W.R., editors, Guidelines for investigating geologic hazards and preparing engineering geology reports, with a suggested approach to geologic-hazard ordinances in Utah: Utah Geological Survey Circular 122, p. 31–53.

Personius, S.F., and Scott, W.E., 1992, Surficial geologic map of the Salt Lake City segment and parts of adjacent segments of the Wasatch fault zone, Davis, Salt Lake, and Utah Counties, Utah: U.S. Geological Survey Miscellaneous Investigations Series Map I-2106, scale 1:50,000.

Utah Automated Geographic Reference Center, 2013–2014, Wasatch Front LiDAR elevation data: Online, Utah Automated Geographic Reference Center, State Geographic Information Database, https://gis.utah.gov/data/elevation-terrain-data/2013-2014-lidar/.

Van Horn, R., and Crittenden, M.J., Jr., 1987, Map showing surficial units and bedrock geology of the Fort Douglas quadrangle and parts of the Mountain Dell and Salt Lake City North quadrangles, Davis, Salt Lake, Morgan Counties, Utah: U.S. Geological Survey Miscellaneous Investigations Series Map I-1762, scale 1:24,000.



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This map is a plot of geographic information system (GIS) files created to visually represent the content of the GIS data files. This preliminary map contains features that do not meet UGS cartographic standards.

U T A H
QUADRANGLE LOCATION

SCALE 1:24,000
1 0.5 0 1 MILE
5000 2500 0 5000 FEET
1 0.5 0 1 KILOMETER
CONTOUR INTERVAL 20 FEET

TRUE NORTH
MAGNETIC NORTH
11°26'
APPROXIMATE MEAN DECLINATION, 2018

Base from USGS Magna 7.5' Quadrangle (2017)
Projection: UTM Zone 12
Datum: NAD 1983

Surficial fault mapping: Barry J. Solomon
GIS and Cartography: Jessica J. Castleton, Adam I. Hiscock, and Gordon E. Douglass
Project Manager: Greg N. McDonald

Utah Geological Survey
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(801) 537-3300
geology.utah.gov

SURFACE FAULT RUPTURE HAZARD MAP OF THE MAGNA QUADRANGLE, SALT LAKE COUNTY, UTAH

by

Adam I. Hiscock and Jessica J. Castleton

2018

1	2	3
4		5
6	7	8

1. Antelope Island South
2. Baileys Lake
3. Salt Lake City North
4. Farnsworth Peak
5. Salt Lake City South
6. Bingham Canyon
7. Copperton
8. Midvale

ADJOINING 7.5' QUADRANGLE NAMES

EXPLANATION

2013–2014 lidar extent: 0.5-meter Wasatch Front bare earth light detection and ranging (lidar) elevation data, available from the Utah Automated Geographic Reference Center and OpenTopography. Entire Magna quadrangle contained within lidar extent.

SURFACE FAULT RUPTURE HAZARD CATEGORIES

Holocene-active fault (movement within the past 11,700 years) or suspected Holocene-active fault: Surface-fault-rupture hazard investigations recommended for all structures intended for human occupancy and all International Building Code (IBC; International Code Council, 2014) Risk Category IIa, IIb, III, and IV structures (see Lund and others, 2016). Ball and bar on downthrown side of fault. Solid line indicates well-defined fault trace, dashed line indicates moderately well defined fault trace, and dotted line indicates buried or inferred fault trace, queried where uncertain.

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Surface-fault-rupture hazard special-study area: For well-defined faults, special-study area extends 500 feet on the downthrown side and 250 feet on the upthrown side of each fault. For moderately well located or buried/inferred faults, special-study area extends 1000 feet on each side of the suspected trace of each fault (Lund and others, 2016). Refer to booklet for more details on special-study area designations.

USING THIS MAP

This map shows potentially active faults in the Magna quadrangle along which surface faulting may occur and delineated special-study areas around those faults. Within each area, the UGS recommends a site-specific, surface-fault-rupture hazard investigation (such as fault trenching) be performed before development following the guidelines of Lund and others (2016). Site-specific geotechnical/geologic-hazard investigations can resolve uncertainties inherent in the generalized map scale and help ensure safety by identifying the need for and determine distances for fault setbacks from infrastructure. These investigations use the characteristics of past surface faulting at a site as a scientific basis for providing recommendations to reduce the risk for damage, injury, and/or death from future, presumably similar, surface faulting. Site-specific fault-trenching investigations should be preceded by a careful field evaluation of the site to identify the surface trace of the fault as well as other faults and fault-related features not evident at the mapped scale.

Aleatory (natural) variability in fault behavior cannot be reduced; therefore, predicting exactly when, where, and how much ground rupture will occur during future surface-faulting earthquakes is not possible. New faults may form, existing faults may propagate beyond their present lengths, elapsed time between individual surface-faulting earthquakes can vary by hundreds or thousands of years and be affected by clustering, triggering, and multi- or partial-segment ruptures. For these reasons, developing property in the vicinity of hazardous faults will always involve a level of irreducible, inherent risk. The special-study areas were delineated to account for much of the uncertainty in fault trace location and propagation.

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We focused on mapping traces of the Wasatch fault zone and other nearby faults within the available high-resolution lidar elevation data. Additionally we used aerial photography from the *UGS Aerial Imagery Collection* (https://geodata.geology.utah.gov/imagery/), and previous geologic and related mapping (Solomon and others, 2007; Castleton and others, 2011). Fault traces outside the available lidar extents are from the *Utah Quaternary Fault and Fold Database* (https://geology.utah.gov/apps/qfaults/). We encourage local governments to forward surface-fault-rupture hazard investigation reports they receive to the UGS so that fault mapping accuracy and detail for future maps can be improved. Additional information on earthquakes and other geologic hazards is available at https://geology.utah.gov/hazards/.

REFERENCES

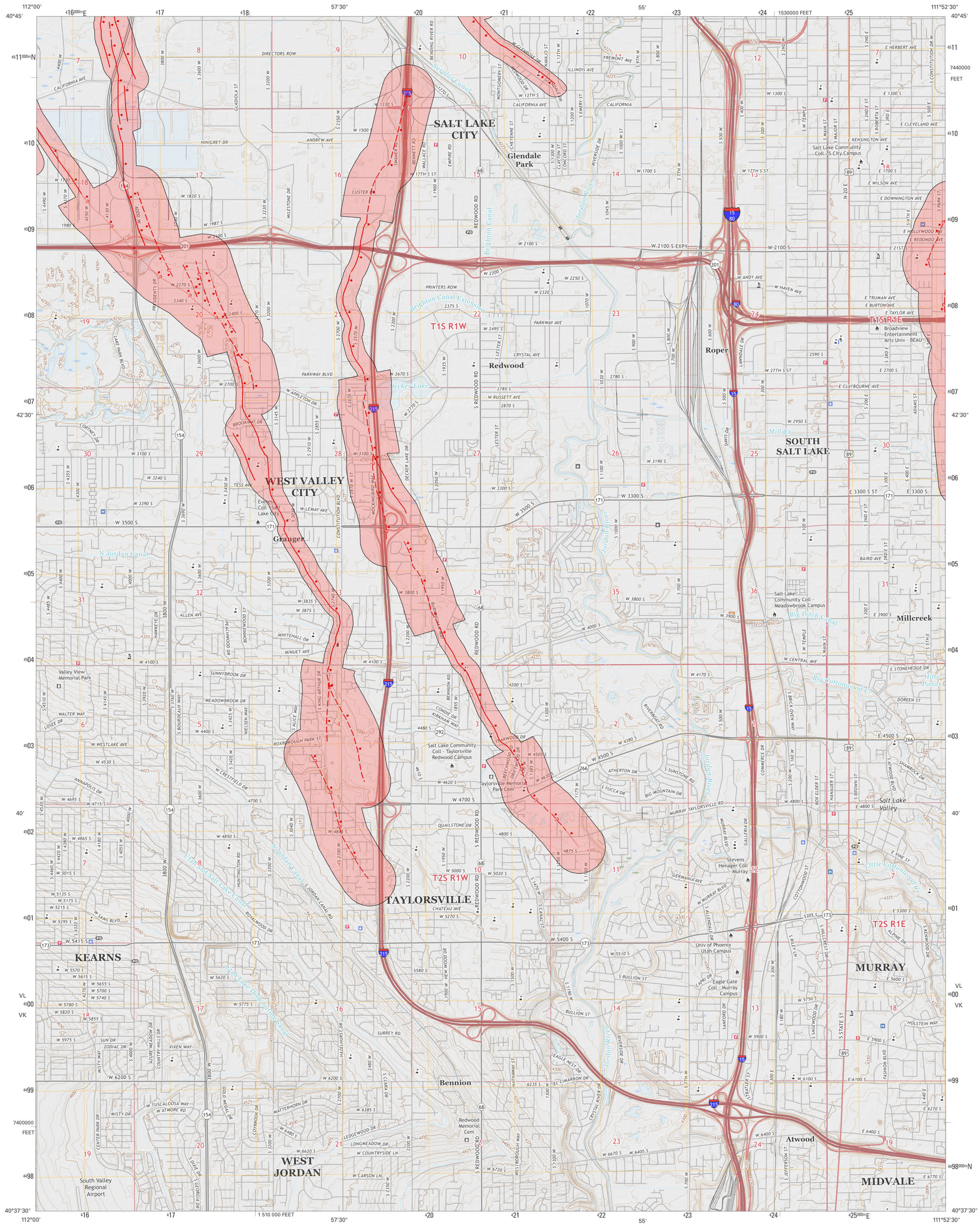
Castleton, J.J., Elliott, A.H., and McDonald, G.N., 2011, Geologic Hazards of the Magna quadrangle, Salt Lake County, Utah: Utah Geological Survey Special Study 137, scale 1:24,000, 8 pl.

International Code Council, 2014, International Building Code: Country Club Hills, Illinois, 700 p.

Lund, W.R., Christenson, G.E., Batatian, L.D., and Nelson, C.V., 2016, Guidelines for evaluating surface-fault-rupture hazards in Utah, *in* Bowman, S.D., and Lund, W.R., editors, Guidelines for investigating geologic hazards and preparing engineering geology reports, with a suggested approach to geologic-hazard ordinances in Utah: Utah Geological Survey Circular 122, p. 31–53.

Solomon, B.J., Biek, R.F., and Smith, T.W., 2007, Geologic map of the Magna quadrangle, Salt Lake County, Utah: Utah Geological Survey Map 216, scale 1:24,000.

Utah Automated Geographic Reference Center, 2013–2014, Wasatch Front LiDAR elevation data: Online, Utah Automated Geographic Reference Center, State Geographic Information Database, https://gis.utah.gov/data/elevation-terrain-data/2013-2014-lidar/.



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This map is a plot of geographic information system (GIS) files created to visually represent the content of the GIS data files. This preliminary map contains features that do not meet UGS cartographic standards.

UTAH
QUADRANGLE LOCATION

SCALE 1:24,000
1 0.5 0 1 MILE
5000 2500 0 5000 FEET
1 0.5 0 1 KILOMETER
CONTOUR INTERVAL 5 FEET

TRUE NORTH
MAGNETIC NORTH
11°25'
APPROXIMATE MEAN DECLINATION, 2018

Base from USGS Salt Lake City Ssouth 7.5' Quadrangle (2017)
Projection: UTM Zone 12 N
Datum: NAD 1983

Surficial fault mapping: Adam P. McKean
GIS and Cartography: Gordon E. Douglass, Adam I. Hiscock, and Adam P. McKean
Project Manager: Greg N. McDonald

Utah Geological Survey
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P.O. Box 146100, Salt Lake City, UT 84114-6100
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geology.utah.gov

SURFACE FAULT RUPTURE HAZARD MAP OF THE SALT LAKE CITY SOUTH QUADRANGLE, SALT LAKE COUNTY, UTAH

by

Adam I. Hiscock and Adam P. McKean

2018

1	2	3
4		5
6	7	8

1. Baileys Lake
2. Salt Lake City North
3. Fort Douglas
4. Magna
5. Sugar House
6. Copperton
7. Midvale
8. Draper

ADJOINING 7.5' QUADRANGLE NAMES

EXPLANATION

2013–2014 lidar extent: 0.5-meter Wasatch Front bare earth light detection and ranging (lidar) elevation data, available from the Utah Automated Geographic Reference Center and OpenTopography. Entire Salt Lake City South quadrangle contained within lidar extent.

SURFACE FAULT RUPTURE HAZARD CATEGORIES

Holocene-active fault (movement within the past 11,700 years) or suspected Holocene-active fault: Surface-fault-rupture hazard investigations recommended for all structures intended for human occupancy and all International Building Code (IBC; International Code Council, 2014) Risk Category IIa, IIb, III, and IV structures (see Lund and others, 2016). Ball and bar on downthrown side of fault. Solid line indicates well-defined fault trace, dashed line indicates moderately well defined fault trace, and dotted line indicates buried or inferred fault trace, queried where uncertain.

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USING THIS MAP

This map shows potentially active faults in the Salt Lake City South quadrangle along which surface faulting may occur and delineated special-study areas around those faults. Within each area, the UGS recommends a site-specific, surface-fault-rupture hazard investigation (such as fault trenching) be performed before development following the guidelines of Lund and others (2016). Site-specific geotechnical/geologic-hazard investigations can resolve uncertainties inherent in the generalized map scale and help ensure safety by identifying the need for and determine distances for fault setbacks from infrastructure. These investigations use the characteristics of past surface faulting at a site as a scientific basis for providing recommendations to reduce the risk for damage, injury, and/or death from future, presumably similar, surface faulting. Site-specific fault-trenching investigations should be preceded by a careful field evaluation of the site to identify the surface trace of the fault as well as other faults and fault-related features not evident at the mapped scale.

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McKean, A.P., 2017, Interim geologic map of the Salt Lake City South quadrangle, Salt Lake County, Utah: Utah Geological Survey Open-File Report 676, 17 p., 1 plate, scale 1:24,000.

Personius, S.F., and Scott, W.E., 1992, Surficial geologic map of the Salt Lake City segment and parts of adjacent segments of the Wasatch fault zone, Davis, Salt Lake, and Utah Counties, Utah: U.S. Geological Survey Miscellaneous Investigations Series Map I-2106, scale 1:50,000.

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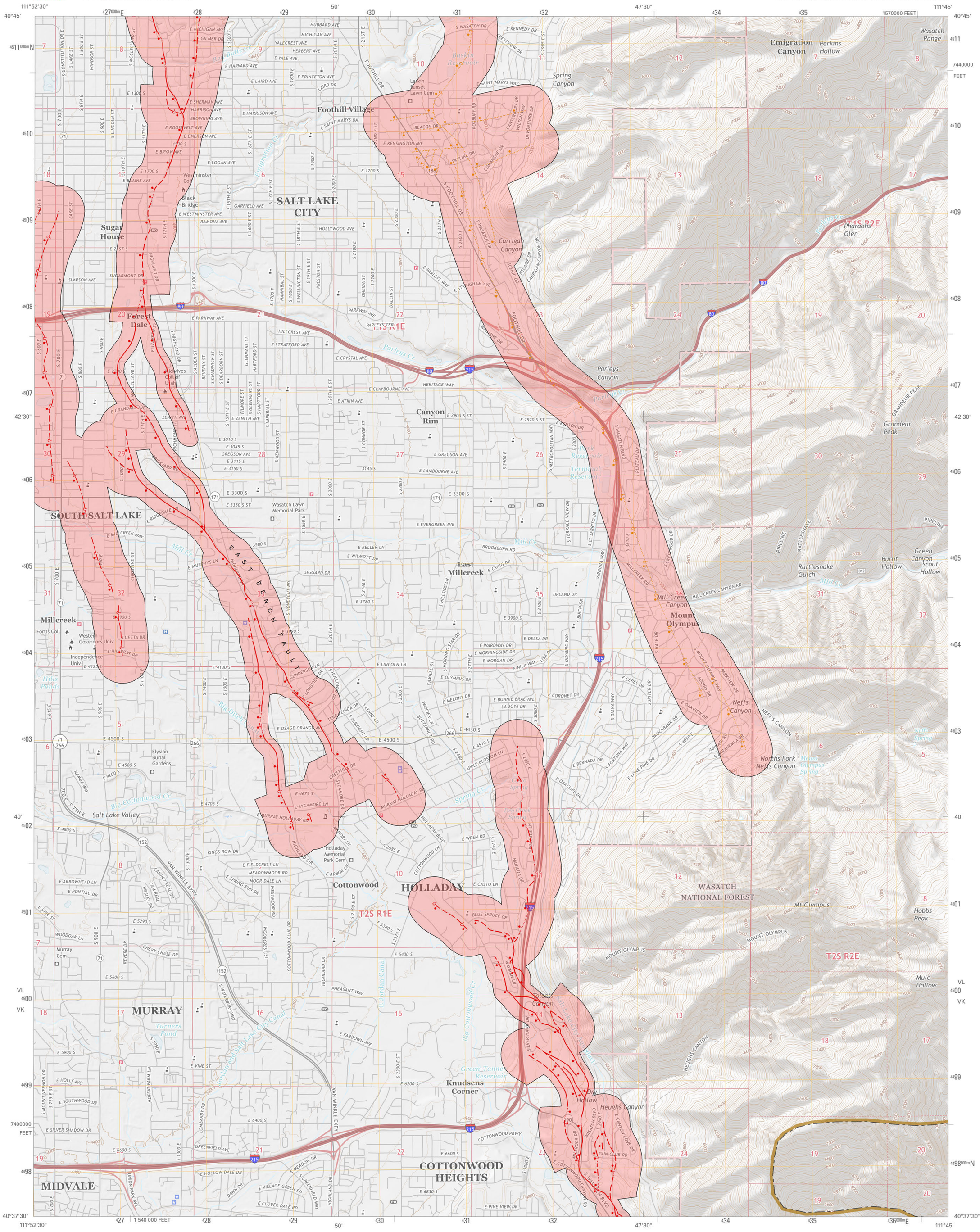

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UTAH
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5000 2500 0 5000 FEET
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CONTOUR INTERVAL 40 FEET

TRUE NORTH
MAGNETIC NORTH
11°20'
APPROXIMATE MEAN DECLINATION, 2018

Base from USGS Sugar House 7.5' Quadrangle (2017)
Projection: UTM Zone 12 N
Datum: NAD 1983

Surficial fault mapping: Adam P. McKean
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1	2	3
4		5
6	7	8

1. Farmington
2. Bountiful Peak
3. Porterville
4. Salt Lake City North
5. Mountain Dell
6. Salt Lake City South
7. Sugar House
8. Mount Aire

ADJOINING 7.5' QUADRANGLE NAMES

SURFACE FAULT RUPTURE HAZARD MAP OF THE SUGAR HOUSE QUADRANGLE, SALT LAKE COUNTY, UTAH

by

Adam I. Hiscock and Adam P. McKean

2018

EXPLANATION

2013–2014 lidar extent: 0.5-meter Wasatch Front bare earth light detection and ranging (lidar) elevation data, available from the Utah Automated Geographic Reference Center and OpenTopography.

SURFACE FAULT RUPTURE HAZARD CATEGORIES

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Late Quaternary-active fault (movement within the past 130,000 years) or suspected late Quaternary-active fault: Surface-fault-rupture hazard investigations recommended for all IBC Risk Category IIb, III, and IV structures (see Lund and others, 2016). Investigations for IBC Risk Category IIa and other structures for human occupancy remain prudent, but should be based on an assessment of whether risk-reduction measures are justified by weighing the probability of occurrence against the risk to lives and potential economic loss. Ball and bar on downthrown side of fault. Solid line indicates well-defined fault trace, dashed line indicates moderately well defined fault trace, and dotted line indicates buried or inferred fault trace, queried where uncertain.

Quaternary-active fault (movement within the past 2,600,000 years) or suspected Quaternary-active fault: Surface-fault-rupture hazard investigations recommended for all IBC Risk Category III and IV structures (see Lund and others, 2016). Investigations for IBC Risk Category IIb and other structures for human occupancy remain prudent because a low likelihood of surface faulting still exists. Ball and bar on downthrown side of fault. Solid line indicates well-defined fault trace, dashed line indicates moderately well defined fault trace, and dotted line indicates buried or inferred fault trace, queried where uncertain. None currently mapped within this quadrangle.

Other lineaments, unknown activity/source: Lineaments and traces mapped using lidar and other data. None currently mapped within this quadrangle.

Surface-fault-rupture hazard special-study area: For well-defined faults, special-study area extends 500 feet on the downthrown side and 250 feet on the upthrown side of each fault. For moderately well located or buried/inferred faults, special-study area extends 1000 feet on each side of the suspected trace of each fault (Lund and others, 2016). Due to the height of the East Bench fault scarp (labeled on map), the special-study area extends for 1000 feet on each side of the fault trace. Refer to booklet for more details on special-study area designations.

USING THIS MAP

This map shows potentially active faults in the Sugar House quadrangle along which surface faulting may occur and delineated special-study areas around those faults. Within each area, the UGS recommends a site-specific, surface-fault-rupture hazard investigation (such as fault trenching) be performed before development following the guidelines of Lund and others (2016). Site-specific geotechnical/geologic-hazard investigations can resolve uncertainties inherent in the generalized map scale and help ensure safety by identifying the need for and determine distances for fault setbacks from infrastructure. These investigations use the characteristics of past surface faulting at a site as a scientific basis for providing recommendations to reduce the risk for damage, injury, and/or death from future, presumably similar, surface faulting. Site-specific fault-trenching investigations should be preceded by a careful field evaluation of the site to identify the surface trace of the fault as well as other faults and fault-related features not evident at the mapped scale.

Aleatory (natural) variability in fault behavior cannot be reduced; therefore, predicting exactly when, where, and how much ground rupture will occur during future surface-faulting earthquakes is not possible. New faults may form, existing faults may propagate beyond their present lengths, elapsed time between individual surface-faulting earthquakes can vary by hundreds or thousands of years and be affected by clustering, triggering, and multi- or partial-segment ruptures. For these reasons, developing property in the vicinity of hazardous faults will always involve a level of irreducible, inherent risk. The special-study areas were delineated to account for much of the uncertainty in fault trace location and propagation.

This map is not intended for use at scales other than 1:24,000; it is our opinion that the inventory of potentially active faults shown on this map is likely complete at this scale where high-resolution lidar data is available. However, smaller faults may not have been detected during mapping (such as those with very small offset or surface warping) or are concealed beneath young geologic deposits. Bedrock faults having no documented Quaternary movement were not included, but could represent an unlikely source of surface-fault-rupture hazard. Additionally, concealed and approximately located faults by definition lack a clearly identifiable surface trace; therefore, their locations are approximate. Fault traces were mapped at 1:24,000-scale where possible.

We focused on mapping traces of the Wasatch fault zone and other nearby faults within the available high-resolution lidar elevation data. Additionally, we used 1970s low-sun-angle and oblique aerial photography from Woodward-Lundgren & Associates Wasatch fault investigations (Cluff and others, 1970; compiled in Bowman and others, 2015) supplemented by other aerial photography from the *UGS Aerial Imagery Collection* (https://geodata.geology.utah.gov/imagery/), and previous geologic and related mapping (Personius and Scott, 1992; McKean, in preparation). Fault traces outside the available lidar extents are from the *Utah Quaternary Fault and Fold Database* (https://geology.utah.gov/apps/qfaults/). We encourage local governments to forward surface-fault-rupture hazard investigation reports they receive to the UGS so that fault mapping accuracy and detail for future maps can be improved. Additional information on earthquakes and other geologic hazards is available at https://geology.utah.gov/hazards/.

REFERENCES

Bowman, S.D., Hiscock, A.I., and Unger, C., 2015, Compilation of 1970s Woodward-Lundgren & Associates Wasatch fault investigation reports and low-sun-angle aerial photography, Wasatch Front and Cache Valley, Utah and Idaho: Utah Geological Survey Open-File Report 632, variously paginated, DVD.

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McKean, A.P., in preparation, Interim geologic map of the Sugar House quadrangle, Utah: Utah Geological Survey Open-File Report, booklet, scale 1:24,000.

Personius, S.F., and Scott, W.E., 1992, Surficial geologic map of the Salt Lake City segment and parts of adjacent segments of the Wasatch fault zone, Davis, Salt Lake, and Utah Counties, Utah: U.S. Geological Survey Miscellaneous Investigations Series Map I-2106, scale 1:50,000.

Utah Automated Geographic Reference Center, 2013–2014, Wasatch Front LiDAR elevation data: Online, Utah Automated Geographic Reference Center, State Geographic Information Database, https://gis.utah.gov/data/elevation-terrain-data/2013-2014-lidar/.

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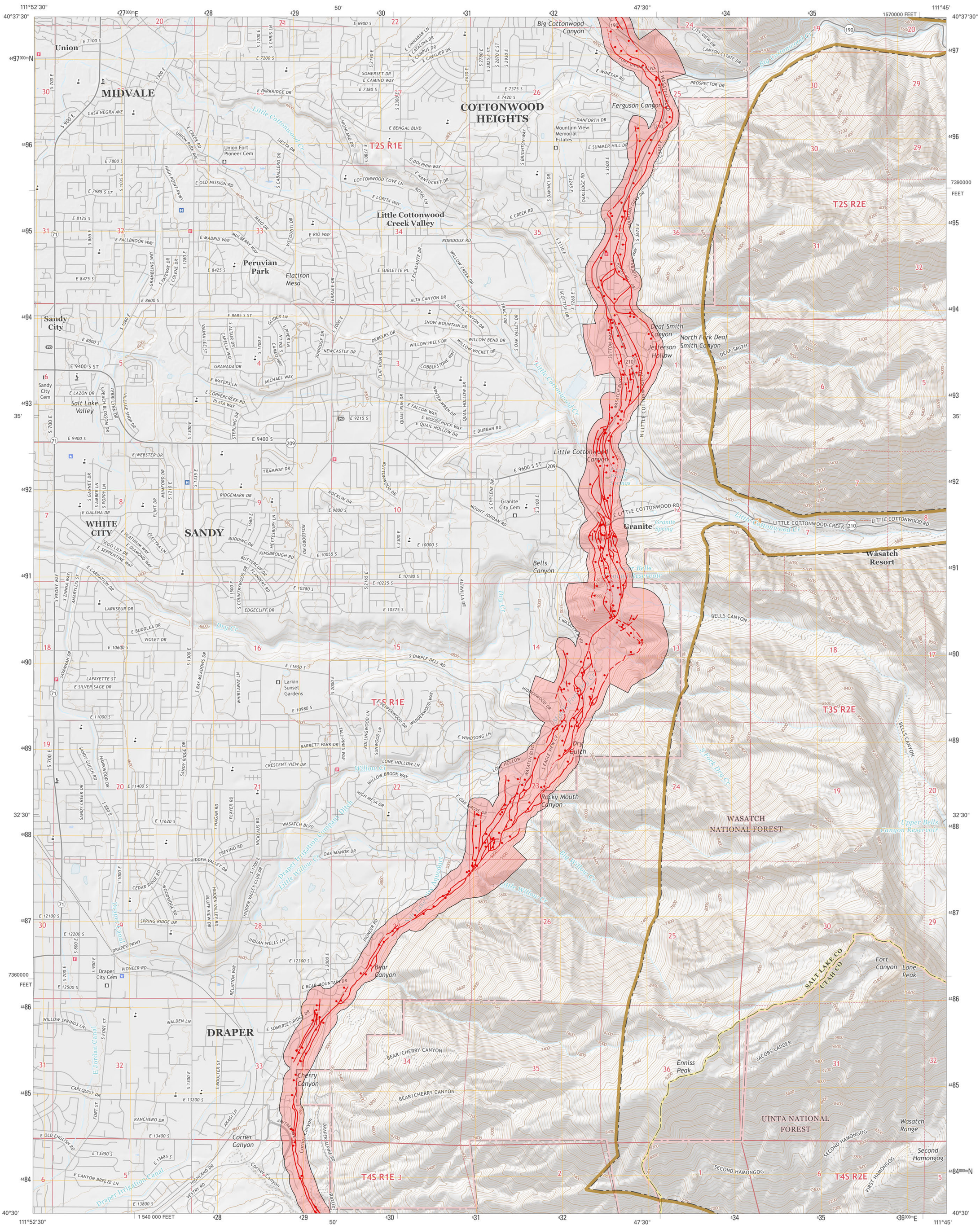
Utah Department of Natural Resources



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UTAH
QUADRANGLE LOCATION

SCALE 1:24,000
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5000 2500 0 5000 FEET
1 0.5 0 1 KILOMETER
CONTOUR INTERVAL 40 FEET

TRUE NORTH
MAGNETIC NORTH
11°19'
APPROXIMATE MEAN DECLINATION, 2018

Base from USGS Draper 7.5' Quadrangle (2017)
Projection: UTM Zone 12 N
Datum: NAD 1983

Surficial fault mapping: Adam P. McKean and Barry J. Solomon
GIS and Cartography: Gordon E. Douglass, Adam I. Hiscock, and Adam P. McKean
Project Manager: Greg N. McDonald

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(801) 537-3300
geology.utah.gov

SURFACE FAULT RUPTURE HAZARD MAP OF THE DRAPER QUADRANGLE, SALT LAKE AND UTAH COUNTIES, UTAH

by

Adam I. Hiscock and Adam P. McKean

2018

1	2	3
4		5
6	7	8

1. Salt Lake City South
2. Sugar House
3. Mount Aire
4. Midvale
5. Dromedary Peak
6. Jordan Narrows
7. Lehi
8. Timpanogos Cave

ADJOINING 7.5' QUADRANGLE NAMES

EXPLANATION

2013–2014 lidar extent: 0.5-meter Wasatch Front bare earth Light Detection and Ranging (lidar) elevation data, available from the Utah Automated Geographic Reference Center and OpenTopography.

SURFACE FAULT RUPTURE HAZARD CATEGORIES

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USING THIS MAP

This map shows potentially active faults in the Draper quadrangle along which surface faulting may occur and delineated special-study areas around those faults. Within each area, the UGS recommends a site-specific, surface-fault-rupture hazard investigation (such as fault trenching) be performed before development following the guidelines of Lund and others (2016). Site-specific geotechnical/geologic-hazard investigations can resolve uncertainties inherent in the generalized map scale and help ensure safety by identifying the need for and determine distances for fault setbacks from infrastructure. These investigations use the characteristics of past surface faulting at a site as a scientific basis for providing recommendations to reduce the risk for damage, injury, and/or death from future, presumably similar, surface faulting. Site-specific fault-trenching investigations should be preceded by a careful field evaluation of the site to identify the surface trace of the fault as well as other faults and fault-related features not evident at the mapped scale.

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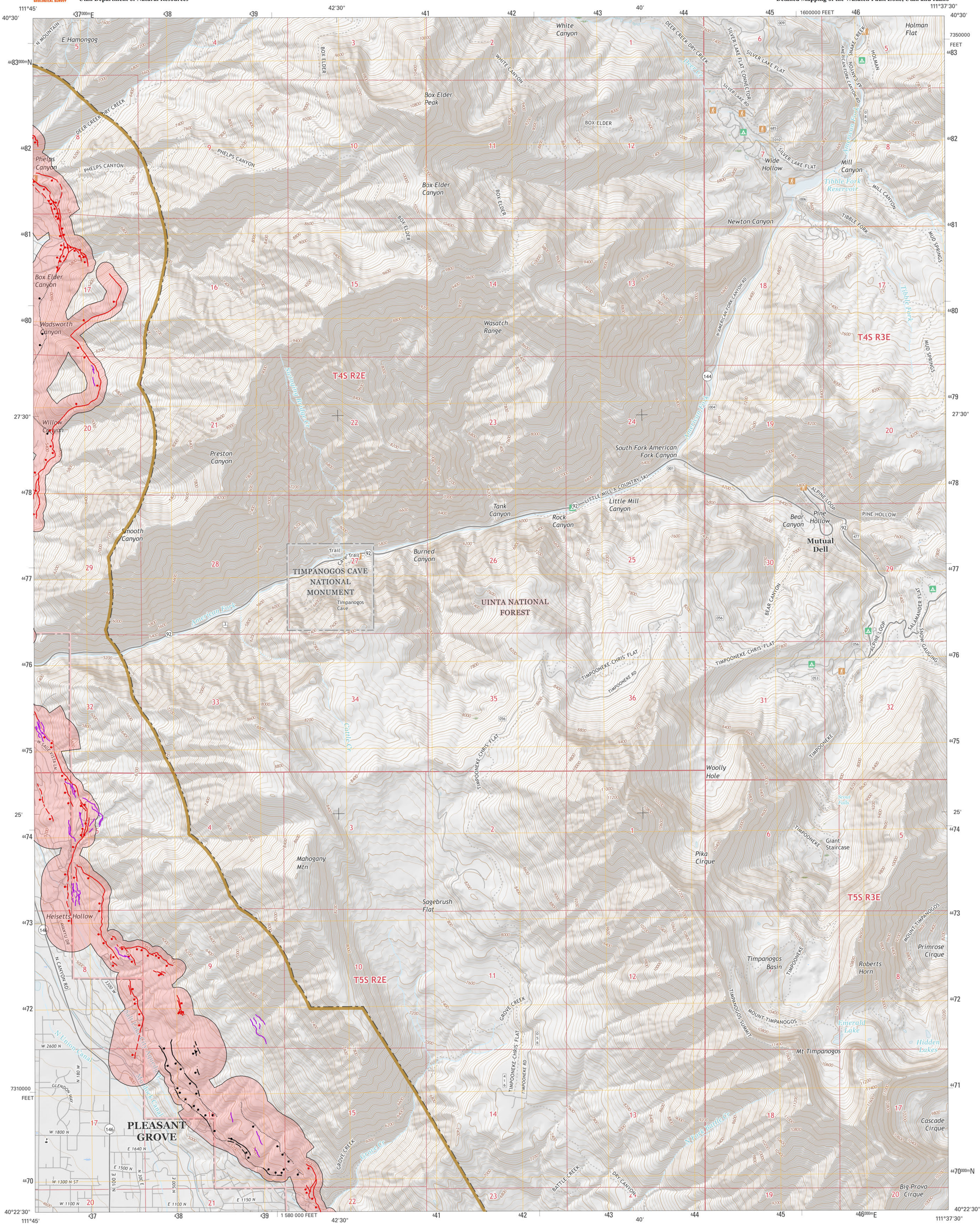

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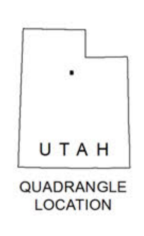
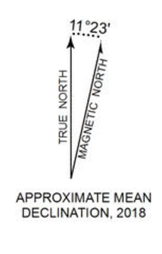


SCALE 1:24,000
1 0.5 0 1 MILE
5000 2500 0 5000 FEET
1 0.5 0 1 KILOMETER
CONTOUR INTERVAL 40 FEET



Base from USGS Timpanogos Cave 7.5' Quadrangle (2017)
Projection: UTM Zone 12 N
Datum: NAD 1983

Surficial fault mapping: Emily J. Kleber, Scott E.K. Bennett, and Nathan A. Toké
GIS and Cartography: Gordon E. Douglass, Adam I. Hiscock and, Emily J. Kleber
Project Manager: Greg N. McDonald

Utah Geological Survey
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P.O. Box 146100, Salt Lake City, UT 84114-6100
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SURFACE FAULT RUPTURE HAZARD MAP OF THE TIMPANOGOS CAVE QUADRANGLE, UTAH COUNTY, UTAH

by

Emily J. Kleber, Scott E.K. Bennett, and Nathan A. Toké

2018

1	2	3
4		5
6	7	8

1. Draper
2. Dromedary Peak
3. Brighton
4. Lehi
5. Aspen Grove
6. Pelican Point
7. Orem
8. Bridal Veil Falls

ADJOINING 7.5' QUADRANGLE NAMES

EXPLANATION

2013–2014 lidar extent: 0.5-meter Wasatch Front bare earth light detection and ranging (lidar) elevation data, available from the Utah Automated Geographic Reference Center and OpenTopography.

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USING THIS MAP

This map shows potentially active faults in the Timpanogos Cave quadrangle along which surface faulting may occur and delineated special-study areas around those faults. Within each area, the UGS recommends a site-specific, surface-fault-rupture hazard investigation (such as fault trenching) be performed before development following the guidelines of Lund and others (2016). Site-specific geotechnical/geologic-hazard investigations can resolve uncertainties inherent in the generalized map scale and help ensure safety by identifying the need for and determine distances for fault setbacks from infrastructure. These investigations use the characteristics of past surface faulting at a site as a scientific basis for providing recommendations to reduce the risk for damage, injury, and/or death from future, presumably similar, surface faulting. Site-specific fault-trenching investigations should be preceded by a careful field evaluation of the site to identify the surface trace of the fault as well as other faults and fault-related features not evident at the mapped scale.

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We focused on mapping traces of the Wasatch fault zone and other nearby faults within the available high-resolution lidar elevation data. Additionally, we used 1970s low-sun-angle and oblique aerial photography from Woodward-Lundgren & Associates Wasatch fault investigations (Cluff and others, 1970; compiled in Bowman and others, 2015) supplemented by other aerial photography from the *UGS Aerial Imagery Collection* (https://geodata.geology.utah.gov/imagery/), and previous geologic and related mapping (Machette, 1992; Biek, 2005; Constenius and others, 2011). Fault traces outside the available lidar extents are from the *Utah Quaternary Fault and Fold Database* (https://geology.utah.gov/apps/qfaults/). We encourage local governments to forward surface-fault-rupture hazard investigation reports they receive to the UGS so that fault mapping accuracy and detail for future maps can be improved. Additional information on earthquakes and other geologic hazards is available at https://geology.utah.gov/hazards/.

REFERENCES

Biek, R.F., 2005, Geologic map of the Lehi quadrangle and part of the Timpanogos Cave quadrangle, Salt Lake and Utah Counties, Utah: Utah Geological Survey Map 210, map, scale 1:24,000.

Bowman, S.D., Hiscock, A.I., and Unger, C., 2015, Compilation of 1970s Woodward-Lundgren & Associates Wasatch fault investigation reports and low-sun-angle aerial photography, Wasatch Front and Cache Valley, Utah and Idaho: Utah Geological Survey Open-File Report 632, variously paginated, DVD.

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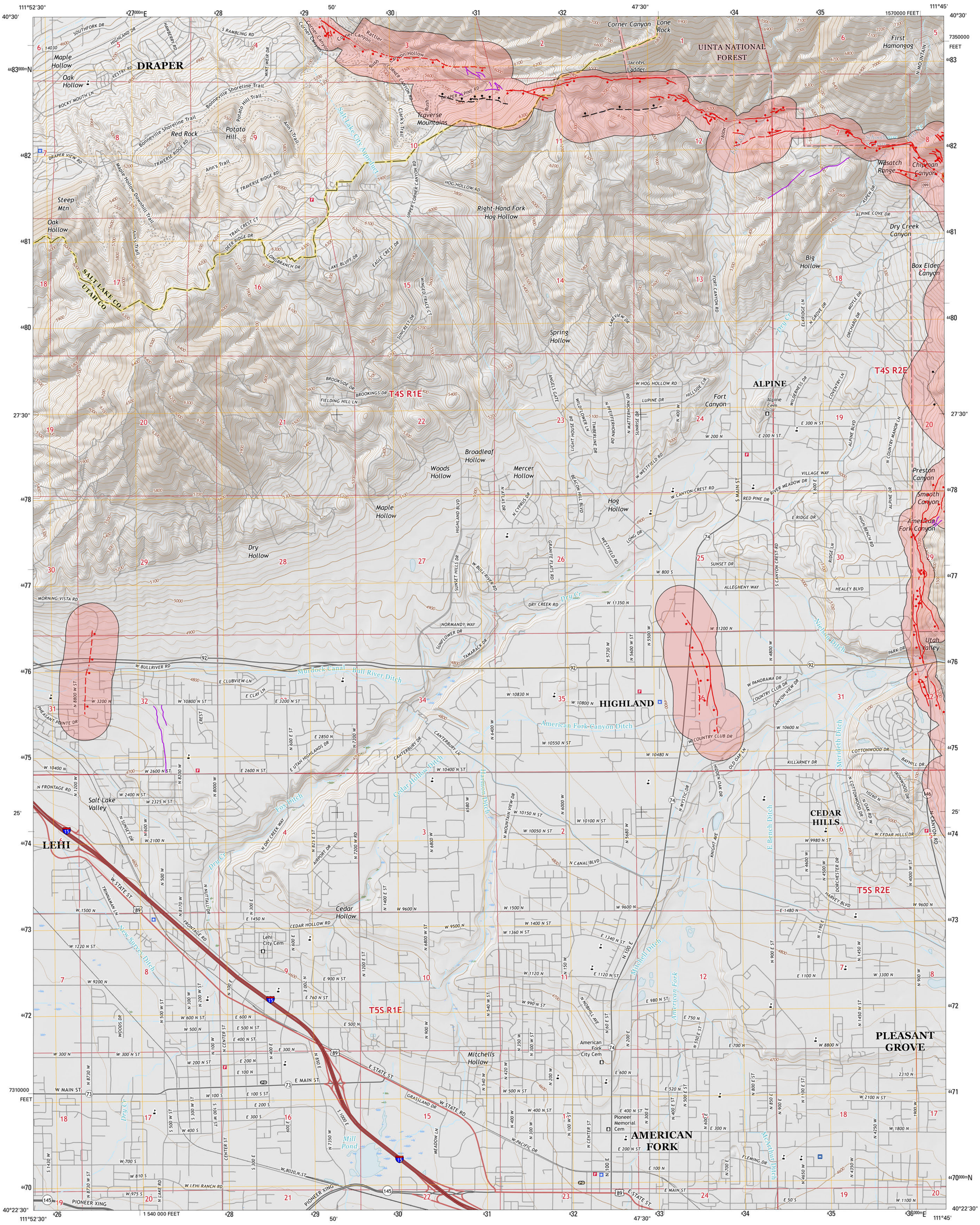
Constenius, K.N., Clark, D.L., King, J.K., Ehler, J.B., 2011, Interim geologic map of the Provo 30' x 60' quadrangle, Utah, Wasatch, and Salt Lake Counties, Utah: Utah Geological Survey Open-File Report 586DM, 42 p., 2 plates, 1:62,000 scale.

International Code Council, 2014, International Building Code: Country Club Hills, Illinois, 700 p.

Lund, W.R., Christenson, G.E., Batatian, L.D., and Nelson, C.V., 2016, Guidelines for evaluating surface-fault-rupture hazards in Utah, *in* Bowman, S.D., and Lund, W.R., editors, Guidelines for investigating geologic hazards and preparing engineering geology reports, with a suggested approach to geologic-hazard ordinances in Utah: Utah Geological Survey Circular 122, p. 31–53.

Machette, M.N., 1992, Surficial geologic map of the Wasatch fault zone, eastern part of Utah Valley, Utah County and parts of Salt Lake and Juab Counties, Utah: U.S. Geological Survey Miscellaneous Investigations Series Map I-2095, 1 plate, 1:50,000 scale.

Utah Automated Geographic Reference Center, 2013–2014, Wasatch Front LiDAR elevation data: Online, Utah Automated Geographic Reference Center, State Geographic Information Database, https://gis.utah.gov/data/elevation-terrain-data/2013-2014-lidar/.



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7. Pelican Point
8. Orem

ADJOINING 7.5' QUADRANGLE NAMES

SURFACE FAULT RUPTURE HAZARD MAP OF THE LEHI QUADRANGLE, SALT LAKE AND UTAH COUNTIES, UTAH

by

Emily J. Kleber, Scott E.K. Bennett, and Nathan A. Toké

2018

EXPLANATION

2013–2014 lidar extent: 0.5-meter Wasatch Front bare earth light detection and ranging (lidar) elevation data, available from the Utah Automated Geographic Reference Center and OpenTopography. Entire Lehi quadrangle contained within lidar extent.

SURFACE FAULT RUPTURE HAZARD CATEGORIES

Holocene-active fault (movement within the past 11,700 years) or suspected Holocene-active fault: Surface-fault-rupture hazard investigations recommended for all structures intended for human occupancy and all International Building Code (IBC; International Code Council, 2014) Risk Category IIa, IIb, III, and IV structures (see Lund and others, 2016). Ball and bar on downthrown side of fault. Solid line indicates well-defined fault trace, dashed line indicates moderately well defined fault trace, and dotted line indicates buried or inferred fault trace, queried where uncertain.

Late Quaternary-active fault (movement within the past 130,000 years) or suspected late Quaternary-active fault: Surface-fault-rupture hazard investigations recommended for all IBC Risk Category IIb, III, and IV structures (see Lund and others, 2016). Studies for IBC Risk Category IIa and other structures for human occupancy remain prudent, but should be based on an assessment of whether risk-reduction measures are justified by weighing the probability of occurrence against the risk to lives and potential economic loss. Ball and bar on downthrown side of fault. Solid line indicates well-defined fault trace, dashed line indicates moderately well defined fault trace, and dotted line indicates buried or inferred fault trace. None currently mapped within this quadrangle.

Quaternary-active fault (movement within the past 2,600,000 years) or suspected Quaternary-active fault: Surface-fault-rupture hazard investigations recommended for all IBC Risk Category III and IV structures (see Lund and others, 2016). Studies for IBC Risk Category IIb and other structures for human occupancy remain prudent because a low likelihood of surface faulting still exists. Ball and bar on downthrown side of fault. Solid line indicates well-defined fault trace, dashed line indicates moderately well defined fault trace, and dotted line indicates buried or inferred fault trace, queried where uncertain.

Other lineaments, unknown activity/source: Lineaments and traces mapped using lidar and other data.

Surface-fault-rupture hazard special-study area: For well-defined faults, special-study area extends 500 feet on the downthrown side and 250 feet on the upthrown side of each fault. For moderately well located or buried/inferred faults, special-study area extends 1000 feet on each side of the suspected trace of each fault (Lund and others, 2016). Refer to booklet for more details on special-study area designations.

USING THIS MAP

This map shows potentially active faults in the Lehi quadrangle along which surface faulting may occur and delineated special-study areas around those faults. Within each area, the UGS recommends a site-specific, surface-fault-rupture hazard investigation (such as fault trenching) be performed before development following the guidelines of Lund and others (2016). Site-specific geotechnical/geologic-hazard investigations can resolve uncertainties inherent in the generalized map scale and help ensure safety by identifying the need for and determine distances for fault setbacks from infrastructure. These investigations use the characteristics of past surface faulting at a site as a scientific basis for providing recommendations to reduce the risk for damage, injury, and/or death from future, presumably similar, surface faulting. Site-specific fault-trenching investigations should be preceded by a careful field evaluation of the site to identify the surface trace of the fault as well as other faults and fault-related features not evident at the mapped scale.

Aleatory (natural) variability in fault behavior cannot be reduced; therefore, predicting exactly when, where, and how much ground rupture will occur during future surface-faulting earthquakes is not possible. New faults may form, existing faults may propagate beyond their present lengths, elapsed time between individual surface-faulting earthquakes can vary by hundreds or thousands of years and be affected by clustering, triggering, and multi- or partial-segment ruptures. For these reasons, developing property in the vicinity of hazardous faults will always involve a level of irreducible, inherent risk. The special-study areas were delineated to account for much of the uncertainty in fault trace location and propagation.

This map is not intended for use at scales other than 1:24,000; it is our opinion that the inventory of potentially active faults shown on this map is likely complete at this scale where high-resolution lidar data are available. However, smaller faults may not have been detected during mapping (such as those with very small offset or surface warping) or are concealed beneath young geologic deposits. Bedrock faults having no documented Quaternary movement were not included, but could represent an unlikely source of surface-fault-rupture hazard. Additionally, concealed and approximately located faults by definition lack a clearly identifiable surface trace; therefore, their locations are approximate. Lidar-derived fault traces were mapped at 1:10,000 scale where possible; however, all traces are shown on this map at 1:24,000 scale.

We focused on mapping traces of the Wasatch fault zone and other nearby faults within the available high-resolution lidar elevation data. Additionally, we used 1970s low-sun-angle and oblique aerial photography from Woodward-Lundgren & Associates Wasatch fault investigations (Cluff and others, 1970; compiled in Bowman and others, 2015) supplemented by other aerial photography from the *UGS Aerial Imagery Collection* (https://geodata.geology.utah.gov/imagery/), and previous geologic and related mapping (Machette, 1992; Biek, 2005; Constenius and others, 2011). Fault traces outside the available lidar extents are from the *Utah Quaternary Fault and Fold Database* (https://geology.utah.gov/apps/qfaults/). We encourage local governments to forward surface-fault-rupture hazard investigation reports they receive to the UGS so that fault mapping accuracy and detail for future maps can be improved. Additional information on earthquake and other geologic hazards is available at https://geology.utah.gov/hazards/.

REFERENCES

Biek, R.F., 2005, Geologic map of the Lehi quadrangle and part of the Timpanogos Cave quadrangle, Salt Lake and Utah Counties, Utah: Utah Geological Survey Map 210, map, scale 1:24,000.

Bowman, S.D., Hiscock, A.I., and Unger, C., 2015, Compilation of 1970s Woodward-Lundgren & Associates Wasatch fault investigation reports and low-sun-angle aerial photography, Wasatch Front and Cache Valley, Utah and Idaho: Utah Geological Survey Open-File Report 632, variously paginated, DVD.

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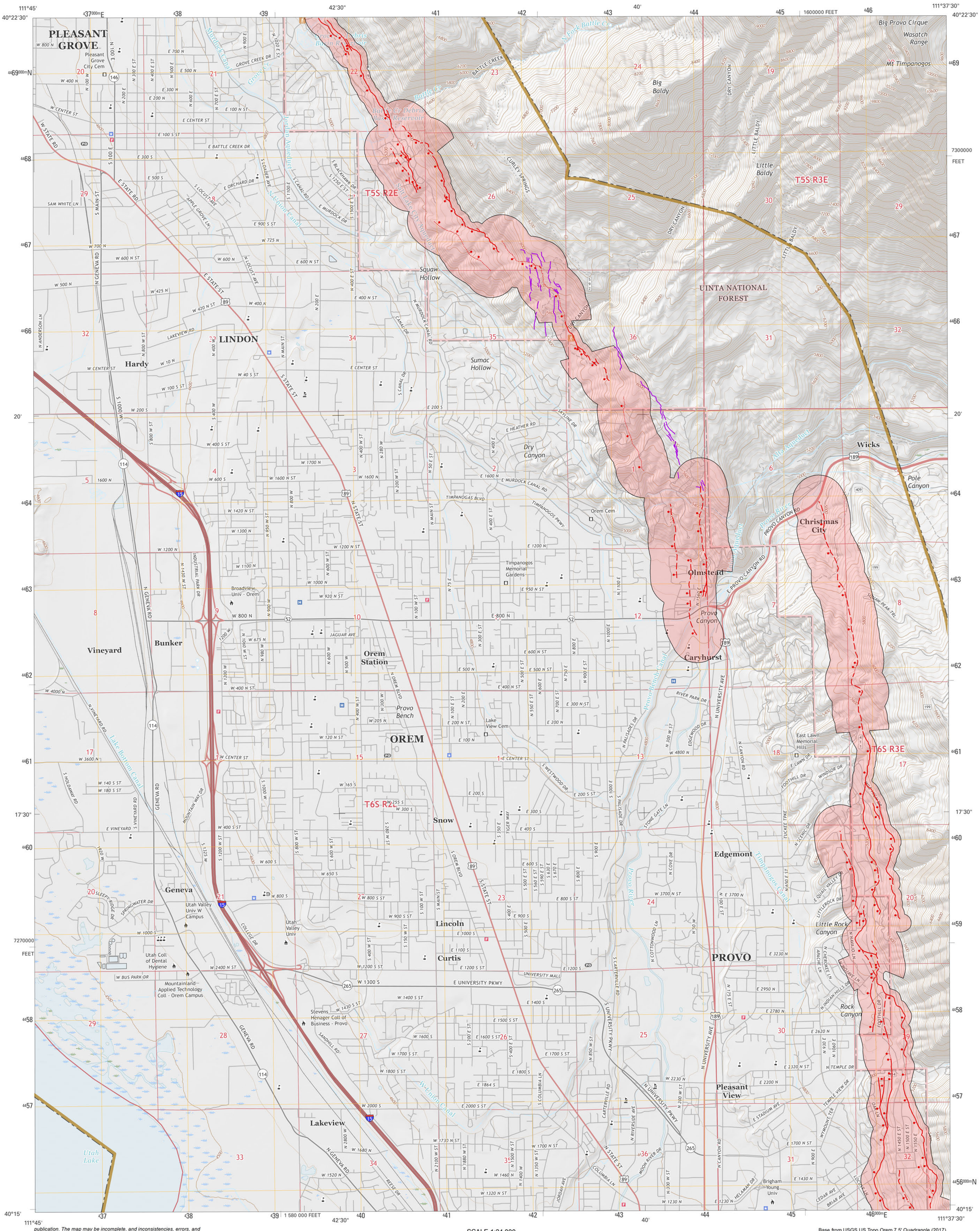

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This map is a plot of geographic information system (GIS) files created to visually represent the content of the GIS data files. This preliminary map contains features that do not meet UGS cartographic standards.

UTAH
QUADRANGLE LOCATION

SCALE 1:24,000
1 0.5 0 1 MILE
5000 2500 0 5000 FEET
1 0.5 0 1 KILOMETER
CONTOUR INTERVAL 40 FEET

TRUE NORTH
MAGNETIC NORTH
11°22'
APPROXIMATE MEAN DECLINATION, 2018

Base from USGS US Topo Orem 7.5' Quadrangle (2017)
Projection: UTM Zone 12
Datum: NAD 1983

Surficial fault mapping: Emily J. Kleber and Scott E.K. Bennett
GIS and Cartography: Gordon E. Douglass, Adam I. Hiscock, and Emily J. Kleber
Project Manager: Greg N. McDonald

Utah Geological Survey
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SURFACE FAULT RUPTURE HAZARD MAP OF THE OREM QUADRANGLE, UTAH COUNTY, UTAH

by

Emily J. Kleber and Scott E.K. Bennett

2018

ADJOINING 7.5' QUADRANGLE NAMES

1	2	3
4		5
6	7	8

1. Lehi
2. Timpanogos Cave
3. Aspen Grove
4. Pelican Point
5. Bridal Veil Falls
6. Lincoln Point
7. Provo
8. Springville

EXPLANATION

2013–2014 lidar extent: 0.5-meter Wasatch Front bare earth light detection and ranging (lidar) elevation data, available from the Utah Automated Geographic Reference Center and OpenTopography.

SURFACE FAULT RUPTURE HAZARD CATEGORIES

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USING THIS MAP

This map shows potentially active faults in the Orem quadrangle along which surface faulting may occur and delineated special-study areas around those faults. Within each area, the UGS recommends a site-specific, surface-fault-rupture hazard investigation (such as fault trenching) be performed before development following the guidelines of Lund and others (2016). Site-specific geotechnical/geologic-hazard investigations can resolve uncertainties inherent in the generalized map scale and help ensure safety by identifying the need for and determine distances for fault setbacks from infrastructure. These investigations use the characteristics of past surface faulting at a site as a scientific basis for providing recommendations to reduce the risk for damage, injury, and/or death from future, presumably similar, surface faulting. Site-specific fault-trenching investigations should be preceded by a careful field evaluation of the site to identify the surface trace of the fault as well as other faults and fault-related features not evident at the mapped scale.

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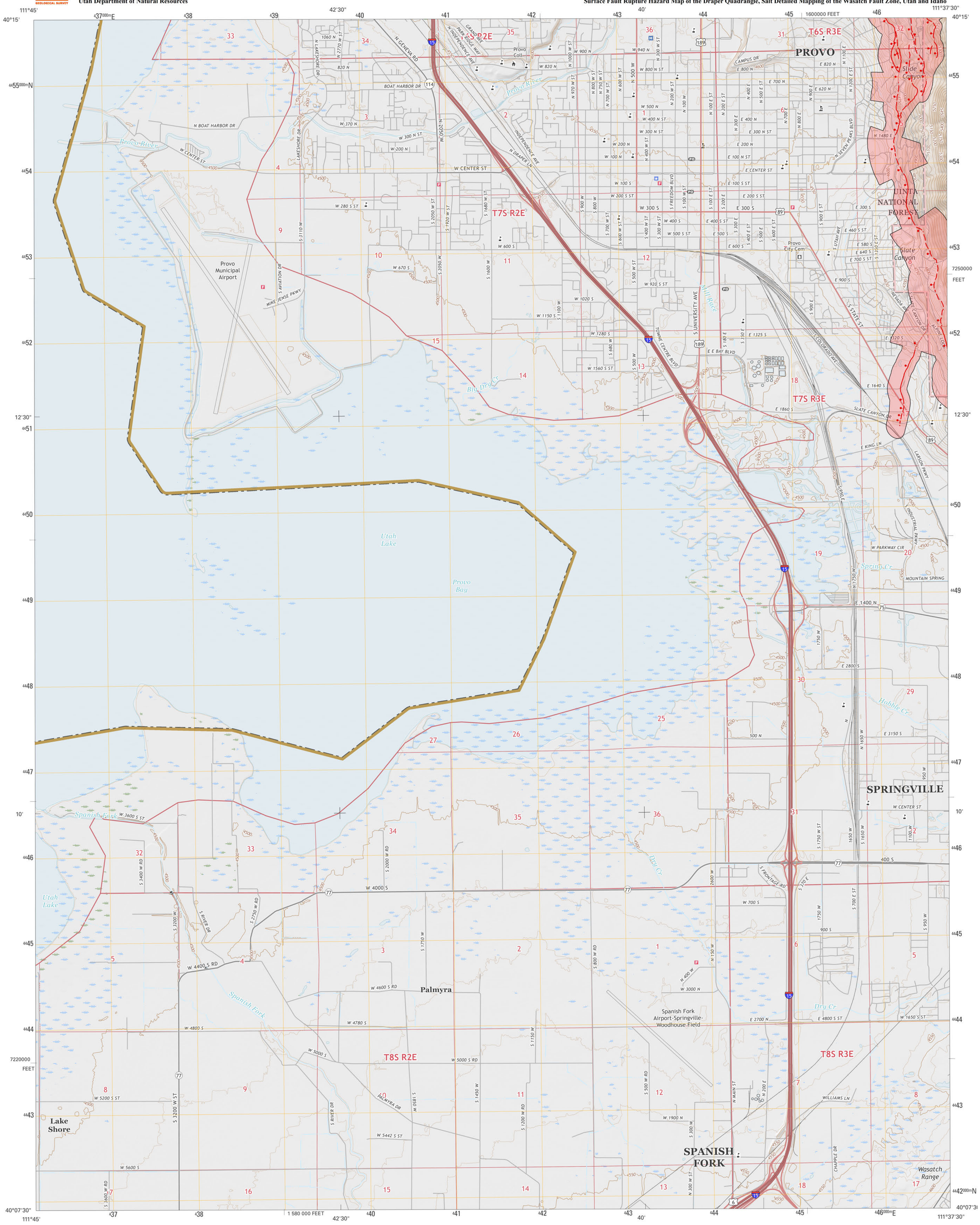

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Base from USGS Provo 7.5' Quadrangle (2017)
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SURFACE FAULT RUPTURE HAZARD MAP OF THE PROVO QUADRANGLE, UTAH COUNTY, UTAH

by

Emily J. Kleber and Scott E.K Bennett

2018

1	2	3
4		5
6	7	8

1. Pelican Point
2. Orem
3. Bridal Veil Falls
4. Lincoln Point
5. Springville
6. West Mountain
7. Spanish Fork
8. Spanish Fork Peak

ADJOINING 7.5' QUADRANGLE NAMES

EXPLANATION

2013–2014 lidar extent: 0.5-meter Wasatch Front bare earth light detection and ranging (lidar) elevation data, available from the Utah Automated Geographic Reference Center and OpenTopography.

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USING THIS MAP

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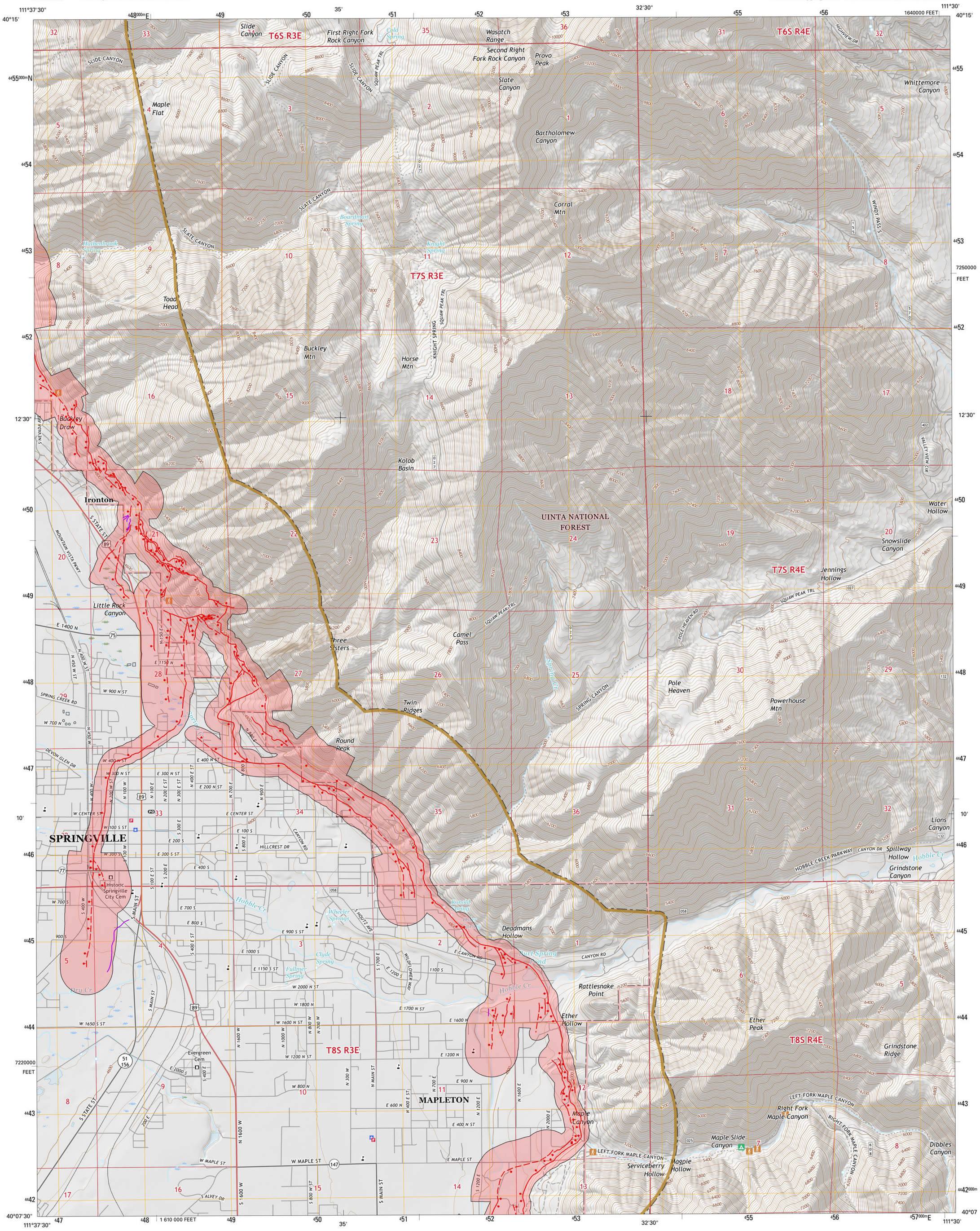

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1. Orem
2. Bridal Veil Falls
3. Wallsburg Ridge
4. Provo
5. Granget Mtn
6. Spanish Fork
7. Spanish Fork Peak
8. Billies Mtn

ADJOINING 7.5' QUADRANGLE NAMES

SURFACE FAULT RUPTURE HAZARD MAP OF THE SPRINGVILLE QUADRANGLE, UTAH COUNTY, UTAH

by

Emily J. Kleber and Scott E.K. Bennett

2018

EXPLANATION

2013 – 2014 lidar extent: 0.5-meter Wasatch Front bare earth light detection and ranging (lidar) elevation data, available from the Utah Automated Geographic Reference Center and OpenTopography.

SURFACE FAULT RUPTURE HAZARD CATEGORIES

Holocene-active fault (movement within the past 11,700 years) or suspected Holocene-active fault: Surface-fault-rupture hazard investigations recommended for all structures intended for human occupancy and all International Building Code (IBC; International Code Council, 2014) Risk Category IIa, IIb, III, and IV structures (see Lund and others, 2016). Ball and bar on downthrown side of fault. Solid line indicates well-defined fault trace, dashed line indicates moderately well defined fault trace, and dotted line indicates buried or inferred fault trace, queried where uncertain.

Late Quaternary-active fault (movement within the past 130,000 years) or suspected late Quaternary-active fault: Surface-fault-rupture hazard investigations recommended for all IBC Risk Category IIb, III, and IV structures (see Lund and others, 2016). Studies for IBC Risk Category IIa and other structures for human occupancy remain prudent, but should be based on an assessment of whether risk-reduction measures are justified by weighing the probability of occurrence against the risk to lives and potential economic loss. Ball and bar on downthrown side of fault. Solid line indicates well-defined fault trace, dashed line indicates moderately well defined fault trace, and dotted line indicates buried or inferred fault trace. None currently mapped within this quadrangle.

Quaternary-active fault (movement within the past 2,600,000 years) or suspected Quaternary-active fault: Surface-fault-rupture hazard investigations recommended for all IBC Risk Category III and IV structures (see Lund and others, 2016). Studies for IBC Risk Category IIb and other structures for human occupancy remain prudent because a low likelihood of surface faulting still exists. Ball and bar on downthrown side of fault. Solid line indicates well-defined fault trace, dashed line indicates moderately well defined fault trace, and dotted line indicates buried or inferred fault trace, queried where uncertain. None currently mapped within this quadrangle.

Other lineaments, unknown activity/source: Lineaments and traces mapped using lidar and other data.

Surface-fault-rupture hazard special-study area: For well-defined faults, special-study area extends 500 feet on the downthrown side and 250 feet on the upthrown side of each fault. For moderately well-located or buried/inferred faults, special-study area extends 1000 feet on each side of the suspected trace of each fault (Lund and others, 2016). Refer to booklet for more details on special-study area designations.

USING THIS MAP

This map shows potentially active faults in the Springville quadrangle along which surface faulting may occur and delineated special-study areas around those faults. Within each area, the UGS recommends a site-specific, surface-fault-rupture hazard investigation (such as fault trenching) be performed before development following the guidelines of Lund and others (2016). Site-specific geotechnical/geologic-hazard investigations can resolve uncertainties inherent in the generalized map scale and help ensure safety by identifying the need for and determine distances for fault setbacks from infrastructure. These investigations use the characteristics of past surface faulting at a site as a scientific basis for providing recommendations to reduce the risk for damage, injury, and/or death from future, presumably similar, surface faulting. Site-specific fault-trenching investigations should be preceded by a careful field evaluation of the site to identify the surface trace of the fault as well as other faults and fault-related features not evident at the mapped scale.

Aleatory (natural) variability in fault behavior cannot be reduced; therefore, predicting exactly when, where, and how much ground rupture will occur during future surface-faulting earthquakes is not possible. New faults may form, existing faults may propagate beyond their present lengths, elapsed time between individual surface-faulting earthquakes can vary by hundreds or thousands of years and be affected by clustering, triggering, and multi- or partial-segment ruptures. For these reasons, developing property in the vicinity of hazardous faults will always involve a level of irreducible, inherent risk. The special-study areas were delineated to account for much of the uncertainty in fault trace location and propagation.

This map is not intended for use at scales other than 1:24,000; it is our opinion that the inventory of potentially active faults shown on this map is likely complete at this scale where high-resolution lidar data are available. However, smaller faults may not have been detected during mapping (such as those with very small offset or surface warping) or are concealed beneath young geologic deposits. Bedrock faults having no documented Quaternary movement were not included, but could represent an unlikely source of surface-fault-rupture hazard. Additionally, concealed and approximately located faults by definition lack a clearly identifiable surface trace; therefore, their locations are approximate. Lidar-derived fault traces were mapped at 1:10,000-scale where possible; however, all traces are shown on this map at 1:24,000-scale.

We focused on mapping traces of the Wasatch fault zone and other nearby faults within the available high-resolution lidar elevation data. Additionally, we used 1970s low-sun-angle and oblique aerial photography from Woodward-Lundgren & Associates Wasatch fault investigations (Cluff and others, 1970; compiled in Bowman and others, 2015) supplemented by other aerial photography from the *UGS Aerial Imagery Collection* (https://geodata.geology.utah.gov/imagery/), and previous geologic and related mapping (Machette, 1992; Solomon and Machette, 2008; Constenius and others, 2011). Fault traces outside the available lidar extents are from the *Utah Quaternary Fault and Fold Database* (https://geology.utah.gov/apps/qfaults/). We encourage local governments to forward surface-fault-rupture hazard investigation reports they receive to the UGS so that fault mapping accuracy and detail for future maps can be improved. Additional information on earthquakes and other geologic hazards is available at https://geology.utah.gov/hazards/.

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Solomon, B.J. and Machette, M.N., 2008, Interim geologic map of the southwest (Utah Valley) part of the Springville quadrangle, Utah County, Utah: Utah Geological Survey Open File Report 524, booklet, scale 1:24,000.

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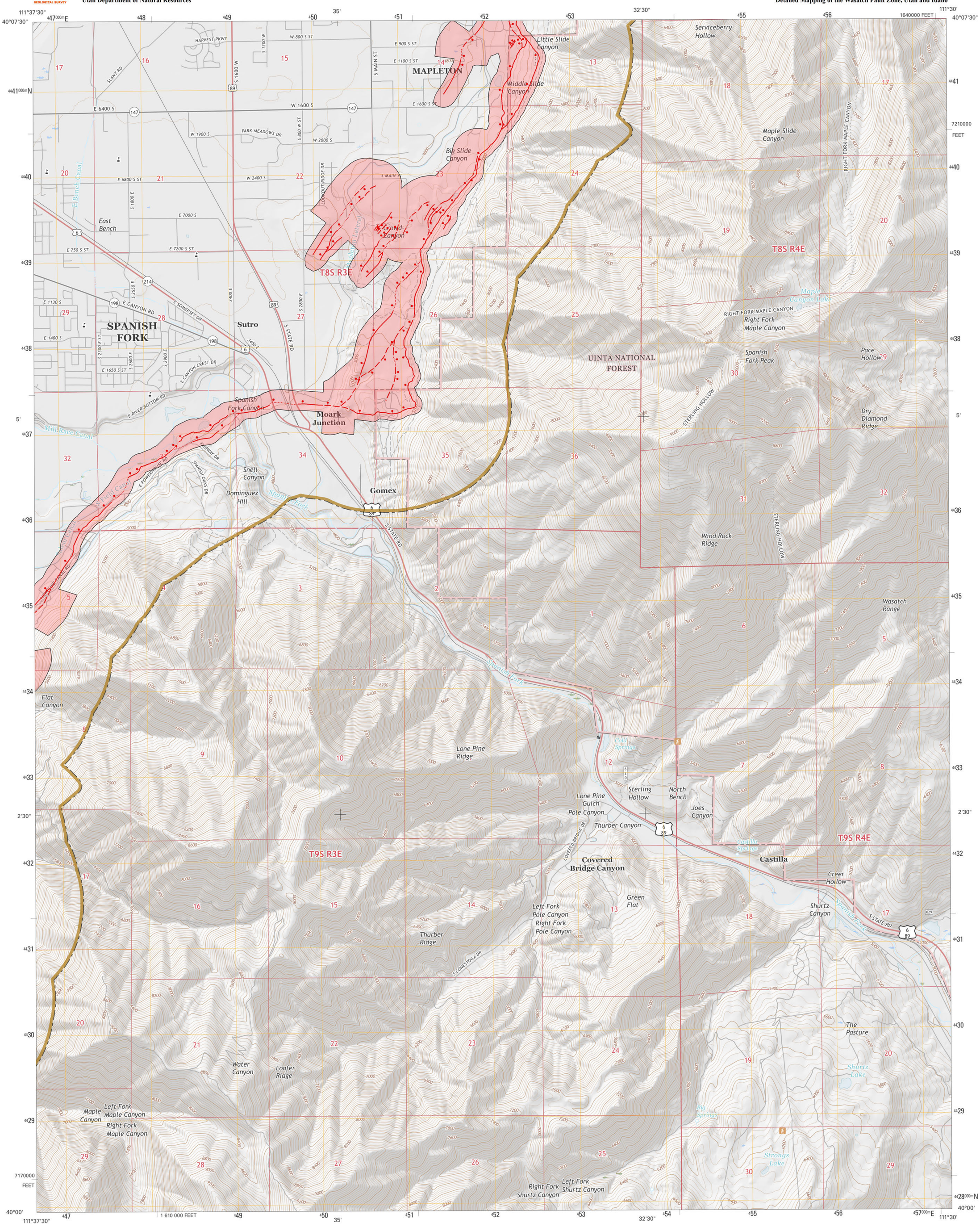

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This map is a plot of geographic information system (GIS) files created to visually represent the content of the GIS data files. This preliminary map contains features that do not meet UGS cartographic standards.

UTAH
QUADRANGLE LOCATION

SCALE 1:24,000
1 0.5 0 1 MILE
5000 2500 0 5000 FEET
1 0.5 0 1 KILOMETER
CONTOUR INTERVAL 40 FEET

TRUE NORTH
MAGNETIC NORTH
11°17'
APPROXIMATE MEAN DECLINATION, 2018

Base from USGS Spanish Fork Peak 7.5' Quadrangle (2017)
Projection: UTM Zone 12 N
Datum: NAD 1983

Surficial fault mapping: Adam I. Hiscock, Emily J. Kleber, Scott E.K. Bennett
GIS and Cartography: Gordon E. Douglass, Adam I. Hiscock, Emily J. Kleber
Project Manager: Greg N. McDonald

Utah Geological Survey
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1	2	3
4		5
6	7	8

1. Provo
2. Springville
3. Granger Mtn
4. Spanish Fork
5. Billies Mtn
6. Payson Lakes
7. Birdseye
8. Thistle

ADJOINING 7.5' QUADRANGLE NAMES

SURFACE FAULT RUPTURE HAZARD MAP OF THE SPANISH FORK PEAK QUADRANGLE, UTAH COUNTY, UTAH

by

Adam I. Hiscock, Emily J. Kleber, and Scott E.K. Bennett

2018

EXPLANATION

2013–2014 lidar extent: 0.5-meter Wasatch Front bare earth light detection and ranging (lidar) elevation data, available from the Utah Automated Geographic Reference Center and OpenTopography.

SURFACE FAULT RUPTURE HAZARD CATEGORIES

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USING THIS MAP

This map shows potentially active faults in the Spanish Fork Peak quadrangle along which surface faulting may occur and delineated special-study areas around those faults. Within each area, the UGS recommends a site-specific, surface-fault-rupture hazard investigation (such as fault trenching) be performed before development following the guidelines of Lund and others (2016). Site-specific geotechnical/geologic-hazard investigations can resolve uncertainties inherent in the generalized map scale and help ensure safety by identifying the need for and determine distances for fault setbacks from infrastructure. These investigations use the characteristics of past surface faulting at a site as a scientific basis for providing recommendations to reduce the risk for damage, injury, and/or death from future, presumably similar, surface faulting. Site-specific fault-trenching investigations should be preceded by a careful field evaluation of the site to identify the surface trace of the fault as well as other faults and fault-related features not evident at the mapped scale.

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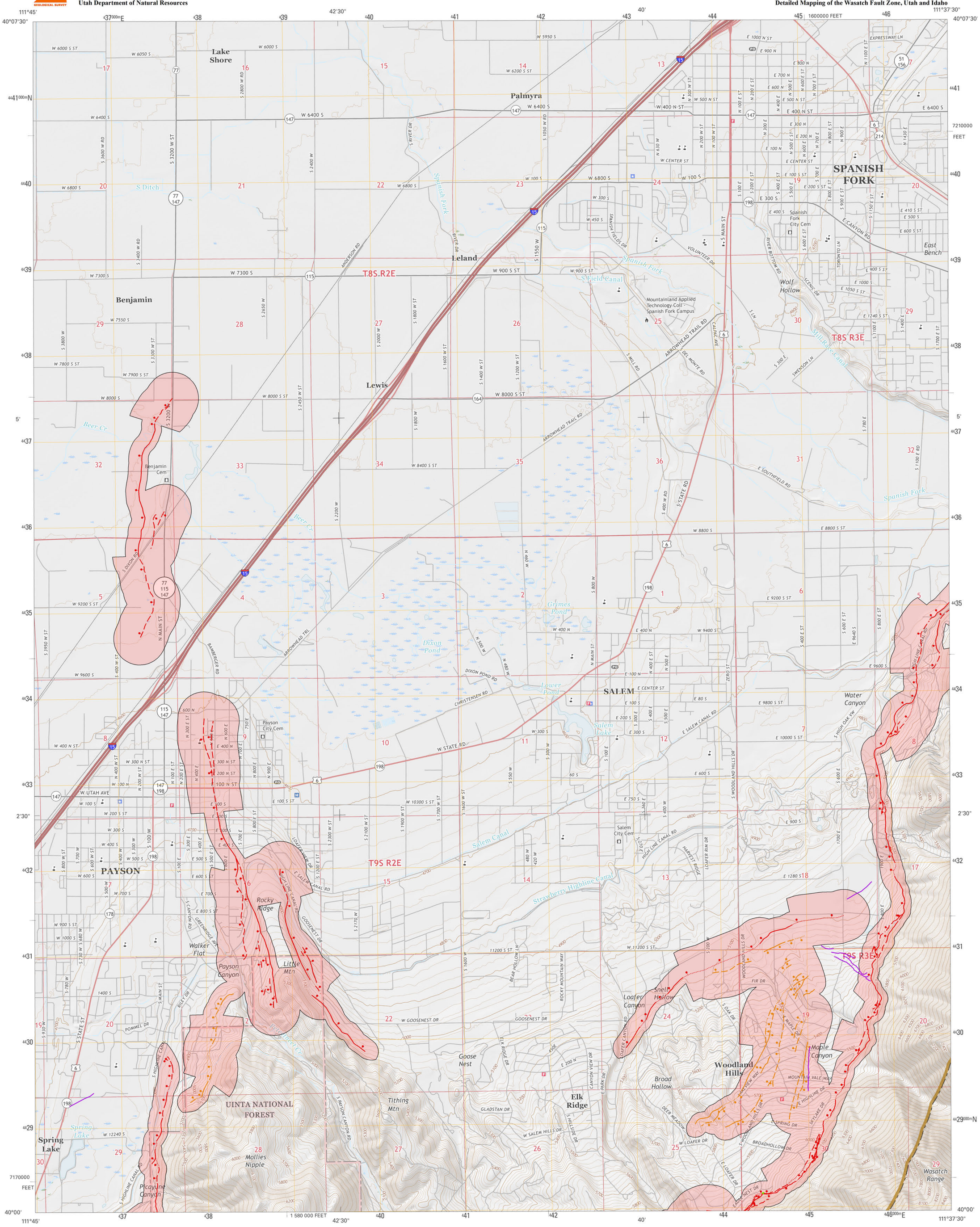

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SCALE 1:24,000
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CONTOUR INTERVAL 20 FEET

TRUE NORTH
MAGNETIC NORTH
11°20'
APPROXIMATE MEAN DECLINATION, 2018

Base from USGS Spanish Fork 7.5' Quadrangle (2017)
Projection: UTM Zone 12
Datum: NAD 1983

Surficial fault mapping: Adam I. Hiscock
GIS and Cartography: Gordon E. Douglass and Adam I. Hiscock
Project Manager: Greg N. McDonald

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SURFACE FAULT RUPTURE HAZARD MAP OF THE SPANISH FORK QUADRANGLE, UTAH COUNTY, UTAH

by

Adam I. Hiscock

2018

1	2	3
4		5
6	7	8

1. Lincoln Point
2. Provo
3. Springville
4. West Mountain
5. Spanish Fork Peak
6. Santaquin
7. Payson Lakes
8. Birdseye

ADJOINING 7.5' QUADRANGLE NAMES

EXPLANATION

2013–2014 lidar extent: 0.5-meter Wasatch Front bare earth light detection and ranging (lidar) elevation data, available from the Utah Automated Geographic Reference Center and OpenTopography.

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USING THIS MAP

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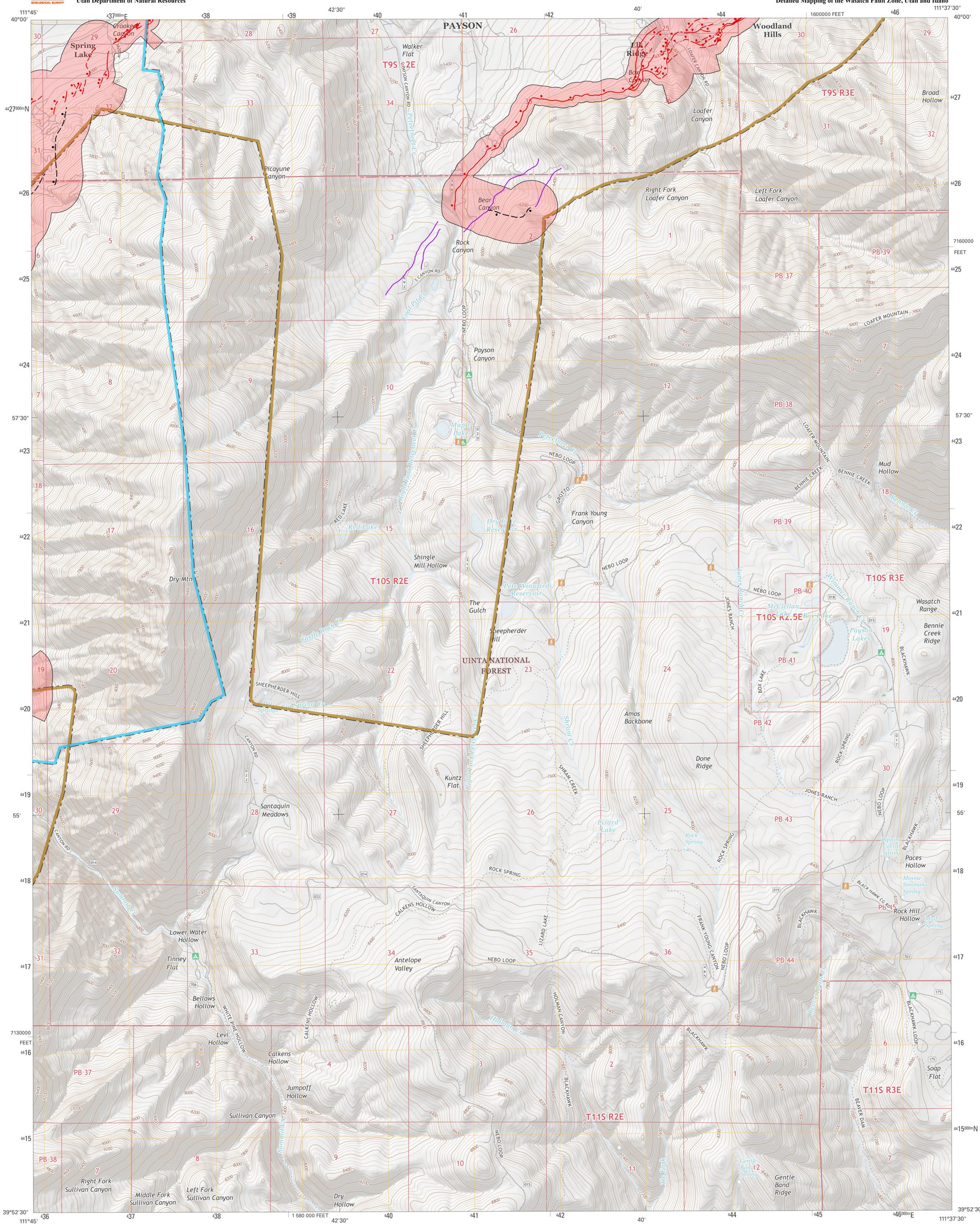

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by

Adam I. Hiscock

2018

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7. Nebo Basin
8. Spencer Canyon

ADJOINING 7.5' QUADRANGLE NAMES

EXPLANATION

2013–2014 lidar extent: 0.5-meter Wasatch Front bare earth light detection and ranging (lidar) elevation data, available from the Utah Automated Geographic Reference Center and OpenTopography.

2008 lidar extent: 0.5-meter bare earth lidar elevation data, available from OpenTopography.

SURFACE FAULT RUPTURE HAZARD CATEGORIES

Holocene-active fault (movement within the past 11,700 years) or suspected Holocene-active fault: Surface-fault-rupture hazard investigations recommended for all structures intended for human occupancy and all International Building Code (IBC; International Code Council, 2014) Risk Category IIa, IIb, III, and IV structures (see Lund and others, 2016). Ball and bar on downthrown side of fault. Solid line indicates well-defined fault trace, dashed line indicates moderately well defined fault trace, and dotted line indicates buried or inferred fault trace.

Late Quaternary-active fault (movement within the past 130,000 years) or suspected Late Quaternary-active fault: Surface-fault-rupture hazard investigations recommended for all IBC Risk Category IIb, III, and IV structures (see Lund and others, 2016). Investigations for IBC Risk Category IIa and other structures for human occupancy remain prudent, but should be based on an assessment of whether risk-reduction measures are justified by weighing the probability of occurrence against the risk to lives and potential economic loss. Ball and bar on downthrown side of fault. Solid line indicates well-defined fault trace, dashed line indicates moderately well defined fault trace, and dotted line indicates buried or inferred fault trace. None currently mapped in this quadrangle.

Quaternary-active fault (movement within the past 2,600,000 years) or suspected Quaternary-active fault: Surface-fault-rupture hazard investigations recommended for all IBC Risk Category III and IV structures (see Lund and others, 2016). Investigations for IBC Risk Category IIb and other structures for human occupancy remain prudent because a low likelihood of surface faulting still exists. Ball and bar on downthrown side of fault. Solid line indicates well-defined fault trace, dashed line indicates moderately well defined fault trace, and dotted line indicates buried or inferred fault trace.

Other lineaments, unknown activity/source: Lineaments and traces mapped using lidar and other data.

Surface-fault-rupture hazard special-study area: For well-defined faults, special-study area extends 500 feet on the downthrown side and 250 feet on the upthrown side of each fault. For moderately well located or buried/inferred faults, special-study area extends 1000 feet on each side of the suspected trace of each fault (Lund and others, 2016). Refer to booklet for more details on special-study area designations.

USING THIS MAP

This map shows potentially active faults in the Payson Lakes quadrangle along which surface faulting may occur and delineated special-study areas around those faults. Within each area, the UGS recommends a site-specific, surface-fault-rupture hazard investigation (such as fault trenching) be performed before development following the guidelines of Lund and others (2016). Site-specific geotechnical/geologic-hazard investigations can resolve uncertainties inherent in the generalized map scale and help ensure safety by identifying the need for and determine distances for fault setbacks from infrastructure. These investigations use the characteristics of past surface faulting at a site as a scientific basis for providing recommendations to reduce the risk for damage, injury, and/or death from future, presumably similar, surface faulting. Site-specific fault-trenching investigations should be preceded by a careful field evaluation of the site to identify the surface trace of the fault as well as other faults and fault-related features not evident at the mapped scale.

Aleatory (natural) variability in fault behavior cannot be reduced; therefore, predicting exactly when, where, and how much ground rupture will occur during future surface-faulting earthquakes is not possible. New faults may form, existing faults may propagate beyond their present lengths, elapsed time between individual surface-faulting earthquakes can vary by hundreds or thousands of years and be affected by clustering, triggering, and multi- or partial-segment ruptures. For these reasons, developing property in the vicinity of hazardous faults will always involve a level of irreducible, inherent risk. The special-study areas were delineated to account for much of the uncertainty in fault trace location and propagation.

This map is not intended for use at scales other than 1:24,000; it is our opinion that the inventory of potentially active faults shown on this map is likely complete at this scale where high-resolution lidar data are available. However, smaller faults may not have been detected during mapping (such as those with very small offset or surface warping) or are concealed beneath young geologic deposits. Bedrock faults having no documented Quaternary movement were not included, but could represent an unlikely source of surface-fault-rupture hazard. Additionally, concealed and approximately located faults by definition lack a clearly identifiable surface trace; therefore, their locations are approximate. Lidar-derived fault traces were mapped at 1:10,000 scale where possible; however, all traces are shown on this map at 1:24,000 scale.

We focused on mapping traces of the Wasatch fault zone and other nearby faults within the available high-resolution lidar elevation data. Additionally, we used 1970s low-sun-angle and oblique aerial photography from Woodward-Lundgren & Associates Wasatch fault investigations (Cluff and others, 1970; compiled in Bowman and others, 2015) supplemented by other aerial photography from the *UGS Aerial Imagery Collection* (https://geodata.geology.utah.gov/imagery/), and previous geologic and related mapping (Machette, 1992; Solomon, 2010). Fault traces outside the available lidar extents are from the *Utah Quaternary Fault and Fold Database* (https://geology.utah.gov/apps/qfaults/). We encourage local governments to forward surface-fault-rupture hazard investigation reports they receive to the UGS so that fault mapping accuracy and detail for future maps can be improved. Additional information on earthquakes and other geologic hazards is available at https://geology.utah.gov/hazards/.

REFERENCES

Bowman, S.D., Hiscock, A.I., and Unger, C., 2015, Compilation of 1970s Woodward-Lundgren & Associates Wasatch fault investigation reports and low-sun-angle aerial photography, Wasatch Front and Cache Valley, Utah and Idaho: Utah Geological Survey Open-File Report 632, variously paginated, DVD.

Cluff, L., Brogran, G., and Glass, C., 1970, Wasatch fault, southern portion, earthquake fault investigation & evaluation, a guide to land use planning: Oakland, California, Woodward-Clyde and Associates, unpublished consultant's report for the Utah Geological and Mineralogical Survey, variously paginated.

EarthScope Intermountain Seismic Belt LiDAR Project, 2008: Online, EarthScope and UNAVCO Plate Boundary Observatory, Supported by National Science Foundation, doi:10.5069/G9VD6WCS

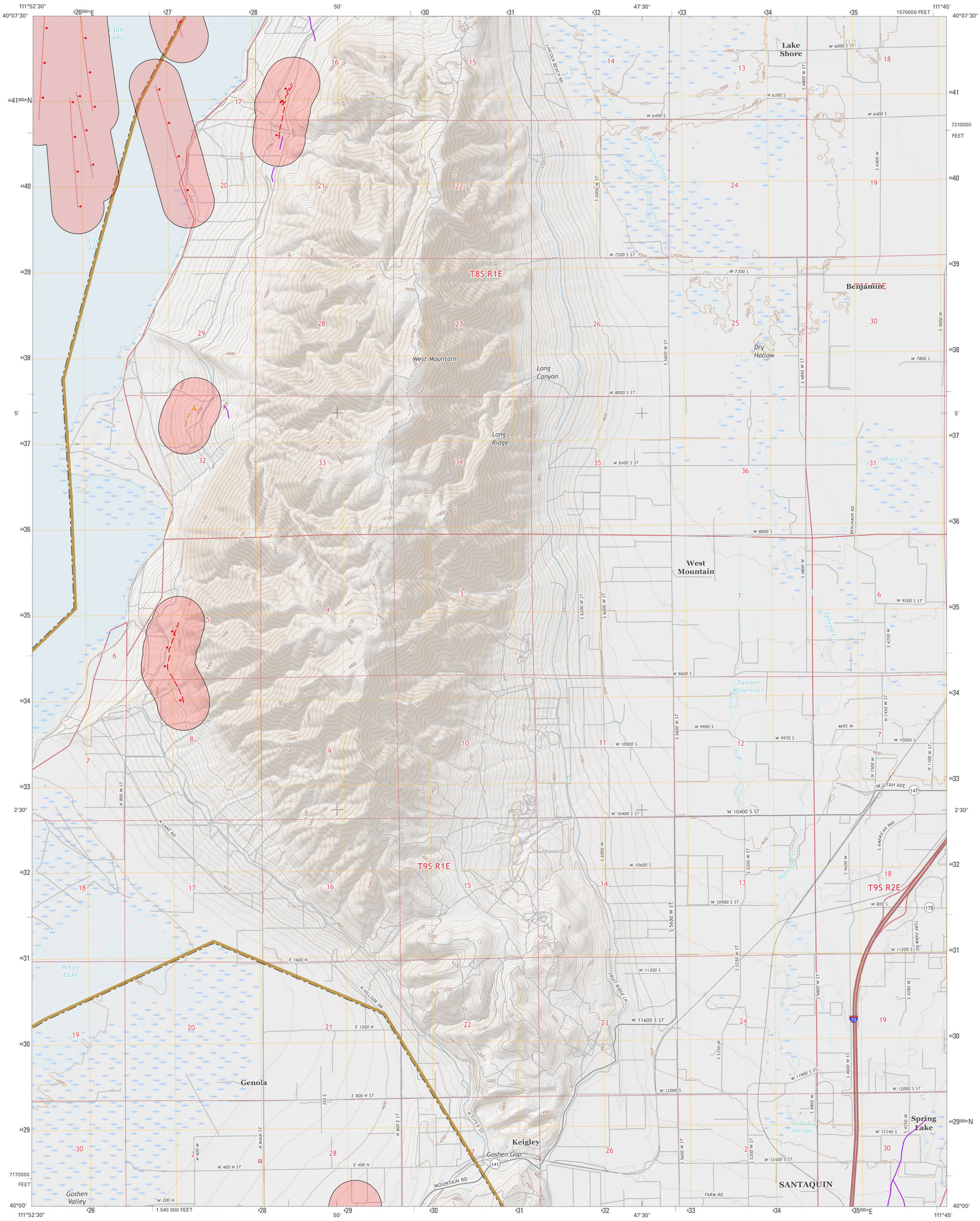
International Code Council, 2014, International Building Code: Country Club Hills, Illinois, 700 p.

Lund, W.R., Christenson, G.E., Batatian, L.D., and Nelson, C.V., 2016, Guidelines for evaluating surface-fault-rupture hazards in Utah, *in* Bowman, S.D., and Lund, W.R., editors, Guidelines for investigating geologic hazards and preparing engineering geology reports, with a suggested approach to geologic-hazard ordinances in Utah: Utah Geological Survey Circular 122, p. 31–53.

Machette, M.N., 1992, Surficial geologic map of the Wasatch fault zone, eastern part of Utah Valley, Utah County and parts of Salt Lake and Juab Counties, Utah: U.S. Geological Survey Miscellaneous Investigations Series Map I-2095, 1 pl., 1:50,000 scale.

Solomon, B.J., 2010, Interim geologic map of unconsolidated deposits in the Payson Lakes quadrangle, Utah County, Utah: Utah Geological Survey Open-File Report 571, 1 pl., 1:24,000 scale.

Utah Automated Geographic Reference Center, 2013–2014, Wasatch Front LiDAR elevation data: Online, Utah Automated Geographic Reference Center, State Geographic Information Database, https://gis.utah.gov/data/elevation-terrain-data/2013-2014-lidar/.



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SCALE 1:24,000
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CONTOUR INTERVAL 20 FEET

TRUE NORTH
MAGNETIC NORTH
11°23'
APPROXIMATE MEAN DECLINATION, 2018

Base from USGS West Mountain 7.5' Quadrangle (2017)
Projection: UTM Zone 12
Datum: NAD 1983

Surficial fault mapping: Adam I. Hiscock
GIS and Cartography: Gordon E. Douglass and Adam I. Hiscock
Project Manager: Greg N. McDonald

Utah Geological Survey
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geology.utah.gov

1	2	3
4		5
6	7	8

1. Soldiers Pass
2. Lincoln Point
3. Provo
4. Goshen Valley North
5. Spanish Fork
6. Goshen
7. Santaquin
8. Payson Lakes

ADJOINING 7.5' QUADRANGLE NAMES

SURFACE FAULT RUPTURE HAZARD MAP OF THE WEST MOUNTAIN QUADRANGLE, UTAH COUNTY, UTAH

by

Adam I. Hiscock

2018

EXPLANATION

2013–2014 lidar extent: 0.5-meter Wasatch Front bare earth light detection and ranging (lidar) elevation data, available from the Utah Automated Geographic Reference Center and OpenTopography

SURFACE FAULT RUPTURE HAZARD CATEGORIES

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USING THIS MAP

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REFERENCES

Clark, D.L., 2009, Geologic map of the West Mountain quadrangle, Utah County, Utah: Utah Geological Survey Map 234, 2 plates, scale 1:24,000.

Dinter, D.A., 2015, Paleoseismology of faults submerged beneath Utah Lake [poster], *in* Lund, W.R., editor, Proceedings Volume, Basin and Range Province Seismic Hazards Summit III: Utah Geological Survey Miscellaneous Publication 15-5, variously paginated, CD.

International Code Council, 2014, International Building Code: Country Club Hills, Illinois, 700 p.

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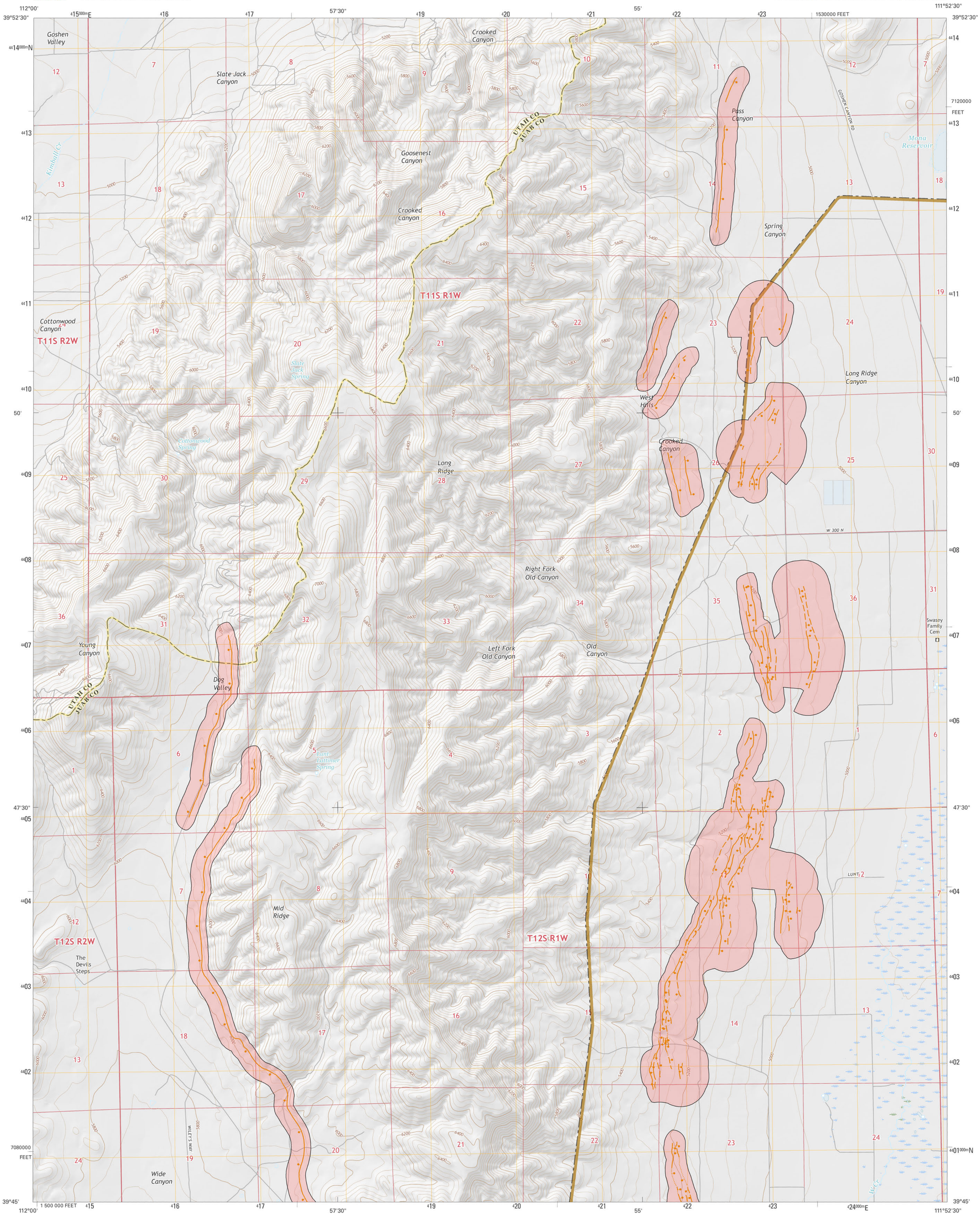
Utah Automated Geographic Reference Center, 2013–2014, Wasatch Front LiDAR elevation data: Online, Utah Automated Geographic Reference Center, State Geographic Information Database, https://gis.utah.gov/data/elevation-terrain-data/2013-2014-lidar/.



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Base from USGS Slate Canyon 7.5' Quadrangle (2017)
Projection: UTM Zone 12
Datum: NAD 1983

Surficial fault mapping: Adam I. Hiscock
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SURFACE FAULT RUPTURE HAZARD MAP OF THE SLATE JACK CANYON QUADRANGLE, UTAH AND JUAB COUNTIES, UTAH

by

Adam I. Hiscock

2018

1	2	3
4		5
6	7	8

1. Eureka
2. Goshen
3. Santaquin
4. Tintic Mountain
5. Mona
6. Furner Ridge
7. Sugarloaf
8. Nephi

ADJOINING 7.5' QUADRANGLE NAMES

EXPLANATION

2013–2014 lidar extent: 0.5-meter Wasatch Front bare earth light detection and ranging (lidar) elevation data, available from the Utah Automated Geographic Reference Center and OpenTopography.

SURFACE FAULT RUPTURE HAZARD CATEGORIES

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USING THIS MAP

This map shows potentially active faults in the Slate Jack Canyon quadrangle along which surface faulting may occur and delineated special-study areas around those faults. Within each area, the UGS recommends a site-specific, surface-fault-rupture hazard investigation (such as fault trenching) be performed before development following the guidelines of Lund and others (2016). Site-specific geotechnical/geologic-hazard investigations can resolve uncertainties inherent in the generalized map scale and help ensure safety by identifying the need for and determine distances for fault setbacks from infrastructure. These investigations use the characteristics of past surface faulting at a site as a scientific basis for providing recommendations to reduce the risk for damage, injury, and/or death from future, presumably similar, surface faulting. Site-specific fault-trenching investigations should be preceded by a careful field evaluation of the site to identify the surface trace of the fault as well as other faults and fault-related features not evident at the mapped scale.

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Robison, R.M., 1989, Draft mapping of faults on the Slate Jack Canyon Quadrangle, Utah: Utah County Geologist, 1 pl.

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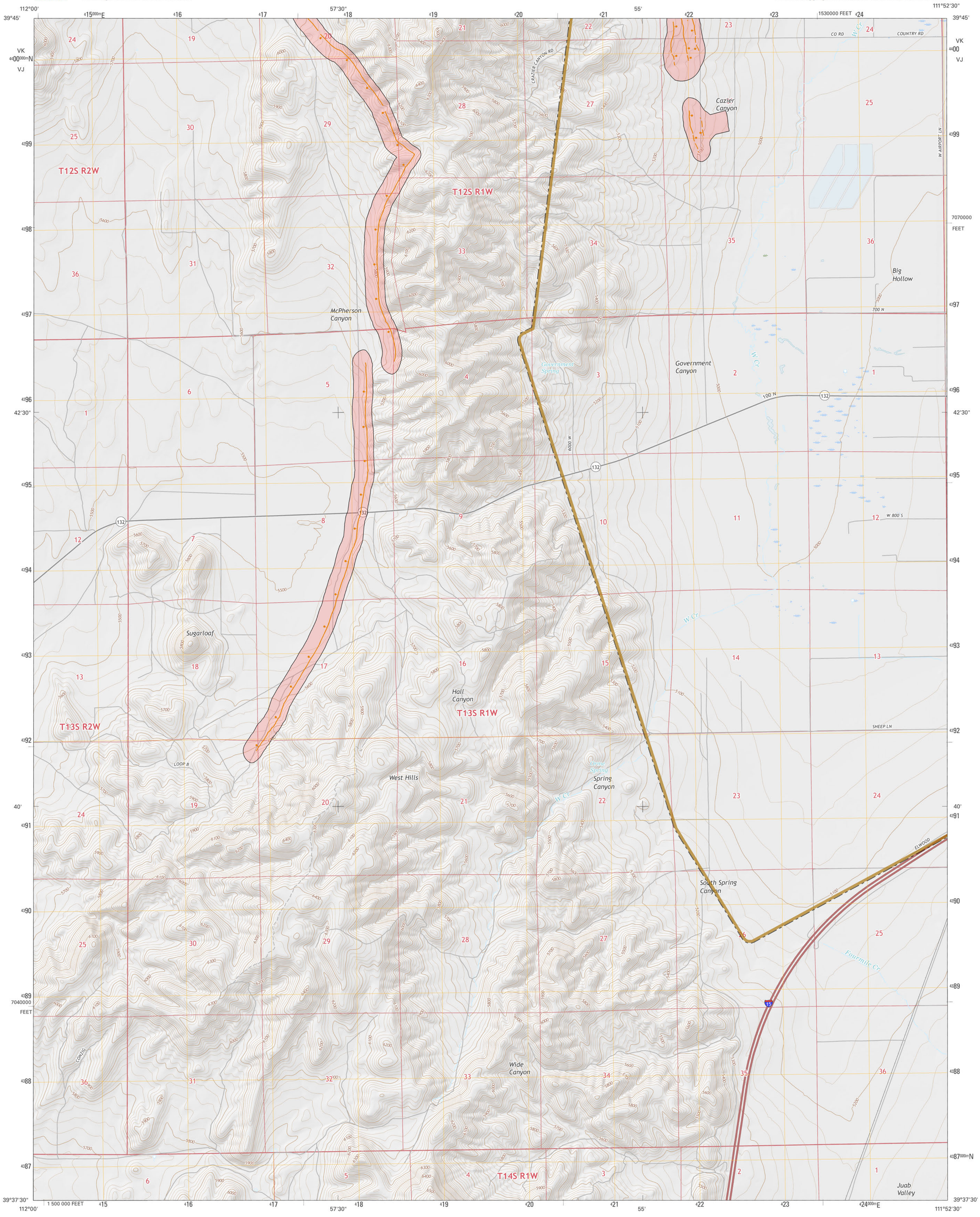
UTAH GEOLOGICAL SURVEY
a division of
Utah Department of Natural Resources



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Base from USGS Sugarloaf 7.5' Quadrangle (2017)
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1	2	3
4		5
6	7	8

1. Tintic Mountain
2. Slate Jack Canyon
3. Mona
4. Furner Ridge
5. Nephi
6. Sage Valley
7. Juab
8. Levan

ADJOINING 7.5' QUADRANGLE NAMES

SURFACE FAULT RUPTURE HAZARD MAP OF THE SUGARLOAF QUADRANGLE, JUAB COUNTY, UTAH

by

Adam I. Hiscock

2018

EXPLANATION

2013–2014 lidar extent: 0.5-meter Wasatch Front bare earth light detection and ranging (lidar) elevation data, available from the Utah Automated Geographic Reference Center and OpenTopography.

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USING THIS MAP

This map shows potentially active faults in the Sugarloaf quadrangle along which surface faulting may occur and delineated special-study areas around those faults. Within each area, the UGS recommends a site-specific, surface-fault-rupture hazard investigation (such as fault trenching) be performed before development following the guidelines of Lund and others (2016). Site-specific geotechnical/geologic-hazard investigations can resolve uncertainties inherent in the generalized map scale and help ensure safety by identifying the need for and determine distances for fault setbacks from infrastructure. These investigations use the characteristics of past surface faulting at a site as a scientific basis for providing recommendations to reduce the risk for damage, injury, and/or death from future, presumably similar, surface faulting. Site-specific fault-trenching investigations should be preceded by a careful field evaluation of the site to identify the surface trace of the fault as well as other faults and fault-related features not evident at the mapped scale.

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We focused on mapping traces of the Wasatch fault zone and other nearby faults within the available high-resolution lidar elevation data. Additionally, we used aerial photography from the *UGS Aerial Imagery Collection* (https://geodata.geology.utah.gov/imagery/). Fault traces outside the available lidar extents are from the *Utah Quaternary Fault and Fold Database* (https://geology.utah.gov/apps/qfaults/). We encourage local governments to forward surface-fault-rupture hazard investigation reports they receive to the UGS so that fault mapping accuracy and detail for future maps can be improved. Additional information on earthquakes and other geologic hazards is available at https://geology.utah.gov/hazards/.

REFERENCES

International Code Council, 2014, International Building Code: Country Club Hills, Illinois, 700 p.

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Utah Automated Geographic Reference Center, 2013–2014, Wasatch Front LiDAR elevation data: Online, Utah Automated Geographic Reference Center, State Geographic Information Database, https://gis.utah.gov/data/elevation-terrain-data/2013-2014-lidar/.

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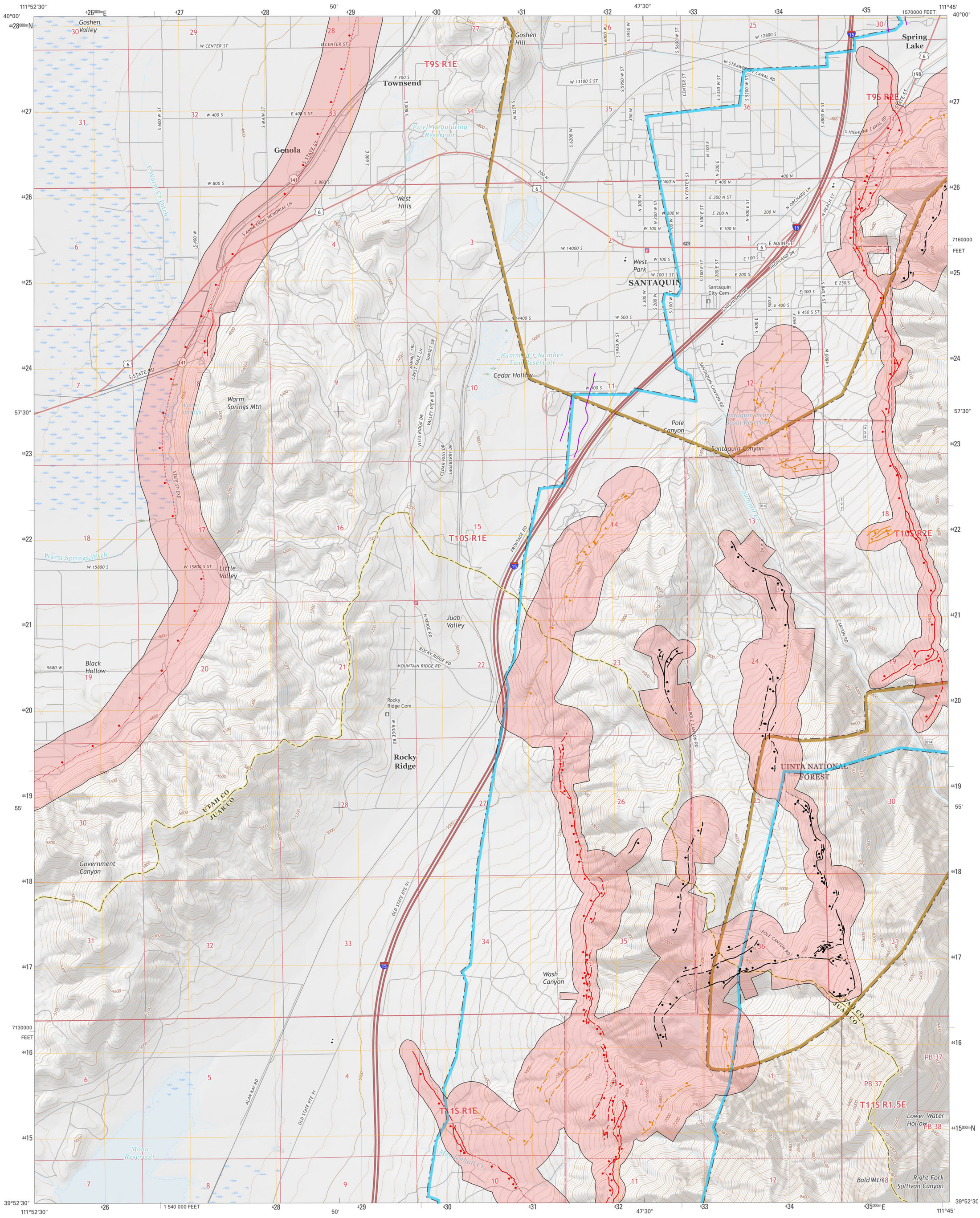
a division of
Utah Department of Natural Resources



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UTAH
QUADRANGLE LOCATION

SCALE 1:24,000
1 0.5 0 1 MILE
5000 2500 0 5000 FEET
1 0.5 0 1 KILOMETER
CONTOUR INTERVAL 40 FEET

TRUE NORTH
MAGNETIC NORTH
11°21'
APPROXIMATE MEAN DECLINATION, 2018

Base from USGS Santaquin 7.5' Quadrangle (2017)
Projection: UTM Zone 12
Datum: NAD 1983

Surficial fault mapping: Adam I. Hiscock
GIS and Cartography: Gordon E. Douglass and Adam I. Hiscock
Project Manager: Greg N. McDonald

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P.O. Box 146100, Salt Lake City, UT 84114-6100
(801) 537-3300
geology.utah.gov

1	2	3
4		5
6	7	8

1. Goshen Valley North
2. West Mountain
3. Spanish Fork
4. Goshen
5. Payson Lakes
6. Slate Jack Canyon
7. Mona
8. Nebo Basin

ADJOINING 7.5' QUADRANGLE NAMES

SURFACE FAULT RUPTURE HAZARD MAP OF THE SANTAQUIN QUADRANGLE, UTAH AND JUAB COUNTIES, UTAH

by

Adam I. Hiscock

2018

EXPLANATION

2013–2014 lidar extent: 0.5-meter Wasatch Front bare earth light detection and ranging (lidar) elevation data, available from the Utah Automated Geographic Reference Center and OpenTopography.

2008 lidar extent: 0.5-meter bare earth lidar elevation data, available from OpenTopography.

SURFACE FAULT RUPTURE HAZARD CATEGORIES

Holocene-active fault (movement within the past 11,700 years) or suspected Holocene-active fault: Surface-fault-rupture hazard investigations recommended for all structures intended for human occupancy and all International Building Code (IBC; International Code Council, 2014) Risk Category IIa, IIb, III, and IV structures (see Lund and others, 2016). Ball and bar on downthrown side of fault. Solid line indicates well-defined fault trace, dashed line indicates moderately well defined fault trace, and dotted line indicates buried or inferred fault trace.

Late Quaternary-active fault (movement within the past 130,000 years) or suspected late Quaternary-active fault: Surface-fault-rupture hazard investigations recommended for all IBC Risk Category IIb, III, and IV structures (see Lund and others, 2016). Investigations for IBC Risk Category IIa and other structures for human occupancy remain prudent, but should be based on an assessment of whether risk-reduction measures are justified by weighing the probability of occurrence against the risk to lives and potential economic loss. Ball and bar on downthrown side of fault. Solid line indicates well-defined fault trace, dashed line indicates moderately well defined fault trace, and dotted line indicates buried or inferred fault trace.

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Other lineaments, unknown activity/source: Lineaments and traces mapped using lidar and other data.

Surface-fault-rupture hazard special-study area: For well-defined faults, special-study area extends 500 feet on the downthrown side and 250 feet on the upthrown side of each fault. For moderately well located or buried/inferred faults, special-study area extends 1000 feet on each side of the suspected trace of each fault (Lund and others, 2016). Refer to booklet for more details on special-study area designations.

USING THIS MAP

This map shows potentially active faults in the Santaquin quadrangle along which surface faulting may occur and delineated special-study areas around those faults. Within each area, the UGS recommends a site-specific, surface-fault-rupture hazard investigation (such as fault trenching) be performed before development following the guidelines of Lund and others (2016). Site-specific geotechnical/geologic-hazard investigations can resolve uncertainties inherent in the generalized map scale and help ensure safety by identifying the need for and determine distances for fault setbacks from infrastructure. These investigations use the characteristics of past surface faulting at a site as a scientific basis for providing recommendations to reduce the risk for damage, injury, and/or death from future, presumably similar, surface faulting. Site-specific fault-trenching investigations should be preceded by a careful field evaluation of the site to identify the surface trace of the fault as well as other faults and fault-related features not evident at the mapped scale.

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REFERENCES

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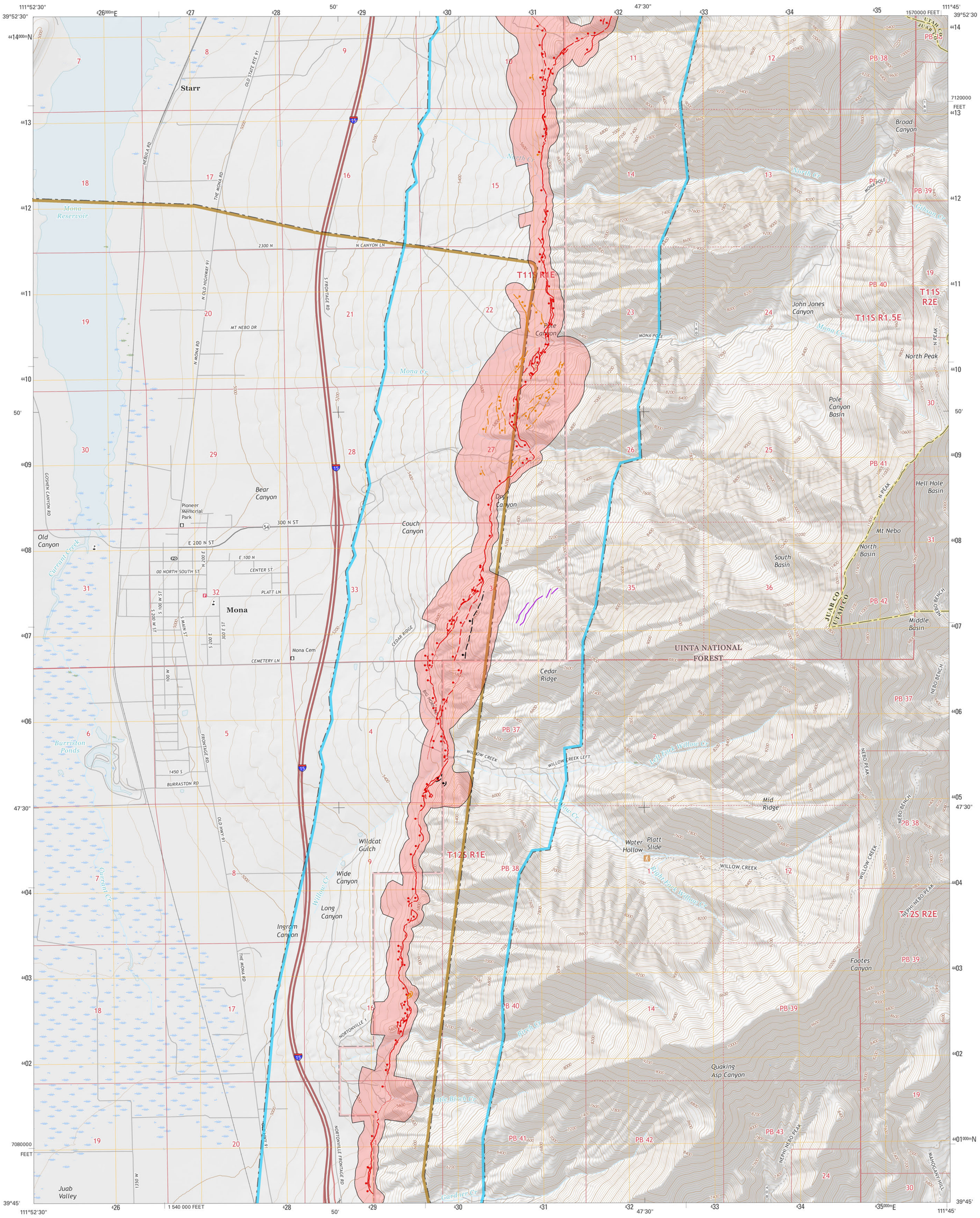
Machette, M.N., 1992, Surficial geologic map of the Wasatch fault zone, eastern part of Utah Valley, Utah County and parts of Salt Lake and Juab Counties, Utah: U.S. Geological Survey Miscellaneous Investigations Series Map I-2095, 1 pl., 1:50,000 scale.

Solomon, B.J., 2010, Interim geologic map of unconsolidated deposits in the Santaquin Quadrangle, Utah and Juab Counties, Utah: Utah Geological Survey Open-File Report 570, 34 p. pamphlet, 1 plate, scale 1:24,000.

Utah Automated Geographic Reference Center, 2013–2014, Wasatch Front LiDAR elevation data: Online, Utah Automated Geographic Reference Center, State Geographic Information Database, https://gis.utah.gov/data/elevation-terrain-data/2013-2014-lidar/.



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11°20'
APPROXIMATE MEAN DECLINATION, 2018

Base from USGS Mona 7.5' Quadrangle (2017)
Projection: UTM Zone 12 N
Datum: NAD 1983

Surficial fault mapping: Adam I. Hiscock
GIS and Cartography: Gordon E. Douglass and Adam I. Hiscock
Project Manager: Greg N. McDonald

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SURFACE FAULT RUPTURE HAZARD MAP OF THE MONA QUADRANGLE, JUAB AND UTAH COUNTIES, UTAH

by

Adam I. Hiscock

2018

1	2	3
4		5
6	7	8

1. Goshen
2. Santaquin
3. Payson Lakes
4. Slate Jack Canyon
5. Nebo Basin
6. Sugarloaf
7. Nephi
8. Fountain Green North

ADJOINING 7.5' QUADRANGLE NAMES

EXPLANATION

2013–2014 lidar extent: 0.5-meter Wasatch Front bare earth light detection and ranging (lidar) elevation data, available from the Utah Automated Geographic Reference Center and OpenTopography.

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EarthScope Intermountain Seismic Belt LiDAR Project, 2008: Online, EarthScope and UNAVCO Plate Boundary Observatory, Supported by National Science Foundation, doi:10.5069/G9VD6WCS

Felger, T.J., Machette, M.N., and Sorensen, M.L., 2004, Provisional geologic map of the Mona quadrangle, Juab and Utah Counties, Utah: Utah Geological Survey Open-File Report 428, 23 p. pamphlet, 2 plates, scale 1:24,000.

Harty, K.M, Mulvey, W.E., and Machette, M.N., 1997, Surficial geologic map of the Nephi segment of the Wasatch fault zone, eastern Juab County, Utah: Utah Geological Survey Map 170, 14 p. pamphlet, 1 plate, scale 1:50,000.

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