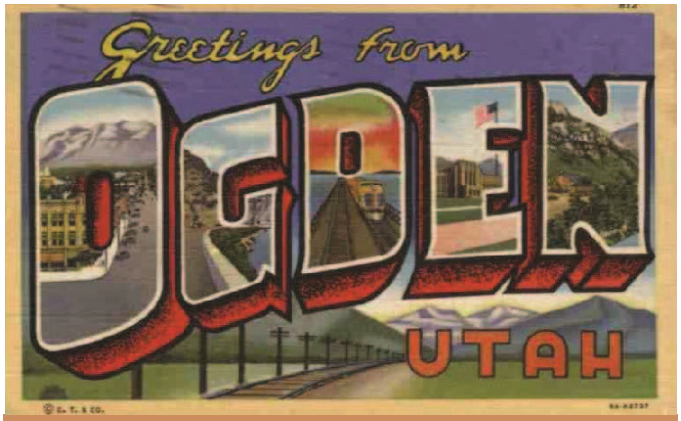
APPENDIX B12

Geology, Soils, and Paleontological Resources
Technical Report



Geology, Soils, and Paleontological Resources Technical Report

Ogden/Weber State University Transit Project

Ogden, Weber County, Utah

October 10, 2018

Contents

Figures

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1.0 Introduction

This technical report describes the topography, geology, geologic hazards, and soils in the geology and soils evaluation area for the Ogden/Weber State University Transit Project and evaluates how those resources would be affected by the Action Alternative. This report also describes paleontological (fossil) resources in the study area. The Action Alternative is the Bus Rapid Transit on 25th Street Alternative, which was selected by the Ogden/Weber State University Transit Project Study partners and adopted by the Ogden City Council as the Locally Preferred Alternative.

Implementation of the No-Action Alternative would not result in adverse impacts to geology, soils, or paleontological resources. The affected environment (existing conditions) would remain unchanged from current conditions.

Project Study Area. The project study area encompasses a 5.3-mile corridor between downtown Ogden, Weber State University, and McKay-Dee Hospital. The project study area is located in the city of Ogden in Weber County, Utah. The project study area encompasses a portion of downtown central Ogden bounded by the Union Pacific Railroad line to the west, 20th Street (State Route [S.R.] 104) to the north, the city limits at the base of the Wasatch Mountains to the east, and about 4600 South to the south, the southwestern part of which follows the Ogden/South Ogden municipal boundary (Figure 1).

This project study area includes the following major destinations and Ogden neighborhood districts that could be served by the Action Alternative (Figure 2):

- The Ogden Intermodal Transit Center (FrontRunner operates frequent service from Ogden to Provo, an 88-mile route)
- Lindquist Field, a minor-league baseball stadium with an 8,262-person capacity
- The Junction, a 20-acre entertainment, residential, retail, and office mixed-use redevelopment
- The Ogden downtown central business district, which includes city, county, and federal offices
- Seven neighborhood districts: Central Business (downtown), East Central, Taylor, Jefferson, T.O. Smith, Mt. Ogden, and Southeast Ogden
- Ogden High School, with an annual enrollment of about 1,000 students in grades 10–12
- Weber State University, with about 2,500 faculty and staff and about 25,000 students (up from 17,000 in 2007), 840 of whom lived on campus as of September 2016 (Sears 2016)
- The Dee Events Center, a 12,000-seat sports and entertainment venue with a 3,000-space parking lot
- The McKay-Dee Hospital Center (at 2,300 employees, the fourth-largest hospital in Utah)

Figure 1. Project Study Area

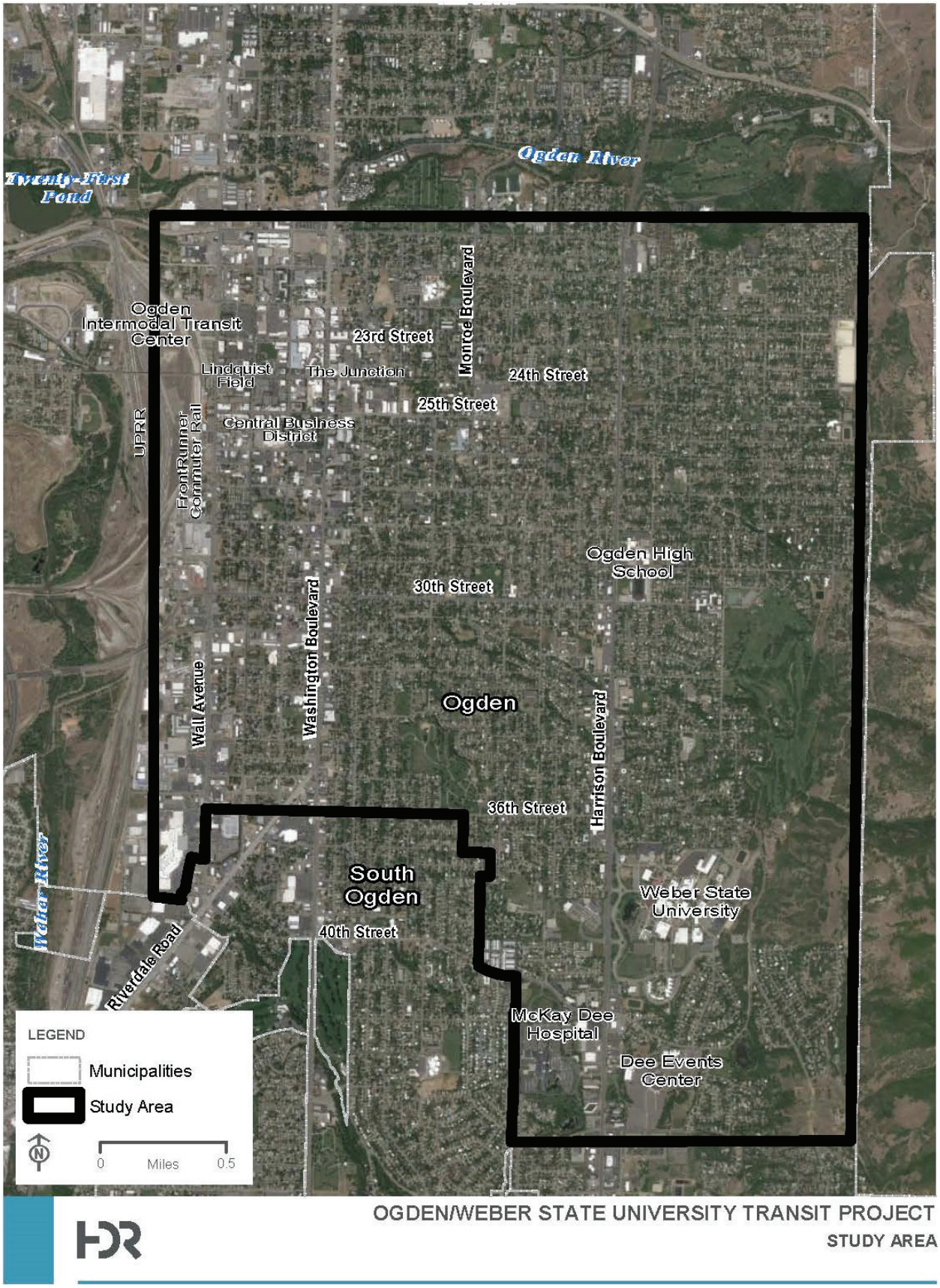
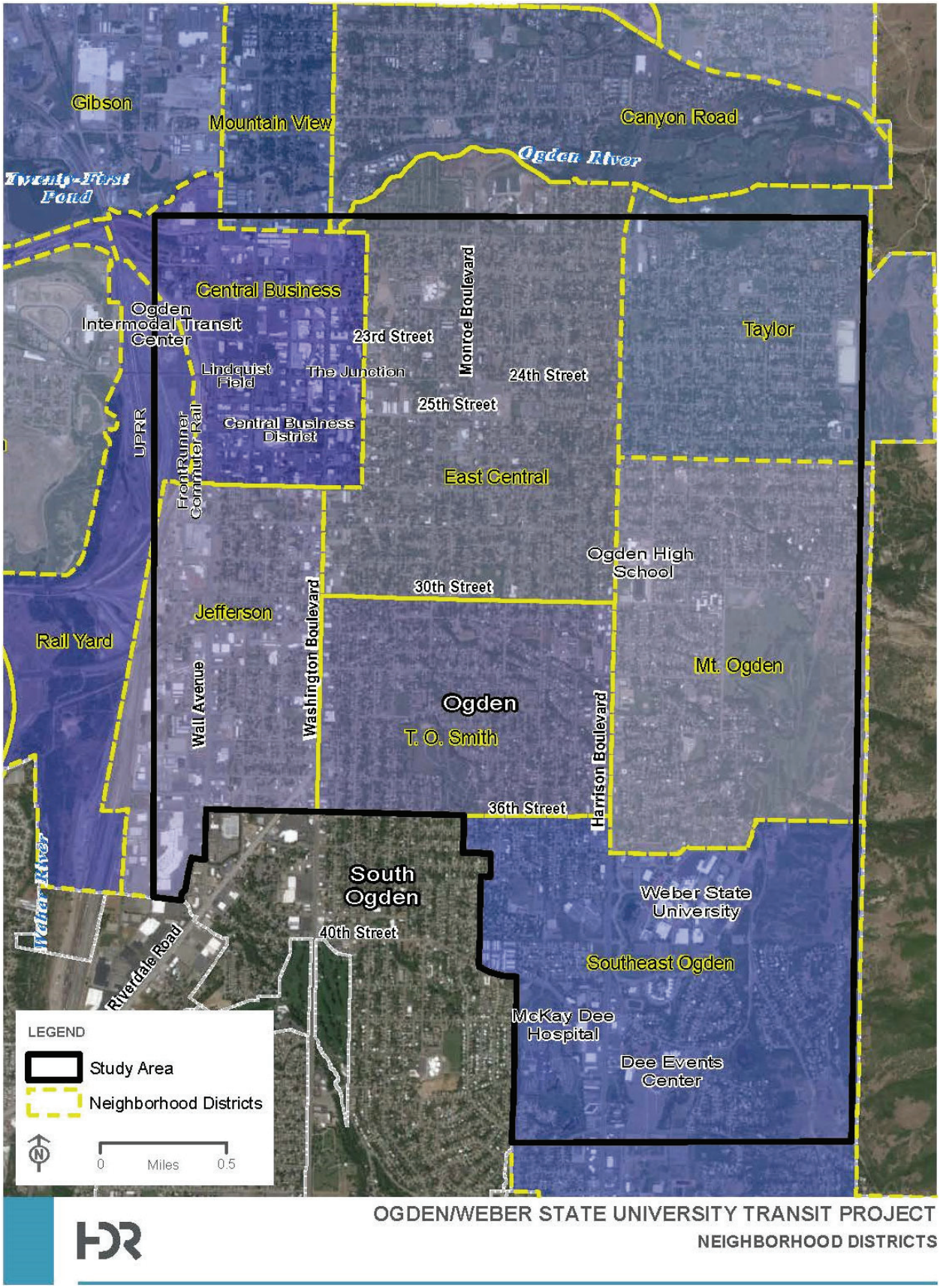


Figure 2. Neighborhood Districts



Ogden is one of the oldest communities in Utah and has a number of historic districts and neighborhoods. Much of central Ogden is served by a traditional grid street system, and a number of the major arterials are state highways managed by the Utah Department of Transportation (UDOT) which serve regional travel through Ogden. These major arterials are Washington Boulevard (S.R. 89), Harrison Boulevard (S.R. 203), and 30th Street (S.R. 79). Harrison Boulevard is part of the National Highway System and is a major north-south arterial that serves an important statewide transportation function through Utah by connecting Washington Boulevard (S.R. 89), Weber State University, and 12th Street (S.R. 39). The Union Pacific Railroad (UPRR) line and the Ogden Intermodal Transit Center are on the western edge of the city, and Interstate 15 is just west of the city.

Geology and Soils Evaluation Area. The geology and soils evaluation area includes the northern Ogden Valley for regional geology and seismicity and about 1 mile on each side of the proposed transit corridor and proposed stations for geologic hazards. The paleontological resources evaluation area is the same as the geology and soils evaluation area.

2.0 Project Description

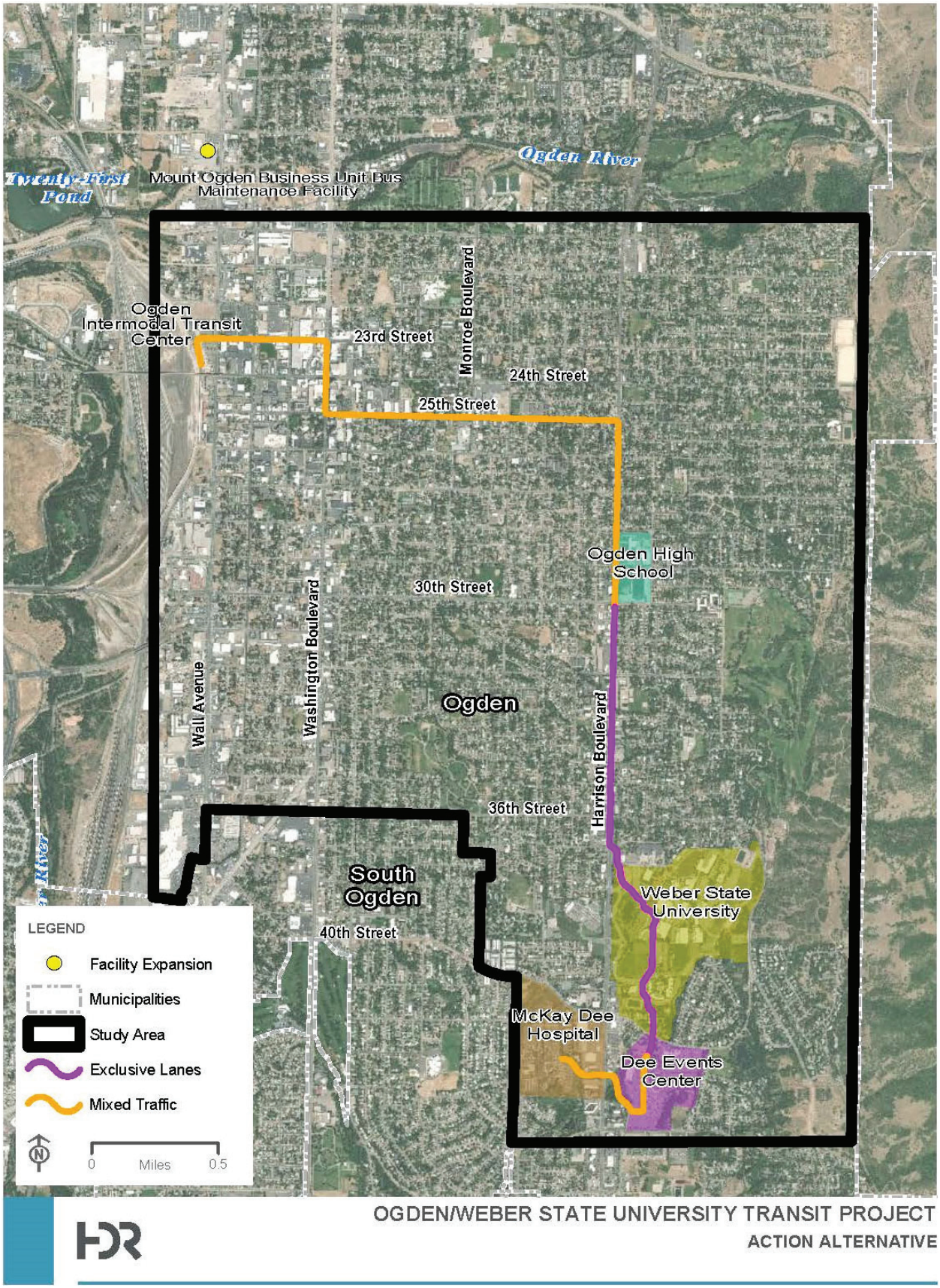
The Federal Transit Administration (FTA) and the Utah Transit Authority (UTA), in cooperation with project partners Ogden City, Weber County, the Wasatch Front Regional Council (WFRC), UDOT, Weber State University, and McKay-Dee Hospital, have prepared an Environmental Assessment under the National Environmental Policy Act (NEPA; 42 United States Code §§ 4321–4347) for the Ogden/Weber State University Transit Project.

Proposed Transit Corridor. The proposed transit corridor is the alignment of the Action Alternative (Figure 3). The BRT route for the Action Alternative would be about 5.3 miles long (10.6 miles round trip), with a western terminus at the Ogden Intermodal Transit Center. From there, the BRT route would head east in mixed-flow traffic on 23rd Street to Washington Boulevard, south on Washington Boulevard to 25th Street, east on 25th Street to Harrison Boulevard, and south on Harrison Boulevard. At about 31st Street and Harrison Boulevard, the BRT route would transition to center–running, bus-only lanes. It would continue on a dedicated busway through the Weber State University campus and then travel west to McKay-Dee Hospital, where it would again travel in mixed-flow traffic. The BRT route would loop back on the same route.

Station Locations. The Action Alternative includes 16 brand-identified stations. The station locations were chosen during the project's Alternatives Analysis update process. Station spacing ranges from about 0.25 mile apart to about 0.50 mile apart; several stations on Harrison Boulevard would be farther apart because of the spacing of major destinations.

Of the proposed 16 stations, 11 are existing bus route 603 stations (including the termini at the Ogden Intermodal Transit Center and McKay-Dee Hospital) that would be enhanced as part of the Action Alternative. The project team agreed that not all 16 stations would be constructed for the BRT service's opening day (2020). Three of the 16 stations are designated as future stop locations. The existing route 603 bus currently stops at two of these three locations, and those locations would be discontinued and new enhanced stations would be constructed in their place in the future based on ridership and station demand.

Figure 3. Action Alternative



Station Amenities. The Action Alternative stations would include a platform, canopy, landscaped planter, and station amenities. The station would sit on a concrete bus pad elevated above the sidewalk curb height between 6 and 9 inches above the street grade. Stations would be about 125 feet long, with a platform length of 100 feet to accommodate two 40-foot-long BRT vehicles. Station shelters would be roughly comparable in size to existing UTA bus passenger shelters in the area, though somewhat longer.

At present, UTA anticipates that the shelters would be designed to include a combination of glass panels and solid support members that would have a minimal visual "footprint." Station canopies would be opaque features that provide shelter from sun and rain and would be about 10 to 15 feet high, depending on the incorporation of decorative architectural features that would be determined during final design.

The platform provides the area for passenger waiting, boarding, and station amenities. The station platform would range from 8 to 25 feet wide, depending on the station location and the need for a platform to accommodate either single-direction travel or both southbound and northbound travel. Station amenities could include ticket vending machines, seating, lighting, a canopy and wind screens, garbage receptacles, and wayfinding information (maps and signs).

Mount Ogden Business Unit Bus Maintenance Facility Expansion. In conjunction with the Action Alternative, UTA would expand the existing Mount Ogden Business Unit Bus Maintenance Facility located at 175 W. 17th Street in Ogden. The Mount Ogden facility is currently operating at maximum capacity and cannot accommodate the additional eight BRT vehicles needed for the Action Alternative. As a result, the existing Mount Ogden facility would be renovated and expanded.

Operations at the Mount Ogden facility would continue to include maintenance, repairs, inspections, and cleaning for the existing bus fleet and the additional BRT vehicles. The BRT vehicles would be maintained and stored overnight at this facility. The north maintenance building would be expanded to the east by about 8,000 square feet, remaining within property currently owned by UTA and remaining within the existing parking lot pavement area; no additional right-of-way would be required. The expansion would consist of four new bus maintenance bays, which are covered areas for maintaining the new BRT vehicles as well as buses already in the fleet. The expansion would bring the existing facility from about 32,000 square feet to just under 40,000 square feet.

23rd Street and 25th Street Roadway Improvements. To further support the Action Alternative, Ogden City would upgrade portions of 23rd Street and 25th Street to better accommodate the Action Alternative. 25th Street would be rebuilt from the bottom up, and, in certain instances, water mains would be replaced, storm sewers would be installed, and sanitary sewers would be repaired. Depending on the extent of the utility work, curbs might be fully replaced. Ogden City would also upgrade the roadway infrastructure on portions of 23rd Street between Wall Avenue and Kiesel Avenue to better support the Action Alternative and active transportation (walking and bicycling). Improvements would include adding a traffic signal at Lincoln Avenue, restriping, adding bicycle lanes, adding crosswalks, reconstructing curbs, and reconfiguring parking.

3.0 Regulatory Setting

FTA guidance states that environmental impact assessments for transit projects require a discussion of the geologic and soil conditions (including hazard areas) in the vicinity of the project area, detailing potential significant adverse impacts of the project alternatives on these conditions (FTA 2016).

4.0 Affected Environment

4.1 Methodology

The project team determined the existing conditions in the project study area by reviewing existing published material and aerial photographs of soils, sub-soils, geologic formations, geologic hazards, and mineral and paleontological resources. The published data were validated during field reconnaissance of the proposed transit corridor. Zones of geotechnical, geologic, and seismic interest in the project study area were documented and located on maps.

The project team identified physical properties and characteristics including general soil classification, soil expansion potential, general geologic classification, stability of material and cut and fill slopes, and potential seismicity and other geologic hazards. The project team also reviewed information from the U.S. Geological Survey and the Natural Resources Conservation Service for the proposed transit corridor.

Significant paleontological resources include vertebrate fossil remains identifiable to a scientifically useful level and other remains that are determined to be rare or of unusually good preservation. Paleontological resources are given consideration and protection under a variety of laws and regulations. Among the federal laws is the American Antiquities Act, which refers only to “objects of antiquity” but has been frequently interpreted to include paleontological resources. Additionally, NEPA also requires consideration of impacts to paleontological resources.

4.2 Soil Conditions

The geology and soils study area is developed with urban uses. The soil associated with many developed parcels is not exposed, or, if it is exposed, it is stabilized using planted landscaping. Subsurface materials are primarily unconsolidated Quaternary soils deposited from the Pleistocene Lake Bonneville and from rivers that fed the lake during the Holocene Epoch. These deposits generally consist of alternating and intermittent layers of clay, silt, and sand with some zones of gravel.

4.3 Geologic Setting

In northern Utah, the Wasatch fault zone is an active fault zone that can produce a large 7.5-to-7.7-magnitude earthquake on the Richter scale on average every 300 to 400 years. The Weber segment of the Wasatch fault zone extends from North Salt Lake along the eastern edge of the Ogden valley to Willard Bay in Weber County. The Weber segment has produced

four large earthquakes over the past 4,000 years, making it one of the most active segments of the Wasatch fault zone (Nelson and Personius, no date).

Weber County is located atop ancient Lake Bonneville, which is made up of very weak soils. The area also has shallow groundwater and a relatively high earthquake threat. The secondary threat, liquefaction associated with an earthquake, could have a greater effect on the county than on the surrounding areas (WFRC 2003). For more information about liquefaction, see Section 4.4.2, Liquefaction.

The Ogden area lies in the Intermountain Seismic Belt, a region of historic seismic activity that extends from northwestern Montana to southwestern Utah (Weber State University, no date, Figure 4B). This belt contains major normal faults capable of generating large-magnitude earthquakes, including the Wasatch fault, which is of particular concern because of its size and proximity to urban areas. The Wasatch normal fault is 240 miles long; extends from near Malad, Idaho, to Fayette, Utah; and consists of multiple segments that have each produced earthquakes (that is, only part of the fault breaks during a single earthquake). The Ogden area is along the Weber segment, which extends 40 miles north-south from Pleasant View to near North Salt Lake (Weber State University, no date).

What is a normal fault?

A normal fault is a geologic fault in which the hanging wall (overlaying wall) has moved downward relative to the footwall (supporting wall).

The Action Alternative would be located in the Bonneville Basin, a subdivision of the Great Basin, a relatively flat lowland plain along the western edge of the Wasatch Range and the eastern shore of the Great Salt Lake. The topography of the terrain in the proposed transit corridor is relatively flat with ground elevations from about 4,300 feet on the northwest end near the Ogden Intermodal Transit Center to about 4,780 feet near the southeastern end of the corridor near the Dee Events Center.

4.4 Geologic Hazards

Several potential geologic hazards are associated with the frequency and distribution of earthquakes in the region, which is dominated by the Wasatch fault zone. These hazards include ground shaking, liquefaction, and tectonic subsidence. Landslides are another geologic hazard that can be directly or indirectly related to earthquake activity. The following sections provide more information about these potential hazards.

4.4.1 Ground Shaking

The Wasatch fault zone is active and can produce damaging seismic waves during an earthquake. Any walls and embankments built for the Action Alternative would have to be designed to withstand the anticipated ground shaking and earthquake accelerations associated with movement along the Wasatch fault zone and other nearby active faults.

Since 1894, two major earthquakes with a magnitude between 5.0 and 5.5 have occurred in the Ogden area. Residents of Weber County have also felt earthquakes with epicenters outside the county. According to WFRC's Natural Hazards Pre-Disaster Mitigation Plan (WFRC 2003), in 1962 an earthquake with an epicenter in Richmond, Utah (along the Cache fault) produced a 5.7-magnitude earthquake that was felt in Weber County. Other similar

earthquakes include three in the Pocatello Valley (in Idaho) along the Hansel Valley fault: a 6.0-magnitude earthquake in 1975, a 6.6-magnitude earthquake in 1934, and a 6.0-magnitude earthquake in 1909. In addition, between 1910 and 1962, four earthquakes with epicenters in Salt Lake County and magnitudes of 5.0–5.2 were felt in Weber County.

A Quaternary fault runs through much of the Weber State University campus (see Figure 4 on page 11). The Utah Geological Survey (UGS) recommends conducting special studies to address surface-fault-rupture hazards prior to development of facilities.

4.4.2 Liquefaction

Liquefaction is the sudden loss of strength and stiffness in soil during strong earthquake shaking. During liquefaction, soil transforms from a solid state to a liquid state. Liquefaction can cause subsidence, sand boils, lateral soil spreading, and loss of support for structures such as buildings and bridges.

The northwestern segment of the proposed transit corridor is in a high-liquefaction zone (see Figure 5 on page 12). The segment of the proposed transit corridor that runs along Harrison Boulevard and through the Weber State University campus has moderate to very low liquefaction potential.

4.4.3 Tectonic Subsidence

A major earthquake along the Wasatch fault zone could cause some degree of tectonic subsidence. Tectonic subsidence is the vertical movement of the outer shell of the earth without any change in the weight of the overlying sediments or water. Although ground subsidence is a potential hazard, it is not practical to incorporate measures in the design of the Action Alternative to mitigate this risk.

4.4.4 Landslides

A landslide is gravity-induced downward and outward movement of rock or soil. Landslides can range in size from tiny pop-outs on soil slopes to massive earth movements. Future landslide areas are usually located in the areas of historical landslides, which are well-defined local areas.

Historically, landslides have been one of the most common hazards in Weber County. The homes along the benches in the canyons have the greatest risk of rockfalls, debris flows, landslides, and other types of slope failure.

The East Ogden landslide, which occurred about 13,000 years ago, covers about 4 square miles in central Weber County, mostly in Ogden, and underlies the Weber State University campus. Because there is a relatively deep water table in this area, the potential for recurrent movement of large, liquefaction-induced landslides is low. However, local areas of shallow, perched groundwater and sandy sediments susceptible to liquefaction are common in eastern Ogden, and slopes are commonly greater than 0.1%, so smaller liquefaction-induced landslides could occur in this area during future earthquakes (UGS 2003).

As shown in Figure 6 on page 13, Weber State University is in an area that is susceptible to both shallow and deep-seated landslides. UGS recommends that special studies to address landslide hazards be conducted before any new facility is built in this type of area (UGS 2008c).

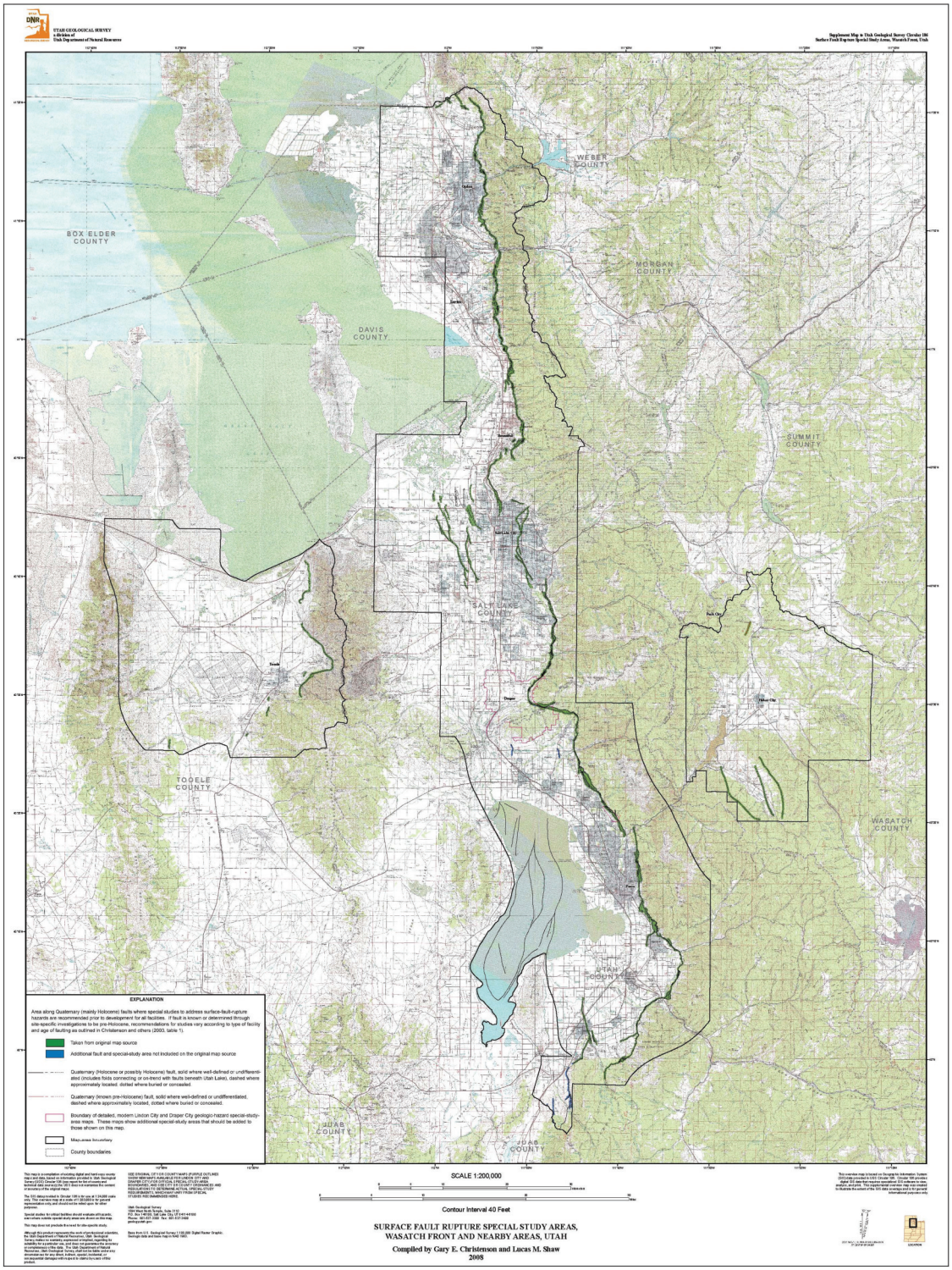
What is a deep-seated landslide?

A deep-seated landslide is a landslide in which the sliding surface is mostly deeply located below the maximum rooting depth of trees (typically to depths greater than about 30 feet).

For all soil types and across a wide range of geological formations, the potential for landslides intensifies as the slope increases. Through the Weber State University campus, primarily through the neighborhood that separates the north and south campuses, the slopes are as steep as 7%. Although this area is already densely developed with homes and city roads, placing the BRT route through this area could introduce or increase the potential for landslides on the steep hillside in this neighborhood.

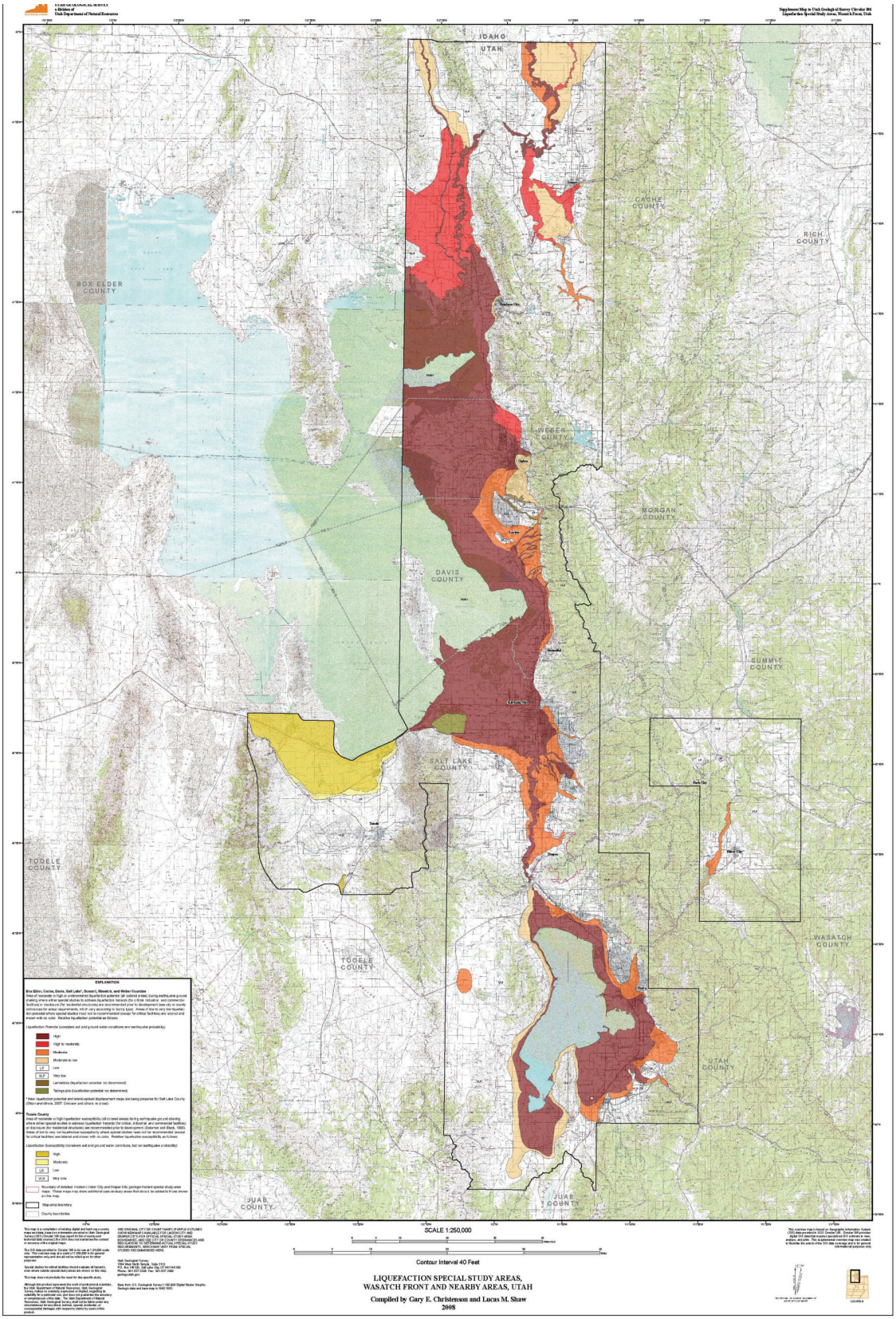
Landslide risk can be reduced by avoiding or stabilizing areas of past landslides. To successfully avoid landslides, the boundaries of landslide masses must be accurately identified and appropriate setbacks determined. If avoidance is not possible, landslide masses and unstable slopes must be stabilized. Controlling surface-water and groundwater drainage is the most widely used and is generally the most successful slope-stabilization method. The stability of a slope can be increased by removing all or part of a landslide mass or by adding earth buttresses placed at the toes of potential slope failures. Restraining walls, piles, caissons, or rock anchors are commonly used to prevent or control slope movement. In most cases, combinations of these measures are used (Spiker and Gori 2003).

Figure 4. Surface Fault Rupture Special Study Areas



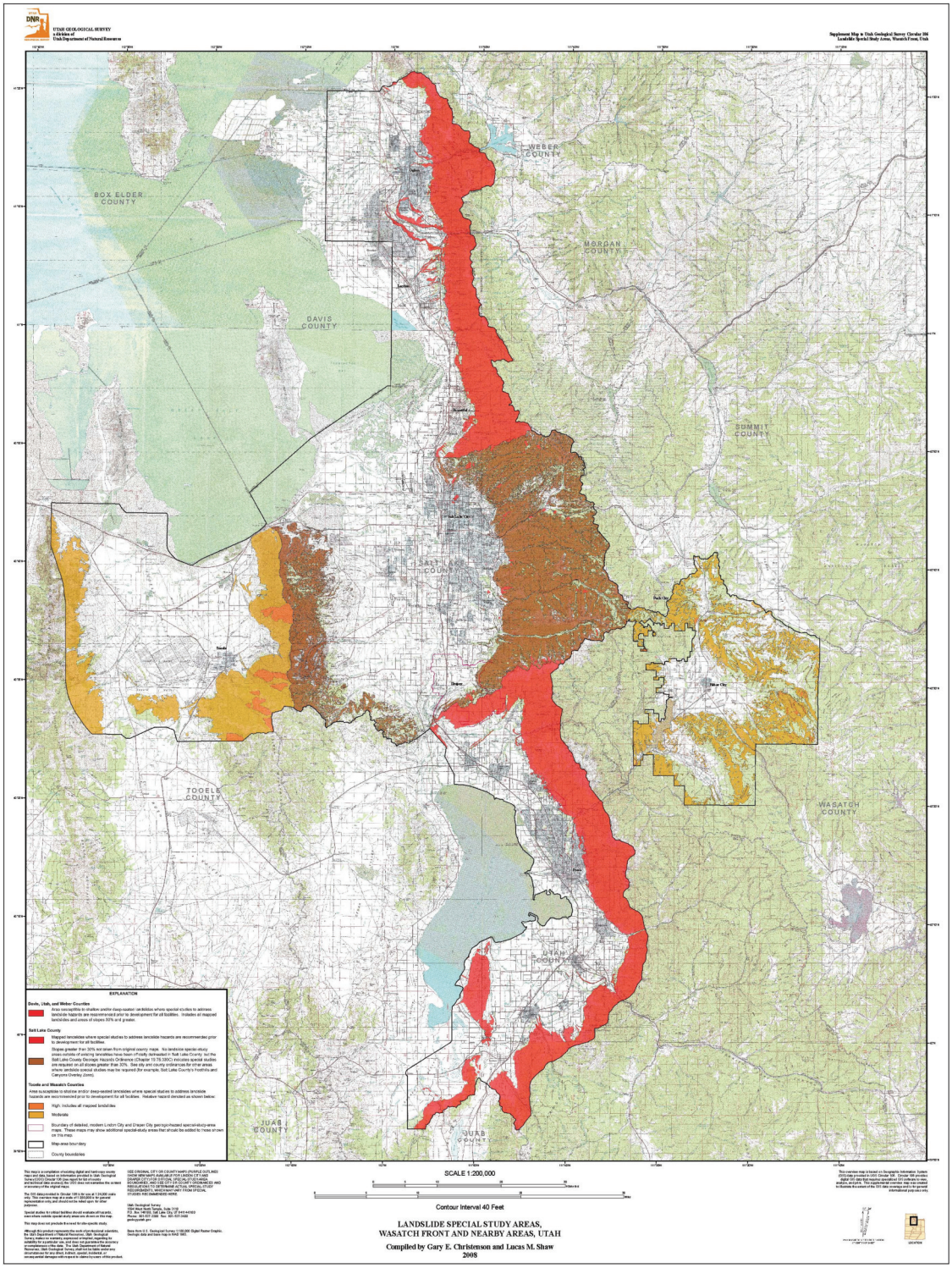
Source: UGS 2008a

Figure 5. Liquefaction Special Study Areas



Source: UGS 2008b

Figure 6. Landslide Special Study Areas



Source: UGS 2008c

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4.5 Paleontological Resources

The project team reviewed published literature regarding the prehistoric and historic uses of and the known geological composition of the project area to determine whether paleontological resources would be affected by the Action Alternative. The project team conducted a search of UGS's files, which indicated that there are no paleontological localities in the project area. Quaternary alluvial deposits that are exposed in the project area have a low potential for yielding significant fossil localities.

No known paleontological resources are present in the paleontological resources evaluation area, and the overall potential for such resources is low because of the area's geology and the urban nature of the proposed transit corridor. However, exposures of Lake Bonneville deposits could be present in the area, and these deposits have been known to yield significant vertebrate fossils elsewhere along the Wasatch Front.

5.0 Environmental Consequences

5.1 No-Action Alternative

With the No-Action Alternative, the existing bus service in the proposed transit corridor would remain unchanged. No new construction would be undertaken, no street facilities would be altered, a new busway would not be constructed through the Weber State University campus, and no new impacts related to soils, geology, or paleontological resources would result. Therefore, there would be no adverse effects on soils, geological resources, or paleontological resources as a result of the No-Action Alternative.

5.2 Action Alternative

5.2.1 Soils and Geology

Construction Effects. Constructing the Action Alternative would not cause adverse impacts to soils or geology. BRT would be implemented mostly on existing roads and would be located mainly within existing public rights-of-way, so for the most part it would have little to no effect on the surrounding geology and soils. In areas of exclusive bus-only travel lanes, construction would not disturb soils beyond a predicted depth of 18 inches of predisturbed land along the alignment. Neither dredging nor boring would be required for construction or operation of the BRT.

Constructing the Action Alternative would involve more substantial earthwork, including major cuts (excavations) and fills, through the Weber State University campus where the new alignment is required. Cut materials would be reused in areas of the proposed transit corridor that require fill. However, there would likely be areas where the excavated soils are unsuitable for reuse, particularly during wet weather. Unsuitable soils would be exported off site for disposal. Similarly, UTA expects to import some fill soils for use along the proposed BRT alignment.

Between Village Drive and Country Hills Drive on the University campus, busway impacts would require retaining walls, particularly near the student housing complex, that range from 3 to 10 feet high. The grades through this area would require a 7% longitudinal grade to minimize the impact at Country Hills Drive. In addition, the new busway alignment would be about 125 feet from the center of the alignment to the edge of the South Ogden Highline Canal detention pond, located just north of 4225 South and south of Village Drive. The top of the basin ranges from roughly 20 feet above the busway to level with the busway as the busway climbs the hill and passes beyond the detention basin.

Although a major landslide or slope failure is not likely to occur along the project alignment, a geotechnical survey of the busway through the University campus, with emphasis in areas with the steeper grades and near the detention basin, would be required during the final design phase of the project.

No mapped landslides cross the Action Alternative alignment, and the steepest slopes are about 7%, as shown in Figure 7. The overall risk for slope instability or failure along the Action Alternative alignment is low because slopes are flatter than 10%. More likely to occur would be minor slope failure, including instability resulting from local construction-induced settlements, or slumping if there were an improperly supported excavation near the base of a hillside.

Erosion would be a concern during construction. Implementing a temporary erosion and sedimentation control plan would substantially reduce the volume of eroded soil and the potential for discharging silt-laden runoff into nearby waters.

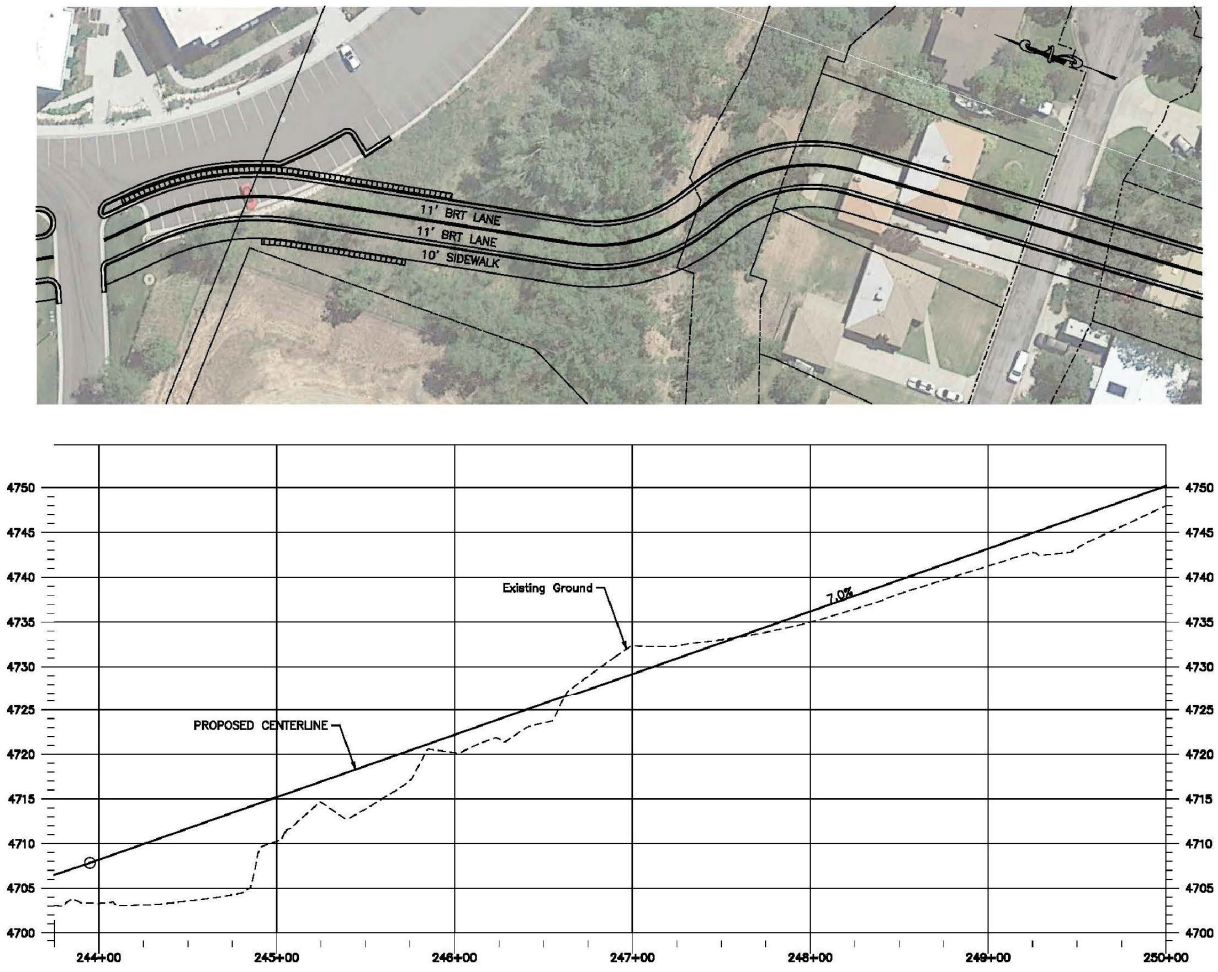
Operational Effects. The Action Alternative would be located in an area that is subject to ground shaking, liquefaction, and landslides. In order to determine whether any additional studies are warranted, UTA would work with Weber State University during the final design phase of the project to obtain any special studies the University has completed when developing its campus facilities. Further, any walls and embankments built for the Action Alternative would need to be designed to withstand the anticipated ground shaking and earthquake accelerations associated with movement along the Wasatch fault zone and other nearby active faults.

UTA would design the BRT system to withstand seismic effects using the best available technology. UTA might require coordination with Weber State University and specific geotechnical investigation and design measures during the final design phase of the project to ensure a stable final slope and earthquake-safe configuration in areas of bus-only lanes and through the Weber State University campus.

5.2.2 Paleontological Resources

Because no known paleontological resources were identified in the paleontological resources evaluation area, no analysis of specific paleontological localities was conducted, and no known paleontological resources would be affected by the Action Alternative.

Figure 7. 7% Profile Section



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