STABILITY OF THE PINE RIDGE LANDSLIDE AT TIMBER LAKES ESTATES, WASATCH COUNTY, UTAH: IMPLICATIONS FOR FUTURE DEVELOPMENT AND LAND-USE PLANNING

by
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INTRODUCTION

This pamphlet provides a non-technical summary of the results of the Utah Geological Survey's preliminary slope-stability evaluation (Hylland, 1996) of the Pine Ridge landslide at Timber Lakes Estates in Wasatch County (figure 1), and discusses the implications for future development and land-use planning on and near the slide. The study was conducted to aid the county and Timber Lakes lot owners in dealing with the landslide hazard. Those interested in the technical details of the study should refer to Ashland and Hylland (1997).

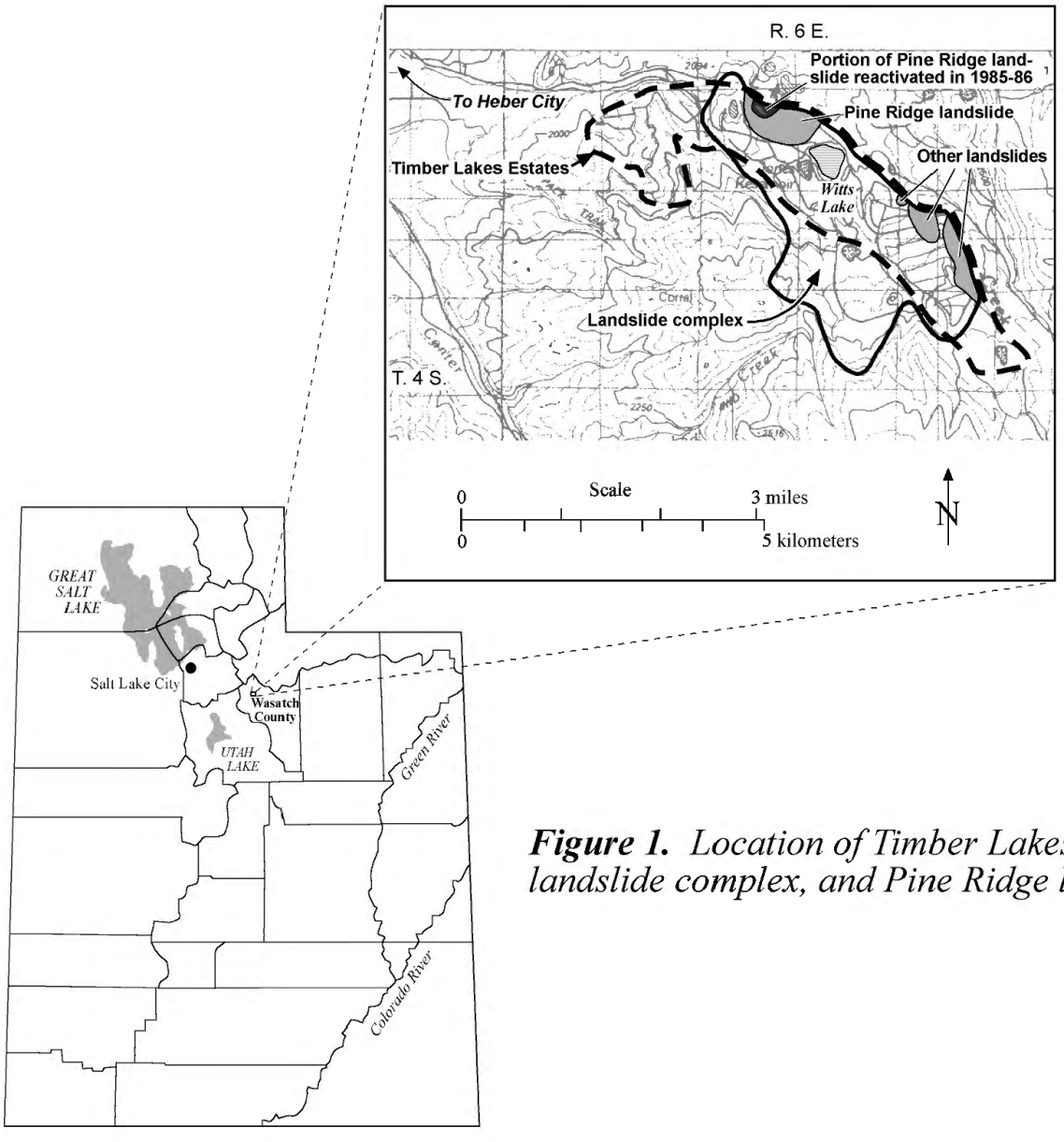

Figure 1. *Location of Timber Lakes Estates, landslide complex, and Pine Ridge landslide.*

The Pine Ridge landslide is the largest of several known relatively young slides (movement occurred in the past 5,000 years) in Timber Lakes Estates. The largest landslides have formed in soil deposited by glaciers over 10,000 years ago. Figure 2 is a conceptual diagram showing a typical landslide along Lake Creek in Timber Lakes Estates. About 114 lots, some with cabins, are either on or abut the Pine Ridge landslide. A part of the slide, about 11 acres in size, reactivated as a "slump" in 1985-86 and damaged a cabin. In addition, active shallow landsliding, known as debris sliding, is modifying the steep slope along Lake Creek that forms the toe, or downslope edge, of the Pine Ridge landslide. A debris slide along Lake Creek and southeast of the Pine Ridge landslide completely destroyed a cabin in 1986.

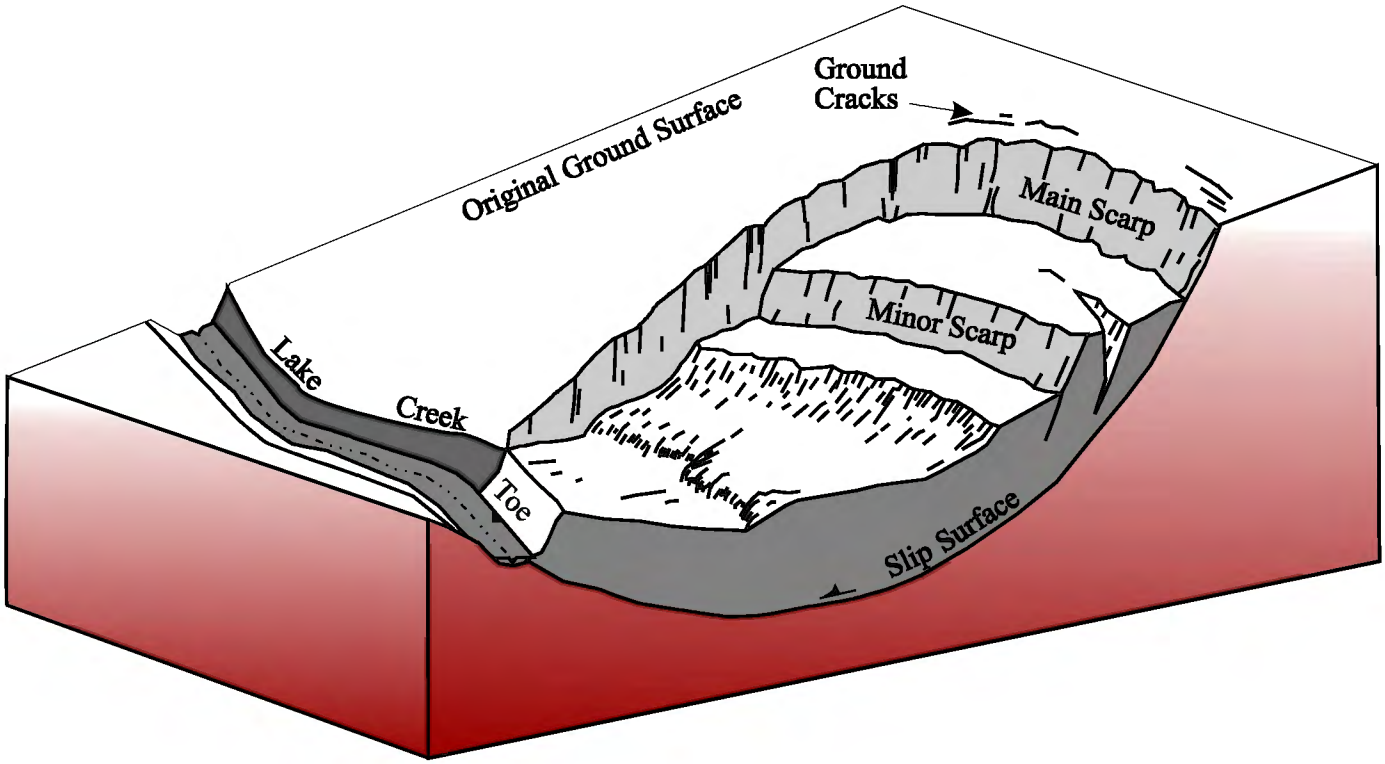

Figure 2. *Conceptual diagram showing main features of landslides at Timber Lakes Estates.*

LANDSLIDE STABILITY

The 1985-86 slump likely moved as a result of a combination of shallow ground water and the weakened ability of soil to resist sliding (called soil strength). The weakened soil strength is caused by repeated landslide movement in the slump area.

The remainder of the Pine Ridge landslide, outside of the 1985-86 slump area, may be more stable because it has not moved recently and soil strengths are probably higher. Our analyses of three debris-slide areas along Lake Creek indicate high strength values exist for the glacial soil where repeated landsliding has not occurred. Actual strengths for the Pine Ridge landslide likely range between the lower strengths in the slump and the higher values in the relatively undisturbed glacial soils.

The Pine Ridge landslide can be separated into two parts with different relative stabilities. The northern part of the landslide along Lake Creek, including the 1985-86 slump (figure 3), is susceptible to localized slumping because of the steep slopes, even if soils have high strengths. The southern part of the landslide would likely be affected only by reactivation of the entire slide, which we believe is unlikely under normal conditions. However, movement of the entire slide could occur during earthquake ground shaking at times of high ground water, assuming weak soils exist along the main slip surface.

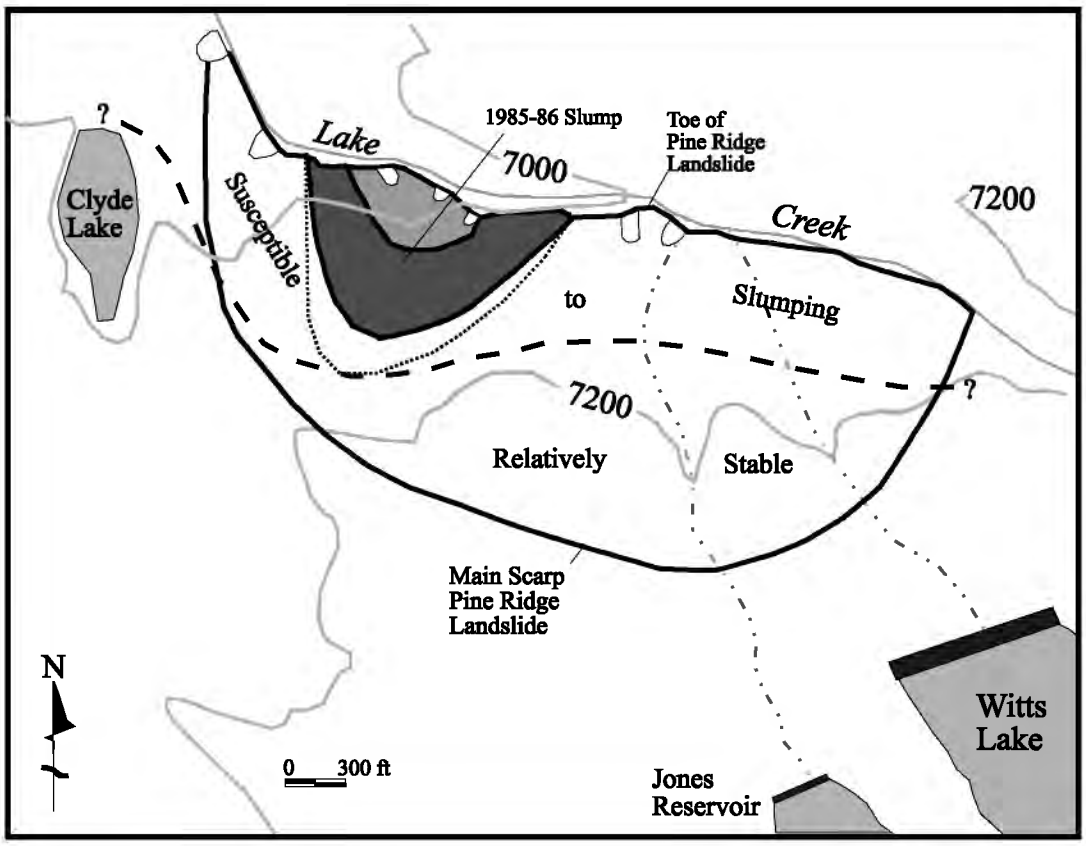

Figure 3. *Map showing area susceptible to slumping. Results of our analyses suggest northern part of landslide is susceptible to slumping at high ground-water levels even if soil strengths approach their highest values. Boundary is based on using average strength value. Shaded area surrounding boundary is zone of uncertainty regarding actual location of boundary. Dotted line shows recommended setback from main scarp of 1985-86 slump. Elevations in feet above mean sea level.*

IMPLICATIONS AND RECOMMENDATIONS

A continuing hazard exists for lots on or abutting the 1985-86 slump area. The slump is capable of repeated movement during periods of high ground water which are most likely to occur each spring. The area directly upslope of the main scarp of the 1985-86 slump may also be susceptible to future slumping. Because of the uncertainties in this preliminary study, we recommend that no development be allowed within at least 200 feet (60 m) upslope of the highest point on the main scarp (see figure 3) without a detailed investigation that demonstrates stability based on data from deep drill holes, laboratory soil-strength testing, and ground water level (depth to water below the ground surface) monitoring.

Debris sliding will continue along Lake Creek, and, in addition, we believe a potential for slumping also exists in the northern part of the Pine Ridge landslide even outside the area of the 1985-86 slump. Because of the uncertainties in this preliminary study, we cannot accurately define the zone of potential landsliding, but at a minimum we recommend that no development be allowed north of the dashed line shown on figure 3 without detailed investigations as described above. Because such investigations are most cost-effectively done on an area-wide basis, and not on a lot-specific basis, we recommend that a single detailed study be performed to evaluate the stability of the northern part of the landslide, including the 1985-86 slump. Long-term cumulative effects of septic-tank drainfields on ground-water levels must also be considered in this study.

Because of the apparent stability in the area south of the dashed line shown in figure 3, lot-specific investigations that address the stability of the landslide are likely unnecessary in this area. To further reduce risks, we recommend the use of minimum building setbacks (Uniform Building Code, 1997; figure 18-I-1, p. 1-176) from the main and minor scarps (figure 2) and other known or readily apparent landslide-related features. As a general rule, the scarps can be identified as any slope higher than 15 feet and steeper than 30 percent. At a minimum, we recommend that the existence of the Pine Ridge landslide be disclosed to all lot owners, including those in the southern part of the slide.

LIMITATIONS

Recommendations given here are based on the results of a preliminary analysis using estimated ground-water and soil conditions. These recommendations are for land-use planning to reduce, not eliminate, the risk from landsliding and to indicate where more detailed studies are needed. These recommendations need to be re-evaluated once actual conditions are known from detailed studies. Our conclusions regarding the relative stability of the entire slide do not preclude the possibility of movement, particularly in the event of significant earthquake ground shaking during wet conditions.

REFERENCES

Ashland, F.X., and Hylland, M.D., 1997, Preliminary geotechnical-engineering slope-stability investigation of the Pine Ridge landslide, Timber Lakes Estates, Wasatch County, Utah: Utah Geological Survey Report of Investigation 232, 28 p.

Hylland, M.D., editor, 1996, Guidelines for evaluating landslide hazards in Utah: Utah Geological Survey Circular 92, 16 p.

Uniform Building Code, 1997, Structural Engineering Design Provisions: International Conference of Building Officials, v. 1, 442 p.

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