December 28, 1999

Glen L. Woodbury, Director
Emergency Management Division
Washington Military Department
Camp Murray, WA 98430-5122

Dear Mr. Woodbury:

The Emergency Management Division, Washington Military Department, requested that staff from the Geology and Earth Resources Division, Washington Department of Natural Resources, perform a field review of slope conditions in the Haussler Road/Apple Lane area of Kelso. Steve Palmer and Tim Walsh of the Geology and Earth Resources Division conducted the requested field review on November 22, 1999. This report summarizes the results of our field review of slope conditions in the Haussler Road/Apple Lane area.

Prior to the field inspection we reviewed a number of recent geotechnical reports of investigations performed for the City of Kelso or local residents of the west side of Davis Terrace. On the day of the field review we first met with a number of local residents of the Haussler Road/Apple Lane area to hear their observations of recent ground movement and damage to residential structures. The residents affected by this landslide are anxious to understand if the ground movement and damage to their homes is likely to continue through this winter season, and if any engineering solution can mitigate this situation. A scheduled late morning meeting with Kay Adams of the City of Kelso was canceled due to unexpected circumstances. Much of the afternoon was spent reviewing slope conditions and building damage with Barbara Nielsen, a local resident living on Sunnyside Drive.

The Haussler Road/Apple Lane area has been long recognized as part of a large prehistoric landslide complex encompassing the west side of Davis Terrace. Nearly 30 years ago the alignment of Interstate 5 was moved westward to avoid the toe of this landslide complex. Chronic pavement distress along Kelso Drive and Grade Street downslope of the Haussler Road intersection provides clear evidence that portions of the toe of this landslide complex are actively moving.

The most recent episode of slope movement in the Haussler Road/Apple Lane area appears to have initiated in February, 1996, with development of a 3 ft drop on Highland Park Drive near the intersection with Sunnyside Drive. Foundation Engineering Inc. performed a geotechnical investigation of this failure, and concluded that movement was along a shallow (~12 ft depth) failure surface at the contact of the ancient landslide debris and the underlying weathered Cowlitz Formation mudstone. Movement of Haussler Road above Rons Court

initiated in January, 1999, and by March, 1999, Haussler Road had been deflected several feet downslope. Slope inclinometer data acquired by GeoEngineers Inc. indicated that the landslide failure surface at this location is shallow (10 to 20 ft depth), and is at the contact of older landslide debris overlying Cowlitz Formation bedrock. They concluded that the landsliding in the vicinity of the Haussler Road failure: "...is generally a translational movement of the ancient landslide debris over the underlying Cowlitz Formation. In some areas, secondary failures are apparently occurring within or on top of the overall, larger failure." GeoEngineers Inc. recommended that a combination of an interceptor drain and a shear key be used to mitigate the Haussler Road failure. These were constructed during the summer of 1999.

As part of their evaluation of the slope failure affecting Haussler Road near Rons Court, GeoEngineers Inc. has generated a map showing key features of the prehistoric landslide, including the headscarp and subsidiary scarps within the landslide mass, locations of springs, seeps, and areas of ponded water, and areas of recent slope movement; a copy of this map is attached for reference. The residents of the Haussler Road/Apple Lane area have compiled a database of damage to residences which was extremely useful during our site review.

Observations

We inspected damage to a number of residences on the database list provided by the local residents, as well as damage to a few structures that were not listed. It is clear that a significant number of residences throughout this area are undergoing structural distress as a result of soil movement. Local residents noted that ground movement and distress to structures became noticeable in March, 1999, and has reached a point where damage to a few residences is compromising the integrity of these structures.

During our field review we observed the headscarp of the prehistoric landslide lying due west of Vista Lane, and secondary scarps that separate blocks within the landslide mass; the most prominent of these secondary scarps runs just south of Sunnyside Drive. The primary damage to residences includes recent cracking of foundation stem walls and footings, distortion of framing elements resulting in sticking doors and windows, cracking of interior sheetrock and exterior masonry facades, and tilting and warping of floors and concrete pads. Our impression is that the houses with the most damage were located either at the top or base of the steep scarps associated with the prehistoric landslide. Indications of ground movement are not restricted to the upper portion of the slope in area of Vista Way and Sunnyside Drive. Recent damage to structures along the lower portion of Haussler Road and Lowrane Drive were also observed.

We observed very few ground cracks during our field review, an observation that stands in stark contrast to the behavior of other recent large landslides in western Washington (e.g., Aldercrest-Banyon or Carlyon Beach). The shallow depth of the landslide failure surface (at least in the vicinity of the Haussler Road failure) also contrasts to the deeper failure surfaces determined for the Aldercrest-Banyon and Carlyon Beach landslides.

Other slope inclinometer data acquired by GeoEngineers, Inc., away from the immediate area of the Haussler Road failure did not conclusively indicate subsurface movement. Two of these slope inclinometers (BH-8 and BH-9) are located near residences that exhibit recent damage due to ground movement. In particular BH-8, located at the intersection of West Vista Way and Haussler Road, is immediately downslope from 123 West Vista Way. This residence is exhibiting cracking of interior sheet rock, movement of a retaining wall, and a recent rupture of the sewer line servicing the house. Also, the pavement on Haussler Road immediately adjacent to BH-8 has recently downdropped a few inches along an arcuate ground crack.

Conclusions

The following observations can be made based on our review of previous geotechnical reports and our field investigation.

- A large number of residences in the Haussler Road/Apple Lane area are undergoing structural distress caused by ground movement. Most of these residences are located either at the top or base of the steep slopes (scarps) associated with the prehistoric landslide.

- The most recent episode of slope movement in the Haussler Road/Apple Lane area appears to have begun in February, 1996, although local residents report that damaging movement began in March, 1999, coincidental with the failure of Haussler Road at Rons Court.

- Slope inclinometer data collected by Foundation Engineers Inc. and GeoEngineers Inc. in the vicinity of the Haussler Road landslide indicate that the failure surface is fairly shallow, occurring in the upper 10 to 20 ft.

- Other slope inclinometer data collected by GeoEngineers Inc. near residences showing structural distress does not indicate movement along a discrete landslide failure surface.

The geotechnical investigations conducted to date do not provide a definitive landslide model that could be used as a basis for corrective actions applicable to the entire Haussler Road/Apple Lane area. There are a number of possible explanations for the ground movement that is damaging residences in this area.

1) Ground surface deformation is resulting from widespread slip along the ancient landslide failure surface, with secondary failures occurring within the overlying landslide debris.
2) Ground surface deformation is resulting from intermittent slip along portions of the ancient landslide failure surface, with secondary failures occurring within the overlying landslide debris.

3) Intermittent slip along portions of the ancient landslide failure surface destabilizes the shallow landslide debris, allowing for secondary failures on nearby steep slopes.

4) Ground movement is caused by shallow failures located entirely within the landslide debris. Factors contributing to these shallow failures would include an elevated

groundwater table associated with above average rainfall since 1996, weakening of surficial soils because of increased moisture content, and proximity to steep slopes.

Recommendations

We recommend the following near-term actions be taken in an attempt to resolve the uncertainties in identifying the underlying cause of the damage to the residences in the Haussler Road/Apple Lane area.

1) The slope inclinometers and piezometers installed by GeoEngineers, Inc., for the Haussler Road investigation should be reoccupied and monitored through this winter and spring. Also, other slope inclinometers or piezometers installed for other geotechnical investigations should be monitored if possible.

2) A network of survey points should be established and monitored through this winter and spring in order to identify areas showing surface movement. These data can be related to subsurface movement indicated by slope inclinometer data, and damage reports from nearby residences.

3) The Haussler Road landslide should be monitored during this winter to determine if the interceptor drain and shear key have stabilized the failure. This action requires that the slope inclinometers and piezometers installed as part of the GeoEngineers Inc. investigation be reoccupied and monitored.

4) Implicit in the above recommendations is that a geotechnical consultant be retained to oversee these activities. The consultant should also generate a plan for a more comprehensive investigation based on the both existing geotechnical data and data obtained this winter.

5) The homeowner's database should be continued and updated to show the location and extent of progressive damage.

As in nearly all landslides, elevated groundwater levels and soil moisture content are significant factors in causing the slope instability. In the near term all reasonable efforts should be taken to convey surface water off of the slopes in order to "dry out" the soils. Local residents should insure that rainfall runoff be directed to stormwater drains; specific actions include using tightlines to direct gutter runoff to storm drains, and draining ponded water accumulating in yards. Also, storm drains should be inspected to insure their effectiveness in conveying runoff water to the base of the west side of Davis Terrace.

Please contact either of us if you or your staff has any questions about our findings or any other aspect of this issue. We appreciate your request for our services.

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