Research Notes

RSN 08-07 June 2008

Keeping Oregon Coast Traffic Moving by Keeping Highway 101 in Place

U.S. Highway 101, on the Oregon coast, is plagued by slope instabilities in numerous locations. One of the common types of instability along the coast is translational landslides along seaward dipping bedding planes. To try and better understand this type of slide ODOT's Research Unit entered into an agreement with the Oregon Department of Geology and Mineral Industries to perform a detailed study of the Johnson Creek landslide located adjacent to Johnson Creek at the northern end of Beverly Beach. This location has chronic highway maintenance issues related to slide movement. The accumulated movement is approaching the point where the highway geometry would benefit from being realigned.

The study began in 2002 and data collection was completed in 2007. The objective was to determine what steps, if any, ODOT could take to prevent future movement on this or similar landslides. The study focused on the mechanics of the landslide and the relationship between ground movement, groundwater fluctuations, precipitation, bluff erosion and beach sand movement. The Johnson Creek landslide has been marginally stable but moves when groundwater levels rise to a threshold that is often reached during winter storms. Rainfall amounts over 55 to 60-milimeters (2.16-2.36 inches), occurring during a 24-hour period, appear to trigger movement. The rate of movement also appears to be tied to prior rainfall.

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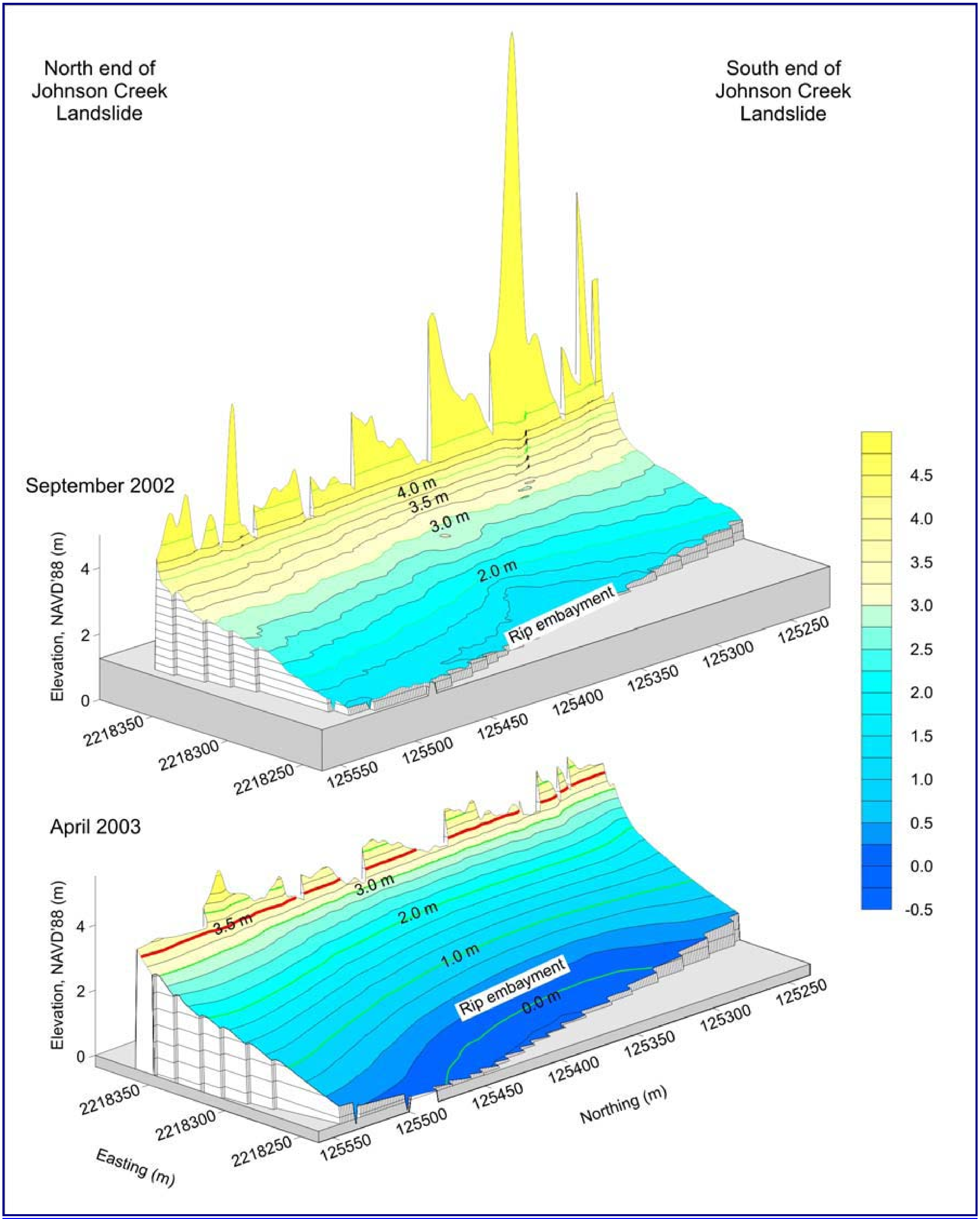
Erosion at the toe of the slide, caused by wave action, was also found to significantly impact the stability of the slide. A limit equilibrium stability analyses found that the factor of safety (FS) declines 2.3 percent for every meter of erosion from the toe of the slide. The same analysis found that a 1 meter (m) rise in the pressure head of the ground water at the middle monitoring site caused a 2 percent decline in FS. The slide was found to be unstable when head at the middle site rises 1.1 m (3.6 ft.) above normal winter levels. Thus, removal of 3 m (9.8 ft.) from the toe could destabilize the slide during most of the winter season.

Ground based Light Detection and Ranging (LIDAR) measurements were made of the bluff face and beach at the toe of the slide to document both the amount of bluff erosion that takes place under winter wave action as well as seasonal changes in the beach geometry. These measurements can be repeated in the future to monitor the continued evolution of the bluff.

Several possibilities for limiting or stopping movement of slides, such as the one at Johnson Creek, were conceptually evaluated as part of the project. Interception of rainfall onto the landslide mass and diverting it off the landslide is one promising approach identified by the study; given the landslide's immediate and direct response to precipitation. Slowing erosion of the bluff face at the toe of the slide was also identified as a potential stabilization effort.

The USGS plans to continue to monitor the landslide over the next three to four years. It is hoped that observing additional winter movement under various precipitation conditions will further illuminate the mechanisms control of these seaward dipping landslides.



A 3-D perspective overlooking the beach in front of the Johnson Creek landslide. View is towards the southeast. Contour elevations are 0.25 m (9.8 in), with 1.0 m contours delineated by green lines. The red line denotes the approximate location of the mudstone/beach contact in April 2003. The beach experienced a vertical drop of 1-2 m over the 2002-03 winter storm seasons.