

Geologic Site of the Month
September, 1997

Aftermath of the 1996 Rockland Landslide



44° 7' 8.43" N, 69° 5' 24.14" W

Text by
Maine Geological Survey



Introduction

Early in the morning of April 16, 1996, a steep bluff along the north shore of Rockland Harbor slumped toward the ocean. Slumping of the bluff occurred progressively in a series of discrete landslide events. Most of the initial motion occurred between 1:15 AM and about 4:00 AM during a falling tide immediately preceding a new moon, but well before a heavy rain on the afternoon of April 16. Figure 1 is an aerial photo of the slide area taken in April of 1996.



Photo by Maine Geological Survey

Maine Geological Survey

Figure 1. Air photo of the Rockland landslide, April 1996.



1996 Rockland Landslide

Before the landslide, the bluff top was about 50 feet above sea level and the base of the bluff ended at the high water mark. During the initial slumping events, portions of two houses collapsed into the main body of the landslide (Figure 2). These structures were about 75 feet landward of the top edge of the bluff prior to the landslide. A topographic survey by geologists from the MGS and the University of Maine determined that by the next week the slide displaced more than half an acre of the original bluff top. When it was over, the slide had moved horizontally over 400 feet onto the mudflats of the intertidal zone and had disturbed a total area of 3.5 acres.



Photo by Maine Geological Survey

Figure 2. Photo of the landslide showing collapsed building.



1996 Rockland Landslide

For a month following the initial slide, smaller blocks continued to fall from the steep landward slopes. These continued slope failures resulted in the enlargement of the affected area by landward progression of the vertical scarp. This progression moved the main scarp to within 15 feet of a sewer main on the seaward side of the road. Possible disruption of a city water main buried beneath the landward shoulder of the road was also of public concern. To protect the road and minimize further enlargement of the landslide area, the City of Rockland hired a private geotechnical engineering firm, R.G. Gerber-Jacques Whitford, Inc. of Freeport, ME, to undertake a stabilization project (Figure 3).



Figure 3. Photo of the Rockland landslide project showing locations of lightweight cement kiln dust, heavy rock fill, and the riprap barrier. The remnants of the slide on the tidal flat will be allowed to gradually erode.

Stabilization and Clean-up

The city received partial funding from the [Federal Emergency Management Agency \(FEMA\)](#). To buttress the road it was necessary to place fill on top of the clay that had failed during the landslide. The failed clay was very soft and unable to support heavy loads of buttressing fill, unless the fill was emplaced in a particular sequence. The toe or front of the slide had to be stabilized before the head of the slide could be filled. To begin, an access to the slide area was constructed across the remaining foundation of one of the destroyed homes. From here a road was built down to the toe of the slide. At the toe, an excavation was dug down to sea level and heavy stone riprap was emplaced to contain the buttressing fill. Heavy rock fill was placed behind the rip rap barrier on the lower part of the landslide area. On the upper part of the slope, lightweight cement kiln dust, available locally from the Dragon Cement Company, was used to cover the slide area progressively from the toe toward the headscarp. The combination of heavy fill at the bottom of the slide and lightweight fill at the top was a critical factor in the success of the stabilization process.



Stabilization and Clean-up

Once this fill was emplaced, topsoil from the slopes surrounding the landslide area was used to cover the fill. This topsoil excavation reduced the slope of the headscarp area to an angle that is normally stable over the long term.



Photo by Maine Geological Survey

Maine Geological Survey

Figure 4. Photo of landslide area taken in April 1996.



Stabilization and Clean-up

Following the spreading of topsoil the entire reclaimed area was seeded with grass and mulched. Figures 4 and 5 show the slide before and after the stabilization project. Figure 4 was taken in April, 1996; Figure 5, in September, 1997.



Photo by Maine Geological Survey

Maine Geological Survey

Figure 5. Landslide area after stabilization, photo taken in September 1997.



Summary

The 1996 landslide in Rockland, Maine was a catastrophic event. Fortunately, there was no loss of life, but two homes were completely destroyed and along with the emergency operations and stabilization project the total cost exceeded \$750,000. A detailed geologic account of the Rockland landslide is available from the Maine Geological Survey as [Open-File Report 96-18](#) "The April 1996 Rockland Landslide."

Although catastrophic events such as the 1996 Rockland landslide are infrequent in Maine, the more gradual erosion of marine bluffs is a continuing natural process affecting much of the coast. Marine geologists of the Maine Geological Survey map and study those areas which may be more susceptible to various types of bluff erosion. The north shore of Rockland Harbor was among several areas identified in a 1989 book, [Living with the Coast of Maine](#), as potentially hazardous.

The City of Rockland has commissioned a detailed engineering study of this area in order to better understand the geologic situation so that further property damage caused by bluff erosion can be minimized.

