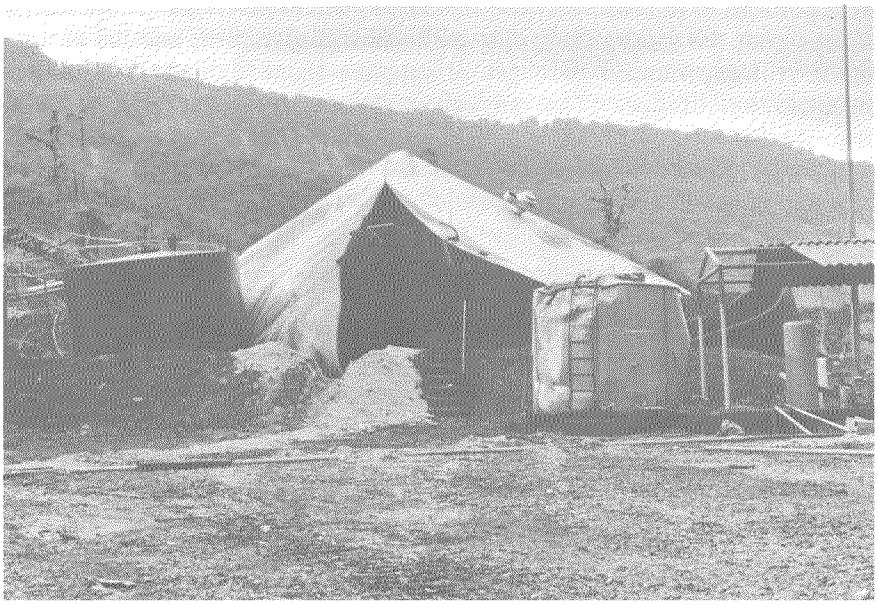

FIGURE 6.14 Oil tank destroyed by landslide debris at the Salado pump station.

structed of 12-mm-thick steel plate and was approximately 10 m high. Debris from the landslide hit the tank, causing it to collapse and to spill roughly 4,500 barrels of oil over the station. Figure 6.14 shows a photo of the collapsed oil tank and two smaller fuel tanks that were destroyed by the landslide and debris flow. Excavation and inspection during reconstruction revealed that oil from the tank had seeped through the ground to the Coca River over 100 m away, infiltrating subsurface soils for a depth of approximately 10 m. An oil fire erupted near the location of the ruptured tank during reconstruction of the station about 2 months after the earthquakes.

Personnel Housing

The barracks and mess halls were one-story reinforced concrete structures. Severe cosmetic damage was observed throughout the housing. Some structural damage to the reinforced concrete beams in the mess hall was also observed.

TRANS-ECUADORIAN HIGHWAY FROM BAEZA TO LAGO AGRIO

The road parallel to the pipelines (Figures 5.1, 6.1, 6.2) is the main transportation artery from Quito to the eastern oil field. Flooding destroyed the highway bridges at the Salado and Aguarico rivers as well as

large portions of the road between the Salado and Malo rivers. More than 6 months after the earthquakes, this road was still disrupted, and the eastern region still experienced shortages of supplies because of the loss of this transportation lifeline. The only alternative means of transportation to Lago Agrio were by plane or by a combination of road and river travel. (The Salado River bridge was replaced in 1988 by a "Bailey" bridge, which currently is in use.)

ECONOMIC CONSEQUENCES

Loss of the Trans-Ecuadorian pipeline deprived Ecuador of 60 percent of its export revenue. As a consequence, the loss of this single lifeline had a dramatic effect on the country's economy. Assuming that the pipeline could transport roughly 250,000 barrels daily at an average price of $19 per barrel, the total lost revenue from March 5 to the first provisional use of the reconstructed line on August 18, 1987, was approximately $790 million. The cost of pipeline reconstruction is estimated at approximately $50 million.

The price of West Texas intermediate crude oil is often used as an index of the world oil price. News of the earthquakes and associated loss of the Trans-Ecuadorian pipeline was followed by a 6.25 percent increase in the price of West Texas crude oil over the 4 trading days immediately following the earthquakes. Although oil prices had been climbing at the time of the earthquakes, market analysts claim that the news of Ecuador's suspension of oil exports encouraged trading at escalating prices. As a consequence, the economic effects of the lifeline failure were not confined to a single country, but were felt worldwide through market speculation.

SUMMARY

Earthquake damage to the Trans-Ecuadorian pipeline represents the largest single pipeline loss in history. Even though the March 5, 1987, earthquakes occurred in a remote region, their consequences in terms of lifeline failure had significant national and international ramifications.

Seismic shaking had only a limited effect on the line pipe, whereas permanent ground deformations had a severe and extensive influence. Landslides and debris flows caused most of the pipeline damage and contributed to virtually all ruptures and permanent deformations of the line. Damage from landslides and debris flows was caused directly by failed soil or rock material that intersected the line, or indirectly by rivers swollen with debris that flooded the line and eroded the pipeline right of way.

Pump station damage at Salado was extensive. Nearly all pump station systems failed to operate properly after the earthquakes. The most severe

structural damage was caused by a landslide that destroyed the crude oil tank at Salado, spilling thousands of barrels of oil across the station. Permanent differential settlements and horizontal displacements were observed at most building foundations and were responsible in part for malfunctioning of control equipment, connections between pumps and heat exchangers, and generators. Seismic shaking damage was especially severe at the water storage tank and radio communications antenna.

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