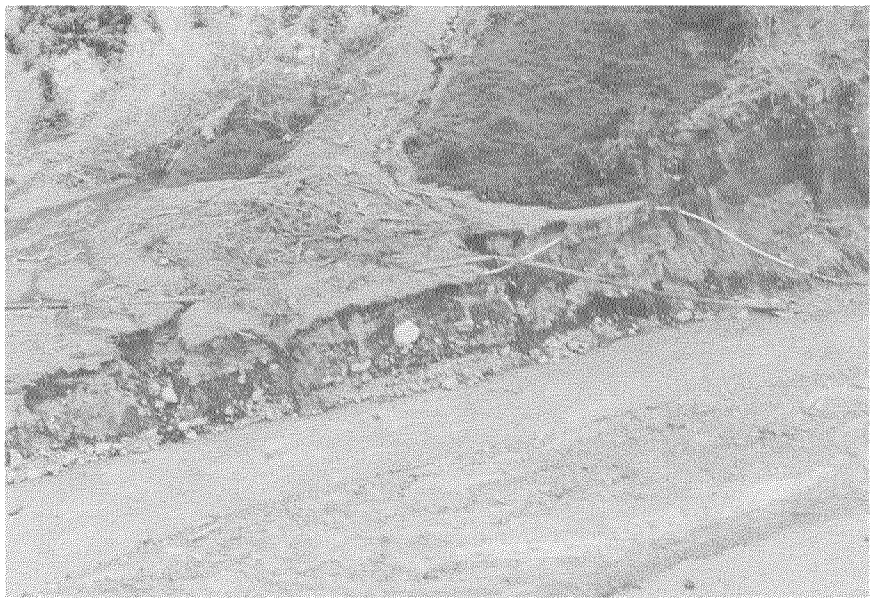

FIGURE 6.8 Trans-Ecuadorian and Poliducto (white) pipelines ruptured by debris flow and deep erosion along the Coca River.

FIGURE 6.9 Broad fan of a very large debris flow with the Trans-Ecuadorian pipeline deformed in the direction of debris movement.

SALADO PUMP STATION DAMAGE

The Salado pump station is located near the confluence of the Salado and Coca rivers on terrace deposits at an elevation approximately 25 m above river level. At this location, alluvial sands, gravel, and cobbles extend to a depth of approximately 200 to 300 m below the floodplain of the Coca River (Almeida and Cruz, 1986).

A plan view of the station is shown in Figure 6.10. Severe damage in the station was caused by a landslide that occurred in weathered granodiorite and terrace deposits at an elevation roughly 80 m above the station. The debris from this slide traveled approximately 240 m to the E, where it ruptured the principal oil tank of the station and buried the main gate valve. The location of the landslide and the outline of the debris flow are shown in the inset diagram in Figure 6.10.

As shown in Figure 6.10, the Salado pump station is composed of several structures, the most important of which include the main gate valve, control building, generators, pump house, water tank, crude oil tank, communication equipment, and personnel housing. Each of these is labeled in the figure. The operational and physical characteristics of these structures and a brief description of their postearthquake condition is given under the headings that follow.

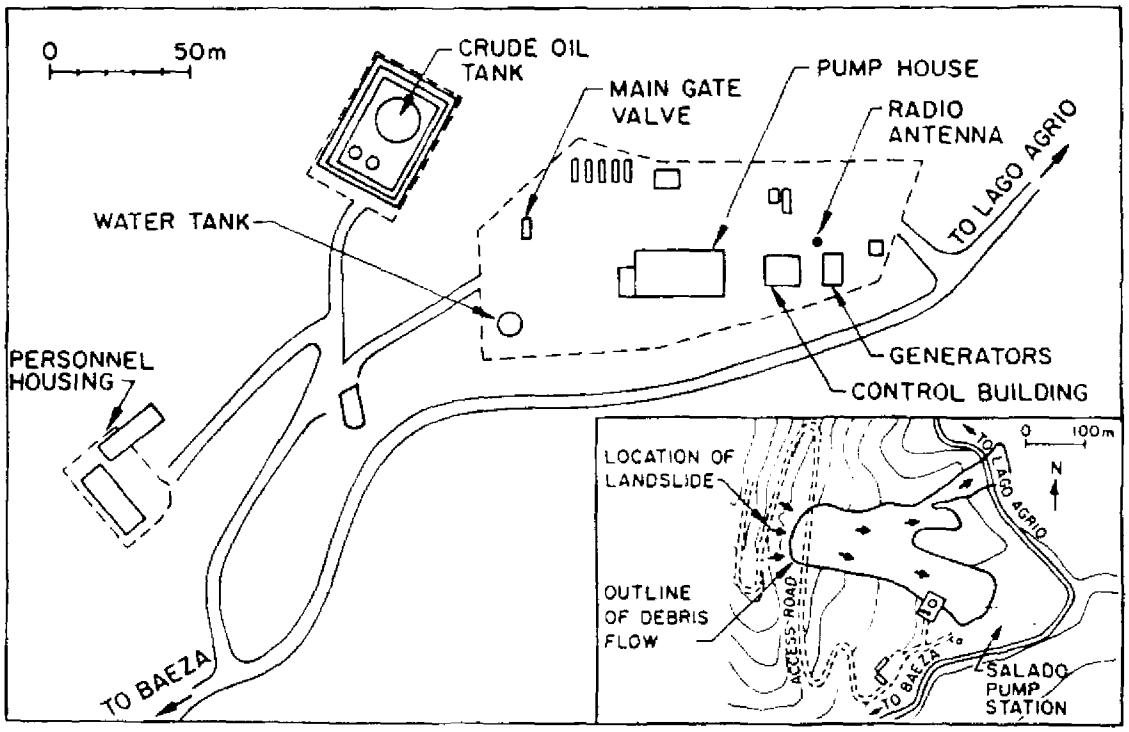

FIGURE 6.10 Plan view of the Salado pump station.

Main Gate Valve

The main gate valve controls the flow from the station and, therefore, controls downstream pressure in the line. It allows for isolation of the line in the event of difficulty. Debris from the landslide completely buried this facility. Because the remote control system of the station was lost, burial by debris prevented manual operation of the valve. As a consequence, an unknown but significant volume of oil in the line E of the pump station was lost by flow from ruptured sections W of the pump station.

Control Building

The control building was a one-story reinforced-concrete structure on a continuous concrete slab foundation. It contained the control equipment necessary for proper operation of the pump station. Visible damage to this structure consisted of a 12-mm-wide crack along the length of the control-room floor slab. The control-room operators indicated that the switching panels had been damaged by the earthquakes. Electrical power was lost throughout the station immediately after the second main shock (M=6.9). Backup equipment and emergency generators failed to operate.

Generators

Two diesel-powered generators are used as the main source of electric power for the station. Approximately 12 mm of differential settlement and over 25 mm of horizontal displacement were observed at the concrete slab foundation of one of the generators. During site reconnaissance, approximately 3 weeks after the earthquakes, this generator was still under repair. In addition, one of the elevated diesel fuel tanks for the generators overturned as a result of the earthquakes.

Pump House

The pump house contained five diesel engine pumps, each supported on isolated concrete blocks and underlying 300-mm-diameter steel pipe piles. Soil settlement relative to the pile-supported blocks ranged from approximately 35 to 100 mm. This settlement apparently contributed to differential movement between the pump motors and the heat exchangers, which were supported on shallow spread foundations. This differential settlement caused distress in the rotating connections. Figure 6.11 shows the pump house during reconstruction of the station. In the photograph, excavation along the side of the structure has exposed the pile-supported block foundation.