



National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date:

In reply refer to: R-98-66

Mr. William E. Loftus
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About 5:56 a.m., on August 9, 1997, National Railroad Passenger Corporation (Amtrak) train 4, the Southwest Chief, derailed on the Burlington Northern Santa Fe Railway (BNSF) tracks about 5 miles northeast of Kingman, Arizona. Amtrak train 4 was en route from Los Angeles, California, to Chicago, Illinois, and had just left the Kingman station. The train was traveling about 89 mph on the eastbound track when both the engineer and assistant engineer saw a “hump” in the track as they approached bridge 504.1S. They applied the train’s emergency brakes. The train derailed as it crossed the bridge. Subsequent investigation revealed that the ground under the bridge’s supporting structure had been washed away by a flash flood. Of the 294 passengers and 18 Amtrak employees on the train, 173 passengers and 10 Amtrak employees were injured. No fatalities resulted from the accident. The damages were estimated to total approximately \$7.2 million.¹

The National Transportation Safety Board determined that the probable cause of this accident was displacement of the track due to the erosion and scouring of the inadequately protected shallow foundations supporting bridge 504.1S during a severe flash flood because the BNSF management had not provided adequate protection, either by inspection or altering train speeds to fit conditions. Contributing to the accident was the failure of the BNSF management to adequately address the erosion problems at bridge 504.1S.

During the investigation, the Safety Board considered the circumstances that precipitated the bridge failure. The investigation examined the adequacy of the design, maintenance,

¹For more detailed information, read Railroad Accident Report—*Derailed Amtrak Train 4, Southwest Chief, on the Burlington Northern Santa Fe Railway, near Kingman, Arizona, August 9, 1997* (NTSB/RAR-98/03).

inspection, and drainage area characteristics of BNSF bridge 504.1² in light of the severe weather and flash flood conditions affecting the bridge and the subsequent failure of a crosswall and the bridge supporting structure.

Bridge 504.1 S was supported by a shallow foundation consisting of timber mud sills and timber blocking. BNSF records showed that the bridge supports were susceptible to scouring and erosion as early as 1959, when it was necessary to add stones and grout to a portion of the streambed. In the succeeding years, additional stones and grouting were added. Records also showed that, in 1975, maintenance personnel were still concerned about the bridge supporting structure and its water-carrying capacity. In fact, they remained so concerned that they recommended that the bridge be placed on the Capital Improvement Program (CIP) list for replacement.

Also, BNSF bridge records identifying the size of the drainage area for bridge 504.1 (the north and south bridge spans) were inconsistent. One record showed the drainage area as encompassing 3.8 square miles, while another showed the drainage area as totaling 19.09 square miles. The size of the drainage area is an important element in determining the required waterway opening for drainage structures. After the accident, a BNSF consultant (HDR Engineering, Inc.) determined that the drainage area for bridge 504.1 was 19.5 square miles. The consultant's report cited the accepted engineering practice of using the 100-year storm criteria to provide for drainage structures but noted that local conditions and circumstances, such as the desert nature of the Kingman area, allowed for making an engineering judgment resulting in higher or lower values. According to the consultant's report, the bridges located at MP 504.1 at the time of the accident were capable of withstanding a 24-year storm. The storm related to this accident was determined to have been approaching a 50-year storm event of 2 hours' duration. (The August 9, 1997, storm's effect differed among the five railroad bridges in the area. Bridge 504.1 experienced an approximate 50-year storm event, while bridge 503.7, for example, experienced an approximate 10-year storm event.)

In 1975, the railroad management placed bridge 504.1 on the 1977 CIP replacement program because the results of engineering studies raised concerns about the bridge's ability to provide an adequate waterway opening and about recurring erosion problems. In early 1976, however, the railroad's bridge maintenance personnel made a field decision to build an unreinforced concrete crosswall on the downstream side of bridge 504.1. Bridge 504.1 was subsequently removed from the 1977 replacement program.

Only two instances of high water were recorded for bridge 504.1 and both took place in 1976. This was after 1971 work affecting the box culverts downstream from the BNSF bridges had been performed by the Arizona Department of Transportation and after bridge 504.1 had been removed from the CIP budget list. Before the 1997 derailment at bridge 504.1S, no accidents involving high water or bridge failure were recorded for the Kingman area.

²The BNSF designates bridges by their milepost (MP) numbers. There are two separate bridges at MP 504.1; one for the eastbound track and another for the westbound track. The bridges are designated by the BNSF as the south and north bridges, respectively.

The purpose of the unreinforced concrete crosswall was to allow silt to back up and accumulate around the mud sills, thus acting to mitigate further scouring and erosion. However, no engineering evaluation was performed on the design and construction of the unreinforced concrete crosswall to determine the necessary anchorage, the appropriate size, the need for reinforcement, or the hydrologic characteristics of the waterway.

The severe flash flooding and resultant stream flow between bridge 504.1 and Arizona State Route 66 caused severe erosion that rapidly progressed upstream. The Safety Board could not determine whether channel improvements made in 1971 contributed to this development, but evidence of streambed erosion was found during the on-site investigation. This erosion progression caused the failure of the unreinforced concrete crosswall because it was not anchored and was only 33 inches in depth. Because it was unreinforced, the crosswall broke into several pieces when its shallow footing was undermined.

When the concrete crosswall failed, the rate of erosion accelerated through the accumulated silt to the point that it quickly progressed to the shallow foundation of the bridge. This process undermined the bridge's mud sills and timber blocking and compromised the bridge's ability to support Amtrak train 4. The Safety Board therefore concluded that the failure of the bridge 504.1S was caused by scour and erosion affecting the inadequately protected shallow foundations that supported the bridge; the scour resulted because a poorly designed concrete crosswall was built instead of a new and better-engineered bridge. The Safety Board is concerned that similar situations may exist on other railroad systems in the country that are subject to flash flooding.

Therefore, the National Transportation Safety Board makes the following safety recommendation to the American Short Line and Regional Railroad Association:

Make your membership aware of the facts and circumstances of the derailment accident that occurred at Kingman, Arizona, on August 9, 1997. (R-98-66)

Also, the Safety Board issued Safety Recommendations R-98-48 through -53 to the Burlington Northern Santa Fe Corporation, R-98-54 through -57 to the Federal Railroad Administration, H-98-41 to the Federal Highway Administration, H-98-42 to the Arizona Department of Transportation, R-98-58 through -61 to the National Railroad Passenger Corporation (Amtrak), R-98-62 to the Mohave County Sheriff's Department, R-98-63 to the International Association of Chiefs of Police, R-98-64 to the National Sheriffs' Association, and R-98-65 to the Association of American Railroads.

The National Transportation Safety Board is an independent Federal agency with the statutory responsibility "to promote transportation safety by conducting independent accident investigations and by formulating safety improvement recommendations" (Public Law 93-633). The Safety Board is vitally interested in any action taken as a result of its safety recommendations. Therefore, it would appreciate a response from you regarding action taken or contemplated with respect to the recommendation in this letter. Please refer to Safety Recommendation R-98-66 in your reply. If you need additional information, you may call (202) 314-6430.

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in this recommendation.

By: Jim Hall
Chairman