Report of Investigation

No. 199

PRELIMINARY GEOLOGIC HAZARD AND RESOURCE INVENTORY FOR STATE LANDS IN WASHINGTON COUNTY, UTAH

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PURPOSE AND SCOPE

In response to a request from Karl F. Kappe of the Division of State Lands and Forestry, an inventory of geologic hazards and resources for state lands in Washington County was compiled by Utah Geological and Mineral Survey personnel. The information is needed by the Division for use in development of a general management plan. All information compiled in this inventory is taken from published literature and UGMS file data, including the Computerized Resource Information Bank (CRIB). Approximately three weeks were taken to complete the project, and no field work or air photo analysis was performed. The inventory consists of a table of data with accompanying explanatory text. The table presents a parcel by parcel compilation of possible hazards and resources, and the text contains a more detailed description and discussion of methods used in the analysis. Figure 1 is a general location map which may be used in conjunction with descriptions given in table 1 to locate parcels. The hazards and resources noted for each parcel may be present based on the results of this literature review, but all data are subject to revision based on site-specific investigations. Therefore, this inventory is preliminary and is to be used for general planning purposes only.

GEOLOGIC HAZARDS

The principal geologic hazards considered in this inventory include seismic activity (ground shaking, surface fault rupture), slope stability (chiefly debris flows/mudflows, rock falls, and rotational/translational slides), flooding, shallow ground water, and poor foundation conditions

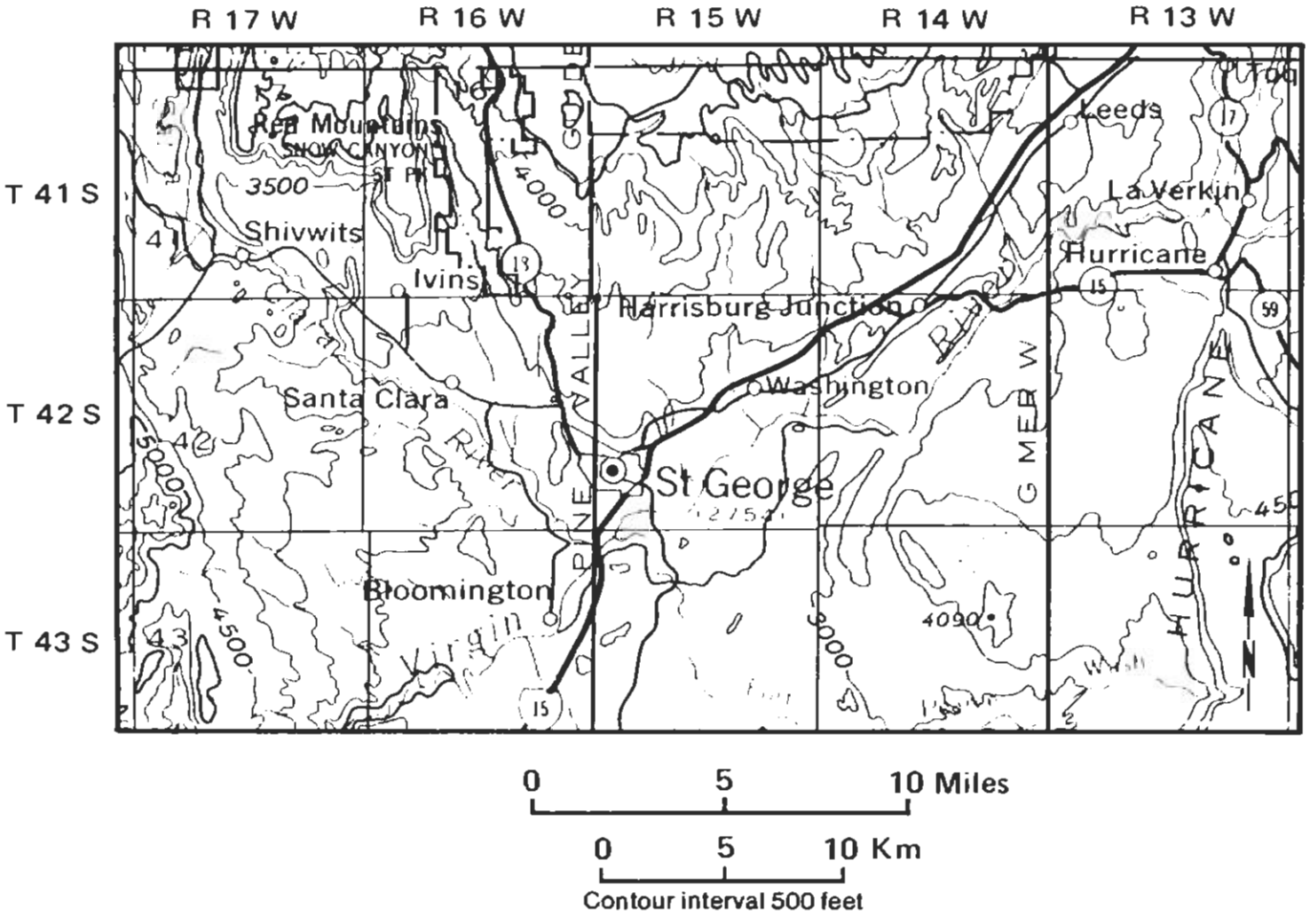

Figure 1. Location map (see table 1 for parcel location).

Table 1. Geologic hazard and resource inventory for state lands in Washington County, Utah

Land Parcel			Geologic Hazards[2]						
Township	Range	Section[1]	Surface fault rupture[3]	Slope failure	Debris flow/ mudflow	Flooding	Shallow ground water	Poor foundation/ soil conditions	Geologic Resources[5]
41S	13W	2-Lot 3, SE4NE4, NE4SE4		X	X				
		2-SW4NE4, W2SE4, SE4SE4, Part SW4SW4		X	X	X	X		
		3-SW4NE4, SE4NW4, NE4SW4 NW4SE4, S2S2				X	X		
		10-N2, N2S2, SW4SW4, SW4SE4, Part SE4SE4				X			
		11-Part SW4NW4, W2SW4							
		14-NW4NW4		X		X			
		15-Part NE4NE4							
		16-Lots 1-4, E2SW4, W2SE4		X	X				
		16-NW4, W2SW4				X			
		25-E2NE4, SW4NE4		X	X	X	X		Sand and gravel
		27-SE4SW4, W2SE4		X	X				Cinders
		28-NE4SE4							Cinders
		30-Lot 7		X	X	X	X	X	Silver, copper, uranium
		31-Lots 7-12							
		32-N2NE4, SW4NE4, SW4, N2SE4, SE4SE4							
		33-NW4SW4, Part NW4SE4, Part NE4SE4				X	X	X	
		36-NE4, E2NW4, SW4NW4, SW4, E2SE4		X	X	X		X	
41S	14W	12-SW4SE4						X	
		16-All		X	X				
		31-All		X	X				
		32-All		X	X	X			
		36-Lots 1-3		X	X	X	X		Sand and gravel, silver potential
41S	15W	16-N2				X			
		26-SW4		X	X				
		27-SE4			X	X			
		34-E2, SW4		X	X	X			
		35-All		X	X	X			
		36-All		X	X	X			
41S	16W	10-SW4SE4		X	X				
		14SW4, W2SE4, SE4SE4			X	X			
		15-W2NE4, SE4							
		16-E2NE4, NW4, W2SW4, SE4SW4, SW4SE4, E2SE4		X	X	X			
		22-W2E2		X					
		24-W2NW4		X	X				
		28-SW4NW4		X	X	X			
		30-Lot 4		X	X	X			
		31-Lots 1-7, SW4NE4, E2NW4, NE4SW4, N2SE4				X			
		32-N2, NE4SW4		X	X	X			
		33-SW4NE4, S2NW4, SW4, W2SE4		X		X			
		34-E2NE4							
		35-SW4NW4, W2SW4, SE4SW4				X			
		36-All		X	X	X	X		
41S	17W	2-All		X	X	X			
		16-All	X						
		17-NW4SE4		X		X	X		
		25-E2SW4						X	
		36-NE4, N2SW4, SW4SW4 S2SE4		X		X	X	X	
42S	13W	2-Lots 1-3, 6-9, 12	X	X	X	X		X	
		6-Lots 2-6, 11, 12		X					
		7-Lots 8, 10, 11		X					
		10-NE4SE4	X	X	X			X	
		17-S2NE4, SE4SW4, S2SE4				X		X	
		18-Lots 2, 8, 11		X		X		X	
		20-E2NW4, NE4SW4, S2SE4				X		X	
		22-SW4NW4, W2SW4	X		X			X	
		29-N2NE4				X			
		33-NW4							
		36-E2NE4, E2NW4, S2		X		X		X	
42S	14W	1-Lots 1, 2, 8, 9, SE4NE4, NE4SE4				X	X		
		2-Lots 11-15		X		X	X		Sand and gravel
		6-Lots 1-6, S2NE4, SE4NW4, NE4SW4, N2SE4, SW4SE4		X					Riprap (basalt)

Land Parcel			Geologic Hazards[2]						
Township	Range	Section[1]	Surface fault rupture[3]	Slope failure	Debris flow/ mudflow	Flooding	Shallow ground water	Poor foundation/ soil conditions	Geologic Resources[5]
		6-SE4SE4							
		7-Lots 2-6, 9, W2NE4, E2NW4, NE4SW4		X		X		X	
		12-N2NE4, SW4NE4, SE4NW4, SW4SE4							
		13-NE4						X[4]	
		19-Lots 1, 12		X		X	X	X	Sand and gravel
		20-Lot 9				X	X	X	Sand and gravel
		28-NW4NE4		X			X		
		29-SE4SW4		X			X		
		32-All		X	X	X	X		Sand and gravel
		36-NE4NE4, S2NE4, NE4NW4, S2NW4, S2						X[4]	Sand and gravel
42S	15W	1-Lots 1-10, S2NE4, SE4NW4, N2SE4	X						
		2-All	X						
		3-All				X			
		4-All				X			
		5-Lots 1-10, 15, 16		X		X			
		6-Lots 1, 2, S2NE4, NW4SE4		X		X			
		6-SW4SE4				X			
		7-E2		X		X			
		8-All		X		X			
		9-All							
		10-E2E2, NW4NE4, NE4NW4, W2W2				X			
		11-Lots 1-4, NW4, N2S2, SW4SW4, N2SE4SW4	X						
		11-S2SE4SW4, SE4SE4	X						
		12-N2, N2S2, S2SE4							Copper, silver prospect
		13-NE4		X				X	
		14-NE4NE4	X			X			
		15-NE4NE4, SW4NE4, SW4NW4							
		16-Lots 1-5, NE4, NE4SW4, N2SE4, SW4SE4							Sand and gravel
		17-Lots 1-6, 8, 11-16		X		X			
		18-Lots 5-14, SE4SW4, SW4SE4		X					
		19-N2SE4							Gypsum
		20-NE4,NE4NW4, N2SE4 SE4SE4		X		X			
		21-SE4NE4, SW4SW4, N2SE4, SE4SE4		X		X			Sand and gravel
		22-N2SW4							
		27-Lot 1				X	X	X	
		28-Lot 1, SE4NE4, W2, W2SE4		X		X	X	X	
		29-NE4NE4		X		X			
		33-N2NW4		X				X	
		35-SE4SE4							
42S	16W	2-N2, N2S2		X		X			
		2-S2S2		X		X			
		3-Lot 2, SW4NE4, NW4SE4, SE4SE4		X		X			
		4-Lots 1-3				X			
		5-Lots 1, 3, SW4NE4, SE4SW4, NE4SE4				X			
		6-Lots 4, 6, NW4SE4							
		7- NE4NE4							
		8-S2NE4, W2NW4, NE4SW4, N2SE4							
		9-SW4NW4, SW4				X			
		10-NE4NE4						X	
		10-W2E2, SE4SE4				X		X	
		11-W2SW4, SE4SW4							
		11-NE4SE4							
		12-W2SW4		X					
		13-NW4NW4, Part SW4NW4							
		14-E2SE4							
		22-E2NE4, NE4NW4,NW4SE4				X		X	
		26-SW4SW4		X				X	
		32-NW4NE4, S2NE4, NW4, S2		X					
		34-W2SW4, SE4SW4, SW4SE4		X					
		35-NW4SE4		X		X	X	X	
		36-Lots 1, 2, NW4NE4 S2NE4, SE4NW4, Part SW4NW4, Part SW4		X		X	X	X	Riprap (basalt), sand and gravel
42S	17W	1-Lot 6		X		X	X	X	Sand and gravel
		1-Lots 3-5, SW4NW4, S2SW4, SE4SW4		X		X	X	X	

Land Parcel			Geologic Hazards[2]						
Township	Range	Section[1]	Surface fault rupture[3]	Slope failure	Debris flow/ mudflow	Flooding	Shallow ground water	Poor foundation/ soil conditions	Geologic Resources[5]
		32-All	X	X	X				Gypsum
		36-All		X		X		X	
43S	13W	2-All		X		X			
		16-All		X		X			
		32-All	X	X					
43S	14W	2-All						X[4]	Sand
		16-All		X	X				
		32-All		X	X			X	Sand and gravel
		36-All				X			
43S	15W	5-S2SE4		X		X	X	X	
		8-Part SW4NE4, Part NW4SE4				X	X	X	
		9-NW4NW4, NE4SW4, NW4SE4				X	X		
		11-Lot 11		X				X	
		14-NE4, N2NW4, SW4NW4		X				X	
		15-S2NE4, NE4SW4, S2SW4, SE4		X				X	
		17-All		X				X	
		18-All		X				X	
		19-All		X				X	
		20-All						X	
		21-S2				X	X	X	Sand and gravel
		22-W2NE4, W2, W2SE4, SE4SE4						X	
		28-All		X		X	X	X	
		29-All		X				X	
		30-All		X				X	
		31-All						X	
		32-All		X				X	
		33-All						X	
		36-W2				X	X	X	
43S	16W	1-Lots 5-10		X		X	X	X	Sand and gravel
		2-Lots 4-6, 11-14		X				X	
		2-Lots 7, 10, 15		X				X	
		3-All		X				X	
		4-S2NE4, SE4		X					
		10-All		X					
		11-N2N2, S2NW4, W2SW4		X					
		11-SE4							
		12-Lot 3, N2NW4		X		X	X	X	
		12-Lot 7		X		X	X		
		13-S2SE4		X				X	
		13-Lot 5, Part SE4NW4, Part NE4SW4, Part NW4SW4		X		X	X	X	
		14-Part NE4NE4, Part NW4NE4, Lot 7				X	X	X	
		15-N2,N2SW4, SW4SW4		X		X	X	X	
		15-Part Lot 1, Lots 2-4		X		X	X	X	
		16-All					X	X	
		22-Lot 1				X	X		
		22-E2SE4				X			
		23-E2NE4, NW4NE4, SE4				X		X	
		23-SW4NE4, S2NW4, SW4				X		X	Sand and gravel
		24-All		X				X	Sand and gravel
		25-All		X		X		X	Sand and gravel
		26-All		X		X		X	
		32-All		X					
		35-All						X	
		36-All				X			
43S	17W	2-All		X					
		16-All							
		32-All	X	X	X				Gypsum
		36-All		X	X	X	X		

1) Where lot numbers are listed in parcel description, the assessment applies to the entire section because locations of lots within sections were not known.

2) The hazards indicated may exist based on topography and existing geologic data, but have not been confirmed through field investigation. This inventory is preliminary, subject to revision, and should be used for general planning purposes only.

3) Hazards due to surface fault rupture considered present only in parcels traversed by active faults. However, severe ground shaking accompanying earthquakes may occur at all parcels.

4) Possible active dunes creating hazards due to shifting sands.

5) Resource data taken from published sources and USGS file data. Resources considered include industrial minerals, metals, geothermal, oil and gas, and coal.

(collapsible and expansive soils). Other hazards such as erosion, subsurface piping (underground erosion), subsidence due to dissolution (gypsum, limestone), and ground failure accompanying seismic shaking (liquefaction, lateral spreading) are not included in this hazard assessment because they are of limited local extent and require site-specific information to predict. However, they should be considered in any detailed hazard assessment of the parcels.

Hazards related to seismic activity considered in this inventory include surface fault rupture and ground shaking. The location of surface fault rupture zones is based on the presence of Quaternary-age faults (Anderson and Miller, 1979; Earth Science Associates, 1982), and only those lots which are along mapped active fault traces are listed as subject to this hazard. In terms of ground shaking, the Uniform Building Code and Utah Seismic Safety Advisory Council include the entire area in seismic zone 2, considered subject to earthquakes producing moderate damage corresponding to maximum modified Mercalli intensities (MMI) of VII or greater (appendix). Recent work regarding earthquake probabilities and magnitudes in southwestern Utah indicates that magnitude 7.5 earthquakes (approximate MMI of X) are possible every 1,000 - 10,000 years, and that earthquakes of magnitude 6.0 (approximate MMI of VII-VIII) may occur every 200-300 years (Earth Science Associates, 1982). Hazards due to ground shaking are considered present in all parcels, although the intensity of ground shaking is dependent on soil conditions and proximity to the earthquake epicenter.

Hazards due to slope failure include chiefly rock falls, rotational

slumps, and translational slides. Any parcel which includes steep slopes or known existing slope failures is considered subject to this hazard. Because of the arid climate of the area and predominance of competent sandstone and basalt bedrock, the most probable slope failure hazard would likely be due to rock falls. Slumps and slides are generally rare except in areas underlain by less competent geologic units such as the Chinle Formation. Debris flow and mudflow hazards are considered separately from other slope failures listed above. They are most common in small, steep canyons in fine-grained or deeply weathered bedrock where thick accumulations of hillslope debris may occur. The hazard from debris flows and mudflows is greatest in runout zones at the mouths of canyons and is indicated by debris fans in these areas. Thus, any parcels near such canyon mouths are included under this hazard if the streams do not appear to be entrenched so that the debris flows and mudflows would be safely confined to pre-existing channels.

Flood hazard includes only those areas subject to overbank flooding from major drainages such as the Virgin River and its principal tributaries. It does not include flow in normally dry ephemeral streams except in downstream areas where overbank flooding may occur. Some sheet and flash flooding is possible along any normally dry drainage and should be evaluated on a site-specific basis.

To address potential building foundation problems, parcels with possible shallow ground water or poor soil conditions are noted. Shallow ground water is that which may be encountered at normal basement depths and is predicted on the basis of topography, recharge, and the presence of phreatophytic

vegetation along major rivers as shown in Cordova and others (1972, pl. 1). Poor foundation conditions include expansive and collapsible soils. Both are known to occur in southwestern Utah, but their extent has not been delineated. In our analysis, expansive soils were considered present in soils over rocks containing shale and claystone (principally the Chinle and Moenkopi Formations), in sediment derived chiefly from these rocks, and in soils with high shrink-swell potential as mapped by Mortensen and others (1977). Collapse-prone soils are much more difficult to predict but are noted in areas of small, steep alluvial fans likely to contain debris flow and mudflow deposits. They are common near the base of cliffs, particularly where they contain fine-grained gypsiferous rocks such as the Moenkopi Formation. Assessments of soil foundation conditions refer only to flat and gently sloping areas in each parcel where soils are likely to occur, not to steep slopes and bedrock areas. Potential foundation problems such as excavation difficulty due to coarse clasts, caliche, bedrock, or gypsum are not included.

The available published information permits only a limited geologic hazards evaluation. Geologic hazards mapping has been completed in the St. George area (Christenson and Deen, 1983), but elsewhere the analysis is based on interpretations from 1:62,500 topographic quadrangles and a 1:125,000 geologic map (Cooke, 1960). Data regarding soils and ground-water conditions are included in Mortensen and others (1977) for much of Washington County at a scale of 1:24,000, and selected ground-water data are available in Cordova and others (1972). A detailed seismic hazards analysis of the area was prepared by Earth Science Associates (1982). Other sources either covering small areas or of limited applicability are available and some are included in the list of

references. It must be noted that this inventory lists the possible existence of the major hazards common in Utah but does not include all possible hazards and does not insure that those listed occur. A site-specific field investigation is recommended to determine which, if any, of the possible hazards are actually present.

GEOLOGIC RESOURCES

Based on the interpretation of available data, no resources are now being produced on a continuous basis on these state lands. Resources that have been produced in the area include silver, uranium, copper, sand and gravel, and volcanic rock.

The Silver Reef (Harrisburg) Mining District is located in Township 41 South and Range 13 and 14 West. Active mining for silver in this area began in 1875 and lasted until about 1910. The district produced nearly eight million dollars in silver during this time, along with some copper and uranium. Intermittent activity occurred after 1910 until the 1950's when uranium became an important commodity. Between 1950-1957, approximately 1600 tons of 0.27 percent U_3O_8 was produced from the district. The uranium ore was found to be associated with the silver and copper in the Springdale Member of the Moenave Formation.

Sand and gravel are found in river terraces associated with the Virgin and Santa Clara Rivers and have been developed mostly for local use near towns. Volcanic rock has been produced from Cenozoic basalts and used for rip-rap and

cinders. The area has some potential for gypsum which is found in the Moenkopi Formation, but the available data indicate that no gypsum has been mined. The area is also favorable for the discovery and development of local sources of low-temperature (less than 90°C) geothermal water. The Harmony Coal Field is located to the north, but no known coal occurs within the area. The Anderson Junction and Virgin Oil Fields are located to the north and east, respectively, but there are no producing oil fields on state lands. However, a fair potential for hydrocarbon production exists in the area because exploration wells have shown oil in the Callville Limestone which is the producing unit in the Anderson Junction Field.

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APPENDIX

MODIFIED MERCALLI INTENSITY SCALE OF 1931
(Abridged)

I. Not felt except by a very few under especially favorable circumstances.

II. Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing.

III. Felt quite noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibration like passing of truck. Duration estimated.

IV. During the day felt indoors by many, outdoors by few. At night some awakened. Dishes, windows, doors disturbed; walls made cracking sound. Sensation like heavy truck striking building; standing motor cars rocked noticeably.

V. Felt by nearly everyone; many awakened. Some dishes, windows, etc., broken; a few instances of cracked plaster; unstable objects overturned. Disturbance of trees, poles and other tall objects sometimes noticed. Pendulum clocks may stop.

VI. Felt by all; many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster or damaged chimneys. Damage slight.

VII. Everybody runs outdoors. Damage negligible in buildings of good design and construction slight to moderate in well-built ordinary structures; considerable in poorly built or badly designed structures; some chimneys broken. Noticed by persons driving motor cars.

VIII. Damage slight in specially designed structures; considerable in ordinary substantial buildings with partial collapse; great in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Disturbed persons driving motor cars.

IX. Damage considerable in specially designed structures; well designed frame structures thrown out of plumb; great in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken.

X. Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Rails bent. Landslides considerable from river banks and steep slopes. Shifted sand and mud. Water splashed (slopped) over banks.

XI. Few, if any (masonry), structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipe lines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.

XII. Damage total. Waves seen on ground surfaces. Lines of sight and level distorted. Objects thrown upward into the air.

Source: *Earthquake Information Bulletin* 6 (6), p. 28, 1974.