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February 14, 1990
RO 90-140

Mr. Boyd Hamilton
New Mexico Health and Environment Department
1190 St. Frances Drive
Santa Fe, New Mexico 89503

Subject: Albuquerque Service Center
NMD 000804294

Dear Mr. Hamilton,

This has been prepared as an addendum to my letter dated November 7, 1989. Please find enclosed the Fault Analysis Study for the subject facility.

If you have any questions or require further information, please contact me on extension 2550.

Sincerely,

Rob Omiecinski

Rob Omiecinski
Environmetal Permit Writer

RO/dfs

cc: W. Johnson, Denver Reg. Mgr.
Br. Mgr. (7-008-01)
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FAULT ANALYSIS OF THE SAFETY-KLEEN SITE 2720 GIRARD AVENUE ALBUQUERQUE, NEW MEXICO

Prepared For

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Prepared By
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FAULT ANALYSIS
OF THE
SAFETY-KLEEN SITE
2720 GIRARD AVENUE
ALBUQUERQUE, NEW MEXICO

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1.0 PURPOSE AND SCOPE OF REPORT

The following fault analysis study is presented to comply with Federal Standards set forth in 40 CFR 264.18(a), regarding seismic standards for hazardous waste storage facilities. The purpose of the investigation is to determine whether any faults having displacement during the Holocene Epoch are within 3,000 feet of the Safety-Kleen service center in Albuquerque, New Mexico. If Holocene faults, or lineations which suggest fault presence does exist, it must be demonstrated that the proposed storage facility is not located within 200 feet of an active fault. This report will document the location of faults near the proposed site, based on analysis of existing geologic literature, geologic maps, and aerial photographic interpretation.

1.1 Site Description and Geologic Setting

The Safety-Kleen site is located at 2720 Girard Avenue, Albuquerque, New Mexico (latitude 35° 06' 49" N. by longitude 106° 36' 46" W.). The site is located northeast of the intersection of I-25 and I-40 in the City of Albuquerque, approximately four miles east of the Rio Grande River in the Albuquerque East Quadrangle (T.10N., R.3E. Section 10) (Figure 1).

The facility is located on the Sandia Mesa, bordered on the west by the Rio Grande flood plain, and on the east by the foothills of the Sandia Mountains. (Herrick and Johnson, 1900). The topography of the mesa decreases to the west, averaging 85 feet to the mile. Surface deposits on the mesa consist of sand and gravel, including weathered material from the Ogallala Formation, the Gila Conglomerate, and Santa Fe Group. Outcrops of marly silt and mudstones of the Santa Fe Group occur between the facility and the Sandia Mountains to the east.

The Sandia Mountains, located approximately 12 miles east of the Safety-Kleen site, are part of an eastward-tilted fault block 18 miles long and roughly 10

SITE LOCATION MAP

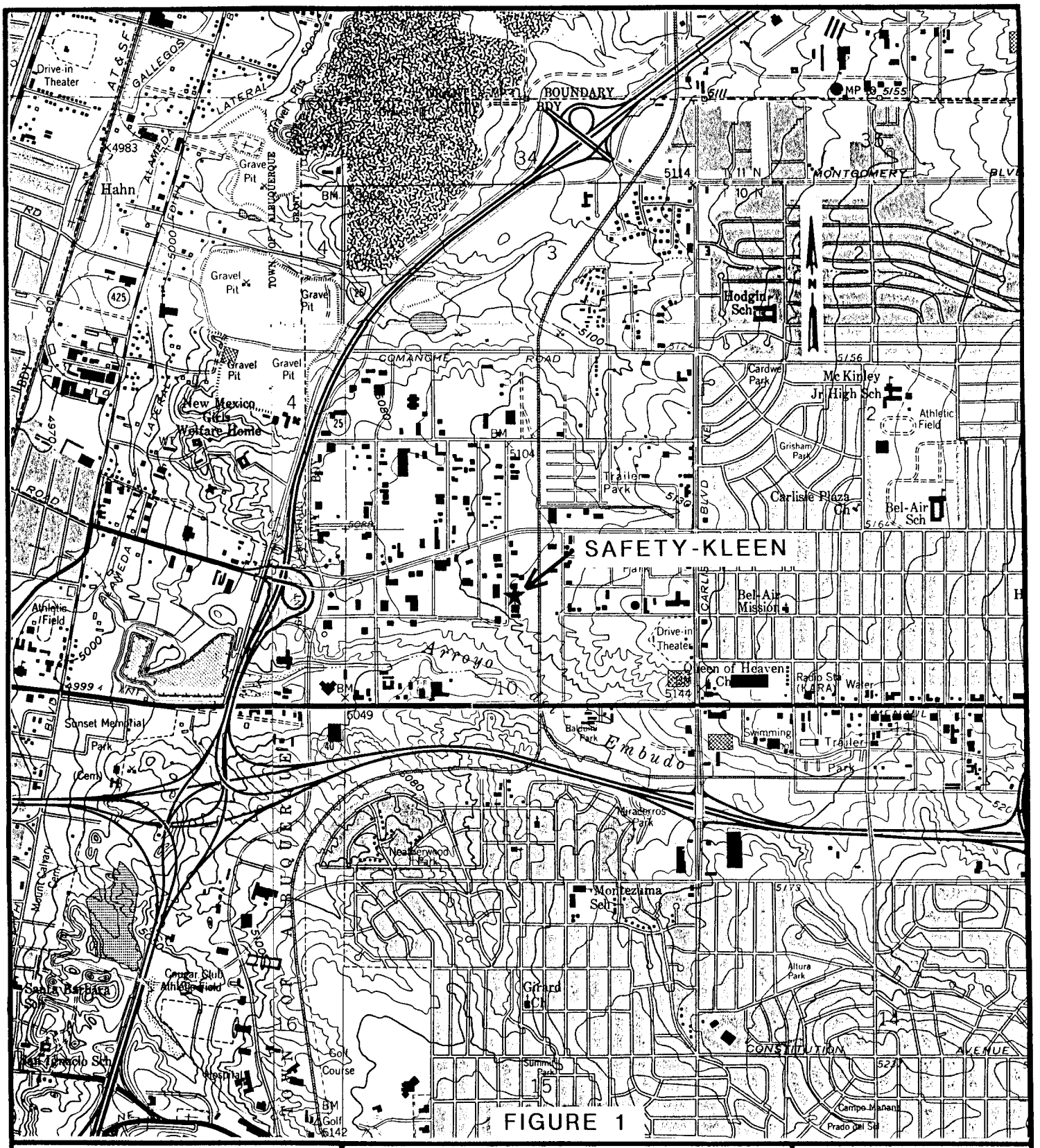

FIGURE 1

SCALE: 1 : 24000	UNITED STATES DEPARTMENT OF THE INTERIOR GEOLOGICAL SURVEY	DATE: 12/14/89

ALBUQUERQUE EAST QUADRANGLE
ALBUQUERQUE WEST QUADRANGLE
LOS GRIEGOS QUADRANGLE
ALAMEDA QUADRANGLE

NEW MEXICO

7.5 MINUTE SERIES (TOPOGRAPHIC)

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miles wide (Helund, 1985). The fault block is within the Mexican Highlands section of the Basin and Range Province and is bounded by the Rio Grande trough to the west and the Tijeras Coal Basin and Monte Larago to the east (Figure 2). About 50 percent of the rocks exposed in the Sandia Mountains are of Precambrian age. These rock units include the Sandia Granite, the Cibola Gneiss, and the Tijeras Greenstone (Helund, 1985). Approximately 2,500 feet of Paleozoic strata lies above the basement complex and forms the dip-slope on the east-tilted fault block. A Permian-Triassic section of siltstone, mudstone, sandstone, and thin limestone crops out along the dip-slope. Jurassic through Cretaceous sedimentary rocks include the Entrada, Todilto, Morrison and Mesaverde Formations folded into synclinal depressions north of Albuquerque. Tertiary units include poorly consolidated sand, gravel, and silt of the Santa Fe Formation and occur as incomplete sections throughout the area. Basin fill sediments of Miocene, Pliocene, and Pleistocene Age comprise thick down-faulted sections in the Rio Grande Trough (Helund, 1985).

1.2 Methods of Research

1.2.1 Review of Published Geologic Information

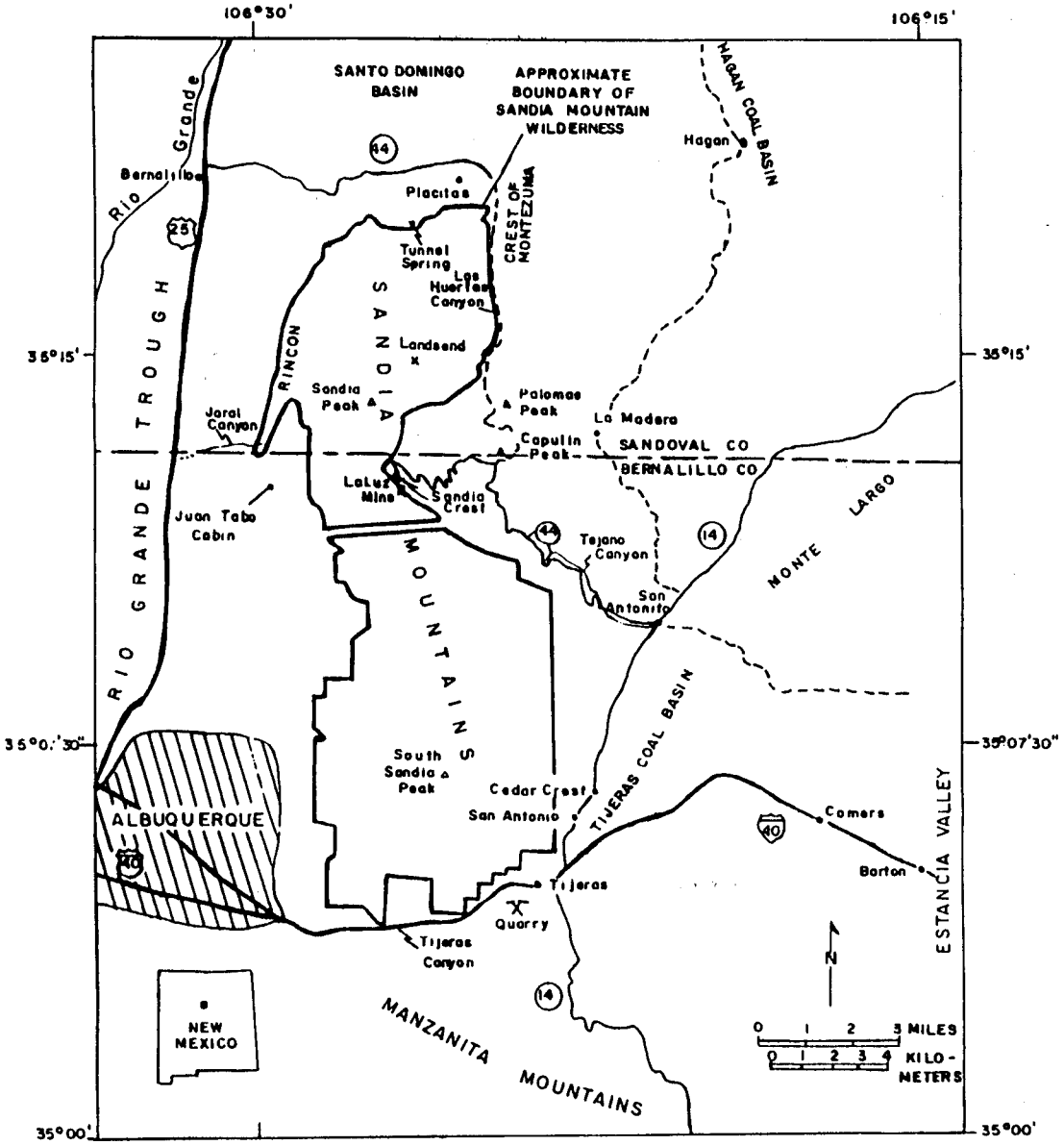
The following geologic documentation was reviewed according to federal standards specified in 40 CFR 270.14:

- Geologic map of the Sandia Mountain Wilderness, Bernalillo and Sandoval Counties, New Mexico; United States Geological Survey, Miscellaneous Field Studies, 1985.

- The Geology of the Albuquerque Sheet; Bulletin of the University of New Mexico, Volume II, pages 8-12, 1900.

- Earthquakes in New Mexico, 1849-1977; New Mexico Bureau of Mines and Mineral Resources, Circular 171, pages 7-18, 1981.

SANDIA MOUNTAINS LOCATION MAP



DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

FIGURE 2

MISCELLANEOUS FIELD STUDIES
MAP MF-1631-B

GEOLOGIC MAP OF THE SANDIA MOUNTAIN WILDERNESS, BERNALILLO AND SANDOVAL COUNTIES, NEW MEXICO

By D.C. Helund

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- Earthquakes of Albuquerque Country; New Mexico Geological Society Guidebook, 33rd Field Conference, Albuquerque Country II, 1982, pages 171-178.

1.2.2 Interpretation of Aerial Photographs

- Aerial photographs, dated 1945 and 1935 were obtained from the National Archives and reviewed for evidence of faulting.

- Interpretation of 8 photographic prints surrounding the Safety-Kleen site provided a five-mile radius for aerial investigation.

- Photographic enlargement of print 148A, dated 1935, provided aerial coverage to examine a 3,000-foot radius from the facility.

1.2.3 Geologic Map Interpretation

- Geologic maps of the La Gotera, Arch Mesa, and Mesa Gigante Unites States Geological Survey 7.5 minute quadrangles, New Mexico, Scale 1: 24,000.

- Geologic map of New Mexico, United States Geological Survey, 1965, Scale 1: 500,000.

- Geologic map of the Sandia Mountain Wilderness, United States Geological Survey, 1985, Scale 1: 50,000.

- Geologic map of the Albuquerque 1° x 2° Quadrangle, Northwestern New Mexico, United States Geological Survey, 1978, Scale 1: 250,000.

2.0 RESULTS OF INVESTIGATION

2.1 Seismic History

The United States occupation of the New Mexico Territory in 1848 was the commencement for the present day record of seismic activity for this region. From 1848 to 1961, evidence exists, primarily from old newspapers, for over 600 reported earthquakes felt in New Mexico. The earliest report of earthquakes is the description of 22 shocks in the Rio Grande Rift near Socorro, between December 11, 1849 and February 8, 1850 (Table 1).

Existing data on location and strength of earthquakes prior to 1962 is based on non-instrumental values of earthquake intensity. Roman numerals were assigned on the basis of visual observations and structural damage (Figure 3). The majority of New Mexico's earthquakes prior to 1962 were located in the Rio Grande Rift Zone from Albuquerque to Socorro. Population density in the Rio Grande Valley is greater than most other sections of the state, and may have contributed to an increase of earthquake reports from this region. One of the strongest earthquakes in New Mexico during the past 100 years occurred near Socorro on November 15, 1906. This shock was assigned an intensity of VII-VIII and was felt over an area of approximately 100,000 square miles.

The number of seismograph stations in New Mexico was inadequate to locate moderate earthquakes prior to 1962. This situation changed in 1962 with the addition of three seismograph stations, which permitted location of earthquakes throughout the region. Ninety-eight percent of the seismograph recordings since 1962 have magnitudes of less than 3.5 on the Richter scale (Figure 4). An earthquake of magnitude 3.5 can be generated by displacement on fault surfaces ranging in area from 0.05 to 3.0 square kilometers (Thatcher and Hanks, 1973). One of the strongest earthquakes since 1962 occurred at Dulce on the northern New Mexico border. On January 23, 1966, a 4.29 magnitude earthquake was recorded, followed by a large number of aftershocks.

On the basis of data gathered since 1962, an estimate of the seismicity of New Mexico for longer periods can be obtained by extrapolating the relationship

Date	Duration in weeks	Location of nearest population center	Number of reported shocks	Maximum intensity (m.M.) of strongest earthquake(s)	Reference	Remarks
Dec. 11, 1849 to Feb. 8, 1850	8	Socorro	22	IV	Hammond (1966)	Extent of felt region suggests a location beneath Socorro Mountain, an intra-graben horst block
Sept. 1893	12	Los Lunas	Daily?	VII	Woollard (1968), Coffman and von Hake (1973), Northrop (1976)	One listing (Woollard, 1968) indicates daily shocks at Sabinal (35 km south of Los Lunas) with maximum intensities >V for 3 months
Jan. 19, 1904 to March 8, 1904	8	Socorro	34	V	Bagg (1904), Woollard (1968)	Newspaper accounts indicate that shocks on September 10, 1904, at Socorro were not a continuation of this swarm
July 2, 1906 to Jan. 1907	28	Socorro	Daily	VIII(2)	Reid (1911)	Distribution of isoseismals suggests hypocenters beneath Socorro Mountain, an intra-graben horst block
Dec. 12, 1935 to Dec. 30, 1935	3	Belen	>24	V-VI	Neumann (1937), Coffman and von Hake (1973)	At Los Lunas (18 km north of Belen) shocks were much weaker than at Belen. This suggests epicenters near the central part of the rift rather than the margins

MODIFIED MERCALLI INTENSITY SCALE OF 1931 (ABRIDGED)

From Abstracts of earthquake reports for the Pacific Coast and western mountain region

I Not felt except by a very few under especially favorable circumstances. (Rossi-Forel scale.)

II Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing. (I to III Rossi-Forel scale.)

III Felt quite noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing motorcars may rock slightly. Vibration like passing truck. Duration estimated. (III Rossi-Forel scale.)

IV During the day felt indoors by many, outdoors by few. At night some awakened. Dishes, windows, and doors disturbed; walls make creaking sound. Sensation like heavy truck striking building. Standing motorcars rocked noticeably. (IV to V Rossi-Forel scale.)

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. (V to VI Rossi-Forel scale.)

VI Felt by all; many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster or damaged chimneys. Damage slight. (VI to VII Rossi-Forel scale.)

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 motorcars. (VIII Rossi-Forel scale.)

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. Persons driving motorcars disturbed. (VIII+ to IX Rossi-Forel scale.)

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. (IX+ Rossi-Forel scale.)

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. (X Rossi-Forel scale.)

XI Few, if any (masonry), structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines 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: NEW MEXICO BUREAU OF MINES & MINERAL RESOURCES
CIRCULAR 171
BY SANFORD, OLSEN, AND JAKSHA

TABLE 1

CHARACTERISTICS OF EARTHQUAKE SWARMS IN THE RIO GRANDE RIFT, 1849 TO 1961

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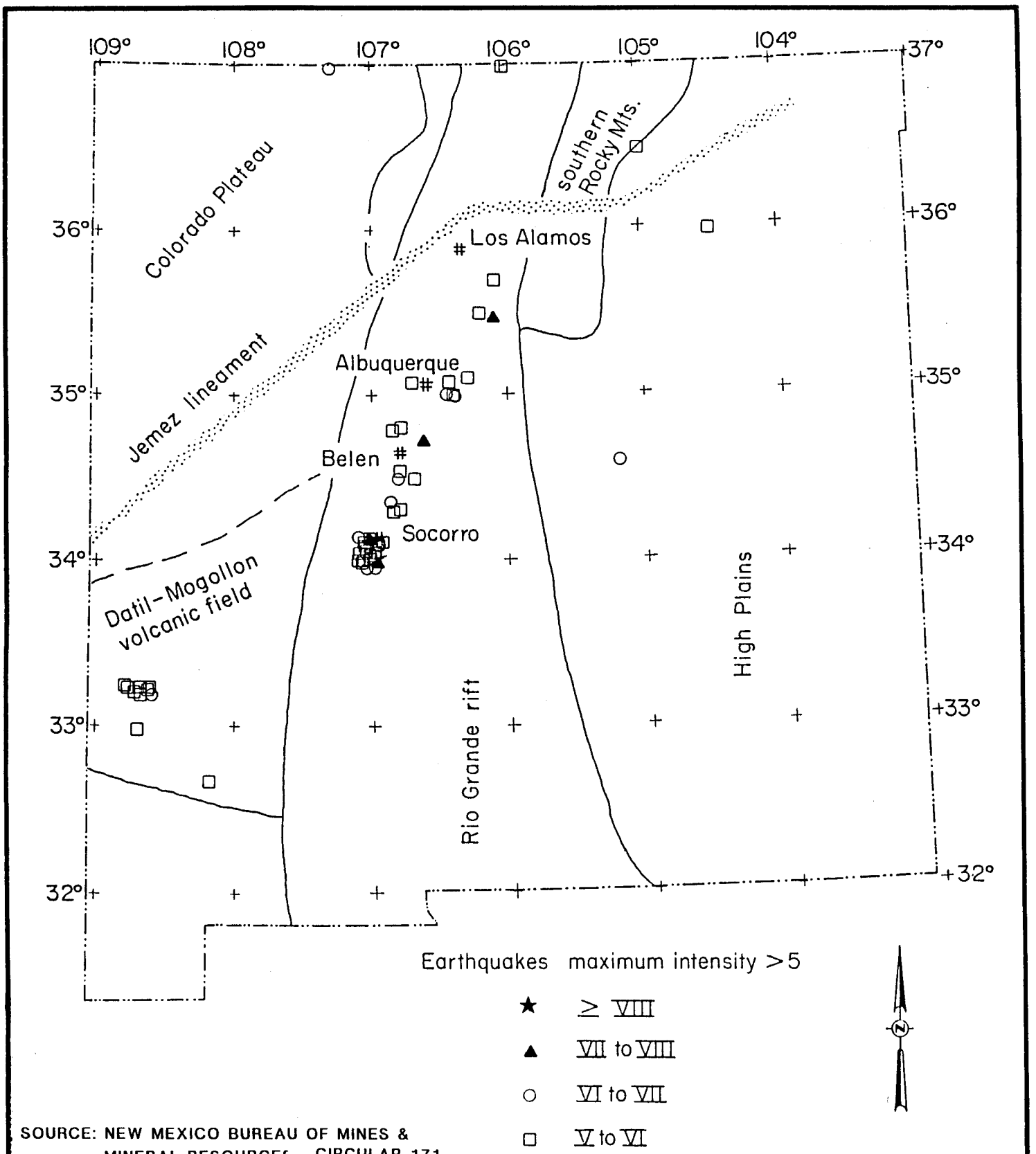

SOURCE: NEW MEXICO BUREAU OF MINES & MINERAL RESOURCES CIRCULAR 171 BY SANFORD, OLSEN, AND JAKSHA

FIGURE 3

LOCATIONS OF EARTHQUAKES REPORTED PRIOR TO 1962

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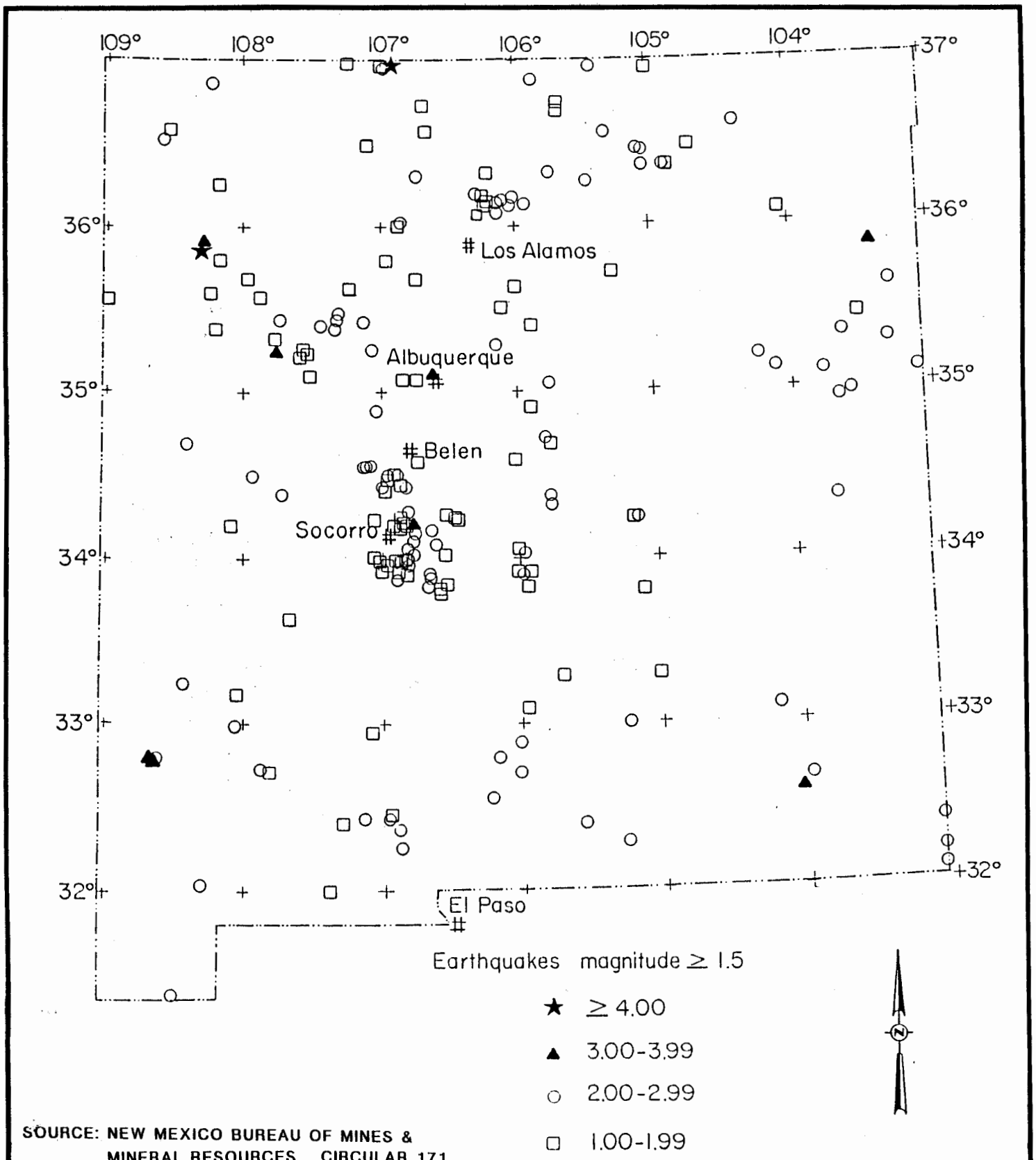
CONSULTING ENGINEERS
345 North 95th Street
Milwaukee, Wisconsin 53226



SOURCE: NEW MEXICO BUREAU OF MINES & MINERAL RESOURCES CIRCULAR 171 BY SANFORD, OLSEN, AND JAKSHA

FIGURE 4

LOCATIONS OF EARTHQUAKES RECORDED DURING THE PERIOD 1962 TO 1977

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CONSULTING ENGINEERS
345 North 95th Street
Milwaukee, Wisconsin 53226

between number of earthquakes and magnitude of recorded shocks. On the basis of these extrapolations, the strongest earthquake to be expected within New Mexico is estimated at 4.8 (Richter) in a 50-year period and 5.1 (Richter) in a 100-year period (Sanford, Olsen, and Jaksha, 1981).

2.2 Rio Grande Rift

The Safety-Kleen site at 2720 Girard Avenue, Albuquerque, is located within the Rio Grande Rift Zone. This physiographic province passes through central New Mexico and is a major structure formed by east-west crustal extension beginning about 30 million years ago and continuing to recent time. The greatest concentration of earthquake activity along the rift is between Belen and Socorro, and north of Los Alamos. Common seismicity characteristics are the occurrence of shocks in swarms, and epicenter that appear unrelated to major-rift boundary faults. Earthquake swarms occur in the vicinity of active volcanoes, and in regions of recent volcanic activity. The source of the earthquake swarms in the rift may be caused by the injection of magma into the crust. Late Pliocene and Quaternary basalt flows, from north of Albuquerque to south of Socorro, are confined to the central portion of the rift and could indicate continued magma injection. Seismic activity in the Socorro area is centered above a mid-crustal magma body. The uplift, discovered in 1912, appears to be continuous at an average rate of 5 mm/year (Sanford, Olsen and Jaksha, 1985). This observation suggests that the seismicity is arising from crustal stress created by the injection of magma, rather than extensional stress along the rift boundaries.

The northern portion of the Rio Grande Rift is transversed by a line of Pliocene and Pleistocene volcanoes. This structure, defined as the Jemez Lineament, has been mapped from the northeast corner of the state, across the rift and southward through the Colorado Plateau. Seismic activity occurs over much of the lineament and is particularly active northeast of the Mount Taylor volcanic region. As a result of this volcanic activity, a line of epicenters trending along this feature occurs roughly 50 miles northwest of Albuquerque.

2.3 Quaternary Faulting

The majority of Quaternary faulting in New Mexico is located within the Rio Grande Rift Zone. The discrepancy between the geologic evidence of major tectonic movement and present seismic activity suggests that earthquake activity is currently at a low level within the rift.

Evidence for major offsets of Holocene Age deposits exists at two locations within the Rio Grande Rift; along the La Jencia Fault on the eastern margin of the Magdalena Mountains (approximately 12 miles west of Socorro), and along the Cox Ranch Fault on the eastern margin of the Organ Mountains (approximately 40 miles north of El Paso) (Sanford, Olsen, and Jaksha, 1985).

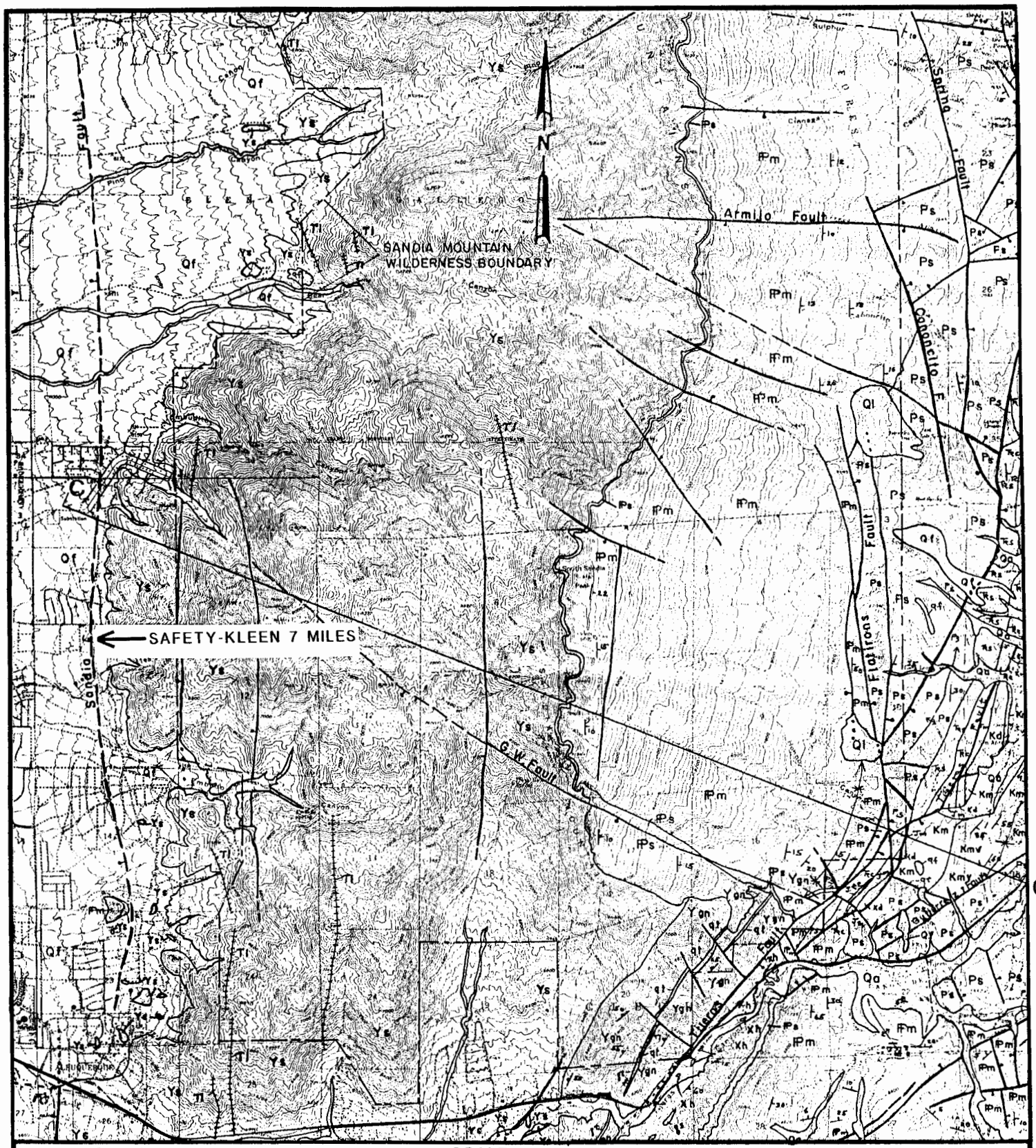
Earthquakes elsewhere in the rift may have been generated along faults showing late Quaternary movement. An area along the eastern margin of the rift, between 33.8° N. and 35.0° N. latitude suggests active faulting during this time frame. This area, approximately 12 miles to the southeast, represents the closest Holocene Fault activity to the Safety-Kleen Facility.

2.4 Local Faulting

The dominant structural feature near the Safety-Kleen facility is the east-tilted Sandia Fault Block. The north-south striking Sandia Fault is located approximately 7 miles east of the facility (Figure 5). This fault is largely buried by thick alluvial fans that conceal the estimated 20,000 to 28,000 feet of fault throw. There also exists numerous unnamed north trending faults along the dip-slope of the Sandia Fault Block (Figure 6). The majority of the local fault activity has been dated to the Pliocene-Miocene Epoch, with some faults displacing older, diastrophic movement from the Laramide Orogeny (Helund, 1985).

The Tijeras and Gutierrez faults strike northeast and form the southern boundary of the Sandia Mountains. These faults principally of Laramide age, displace the Upper Cretaceous Mesaverde and Eocene Galisteo formations. Both fault systems are characterized by auxiliary and splayed faults having

SANDIA MOUNTAIN GEOLOGIC MAP



DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

SCALE 1 : 57500
FIGURE 5

MISCELLANEOUS FIELD STUDIES
MAP MF-1631-B

GEOLOGIC MAP OF THE SANDIA MOUNTAIN WILDERNESS, BERNALILLO AND SANDOVAL COUNTIES, NEW MEXICO

By D.C. Helund
1985

FAULT--Showing dip where known. Dashed where approximately located or inferred; dotted where concealed. Bar and ball on downthrown side

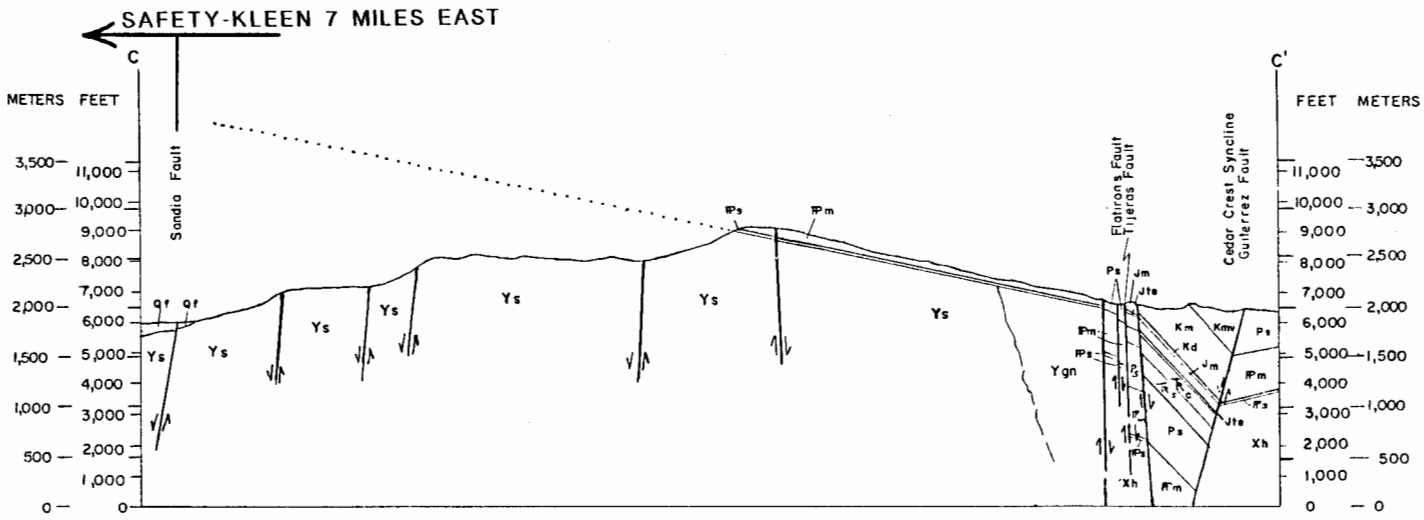
ANTICLINE--Showing plunge. Dashed where approximately located or inferred

SYNCLINE--Showing plunge. Dashed where approximately located or inferred

CROSS-SECTION OF SANDIA MOUNTAINS

CORRELATION OF MAP UNITS

ALLUVIUM	Qa	Holocene	QUATERNARY
FAN, TALUS, LANDSLIDES	Qf Qt Ql	Holocene and Pleistocene	
SANTA FE FORMATION	QTsf	Pleistocene, Pliocene and Miocene	
LAMPROPHYRE DIKES	Tl	Oligocene(?)	TERTIARY
GALLISTEO FORMATION	Tg	Eocene	
MESAVERDE FORMATION	Kmv	Upper Cretaceous	CRETACEOUS
MANCOS SHALE	Km		
DAKOTA SANSTONE	Kd		
MORRISON FORMATION	Jm	Upper Jurassic	JURASSIC
TODILTO AND ENTRADA	Jte	Middle Jurassic	
CHINLE FORMATION	Ꞧc	Upper Triassic	TRIASSIC
SANTA ROSA FORMATION	Ꞧs		
SAN ANDRES FORMATION	Ps	Lower Permian	PERMIAN
MADERA GROUP	Pm	Upper Pennsylvanian	PENNSYLVANIAN
SANDIA FORMATION	Ps	Middle Pennsylvanian	
ARROYO PENASCO GROUP	Ma	Upper and Lower Mississippian	MISSISSIPPIAN
SANDIA GRANITE	Ys, pg		MIDDLE PROTEROZOIC
GNEISS AND SCHIST	Yr		MIDDLE(?) PROTEROZOIC
CIBOLA GNEISS	Ygn, qt		EARLY PROTEROZOIC
TIJERAS GREENSTONE	Xh, qs		



DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

FIGURE 6

MISCELLANEOUS FIELD STUDIES
MAP MF-1631-B

GEOLOGIC MAP OF THE SANDIA MOUNTAIN WILDERNESS, BERNALILLO AND SANDOVAL COUNTIES, NEW MEXICO

By D.C. Helund
1985

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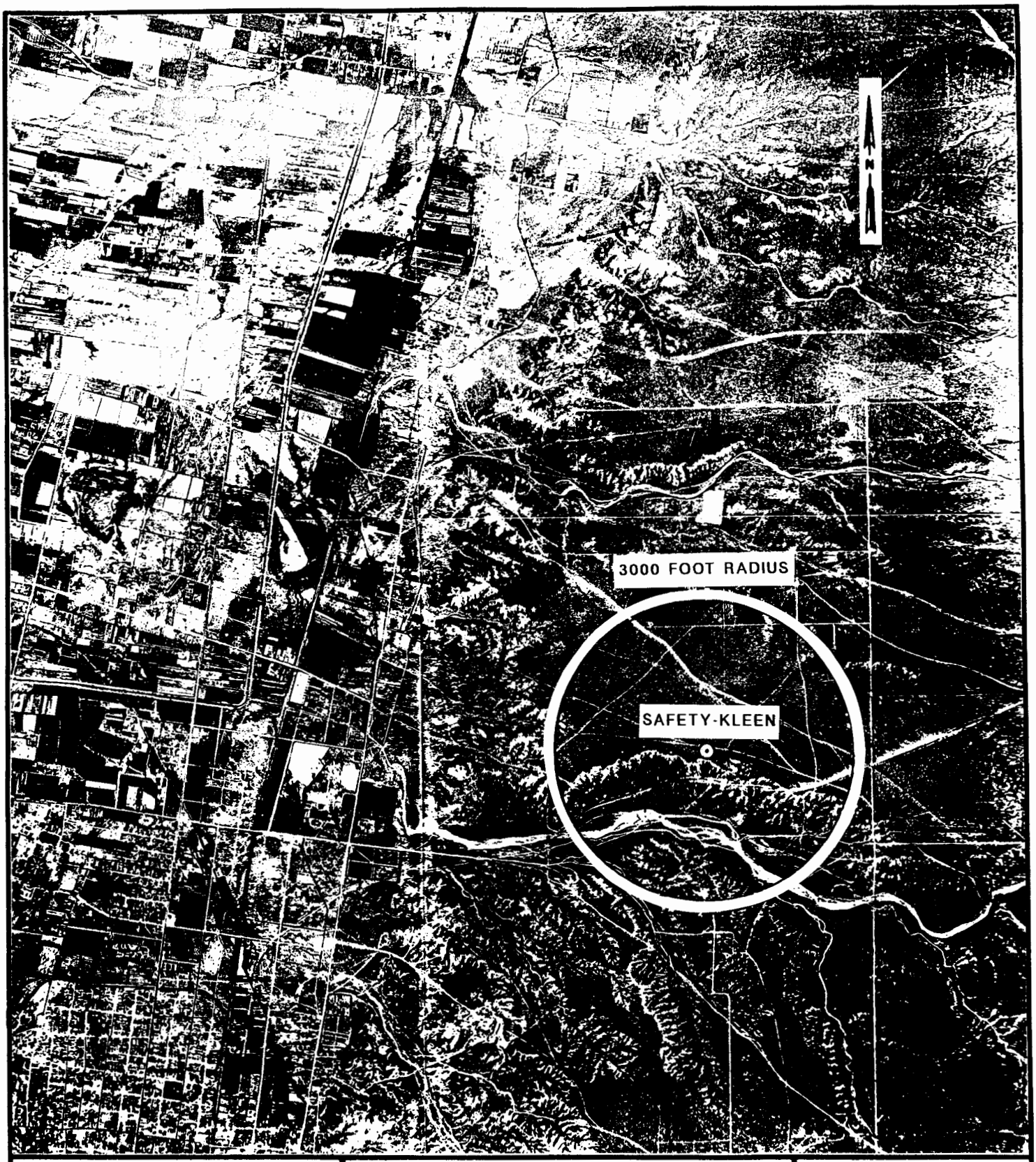
combined throws of up to 3,000 feet (Helund, 1985). The Tijeras and Gutierrez Faults bound the Monte Larago horst and the Tijeras graben and syncline. One of the more active faults throughout geologic time, the Tijeras Fault shows evidence of displacement from Precambrian through Holocene time. This fault, located approximately 12 miles southeast of the Safety-Kleen facility, represents the closest Holocene movement.

Additional pre-Quaternary faulting has occurred along the western boundary of the Rio Grand Rift. Numerous northeast-trending faults occur near Mesa Gigante, approximately 25 miles west of Albuquerque. Roughly 10 miles west of the site a fault occurs south of seven volanic vents (Wyant and Olson, 1978). This fault, trending north-south, extends south of the vents, and represents the closest faulting to the Safety-Kleen Facility in a westerly direction.

2.5 Aerial Photographs

Air photos within a five-mile radius of the proposed Safety-Kleen site were studied in detail (Can A-3527-54, 56, 88, 90 and 75A, 77A, 146A, 148A Rio Grande Project). An enlargement of 148A was obtained and used for a 3,000-foot radius investigation. The above mentioned aerial photographs were originally completed for the Defense Intelligence Agency 1945, Soil Conservation Service 1935, and are presently stored in the National Archives, Washington, D.C. These photographs are black and white, 1:20,000 and 1:31,680 scale, taken before significant industrial development of the area (Figure 7). The photos were examined for lines suggestive of faulting. Lines indicative of faults may be expressed as alignments of vegetation, straight segments of streams, and waterfalls across streams. Other fault indicators include alignment of lakes, ponds, springs, and changes in photographic tone, drainage, or erosional texture on opposite sides of a linear feature. Alignments of topographic features including saddles, knobs, straight scarps, or any combination of such features may indicate faulting. A close examination of the area within a five-mile radius of the Safety-Kleen site indicates no evidence for Holocene faulting.

AERIAL PHOTOGRAPH DATED 1935



SCALE: 1 : 31680	FIGURE 7	NATIONAL ARCHIVES WASHINGTON, D.C.

SOIL CONSERVATION SERVICE
RIO GRANDE PROJECT 1935
EXPOSURE 148 A

GRAEF ANHALT SCHLOEMER & ASSOCIATES INC
CONSULTING ENGINEERS
345 North 95th Street
Milwaukee, Wisconsin 53226

3.0 CONCLUSION

Based on an analysis of published geologic literature, fault mapping, and aerial photographic interpretation, no Holocene faults exist within five miles of Albuquerque. Available evidence suggests that present day seismicity near Albuquerque is the result of magma injection into the crust rather than stress along the Rio Grande Rift boundaries. The Sandia Fault, located approximately 7 miles east of the Safety-Kleen facility, is the closest existing fault. Geologic investigations suggest the Tertiary period for the last displacement along the Sandia Fault. Roughly 12 miles southeast of the facility evidence exists for Holocene faulting. The Tijeras Fault, forming the southern boundary of the Sandia Mountains, shows signs of activity from Precambrian to Holocene time. The site is, therefore, not within 3,000 feet of a fault which has had displacement in the Holocene Epoch. Based on the above, no further fault zone study is required for this facility.

4.0 REFERENCES

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