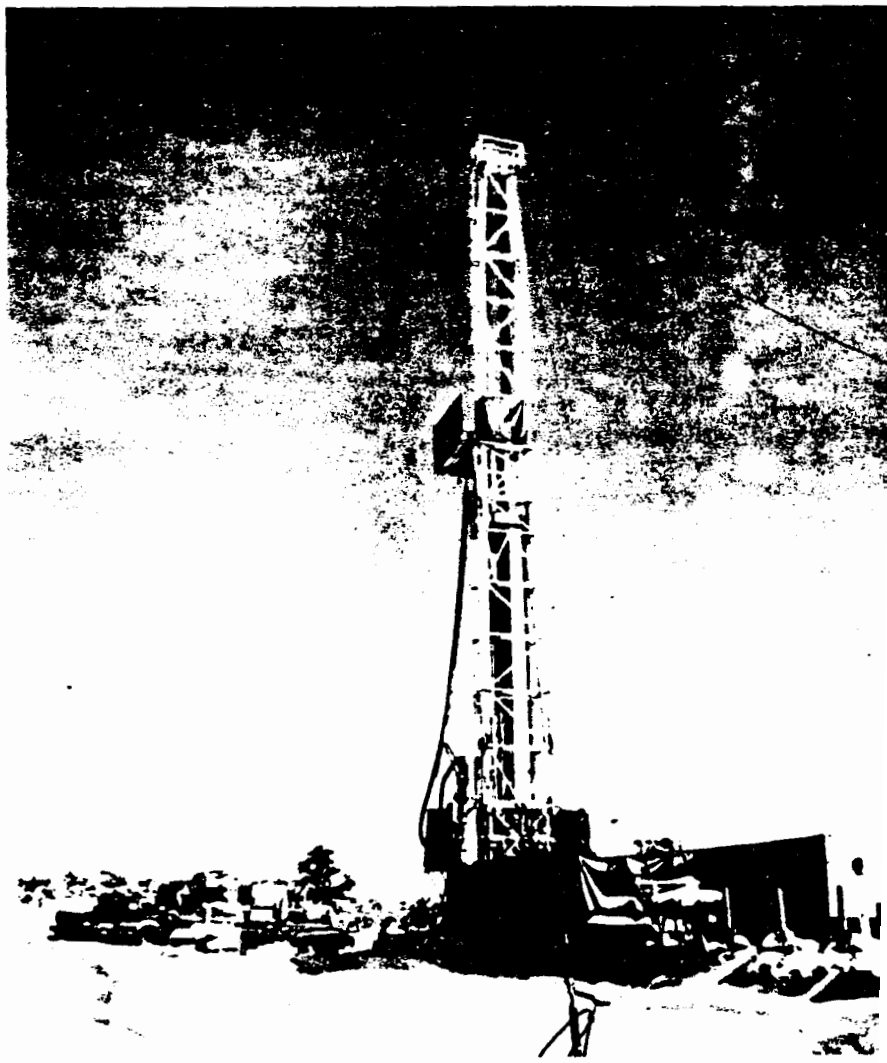
LA-12733-MS
Vol. I [redacted]

179

LA-12733-MS
c. 4 Purtymun 1994
ERID # 58233

Source Document Compilation: Los Alamos Investigations Related to the Environment, Engineering, Geology, and Hydrology

1961–1990



Received by ER-RPI
JUL 13 1998

7430

Los Alamos
NATIONAL LABORATORY

Los Alamos National Laboratory is operated by the University of California for the United States Department of Energy under contract W-7405-ENG-36.

Cover Photo: Drilling Supply Well PM-5, January 1982, total depth 3120 feet, completed 3092 feet. Photo taken by W. Purtymun.

An Affirmative Action/Equal Opportunity Employer

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither The Regents of the University of California, the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by The Regents of the University of California, the United States Government, or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of The Regents of the University of California, the United States Government, or any agency thereof.

SOURCE DOCUMENT COMPILATION: LOS ALAMOS INVESTIGATIONS RELATED TO THE ENVIRONMENT, ENGINEERING, GEOLOGY, AND HYDROLOGY 1961–1990

Compiled by

William D. Purtymun

ABSTRACT

This document is a compilation of informal reports, letters, and memorandums regarding geologic and hydrologic studies and investigations such as foundation investigations for structures, drilling or coring for environmental studies, development of water supply, or construction of test or observation wells for monitoring. Also included are replies requested for specific environmental, engineering, geologic, and hydrologic problems.

The purpose of this document is to preserve and make the original data available to the environmental studies that are now in progress at Los Alamos and provide a reference for and supplement the LAMS report "Records of Observation Wells, Test Holes, Test Wells, Supply Wells, Springs, and Surface water stations at Los Alamos: with Reference to the Geology and Hydrology," which is in preparation. The informal reports and memorandums are listed chronologically from December 1961 to January 1990.

Item 208 is a descriptive history of the U.S. Geological Survey's activities at Los Alamos from 1946 through 1972. The history includes a list of published and unpublished reports that cover geology, hydrology, water supply, waste disposal, and environmental monitoring in the Los Alamos area.

Contents

Chapter	Descriptive Title	Date	Page
1.	Bayo Canyon test holes	12/15/61	1-1
2.	Ultra-High Temperature Reactor	8/18/61	2-1
3.	Rocks and mineral of concrete aggregate	10/2/61	3-1
4.	Particle Accelerator Mesita de Los Alamos	11/6/63	4-1
5.	Exploratory holes Mesita de Los Alamos	2/5/64	5-1
6.	Geology at proposed Meson Facility	10/16/64	6-1
7.	Inspection of Pit 3, Area G	2/18/63	7-1
8.	Inspection of Pit 5, Area G	12/9/66	8-1
9.	Geology, loading tests Mesita de Los Alamos	12/16/66	9-1
10.	Seepage pits near Bldg. 35, TA-21	2/20/67	10-1
11.	Quality of water for use at power plant	4/7/67	11-1
12.	Geology of proposed waste pit near Bldg. 40, TA-21	3/7/69	12-1
13.	Sand with pumpage from Pajarito Field	2/18/69	13-1
14.	Hydrologic data for densely welded tuff	4/2/69	14-1
15.	Materials waste pit, Area "A", TA-21	6/30/69	15-1
16.	Geology near Bldg. 257, TA-21	7/19/69	16-1
17.	Induced radiation in tuff, Meson Facility	10/16//69	17-1
18.	Geohydrology of tuff at Mesita de Los Alamos	10/16/69	18-1
19.	Permeability of the tuff to water vapors	11/21/69	19-1
20.	Migration of tritium in tuff Area G, TA-54	7/7/70	20-1
21.	Geologic section at TA-46	2/2/71	21-1
22.	Engineering tests Area C	4/28/71	22-1
23.	Survey of storage pits Area G, TA-21	7/26/71	23-1
24.	Waste Storage Areas H,J, and L, TA-51	0/22/71	24-1
25.	Radiochemical analyses Area G, TA-54	12/2/71	25-1
26.	Logs and casing schedules heat flow holes Fenton Hill	12/22/71	26-1
27.	Geology and hydrology near TA-15	1/7/72	27-1
28.	Conversion of heat flow holes to wells	11/27/72	28-1
29.	Tentative test sites for heat penetrator experiments	4/13/73	29-1
30.	Test holes TA-56 (heat penetrator site)	5/2/73	30-1
31.	Physical and hydrologic of the Bandelier Tuff (from Geohydrology of the Pajarito Plateau with reference to the quality of water - 1949 to 1972)	May 1973	31-1
32.	Moisture content of tuff, Pit 7, Area G	12/12/73	32-1
33.	Moisture content 3 test holes Area G	2/7/74	33-1
34.	Moisture and tritium content in fill material Area G TA-54	2/13/74	34-1
35.	Test holes at Bldg. 260, TA-16	3/19/74	35-1
36.	Geohydrology for supply well at TA-57	2/2/74	36-1
37.	Flood flow and maximum discharge of sixteen drainage areas in the vicinity of Los Alamos	5/74	37-1
38.	Site selection Fusion Test Reactor	9/10/74	38-1
39.	Geologic section at Fusion Test Reactor	10/22/74	39-1

40.	Storm runoff Mortandad Canyon	10/23/74	40-1
41.	Infiltration shafts and sediment traps, Mortandad Canyon	10/25/74	41-1
42.	Inventory and movement of plutonium in Acid-Pueblo, DP- Los Alamos, and Mortandad Canyons	11/14/74	42-1
43.	Up date above memo	12/3/74	43-1
44.	Radiochemical analyses Jemez Area	10/10/74	44-1
45.	Moisture and density logging of basalt hole TA-56	3/3/75	45-1
46.	Geologic section at TA-56	9/19/75	46-1
47.	Stockpile and storage area for proposed laser Bldg. near TA-35	9/19/75	47-1
48.	Designation of sampling stations Jemez area	10/3/75	48-1
49.	Logs of test holes at TA-1	11/7/75	49-1
50.	Logs of test holes at TA-1	11/12/75	50-1
51.	Logs of test holes at TA-1	11/24/75	51-1
52.	Logs of test holes at TA-1	11/26/75	52-1
53.	Logs of test holes at TA-1	12/16/75	53-1
54.	Test holes (heat flow) Jemez Area	1/5/76	54-1
55.	Logs of test holes at TA-1	1/5/76	55-1
56.	Seepage pits DP-East (TA-21-DPE-164)	1/7/76	56-1
57.	Logs of test holes at TA-1	2/3/76	57-1
58.	Field notes hole M-1 (Horizontal holes) Area G TA-54	4/15/76	58-1
59.	Gaging Stations Rio Guadalupe and Jemez River	4/30/76	59-1
60.	Use of Iodine 131 at TA-57	5/19/76	60-1
61.	Safe level of alpha activity in evaporation ponds	5/27/76	61-1
62.	Disposal of sulfuric acid	6/24/76	62-1
63.	Estimated size of disposal ponds or shafts	10/28/76	63-1
64.	Test boring at proposed Bldg. RD-33, TA-52	12/8/76	64-1
65.	Log of test holes TA-45	4/6/77	65-1
66.	Test borings East of TA-48	11/3/77	66-1
67.	Test borings H-Division office Bldg.	11/16/77	67-1
68.	Rockfalls at proposed Tritium Bldg.	12/28/77	68-1
69.	Aquifer tests at supply well Fenton Hill	1/31/78	69-1
70.	Log of test hole near TA-22	2/1/78	70-1
71.	Logs of test holes on 2-Mile Mesa	5/15/78	71-1
72.	Logs of test holes at TA-53	6/2/78	72-1
73.	Location of heat flow hole near El Cajete	6/23/78	73-1
74.	Chemical and radiochemical analyses Bandelier National Monument	6/6/78	74-1
75.	Water temperatures in distribution system	7/20/78	75-1
76.	Log of test hole at TA-46	10/18/78	76-1
77.	Data from deep test hole on Sigma Mesa	5/4/79	77-1
78.	Aquifer, supply well Fenton Hill	5/4/79	78-1
79.	Location of exploratory holes Fenton Hill, water rights	5/14/79	79-1
80.	Foundation holes Fenton Hill	7/17/79	80-1
81.	Test holes at proposed storage pond Fenton Hill	9/7/79	81-1
82.	Test holes Fenton Hill proposed tower	10/29/79	82-1
83.	Logs at proposed site for storage pond Fenton Hill	10/29/79	83-1
84.	Water quality Santa Clara Creek	12/14/79	84-1

85.	Rockfall inspection TA-2	12/14/79	85-1
86.	Water supply Fenton Hill	3/12/80	86-1
87.	Water well #3 Fenton Hill	2/13/80	87-1
88.	Logs of test holes SM-66, TA-3	3/18/80	88-1
89.	Hydrologic characteristics of supply well #2 Fenton Hill	4/4/80	89-1
90.	Test holes at proposed pump station at TA-57 Fenton Hill	5/12/80	90-1
91.	Well location Pueblo Canyon	5/27/80	91-1
92.	Update on activities at TA-49	7/17/80	92-1
93.	Test borings Bldg. SM-200, TA-3	9/3/80	93-1
94.	Test borings Bldg. SM-102, TA-3	9/3/80	94-1
95.	Test borings MPF-16, TA-53	10/6/80	95-1
96.	Test hole near Bldg. M, TA-53	11//14/80	96-1
97.	Test holes Bayo and Pueblo Canyons	11/17/80	97-1
98.	Inspection Pit 27, Area G, TA-54	1/19/81	98-1
99.	Test hole waste demonstration site LS-6	1/19/81	99-1
100.	Rockfall inspection TA-2	2/23/81	100-1
101.	Tests hole near Bldg. M TA-53	4/7/81	101-1
102.	Characteristics of tuff HRL	4/7/81	102-1
103.	Log test holes at Waste Area C	4/8/81	103-1
104.	Inspection, addition to Pit 27, Area G, TA-54	4/29/81	104-1
105.	Test holes proposed solar pond near TA-46	5/15/81	105-1
106.	Generalized geohydrology of TA-22	5/21/81	106-1
107.	Logs of test holes solar evaporation waste ponds on Sigma Mesa	7/27/81	107-1
108.	Test borings Bldg. SM-29, TA-3	8/27/81	108-1
109.	Shaft inspection Area G, TA-54	8/31/81	109-1
110.	Geohydrology of Area L, TA-54	1/19/82	110-1
111.	Test hole west of Omega Reactor Bldg.	1/27/82	111-1
112.	Soil used for dikes around oil storage	3/16/82	112-1
113.	Test borings security and safeguards upgrading TA-41	5/24/82	113-1
114.	Test borings TA-16	7/14/82	114-1
115.	Radium 226 analyses Fenton Hill	8/6/82	115-1
116.	Oil disposal shaft Area L, TA-54	9/23/82	116-1
117.	Rockfall inspection TA-2	9/23/82	117-1
118.	Inspection of Pit 33, Area G, TA-54	10/10/82	118-1
119.	Location of shafts Area G, TA-54	12/1/82	119-1
120.	Test hole LS-6 experimental site	10/26/82	120-1
121.	Inspection of shafts in Area L, TA-54	2/15/83	121-1
122.	Inspection of shafts in Area G, TA-54	2/15/83	122-1
123.	Inspection of shafts in Area G, TA-54	4/1/83	123-1
124.	Test holes at TA-55	4/11/83	124-1
125.	Test holes near Bldg. MD-22, TA-54	5/3/83	125-1
126.	Test borings TA-51	5/25/83	126-1
127.	Test borings at TA-35	7/3/83	127-1
128.	Test holes in upper Canada del Buey	8/19/83	128-1
129.	Test holes for percolation tests at TA-51	8/22/83	129-1
130.	Test borings SM-29, TA-3	8/24/83	130-1
131.	Rockfall inspection TA-2	7/25/83	131-1

132.	Proposed barrow pit Mortandad Canyon	9/24/83	132-1
133.	Test borings in Museum Parking Lot	10//28/83	133-1
134.	Test borings Sigma Mesa	10/31/83	134-1
135.	Test borings visitor entry station Ad Bldg. TA-3	1/5/84	135-1
136.	Shaft inspection Area G. TA-54	10/31/83	136-1
137.	Pit inspection Area G. TA-54	11/16/83	137-1
138.	Location of soil sampling stations related to siting sanitary landfill	2/3/84	138-1
139.	Shaft 29 inspection Area G. TA-54	3/1/84	139-1
140.	Pit 29 excavation Area G. TA-54	3/16/84	140-1
141.	Test borings SM-410. TA-3	4/27/84	141-1
142.	Inspection shaft 31, Area L. TA-54	5/21/84	142-1
143.	Location of decontamination pit	5/21/84	143-1
144.	Test holes Bldg. 210. TA-3	5/30/84	144-1
145.	Rockfall inspection TA-2	6/15/84	145-1
146.	Test holes meteorological tower TA-16	6/28/84	146-1
147.	Inspection shaft 30. Area L. TA-54	6/28/84	147-1
148.	Subsurface investigation TA-16, weapons subsystem	7/9/84	148-1
149.	Log of test holes-Acid Sewer Line Removal	7/13/84	149-1
150.	Inspection of Pit 29-Area G-TA-54	7/13/84	150-1
151.	Test borings TA-46 and TA-55	7/18/84	151-1
152.	Test borings TA-55, Guard Tower Installation	7/18/84	152-1
153.	Test Borings At Ponds GT-2 and EE-1 TA-57	8/2/84	153-1
154.	Test Borings, road realignment near TA-55	9/10/84	154-1
155.	Proposed geohydrologic investigation at Area L	9/19/84	155-1
156.	Inspection Shaft 32, Area L	9/19/84	156-1
157.	Test borings, Kryton Fluoride Project	9/20/84	157-1
158.	Test borings advance laser addition	10/10/84	158-1
159.	Cement storage and handling system TA-55	10/10/84	159-1
160.	Shaft inspection shafts 126, 127, and 128	10/11/84	160-1
161.	Soil borings and subsurface investigation TA-16	10/18/84	161-1
162.	Subsurface investigation. tower installation TA-18	10/29/84	162-1
163.	Inspection shaft 33. Area L	11/19/84	163-1
164.	Test borings Bldg. RC-33 TA-48	11/19/84	164-1
165.	Evaporation and estimated infiltration from ponds at Fenton Hill	1/15/85	165-1
166.	Test borings Bldg. WA-200, TA-46	1/12/85	166-1
167.	Test borings SM-29, TA-3	3/6/85	167-1
168.	Inspection shaft 34 Area L	3/6/85	168-1
169.	Test borings SM-494, TA-3	3/9/85	169-1
170.	Test holes near TD-91, TA-22	7/9/85	170-1
171.	Inspection of shafts 128 through 133 Area G	8/16/85	171-1
172.	Test borings Bldg. SM-141, TA-3	8/16/85	172-1
173.	Test boring cooling tower TA-3	9/3/85	173-1
174.	Inspection shaft C-11, Area G	10/7/85	174-1
175.	Test holes Bldg. SM-200, TA-3	10/16/85	175-1
176.	Rockfall inspection TA-2	10/16/85	176-1
177.	Test borings Bldg. 200, TA-3	2/18/86	177-1
178.	Soil borings at TA-35 and TA-46	4/7/86	178-1

179.	Test hole TA-48	6/13/86	179-1
180.	Test borings Accelerator No.2, TA-53	7/22/86	180-1
181.	Construction of Retention Ponds (sediment traps) in Mortandad Canyon	8/1/86	181-1
182.	Test holes in Potrillo Canyon Rocket Sled Track	7/15/86	182-1
183.	Soil borings storage Bldg. TA-16	5/19/86	183-1
184.	Test holes Meteorological Tower TA-O	5/27/86	184-1
185.	Inspection shafts 136 and 137 Area G	7/14/86	185-1
186.	Mayfield test holes Area G (1979 ?) WDP	1987	186-1
187.	Geologic data, TA-21	5/7/87	187-1
188.	Test holes TA-59	4/23/87	188-1
189.	Test holes strain gage at TA-33	6/9/86	189-1
190.	Root Tomography holes at TA-33	6/11/87	190-1
191.	Rockfall inspection TA-2	6/17/87	191-1
192.	Test hole TA-16 package treatment plant	7/16/87	192-1
193.	Test borings MPF-3, TA-53	3/24/87	193-1
194.	Log of holes at junction SR-4 and main hill road	8/31/87	194-1
195.	Soil borings Pajarito and Puye roads	9/28/87	195-1
196.	Inspection of shafts 140 through 143	10/30/87	196-1
197.	New pump well 1, TA-57	12/2/87	197-1
198.	Test holes East Jemez Road-Telephone duck bank-	3/16//88	198-1
299.	Rockfall inspection TA-2	11/1/88	199-1
200.	Rockfall inspection TA-41	11/10/88	200-1
201.	Test holes meteorological tower north of TA-40	7/7/88	201-1
202.	Inspection of shafts 142 through 149 Area G	5/4/89	202-1
203.	Test holes TA-35 LAPRE reactor	7/7/89	203-1
204.	Rockfall TA-41	12/7/89	204-1
205.	Rockfall TA-2	1/29/90	205-1
206.	Review Installation work plan (with hydrologic properties of Bandelier Tuff and Puye Conglomerate)	6/19/90	206-1
207.	U.S. Geological Survey Ground Water Branch history of operations at Los Alamos	1946-1972	207-1

Ground Water Branch
P.O. Box 4217
Albuquerque, New Mexico
Dec. 15, 1961

Mr. William P. Kennedy
H-6, LASL
P.O. Box 1663
Los Alamos, New Mexico

Dear Bill:

Four test holes were drilled in or near Bayo Site, at your request made to John Abrahams on November 29, 1961. The purpose of these holes was to determine if water was present within the upper 100 feet of tuff, pumice, or conglomerate beneath the site.

The four test holes designated as Bayo Canyon 1, 2, 3, and 4, (see attached logs for location) were drilled with a power auger on December 7 and 8, 1961. Bayo Canyon 1, 3, and 4 penetrated the top of the conglomerate, where drilling was discontinued because of the inability of the auger to penetrate this material.

No water was found in any of the holes. Although a high moisture content in cuttings from Bayo Canyon was noted no perched water was present. The high moisture content probably represents infiltration into the tuff and pumice from flood flow in Bayo stream.

Bayo Canyon 3 and 4 will be utilized in the future for monitoring the moisture content of the tuff and pumice.

Yours very truly,

William D. Purtyman
Geologist

Attachment

cc: D. W. Mueller, GMX-5

Log of Test Holes

Bayo Canyon 1 - Located or near southeast corner of firing pad.

0 - 16	Weathered tuff
16 - 57	Light gray tuff
57 - 85	Light gray pumice
85 - 89	Silt and clay with a few rock fragments

Bayo Canyon 2 - Located about 50 feet east of the southeast corner of firing pad

0 - 5	Weathered tuff
5 - 25	Gray tuff

Drilling discontinued at 25 feet because of the similar material to Bayo Canyon 1 which is near by.

Bayo Canyon 3 - Located about 150 feet northeast of main gate to Bayo Site, south of Bayo stream

0 - 12	Light brown silty sand
12 - 65	Light gray tuff and pumice. The pumice represents the interval of about 40 - 65 feet.
65 - 70	Silt and clay with some rock fragments

Bayo Canyon 4 - Located about 150 feet northeast of firing pad on south bank of Bayo stream

0 - 10	Light brown silty sand
10 - 52	Light brownish tuff
52 - 77	Light gray pumice
77 - 79	Silt and clay with a few rock fragments

Ground Water Branch
P.O. Box 4217
Albuquerque, New Mexico
August 18, 1961

Mr. C. W. Christenson
Group Leader, H-7
Los Alamos Scientific Laboratory
Los Alamos, New Mexico

Dear Mr. Christenson:

The following information is in reply to your request of August 10, 1961. The information was compiled by John Abrahams and Elmer Baltz from data collected during ground-water investigations in cooperation with the Atomic Energy Commission.

The area selected by the Los Alamos Scientific Laboratory for the Ultra-high Temperature Reactor Facility is in the southeast quarter of sec. 23. T. 19 N., R. 6 E at an altitude of about 7,150 feet. This area is about a half mile east-southeast of the site proposed for the new waste-treatment plant, and slightly more than 1,000 feet south-southeast of the present 10-Site facilities. The Reactor facility is to be located on the south wall of 10-Site Canyon, which is immediately south of the 10-Site facilities and is a tributary canyon of Mortandad Canyon. The topographic relief in the upper part of 10-Site Canyon is about 70 feet in the vicinity of the proposed site. The area is on the western half of the Pajarito Plateau which has been dissected into a number of finger-like mesas by eastward flowing intermittent streams tributary to the Rio Grande. Mortandad Canyon and its tributaries, including 10-Site Canyon, drain the immediate area.

The proposed site of the Reactor facility is in the area investigated recently by the Geological Survey for the proposed waste-treatment plant. This part of the Pajarito Plateau is capped by the Bandelier Tuff of Pleistocene Age. The Bandelier is a welded rhyolite tuff consisting of crystal fragments, tuff breccia, and pumiceous material. The Bandelier is about 700 feet thick near 10-Site. The base of the Bandelier was encountered at an altitude of about 6,380 feet at Test Well 8 in Mortandad Canyon, three-quarters of a mile east of the proposed Reactor facility site. No bodies of water were found in the Bandelier at Test Well 8.

In the subsurface the Bandelier Tuff is underlain by the Puye Conglomerate of Pliocene (?) Age. The Puye consists of silt, sand, and gravel composed of pebbles to boulders of volcanic rocks. Basalt flows are interbedded with Puye sediments in the eastern part of the Pajarito Plateau. Test Well 8 was drilled through 575 feet of the Puye Conglomerate but did not reach the base of the formation. Water was not found in the upper part of the Puye, but was encountered in the lower part at a depth of about 985 feet below the floor of the canyon. The water rose about 25 feet in the well. This body of water, which is the main aquifer in the Los Alamos area is

at an altitude of about 5,960 feet in the vicinity of the prop ed Reactor facility.

The average annual precipitation in the vicinity of the proposed Reactor site is about 17 or 18 inches, about 25 percent of which is in the fo of snow. Generally during winter months snowfall is sufficient to maintain a layer of snow on the western part of the plateau, but in the upper parts o the canyons the depth of snow is commonly 1 or 2 feet. Most of the prec pitat on here occurs during summer thundershowers, sometimes with as much as 6 o 8 inches during 1 month.

Studies indicate that little of the precipitation falling on the mesa tops filters into the Bandelier Tuff where it is overlain by soil. Probably clay in the alluvium in the canyons also inhibits or retards infiltration into the Bandelier. Data concerning the movement of water through tuff are scanty, but because the upper part of the Bandelier is moderately welded and jointed, some infiltration may occur along joints when water flows on bare rock. These joints commonly extend across and along the canyons.

Generally there is flow on 10-Site Canyon only during spring snow-melt or during summer thundershowers, although an emergency over-flow from 10-Site empties into the canyon. Radioactive liquids discharged accidentally into 10-Site Canyon would flow eastward across the Bandelier Tuff for several hundred yards, then presumably infiltrate into the alluvium in the lower part of 10-Site Canyon and in Mortandad Canyon. However, if the accident occurred during spring runoff or during a heavy summer thundershower, the wastes could be carried as a 'slug' into Mortandad Canyon or conceivably to the Rio Grande. An earth dam near the mouth of 10-Site Canyon, designed to control the release of impounded liquids, would serve as a safety feature to check accidentally discharged liquids, and to facilitate infiltration into the alluvium. Observation wells already constructed in Mortandad Canyon below the mouth of 10-Site Canyon would serve to monitor the liquids in the alluvium.

Concerning seismic conditions a brief report on the seismicity of north-central New Mexico was prepared by Dr. Stuart A. Northrop of the University of New Mexico for a February 1949 meeting of a Reactor Safety Committee at Los Alamos. A copy of this report is probably in the files of the Atomic Energy Commission. A summary of Dr. Northrop's report is as follows:

> About 94 percent of the earthquakes recorded in New Mexico in the last century have originated in the 75-mile strip along the Rio Grande Valley between Socorro and Albuquerque, mainly in the Socorro-Belen area. Most of the earthquakes have been of low intensity, but there have been numerous moderately strong shocks, and a few very strong shocks.
>
> Using the Rossi-Forel intensity scale (I equals microseismic shocks; X equals extreme intensity and general disaster), there have been 4 quakes of intensity VIII plus to IX, 6 of intensity VIII, 15 of intensity VII, 27 of intensity VI, and 33 of intensity V.

An extremely strong shock (intensity IX plus) occurred near Cerrillos on May 28, 1918, at 5:30 am. It was felt over an area of only about 45,000 square miles, with some affects at Santa Fe, Espanola, and several other places. It would have presumably attained intensity VI at Los Alamos, or possibly intensity VII with a deeper-focus quake. A quake of intensity III occurred at Chama in 1939.

Seismologists generally believe that a region of high frequency (such as New Mexico) with quakes of intensity less than VIII may be fairly safe because these frequent shocks act as a safety valve and relieve earth stress before it can accumulate in force to produce a violent shock of intensity IX or X.

However, a shock did occur at Los Alamos on August 17, 1952. The shock was brief and of intensity V, according to the official report published in "Abstracts of earthquake reports for the Pacific Coast and the Western Mountain region", MSA-75, July, August, and September, 1952, issued by the U.S. Coast and Geodetic Survey.

Although few quakes have occurred near Los Alamos, this area is on the Rio Grande structural trough near faults of large magnitude. Thus, earthquakes might be expected to occur at any time, and the Los Alamos area might experience tremors from quakes originating in other parts of the trough. There is no geologic evidence to indicate that intensive earthquakes have occurred recently in this region.

Very truly yours,

William E. Hale
District Engineer

JHA/mvm

cc: Branch Area Chief, GW, Denver

Ground Water Branch
P.O. Box 3217
Albuquerque, New Mexico
Oct. 2, 1961

Mr. George Best
Group K-1
Los Alamos Scientific Laboratory
P.O. Box 1663
Los Alamos New Mexico

Dear Sir:

Following our telephone conversation on September 29, this information on rocks and minerals that make up concrete aggregate for a seal on a disposal area was compiled.

Analyses of average granite, quartzite, "basic" and "acid" volcanics are shown on the attached table. These give approximations of the chemical constituents of these rock types.

The chemical formula for quartz and chert is SiO_2.

The feldspar group of minerals consists of orthoclase and microcline and the plagioclase feldspar series. The formula for orthoclase and microcline is $KAlSi_3O_8$. The plagioclase feldspar series forms an isomorphous series from pure albite $NaAlSi_3O_8$ to anorthite $CaAl_2O_8$. The predominate feldspar probably present in the concrete aggregate is orthoclase because of its resistance to weathering and its abundance as phenocrysts in granite and acid volcanic rocks.

The information was collected from "Rocks and Minerals" by Louis V. Pirsson, "Dana's Manual of Mineralogy" revised by C. S. Hurlbut, Jr. and "Igneous and Metamorphic Petrology" by F. J. Turner and Jean Verhoogen.

Please call us if we can be of further assistance.

Yours truly,

William D. Purtyman
Geologist

WDP/mvm

		SiO_2	Al_2O_3	Fe_2O_3	FeO	MgO	CaO	Na_2O	CO_2	K_2O	P_2O_5	TiO_2	MnO	H_2O	X_yO 1/	Total
Granite	1	77.0	12.0	0.8	0.9	0.0	0.8	3.2		4.9				0.3	0.1	100.3
	2	71.6	14.5	1.5	1.1	0.9	2.0	3.0		4.1				0.8	.5	100.0
Basic Volcanics	3	49.1	15.7	5.4	6.4	6.2	9.0	3.1		1.5				1.6	2.0	100.0
	4	47.26	14.91	2.53	9.59	8.05	9.98	3.13		1.20	0.69	2.48	.18			100.0
Acid Volcanics	5	75.6	12.7	1.2	.34	.12	.59	4.0	<.05	4.6	.05	.18	.04	.46		100
Quartzite	6	97.71	1.39	1.25	-	.13	.18									100.66
	7	74.22	10.61	7.45	.85	1.48	.56	2.12		1.08				1.79		100.15

1/ XyO represents small quantities and traces of other oxides

1. Granite, Sentinel point, Pikes Peak, Colo. (Pirsson, 1948)
2. Average biotite granite, average 90 analyses (Pirsson, 1948)
3. Average 198 analysis of basalt by R.A. Daley (Pirsson, 1948
4. East Otago Pliocene, average 5 olivine basalts (Turner and Verhoogan 1951
5. Rhyolite tuff, Los Alamos County, N. Mex. (U.S. Geological Survey 1960)
6. Pure quartzite, Chickies Station, Penn. (Pirsson, 1948)
7. Impure quartzite, Pigeon Point, Minn., contains small quantities of feldspar, mica, chlorite, and magnetite (Pirsson, 1948)

IN REPLY REFER TO:

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
GROUND WATER BRANCH
P.O. BOX 4217
ALBUQUERQUE, NEW MEXICO

Nov. 6, 1963

Mr. C. W. Christenson
Group Leader H-7
Los Alamos Scientific Laboratory
Los Alamos, New Mexico

Dear Chris:

The following information is in response to your verbal request of October 31, 1963. The information was compiled from data collected during ground-water investigations in cooperation with the Los Alamos Scientific Laboratory and the Atomic Energy Commission and is found in the following reports: Griggs, R. L., 1955, Geology and groundwater resources of the Los Alamos area, New Mexico: U.S. Geol. Survey administrative report to the AEC, 219 p., 17 figs.; Weir, J. E., Jr., and Purtymun, W. D., 1962, Geology and hydrology of Technical area 49, Frijoles Mesa, Los Alamos County, New Mexico: U.S. Geol. Survey administrative report to AEC and LASL, 225 p., 62 figs.; and Baltz, E. H., Abrahams, J. H., Jr., and Purtymun, W. D., 1963, Preliminary report on the geology and hydrology of Mortandad Canyon near Los Alamos, N. Mex., with reference to disposal of liquid low-level radioactive waste: U.S. Geol. Survey open-file report, 104 p., 13 figs.

The area selected by the Los Alamos Scientific Laboratory for the new "high speed particle accelerator" is in the northern half of sec. 24, T. 19 N., R. 6 E. on the Mesita de los Alamos which is part of the Pajarito Plateau. The Pajarito Plateau is dissected into a number of finger-like mesas by eastward flowing intermittent streams tributary to the Rio Grande. Mesita de los Alamos is one of these finger-like mesas that is bounded on the north by Los Alamos Canyon and on the south by Sandia Canyon. The width of the mesa ranges from about 800 to 2,200 feet. There is a small east-west ridge along the northern edge of the mesa and the surface of the mesa slopes southward from the ridge at an altitude of about 7,020 feet to an altitude of about 6,920 feet along the southern edge of the mesa. Los Alamos and Sandia Canyons have been cut 200 to 400 feet below the surface of the mesa.

Mesita de los Alamos is capped by the Bandelier Tuff of Pleistocene age. Underlying the Bandelier Tuff are rocks of the Santa Fe Group of Middle (?) Miocene to Pleistocene age. The rocks of the Santa Fe Group in ascending order are the Tesuque Formation and the Puye Conglomerate which contains interbedded basaltic rocks of Chino Mesa.

The Tesuque Formation of the Santa Fe Group is a sequence of light-colored sediments laid down as flood-plain deposits in the Rio Grande depression. It is composed of friable to moderately well-cemented beds of siltstone and sandstone with some conglomerate and clay lenses. The total thickness of the unit in the region exceeds [illegible],400 feet as interpreted from well logs and exposures in lower Los Alamos Canyon.

Overlying the Tesuque Formation is the Puye Conglomerate composed of two members. The lower member is a poorly consolidated channel-fill deposit called the Totavi Lentil which is composed of arkosic and quartzitic debris, from sand to boulder size. The upper member the fanglomerate member is made up of volcanic debris and is interbedded with the basaltic rocks of Chino Mesa. The Totavi Lentil member consists of pebbles, cobbles, and boulders of rhyolite, latite, quartz latite, and pumice in a matrix of silt and sand. The thickness of the Puye Conglomerate and basalts exceeds 640 feet at test well 3 (SE¼SE¼SW¼ sec. 13, T. 19 N., [illegible] 6 E.), in Los Alamos Canyon north of Mesita de los Alamos. Test well 3 bottomed within the Puye Conglomerate at an altitude of [illegible],510 feet. A basalt flow was encountered in the fanglomerate member at a depth of 265 to [illegible] feet or at an altitude of 6,359 to [illegible],237 feet.

The Bandelier Tuff overlies the fanglomerate member and dips gently eastward. It consists of ash-fall and ash-flow rocks that are draped over the older rocks, filling the lows and smoothing out the topography of the older rocks. The Bandelier Tuff is composed of three members. In ascending order they are: the Guaje Member, an ash-fall pumice found in the subsurface at Mesita de los Alamos; the Otowi Member, a friable ash-flow that is exposed in the lower wall of Los Alamos and Sandia Canyons adjacent to Mesita de los Alamos; and the Tshirege Member, a series of ash-flow tuffs which form Mesita de los Alamos.

The Guaje Member of the Bandelier Tuff is composed of lump pumice fragments consisting of glass shards, and quartz and sanidine crystals in a cellular structure of pumice. At test well [illegible], the Puye-Guaje contact is at an altitude of [illegible],450 feet and the Guaje-Otowi contact is at an altitude of [illegible],[illegible] feet, thus the Guaje Member is [illegible] feet thick in that well. The Otowi Member consists of a light-gray pumiceous rhyolite tuff which is friable or partly welded. It contains quartz crystals, glass shards, and minor amounts of mafic minerals and varying amounts of rhyolite, latite, and pumice fragments in a fine-grained ash. The Otowi Member is [illegible] feet thick at Mesita de los Alamos. The Otowi-Tshirege contact occurs at an altitude of [illegible],[illegible]0 feet in the wall of Los Alamos Canyon near test well [illegible]. The Tshirege Member is composed of a series of ash flows of rhyolite tuff which contain quartz and sanidine crystals and fragments, some mafic minerals and rock fragments of gray rhyolite and latite in a fine ash matrix. The ash flows vary from a partly welded to a densely welded tuff. The Tshirege Member is about 300 feet thick under the village at Mesita de los Alamos.

The rocks of the Bandelier Tuff at Mesita de los Alamos covers the older rocks and obscures any pre-Bandelier structure. Pajarito Fault Zone is about 5 miles to the east; however, movement in this zone probably occurred shortly after the deposition of the tuff in Pleistocene time. Several small faults in the Tesuque Formation have been noted in Los Alamos and Guaje Canyon about 7 miles to the northwest. The movement on these faults occurred long before the end of Pleistocene time. There is no evidence of post Bandelier faults on the Pajarito Plateau in the area of Mesita de los Alamos.

Concerning seismic conditions, a brief report on the seismicity of north central New Mexico was prepared by Dr. Stuart A. Northrop of the University of New Mexico for a February 1949 meeting of a Reactor Safety Committee at Los Alamos. A copy of this report is probably in the files of the Atomic Energy Commission. A summary of Dr. Northrop's report is as follows:

> About 94 percent of the earthquakes recorded in New Mexico in the last century have originated in the 75-mile strip along the Rio Grande Valley between Socorro and Albuquerque, mainly in the Socorro-Belen area. Most of the earthquakes have been of low intensity, but there have been numerous moderately strong shocks, and a few very strong shocks. Using the Rossi-Forel intensity scale (I equals microseismic shocks; X equals extreme intensity and general disaster) in the Rio Grande Valley there have been 4 quakes of intensity VIII plus to IX, 5 of intensity VIII, 15 of intensity VII, 27 of intensity VI, and 35 of intensity V. An extremely strong shock (intensity IX plus) occurred near Cerrillos on May 28, 1918, at 5:30 am. It was felt over an area of only about 45,000 square miles; however, plaster fell at Santa Fe and people were awakened at Espanola, and several other places. It would have presumably attained intensity VI at Los Alamos, or possibly intensity VII with a deeper-focus quake. A quake of intensity III occurred at Chama in 1939.
>
> Seismologists generally believe that a region of high frequency (such as New Mexico) with quakes of intensity less than VIII may be fairly safe because these frequent shocks act as a safety valve and relieve earth stress before it can accumulate in force to produce a violent shock of intensity IX or X.

A shock did occur at Los Alamos on August 1[illegible], 1952. The shock was brief and of intensity V, according to the official report as published in "Abstracts of earthquake reports for the Pacific Coast and the Western Mountain region", MSA-[illegible], July, August, and September, 1952, issued by the U.S. Coast and Geodetic Survey.

Although few quakes have occurred near Los Alamos, this area is on the Rio Grande structural trough near faults of large magnitude. Thus, earthquakes might be expected and the Los Alamos area might experience tremors from quakes originating in other parts of the trough.

The streams are intermittent in Sandia and Los Alamos Canyon adjacent to Mesita de los Alamos. The static water level in test well 3 is at an altitude of 5,370 feet and probably coincides with the upper surface of the main ground-water body. This surface is in Puye Conglomerate. Movement of water in the main ground-water body is toward the east. No water was found above the main ground-water body at test well 3.

Sincerely yours,

William D. Purtymun

William D. Purtymun
Geologist

WDP/m

cc: Branch Area Chief, GW, Denver, Colo
William Kennedy, H-6, LASL
Charles Wenrich, Eng. 1, LASL
Edwin Wingfield, AEC

N M - 94

Ground Water Branch
P.O. Box 4217
Albuquerque, New Mexico
February 5, 1964

Mr. Charles R. Wherritt
Engineering 1
Los Alamos Scientific Laboratory
Los Alamos, New Mexico

Dear Mr. Wherritt:

Covering the request of C. W. Trask, Engineering 1, LASL, and of Edwin Wingfield, Chief, Project Support Branch AEC, representatives of the U.S. Geological Survey were present during foundation testing at the proposed Meson factory site on Mesita de los Alamos.

Six exploratory holes were cored or drilled from 30 to 50 feet beneath the proposed foundation level which is at an elevation of 6,970 feet. Core recovery below the foundation level was complete in holes "A" and "B", less than 20 percent recovery in holes "C", "D", and "E" and no recovery in hole "F".

Penetration tests were made by the contractor, Alpha Testing Laboratory of Albuquerque, in holes "C", "D", "E", and "F" to determine the bearing capacity of the tuff where no cores were recovered for testing in the laboratory.

The foundation holes were left open for access with density and moisture measuring equipment. The moisture content and density of the tuff adjacent to the wall of the hole was determined by neutron scattering moisture equipment and gamma ray emitting density equipment respectively.

The moisture content of the tuff was less than 5 percent by volume below the elevation of the proposed foundation level. Study of the distribution of moisture in the tuff in the Los Alamos area indicate that the natural moisture content of the tuff beneath the mesas is generally less than 5 percent by volume in areas where the soil cover and natural drainage have not been disturbed.

The density measurements of the tuff were made to detect any vertical and horizontal density changes which may effect the bearing capacities of the tuff and to make available data to correlate bearing capacities of the tuff as determined by Alpha Testing Laboratory with the zones of varying density in the tuff

The attached figure illustrates a correlation of these different zones. The densities are divided into two classifications: Tuff with density from 95 to 105 lbs/cu. ft. (pounds per cubic foot) and 105 to 115 lbs/cu.ft.

Density measurements were made at four foot intervals in the borings. The zonal changes in density of the tuff are not necessarily abrupt changes but are of a gradual change which can occur over a four to eight foot interval.

Core was not recovered in zones of the tuff with a density of 95 to 105 lbs/cu.ft. while partial recovery to total recovery was made in zones with a density of 105 to 115 lbs/cu.ft.

Correlation of zonal densities of the tuff were uniform (see attached figure). Alternate changes in density occurred in hole "D" which was the deepest hole.

The changes in vertical density are due to different degrees of welding when the tuff was emplaced as a hot ash flow with the denser welding occurring near the center of the flow.

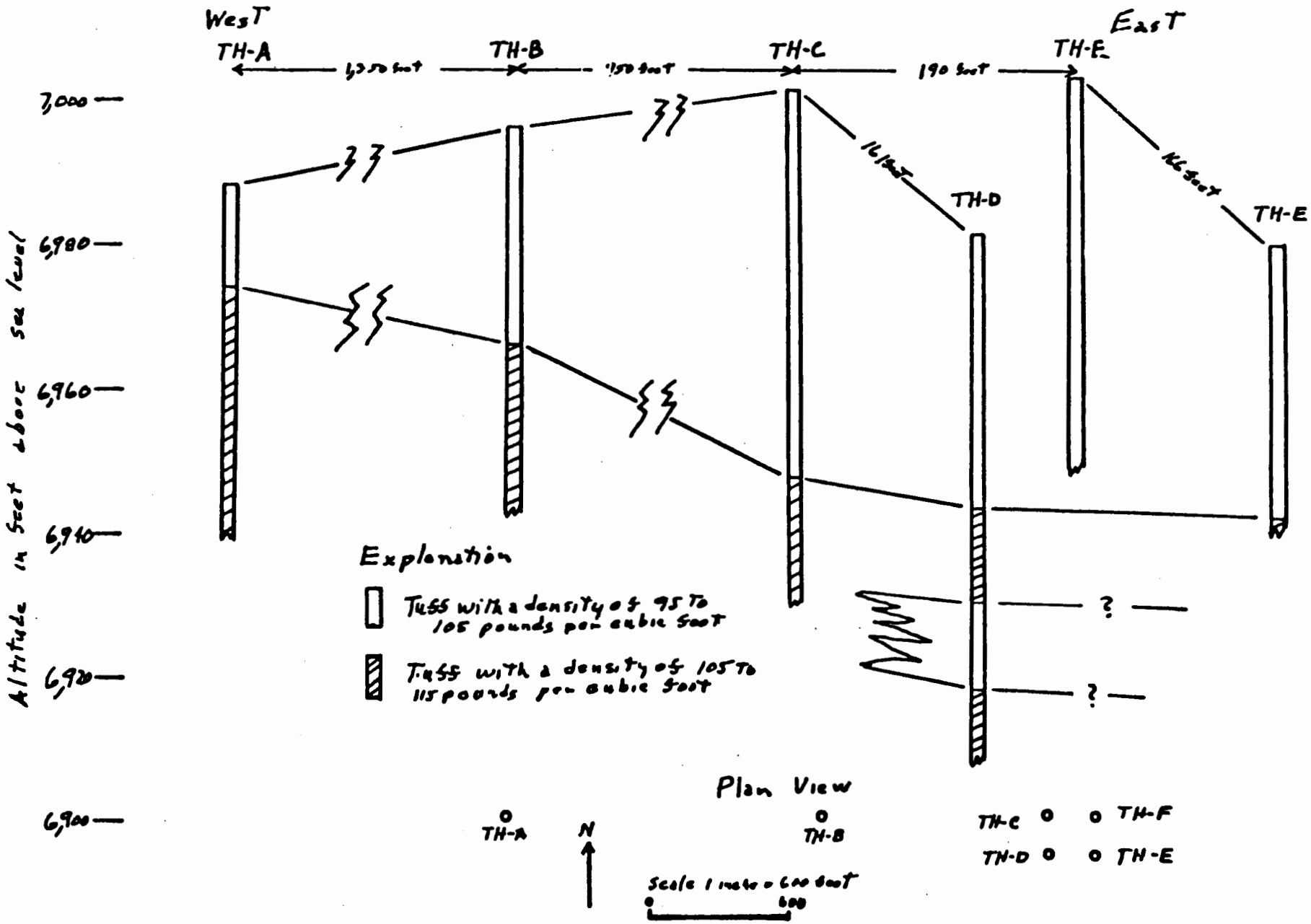
A brief description of the geology in the area of Mesita de los Alamos in a letter report was sent to C. W. Christenson on November 6, 1963 with copies to your office. If we can be of further service please feel free to call on us.

Yours very truly,

William D. Purtymun
Geologist

cc: Branch Area Chief,
Ground W ter Branch, Denver, Colo.

Edwin Wingfield, AEC, Los Alamos



Cross section and plan view of 6 Test holes at Mesita de los Alamos showing density characteristics of The Tuff

nm 9 Y

Ground Water Branch
P.O. Box 4217
Albuquerque, New Mexico
Oct. 16, 1964

Mr. Cecil E. Bingham
Construction Branch
U.S. Atomic Energy Commission
Los Alamos, New Mexico

Subject: Geology at proposed Meson Factory

Dear Mr. Bingham:

The following information is in response to your verbal request of October 13, 1964 concerning the geology at the proposed Meson Factory on Mesita de los Alamos.

The structure is to be built on the Tshirege Member of the Bandelier Tuff. It is about 250 feet thick at the proposed "site" area. The Bandelier Tuff is over 500 feet thick and is a pyroclastic rock made up of a large number of volcanic ash flows and falls that have been subsequently hardened by heat and pressure. The Tshirege Member of the Bandelier Tuff is the upper unit and is composed of a series of hardened ash-flows of rhyolite tuff which contains quartz and sanidine crystals and fragments, some mafic minerals and rock fragmehts of gray rhyolite and latite in a fine ash matrix. This ensemble of materials has been physically bonded in such a way that it became a tough and resistant material shown by the vertical cliffs along the edges of the mesas.

The individual ash flows in the Tshirege Member may range from 20 to 120 feet in thickness. Thin lens-like shapes of pumiceous material may occur between these flows. Preliminary borings (up to 38 feet below the foundation level) did not encounter any of this pumiceous material.

Test borings at the site indicated the unconfined compressive strength tests made on tuff cores ranged from 20 to 60 tons per square foot, while penetration tests (made on the tuff where no cores were recovered) indicate that a bearing capacity of 7,000 pounds per square foot could be used in the design of the foundation. (Alpha Testing Laboratories report to LASL on February 5, 1964).

The following geologic section is for your information. It was interpreted from the Mesita de los Alamos subsurface conditions, from measurements of outcrops of adjacent canyon walls, and from the lithologic log of test well 3 in Los Alamos Canyon immediately north of the area.

Foundation Elevation of proposed structure at Meson Factory
6,970 feet above sea level.

	Thickness (feet)	Depth (feet)
Bandelier Tuff		
Tshirege Member, consisting of hardened volcanic ash-flows partly to densely welded rhyolite tuff.	250	250
Otowi Member consisting of ash-flow of partly welded rhyolite tuff	235	485
Guaje Member consisting of lump pumice	35	520
Puye Conglomerate		
Fanglomerate Member consisting of moderately well consolidated gravels and boulders	91	611
Basalt	122	733
Fanglomerate member consisting of moderately consolidated gravels and boulders. Test well 3 bottomed in this formation at an elevation of 5,810 feet	427	1,160

Wh is at about 1,100 feet

Sincerely yours,

William D. Purtymun
Geologist

cc: Austin McGuire, LASL
Edwin C. Wingfield AEC

Ground Water Branch
P.O. Box 4217
Albuquerque, New Mexico
February 18, 1963

Mr. Dean Meyers
H-1 LASL
P.O. Box 1663
Los Alamos, New Mexico

Dear Dean:

Bill Kennedy, Charles Barnett, and I made a brief inspection on February 6, 1963 of the recently completed disposal pit at Mesita del Buey, (Area "G" pit no. 3). Bill requested that I transmit to you some of my impressions as to the condition of the pit for disposal use.

The soil cover ranges from about 1 to 2 feet thick. The tuff below the soil zone appears to be dry. Investigations in the Los Alamos area have shown that very little water moves into the tuff where the soil cover has not been disturbed.

The lithologic character of the tuff in the pit is the same as that of the tuff in the other pits in the area. The zone of soft pumice fragments at a depth of 20-25 feet in pit number 2 was not as well developed as in the new pit; the pumice fragments are smaller and wider spaced in the tuffaceous matrix.

Numerous joints in the tuff are exposed along the walls of the pit. The joints range from open to closed with clay or alteration products. Most of the joints are near vertical and beneath the soil zone are clay filled. In general the joints appear to be the same type that occur in adjacent pits.

The surface of the mesa slopes toward the east and southeast which makes the east rim the low rim of the pit. Fill from excavation of the pit is piled over the soil zone on the east side of the pit to raise the altitude of that rim. Filling of the pit with waste material should be completed below the soil zone as heavy precipitation may cause erosion of the artificial east rim and expose some of the wastes or allow water to move radioactive contaminants out of the pit on to the surface of the mesa.

There should be little danger of water moving radioactive contamination from the waste material in the pit into the adjacent canyons, if the pit, when filled, is sealed with a material which would restrict infiltration of precipitation.

Little is known of the hydrologic characteristics of the crushed tuff that now is used to seal over waste disposal pits. A field study utilizing the neutron-neutron scattering moisture probes and the access tubes installed in a disposal pit that is filled and sealed is planned in the future to determine the depth of infiltration into the seal material from precipitation and the loss of moisture by evaporation.

The new pit appears to be similar to the adjacent pits, indicating that the new pit is suitable for the disposal of radioactive waste solids.

We plan to make a detailed map of the east and west wall of the pit when the weather permits.

Yours truly,

William D. Purtyman
Geologist

cc: William Kennedy H-6
Ted Russo ENG - 3

Room 115, Federal Building
Santa Fe, New Mexico
87501

December 9, 1966

Mr. Dean Meyers
Group Leader
H-1, LASL
P. O. Box 1663
Los Alamos, New Mexico

Dear Dean,

An inspection of the new disposal pit, Area G Pit No. 5, was made on December 6, 1966. Bill Kennedy requested that I transmit to you some of my impressions as to the conditions of the pit for disposal use.

The disposal pit is about 100 feet wide, 600 feet long, and with a maximum depth of 29 feet. An inner pit is about 50 feet wide, 400 feet long, and has a maximum depth of 5 feet. The long dimension of the pit is east-west.

The pit was constructed into two ash flows of the Bandelier Tuff. The contact between the flows is marked by a pumice zone which is well exposed on the north wall of the pit and along the western half of the south wall. The rim of the eastern half of the south wall has been cut and eroded below the contact. The ash flow units are of rhyolite tuff and are the same units as found in pits Nos. 2 and 4. Both units in this area are of fairly competent rocks that would form a stable cut in the tuff; however, the numerous joints which are near vertical and strike in random directions have caused some large slabs of the tuff to dislodge from the walls of the pit. This is caused by intersection of joints behind the cut face. John Enders has informed me that the pit will not be used until these slabs are scaled from the wall (safety measures have been taken by H-1, as the entrance of the pit roped off and posted). The joints exposed in the walls of the pit range from closed to open as much as 1 inch; however, the joints immediately below the soil zone are filled with clay or altered material. Any open joints in the floor of the pit are filled with crushed tuff due to traffic of equipment used during construction. No open joints that would require filling were noted.

The soil cover exposed in the walls of the pit ranges from about 0.5 foot to about 3 feet. Along the south wall of the pit from about sections 2+75 to 3+90 feet the upper 8 to 4 feet of the wall consists of fill material as the present pit was cut into the ramp leading into Pit No. 3 which is now filled and covered.

The land surface around the pit slopes gently to the southeast from an altitude of 6,678 feet at the northwest corner to an altitude of 6,658 feet at the southeast corner. The bottom of the inner pit is at an altitude of 6,643 which is about 50 feet above the floor of Canada del Buey and Pajarito Canyon.

The disposal pit is suitable for disposal of solid or package wastes as it meets the guidelines for pit construction set forth in a conference between Eng. 3, H-1, H-6, H-7 of the Los Alamos Scientific Laboratory and the U. S. Geological Survey held at Los Alamos on June 23, 1965. The guidelines are summarized in a letter to Mr. Ted Russo, Eng. 3, dated June 30, 1965 from F. C. Koopman, U. S. Geological Survey.

If we can be of any further assistance please feel free to contact us.

Yours truly,

William D. Purtyman

for: W. E. Hale
District Chief, WRD

cc: Wm. Kennedy, Group Leader
LASL, H-6

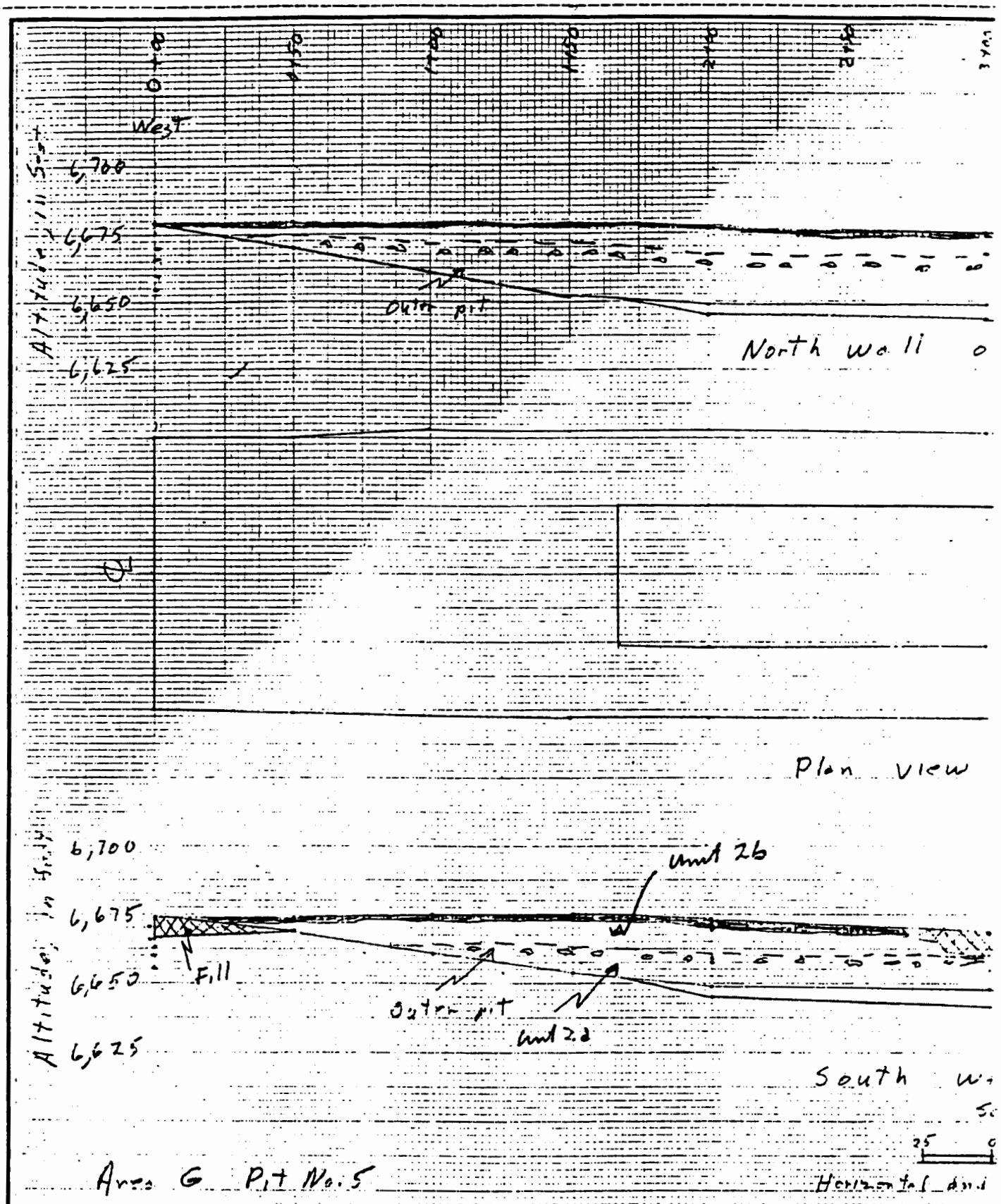
Salvatore Russo, Group Leader
LASL, Eng. 3

George Hilton, Chief
Construction and Maintenance, AEC

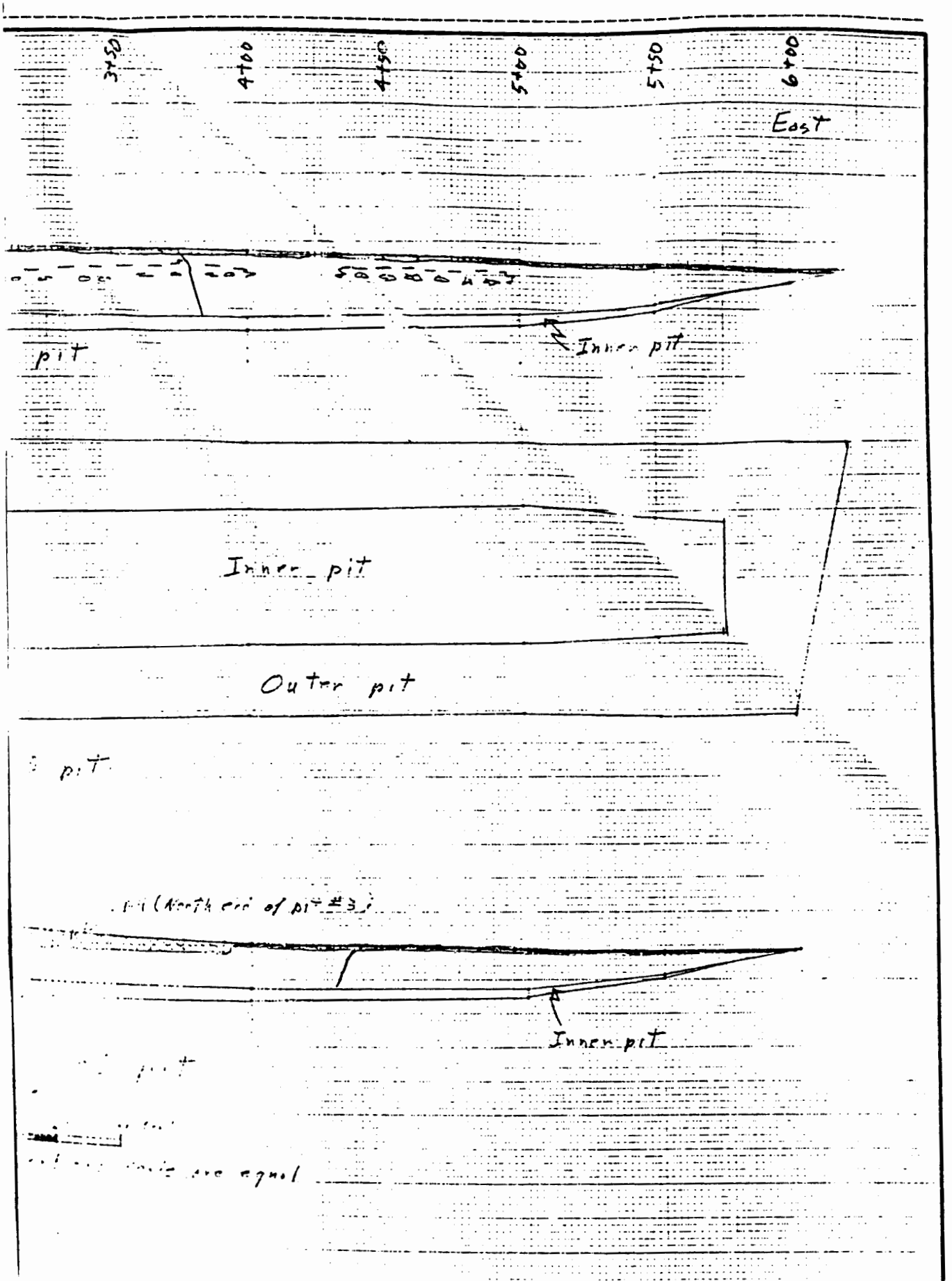
9-213-f
(March 1949)
Cross-Section—Double

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

File.....



Sheet No.....of..... Sheets. Prepared by..... Date..... Checked by..... Date.



U. S. GOVERNMENT PRINTING OFFICE : 1958 OF—476257

Room 115, Federal Building
Santa Fe, New Mexico

December 16, 1966

Mr. C. W. Trask
Eng. 1, LASL
P. O. Box 1663
Los Alamos, New Mexico

Dear Wes,

Dean Keller, Eng. 1, has kept us advised on the progress of the study to determine the deformation of the tuff by loading tests. The tests being conducted on Mesita de los Alamos and Mesita del Buey are a part of the foundation investigation for the Meson Facility. Dean requested some geologic information on the test areas in accordance with your memorandum to F. R. Tesche, MP-DO, dated July 26, 1966. The following information was compiled from a previous investigation at Mesita de los Alamos. A stratigraphic section was measured at Mesita del Buey at Pajarito Reservoir No. 2. These geologic units were correlated with a similar section at Mesita de los Alamos near the proposed location of the Meson Facility Experimental Building. Correlation of the various geologic units in the sections were made to determine the geology underlying the test areas and the unit in which the tests are being conducted.

General description of the near surface rocks. Mesita de los Alamos and Mesita del Buey are a part of the Pajarito Plateau that is formed by the Tshirege Member of the Bandelier Tuff. The Tshirege Member, a series of ash flows of rhyolite tuff, is composed of quartz and sanidine crystals and crystal fragments, with rock fragments of pumice latite and rhyolite in a fine ash matrix. The amount and size of the quartz sanidine, pumice, latite, and rhyolite vary in each of the ash flows as does the degree of welding of the ash matrix.

The degree of welding is classified at Los Alamos as nonwelded, moderately welded, and welded tuff. The transition between nonwelded (porosity as much as 60 percent) to welded tuff (porosity as small as 15 percent) is due to compaction and fusing by heat of the crystals, crystal fragments, and rock fragments in the ash matrix. The degree of welding and the amounts and size of pumice, latite, and rhyolite rock fragments determine the physical characteristics of the tuff (i.e., porosity, density and bearing capacity).

Units of the Tshirege Member. The Tshirege Member of the Bandelier Tuff has been divided into five geologic units at Mesita de los Alamos. These units correlate with similar units to the south at Mesita del Buey (figure 1). The units from the oldest to youngest are 1a, 1b, 2a, 2b, and 3

Unit 1a is a light orange to light brown pumiceous tuff breccia. It contains numerous pumice fragments which may be as much as 6 inches in length, small quartz crystals and a few small rock fragments of latite and rhyolite. The unit, nonwelded to moderately welded, weathers to a steep slope and in places may form a vertical wall.

Unit 1b is a grayish brown tuff that contains larger quartz crystals but fewer and smaller pumice fragments. It is a nonwelded to moderately welded tuff that weathers to a steep slope.

Unit 2a is a light gray pumiceous tuff that contains some rock fragments of pumice, latite and rhyolite that are as much as 3 inches across. It is a nonwelded to moderately welded tuff that weathers to form a moderate to steep slope.

Unit 2b is a light pink to brownish gray tuff with some pebble size rock fragments of pumice, latite and rhyolite and numerous crystals and crystal fragments of quartz and sanidine. It is a moderately welded to welded tuff and weathers to form ledges, benches, and vertical walls along canyons cut into the plateau.

Unit 3 is a light gray pumiceous tuff that contains numerous pumice fragments. The pumice fragments may be as much as 6 inches across. It also contains a few smaller rock fragments of rhyolite and latite. The unit is a nonwelded to moderately welded tuff, and weathers to form a gentle to moderate slope.

Stratigraphic Sections. A stratigraphic section of the Tshirege Member was measured at Mesita del Buey near Pajarito Reservoir No. 2, and the geologic units of the section were correlated with a section previously measured at Mesita de los Alamos near the proposed location of the Experimental Building (figure 1). Correlations of the geologic units were made by the lithology of the units and their weathering characteristics. The units were also traced southward from Mesita de los Alamos to Mesita del Buey. A datum was established on the prominent marker bed of tuff between Units 1a and 1b which is light orange and weathers to a slight notch. It is a persistent and readily identified geologic feature that is present where the two units are exposed on the plateau.

Units 1b and 2a thicken slightly from Mesita de los Alamos southward to Mesita del Buey (table 1). Unit 2b thins some 47 feet from Mesita de los Alamos to Mesita del Buey. The difference in thickness of Unit 2b on the two mesas may be due to the direction of the ejection of the ash flow that formed Unit 2b and point of origin of the flow (an area west of the Pajarito Plateau) and in part to topography that existed in pre-Bandelier time. The thickness of the Tshirege Member decreases rapidly east of the section at Mesita del Buey to the vicinity of White Rock where the tuff lies directly on basalt.

The basalt formed a topographic high in the area in pre-Bandelier time. The upper part of Unit 3 is eroded on both mesas. The thickness of the remaining part of Unit 3 is 45 feet at Mesita del Buey and 98 feet at Mesita de los Alamos.

Thickness of units at test areas. The two test areas at Mesita de los Alamos are at altitudes of 6,970 feet and 6,990 feet. At Mesita del Buey the test area is at an altitude of 6,935 feet. The test areas on both mesas are in Unit 3 but at different stratigraphic positions in the unit (table 3).

Care should be taken in extrapolation of test data from one area to another because the physical characteristics of a tuff in a single unit varies both vertically and laterally due to the degree of welding and the size and amount of rock inclusions in the tuff. Another factor that may affect the results of the test data is the thickness of the units beneath the test areas. The thickness of the units beneath the test areas vary due, in part, to the location of the test area in the unit and, in part, to thinning or thickening of the units as they were deposited as ash flows.

If we can be of further assistance, please feel free to contact us.

Yours truly,

William D. Purtymun
Geologist

for W. E. Hale
District Chief, WRD

cc: Charles Huff, Project Engineer, AEC
George Hilton, Chief,
Construction and Maintenance Branch, AEC
Wm. Kennedy, Group Leader, H-6 LASL

TABLE 1.

Thickness of geologic units at stratigraphic sections

Geologic Units	Mesita de los Alamos 1/ (Feet)	Mesita del Buey 2/ (Feet)	Remarks
3	98	45	Upper part eroded.
2b	76	29	
2a	51	60	
1b	21	23	
1a	74+	16+	Lower part covered.

1/ Altitude at top of section - 7,034 feet.
2/ Altitude at top of section - 6,935 feet.

TABLE 2.

Thickness of geologic units at test areas

Geologic Units	Mesita de los Alamos 1/ (Feet)	Mesita de los Alamos 2/ (Feet)	Mesita del Buey 3/ (Feet)	Remarks
3	54	34	45	
2b	76	76	29	
2a	51	51	60	
1b	21	21	23	
1a	74+	74+	16+	Lower part covered.

1/ Altitude at test area - 6,990 feet.
2/ Altitude at test area - 6,970 feet.
3/ Altitude at test area - 6,935 feet.

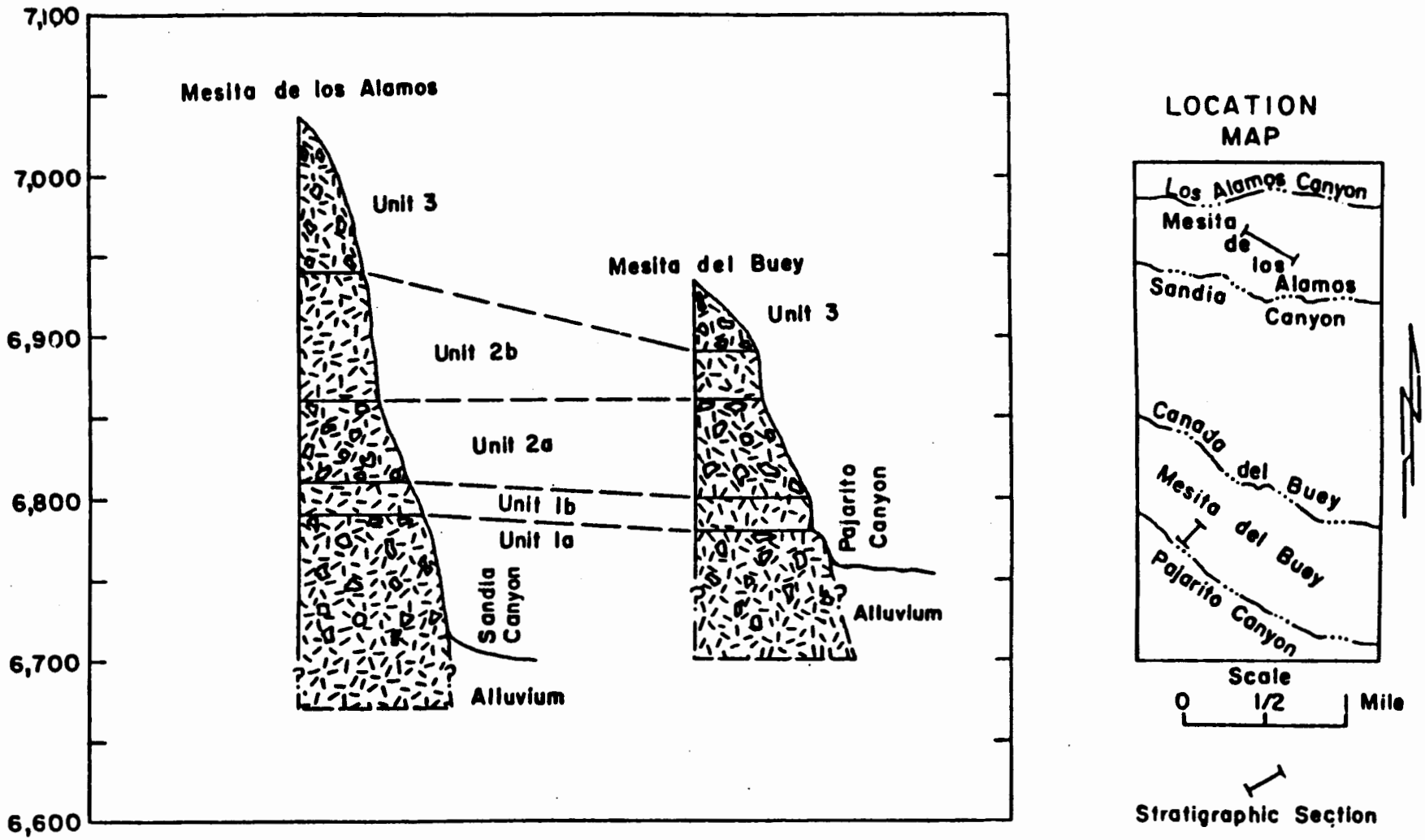


Figure 1.--Stratigraphic sections of the Tshirege Member of the Bandelier Tuff at Mesita de los Alamos (Proposed Meson Facility) and at Mesita del Buey (Pajarito Reservoir No. 2)

IN REPLY REFER TO:

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
Room 115, Federal Building
Santa Fe, New Mexico

February 20, 1967

Mr. William Kennedy, Group Leader
Group H-6
Los Alamos Scientific Laboratory
Los Alamos, New Mexico

Dear Bill,

A reconnaissance of the seepage pits near Building 35 in TA-21 was made on January 30, 1967. The distribution of moisture of the tuff in several test holes adjacent to the pits was determined by a neutron-scattering moisture probe. Several water samples and a sample of weathered tuff were collected for radiochemical analyses. This data and data collected from previous studies near the seepage pits that would pertain to the construction of a solid waste disposal pit in the area have been recapped as you requested and are contained in the following letter.

Pit construction and geology

The disposal area consists of 4 pits that are about 120 feet long, 20 feet wide and about 6 feet deep (figure 1). The pits are filled with about 4 feet of sand, gravel and boulders with berms extended around the individual pits. Effluents were released through a distribution system into pits 1 and 2 and through overflow pipes into pits 3 and 4 respectively. In January 1967 the outline of the gravel portion of the pits was obscured by the growth of grasses and weeds and erosion of the berms. A new road has covered part of pit 1 and construction has destroyed some of the berm around pit 3.

The pits are probably excavated in unit 3 of the Tshirege Member of the Bandelier Tuff. The lower part of this unit is nonwelded tuff grading up into a moderately welded tuff which underlies the pits. Joints are more numerous in the upper part of the unit due to the denser welding. Most of the joints are orientated vertical or near vertical. The total thickness of the unit is about 110 feet. It is underlain by a moderate to dense welded tuff.

The total thickness of the Bandelier Tuff underlying the mesa at Building 35 exceeds 800 feet. The tuff is in the zone of areation; the top of the main zone of saturation is about 1,150 feet below the surface of the mesa.

History

The seepage pits near Building 35 are the oldest used for the disposal of liquid wastes at Los Alamos. Wastes from the processing of plutonium at TA-21 were released into pits during the period 1943 to 1952. The use of the pits was discontinued in 1952 when a treatment plant (Building 35) was installed to remove plutonium and other radionuclides. The effluents from the plant are released into DP Canyon, a southeast trending canyon north of the pit area.

The amount of effluents released into the pits during the period 1943 to 1952 has been estimated to range from 2 to 3 million gallons a year. The concentration of plutonium in the effluents during this period has been estimated at 60 c/m/ml (counts per minute per milliter) with an average fluoride concentration (associated with the wastes) of 160 ppm (parts per million). In addition 10,450 gallons of effluent highly concentrated with ammonium citrate was released into the pits from June 1951 to July 1952. The plutonium concentration of this waste averaged about 7,000 c/m/ml and the fluoride concentrations were about 200 ppm.

The pits were not used from 1952 to January 1965. Since January 1965 pits 1 and 2 have received an average of 74.3 thousand gallons a month or a total of 1.8 million gallons of low level radioactive effluent from DP-East.

A study was made in 1953 to determine the retnetion characteristics of the tuff with regard to plutonium (Hermann, 1954). Another study was made in 1961 to determine the movement of plutonium in the tuff (Christenson and Thomas, 1962). The results of these studies are summarized in the following sections.

Retention of plutonium in the tuff

Five test holes were drilled in and around the pits in 1953. Material from the test holes was analyzed to determine the relative amounts of plutonium and the ion exchange capacities of the tuff adjacent to and underlying the pits. Location of test holes are shown in figure 1. The exact location of the TH-3 in pit 1 is unknown. Plutonium and ion exchange capacities of the tuff are shown in table 1.

> Hermann (1954) concluded from the study that plutonium is readily retained by the various earth media (clay, sand, and gravel) and that the retention is greater in the finer materials. The horizontal migration of plutonium is very small within 20 feet of the surface, (TH-1 and TH-2, figure 1 and table 1). Other observations were that the ion exchange capacities of the tuff is inadequate to account for the retention of plutonium. The retention of plutonium in the tuff is mostly due to absorption, and the effect of ion exchange is of secondary importance.

Movement of plutonium

The purpose of the study in 1961 was to determine the movement of plutonium and effluent in the tuff. A shaft (caisson) 30 feet deep, 6 feet wide, and 12 feet long was dug near pit 1 (figure 1). Horizontal holes were cored into the wall of the shaft at 2 foot depth intervals so as to terminate beneath pit 1. A vacuum cup system was placed in the horizontal holes to obtain samples of the effluent moving through the tuff for chemical and radiochemical analyses. Six additional vertical or near vertical holes were drilled to a depth of about 100 feet around pit 1. The vertical holes and some of the horizontal holes in the shaft were used to determine the moisture content of the tuff by use of a neutron moisture-scattering probe. About 211 thousand gallons of tap water was released into pit 1 in July 1961. A month later 178 thousand gallons of effluent containing plutonium was added.

Christenson and Thomas (1962) concluded from the study that plutonium had penetrated to a depth of at least 28 feet in the tuff beneath the pits and that this penetration at depth takes place mainly along joints. Clay formed in joints and in devitrified fragments by weathering will sorb plutonium and result in localized areas of high plutonium concentrations. The low concentrations of aluminum and silica in the effluent in all samples indicated the absence of colloidal clays that might provide a means of transporting plutonium through the tuff. The chemical quality of the effluents through the tuff indicated an inverse relationship between the gross alpha (plutonium) and pH of the effluent (high pH, low concentrations of gross alpha, low pH, high concentrations of gross alpha). Hardness and total dissolved solids increased at depth suggesting the dissolution of materials from the tuff. The movement of effluents through the tuff is predominantly downward beneath the pits aided by open joints.

Of interest in possible construction on a solid waste disposal pit in the area is the amount of plutonium that was reported from cores and rock samples obtained during construction of the facilities for the study in 1961. These data are given in table 2.

Observations January 1967

Effluents from DP-East have at times partially filled the shaft near Pit 1, thus creating a more localized point for infiltration of liquids. Test holes DPW-1A and DPW-3 contained some effluent at the time of observation. It is supposed that the water in DPW-3 moved down the outside of the casing from water ponded in the pit. Radiochemical analyses of water from these holes contained only background amounts of gross alpha and gross beta gamma radioactivity and no plutonium or uranium. Results of analyses of water for tritium shown below are approximations and are subject to revision.

DPW-1A - 462 DPM ^3H or 70% of non-occ RPG a/
DPW-3 - Background
Effluent running into shaft - 2,000 DPM ^3H or 300% of non-occ RPG

a/ DPM - disintegrations per minute
non-occ RPG - Non-occupation Radiological Protection Guide numbers

A sample of weathered tuff collected beneath the gravel fill of pit 1 near the shaft contained 978 c/m/g (counts per minute per gram) of gross alpha radioactivity.

The moisture contents of the tuff in holes DPW-1, DPW-2, and DPW-5 were logged at selected depths (table 3). A comparison of the moisture content with previous moisture measurements (March 1961 prior to the addition of 389 thousand gallons of tap water and effluents and August 1961 during the study) is shown in table 3.

The January 1967 measurements of hole DPW-1 show the effect of the 1.9 million gallons of effluent from DP-East in which the maximum concentrations of water have moved from a depth of 12 feet (40 percent, August 1961) to 40 feet (41 percent, January 1967). The hole is next to the shaft. The moisture measurements in DPW-2 and DPW-5 show a general decrease in the moisture content of the tuff from August 1961 to January 1967. The indication is that most of the effluents released into pit 1 have moved down in the area of the shaft, a focal point for collection and infiltration of effluents into the tuff.

General statement

The studies have shown that the movement of the effluents in the tuff underlying the seepage pits is mostly downward beneath the pits. The plutonium moves with the effluents and the data indicate that the most of the plutonium is retained by absorption in the upper 20 feet of the tuff (tables 1 and 2). Some, however, may move to greater depths through open joints.

The construction of a solid waste disposal pit in the area may necessitate the drilling of several holes to determine the amount of contamination present as well as the structure and lithology of the underlying rock. The number and depth of the holes would depend on the size, depth and location of the proposed pit.

Source of data

Abrahams, John H., 1963, Geologic and hydrologic environment of radioactive waste disposal sites at Los Alamos, New Mexico: U.S. Geol. Survey Admin. Rept., 35 p., 3 figs.

Christenson, C. W., and Thomas, R. G., 1962, Movement of plutonium through Los Alamos Tuff, in Second ground disposal of radioactive wastes conference: Technical Services, U.S. Dept. of Commerce, TID-7628, p. 249-81.

Hermann, R. R., 1954, Retention of plutonium in waste seepage beds at Los Alamos: Unpublished manuscript in files of U.S. Geol. Survey at Santa Fe, N. Mex.; 14 p., 2 figs.

This recaps all the data we have on the seepage pits near Building 35. The bulk of it is on or near pit 1.

Please contact us if we can be of further assistance.

Yours truly,

William D. Purtyman
For: W. E. Hale, Dist. Chief, WRD

cc: George H. Hilton, Chief
Construction & Maintenance Br.
AEC
C. W. Christensen, Group Leader
H-7, L.A.S.L.

Table 1.--Plutonium concentrations in tuff from test holes, 1953.

TH-1		TH-2		TH-3		TH-4		TH-5	
Depth (feet)	Plutonium (d/m/g)a/	Depth (feet)	Plutonium (d/m/g)a/	Depth (feet)	Plutonium (d/m/g)a/	Depth (feet)	Plutonium (d/m/g)a/	Depth (feet)	Plutonium (d/m/g)a/
Surface	70	Surface	9	Surface	8	Surface	410	Surface	32
2	4	2	3	1	400	1	600	2	9
4	4	4	2	2	36,100	2	10	4	8
6	4	6	2	3	45,600	3	80	6	4
6 to 10	2	8	1	12	1,400	4	3,400	8	3
10 to 14	2	10	4	15	5,000	5	530	10	2
15	4	12	3	16	5,100	6	80	11	2
		14	3	17	720	7	1,800	12 b/	450
		16	4	18	24	8	40	12.5	1,510
		18	2	19	12	9	380	13	1,330
		20	3	20	12	10	2,400		

a/ Disintegrations per minute per gram.
b/ Angle hole, point of intersection with pit.

Note: TH-1 and Th-2 are vertical holes in earth filled berm.
TH-3 and TH-4 are vertical holes in pits.
TH-5 is angle hole at 45 degrees extending under pit.

Ion exchange Capacity

TH-3 at 19 feet	0.7	milliequivalent	per	100 grams
TH-4 at 5 feet	3.2	"	"	"
TH-5 at 12 feet	1.7	"	"	"

(Table modified from Hermann, 1954)

Table 2.--Gross Alpha radioactivity of tuff from test holes, 1960

Horizontal holes in caisson

Depth (feet)	No. Cores	Average Gross alpha-a/	Gross alpha-a/ - All cores (Max.)	(Min.)
6	10	3,003	6,613	4
8	7	1,306	2,850	11
10	8	1,143	1,872	12
12	6	821	1,729	414
14	9	749	2,094	1
16	9	732	1,305	8
18	4	517	923	141
20	7	183	506	45
22	4	15	20	11
24	8	402	1,038	175
26	10	13	88	2
28	6	28	156	2

Vertical or near vertical holes around pit

Hole No.	No. of Samples	Depth (feet)	Gross alpha a/ (Avg.)	(Max.)	(Min.)
1	10	76	2	3	1
1-A	10	83	24	24	9
2	11	93	698	3,722	142
3	11	99	3	7	2
4	13	99	1.5	2	1
5	7	92	3	6	1

a/ Counts per minute per gram.

Note: Hole DPW-1A angled at 11½ degrees toward pit 1.
Hole DPW-2 angled at 19 degrees toward pit 1.

(Tables modified from Christenson and Thomas, 196

Table 3.--Moisture content of tuff adjacent to test holes

DPW-1				DPW-2				DPW-5			
Depth (feet)	Percent Moisture (by volume)			Depth (feet)	Percent Moisture (by volume)			Depth (feet)	Percent Moisture (by volume)		
	3-17-61	8-23-61	1-30-67		3-18-61	8-23-61	1-30-67		3-19-61	8-25-61	1-30-67
1	22	28	34	1	26	34	39	1	20	20	36
5	24	34	37	4	25	38	40	5	16	16	26
8	18	38	39	8	30	24	30	10	19	20	26
12	13	40	22	12	25	>50	30	15	20	25	29
16	14	34	22	16	22	>50	28	20	17	22	25
20	16	35	40	20	16	>50	18	25	13	19	18
24	18	30	34	24	24	>50	28	30	12	16	15
28	16	27	36	28	25	>50	>50	35	13	18	20
32	28	36	39	32	22	>50	>50	40	13	20	18
36	18	29	41	36	20	>50	47	45	11	16	16
40	14	23	41	40	10	44	16	50	13	21	20
44	14	27	36	44	10	46	16	55	12	19	20
48	14	29	30	48	10	42	17	60	12	14	16
52	16	34	30	52	12	44	22	65	12	15	17
56	14	28	19	56	14	40	25				
60	13	23	16	60	15	28	22				
64	13	22	26	64	12	24	17				

Note: Water level DPW-1A 1-30-67 24.2 feet
Water level DPW-3 1-30-67 50.3 feet
DPW-4 Destroyed
Depth of DPW-a, 76 ft; DPW-2, 93 ft; DPW-5, 92 ft.
Logging length of cable - 65 feet in 1967.

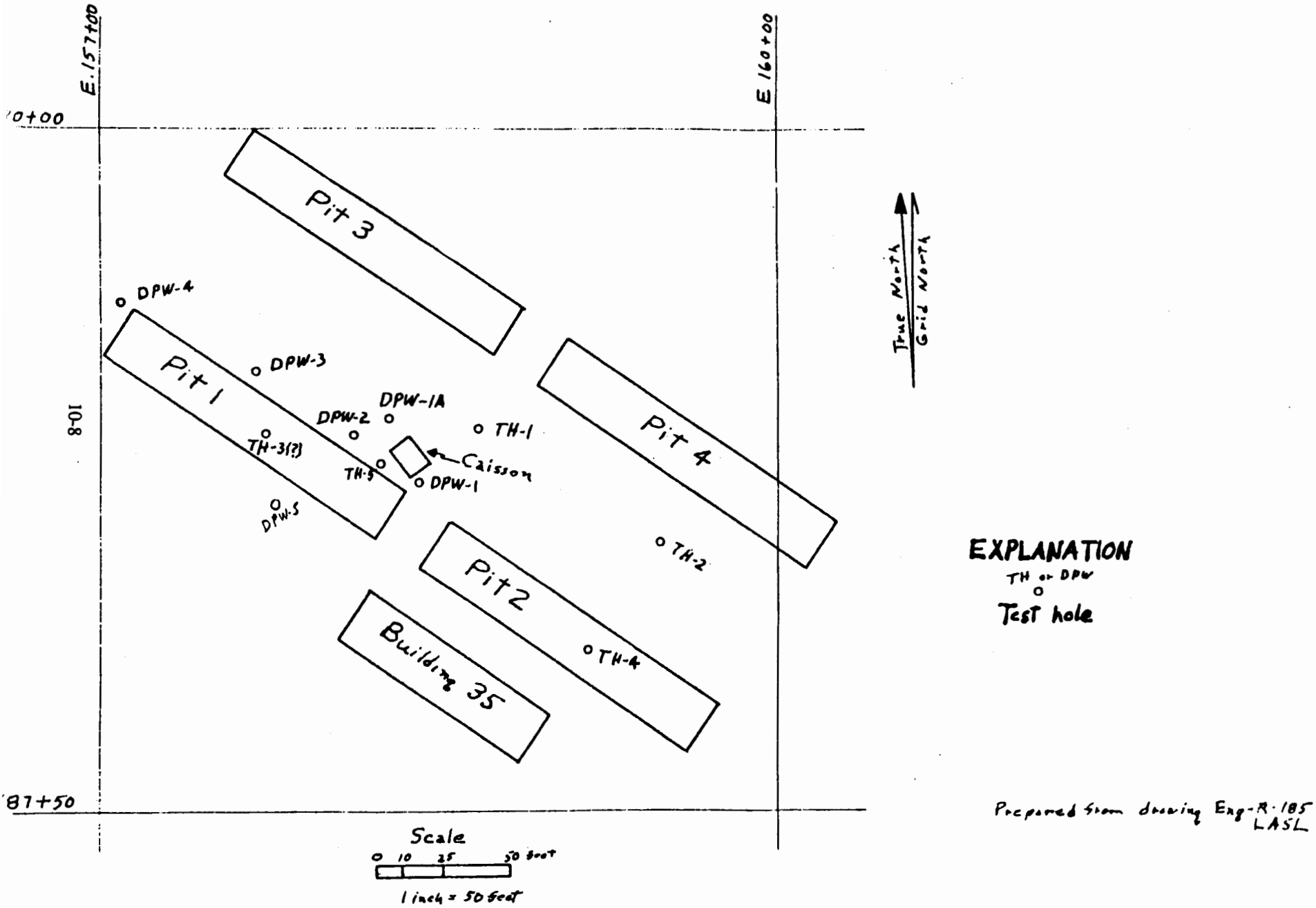


Figure 1.--Sketch map of seepage pits near Building 35 in TA-21, showing location of test holes.

William R. Kennedy, Group Leader, H-6 February 5, 1968

William D. Purtyman, USGS

CUTTING FROM MONITORING HOLES AT DP-WEST NEAR BLDG. 257

USGS

The test hole cuttings described herein were delivered to your laboratory on February 3, 1968. They were collected during the construction of monitoring holes at the sludge disposal area near Building 257 at DP-West. The enclosed sketch shows the lithology penetrated by the holes as well as their approximate location. The sketch is preliminary - subject to reversion.

The following Table gives depth interval of sample collection:

Sample Designation	Sample Interval (ft.)
B-1	0-5, 5-12, thereafter at 5 ft. intervals to a depth of 97 ft.
B-3	" " " "
B-5	" " " "
B-7	" " " "
B-9	" " " "
X-1	0-7, thereafter at 5 ft. intervals to a depth of 47 ft.
X-2	" " " "
X-3	0-7, thereafter at 5 ft. intervals to a depth of 42 ft.
X-4	" " " "

Holes in "B" series are cased with 100 ft. of 2-inch plastic tubing which extends about 3 ft. above land surface.

Holes in "X" series are cased with 40 ft. of 2-inch diameter plastic tubing which extends about 1 foot above land surface.

William D. Purtymun

WDP:mtj

Enc. As noted above

CC: C. W. Christenson, H-7
P. E. Trujillo, Jr., H-6
W. D. Purtymun, USGS

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
Room 115, Federal Building
Santa Fe, New Mexico 87501

April 7, 1967

Mr. George Hilton
Construction and Maintenance Branch
U.S. Atomic Energy Commission
Los Alamos, New Mexico

Dear Mr. Hilton:

The following letter presents data on the chemical quality of water from supply wells related to use at the Power Plant (TA-3). It is not a comprehensive study but reviews the chemical quality of water from the supply wells at Los Alamos that pertains to scale forming constituents in the water. The letter also includes a section on water production and distribution, and some of the hydrologic characteristics of the wells. It was prepared at the request of Mr. Henry Strandring at the meeting of members of the U.S. Atomic Energy Commission, Los Alamos Scientific Laboratory, and members of the U.S. Geological Survey held at Los Alamos on January 11, 1967.

Background: The major use of water at the power plant is in generation of steam and in condensers for cooling the steam after is passes through the turbines. Water from the supply wells is used in production of steam in the boilers after it is passed through deionization columns to remove minerals that will cause scale. A major portion of the water supplied to the power plant is used in the condenser and cooling tower. Since 1950 the major amount of water used for cooling has been the effluent from the East Road Sewage Treatment Plant but some water for this use is supplied from the TA-3 Sewage Treatment

Plant and regular water supply (wells). The water used in the condensers has required some chemical treatment; however, the mixture of the effluents and well water on the whole has been satisfactory.

The effluent from the East Road Plant will no longer be available in the spring of 1967. Thus, make-up water for the condensers and cooling tower will be from the supply wells supplemented by effluent from the TA-3 Sewage Treatment Plant. The change in the major source of water for use in the condensers from the East Road Plant to the supply wells may require a different type of treatment to remove or reduce mineral constituents that will cause scale in the condensers and feed lines. The major scale forming constituents in water at Los Alamos are silica, calcium and magnesium.

Water production and distribution: Water supply to the town and technical areas, White Rock, and Pajarito Acres is from the Los Alamos field (6 wells in Los Alamos Canyon), the Guaje field (7 wells in Guaje and Rendija Canyons) and the Pajarito field (2 wells on the Pajarito Plateau). A third well is completed in the Pajarito field and is to be added to the supply system in the summer of 1967. The S-Site area water supply is supplemented by several springs west of the site. Ground water pumpage from the Los Alamos, Guaje, and Pajarito fields from 1960 to 1966 is shown on table 1.

The water supply to the town area is from the wells in the Los Alamos and Guaje fields. White Rock and Pajarito Acres are supplied from wells in Sandia Canyon, PM-1 and PM-3, when it is added to the system. The surplus from these wells is used to supply the town area through the

transmission line from the Los Alamos field. The technical areas south of Los Alamos Canyon are supplied from well PM-2 (Pajarito Canyon). This will include water to the Power Plant at TA-3.

Lithology of rocks related to quality of water: The lithology of rocks yielding water to the wells determine in large part the chemical quality of the water. Rocks yielding water to the supply wells are the Tesuque Formation and the Puye Conglomerate. The Tesuque Formation is composed of siltstone and sandstone with sporadic lenses of clay or pebbly conglomerate. In some wells basalts are interbedded with the sediments. Basalt flows interbedded with the sediments of the Tesuque Formation are sources of silica, calcium, and magnesium and thus may increase the silica, calcium, and magnesium concentrations in the water moving through them. Thus if the major part of the yield to the well is from the interbedded basalts the silica, calcium, and magnesium concentrations may be higher than water from wells developed in other units. The Puye Conglomerate overlies the Tesuque Formation and yields a part of the water to wells completed on the Pajarito Plateau. It is composed of a thin lower unit (about 50 feet thick) of a poorly consolidated conglomerate that is made up of arkosic and quartzitic debris derived from igneous and metmorphic rocks (table 2). The upper unit (saturated thickness from a few feet to more than 500 feet) is a moderately well cemented conglomerate that is composed of volcanic debris, mainly rhyolite, quartz latite, latite, and minor amounts of rhyolitic tuff and pumice. Water from the thin lower unit has higher calcium (about 10 ppm) and magnesium (about 6 ppm) concentrations than water in the upper unit while the silica content is about the same.

General statement: Silica, calcium, and magnesium in water from the supply wells contribute most of the scale to the water feed lines and condensers at the TA-3 Power Plant. Silica, calcium, and megnesium concentrations in and total hardness of water from wells in the three well fields is shown on table 3.

Silica concentrations in water from the well fields range from 27 ppm (parts per million) (LA-1 to 80 ppm (G-1A). Silica concentrations may vary with increased pumpage; however, not enough analyses are available to confirm such a trend. Calcium concentrations range from an average of 4 ppm (LA-6) to 27 ppm (PM-3) and magnesium concentrations range from 0 ppm (LA-6) to 8 ppm (PM-3). The wells in the Los Alamos and Guaje fields show no significant changes in the concentrations of calcium and magnesium after long periods of use. Slight changes in concentration of calcium (1 to 4 ppm) and magnesium (1 to 2 ppm) do occur during periods of light pumpage (winter and early spring) as compared to periods of heavy pumpage (summer). The higher concentrations of these ions occur during periods of lighter pumpage.

Silica, calcium and magnesium concentrations may vary within a well field due to local conditions within the aquifer that yields water to the well. In general, the sediments of the Tesuque Formation (Los Alamos field) yield water with the smaller concentrations of silica, calcium, and magnesium. Wells completed in sediments interbedded with basalts in the Tesuque (Guaje field) yield water with greater amounts of silica, calcium and magnesium.

The silica concentration of water from the wells in the Pajarito field is high (70 to 79 ppm, average, table 3), and calcium and magnesium concentrations are higher in water from wells PM-1 and PM-3 than in water from the other supply wells.

Pajarito field: The wells in the Pajarito field yield water from the Puye Conglomerate and sediments and interbedded basalt flows in the Tesuque Formation (table 2). The sediments in the Tesuque Formation are coarser in the Pajarito field than in the Los Alamos and Guaje fields

and these sediments along with the permeable Puye Conglomerate accounts for higher yields from wells in the Pajarito field (table 2).

The analyses of water prior to February indicate two different types of water being added to the supply system (table 3). Silica concentrations of water from the Pajarito well field range from 70 ppm to 79 ppm, however, the average calcium concentrations of water from wells PM-1 (26 ppm) and PM-3 (27 ppm) are higher than those from well PM-2 (10 ppm). The average magnesium concentrations are higher also (PM-1, 6 ppm; PM-3, 8 ppm; and PM-2, 2 ppm).

Additional water samples were collected from PM-1, PM-2 and PM-3 during February to determine if quality changed with increased pumpage (wells PM-1 and PM-2) and if quality changes occur at depth within the well (PM-3).

Well PM-1 was shut down for 12 days and pumped for 6 days at an average rate of 650 gpm (gallons per minute). Water samples were collected at selected time intervals (table 4). The silica concentration of the water increased from 65 ppm after 15 minutes of pumping to 80 ppm after 22 hours of pumping and then fluctuated between 79 ppm and 84 ppm during the remainder of the test. Calcium and magnesium concentrations remained fairly steady during the test; however, several anomalies were noted in samples collected after 22 and 94 hours of pumping. The temperature of the water increased from 75° after 15 minutes of pumping, to 82° at 121 hours of pumping, and remained at 82° until the end of the test.

Similarly, well PM-2 was shut down for 12 days and then pumped for 2 days with water samples collected at selected time intervals (table 5). The silica concentrations ranged from 78 ppm to 81 ppm,

calcium from 9 ppm to 10 ppm, and magnesium from 2 to 4 ppm during the test. No specific trends in changes of quality were noted. Temperature of the water increased from 72° after 5 minutes of pumping, to 73° after 2½ hours and remained constant during the remainder of the test.

Samples were collected in November 1966 from well PM-3 during development and test pumping (table 6). There was no significant change in calcium and magnesium concentrations in the period the samples were collected. The samples were not analyzed for silica. Water samples were collected at selected depths from well PM-3 in February. Silica concentrations increased from 50 ppm at a depth of 1,000 feet to 74 ppm at 2,000 feet, then decreased to 58 ppm in the sample from 2,400 feet. The higher concentrations of silica occurred in or near interbedded basalt in the Tesuque. There was no significant change in calcium and magnesium concentrations.

The test in well PM-1 indicated that some change in chemical quality of water occurred during the first 22 hours of pumping. This change probably is caused by the initial withdrawal of water from the lower unit of the Puye Conglomerate. Silica increased as the yield from the Tesuque increased. The temperature and the chemical composition of the water remained constant after prolonged pumping of wells PM-1 and PM-3. The wells are located about 7,000 feet apart in Sandia Canyon. They penetrate about the same saturated thickness of the lower unit of the Puye Conglomerate and basalts are interbedded with sediments in the upper part of Tesuque Formation. The major part of the yield to the wells is probably from the basalts interbedded in the sediments in the upper part of the Tesuque and from the thin lower unit of the Puye Conglomerate. No significant change was noted during the test in well PM-2.

The major yield to well PM-2 in Pajarito Canyon is probably from the thick section of saturated sediments in the upper part of the Puye Conglomerate which contains low concentrations of calcium and magnesium.

A review of the chemical quality of water from test wells on the Pajarito Plateau, shows that higher concentrations of calcium and magnesium exist in the water in an area north of Sandia Canyon then to the south. There has been little pumpage from the wells in the Pajarito field, but on the basis of the tests made in February and the quality of water from test wells it is assumed that there will be little change in calcium-magnesium concentrations with increased pumpage; however, periodic analyses should be made on water from the new wells to determine any changes or trends.

Summary: Water supply to the Power Plant (TA-3), according to the distribution plan of water from wells and well fields, will be from well PM-2 in Pajarito Canyon. The silica concentrations in this water is high (average 79 ppm); however, calcium and magnesium concentrations (average 10 ppm and 2 ppm respectively) are about the same as from most wells in the Los Alamos and Guaje fields.

If other data or information are needed please feel free to contact us.

Sincerely yours,

W. D. Purtymun
for W. E. Hale
District Chief, WRD

cc: William Kennedy Group H-6

Table 1.--Ground-water pumpage from the Los Alamos, Guaje, and Pajarito well fields in the years 1960-66.

(pumpage, in millions of gallons)

Year	Los Alamos	Guaje	Pajarito	Total
1960	530	533	-	1,063
1961	547	623	-	1,170
1962	577	597	-	1,174
1963	538	655	-	1,193
1964	627	665	-	1,292
1965	447	573	99	1,119
1966	450	614	127	1,191

Table 2.--Well characteristics and saturated thickness of formations

Well field and Well number	Average pumping rate 1966 (gpm)	Average specific capacity 1966 (gal/ft of draw down)	Average depth to water 1966 (feet)	Saturated Thickness (feet) of formation		
				Puye Cong. (feet)	Tesuque formation	
					Sediment (feet)	Basalt (feet)
Los Alamos field						
LA-1	--	--	70		800	--
1 B	543	5.1	50		1,700	--
2[a/]	342	1.4	108		762	--
3	350	2.6	81		789	--
4	593	8.4	285		1,680	--
5	476	--	180		1,570	--
6	553	13.8	129		1,661	--
Guaje field						
G-1	423	4.5	269		1,433	298
1-A	562	11.5	306		1,199	14
2	395	11.6	349		1,641	--
3	311	4.7	353		1,354	93
4	231	2.1	392		1,379	159
5[b/]	549	7.4	445		1,085	337
6	392	5.4	585		615	330
Pajarito field						
PM-1	589	15.1	740	55	1,435	270
PM-2[c/]	1,429	22.7	826	586[d/]	756	134
PM-3[e/]	1,400	38.0		50	1,585	175

a/ Jan - June 1966

b/ Jan - Aug 1966

c/ Dec 1966

d/ Includes 16 feet of basalt

e/ Test pumped Nov 1966

Table 3.--Silica, Calcium, Magnesium and hardness of water from supply wells for samples to date (March 1967)

	Number of analyses	Silica[1/] (SiO_2 in ppm)	Calcium (Ca, in ppm) Range Min	Max	Avg	Magnesium (Mg, in ppm) Range Min	Max	Avg	Hardness as $CaCO_3$ (in ppm) Range Min	Max	Avg
Los Alamos field											
LA-1[2/]	8	27	7	10	8	0	2	0.2	17	30	21
LA-1B	13	40	6	9	7	0	2	.2	17	28	21
LA-2	13	30	5	9	7	0	2	1.0	14	28	20
LA-3	15	32	10	17	13	0	2	.4	28	44	39
LA-4	16	36	7	14	11	0	1	.6	18	40	29
LA-5	14	36	7	13	10	0	2	.2	18	35	27
LA-6	61	30	2	6	4	0	1	0	7	20	11
Guaje field											
G-1	12	66	10	14	12	0	2	1	28	40	34
G-1A	11	80	11	15	12	0	4	2	29	54	38
G-2	10	54	10	17	13	0	4	1	28	56	36
G-3	13	56	9	18	12	1	5	2	29	64	41
G-4	11	50	12	19	16	3	7	5	50	73	59
G-5	13	46	10	21	16	2	7	5	54	76	59
G-6	4	50	8	13	11	2	3	2	36	47	41
Pajarito field											
PM-1	8	70	17	32	26	4	9	6	79	110	89
PM-2	4	79	9	12	10	2	3	2	34	38	36
PM-3	3	74[3/]	26	30	27	7	9	8	98	104	101

1/ 1 or 2 analyses only

2/ No pumpage since 1956

3/ Maximum, _____ in sample from a depth of 2,000 feet (2-14-67)

Table 4.--Hydrologic data from well PM-1, February 14-20, 1967.

Sample interval hours	Pumpage (1,000 of gallons)	Specific capacity (gal/ft of drawdown)	Temperature (°F)	Silica (SiO_2 in ppm)	Calcium (Ca in ppm)	Magnesium (Mg in ppm)	Hardness as $CaCO_3$ (in ppm)
¼ (15 min)	10	31.5	75.0	65	26	7	97
5	197	22.8	78.0	73	26	7	93
22	867	19.6	79.5	80	34	2	92
47	1,853	17.8	81.5	84	26	6	90
72	2,839	16.3	81.5	80	26	7	92
94	3,701	15.4	81.5	80	26	11	108
121	4,768	15.0	82.0	79	26	7	92
144	5,665	14.6	82.0	82.5	26	6	88

Table 5.--Hydrologic data from well PM-2, February 20-22, 1967.

Sample interval hours	Pumpage (1,000 of gallons)	Specific capacity (gal/ft drawdown)	Temperature (°F)	Silica (SiO_2 in ppm)	Calcium (Ca in ppm)	Magnesium (Mg in ppm)	Hardness as $CaCO_3$ (in ppm)
1/12 (5 min)	7	31.3	72	78	9	4	38
2½	213	25.5	73	80	10	2	36
10	860	24.1	--	81	10	3	38
22	1,890	23.2	--	81	10	4	42
34	2,903	23.2	73	78	10	3	38
47	4,034	22.7	73	79.5	10	4	40

Table 6.--Hydrologic data from well PM-3

Test pumping and development October 31, November 1-2, 1966

Sample interval hours	Estimated (pumpage 1,000 of gallons)	Temperature (°F)	Calcium (Ca in ppm)	Magnesium (Mg in ppm)	Hardness as $CaCO_3$ (in ppm)
58	3,060	82	26	9	102
82	4,480	82	30	7	104
95	5,130	82	26	8	98

Samples collected at selected depths, February 16, 1967

Depth of sample (feet)	Temperature (°F)	Silica (SiO_2 in ppm)	Calcium (Ca in ppm)	Magnesium (Mg in ppm)	Hardness as $CaCO_3$ (in ppm)
1,000	74	50	26	8	98
1,500	76	67	25	9	100
2,000	76	74	26	9	101
2,400	76	58	24	8	94

Room 115, Federal Building
Santa Fe, New Mexico 87501

March 7, 1969

Mr. William Kennedy
Group H-6
Los Alamos Scientific Laboratory
Los Alamos, New Mexico 87544

Dear Bill:

A brief reconnaissance was made of the proposed burial pit near Building 40 in TA-21 on March 6, 1969.

The mesa at the proposed pit is underlain by Unit 3 of the Tshirege Member of the Bandelier Tuff. The total thickness of this unit is about 120 feet with the lower part consisting of a nonwelded tuff grading up into a moderately welded tuff which forms the surface of the mesa.

Near Building 257 in TA-21 the shafts drilled for disposal of sludges penetrated buried channels cut into the upper surface of Unit 3. These channels were filled with varying amounts of latite and rhyolite boulders which were later covered by a subsequent ash flow firmly welding them in place. Such channels may or may not be encountered in the proposed excavation.

Joints in Unit 3 will be more numerous in the upper moderately welded tuff with most joints orientated vertical or near vertical. These joints may cause large slabs of tuff to fall into the pit endangering personnel during excavation or disposal operations. Hence it may be necessary that the walls be sloped inward about 1 foot for every 4 foot of depth with loose slabs scaled from sloped walls. While this does not solve the whole problem it does minimize the danger to personnel working in the pit. A similar design has been used in construction of the pits at Mesita del Buey.

The total thickness of the Bandelier Tuff underlying the mesa probably exceeds 800 feet. The tuff is in the zone of aeration; the top of the main zone of saturation is at about 1,150 feet below the surface of the mesa.

Existing solid disposal pits and buried stainless-steel storage tanks are located to the east and west of the proposed pit (see Eng. Drawing 6250). The disposal pits are reported to contain plutonium and uranium wastes. The last liquid wastes probably were added to the tanks in 1949. In the early 1950's the tanks were estimated to contain 160 to 1,000 grams of plutonium (Abrahams, 1963, p. 21).

I would like to make a brief visit to the pit when completed to have a look at the geology. Please contact us if we can be of further assistance.

Sincerely yours,

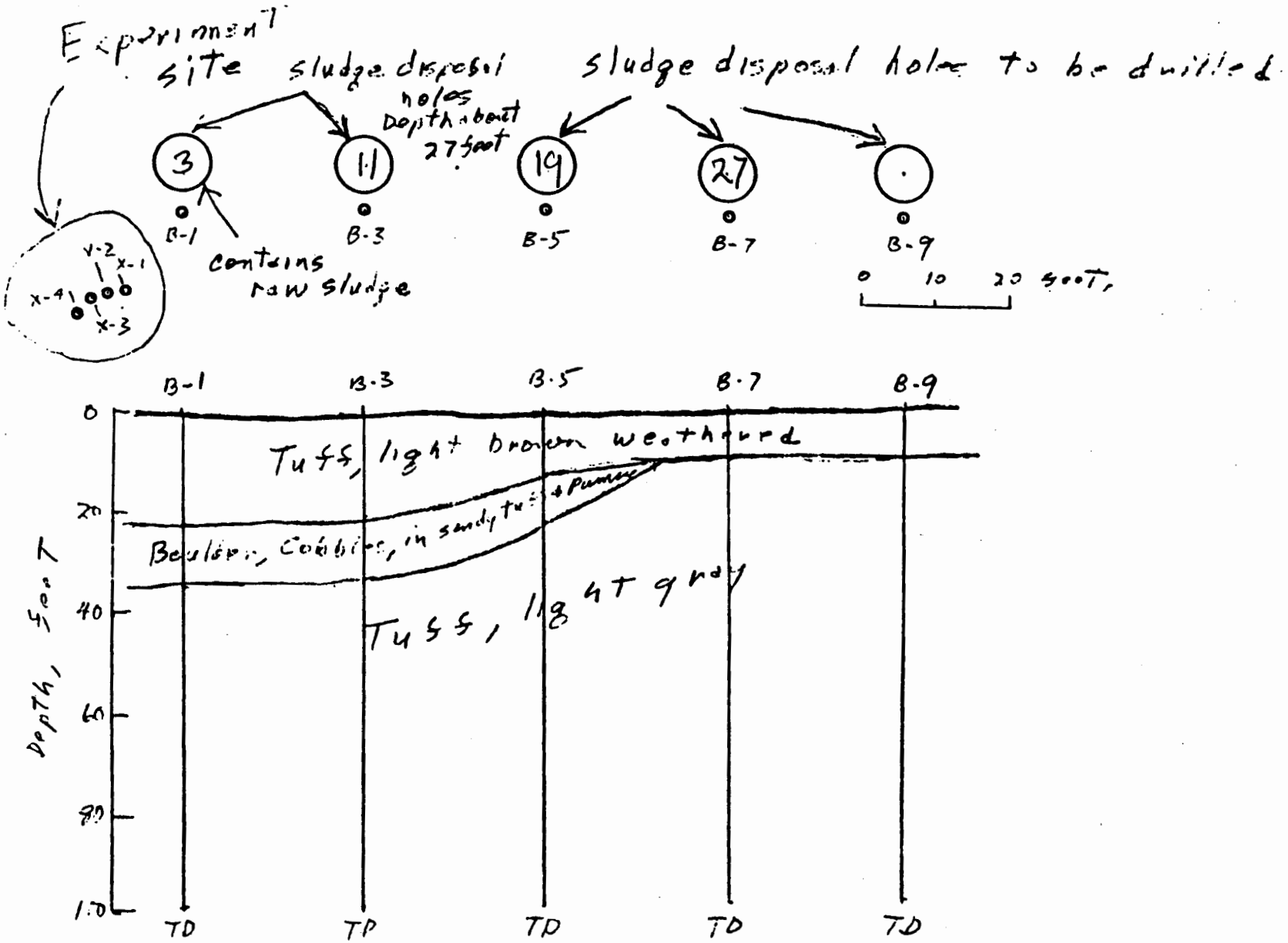
William D. Purtymun

for: William E. Hale, District Chief
WRD, USGS

Reference:

Abrahams, John H., 1963, Geologic and hydrologic environment of radioactive waste disposal sites at Los Alamos, New New Mexico: U.S. Geol. Survey Admin. Rept., 35 p., 3 figs.

cc: F. C. Koopman
Albuquerque, N. Mex.



Sketch showing location of Monitoring holes and cross-section based on drill cuttings Preliminary, subject to revision—

Room 115, Federal Building
Santa Fe, New Mexico 87501

March 18, 1969

Mr. Richard Crook
Utilities and Engineering Division
Zia Company
Los Alamos, New Mexico 87544

Subject: Sand produced with pumpage from well in the Pajarito Field

Dear Dick:

I have compiled some data concerning sand produced with pumpage from the three wells in the Pajarito Field. Wells PM-2 and PM-3 produce only trace amounts of sand during the initial part of the pumping period. The largest produce of sand of the three wells is PM-1. Instantaneous measurements during an Inhoff Cone of pumpage from PM-1 and PM-3 yielded sand contents too small to measure. Measurements made by using a Centrifugal Sand Sampler collected by Hal York and John Stump are tabulated on table 1. The centrifugal sampler collects sand over a period of time, thus, amounts collected were enough for measurement.

Table 2 presents data collected during the development and step testing of well PM-1 with notations concerning sand during similar testing of wells PM-2 and PM-3.

Table 3 lists some of the tolerances for sand produced with pumpage. As you see there is a wide variation of limits. Tolerances vary with the distribution system.

Sand concentrations are greater when the well is first started and as pumping continues the concentration decrease. The sand determination shown on table 1, was taken during the initial part of the pumping or after the well has been surged. This does not provide an accurate estimate of sand produced during a normal pumping period; however, by using this data I made a very rough estimate of the sand produced in about a million gallons of water during a pumping period of 27 hours at 620 gpm from PM-1. This amounted to about 0.06 cu ft per million gallons. I intergrated the pumpage with estimated sand contents for the first 5 hours and thereafter assumed only trace amounts of sand in the production (see step test 2-12-65, table 2).

The amount of sand produced during a pumping period or a realistic estimate for a year could be made by installation of theCentrifugal Sand Sampler on a well during a pumping period 4 to 6 times a year. If possible it would be to our advantage to invest in one of these samplers as the one we used was borrowed from Glen Hammock. Collection of data as to sand concentrations with pumpage of various wells would give us some idea of well deterioration as well as the amount of sand wear on pumping equipment. Thus with this information we could regulate pumpage to minimize both.

Hal informed me that you had received numerous complaints from White Rock residents concerning sand in the water. A possible cause would have been the off and on pumping which occurred during installation of the automatic control for the well system. Surge caused by numerous starts and stops of the pump will cause large amounts of sand to be produced with the pumpage. There were over 100 pumping periods of less than 60 minutes at well PM-1 during the year 1968. Most of these occurred during the spring and summer.

If I can be of further assistance please call.

Sincerely yours,

William D. Purtymun
Hydrologist

for: W. E. Hale
District Chief, WRD

Encls:

cc:
George Hilton, AEC, Los Alamos, N. Mex.
F. C. Koopman, USGS, Albuquerque, N.Mex.

Table 1.--Sand content in pumpage of wells PM-1, PM-2 and PM-3, 1969.

	Time since pumping began (Minutes)	Sand Content (ppm)	(cu ft/mg
PM 1 - 620 gpm			
2-26-69	0 - 15	34	4.6
	15 - 30	1	0.14
	Surge		
	0 - 5	8	0.85
3-6-69	0 - 5	-	
	5 - 15	43	5.5
	15 - 16	-	
	16 - 21	8	1.1
	Surge		
	0 - 2	-	
	2 - 12	6	0.8
PM-2 - 1,410 gpm			
2-26-69	0 - 15	Trace	-
	15 - 20	Trace	-
	Surge		
	0 - 10	1	0.14
3- 7-69	0 - 2	-	-
	2 - 12	3.5	0.49
	13 - 14	-	-
	14 - 18	0	0
PM-3 - 1,320 gpm			
2-27-69	0 - 10	3	0.4
	10 - 20	1.5	.2
	Surge	-	-
	0 - 5	2	.26
	5 - 10	1	.14
3- 6-69	0 - 6	-	-
	6 - 16	1.5	.2
	16 - 18	-	-
	18 - 23	0	0
	Surge		
	0 - 1	Motor fail	
	1 - 13	Pump off	
	13 - 14	-	-
	14 - 4	0.8	0.1

Table 2.--Sand contents in pumpage during development and testing of wells PM-1, PM-2 and PM-3.

PM-1 - Development and aquifer tests February 3 to 12, 1965. Shown below are sand contents for select periods during development and step tests.

Development PM-1

Date 1965	Hour	Average pumping Rate (gpm)	Sand Content ppm	Sand Content (cu ft per million gallons)
2- 4	15:20	Start		
	15:30	780	51	7
	16:00	"	160	20
	16:30	"	63	9
	17:00	"	63	9
	17:30	"	86	12
	18:00	"	50	7
	18:30	"	36	4
	19:00	"	16	2
2-6	14:10	Start		
	14:30	857	26	3.2
	15:00	"	9	1.2
	15:30	"	5	.7
	16:00	"	6.5	.9
	16:30	"	5	.7
	17:00	"	3.8	.5
2-8 1/	08:00	Start		
	08:30	784	12	1.7
	09:00	"	3.6	.5
	09:30	"	2.6	.35
	10:00	"	1.3	.18
	10:30	"	.9	.12
2-9	18:45	Start		
2-11	13:20	Start		
	13:25	726	14	1.8
	13:30	"	21	2.7
	13:35	"	11	1.4
	13:50	"	9	1.2
	14:20	"	4	.6
	14:50	"	2.3	.4
	15:20	"	.9	.12

1/ Well not pumped for 24 hours.

Table 2.--Continued

Step test - PM-1

Date 1965	Hour	Average pumping Rate (gpm)	Sand Content ppm	Sand Content (cu ft per million gallons)
2-12	13:00	Start		
	13:05	842	31	4.2
	13:10	"	33	4.8
	13:15	"	17	2.2
	13:30	"	12	1.8
	14:00	"	2.9	.48
	14:30	"	1.8	.25
	15:00	"	1.5	.19
	15:30	"	1.3	.17
	16:00	"	.7	.095
	16:15	726	.7	.095
	16:30	"	.2	.07
	17:00	"	.1	.07
	17:15	636	TSTM 1/	TSTM 1/
	17:30	"	"	"
	18:00	"	"	"
	18:30	"	"	"
	18:45	"	None	None
	19:00	541	"	"
	19:30	"	"	"
	20:00	"	"	"
	20:15	421	None	None
	20:30	"	"	"
	20:45	"	"	"
	21:00	"	"	"

1/ Amount to small to measure.

PM- 2 - Development and aquifer tests June 30 to July 6, 1965. Reported only traces of sand (amounts to small to measure) during step tests, July 6, at pumping rates ranging from 617 gpm to 1,476 gpm.

PM - 3 - Development and aquifer test October 26 to November 5, 1966. Reported only traces of sand (less than 0.1 ppm) during step tests November 4 and 5, 1966 at pumping rates ranging from 899 to 1,401 gpm.

Table 3.--Tolerances for sand produced with pumpage.

A. Sand production shall be less than 30 ppm within 20 minutes after commencement of pumping (Well specifications for wells PM-1, PM-2 and PM-3 during development and test pumping).

B. One ounce of sand per 100 gallons of water (Corps of Engineers, USGS Memo by E. H. Herrick, May 24, 1956).

C. Size and character of sand influence the tolerable sand concentrations; however,where sand concentrations is less than 0.10 cu ft per million gallons, no sand troubles have been found, while where it exceeds 0.3 cu ft, consumer complaints or sanded meters invariably result. A purely arbitrary limit of 0.1 cu ft per million gallons has tentatively been selected ("Control of sand in water systems," by John R. Rossum, p. 132, in Journal of American Water Works Association, Vol. 46, No. 2, February 1954).

D. In some cases, one ppm may be the permissible limit in a system that has many valves and small orifices, such as a water-flood system for secondary recovery of oil. Two or 3 ppm may be tolerable for municipal and industrial supply ("Ground Water and Wells, "p. 373, Published by Edward E. Johnson, Inc. St. Paul, Min., 1st Ed., 1966).

Comparison of Sand Tolerances

Source of Data	ppm	cu ft per million gallons
A 1/	30	4.0
B	50	7.0
C	0.75	0.10
D 2/	1.0	0.14
D 3/	2.0	0.24

1/ After 20 minutes of pumping.
2/ Systems containing many valves and small orifices.
3/ May be tolerable for municipal and industrial supply.

Room 115, Federal Building
Santa Fe, New Mexico 87501

April 2, 1969

Mr. Dean Miller
Utilities and Engineering
Zia Company
Los Alamos, New Mexico 87544

Subject: Hydrologic data for a densely welded tuff.

Dear Dean:

Enclosed is data that John Stump requested. These data were collected during a study at TA-49 where the Bandelier Tuff has similar properties to that at TA-8 and TA-9.

I looked over a section of the tuff within one-half mile east of the septic tank at TA-8 and have estimated from a topographic sheet that the welded tuff is in excess of 150 feet thick in this area. There is some sheeting and breccia in the lower 50 feet but on the whole this section looks harder and denser near the base. Back at the septic tank this unit may be thicker due to faulting to both east and west which may have formed a slight through prior to the emplacement of the unit.

We left a recorder on the hole, if it is in the way call 983-3801, extension 3307 and leave word for Kunkler to remove it.

Sincerely yours,

William D. Purtymun
Hydrologist

Encl:

cc:
F. C. Koopman

Transmitted by:

J. L. Kunkler

Here are some hydrologic properties of a similar tuff at TA-49.

UNIT 2

Depth below top of flow (feet)	Specific retention (percent)	Specific Yield (percent)	Porosity (percent)	Coefficient of Permeability
2	11.3	26.1	37.4	2.0
6	12.3	15.9	28.2	.2
11	17.3	2.0	19.3	.04
10	20.2	.6	20.8	.08
44	20.8	7.6	28.4	.2
75	14.4	-	-	.2
79	13.9	13.9	27.8	.3
97	17.2	12.1	29.3	.2
104	17.3	12.0	29.3	.2

1/ Gallons per day per square foot.
Note: Samples collected from 4 core holes. The depths are referenced to the contact between Unit 3 and Unit 2 of the Bandelier Tuff.

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
Water Resources Division
P. O. Box 4369
Albuquerque, New Mexico 87106

30 June 1969

Mr. William Kennedy
Group Leader, Group H-6
Los Alamos Scientific Laboratory
Los Alamos, New Mexico 87544

Subject: Materials Waste Pit, Area "A", TA-21--excavated April 1969

Dear Bill:

A reconnaissance was made of the waste pit at TA-21 on May 9, 1969. At that time the first layer of waste had been placed in the pit and covered with tuff. The wastes are contaminated material from the facilities that are being renovated at TA-21.

General description

TA-21 is on a eastward-trending "finger-like" mesa, a part of the Pajarito Plateau. The land surface in the immediate area of the pit slopes northward about 100 yards then breaks into a series of benches and steep slopes to the channel of DP Canyon about 100 feet below the top of the mesa. The pit was excavated in a near east-west direction leaving steep ramps on each end (figure 1). The excavated tuff was piled over two sealed solid disposal pits (see LASL Eng. Drawing 6250). An access road to the bottom of the pit was cut along the south wall.

Parts of the north and south walls are nearly vertical with the remainder sloping at about 1 to 5. The walls at present are stable, though several small blocks were dislodged during construction.

General Geology and hydrology

The pit is excavated in Unit 3 of the Tshirege Member of the Bandelier Tuff (figures 2 and 3). Total thickness of the unit is about 120 feet with the lower part consisting of a nonwelded tuff grading up into a moderately welded tuff which form the upper part of the mesa. The pit is completed in the moderately welded tuff. The soil cover exposed by excavation ranges from 2 to 5 feet in thickness.

The attitude of most of the major joints are near vertical to vertical ranging from 70 to 90 degrees measured from the horizontal. Some of the joints were slightly curved, open in places and closed in others. All of the joints were filled with dark brown clay beneath the soil zone while at depth were filled or plated with dark brown or gray clay.

The orientation and distribution of the major joints in the horisontal plane of the north and south walls of the pit are shown on a rose diagram (figure 4). Three point sets occur true north to N10°W, N40°E to N60°E and N70°E to N80°E. Though all the joint sets do not intersect at 60 degrees as they would if formed in a homogeneous liquid as it cooled, the predominance of the three joints set and near vertical attitude of the joints suggest that the joints formed as the ash flow tuff of Unit 3 cooled after emplacement.

Surface drainage in the area of the pit is to the north into DP Canyon. Intermittent flow in the canyon is from storm runoff and release of treated-industrial effluents from the waste treatment plant at Building 257, TA-21.

The total thickness of the Bandelier Tuff underlying the mesa probably exceeds 800 feet. The tuff is in the unsaturated zone; the top of the saturated zone in the Puye Formation is at about 1,150 feet below the surface of the mesa.

General statement

A few open joints are exposed in the walls of the pit; however, they should cause no trouble when the pit is sealed. Wastes should be buried below the soil zone within the natural confines of the tuff. The seal (tuff removed from excavation) should be 6 to 8 feet thick over the wastes, extended beyond the edges of the pit, and slightly rounded with adequate surface drainage. It may be necessary to plant the seal material with vegetation, not only to prevent water erosion but to prevent wind erosion which may cause problems in nearby shops and laboratories. If the pit is to be left open any length of time, steps should be taken to prevent summer storm runoff from draining into the wastes in the pit along the south wall (see figure 3).

Consideration is given to the preceding paragraph, the pit is acceptable for disposal of solid wastes as outlined in guidelines set up by the University and Geological Survey (letter to S. E. Russo, Eng. 3, from F. C. Koopman, USGS, June 30, 1965). Please contact us if we can be of further assistance.

Sincerely yours,

For: William E. Hale
District Chief

Prepared by
W. D. Purtymun

Enclosures 4

Copy to:

George Hilton, AEC, Los Alamos
Jim Desilits, Eng. 2, LASL, Los Alamos
Dean Meyers, H-1, LASL, Los Alamos

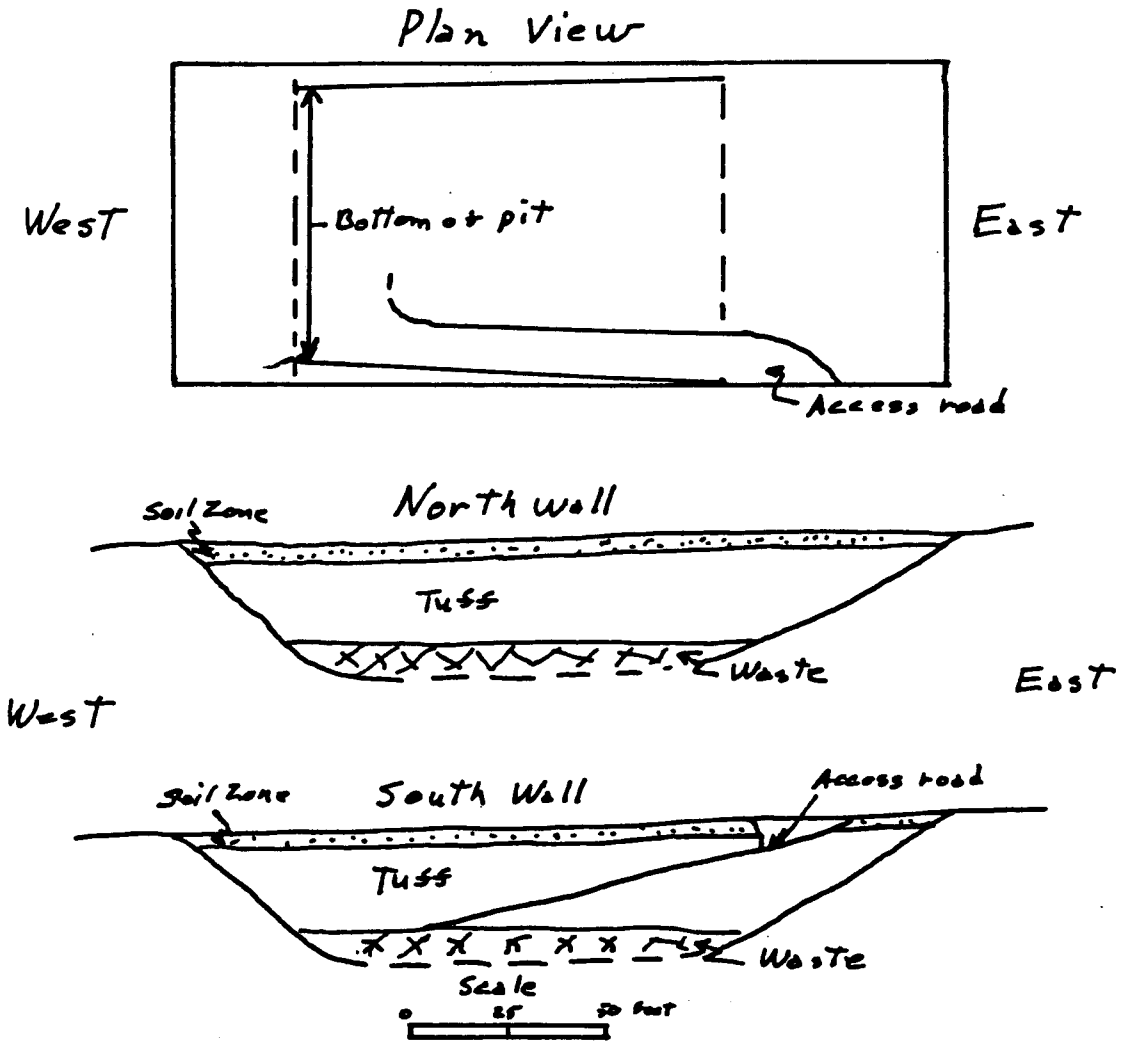
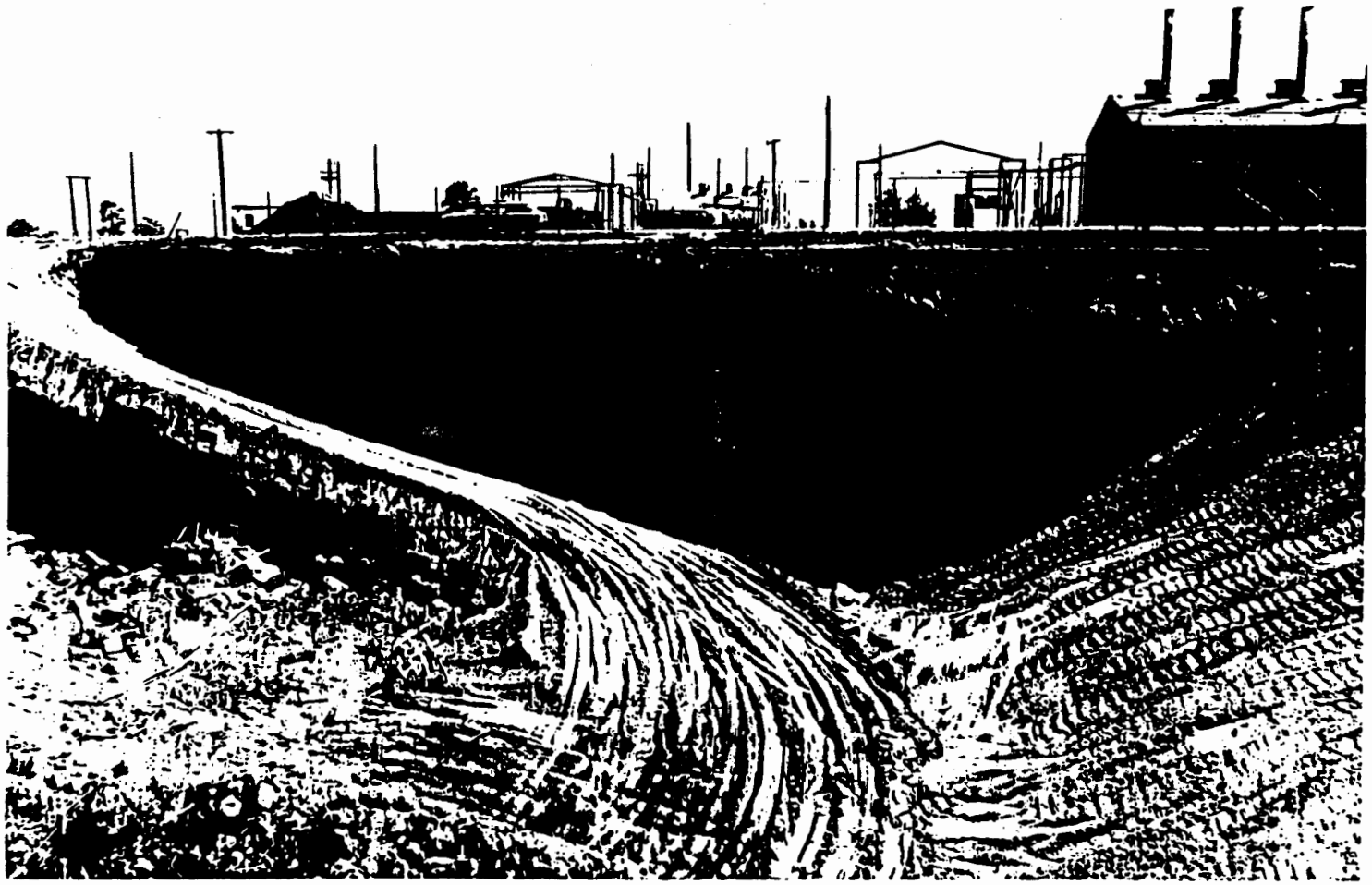


Figure 1.- Sketch of pit showing plan view and North and south walls

Figure 2.--North wall of pit showing soil zone, tuff and joints, and first layer of waste.

Figure 3.--South wall of pit showing soil zone, tuff and joints, first layer of waste and access road.



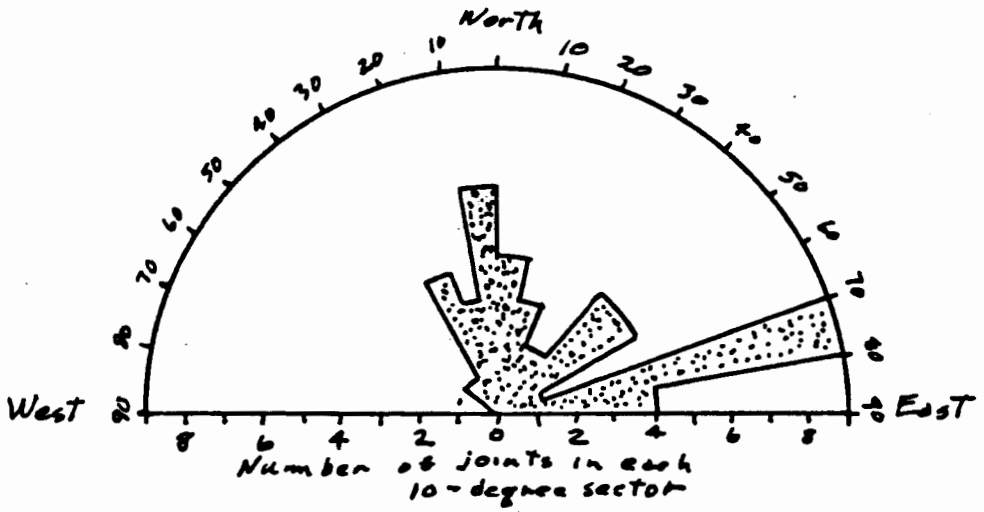


Figure 4.- Orientation of joints in North and South walls of pit

Room 115, Federal Building
Santa Fe, New Mexico 87501

August 19, 1969

Mr. C. W. Christenson, Group Leader
Group H-7
Los Alamos Scientific Laboratory
Los Alamos, New Mexico 87544

Subject: Geology at disposal area near Bldg. 257, TA-21.

Dear Chris:

At your request I have compiled data related to the geology at the disposal area near Bldg. 257 at TA-21. Two sketches showing sections of rock units from pit 3 to 27 and pit 2 to 27 are attached.

The lower unit is a light gray moderately welded tuff with an approximate thickness of 100 feet. It is overlain in part by a reworked tuff which is deposited in a channel or low relief cut into the lower light gray tuff unit. The upper unit forming the surface of the mesa at the disposal area is a light brownish gray moderately welded tuff (see sketch 1 and 2).

The unit that is giving us trouble in drilling additional pit is the reworked tuff and pumice which contains cobbles and boulders in the lower part. The reworked tuff was deposited by gaseous forces accompanying the emplacement of the upper ash flow. The cobbles and boulders occur in tabular shapes or if in mass show faceted sides as if deposited by sliding rather than rolling as one would expect with water-laid material. The blast caused by expanding gases accompanying the emplacement of the upper ash flow deposited the larger materials (cobbles and boulders) into areas of low relief in the upper surface of the lower unit. As the upper unit and reworked tuff were emplaced contemporaneously they have cooled as a single unit thus the contact between the two is gradiational and not very distinct. A sharp contact is found between the reworked tuff and lower light gray unit.

Pit 18 and 26 (sketch 2) were drilled in July 1969. Pit 18 went to a depth of 59 feet (pilot hole 64 ft) passed through the reworked tuff which evidently had few boulders in the lower part. The walls of the pit are rough and irregular in the reworked tuff from a depth of about 14 to 22 feet.

Pit 26 was drilled into a nest of boulders near the base of the reworked tuff and was abandoned at a depth of 15 feet (pilot hole 19 feet). The walls of the pit from the land surface (I was not able to get a ladder long enough to get to the bottom) showed no cobbles or boulders, fairly smooth walls. The only evidence of the reworked unit in the walls was a small patch of reworked sand and tuff at a depth of about 12 feet along the northwest wall of the pit. Evidently the pilot hole (dug with a 3 foot bucket auger to a depth of 19 feet) encountered cobbles and boulders too large to dislodge or pick up thus was probably abandoned several feet above the top of the lower unit of light gray tuff.

Inspection of pits when the rig is setting on the hole to allow access may be of value determining extent of the reworked tuff containing the cobbles and boulders. This would aid in location of future pits. If we can make the inspection for you or if you need additional information please feel free to give us a call.

Sincerely yours,

W. D. Purtymun
Hydrologist

For: W. E. Hale
District Chief, WRD

cc: Wm. Kennedy, H-6, LASL
Los Alamos, N.Mex.

F. C. Koopman, USGS
Albuquerque, N. Mex.

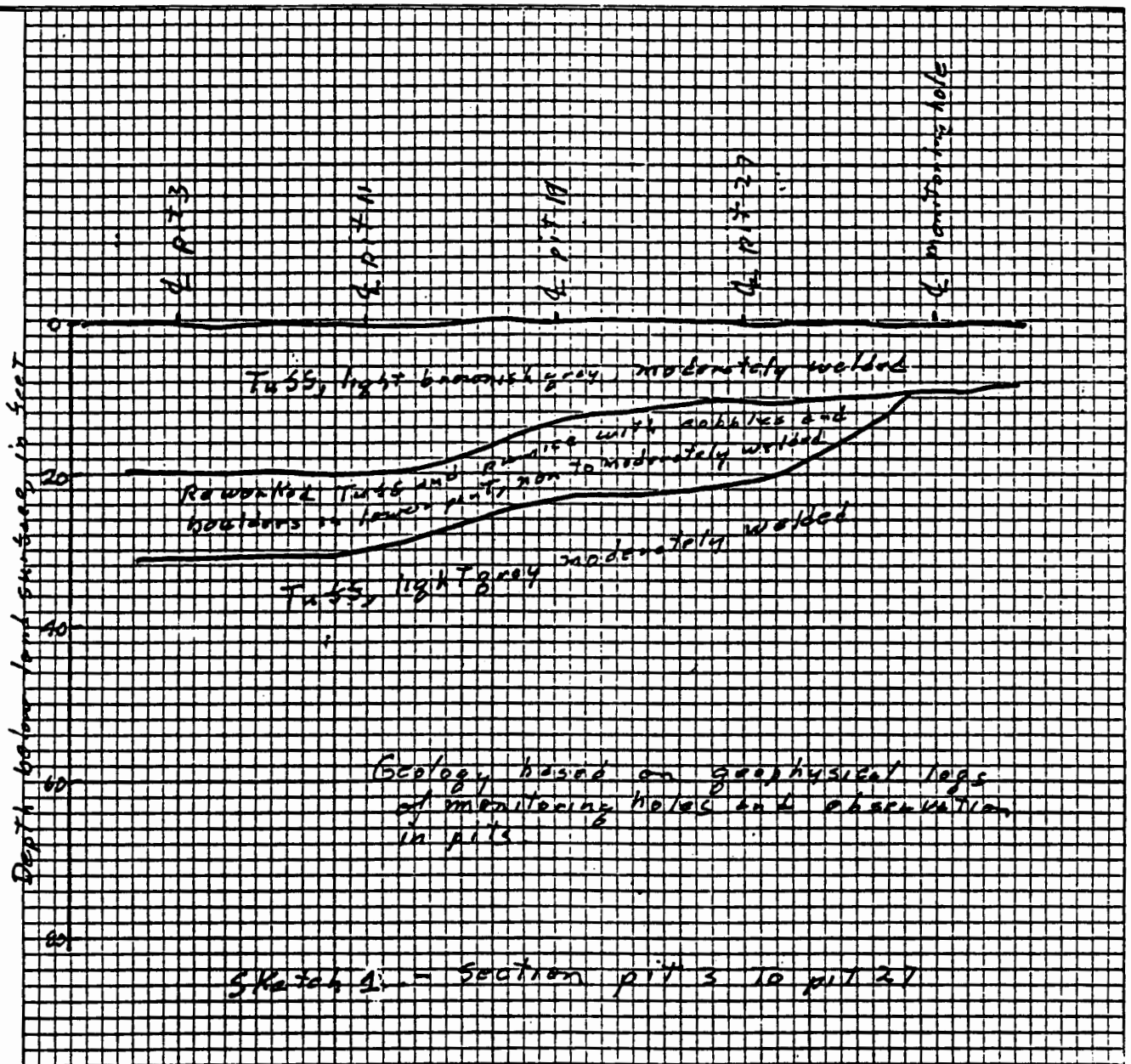
9—213-A
(October 1948)

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

File Number { Washington ..... District .....

16—13468-2 GPO

(DO NOT USE THIS SPACE EXCEPT FOR BINDING PURPOSES)



Sketch 1 — Section pit 3 to pit 27

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO

OFFICE MEMORANDUM

TO : Paul R. Franke, Jr., MP-6 DATE: October 16, 1969

THRU : William R. Kennedy, Group Leader, H-6

FROM : William D. Purtymun, H-6

SUBJECT: MOVEMENT OF INDUCED RADIATION IN THE TUFF ADJACENT TO THE BEAM CHANNEL AT THE MESON FACILITY

SYMBOL : H-6

The problem expressed to us on October 13, 1969 was the possible movement of induced radiation in the tuff adjacent to the beam channel by precipitation to areas where it would be a health hazard. The following recaps the general hydrology with respect to the problem.

Thickness and depth of rocks underlying the Mesa at the east end of the Meson Facility

Rock Type	Thickness (feet)	Depth (feet)
Tuff	520	520
Conglomerate	90	610
Basalt	120	730
Conglomerate	420	1,160

1) Section based on outcrop and log of TW-3 and foundation elevation of Meson Facility of 6,970 feet.

The main aquifer (zone of saturation capable of water supply) lies at a depth of about 1,100 feet below the surface of the mesa. Recharge to the aquifer is along the

See following informal Rept Transmitted to MP-6 - Nov 1969

flanks of the mountains to the west and deep canyons cut into the western third of the plateau. Movement of water is eastward toward the Rio Grande at an average of about 450 feet per year (aquifer tests TW-3 and PM-2). No measurable amount of tritium was detected in water from well PM-3 so that it is assumed that water reaching the main aquifer in this area from recharge to discharge has been in transit for more than 50 years.

There was no water in the formations above the main aquifer; however, intermittent streams in Los Alamos and Sandia Canyon (cut to a depth of 200 to 400 feet below the surface of the Mesa) recharge small bodies of water perched in the alluvium along the stream channels. As the water in the alluvium moves eastward some is lost to evapotranspiration while some move into the tuff and conglomerate interbedded with basalt to maintain a body of water perched in the basalt near State Highway 4. Water in the basalt is discharged through springs in lower Los Alamos and Sandia Canyon where the channel has cut through the basalt.

Studies related to distribution of moisture in the soil and tuff on the mesa tops indicate little if any precipitation moves through the soil zone where the soil

cover is undisturbed; however, where water was allowed to pond, it has been observed to move to a depth of 16 feet. Studies made of crushed tuff used as seal material on pits for the disposal of solid wastes have shown precipitation from a single storm has infiltrated to a depth of 6 feet; however, most of this moisture was returned to the atmosphere by evaporation in the dry period following the storm.

The beam channel is constructed in a trench cut into the tuff and backed filled with a cover of about 25 feet of tuff. A roadway is to be constructed on the top of the fill. As the roadway will probably be paved only the slope areas adjacent to the road are areas of possible infiltration into the tuff fill overlying the beam channel.

With adequate drainage along the roadway, it seems improbable that precipitation could infiltrate into the tuff adjacent to the beam channel, or if it did, would be insufficient in volume to move contaminates into the canyon walls thus into the perched water in the canyon floor or downward to the main aquifer 1,100 feet below the surface of the mesa.

Enclosed are two articles that you requested. If you need further information please feel free to contact us.

Enc. (2)

CC: Dean Kelley, ENG-1 17-3
[illegible] 17-1

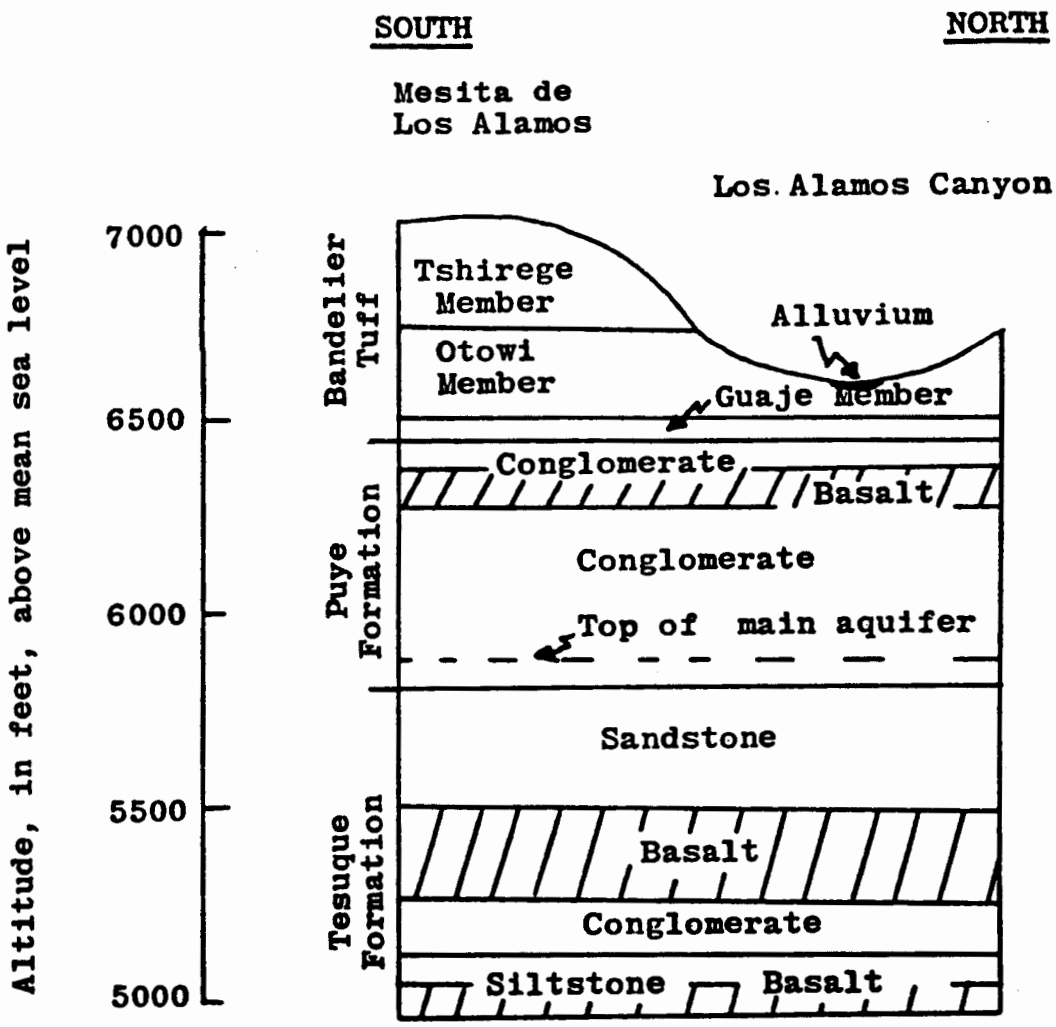


Figure 1 - Generalized Geologic Section

GEOLOGY, HYDROLOGY, AND HYDROLOGIC CHARACTERISTICS OF THE TUFF AT MESITA DE LOS ALAMOS

By William D. Purtymun

Prepared for Meson Physics Group MP-6

By Environmental Studies Group, H-6

See Memo Oct 16, 1969
To Paul Tramke MP-6
From W D Purtymun

CONTENTS

Page

Introduction 1

Geology 1

Hydrology 2

Hydrologic Characteristics of the Tuff..... 5

References..... 7

ILLUSTRATION

Figure 1 - Generalized Geologic Section 3

GEOLOGY, HYDROLOGY, AND HYDROLOGIC CHARACTERISTICS OF THE TUFF AT MESITA DE LOS ALAMOS

INTRODUCTION

This report describes the geology and hydrology of the Meson Facility on Mesita de Los Alamos. It also includes a section on the hydrologic characteristics of the tuff adjacent to the beam channel with reference to movement of radioisotopes by moisture.

Mesita de Los Alamos is an eastward trending "finger-like" mesa which is a part of the larger Pajarito Plateau. The mesa is formed by a series of ashfall and ashflows of rhyolite tuff. It is bounded on the north by Los Alamos Canyon and on the south by Sandia. The surface on the mesa slopes gently eastward. A small east-west ridge lies along the northern edge of the mesa in the area of the Meson Facility. The beam channel and other buildings are located on the southern flank of the ridge.

GEOLOGY

The ashfalls and ashflows of rhyolite tuff that form the mesa are rocks of the Bandelier tuff. In the subsurface beneath the mesa are rocks of the Puye and Tesuque Formations.

The lower-most formation, the Tesuque, is composed of siltstones, sandstones with lenses of clay and pebbly conglomerate with some interbedded basalt. (Spiegel and

Baldwin, 1963). Above the Tesuque is the Puye Formation (Figure 1). The lower part is a poorly consolidate channel fill deposit overlain by a conglomerate composed of volcanic debris (Bailey and others, 1969). Interbedded with the conglomerate is a basalt flow that originated from volcanic centers to the southeast.

The Bandelier tuff overlies the Puye Formation, forming the walls and upper surface of the mesa. It is composed of three members (Griggs, 1964). In ascending order they are: the Guaje Member (an ashfall pumice), the Otowi Member (a friable ashflow tuff), and the Tshirege Member (a series of ashflow and ashfall tuffs). Total thickness of the Bandelier is about 570 feet.

HYDROLOGY

Surface drainage from Mesita de Los Alamos is into Los Alamos and Sandia Canyons which are tributary to the Rio Grande. The intermittent stream in the canyons (cut to depths of 200 to 400 feet below the surface of the mesa) recharge small bodies of water perched in the alluvium along the stream channels. As the water in the alluvium moves eastward some is lost to evapotranspiration while some moves into the tuff and conglomerate and interbedded basalt to maintain a body of perched water in the basalts near State Highway 4. Water in the basalt is discharged through springs in lower Los Alamos and Sandia Canyons where the channel has cut through the basalt.

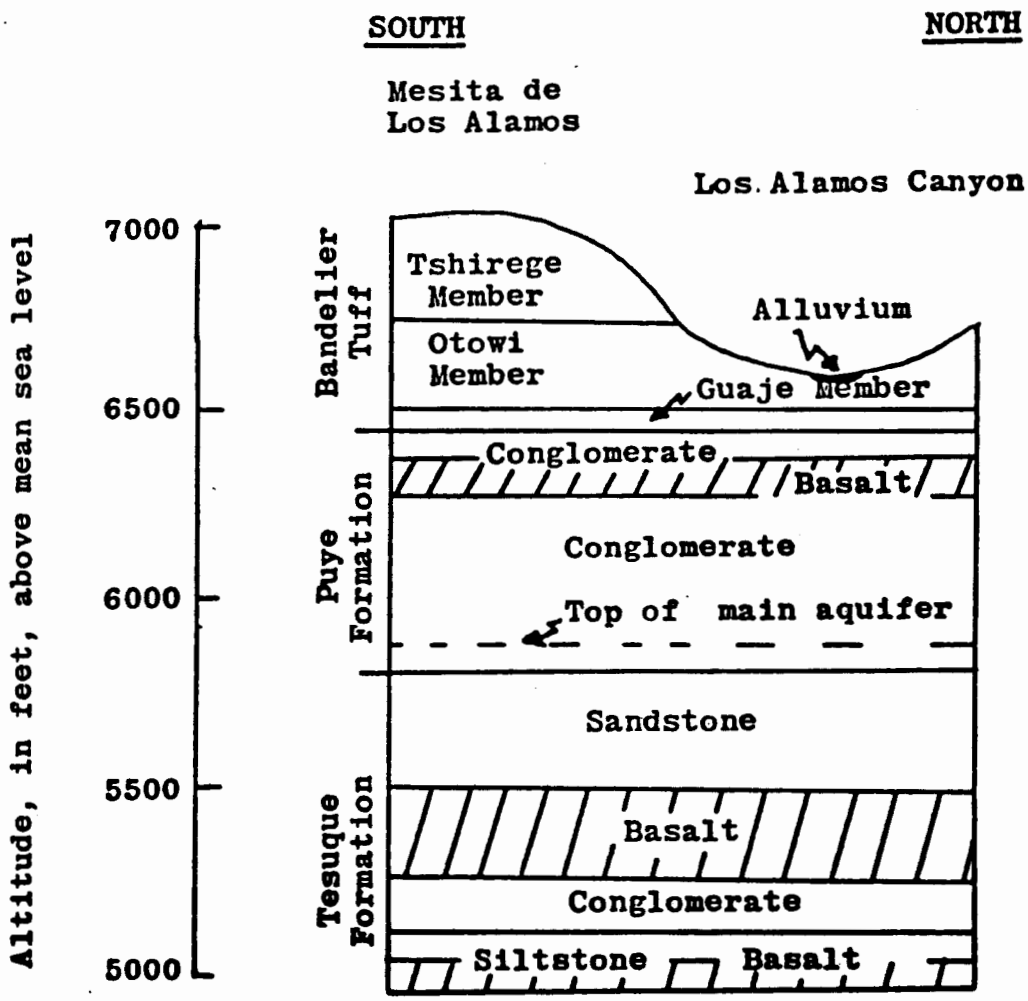


Figure 1 - Generalized Geologic Section

The main aquifer (zone of saturation capable of municipal and industrial water supply) lies at a depth of about 1,100 feet below the surface of the mesa within the Tesuque Formation and lower part of the Puye (Figure 1). The movement of water in the aquifer is eastward toward the Rio Grande where a part is discharged into the river through a series of seeps and springs. At the Meson Facility there is no water perched between the main aquifer and stream connected aquifers in the alluvium in Los Alamos and Sandia Canyons.

Little if any water from precipitation infiltrates into the tuff on the mesas where the normal soil cover is undisturbed due in part to the high evaporation rate and hydrologic characteristics of the soil (Abrahams and others, 1961). As a result there is no recharge to the main aquifer from the mesas.

In trying to date the age of the water at Supply Well PM-3, located about 1.5 miles east of the Experimental Buildings, analyses (electrolysis enrichment method) showed no measurable amount of tritium. It is assumed then that the water in the aquifer has been in transit from the recharge area to the well for more than 50 years. The rate of movement of water in the aquifer is estimated at 450 feet per year (aquifer tests, Test Well TW-3 and Supply Well PM-3). Based on tritium results and rate of movement the, recharge area would be from the west along the flanks of the mountains. Cushman, 1965, also postulated that the

main recharge area to the aquifer was along flanks of the mountains and deep canyons cut into the western part of the plateau.

HYDROLOGIC CHARACTERISTICS OF THE TUFF

In an area where the soil cover or near surface tuff has been disturbed and water was allowed to pond, moisture has been observed to move to a depth of 16 feet in the tuff. The moisture beneath the pond was distributed by gravity and capillarity while on the outer edges movement was by diffusion. The following example illustrates the ability of this tuff to absorb and retain water. Injection of 500,000 gallons of water into a 10 foot, 4 inch diameter zone in the tuff took about 3 months. Five months after the test, the 500,000 gallons of water had assumed a spherical shape of moisture about 180 feet in diameter. The moisture content of the tuff ranged from about 22 percent by volume beneath and adjacent to the injection zone to less than 4 percent by volume at the edges of the sphere. Moisture near the injection zone was being distributed by gravity and capillarity while at the edges movement was by diffusion.

The beam channel is constructed in a trench cut into the tuff and is backfilled with about 25 feet of compacted tuff. The rate and depth of infiltration of water from precipitation can be only approximated from other data. Infiltration from a single storm moved moisture to a depth of about 6 feet in a crushed tuff used as seal material on a filled disposal pit. Most of this moisture was returned to the atmosphere by evaporation in the week that followed the storm.

With adequate drainage along the surface of the beam channel, it seems improbable that precipitation could infiltrate into the backfill and tuff adjacent to the beam channel, or if it did, would be in sufficient volume to move contaminates into the canyon walls or downward to the main aquifer 1,100 feet below the surface of the mesas.

REFERENCES

Abrahams, J. R., Jr., Weir, J. E., Jr., and Purtymun, W. D., 1961, "Distribution of moisture in soil and near surface tuff on the Pajarito Plateau, Los Alamos County, New Mexico," U. S. Geological Survey Prof. Paper 424-D, p. 142-145.

Bailey, R. A., Smith, R. L., and Ross, C. S., 1969, "Strategraphic nomenclature of volcanic rock in the Jemez Mountains, New Mexico," U. S. Geological Survey, Bull. 1274-P, 19p., 2 figs.

Cushman, R. L., 1963, an evaluation of the aquifer and well characteristics of municipal well fields in Los Alamos and Guaje Canyon near Los Alamos, New Mexico: U. S. Geological Survey Water-Supply Paper 1809-D, 50 p., 3 pls., 17 figs.

Griggs, R. L., 1964, Geology and ground-water resources of the Los Alamos Area, New Mexico: U. S. Geological Survey, Water-Supply Paper 1753, 106 p., 1 pl., 20 figs.

Spiegel, Zane, and Baldwin, Brewster, 1963 Geology and water resources of the Santa Fe Area, New Mexico: U. S. Geological Survey Water-Supply Paper 1525, 258 p., 7 pls., 56 figs.

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO

OFFICE MEMORANDUM

TO : William R. Kennedy, Group Leader, H-6 DATE: November 21, 1969

FROM : Jack W. Aeby, H-6

SUBJECT: PERMEABILITY OF THE TUFF TO WATER VAPOR

SYMBOL : H-6

In order to establish a background bore line for tritium samples taken from test borings around the DP slurry dump holes, advantage was taken of the fact that drillers were in the process of boring a new 8 ft. diameter hole in Area "H", the classified shops disposal area. When we arrived at this area in the afternoon of November 6, we found them bailing out the loose tuff from the 40 ft. depth. We simply bagged a few handfuls of the loose material for our background sample.

Approximately one liter of this material was placed in a two liter beaker and heated to drive off the moisture which was collected on a watch glass cooled with a single ice cube. It required a very high heat to drive off 1 ml of water for our analysis. (This tuff actually gave a slightly negative reading on the moisture balance.) A 500 lambda alliquote of the water was placed in a standard scintillation counting bottle along with 15 ml of scintillation solution for scintillation counting. The counting results showed an activity of 4,586,795.9 ± 8,958.8 dis/min. ml or 69,496.91% RCG. A very surprising result indeed for a background sample. Subsequent repeat counting verified the above values.

The search continues for an adequate background sample. However, our initial failure and subsequent failures have launched us on an interesting experiment to determine the permeability of the local formations to tritium or moisture. The results to date are contained in the enclosed chart.

Even though this sample is 69,496.9% RCG for water, one must remember that it is rather difficult to extract from the tuff. Subsequent air samples taken in this same hole at the 45 ft. depth ran a maximum of 118% RCG air, 100% is the concentration in the air one could tolerate with no measurable effects.

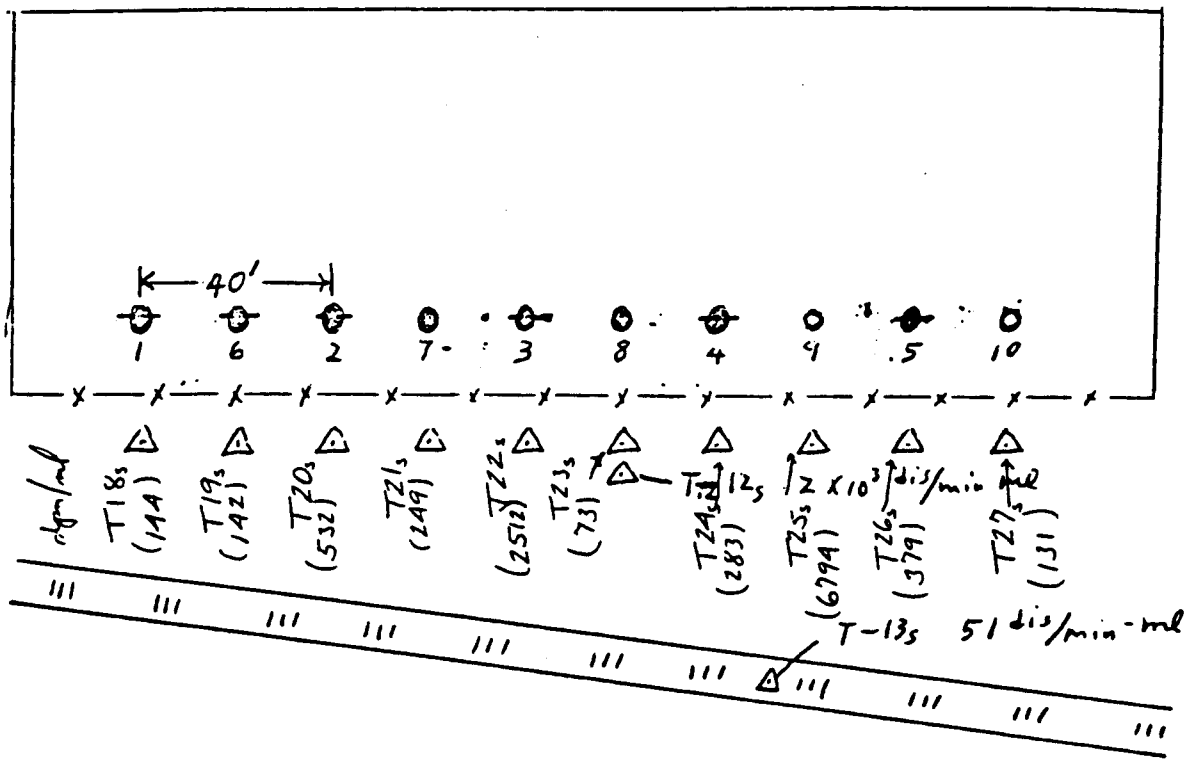
The Boys

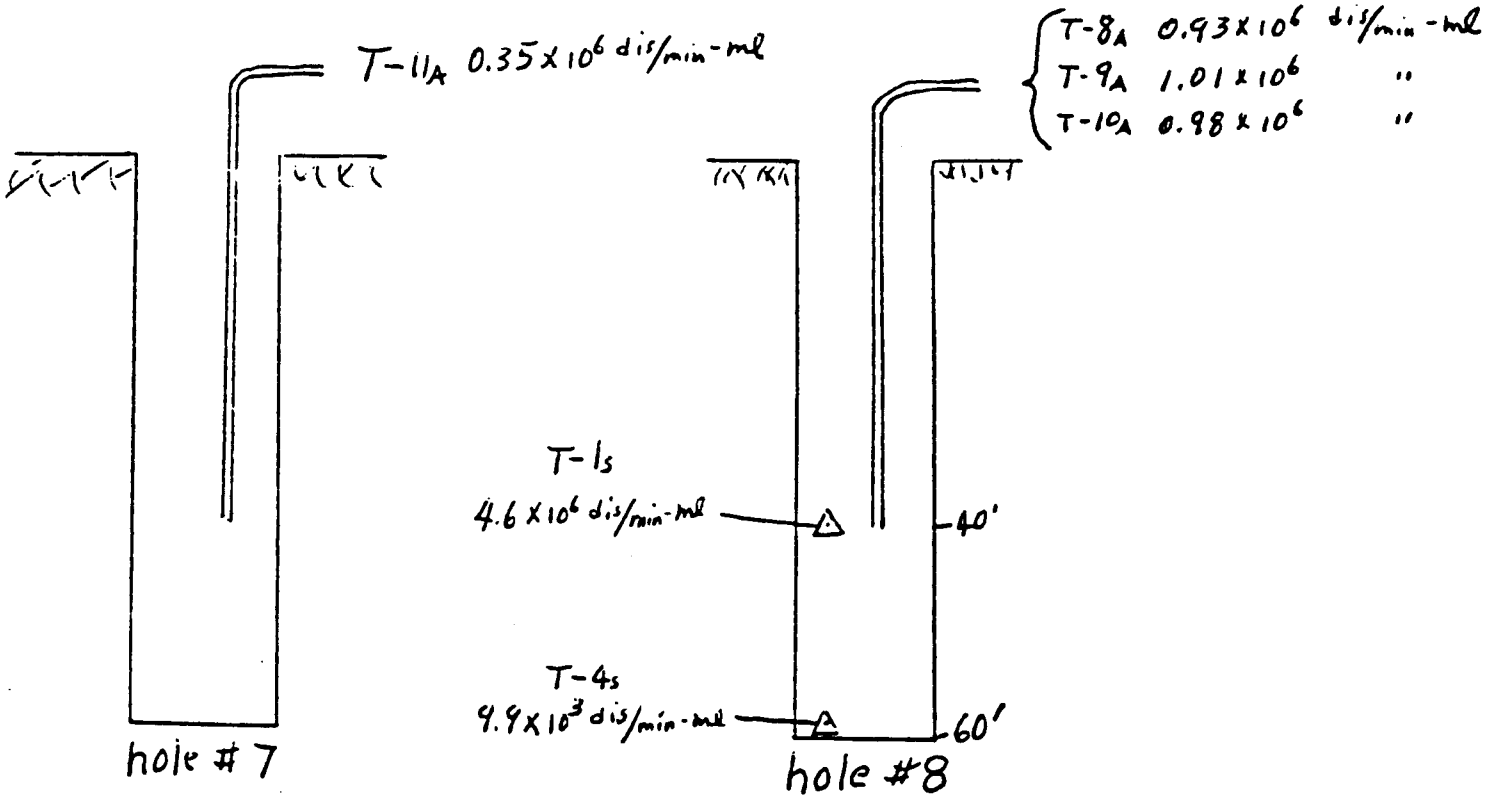
Jack W. Aeby

JWA:mtj

Enc. Chart

Area "H"





Soil Sample location △

Shaft 8 Area H excavated Sept. 25-30, 1973

Depth		% H_2O by wgt.	H^3 content PCi/liter
5'		2.0	$1.35946 \times 10^8 \pm 2.9 \times 10^6$
10'		2.3	$1.33645 \times 10^8 \pm 2.8 \times 10^6$
12'	Pile	2.6	$1.69422 \times 10^8 \pm 3.6 \times 10^6$
12'	loose	2.1	$9.70008 \times 10^8 \pm 2.1 \times 10^6$
12'	rock	2.0	$1.06533 \times 10^9 \pm 2.2 \times 10^6$
15'		1.7	$7.89482 \times 10^8 \pm$
19'	soft	.4	$1.31754 \times 10^9 \pm 2.7 \times 10^7$
20'		.5	$1.610954 \times 10^9 \pm 3.3 \times 10^7$
25'		.8	$1.72580 \times 10^9 \pm 3.7 \times 10^7$
30'		.2	$1.24583 \times 10^9 \pm 2.6 \times 10^7$
35'	Very soft	.5	$8.87258 \times 10^8 \pm 1.9 \times 10^7$
40'		.5	$3.65550 \times 10^8 \pm 7.6 \times 10^6$
45'		.5	$1.86000 \times 10^8 \pm 3.9 \times 10^6$
50'		.3	$1.58442 \times 10^8 \pm 3.3 \times 10^6$
55'		.3	$4.2835 \times 10^7 \pm 1.0 \times 10^6$
60'		.5	$2.5446 \times 10^7 \pm 5.4 \times 10^5$

Area, background + transpiration samples
@ Area H

9-27-73

SOILS	Tritium content - pCi/liter
Soil @ fence	$7.7900 \times 10^4 \pm 1.8 \times 10^3$
Soil 20' South of fence	$7.3800 \times 10^4 \pm 1.7 \times 10^3$
Soil 75' S of fence	$3.0800 \times 10^4 \pm 1.1 \times 10^3$
Soil 150' S. of fence	$3.400 \times 10^3 \pm 4.0 \times 10^2$
Background soil	$2.4000 \times 10^4 \pm 7.0 \times 10^2$
TRANSPIRATION	
Mountain Daisy near Shaft 8	$3.412 \times 10^6 \pm 7.2 \times 10^4$
Weed near Shaft 8	$2.789 \times 10^6 \pm 5.9 \times 10^4$
Pinon 60' East of SW corner of fence	$6.100 \times 10^3 \pm 4.0 \times 10^2$
Cedar 60' E of SW corner of fence	$2.181 \times 10^6 \pm 4.6 \times 10^4$
Cedar 65' West of SE corner of fence	$1.397 \times 10^6 \pm 3.0 \times 10^4$
Pinon - Background	$2.400 \times 10^3 \pm 3.0 \times 10^2$
Cedar - Background	$2.300 \times 10^3 \pm 3.0 \times 10^2$
Background Weeds	$2.000 \times 10^3 \pm 3.0 \times 10^2$
Background Mountain Daisy	$2.100 \times 10^3 \pm 3.0 \times 10^2$

Tritium in pile @ Area H in PCi/liter

Date	Surface	0-1 H	1-3 H	3-4 H	0-1 V	1-3 V	3-4 V	Average
9-73								
10-5-73	$7.9803 \times 10^7 \pm 4.0 \times 10^6$	$1.07694 \times 10^8 \pm 2.3 \times 10^6$	$1.88289 \times 10^8 \pm 4.0 \times 10^6$	$1.19081 \times 10^8 \pm 2.5 \times 10^6$	$7.6287 \times 10^7 \pm 1.6 \times 10^6$	$2.20052 \times 10^8 \pm 4.6 \times 10^6$	$2.70317 \times 10^8 \pm 5.7 \times 10^6$	$1.63318 \times 10^8 \pm 3.7 \times 10^6$
10-18-73	$3.0753 \times 10^7 \pm 6.5 \times 10^5$	$5.4444 \times 10^7 \pm 1.2 \times 10^6$	$8.7683 \times 10^7 \pm 1.9 \times 10^6$	$8.2521 \times 10^7 \pm 1.7 \times 10^6$	$5.4573 \times 10^7 \pm 1.2 \times 10^6$	$1.27797 \times 10^8 \pm 2.7 \times 10^6$	$1.90520 \times 10^8 \pm 4.0 \times 10^6$	$9.3754 \times 10^7 \pm 2.0 \times 10^7$
10-30-73		$7.4870 \times 10^7 \pm 1.6 \times 10^6$	$9.0623 \times 10^7 \pm 1.9 \times 10^6$	$1.00212 \times 10^8 \pm 2.1 \times 10^6$	$8.0497 \times 10^7 \pm 1.7 \times 10^6$	1-4 V $1.11947 \times 10^8 \pm 2.4 \times 10^6$		9.6583×10^7

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO

OFFICE MEMORANDUM

TO : Dean D. Meyer, Group Leader, H-1 DATE: July 7, 1970

THRU : William R. Kennedy, Group Leader, H-6 WRK.

FROM : William D. Purtymun, H-6

SUBJECT: MIGRATION OF TRITIUM IN SHAFT DISPOSAL AREA, TA-54, AREA "G"

SYMBOL : H-6

Samples of tuff were collected during the drilling of shafts 34 through 48. Tritium analyses of the moisture content from the samples as well as moisture content are shown on the attached table. Also enclosed is a sketch map showing location of shafts.

Laboratory analyses of three samples of tuff from a depth of 25 feet indicated the following hydrologic properties.

Porosity	Specific Retention	Specific Yield
	(percent by volume)	
44	17	27
37	20	17
36	18	18

The moisture content of the tuff ranged from 0.1 to 6.4 % with an average of 1.2 percent by volume.

The tritium concentrations from samples collected from shaft 34 (November 1969) located about 55 feet east of existing shaft 14 ranged from 62 to 454 x 10^{-6} μCi/ml of moisture.

The concentrations in samples from shafts 35 to 38 located about 80 feet south of shaft 14 ranged from 0 to 106 x 10^{-6} μCi/ml of moisture.

High tritium concentrations (range 1,779 to 1,180,630 x 10^{-6} μCi/ml of moisture) were found in samples collected from shafts 39 through 48 which are located in a line about 6 feet east of shafts 4 through 13 that are filled with wastes.

The low moisture content of the tuff indicates that the tritium is being distributed through the pore space of the tuff as well as joints or fractures by diffusion in a water vapor. There is probably some moisture gradient (greater in the wastes themselves) which will aid in the outward movement of the tritium as the volumes of greater moisture seek equilibrium in the tuff. There appears to be little if any pattern in the distribution of the tritium, probably due in part varying concentrations buried at various depths within the shafts and in part to a possible distribution that could be joint controlled.

In talking to Jack Healy there was some question as to if the moisture distilled from the tuff for analyses was in part bound water or water of crystallization. I ran a few tests and as near as I could determine the moisture distilled from the tuff was not in the form of bound water or water of crystallization.

Bill

William D. Purtymun

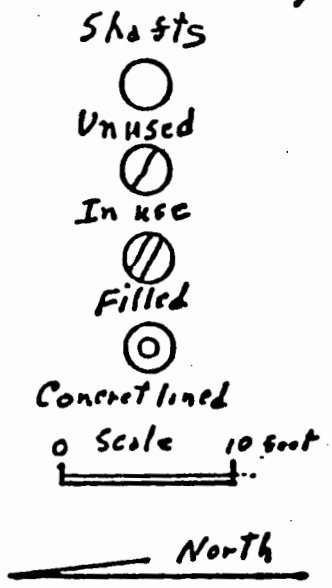
WDP:mtj

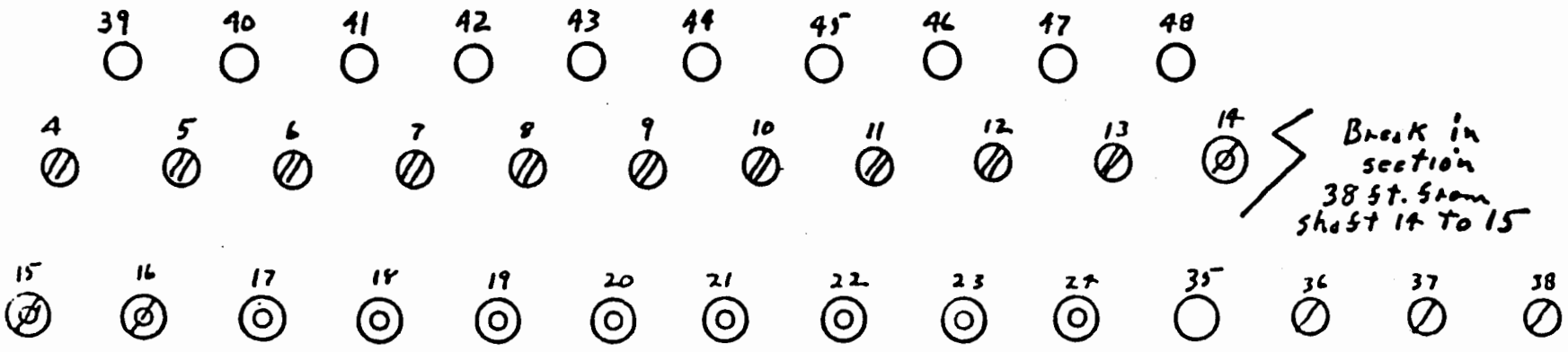
Enc. 1 - Table
1 - Sketch

Table shows percent of moisture and tritium content of moisture in samples of tuff collected from shafts in Area "G", TA-54.

Shaft Number	Depth (feet)	Date Collected	Percent Moisture (by weight)	Tritium μCi/ml of moisture ($\times 10^{-6}$)
34	20	11-7-69	0.4	454 ± 8
34	40	11-7-69	0.1	136 ± 6
34	65	11-7-69	0.3	62 ± 5
35	20	5-26-70	6.4	11 ± 5
35	40	5-26-70	1.2	106 ± 6
36	20	5-27-70	.7	37 ± 5
36	40	5-27-70	1.2	83 ± 6
37	20	5-27-70	.2	7 ± 5
37	40	5-27-70	.6	41 ± 5
38	20	5-27-70	.1	27 ± 5
38	40	5-27-70	.6	0 ± 5
39	25	6-9-70	1.2	52,797 ± 104
40	15	6-9-70	2.0	7,374 ± 32
40	25	6-9-70	1.0	15,135 ± 43
41	15	6-9-70	1.1	115,[illegible] ± [illegible]
41	25	6-9-70	1.4	6,833 ± 2[illegible]
42	15	6-9-70	1.4	70,761 ± 140
42	25	6-9-70	.9	10,633 ± 36
43	15	6-10-70	1.2	3,115 ± 20
43	25	6-10-70	.2	23,029 ± 52
44	15	6-10-70	1.6	4,644 ± 22
44	25	6-10-70	.6	1,779 ± 16
45	15	6-10-70	1.0	211,094 ± 414
45	25	6-10-70	.8	178,198 ± 198
46	15	6-11-70	.9	30,828 ± 61
46	25	6-11-70	.5	6,813 ± 29
47	15	6-11-70	.9	220,966 ± 432
47	25	6-11-70	.7	1,180,630 ± 1995
48	15	6-12-70	2.3	170,824 ± 336
48	25	6-12-70	.8	324,832 ± 187

Sketch showing planview of Shafts at TA-54, Area "G"





June 24, 1970

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

OFFICE MEMORANDUM

TO : C. H. Stevens, Eng-2 DATE: February 2, 1971

THRU: W. R. Kennedy, Group Leader, H-6

FROM : William D. Purtymun, H-6

SUBJECT: GEOLOGIC SECTION AT TA-46

SYMBOL : H-6

Shown below is anticipated geologic section which would be encountered by drilling a test hole at TA-46.

ANTICIPATED GEOLOGIC SECTION AT TA-46 ELEVATION 7,120 FEET

Geologic Unit	Thickness (Feet)	Depth (Feet)
Bandelier Tuff		
Tshirege Member		
Unit 3 - non to moderately welded tuff	85	85
Unit 2 - Moderately welded tuff	140	225
Unit 1 - non to moderately welded tuff	100	325
Otowi Member		
non to moderately welded tuff	340	665
Guaje Member		
Pumice	35	700
Puye Formation		
Conglomerate	70	770
Basaltic rocks of Chino Mesa		
Basalt and interbedded sediments	190	960
Puye Formation		
Conglomerate	300±	1260±

The section is based on log of Supply Well PM-2 in Pajarito Canyon and Test Well 8 in Mortandad Canyon. A magnetic survey that was run from near Well PM-2 to about 0.5 west of TA-46 did not show any significant anomalies that would indicate a basalt high in the area.

TO: C. H. Stevens, Eng-2 DATE: February 2, 1971

Test drilling on the Pajarito Plateau has not [illegible] ground water in the Bandelier Tuff. The top of [illegible] is estimated to be at a depth of about 1,160 feet [illegible] at TA-46.

William D. Purtymun

cc: F. J. Zimmerman, Eng-2

Dwitymun

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

OFFICE MEMORANDUM

TO : Vernon J. Stephens, Eng-2 DATE: April 28, 1971

FROM : William D. Purtymun, H-8 WDP

SUBJECT: RESULTS OF TEST DRILLING AND PENETRATION TESTS AT AREA "C"

SYMBOL : H8-M-2124

Twelve test holes ranging in depth from 5 to 25 feet were drilled in Solid Waste Disposal Area "C", on April 14 and 15,1971. Enclosed are the results: geologic logs, penetration tests, moisture content of soil, fill, or tuff, and a particle distribution analyses of the soil.

Tests at the 120 SW guy indicated that the location is underlain by a disposal pit, probably the chemical pit. No holes were drilled at the 240N guy, 120N guy or the 120SE guy.

Robert Sandoval, H-1, monitored cuttings from all holes drilled. No radioactive contamination was detected.

Notes:

1. - "N" is equal to the number of blows required to drive a 2-inch outside diameter by 1.375-inch outside diameter standard split spoon sampler through a vertical distance of one foot using a 140 lb. hammer with a free fall of 30 inches.

2. - Penetration count at 6 inch interval.

3. - Natural or existing moisture content of recovered core of soil, fill, or tuff is listed to right of penetration test results. Moisture contents are circled and are in percent moisture by weight.

4. - General description of soil, fill, and tuff

Soil, weathered in place, light brown, containing small crystal fragments of quartz and sanidine, rock fragments of tuff, pumice, latite, and rhyolite generally less than 1-inch in diameter in soil matrix (see particle size distribution).

Fill, reworked material consisting of pebble, cobble to boulder size fragments of tuff in a matrix of soil.

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

TO: Vernon J. Stephens 2- DATE: April 28, 1971
H8-M2124

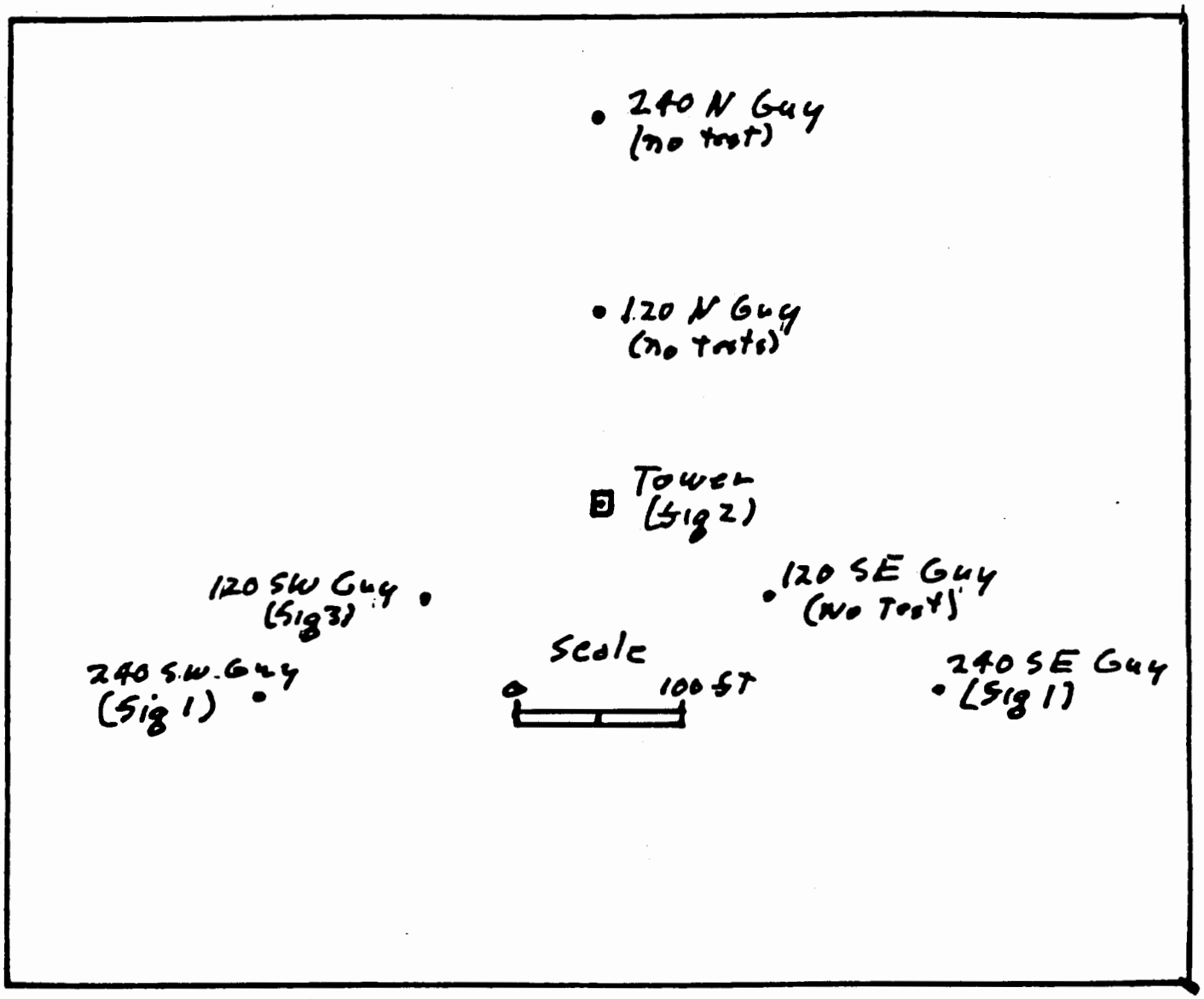
Tuff beneath the soil zone is weathered, consisting of crystal and crystal fragments of quartz and sanidine with small rock fragments of latite, rhyolite and pumice in a light brownish gray ash matrix. Pumice fragments are weathered to a light brown and are less than 1 inch in length. The unweathered tuff at depth (hole C, Fig. 2) same as above except ash matrix and pumice fragments are unweathered; matrix light gray; pumice fragments, dark gray.

5. - Particle size Distribution of Soil

Classification	Particle Diam. mm	Distribution Wt. %
Silt and clay	<0.062	8
Very fine sand	0.062 - 0.125	4
Fine Sand	0.125 - 0.250	7
Medium Sand	0.250 - 0.500	9
Coarse sand	0.500 - 1.00	16
Very coarse sand	1.00 - 2.00	11
Gravel	>2.00	45

WDP:et

cc: Roland Pettitt, Zia Engineering



Lay out of guy and tower
at Area "C"

Index of Tests

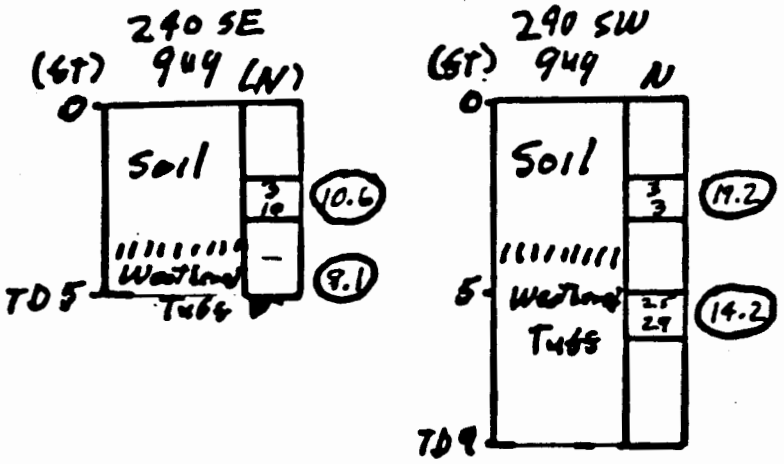
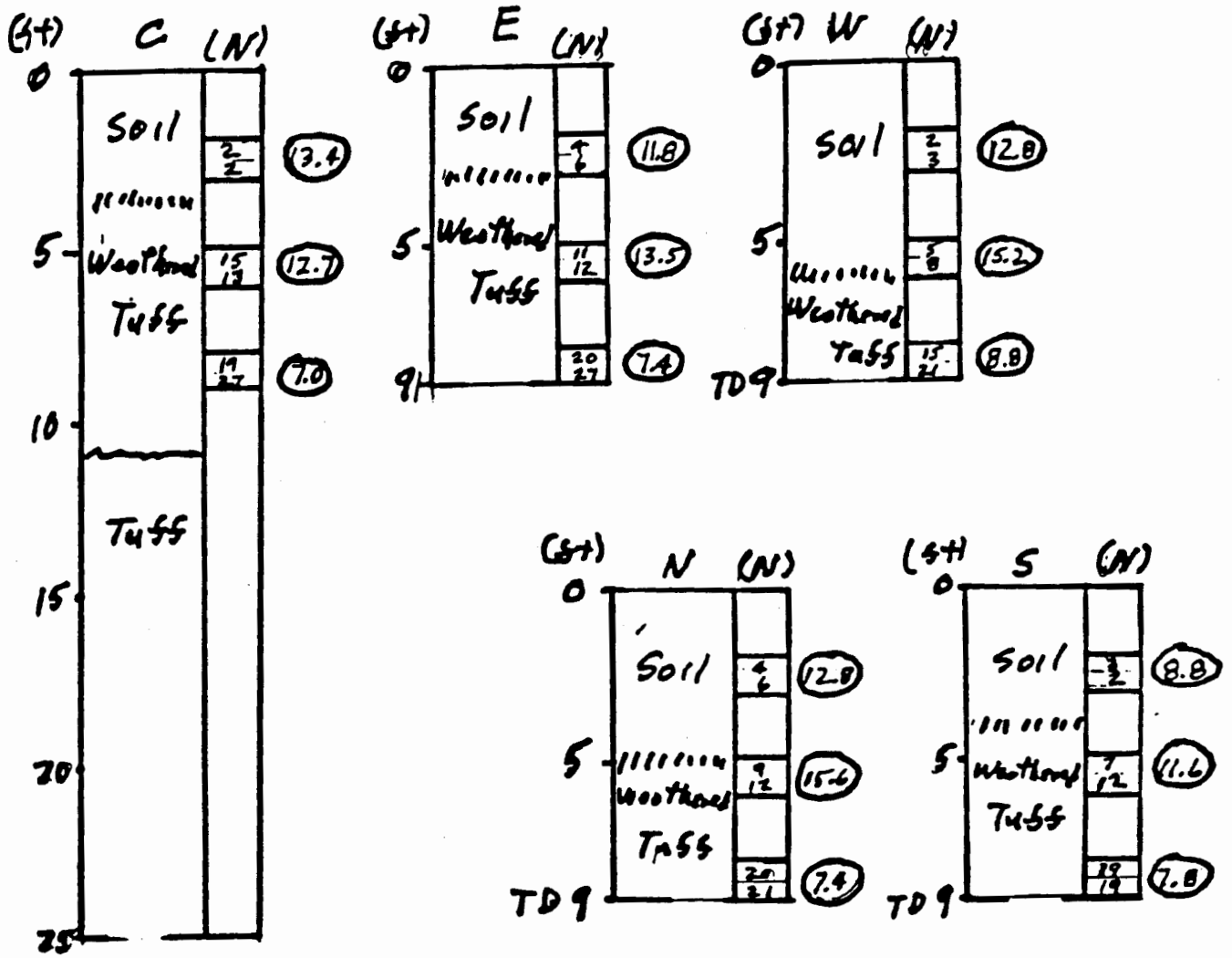
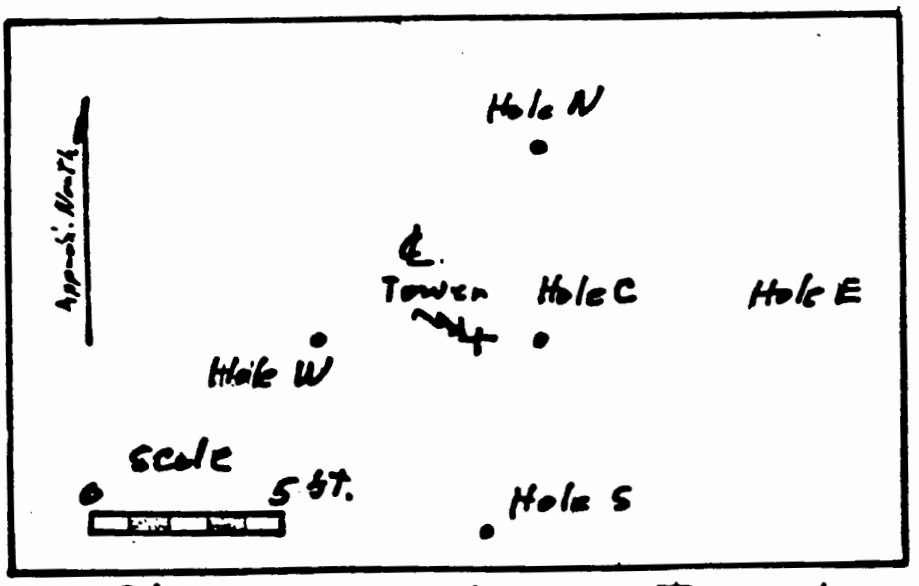


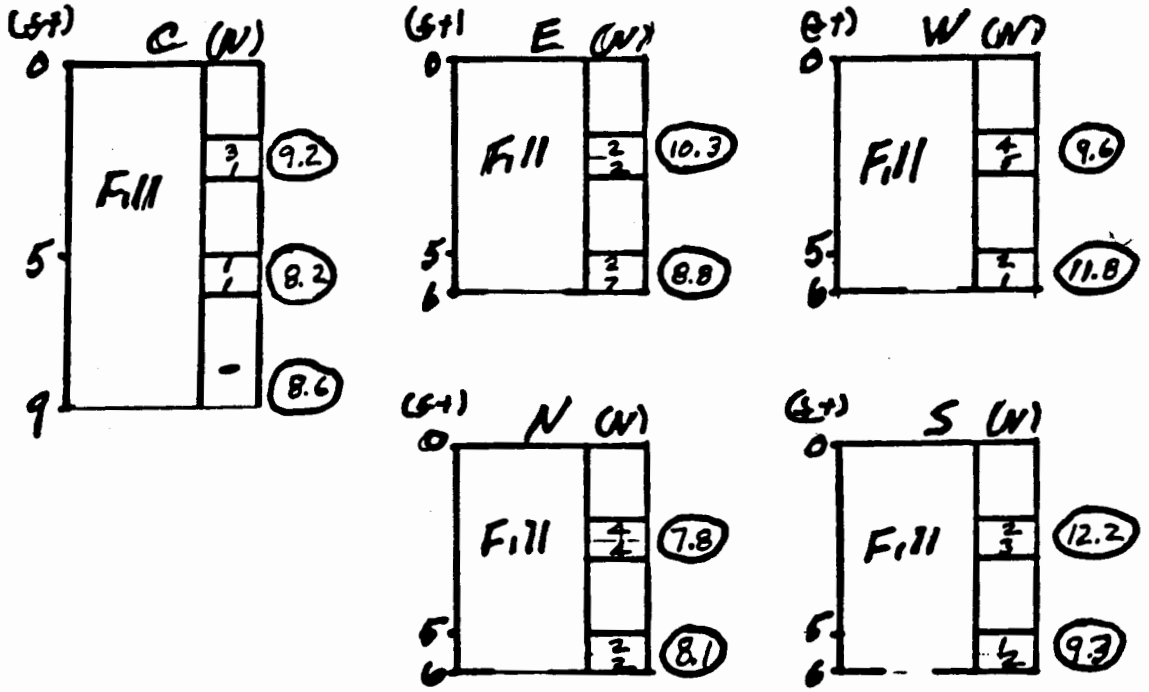
Fig 1.- Details of Tests

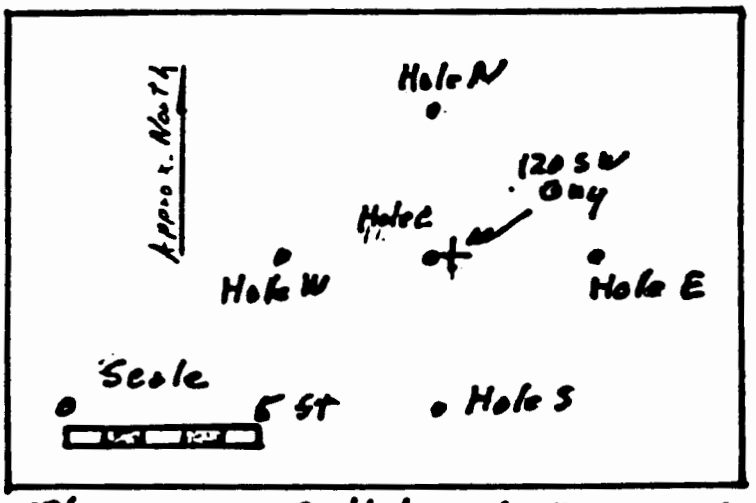




Planview of Hole at Tower Base

Fig. 2 Details of Tests





(Plan view of Holes at 120 SW Guy

Figure 3:- Details of testing

S ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

OFFICE MEMORANDUM

TO : John Enders, H-1, CMR Bldg. DATE: July 26, 1971

FROM : Harry S. Jordan, H-8

SUBJECT: SURVEY OF STORAGE PITS, TA-54

SYMBOL : H8-M2210

A survey was made of pits 8, 12, 16, 17, and 21 at TA-54, Area G on July 20, 1971. The survey, in response to your memo June 1, 1971, was made to determine if the pits conformed to guidelines for pit construction as outlined in a memo from F. C. Koopman, USGS to S. E. Russo, Eng-3 dated June 30, 1965.

1. - The pits inspected were 50 feet from the canyon rim.

2. - Maximum depths of the pits were above adjacent canyon floors.

3. - Generally the pits were laid out with long dimension parallel to surface topographic contours. Pit 21, the long dimension is at right angles to the contours. When the pit is filled, a greater thickness of seal material should be used to cover the wastes to prevent erosion from forming gullies down the long dimension.

4. - There are numerous joints and fractures in the walls of the pits. Joint frequency is about 1 joint per 6 ft. of wall in the pits. This is about the same joint frequency as found in other pits in the area. Most of the joints are vertical or near vertical ranging from 70 to 90 degrees from a horizontal plane The joint ranged from clay filled to open. The only joint that will need attention is in pit 17 about 265 ft. from the NW corner on the SW wall. The joint opening, strikes 75° to 80° NW and is open 2 to 5 inches, extends 4 to about 12 ft. below the rim of the pit. Joint opening is near vertical. The opening can be filled and plugged when wastes in the pit are laid up to this level.

Pits 8, 12, 16, and 21, cut through two ashflows in Unit 2b. The contact is characterized by increase in size of pumice fragments and thin layers of reworked sediments. Pit 17 is within the lower ashflow. It was noted in several of the pits that the thin sediments in the contact

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

TO: John Enders, H-1 2 DATE: July 26, 1971

were offset several inches along near vertical joints cutting both ashflows. The offset is probably caused by compaction of the lower flows. This is general information and does not effect the use of the pits for disposal of wastes.

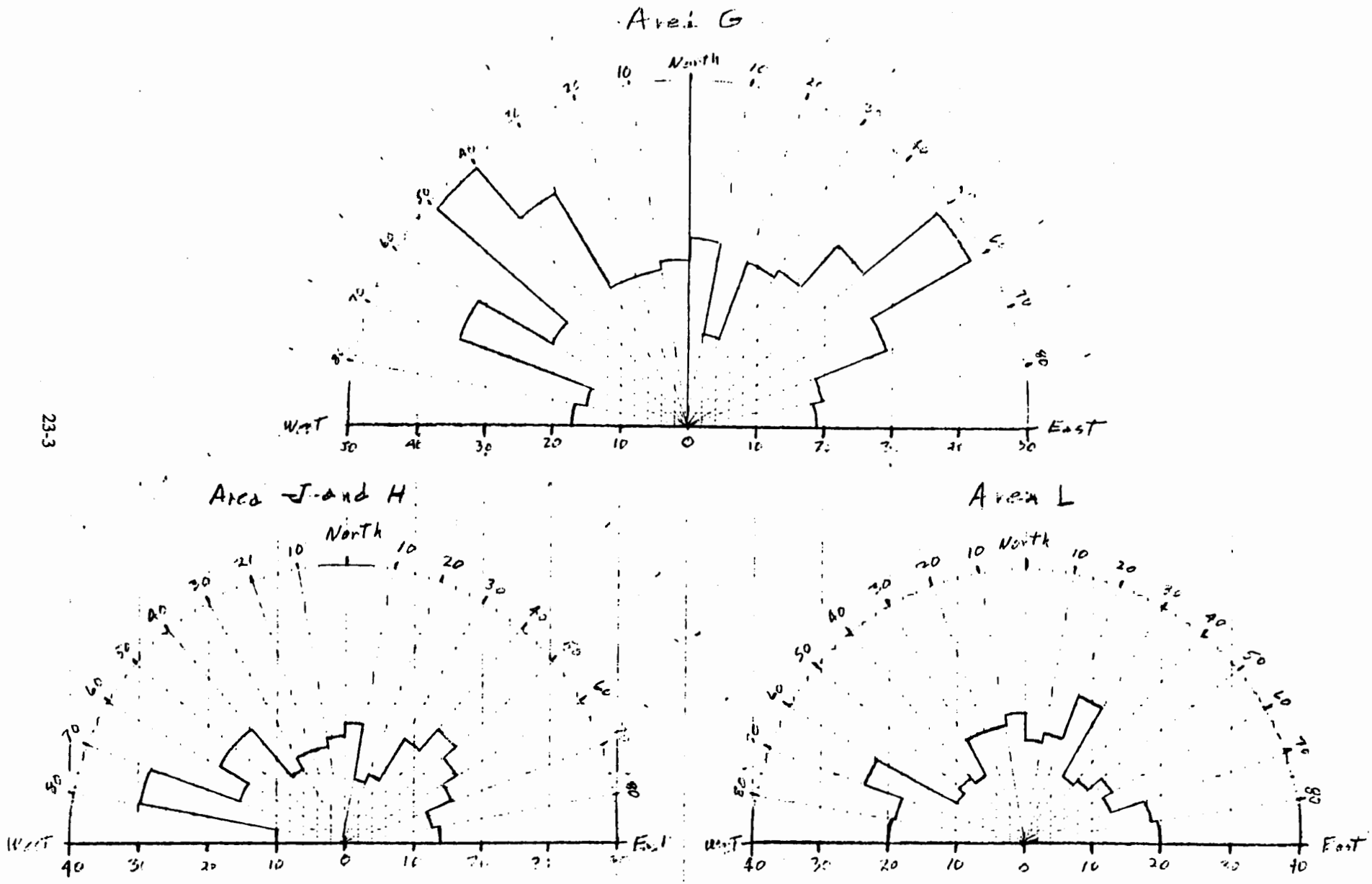
5. - Recent rains have produced small amounts of runoff which has entered the ramp on the NW ends of pits 8 and 17. Runoff should be diverted from the pits. Pit 17 will probably experience some sheet wash runoff into the pit along the SW wall. In the future tuff excavated from the pits should be piled up gradient from the pit to prevent runoff along the walls.

Unless noted, the pit construction meets the suggested guidelines as presented in the letter of June 30, 1965.

As per conversation with W. D. Purtymun on July 20, 1971, photographs of the walls and bottoms of the pits should be obtained for the record prior to the disposal of any wastes in the pits.

Harry S. Jordan
Group Leader H-8

HSJ:WDP:et
cc: W. D. Purtymun



Joint Orientation
Areas G and H, and Area L TA-51 7/1970

Waste Storage at Areas H, J, and L, TA-54

Mesita del Buey

H-8

October 22, 1971

Compiled
by
William D. Purtymun

CONTENTS

Introduction 1

Area H..... 4

Area J..... 5

Area L 5

Waste Storage and Geohydrologic Environment 8

References..... 10

Appendix A..... 11

Appendix B..... 13

ILLUSTRATIONS

Figure 1. - Geologic Map and Section of Mesita del Buey..... 2

Figure 2. - Entrance to TA-54, Area H in background... 3

Figure 3. - Area H enclosed in security fence, shaft covers to right..... 3

Figure 4. - Area H, south of wall of Shaft 8 showing vertical joint from a depth of 30 feet..... 6

Figure 5. - Area J, pit filled and sealed with tuff..... 6

Figure 6. - Area H pit in use, wastes to left, layers of wastes covered with tuff in bottom and sides of pit.... 7

Figure 7. - Area L pit in use water tank for fire protection..... 7

Waste Storage at Areas H, J, and L, TA-54

Mesita del Buey

Introduction

Mesita del Buey is a narrow southeastward trending mesa located about 4 miles southeast of the community of Los Alamos. The main aquifer of the area lies at a depth of about 1,050 feet below the surface of the mesa at Area H and at a depth of about 950 feet at Area L. Surface drainage from the mesa is into Pajarito Canyon to the south and an unnamed canyon to the north that is tributary to Canada del Buey (Fig. 1). Stream flow in Pajarito Canyon and Canada del Buey is intermittent, occurring occasionally during the summer from heavy thunder showers activity. Both canyons are tributary to the Rio Grande.

Pajarito Canyon has a large drainage area as it heads on the mountain to the west. As a result the alluvium in the canyon contains water that is recharged from intermittent flow on the flanks of the mountain. Canada del Buey has a small drainage area and contains no water in the thin alluvium in the canyon. Test drilling indicates no water occurring beneath the mesa and the top of the main aquifer.

The surface of the mesa where the storage area is located is covered with a clay-like soil and is underlain by a series of ashflow and ashfall of dry rhyolite tuff. The tuff is underlain by volcanic flow rocks of basalt and sediments. For a detailed description of the geology and hydrology of the mesa see Los Alamos Scientific Laboratory Report LA-4660.[1/]

Area H is used for the storage of classified materials. Area J is used for storage of material contaminated by explosive chemical while Area L is used for storage and chemical and toxic wastes.

Access to TA-54 is off Pajarito Road about 0.5 west of TA-18. The mesa is fenced from Canyon to Canyon with a 5 strain barb wire fence (Fig. 2). Access is controlled by SP-Division and H-Division.

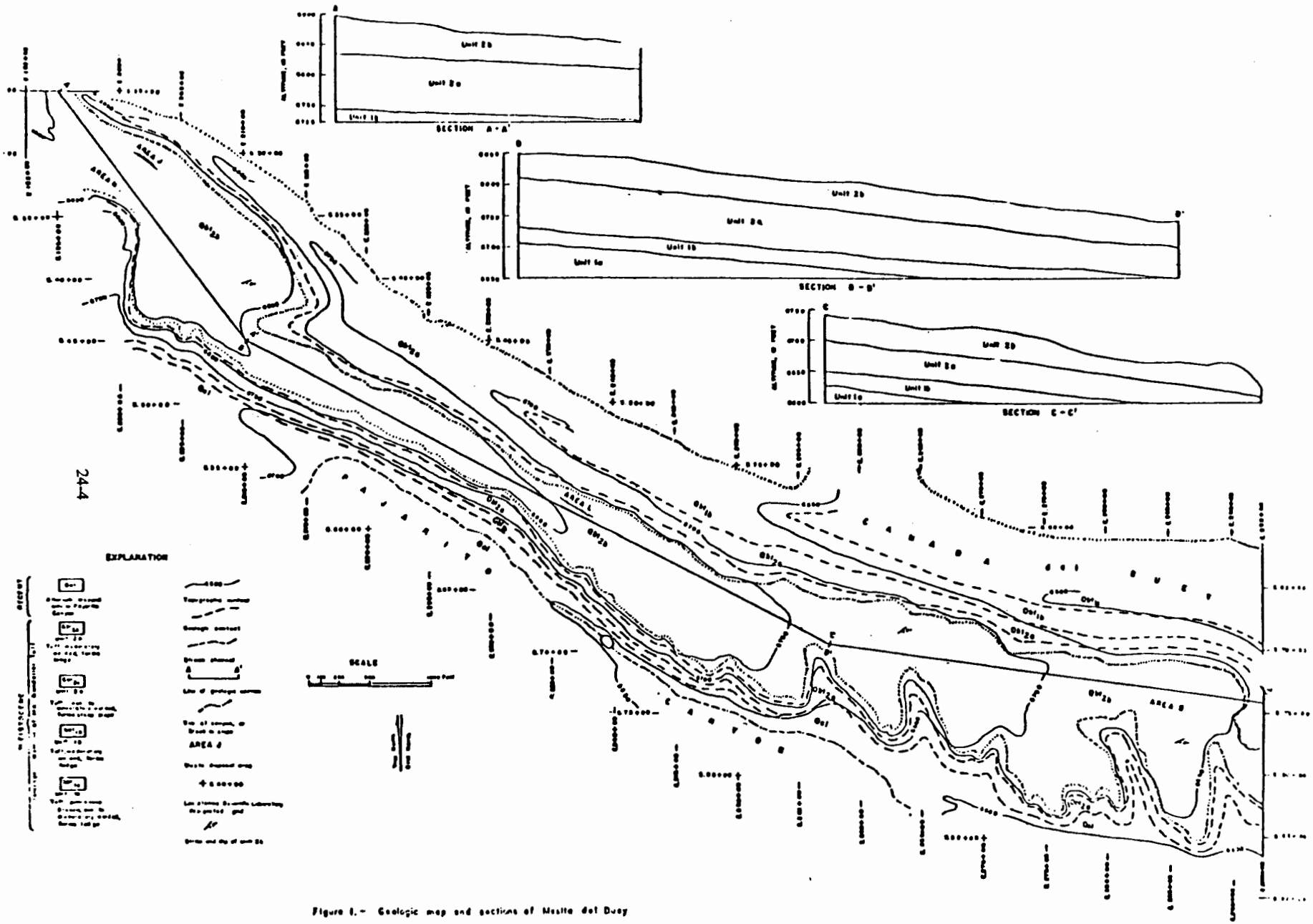


Figure 1.- Geologic map and sections of Mesita del Buey

Figure 2. - Entrance to TA-54, Area H in background.

Figure 3. - Area H, enclosed in security fence shaft cover to right.

The purpose of this report is to outline the geologic and hydrologic environment at each of the areas in reference to possible transport of waste material into the environment beyond the storage areas.

Pits and shafts on Mesita del Buey are constructed according to guidelines set up by the H-Division and Eng. Divisionof the Los Alamos Scientific Laboratory and the U. S. Geological Survey. The guidelines cover construction burial of wastes, and surface seal of pits are designed to prevent the migration or transport of waste materials of the environment. Guidelines are found in Appendix A, report LA-4660.[1/]

AREA H

Area H is used for the storage of classified materials. The materials are placed in 6 foot diameter shafts about 60 feet deep.[2/] The shaft currently in use has a cover that is locked except when materials are being placed in the shaft (Fig. 3). The shafts are filled 5 to 6 feet of the surface and then capped with concrete.

The surface of the mesa at Area H slopes gently southeastward with the drainage into Pajarito Canyon. The mesa is underlain by about 590 feet of dry tuff and 460 feet of dry volcanic flow rocks. The main aquifer of the Los Alamos area lies at a depth of about 1,050 feet below the surface of the mesa.

The shafts are completed in the tuff, penetrating Unit 2b and into the top of Unit 2a (Fig 4). Analyses of moisture distilled out of the tuff for tritium indicated that some migration of tritium with water vapors through the tuff (Appendix I). The extent of the migration of tritium or shaft containing the tritium has not been determined. The tritium is migration with the material moisture in the tuff (generally less than 1 percent moisture by weight of the tuff). The 1,050 feet of dry tuff, volcanic rocks and sediments overlying the main aquifer are of sufficient thickness to conclude the migration in the vapor phase from the shafts to the main aquifer will not occur. The tritium is being released to the atmosphere by transpiration through plants and trees as well as evaporation from the surface soil in the area (Appendix II).

The area is enclosed with a security type fence with access controlled by SP Division.

AREA J

Area J is used for the storage of wastes contaminated by explosive chemicals. The waste consists mainly of equipment or solid materials that are contaminated or are suspected to be contaminated. No explosives are placed in the pits. The area contains two pits. One filled and sealed (Fig. 5) and the other in use (Fig. 6). The pits are 50 feet wide, 250 feet long and about 15 feet deep. There are ramps at the long dimension of the pit.

The wastes are buried in layers with each successive layer covered with 0.5 to 1 foot of tuff. This prevents fire and some scourging of the wastes by the public until the final seal is put on the pit.

The surface of the mesa slopes gently to the north with drainage into an unnamed canyon to the north of Mesita del Buey that is tributary to the Canada del Buey to the east. The mesa is underlain by about 575 feet of dry tuff and about 465 feet of dry volcanic flow rocks and sediments. The main aquifer of the Los Alamos Area lies at a depth of about 1040 feet below the surface of the mesa. The pits are completed into the top of Unit 2b of the Tshirege Member of the Bandelier tuff. The soil thickness in the area of the pit ranges from about 0.5 to about 1.5 feet.

The area is open access to the public. The only fence is a locked gate at entrance to TA-54.

AREA L

Area L is used for the storage of chemicals or toxic materials. The wastes consist of solid chemical liquids. Liquid chemicals are usually in laboratory size that have become out of date. The actual quantity of fluid is low. The storage area consists of a pit that is 12 feet wide, 200 feet long and about 12 feet deep with ramps on the long dimension.[4/] One shaft 6 feet in diameter and 60 feet deep is located in the southeast corner of the area (Fig. 7).

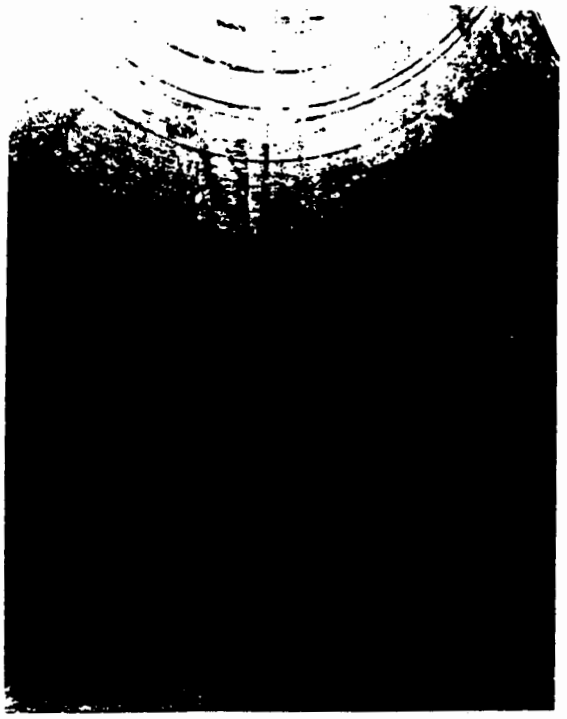


Figure 4. - Area H, South wall of shaft 8 showing vertical joint from a depth of 30 feet.

Figure 5. - Area J, pit filled and sealed with tuff.

Figure 6. - Area H pit in use, wastes to the left, layers of wastes covered with tuff in sides and bottom of pit.

Figure 7. - Area L pit in use, water tank for fire protection.

into an unnamed canyon north of Mesita del Buey that is tributary to Canada del Buey to the east. The mesa is underlain by about 340 feet of dry tuff and 610 feet of dry volcanic flow rocks and sediments. The main aquifer of the area lies at a depth of about 950 feet below the surface of the mesa. The pit is completed into the top of Unit 2b of the Tshirege Member of the Bandelier Tuff while the shaft extends through Unit 2b into the top of Unit 2a. The soil thickness in the pit area averages about 1 foot.

The entire area is enclosed with a security type fence and access is controlled by H-Division.

WASTE STORAGE AND THE GEOHYDROLOGIC ENVIRONMENT[1/]

Total containment of contaminants is of paramount importance in the disposal of wastes at Mesita del buey. Initial containment is accomplished with the burial of wastes in pits or shafts. After burial, the major means of transport of contaminants to the environment would be in the hydrologic cycle.

Transport of contamination by surface runoff on the mesa seems unlikely because the wastes are buried.

Little if any water from precipitation or surface runoff infiltrates through the seal material overlying wastes in filled pits. There is not enough water to leach the contaminants from the wastes and move them into the tuff. The bottoms of the pits are underlain by about 500 feet of tuff at Area H to about 340 feet of tuff at Area J. The hydrologic characteristics and conditions of the soil, seal material, and tuff indicate no recharge to the stream-connected aquifers or main aquifer through the surface soil, buried wastes, or underlying tuff at Mesita del Buey.

The natural moisture content of the unsaturated tuff is in the range in which moisture is redistributed by diffusion. Contaminants may be transported by diffusion if gases or volatile fluids are placed in shafts or pits. Diffusion may take place through the tuff where there are large amounts of pore space, through open joints, or along contacts between ashflows.

The physical and hydrologic characteristics of the tuff are ideal for the storage receptacles for the wastes in Areas L, H, and J. There is no hazard to the environment by use of these storage areas. The wastes are contained within the storage area.

REFERENCES

1/ W. D. Purtymun and W. R. Kennedy, "Geology and Hydrology of Mesita del Buey," Los Alamos Scientific Laboratory Report LA-4660.

2/ Materials Disposal Area H, Los Alamos Scientific Laboratory Eng-R-3647.

3/ Materials Disposal Area J, Los Alamos Scientific Laboratory Eng-R-3648.

4/ Materials Disposal Area L, Los Alamos Scientific Laboratory, Eng-R-3650.

APPENDIX A

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO

OFFICE MEMORANDUM

TO : William R. Kennedy, Group Leader, H-6 DATE: November 21, 1969

FROM : Jack W. Aeby, H-6

SUBJECT: PERMEABILITY OF THE TUFF TO WATER VAPOR

SYMBOL : H-6

In order to establish a background bore line for tritium samples taken from test borings around the DP slurry dump holes, advantage was taken of the fact that drillers were in the process of boring a new 8 ft. diameter hole in Area "H", the classified shops disposal area. When we arrived at this area in the afternoon of November 6, we found them bailing out the loose tuff from the 40 ft. depth. We simply bagged a few handfuls of the loose material for our background sample.

Approximately one liter of this material was placed in a two liter beaker and heated to drive off the moisture which was collected on a watch glass cooled with a single ice cube. It required a very high heat to drive off 1 ml of water for our analysis. (This tuff actually gave a slightly negative reading on the moisture balance.) A 500 lambda alliquote of the water was placed in a standard scintillation counting bottle along with 15 ml of scintillation solution for scintillation counting. The counting results showed an activity of 4,586,795.9 ± 8,958.8 dis/min. ml or 69,496.91% RCG. A very surprising result indeed for a background sample. Subsequent repeat counting verified the above values.

The search continues for an adequate background sample. However, our initial failure and subsequent failures have launched us on an interesting experiment to determine the permeability of the local formations to tritium or moisture. The results to date are contained in the enclosed chart.

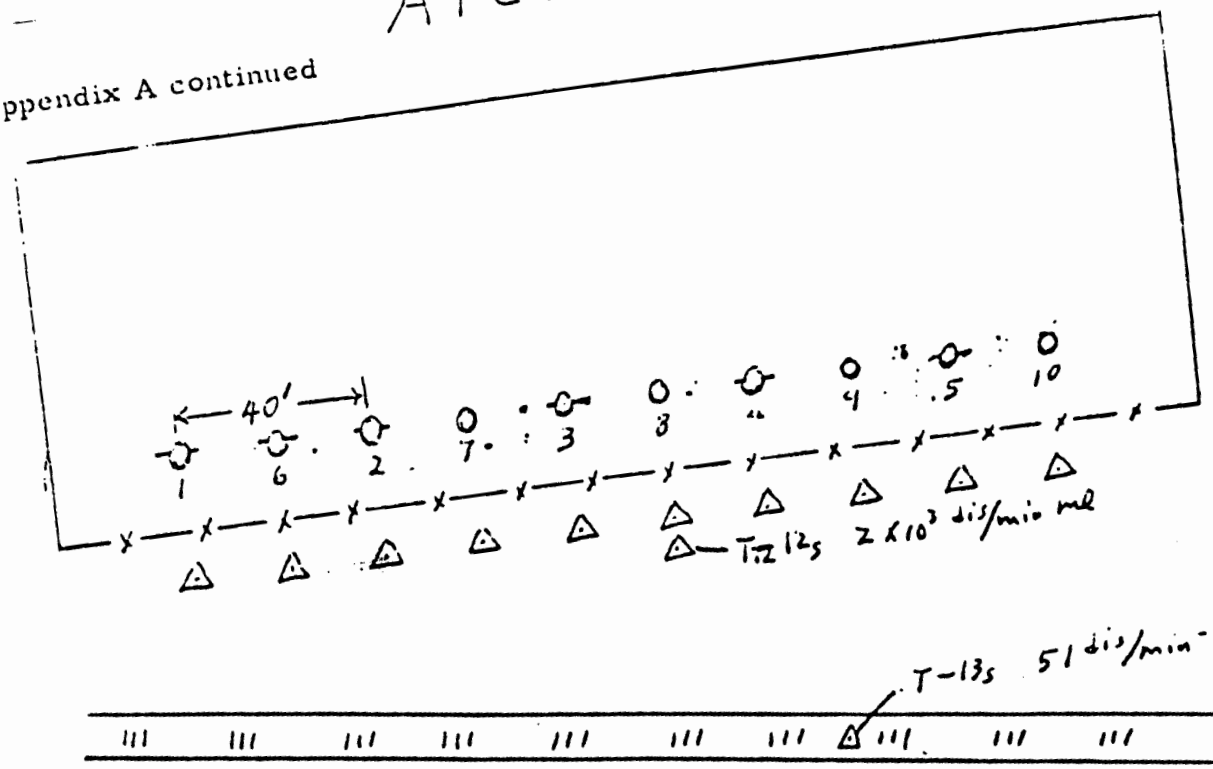
Even though this sample is 69,496.9% RCG for water, one must remember that it is rather difficult to extract from the tuff. Subsequent air samples taken in this same hole at the 45 ft. depth ran a maximum of 118% RCG air, 100% is the concentration in the air one could tolerate with no measurable effects.

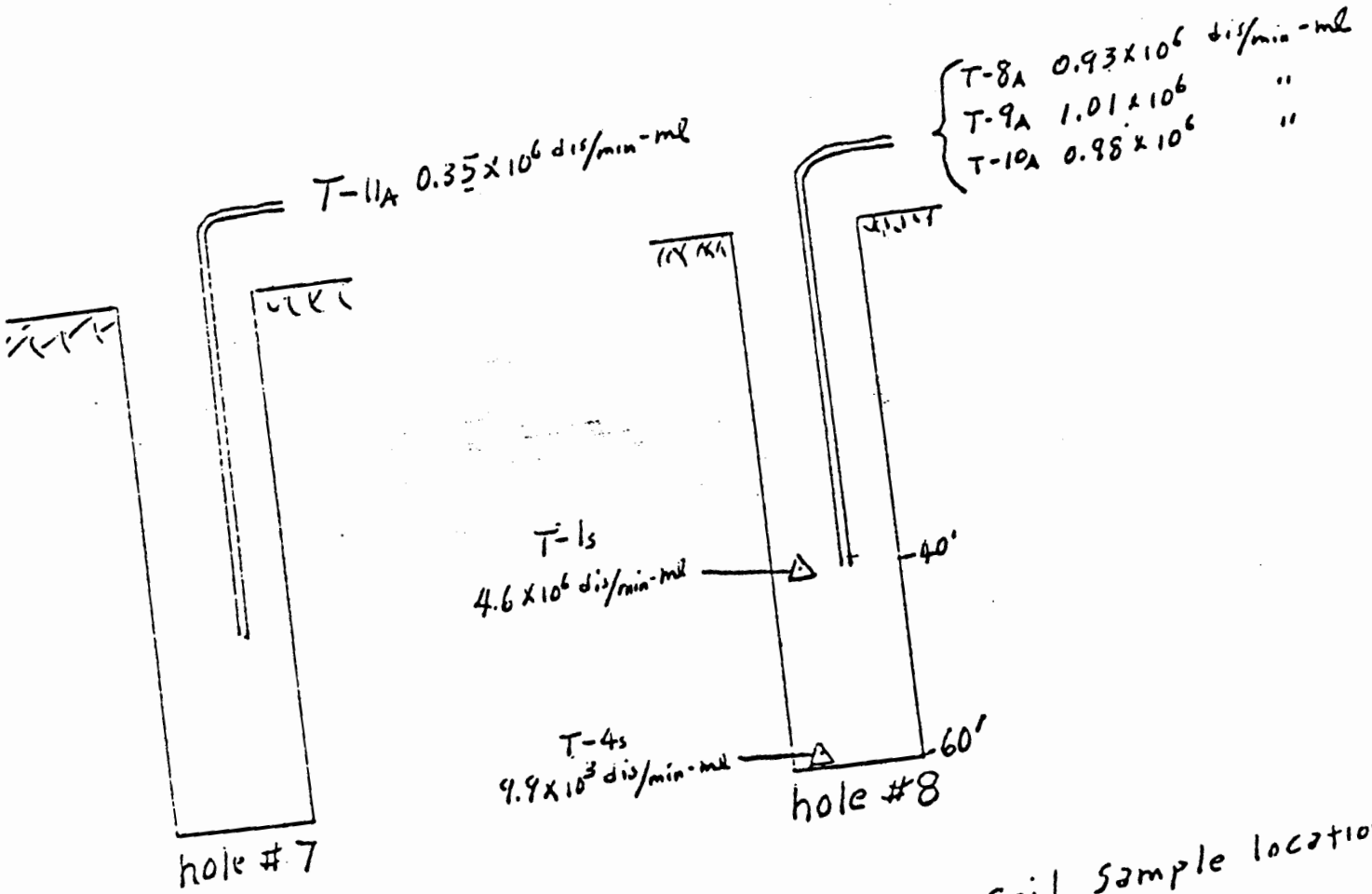
JWA:mtj

Enc. Chart

Area "H"

Appendix A continued





Soil sample location

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO

OFFICE MEMORANDUM

TO : William R. Kennedy, Group Leader, H-6 DATE: December 23, 1969

FROM : William D. Purtymun, H-6

SUBJECT: APPENDIX TO PERMEABILITY OF THE TUFF TO WATER VAPORS (NOVEMBER 21, 1969)

SYMBOL : H-6

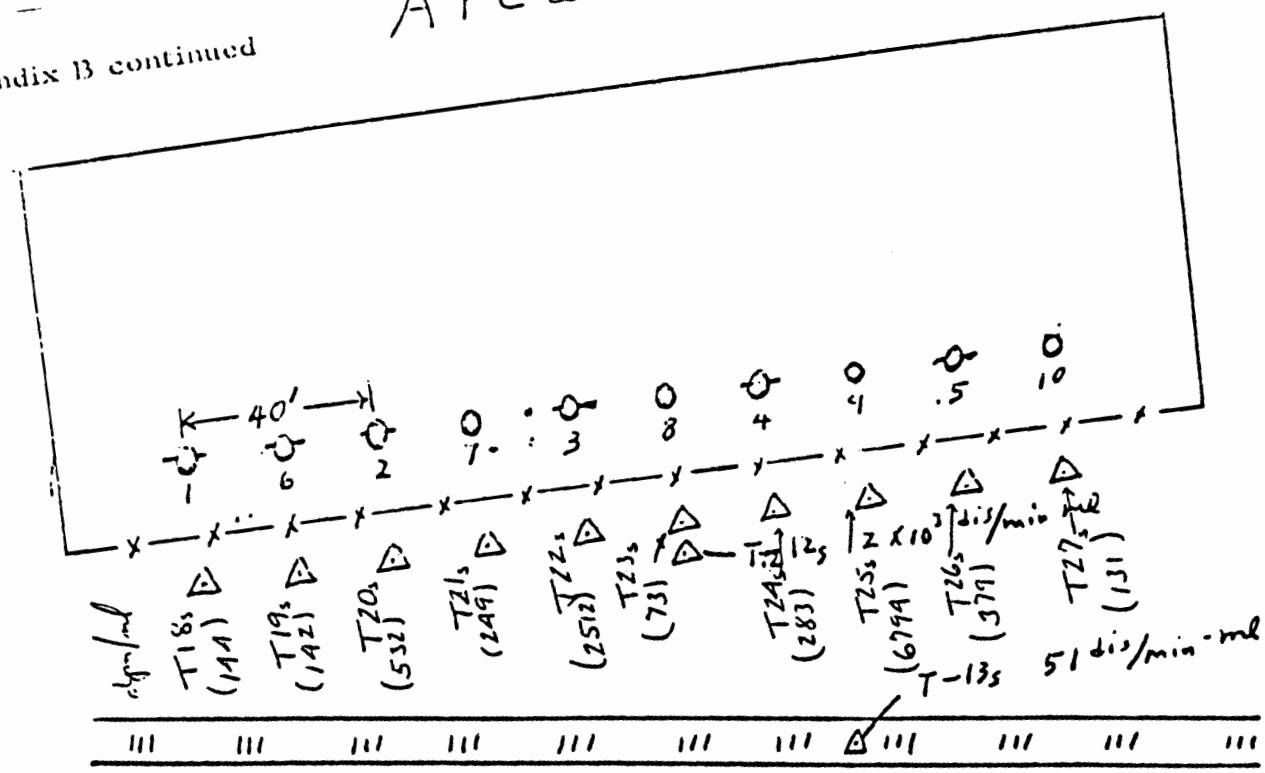
Ten additional soil samples were collected about 5 feet out from the south fence of Area "H" at a depth of 1 foot. These soil samples were analyzed for tritium in the same manner described in the original memorandum.

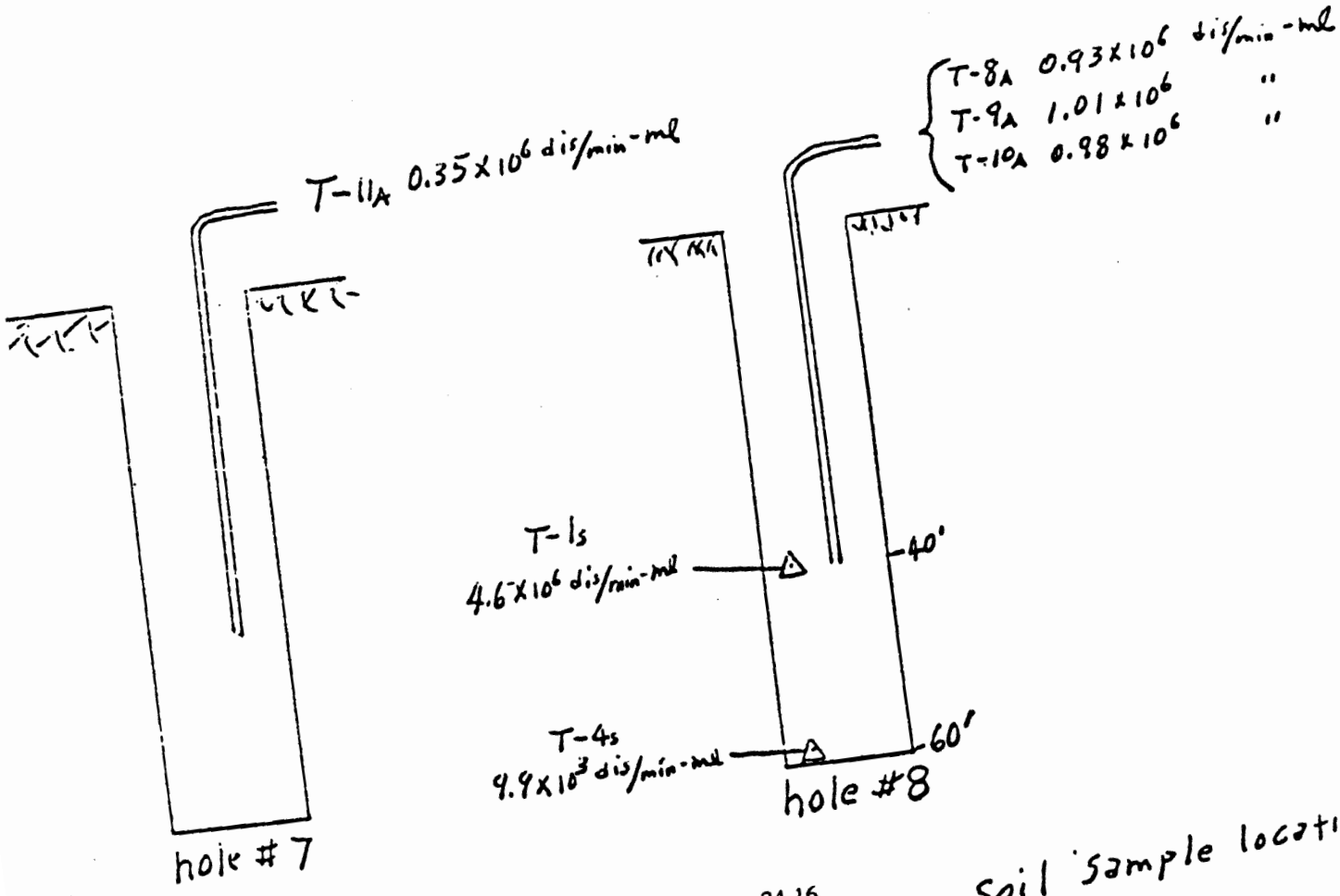
The results in dpm/ml are listed beside sample numbers at sample locations.

Samples are too few and not of sufficient depth to be conclusive and the patterns maybe only a result of chance, however, if a northwest trending joint set occurs in this area as in Area "G" the source maybe shafts 4 and 7.

WDP:mtj

Area "H"





Soil sample location

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

OFFICE MEMORANDUM

TO : Dean Meyer, Group Leader, H-1 DATE: December 2, 1971

FROM : Harry S. Jordan, Group Leader, H-8

SUBJECT: TRITIUM AND RADIOCHEMICAL ANALYSES, PITS 8, 12, 16, 17 and 21, TA-54: REFERENCE MEMO H-1, 71-139

SYMBOL : H8-M2371

Nine test holes were drilled in August 1971 in and adjacent to the new disposal pits at TA-54 (See sketch on location). Five of the test holes (8A, 12A, 16A, and 21A)were drilled to a depth of 30 feet in the floor of the pits. Four of the test holes (8A, 16B, 17B and 21B) were drilled to depths of 60 feet, three on the perimeter and one near the center of the area. The test holes were drilled to establish background data on radioactivity in the tuff prior disposal of wastes in the pits.

Samples of tuff were collected over a five foot interval. The moisture content of each sample was determined and moisture distilled out for tritium analyses. The data is tabulated on Table 1. The tritium concentrations range from 4 to 33 pCi/ml (picocuries per milliliter of moisture). with an average of 14 pCi/ml. There was no pattern to the distribution of tritium with depth. Concentrations are low, within background data on tritium collected from a shaft at Area L (20 pCi/ml).

In undisturbed areas on the mesa moisture concentrations in the tuff will range from 3 to 8 per cent by weight in upper 10 feet of soil and tuff. The concentrations decrease with depth. Soil cover in the areas of holes 8B, 16B, 17B, and 21B was distributed by heavy equipment used in construction of the pits. The moisture content of samples in the upper 10 feet of soil and tuff from the above holes ranged from 0.6 to 5.0 per cent by weight with an average of 1.8.

The moisture contents of tuff from holes 8A, 12A, 16A, 17A, and 21A (located in bottom of pits) and below depths of 10 feet in holes 8B, 16B, 17B, and 21B ranged from <0.1 to 1.4 per cent by weight with an average of 0.4. The moisture in the soil and tuff is in the low moisture range where movement is by diffusion.

The pits are constructed in Unit 2b of the Tshirege Member of the Bandelier Tuff. Unit 2b consists of a moderately welded tuff consisting of two ashflows separated by eroded material consisting of reworked sand, tuff and pumice. Pits 8, 12, 16, and 21 are constructed through the upper ashflow reworked materials and completed into the lower ashflow. Pit 17, located topographically lower, is constructed within

TO: Dean Meyer, H-1
H8-M2371

DATE: December 2, 1971

the lower ashflow, the surface around the pit below the erosional contact between the two ashflows.

The test holes drilled in the bottom of the pits (within the lower ashflow) are completed into the top of Units 2a. The test holes drilled on the perimeter and near the center of the area are completed through Unit 2b into the top of Unit 2a.

Radiochemical analyses of samples collected from test hole 21B were composited according to stratigraphic units (i. e. upper ashflow, reworked material, and lower ashflow of unit 2b and upper ashflow of unit 2a) and analyzed for gross alpha and beta activity as well as ^{238}Pu, ^{239}Pu, ^{137}Cs and Natural Uranium (Table 2). The results of the analyses are within limits of background data in the Los Alamos area. The positive value of 0.005 pCi/g (picocuries per gram) of ^{239}Pu in the upper ashflow (depth 0-10 feet) is within limits established for ^{239}Pu fallout in the Los Alamos, Santa Fe and Espanola areas.

HSJ:WDP:et

cc: H-8 File
WDP

Table 1. - Tritium Concentr. .ons and Moisture Contents in .ttings from Test Holes.

Depth Internal (feet)	Tritium Picocuries per Milliliter of Moisture								
	Hole 8A	Hole 12A	Hole 16A	Hole 17A	Hole 21A	Hole 8B	Hole 16B	Hole 17B	Hole 21B
0-5	9	11	12	15	11	27	12	10	15
5-10	8	15	10	13	12	13	15	7	24
10-15	11	13	5	11	4	10	15	12	23
15-20	<4	13	14	10	9	14	14	13	20
20-25	9	10	16	12	10	21	16	20	33
25-30	11	12	--	6	8	12	17	18	24
30-35	--	--	--	--	--	20	18	14	25
35-40	--	--	--	--	--	22	12	12	18
40-45	--	--	--	--	--	10	10	15	26
45-50	--	--	--	--	--	13	15	12	21
50-55	--	--	--	--	--	27	16	16	15
55-60	--	--	--	--	--	20	17	13	17

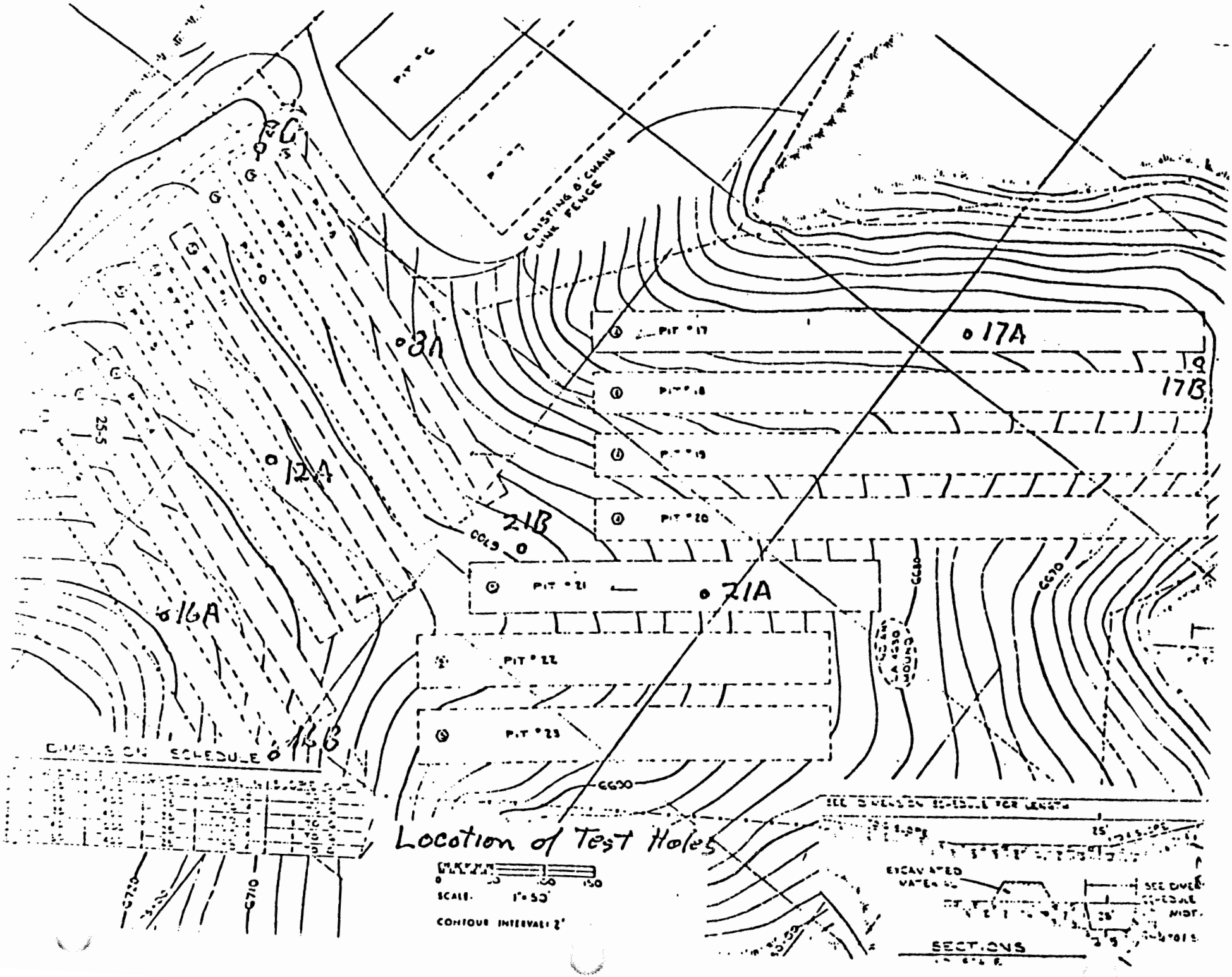
Note Limits of detections 4 picocuries per milliliter.

Depth Internal (feet)	Moisture content of tuff Percent Moisture by Weight								
	Hole 8A	Hole 12A	Hole 16A	Hole 17A	Hole 21A	Hole 8B	Hole 16B	Hole 17B	Hole 21B
0-5	0.2	<0.1	0.1	<0.1	0.8	5.0	0.6	2.0	1.9
5-10	1.1	< .1	.3	< .1	,7	2.7	.4	1.0	1.2
10-15	.9	< .1	<.1	1.0	.8	1.3	.5	.3	.5
15-20	.7	.2	<.1	<.1	<.1	.8	.4	.2	.5
20-25	.8	.1	.1	.4	<.1	.7	6	.3	.4
25-30	1.4	.1	<.1	1.2	< 1	.2	.2	.5	.1
30-35	--	--	--	--	--	1.0	.2	1.1	.4
35-40	--	--	--	--	--	.6	.1	.4	.2
40-45	--	--	--	--	--	.6	.8	.6	.3
45-50	--	--	--	--	--	.9	.4	.4	<.1
50-55	--	--	--	--	--	1.1	<.1	.3	.4
55-60	--	--	--	--	--	.8	.3	.6	.2

Table 2. - Radiochemical analyses of tuff from test hole 21B.

Description	Depth (feet)	Picocuries per gram					Micrograms per gram
		Gross Alpha	Gross Beta	^{238}Pu	^{239}Pu	^{137}Cs	Natural uranium
Unit 2b							
Upper ashflow	0-10	6	2	b/	0.005	c/	0.20
Reworked Material	10-15	8	a/	b/	b/	c/	.28
Lower Ashflow	15-40	7	a/	b/	b/	c/	.24
Unit 2a							
Upper Ashflow	40-60	7	a/	b/	b/	c/	.31

a/ Below limits of detection 1 pCi/g
b/ Below limits of detection 0.002 pCi/g
c/ Below limits of detection 2 pCi/g



Location of Test Holes

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

OFFICE MEMORANDUM

TO : Morton Smith, CMB-13

DATE: 12-22-71

FROM : William D. Purtymun, H-8 WDP

SUBJECT: LOGS AND CASING SCHEDULE OF HOLES DRILLED FOR HEAT FLOW MEASUREMENTS

SYMBOL : H8-M2390

The following presents logs and casing schedules of holes drilled for heat flow measurements. The holes were cased with 2 inch diameter plastic tubing. The annular space between the bore wall and casing was filled with cutting removed from the holes during drilling at Sites 1, 2, 3, and 4. Sand was used for backfill material at Site 5.

It was impossible to complete the holes to a depth necessary for the heat flow measurements due to welded tuff encountered at Sites 6 and 7. Sketch map shows general location of the holes.

SITE 1 - December 7, 1971

	Thickness (feet)	Depth (feet)
Soil, dark brown	4	4
Tuff, light gray	68	72

Hole bottomed on hard rock, probably latites of Tschicoma Formation. Cased with 70 feet of casing which extends 2.0 feet above land surface.

SITE 2 - December 10, 1971

Pumice, dark brown weathered	34	34
Tuff, brown weathered to clay	18	52

Hole bottomed on hard rock, probably latites of Tschicoma Formation. Cased with 49 feet of casing which extends 0.5 feet above land surface.

SITE 3 - December 13, 1971

Pumice, weathered, contain large amounts of moisture	67	67
Tuff, reworked, brown	36	103

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

TO: Morton Smith, CMB-13 -2- DATE: December 22, 1971
H8-M2390

Cased with 102 feet of casing which extends 0.5 feet above land surface.

Site 4 - December 15, 1971

	Thickness (feet)	Depth (feet)
Soil, brown	3	3
Tuff, gray	69	72
Tuff, dark gray dense	2	74

Hole bottomed into weld tuff. Cased with 73 feet of casing which extends 0.5 feet above land surface.

SITE 5 - December 17, 1971

Tuff, brown, weathered to clay	72	72
Tuff, light gray	20	92
Tuff, dark gray, dense	6	98

Hole bottomed into welded tuff. Cased with 95 feet of casing which extends 0.5 feet above land surface.

SITE 6 - December 16, 1971

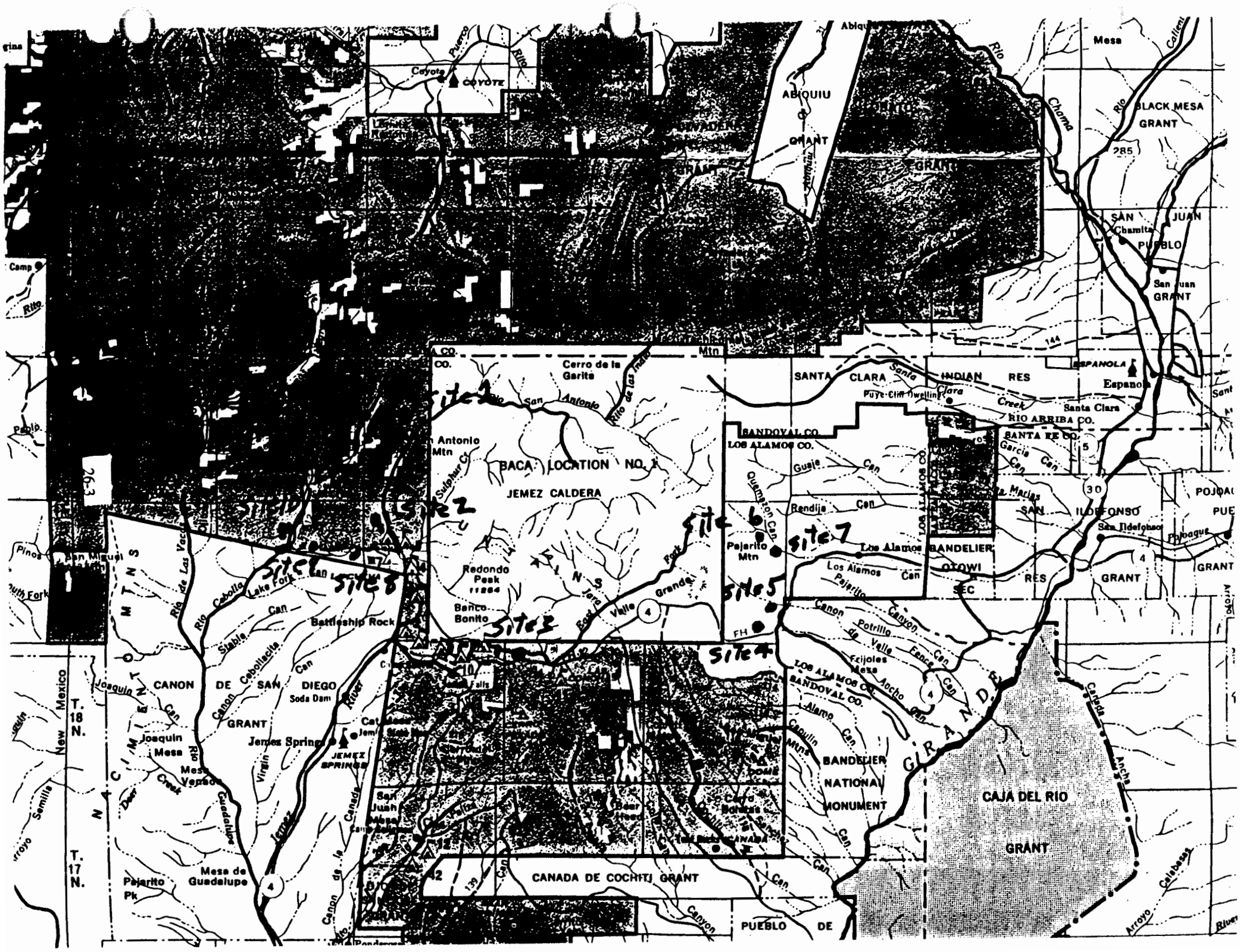
Hole abandoned and filled at a depth of 9 feet in welded tuff.

SITE 7 - December 16, 1971

Hole abandoned and filled at a depth of 24 feet in welded tuff.

WDP:et
enc. 1

cc: Dr. Marshall Reiter, NMMIT (w enc)
Don Brown, N-7 (w enc.)
ISD-5 (2) (w/o enc.)
H-8 File
WDP


Site 1
Site 2
Site 3
Site 4
Site 5
Site 6
Site 7
Site 8
Coyote
COYOTE
ABIQUIU
GRANT
Mesa
BLACK MESA
GRANT
SAN JUAN
PUEBLO
San Juan
GRANT
Chamita
Cerro de la Garita
Antonio Mtn
BACA LOCATION NO. 1
JEMEZ CALDERA
Redondo Peak
11254
Banco Bonito
Battleship Rock
Soda Dam
CANON DE SAN DIEGO
GRANT
Jemez Springs
JEMEZ SPRINGS
Joaquin Mesa
Mesa Verde
Mesa de Guadalupe
Pajarito Pk
SANTA CLARA INDIAN RES
Puye Cliff Dwelling
Santa Clara
RIO ARRIBA CO.
SANTA FE CO.
BANDOVAL CO.
LOS ALAMOS CO.
Pajarito Mtn
Los Alamos
BANDELIER
OTOWI
SEC
RES
SAN ILDEFONSO
San Ildefonso
POJOAQUE
GRANT
ESPANOLA
Espanola
BANDELIER NATIONAL MONUMENT
CAJA DEL RIO
GRANT
CANADA DE COCHITI GRANT
PUEBLO DE
RIO GRANDE
Cerro Bonitas
Bear Head
Dome
Falls
Cat Scan
Pajarito Canyon
Potrillo Canyon
Frijoles Mesa
Valle Grande
Jemez River
Rio Cebolla
Lake Fork
Rio de Las Vacas
Stable Can
Cebollita Can
Canon de la Cañada
Guadalupe
Virgin
Jemez
Deer Creek
Rio Chama
Rio Ojo Caliente
Rio San Antonio
Rio de los Indios
Sulphur Cr
Quemazon Can
Gusle Can
Rendija Can
Garcia Can
Santa Clara Creek
Arroyo Calabasas
Arroyo Ancho
Arroyo Semilla
T. 18 N.
T. 17 N.
New Mexico
Camp
Pinos
San Miguel
South Fork
Pueblo
Rito
Abiquiu
Mesa
Chama
Rio
Coyote
Puerco
Rito
Cerro de la Garita
Mtn
CO.
CO.
144
285
30
4
5
10
12
42
139
26-3

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

OFFICE MEMORANDUM

TO : File

DATE: January 7, 1972

FROM : William D. Purtymun, H-8 WDP

SUBJECT: GEOLOGY AND HYDROLOGY OF TEST AREA NEAR TA-15

SYMBOL : H8-M2413

The test area at TA-15 is on a small narrow east-trending mesa that is part of the Pajarito Plateau (Fig. 1). The surface drainage from the mesa is to the north and south into an unnamed canyon that is a tributary to Pajarito Canyon near TA-18. The unnamed canyon and Pajarito Canyon contain only intermittent streams, runoff occurring during periods of heavy precipitation. Pajarito Canyon is tributary to the Rio Grande about 7 miles east of the test area.

Geology

The Pajarito Plateau is formed by a series of ashflow and ashfall of rhyolite tuff of the Bandelier tuff. Underlying the Bandelier is the Puye Formation composed of a conglomerate of volcanic debris and sediments with possible interbedded basalts and latites. The Puye is underlain by the siltstones and sandstones and possible interbedded basalts of the Tesuque Formation. The following table gives the estimated section of these units underlying the test area based on thickness encountered in Test Wells DT-5A at TA-49, Test Well 8 near TA-50 and Supply Well PM-2 near TA-18.

Estimated Section
Altitude of Land Surface 7,160 feet

	Thickness (feet)	Depth (feet)
Bandelier Tuff		
Tshirege Member - Nonwelded to welded	470	470
Otowi Member - Nonwelded	340	810
Guaje Member - Lump pumice	50	860
Puye Formation - Volcanic debris and sediments with possible interbedded basalt and latite	690	1,550
Tesuque Formation - Siltstones and sandstones with some interbedded basalt	1,200+	2,750+

A gravity survey indicates a north-south trending trough about 2 miles wide underlies the test area. The trough is filled with about 12,000 feet of volcanic and sediments which overlie the Precambrian Crystalline Rocks (Fig. 1).

The north-south trending Pajarito Fault Zone lies about 3 miles west of the test area. A minor north-south trending fault lies about 2 miles west of the site (Fig. 2). The minor fault down thrown to the east displaces the Tshirege Member of the Bandelier tuff about 90 feet. The Pajarito Fault Zone is dropped to the east 400 to 500 feet.

Hydrology

The depth to the main aquifer (aquifer capable of municipal and industrial water supply) varies from about 1,200 feet along the western edge of the plateau to about 800 feet along the rim of White Rock Canyon. Water in the aquifer moves eastward toward the Rio Grande where a part is discharged into the river from seeps and springs. Recharge to the aquifer on the flanks of the mountains to the west and deep canyons cut into the flanks of the mountains and western part of the plateau. This top of the main aquifer lies at a depth of about 1,150 feet below the surface of the mesa at the test area in the volcanic debris and sediments of the Puye Formation. Movement of water in the aquifer is toward Supply Well PM-2 which lies about 11,000 feet to the east (Fig. 2).

Aquifer test of Test Well DT-5A, DT-9, and DT-10 indicated the rate of movement of water in the aquifer at about 400 feet per year, thus it would take about 28 years for the water to move from beneath the test area to the supply well or about 90 years for the water to move 7 miles from test area to the Rio Grande.

Test Wells DT-5A, DT-9 and DT-10 at TA-49, test well TW-8, and Supply Well PM-2 encountered no water perched in the Bandelier tuff or in the Puye Formation above the main aquifer. It is very unlikely that perched water occurred in the rocks beneath the test area and the main aquifer.

Little if any water from precipitation infiltrates into the tuff on the mesas where the normal soil cover is undisturbed due to high evaporation rates and hydrologic characteristics of the soil as a result there is no recharge to the main aquifer from the mesas.

Samples of tuff were collected when hole 15A at the test area was drilled. The moisture content of the cuttings was not determined, but visual inspection rejected them for tritium analyses as the moisture content was too low (less than 1.0 per cent by weight) which would make

TO: File
HS-M2413

DATE: January 7, 1972

water vapor recovery difficult. This also suggests there is no movement of water into the tuff from the surface of the mesa.

Holes that are expended for experiments or abandoned and filled should be sealed at the surface either with a concrete plug or compacted soil to prevent any amount of water to move into the tuff and upset the balance that now exists.

No attempt was made to correlate the ashflows penetrated by the hole at the test area with similar units mapped at TA-49 to the south. The following is a driller log submitted to H-8 after completion of Hole 15A:

	Thickness (feet)	Depth (feet)
Bandelier Tuff		
Nonwelded to moderately welded unit	21	21
Welded tuff	9	30
Nonwelded to moderately welded unit	80	110
Welded Tuff	15	125

Construction: 6 foot diameter to 84 feet
4 foot diameter 84 to 125 feet

The following are references on file at H-8:

1. Records of wells, test holes, springs and surface-water stations in the Los Alamos Area.

2. Geology of the microseismograph station at S-Site, Los Alamos County

3. Development of ground-water supplies on the Pajarito Plateau.

4. Geology and ground-water resources of the Los Alamos area.

5. Geology and hydrology of Technical Area 49, Frijoles Mesa, Los Alamos County.

6. An evaluation of aquifer and well characteristics of municipal well field in Los Alamos and Guaje Canyons near Los Alamos.

7. Distribution of moisture in soil and near-surface tuff on the Pajarito Plateau.

WDP:et
cc: R. R. Brownlee, J-9

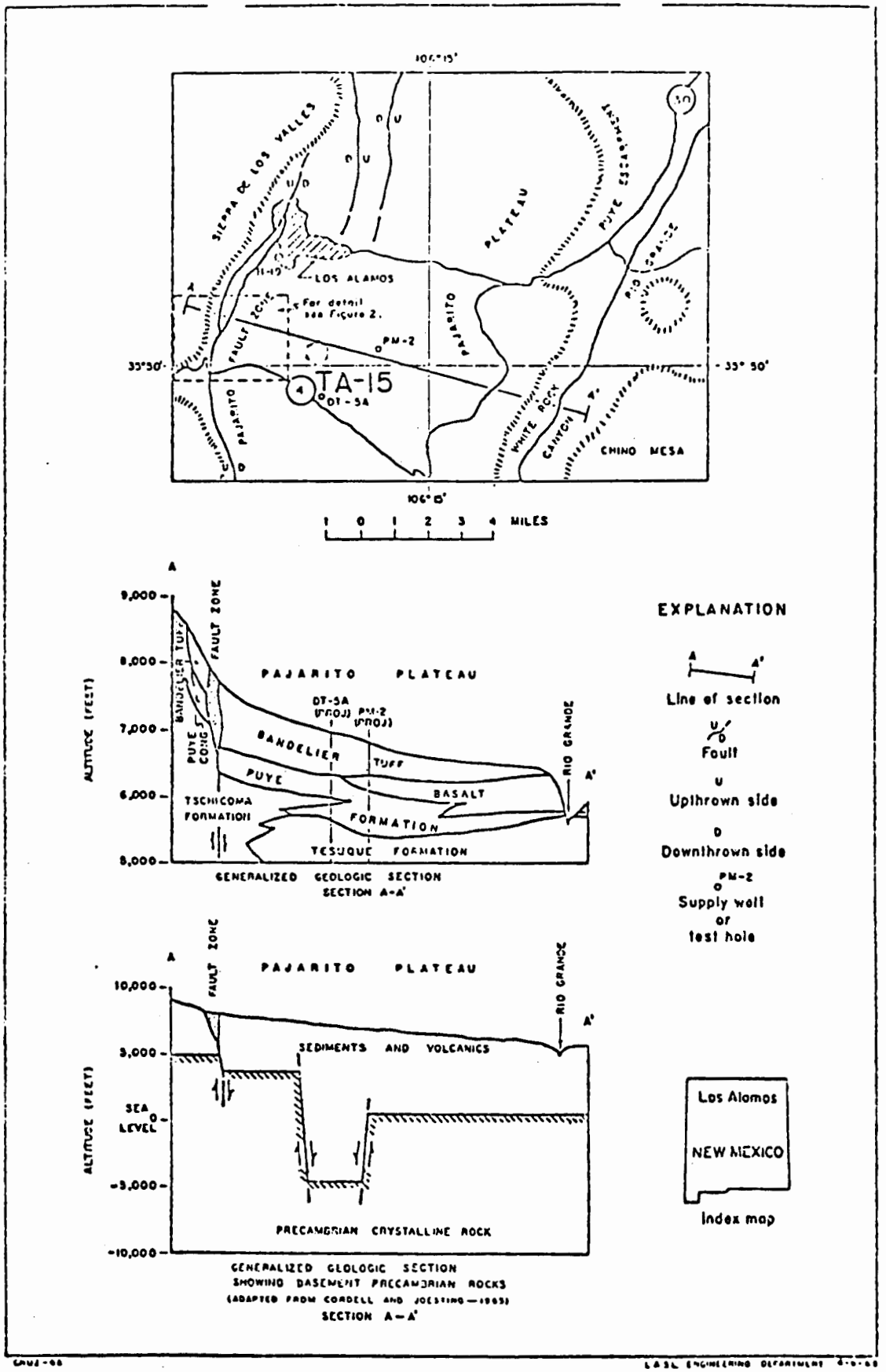


Figure 1.--Physiographic map of the Los Alamos area and generalized geologic sections.

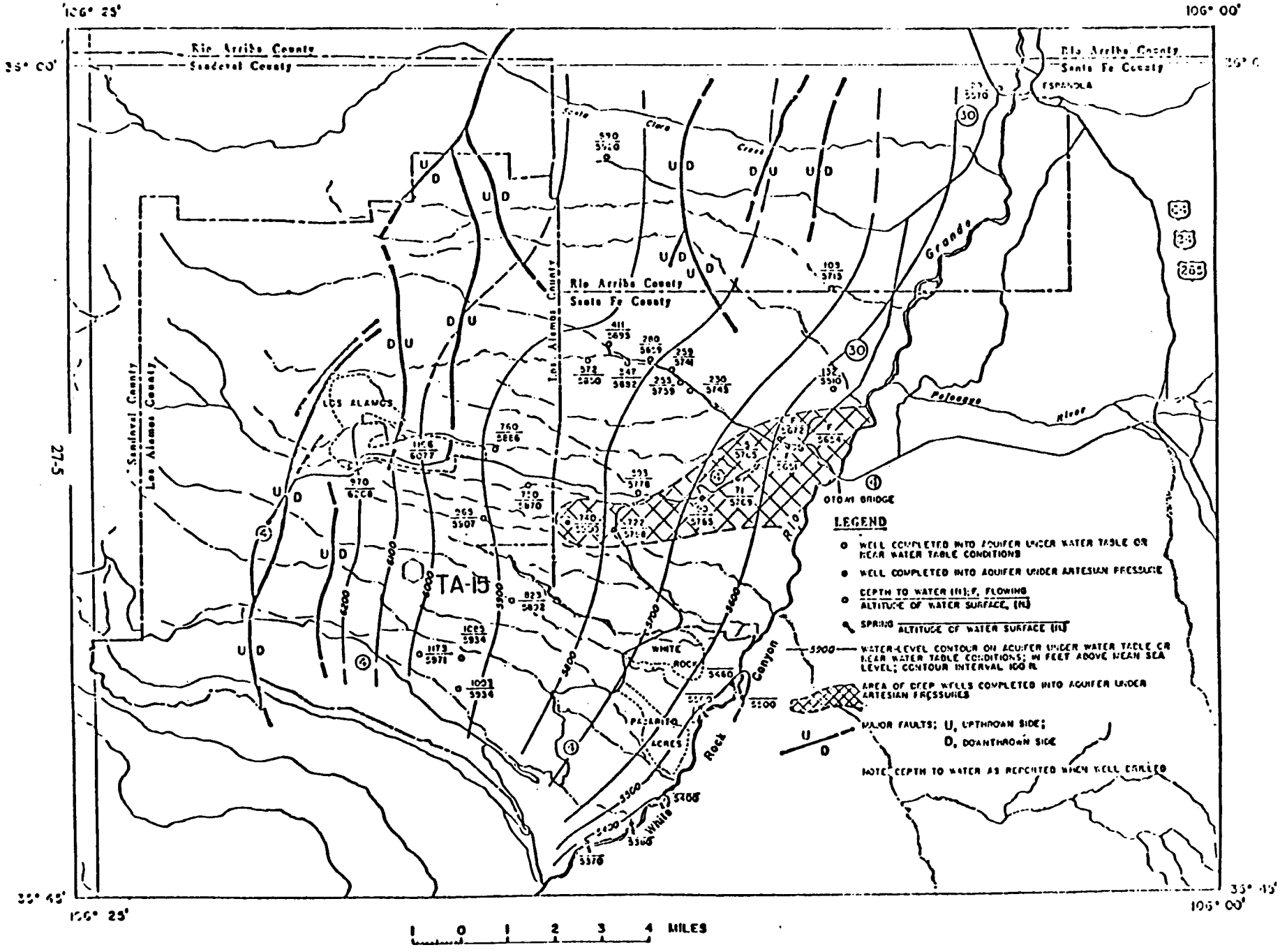


Figure 2. Major faults and water-level contours on top of main aquifer.

UNIVERSITY OF CALIFORNIA
LOS ALAMOS SCIENTIFIC LABORATORY
(CONTRACT W-7405-ENG-36)
P. O. Box 1663
Los Alamos, New Mexico 87544

IN REPLY REFER TO: H8-672

November 27, 1972

Mr. Fred Swetnam
District Forest Ranger
Jemez Springs, New Mexico 87025

Dear Mr. Swetnam:

This is in reply to your inquiry of possible conversion of Hole C, Section 9, T20N, R3E, for use as a stockwell. The hole is 750 feet deep and is cased with 4-1/2 inch O.D. blank pipe.

The drilling contractor, Dan Laughlin, Shamrock Drilling Company, found the water level at about 350 feet in April 1972. At present the water is at a depth of 328 feet. This puts the saturated section within the Abiquiu Tuff (see attached log). The Abiquiu, in part, appears quite permeable.

The water from the hole did not clear up when the hole was bailed after the casing was installed. This may be due to the water in the Abiquiu Tuff creating a positive pressure and entering the casing at the bottom of the hole, thus eroding sediments from the Abo.

The hole could be completed as a stockwell by slotting the casing in place or removing from the hole and replacing with slotted pipe through the Abiquiu Tuff. The well could then yield 3 to 5 gpm (gallons per minute).

If we can furnish additional information, please contact us.

Sincerely,

William D. Purtymun
Environmental and Field
Programs, H-8

WDP:mb
cc: M.D. Smith, CMB-13

AN EQUAL OPPORTUNITY EMPLOYER

ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

OFFICE MEMORANDUM

TO : Ed Williams, Q-23

DATE: April 13, 1973

FROM : William D. Purtymun, H-8

SUBJECT: FIELD TEST SITE FOR BASALT MELTING EXPERIMENTS

SYMBOL : H8M-73-38

Four tentative sites were located with Ed Williams, Q-23, and Randy Hanson, H-8, on April 9. They are located: (1) West of Highway 4 in Canada del Buey; (2) North rim of Water Canyon south of Pajarito Acres; (3) in Water Canyon adjacent to Highway 4; and (4) in Ancho Canyon east of Highway 4. Verbal description of the sites was presented by Ed to the staff of Q-23 and they decided to develop the site in Ancho Canyon for the experiment. The Ancho Canyon site was visited with ENG-2 on April 11 to determine ease of access.

The following presents a general description of the geology of the site. Detailed studies should be made later to correlate penetration rates in the various basalt flows.

The site is located at the western outcrop of Unit 2 of the Basaltic Rocks of Chino Mesa in Ancho Canyon (see attached map). The basalts were extruded from vents in the Cerros Del Rio Volcanic Field which lies to the east across the Rio Grande. The basalts extruded from the volcanic field flow north, northwest and west across the present course of the Rio Grande. Thus, the upper surface of Unit 2 at the site dips gently to the west. The dip is about 130 feet per mile based on the western most outcrop and the top of the basalt penetrated by TH-7 which lies about 0.2 mile to the west.

Unit 2 east of the site is discontinuous. A deep canyon was cut into the unit prior to the deposition of the Bandelier Tuff. The tuff fills the canyon and overlies Unit 2 in Ancho Canyon.

The section of Unit 2 exposed in Ancho Canyon is in excess of 200 feet. The basalt is not a single flow but a series of flows. The upper 100 feet appears massive but is composed of three or four flows. The contact between flows is marked by interflow zones of basalt breccias, which may or may not be associated with some sediments.

The uppermost flow at the site ranges from 20 to 30 feet in thickness. The contact is marked by a thin zone of breccia in the upper flow and vesicular basalt that forms the top part of the underlying flow.

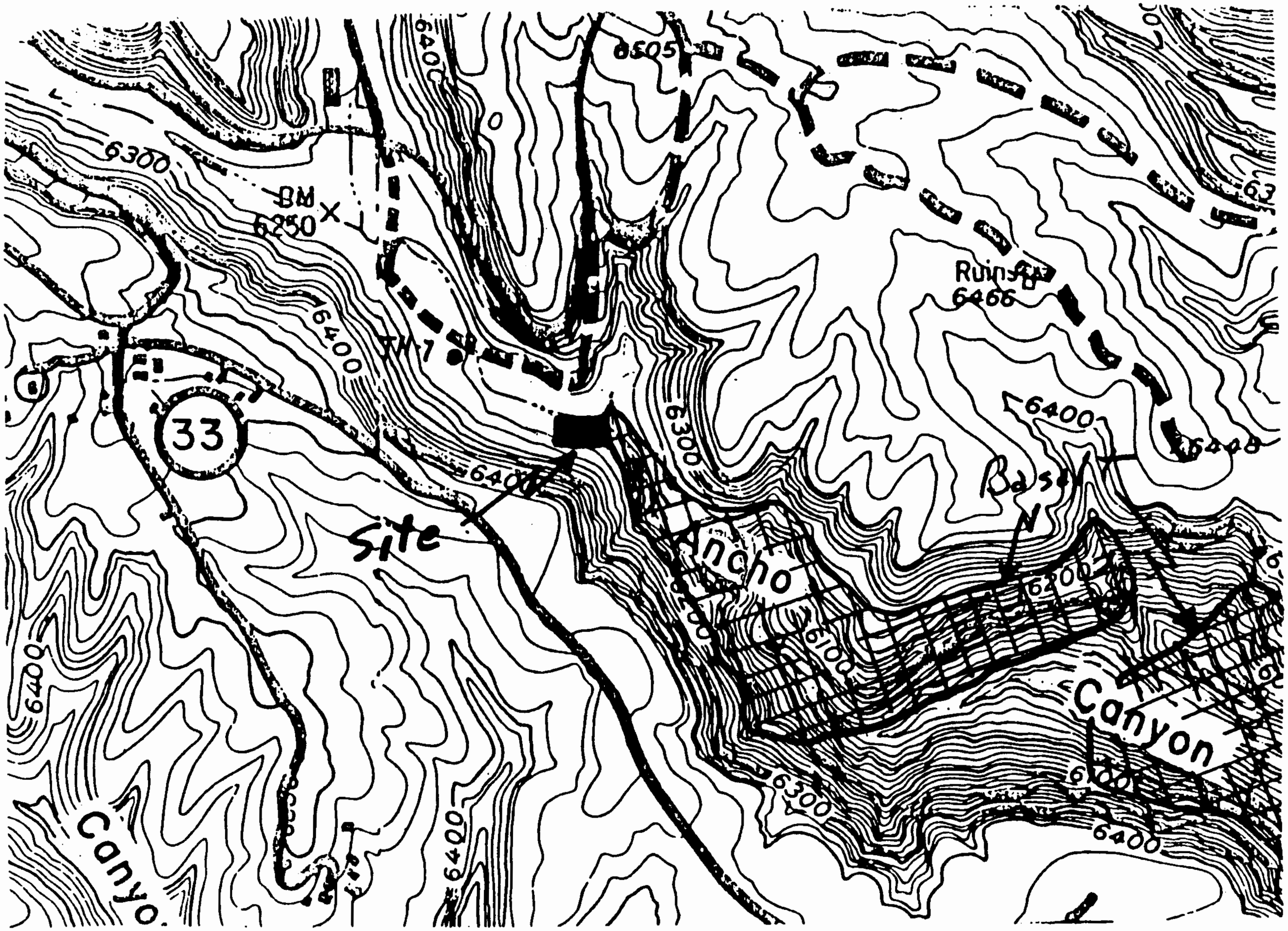
The following is a description of Unit 2 taken from R. L. Griggs, 1964, U. S. Geol. Water Supply Paper 1753.

> Unit 2 conformably overlying unit 1, forms the main cliffs along White Rock Canyon, caps much of Chino Mesa east of the canyon, and west of the canyon unit 2 caps a mesa south of White Rock. Unit 2 is more than 850 feet thick on Chino Mesa and thins gradually northward and wedges out. It consists mainly of flows of basalt and basaltic andesite and a few local beds of basaltic tuff and thin sandstone. The flows generally are more massive than those of unit 1 and in places, individual flows are more than 50 feet thick. They range from gray to dark gray and generally are lighter in color than those of the underlying unit. Some specimens contain small phenocrysts of olivine only. Some contain phenocryasts of olivine and pyroxene; others contain olivine, pyroxene, and plagioclase; and still others, small phenocrysts of pyroxene only. The groundmass is composed of plagioclase, clinopyroxene, and a small amount of magnetite. The groundmass of some specimens may contain a small amount of olivine. The plagioclase ranges in composition from sodic labradorite to calcie andesine.

If we can be of assistance please feel free to call.

WDP:et

cc: Marvin Linke, ENG-2
A. Giger, Q-23
J. Neudecker, Q-23



Location of Test Site for Basalt Rock Melting Experiment

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

OFFICE MEMORANDUM

TO : Ed Williams, Q-23

DATE: May 2, 1973

FROM : W. D. Purtymun, H-8

SUBJECT: TEST HOLES AT TA-56

SYMBOL : H8M-7360

Enclosed is sketch map showing location of test holes and thickness of overburden overlying the basalt at TA-56.

It appears that the best location will require removal of overburden. In the area that was investigated this would be south of the stream channel where the overburden ranges from 4.5 to 8.5 feet. Removal would be to the northeast. This area would be protected from any flash flooding that could occur during the summer.

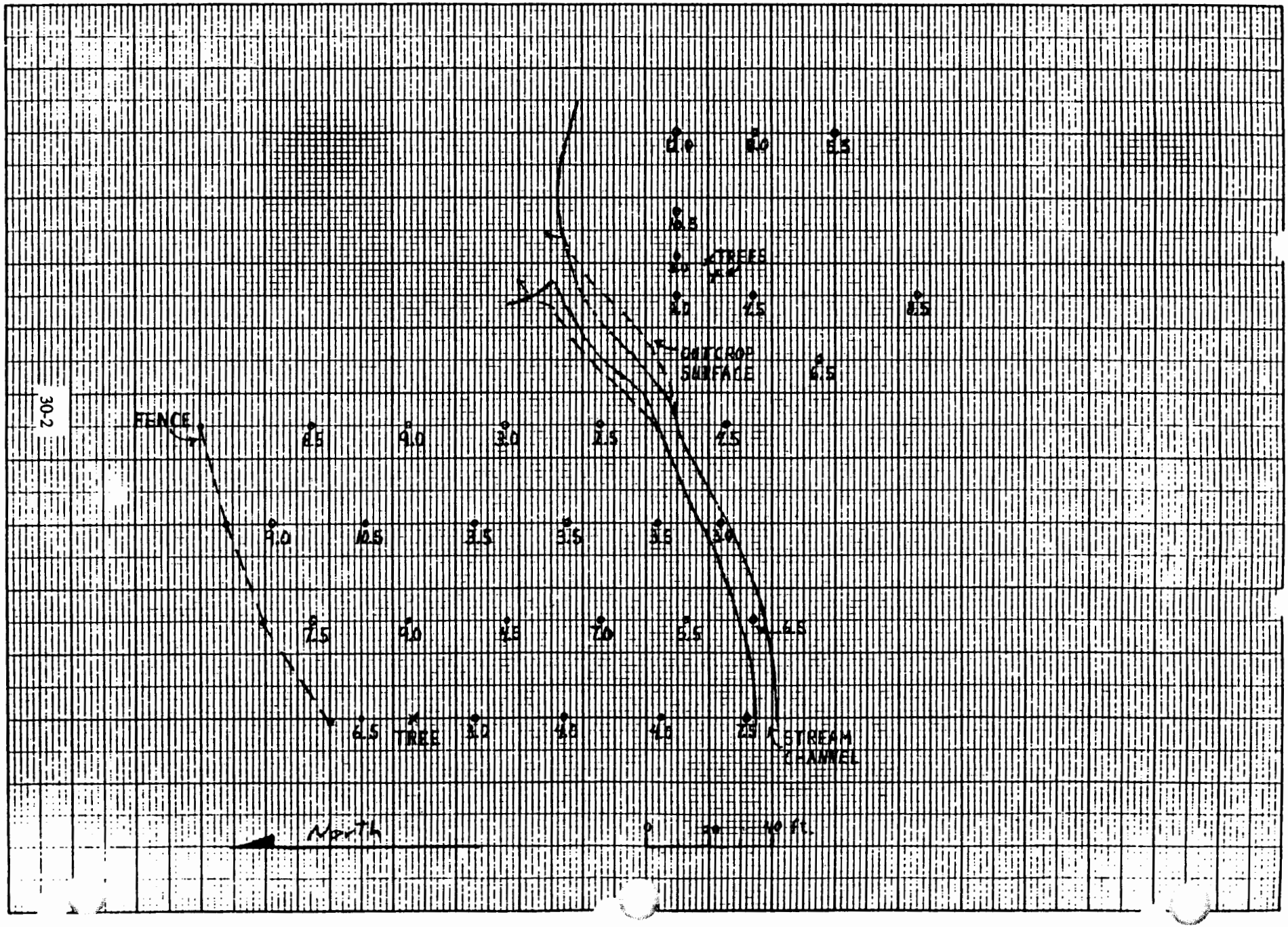
The basalt at shallow depths north of the stream would be subject to flooding. Cuttings from these holes also contained excessive moisture, which indicated some water moving through the alluvium down Ancho Canyon.

If the site south of the stream is developed, overburden removed could be used to level the land surface to the northeast for parking and a trailer area. To minimize the impact on the environment it would be advisable to leave in the two large pines that are plotted on the sketch map.

WDP:et

Attachment 1

SKETCH SHOWING LOCATION OF TEST HOLES AND THICKNESS OF OVERBURDEN (IN FT.) OVER LYING BASALT AT SITE TA-56



GEOHYDROLOGY OF PAJARITO PLATEAU

WITH REFERENCE TO QUALITY OF WATER - 1949-1972

By

William D. Purtymun

Appendix
May 1973

PHYSICAL CHARACTERISTICS OF THE BANDELIER TUFF

The Bandelier Tuff is formed by a series of ash flows and ash falls which are described as nonwelded, moderately welded, and welded tuff. The nonwelded, moderately welded, and welded tuff grade one into the other both vertically and horizontally.

The upper Tshirege Member is about 250 m thick along the western edge of the Pajarito Plateau and thins eastward to less than 15 m. Individual moderately welded and welded ash flows in the upper part of the Tshirege Member range from 6 to 40 m thick. Some of the uppermost ash flows are beveled off by erosion eastward across the plateau. Outliers of tuff overlie the Puye formation along Puye Escarpment. Most all ash flows thin eastward from the source area (Sierra de los Valles). Nonwelded ash flows of the Otowi Member may be as much as 90 m thick near the center of the plateau.(1)

I. Welding

The welding process of an ash flow tuff begins after emplacement. The major factors affecting welding are heat at the time of emplacement, amount of volatiles in the mass, rate of cooling, and thickness of the ash flow.(2) The degree of welding ranges from incipient stages marked by the cohesion of glassy fragments, to complete welding marked by the cohesion of the surfaces of glassy fragments accompanied by their deformation and the elimination of pore space.

Zonal variation of welding occurs vertically within individual flows or within a series of flows that have cooled as a single unit.(3) Single ash flows or series of ash flow that have cooled as a unit may show a greater degree of welding near the center than near the upper and lower contacts. A series of ash flows that have been emplaced in rapid succession may cool as a single unit with the greatest degree of welding near the center.

Variation of welding occurs horizontally within individual flows with greater degree welding near the mountains (the source area). The degree of welding becomes less eastward across the plateau.

The tuffs in the Los Alamos area are classified according to the degree of welding--i.e., nonwelded, moderately welded, and welded tuffs. Welding results in increased cohesion and deformation of the glassy fragments in the tuff. Nonwelded tuff has high porosity, only slight cohesion of the glassy fragments, and crumbly fracture; moderately welded tuff has lesser porosity, moderate cohesion, slight deformation of the glassy fragments, and a somewhat brittle fracture; and welded tuff has lower porosity, good cohesion, a high degree of deformation by flattening of glassy fragments, and a brittle fracture.(4)

The degree of welding influences most of the physical characteristics of the individual ash-flow tuff units.

The following shows a large range in porosity in each of the variations of tuff indicating that welding is only one of several factors determining porosity.

	Range in porosity (percent by volume)
Nonwelded tuff	40 to 60
Moderately welded tuff	30 to 55
Welded tuff	15 to 40

The surface of exposed tuff (nonwelded to welded) becomes "case hardened" as it is exposed to the weather. In this process, due to the porosity of the tuff, moisture is absorbed and some minerals are dissolved. The minerals are returned to the surface by evaporation as the tuff dries out where they are precipitated to form a rind. This rind forms a protective surface which resist the erosion of the surface by wind and water. However, exposed pumice fragments weather out rapidly leaving small cavities in tuff surface.

II. Density

The density of nonwelded tuff is lower than in welded tuff. This is due to the compaction of the matrix (glass shards and ash) and closer arrangement of the quartz and sanidine crystals, and rock fragments in a welded tuff. The specific gravity of the tuff matrix averages about 1.55. The range in bulk density of nonwelded to welded tuff depends on the porosity (i.e., the larger a porosity, the smaller the density).

The following table shows a comparison of the densities of pumice and the tuff (nonwelded towelded) with other rock types.

Rock Type	Range in density (gm/cm^3)
Pumice (nonwelded)	< 1.0
Nonwelded tuff	1.02-1.52
Moderately welded tuff	1.15-1.84
Welded tuff	1.52-2.16
Granite	2.64-2.76
Marble	2.60-2.84
Sandstone	2.14-2.36
Basalt	2.4 -3.1

III. Bearing Capacities

The bearing capacities of a tuff are dependent upon the density of tuff (i.e., the greater bearing capacities occur with the tuff of greater density). The density of the tuff is related to welding (i.e., density of the tuff increases from nonwelded tuff to welded tuff).

Data are available on the bearing capacities of the moderately welded tuff. The following table shows the relationship of density change to the resistance to crushing of a moderately welded tuff.

Density (gm/cm^3)	Resistance to Crushing (kg/m^2)
1.73	2.4×10^5
1.74	3.7×10^5
1.77	3.9×10^5
1.79 (probably with pumice inclusion)	3.4×10^5
1.81	4.8×10^5
1.83	5.6×10^5

Rock inclusions of pumice, rhyolite, and latite are found in the tuff. The frequency of occurrence of the rock fragments differs in individual ash flows and at different locations within the same ash flow.

The pumice fragments may be as much as 5 cm in length and 2 cm in diameter. The pumice is soft and friable. Pumice fragment inclusion in a small sample of the tuff would decrease the bearing capacity as failure would most likely occur within the pumice fragment. The rhyolite and latite fragments are dark gray, hard, and may be as much as five to seven cm across. These large rock fragments would add strength to the matrix of tuff.

The following table is a comparison of the bearing capacities of a moderately welded tuff (density 1.73 and ~ 1.82 g/cm^3) and miscellaneous rock type. The bearing capacity is computed as 1/5 of rupture strength of the material.

Rock Type	Bearing Capacity (kg/m^2)
Moderately welded tuff (1.73 g/cm^3)	4.7×10^4
Moderately welded tuff (1.82 g/cm^3)	1.1×10^5
Sandstone	3.4×10^5
Limestone	8.4×10^5
Marble	1.1×10^6
Granite	1.4×10^6

IV. Thermal Conductivity

The thermal conductivity of the tuff is inversely related to porosity, thus, the thermal conductivity of the nonwelded tuff would be less than a welded tuff as more pore space is available for insulation.

The only data available on the thermal conductivity was made of a moderately welded tuff in one area investigated. The following table is a comparison of the thermal properties of the tuff and miscellaneous rock types. A decrease in thermal conductivity increases the insulating value.

Rock Type	Range of Thermal Conductivity $\left(\frac{\text{cal, gm-cm}}{\text{hr x cm}^2 \text{ x oC}}\right)$
Moderately welded tuff	0.38-0.47
Limestone	4.9-11
Sandstone	9.9-20
Marble	17-25
Granite	16-35

V. Mineral Composition

The tuff is rhyolitic in composition and contains small rock fragments of rhyolite, latite and devitrified pumice and crystals and crystal fragments of sanidine and quartz, in a matrix of glass shards and welded ash. Dark minerals are scarce although traces of crystal fragments of biotite, hornblende, and pyroxene have been observed.(2)

Seven samples of a moderately welded tuff were analyzed petrographically by C. S. Ross (written communication, July 7, 1960). Ross recalculated the proportions of phenocrysts in terms of proportion by weight. The results of all seven were similar, one of which is presented here:

Pore space	about 30 percent by volume
Phenocrysts	about 20 percent by weight
Sanidine	12 percent by weight
Quartz	6 percent by weight
Magnetite	1 percent by weight
Pyroxene	± 0.5 percent by weight

The ground mass is typical devitrified welded tuff. The devitrification products are very fine grained, but show typical cristobalite feldspar structure. Cavities contain radial groups of feldspar and tridymite. The rocks contain a few fragments of altered andesite, and some brown birefracting clay like material (probably montmorillonite).

VI. Chemical Composition

The color of the tuff ranges from very light gray to medium dark gray. Some units range from pinkish gray to light pink. Large fragments of pumice that appear much darker than the matrix in some units enchance the color of the tuff. Moderately welded units are generally lighter in color than the welded units. The coloring is inherent in the tuff and probably the result of minor changes in the chemical constituents and heat of emplacement.

In general the tuff is composed namely of silica and alumina. The range in chemical constituents is shown on the following table.

Chemical Constituents	Range (in percent)
Silica (SiO_2)	72.0-78.2
Alumina (Al_2O_3)	11.2-13.8
Ferric oxide (Fe_2O_3)	1.1-2.1
Ferrous oxide (FeO)	.21-.75
Magnesium oxide (MgO)	.02-.33
Calcium oxide (CaO)	.26-1.17
Sodium oxide (Na_2O)	3.5-4.5
Potassium oxide (K_2O)	4.2-4.7
Water (H_2O)	.15-2.8
Titanium oxide (TiO_2)	.10-.32
Phosphorous oxide (P_2O_5)	.10-.07
Manganese oxide (MnO)	.00-.98
Carbon dioxide (CO_2)	<.05

VII. Joints

Joints and joint systems are prominent in the Tshirege Member. The joints divide the rocks into polygonal blocks, many of which are prismatic or columnar.

The joints can be classified into two groups, master joints and minor joints. The term "master joint" signifies those joints that are numerically predominant, are most persistent in length, and pass through several groups of beds.(5)

The master joints can be traced vertically across two or more units of the Tshirege Member. They are vertical or near vertical, dipping more than 80°. The overall vertical trends of the individual master joints are relatively straight; however, they curve slightly through individual units and upon entering a unit of different degree of welding, may be deflected slightly.

The minor joints dip at angles from about 40° to 80° and in most instances, intersect the master joints. These joints are not as persistent as master joints.

Master joint systems in Mortandad Canyon display orientation differences of about 60°.(6) Joint systems mapped at Mesita del Buey also indicate orientation differences of 60°.(7) The angular differences between these joint systems suggest that these sets are conjugate tension joints caused by shrinkage during cooling of the rocks.

HYDROLOGICAL CHARACTERISTS OF THE BANDELIER TUFF

The natural moisture content of the tuff forming the mesas between the eastward-trending canyons is generally less than five percent of volume. Thus, movement of moisture is under unsaturated conditions. The low moisture content of the tuff is caused by the protective cap of clay soil derived by weathering of the tuff near the surface and low rainfall and high evaportranspiration. The hydrologic characteristics of the tuff depend largely upon the degree of welding of the individual ash flows.

I. Hydrologic Effects of Soil

The surfaces of the finger-like mesas which form the Pajarito Plateau are covered by a clayey soil derived by weathering of the underlying tuff of the Tshirege Member. The soil is thickest near the axes of the mesas and thins toward the edges where the tuff is exposed. Thick sections of soil have also developed along slow draining arroyos cut into the surfaces of mesas and in relatively flat areas where water collects and stands, allowing some infiltration into the tuff. The greatest known thickness of soil is at Frijoles Mesa where 2.7 m was logged in a shallow test hole located in a relatively flat area.

Petrographic examination of the soil derived from the Tshirege Member was made by Staritzky of the Los Alamos Scientific Laboratory.(1) He found that the size distribution of the "sand" fraction (greater than 50 microns in diameter) varied between 15 and 38 percent, the "silt" fraction (2 to 50 microns in diameter) varied between 58 and 73 percent, and the "clay fraction" (less than 2 microns in diameter) varied between 4 and 12 percent. Mineralogically, the principal constituents of the soil were quartz and feldspar, and the most important secondary constituents are the clay minerals, montmorillonite and illite. Montmorillonite is know to have the highest base-exchange capacity (85 to 100 millequivalents per 100 grams) and illite the next highest (25 to 30 millequivalents per 100 grams) among the clay minerals.

A study of the natural distribution of moisture in soil and in near surface tuff was made at Frijoles Mesa during a 2-year period. The moisture content in the soil cover, including the transition zone from the soil to weathered tuff, varied according to prevailing weather conditions. The moisture content was highest in March and April as the result of late winter snows and thawing and was generally lowest in the months of August through October owing to high evapotranspiration rates. Water from precipitation rarely infiltrated through the undisturbed soil cover into the underlying tuff and only in an extremely low moisture range (less than 5 percent moisture by volume) within the upper 1 m of the tuff.(2)

The upper two units of moderately welded tuff (thickness about 36.5 m) at Frijoles Mesa blow air through open joints in response to a declining atmospheric pressure; therefore, the soil cover, which prevents most of the precipitation from infiltrating into the underlying tuff, also impedes the exchange of air from the atmosphere to the tuff.(3)

II. Hydrologic Characteristics of Nonwelded, Moderately Welded and Welded Tuff

The hydrologic characteristics of tuff related to porosity, specific yield, specific retention, pore size distribution and hydrologic conductivity were determined of in six units of the Tshirege Member at Frijoles Mesa. These hydrologic characteristics were determined in the laboratory under saturated conditions. As saturated conditions rarely occur in the tuff, these parameters may be of only general interest.

The porosity of the tuff at Frijoles Mesa ranged from 19 to 54 percent by volume; the lowest porosities are in the welded tuffs. Specific yield and specific retention decrease with a decrease in porosity. Specific yield is greater than specific retention in a nonwelded tuff (high porosity); however, as the porosity decreases the difference becomes smaller and low porosity specific retention in a welded tuff may be greater than specific yield.

The relationship of porosity to pore size depends on the degree of welding, thickness of the flow, and position in the flow. The larger pore sizes and greater porosities are near the top of the flow and decrease vertically through the flow. This is due to the larger pores formed by escaping gases near the top and compaction and baking of the middle and lower portion of the flow as it cools.

The hydrologic conductivity is indirectly related to porosity depending upon pore size and the degree of interconnection of the pores. The permeability of the tuff matrix decreases with depth for the same reasons that the porosity decreases.

Hydrologic characteristics of the Tshirege Member of the Bandelier Tuff, as determined in the laboratory are shown in the following table.

Hydrologic Characteristics of the Tshirege Member at Frijoles Mesa

Hydrologic Characteristics						
Unit	Depth below surface of mesa (m)	Degree of welding	Porosity (percent)	Specific yield (percent)	Specific retention (percent)	Range of Hydrologic Conductivity (m/day)
6	0- 19.5	Moderate	38-54	18-34	16-27	0.004-0.25
5	19.5- 20.1	None (sand)	-	-	-	1.4-2.4
4	20.1- 41.1	Moderate	33-54	11-43	12-22	0.012-0.53
3	41.1- 53.3	Nonwelded	48	34	14	0.9
2	53.3- 83.5	Welded	19-37	.6-26	11-21	0.003-0.08
1B	83.5-152.7	Nonwelded	-	-	=	50-2.1

III. Movement of Water

The Tshirege Member is dry beneath the surfaces of the finger-like mesas. The moisture content of the tuff generally is less than 5

percent by volume, even though the specific retention ranges from 11 to 27 percent. Beneath the canyons which contain perennial or intermittent streams, the moisture content of the tuff may be as much as 60 percent by volume; however, the water movement through the tuff is as unsaturated flow. Test holes drilled through alluvium and into the tuff in Water and Mortandad Canyons penetrated thick sections (up to 55 m) of wet tuff (up to 60 percent moisture by volume); however, no free water moved into the test holes.

Instruments were used to measure moisture content of the bore wall in holes constructed in the tuff beneath the stream channel in upper Mortandad Canyon. These holes contained no free water, although the welded tuff beneath the stream contained as much as 25 percent moisture by volume. Specifically constructed moisture access holes in the tuff underlying water perched in the alluvium in lower Mortandad Canyon had moisture contents of the tuff as much as 45 percent by volume but the rock yielded no free water. The welded and nonwelded tuff in the canyon are transmitting water (high moisture content) downward by gravity into the tuff by unsaturated flow. There is some lateral movement by capillarity.

The water in the tuff moves as unsaturated flow. The majority of the pores are of capillary size. The energy relationship with moisture content of a moderately welded tuff was determined by Abrahams[4] (Fig. 1). The saturated moisture content of the tuff was about 41 percent by volume. When moisture contents are below 4 percent there is no movement of water; from 4 to 8 percent moisture is redistributed by diffusion; from 8 to 23 percent distribution is by gravity and capillarity, and above 23 percent the movement is by drainage from gravity.

A study of the movement of water through the tuff was made at Mesita del Buey by adding water to an infiltration pit. The amount of water added was equivalent to 110 years of precipitation on the Pajarito Plateau. The movement of water from an infiltration pit was monitored by a series

of moisture access tubes set in the tuff and a neutron-scattering moisture probe and scaler. The average infiltration rate from a $1m^2$ pit under a constant head of 23 cm of water averaged about 0.34 m/day for a period of about 160 days. The wetted front moving into the tuff was sharpest during the first part of the test. After about 2 months of infiltration moisture had moved downward more than 4.5 m; moisture content ranged as follows: 35 percent by volume at 0.6 m below the pit, 30 percent at 0.9 m, 25 percent at 4 m, and 20 percent at 4.6 m.

IV. Hydrologic Effects of Welding

The uppermost ash flow at Frijoles Mesa exhibits zonal variations of welding in a single cooling unit which causes vertical changes in porosity. The moderately welded flow is about 24 m thick near the center of the mesa. The greatest porosities are in the upper and basal parts of the flow. Lesser porosities (zone of denser welding) are in the lower one-third of the flow, and pore size decreases with increased depth. The following table presents the hydrologic characteristics at different intervals in a single ash flow tuff.

Hydrologic Characteristics of an Ash-Flow Tuff at Frijoles Mesa

Height above base of flow (m)	Porosity (percent)	Specific yield (percent)	Specific retention (percent)	Hydrologic Conductivity (m/day)		Pore Size distribution (percent of porosity)	
				vert.	horiz.	>.01 mm	<.01 mm
17.9	54	35	19	10.082	-	-	-
14.3	50	34	16	0.12	0.12	39	61
14.3	54	38	16	0.25	0.21	26	74
12.2	51	34	17	0.16	0.16	20	80
8.8	49	28	21	0.041	-	-	-
6.7	41	24	17	0.004	0.082	20	80
6.1	47	27	20	0.082	0.082	15	85
5.8	42	23	19	0.041	0.033	-	-
3.6	38	18	20	0.037	0.041	-	-
0.3	51	33	18	0.041	-	17	83
0.3	49	24	25	0.037	0.082	20	80

A decrease in porosity in an ash flow tuff results in a decrease in specific yield and as the specific yield decreases, the specific retention increases proportionately (Fig. 2). The hydrologic conductivity is related to pore size and pore-size distribution rather than porosity. The permeability of the tuff matrix decreases at increased depth with a general decrease in the percentage of pore sizes greater than 0.1 mm.

Variations in vertical and horizontal permeability in the lower one third of the flow may be due to movement and compaction of the ash flow as it cooled. Movement of flow as it cools could result in elongation of the pores in a horizontal plane, and the greatest permeability probably is in this direction. Three of the five horizontal hydrologic conductivities in the lower one third of the flow are greater than the vertical conductivities; however, the conductivity measurements were taken in random directions and no attempt was made at orientation to the probable direction of movement of the flow.

V. Hydrologic Effects of Joints and Contacts

Joints and the fractures in the tuff are capable of transmitting fluid. The interconnection of the joint system is an important aspect of the hydrologic regime.

Joints in moderately welded to welded tuff of the Tshirege Member range from closed to open. Locally the amount of opening is as much a 5 cm; however, the majority of joints are open less than 1 cm. All joints terminating at the base of the soil zone, which covers the surfaces of the mesas, are filled with a light-brown clay. The depth of clay filling varies from 0.9 to 1.2 m below the soil zone at Mesita del Buey and Frijoles Mesa. The joint openings are plated with clay to depths of 21 m at Frijoles Mesa. Some of the joints are filled or plated with a light-gray clay. The light-gray clay is derived from weathering of the tuff and is composed of minerals leached from the tuff by water. This clay was precipitated along the joint openings prior to the development

of moisture access tubes set in the tuff and a neutron-scattering moisture probe and scaler. The average infiltration rate from a $1m^2$ pit under a constant head of 23 cm of water averaged about 0.34 m/day for a period of about 160 days. The wetted front moving into the tuff was sharpest during the first part of the test. After about 2 months of infiltration moisture had moved downward more than 4.5 m; moisture content ranged as follows: 35 percent by volume at 0.6 m below the pit, 30 percent at 0.9 m, 25 percent at 4 m, and 20 percent at 4.6 m.

IV. Hydrologic Effects of Welding

The uppermost ash flow at Frijoles Mesa exhibits zonal variations of welding in a single cooling unit which causes vertical changes in porosity. The moderately welded flow is about 24 m thick near the center of the mesa. The greatest porosities are in the upper and basal parts of the flow. Lesser porosities (zone of denser welding) are in the lower one-third of the flow, and pore size decreases with increased depth. The following table presents the hydrologic characteristics at different intervals in a single ash flow tuff.

Hydrologic Characteristics of an Ash-Flow Tuff at Frijoles Mesa

Height above base of flow (m)	Porosity (percent)	Specific yield (percent)	Specific retention (percent)	Hydrologic Conductivity (m/day)		Pore Size distribution (percent of porosity)	
				vert.	horiz.	>.01 mm	<.01 mm
17.9	54	35	19	10.082	-	-	-
14.3	50	34	16	0.12	0.12	39	61
14.3	54	38	16	0.25	0.21	26	74
12.2	51	34	17	0.16	0.16	20	80
8.8	49	28	21	0.041	-	-	-
6.7	41	24	17	0.004	0.082	20	80
6.1	47	27	20	0.082	0.082	15	85
5.8	42	23	19	0.041	0.033	-	-
3.6	38	18	20	0.037	0.041	-	-
0.3	51	33	18	0.041	-	17	83
0.3	49	24	25	0.037	0.082	20	80

A decrease in porosity in an ash flow tuff results in a decrease in specific yield and as the specific yield decreases, the specific retention increases proportionately (Fig. 2). The hydrologic conductivity is related to pore size and pore-size distribution rather than porosity. The permeability of the tuff matrix decreases at increased depth with a general decrease in the percentage of pore sizes greater than 0.1 mm.

Variations in vertical and horizontal permeability in the lower one third of the flow may be due to movement and compaction of the ash flow as it cooled. Movement of flow as it cools could result in elongation of the pores in a horizontal plane, and the greatest permeability probably is in this direction. Three of the five horizontal hydrologic conductivities in the lower one third of the flow are greater than the vertical conductivities; however, the conductivity measurements were taken in random directions and no attempt was made at orientation to the probable direction of movement of the flow.

V. Hydrologic Effects of Joints and Contacts

Joints and the fractures in the tuff are capable of transmitting fluid. The interconnection of the joint system is an important aspect of the hydrologic regime.

Joints in moderately welded to welded tuff of the Tshirege Member range from closed to open. Locally the amount of opening is as much a 5 cm; however, the majority of joints are open less than 1 cm. All joints terminating at the base of the soil zone, which covers the surfaces of the mesas, are filled with a light-brown clay. The depth of clay filling varies from 0.9 to 1.2 m below the soil zone at Mesita del Buey and Frijoles Mesa. The joint openings are plated with clay to depths of 21 m at Frijoles Mesa. Some of the joints are filled or plated with a light-gray clay. The light-gray clay is derived from weathering of the tuff and is composed of minerals leached from the tuff by water. This clay was precipitated along the joint openings prior to the development

of the soil zone. The joints are interconnected and master joints transect one or more flows. Joints are more numerous and open in ash flows of moderately welded to welded tuffs than in nonwelded tuff.

Joints in the moderately welded to welded tuffs will transmit depending upon availability of large volumes of water and the amount of opening and the degree of interconnection between different joint systems. More than 15,000 m^3 of drilling fluid was lost while drilling 300 m of Bandelier Tuff at Frijoles Mesa. Most of the loss was in the upper 150 m in the Tshirege Member which here consist of moderately welded to welded tuff in which open joints are numerous. During grouting of a casing in a large diameter hole at Frijoles Mesa (a 76 cm dia., 15.2 m depth casing filled with water to prevent collapse), the bottom seal in the casing ruptured and the water from within the casing drained into the formation within 3 hours. The number and orientation of joints in the hole were determined before the casing was installed. A joint near the bottom was open 1 to 3 cm for about 1.2 m. The 6.9 m^3 of water moved into the joint and downward into the joint systems of the underlying flow. Observation of another large-diameter hole 15.2 deep and located 7.6 m to the north failed to disclose a trace of the water.

The experiment at Mesita del Buey indicated that water from the infiltration pit (42 m^3 of water equivalent of 110 years of precipitation on the Pajarito Plateau) moved downward through a moderately welded tuff into a pumice zone which is more porous and permeable. Movement in the pumiceous zone was lateral. Infiltration into a moderately welded tuff underlying the pumice zone was from near the center of the saturated area in the pumiceous lense. The moisture content of the upper moderately welded tuff was much lower than the underlying pumiceous zone, which indicates that specific retention of the pumice zone is greater.

Vertical infiltration through the Tshirege Member would be affected by zonal variations of welding as well as by horizontal contacts between flows.

Vertical changes in hydrologic conductivity caused by contacts between flows tend to perch infiltrating water. In the stream channel in Mortandad Canyon, water is returned to the surface from underflow in the alluvium and in a moderately welded tuff at the contact with a nonwelded tuff.

Industrial wastes discharged into surface water in Acid Canyon move into the joints and tuff of the Tshirege Member, are perched on the top of the Otowi Member, and then move laterally along the contact into a seep area at the junction of Acid and Pueblo Canyons.

Results of an infiltration experiment in the soil near TA-50 indicated that precipitation that is not removed by surface drainage infiltrates into the soil on the mesas of the Pajarito Plateau; however, the downward movement of this water is impeded or stopped by the dense transition zone between the soil and tuff and the water is returned to the atmosphere by evapotranspiration.[2] During this experiment, the amount of water added to the soil was equivalent to 50 years of precipitation on the Pajarito Plateau.

REFERENCES

Abrahams 1961: J. H. Abrahams, J. E. Weir, and W. D. Purtymun, "Distribution of Moisture in Soil and Near-Surface Tuff on the Pajarito Plateau, Los Alamos County, New Mexico," US Geol. Prof. Paper 424-D (1961).

Cooper 1965: J. B. Cooper, W. D. Purtymun, and E. C. John, "Records of Water Supply Wells Guaje Canyon 6, Pajarito Mesa 1, and Pajarito Mesa 2, Los Alamos, New Mexico, Basic Data Report," US Geol. Survey Open-File Report (July 1965).

Cushman 1965: R. L. Cushman, "An Evaluation of the Aquifer and Well Characteristics of the Municipal Well Fields in Los Alamos and Guaje Canyons near Los Alamos, New Mexico," US Geological Survey Water Supply Paper 1809-D (1965).

Griggs 1964: R. L. Griggs, "Geology and Ground Water Resources of the Los Alamos Area, New Mexico," US Geological Survey Water Supply Paper 1753 (1964).

Nyhan 1978: J. W. Nyhan, L. W. Hacker, T. E. Calhoun, and D. L. Young, "Soil Survey of Los Alamos County, New Mexico," Los Alamos Scientific Laboratory report LA-6779-MS (1978).

Purtymun 1971: W. D. Purtymun and W. R. Kennedy, "Geology and Hydrology of Mesita del Buey," Los Alamos Scientific Laboratory Report LA-4660 (1971).

Purtymun 1973: W. D. Purtymun, "Underground Movement of Tritium from Solid Waste Storage Shafts," Los Alamos Scientific Laboraotry LA-5286-MS (May 1973).

Purtymun 1974: W. D. Purtymun, F. C. Koopman, S. Barr, and W. E. Clements, "Air Volume and Energy Transfer Through Test Holes and Atmospheric Pressure Effects on the Main Aquifer," Los Alamos Scientific Laboratory report LA-5725-MS (1974).

Purtymun 1975: W. D. Purtymun, "Geohydrology of the Pajarito Plateau with Reference to Quality of Water: 1949-1972," Los Alamos National Laboratory Informal Report (December 1975).

Purtymun 1978: W. D. Purtymun, M. L. Wheeler, and M. A. Rogers, "Geologic Description of Cores from Holes P-3 MH-1 through P-3 MH-5, Area G, Technical Area 54," Los Alamos Scientific Laboratory report LA-7308-MS (May 1978).

Purtymun 1980A: W. D. Purtymun and H. Adams, "Geohydrology of Bandelier National Monument, New Mexico," Los Alamos Scientific Laboratory report LA-8461-MS (July 1980).

Purtymun 1980B: W. D. Purtymun, R. J. Peters, and J. W. Owens, "Geohydrology of White Rock Canyon of the Rio Grande from Otowi to Frijoles Canyon," Los Alamos Scientific Laboratory report LA-8635-MS (December 1980).

Purtymun 1984: W. D. Purtymun, "Hydrology of the Main Aquifer with Reference to Location of Additional Water Supply Wells," Los Alamos National Laboratory report LA-9957-MS (January 1984).

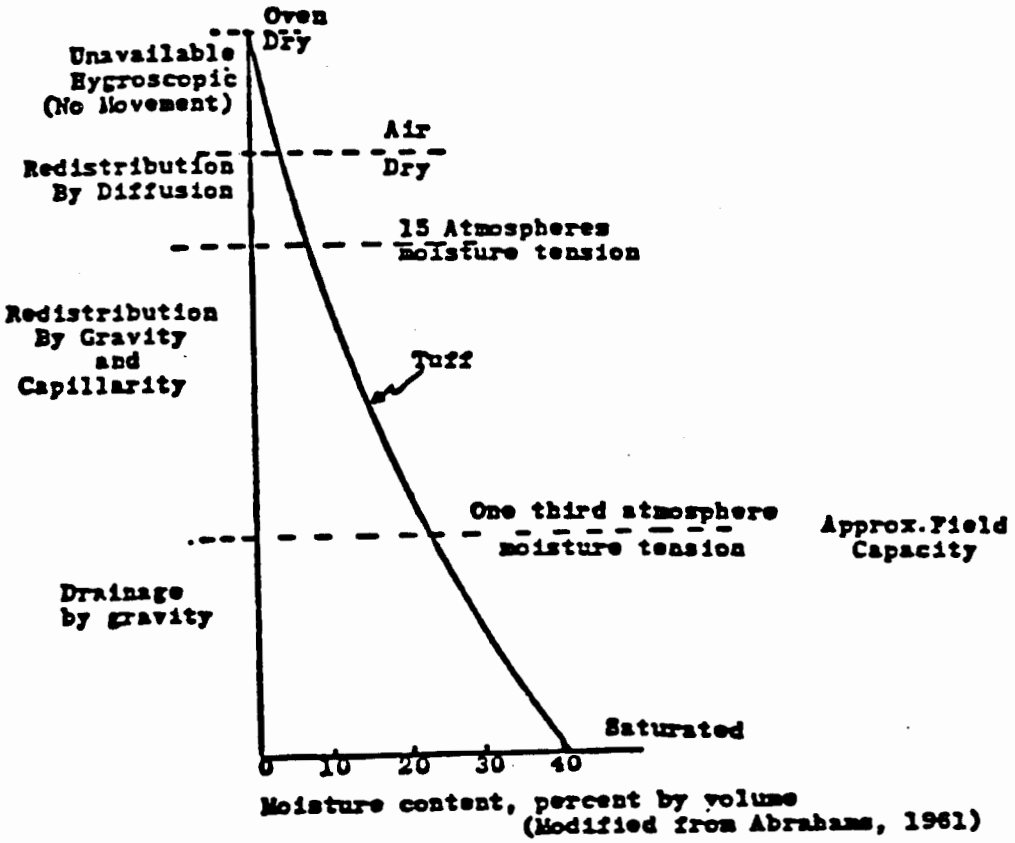


Figure 1. Energy relationships with moisture content of tuff.

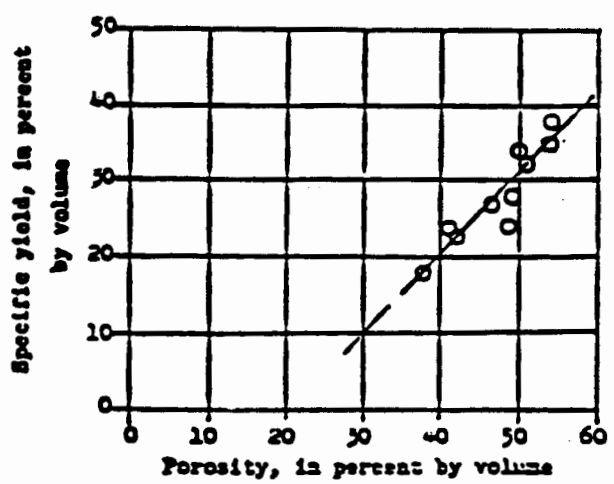


Figure 2. Relationship of specific yield to porosity of the tuff.

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544
TELEPHONE:

OFFICE MEMORANDUM

TO : Margaret Ann Rogers, H-8

DATE: December 12, 1973

FROM : Bill Purtymun and Linda Trocki, H-8

SUBJECT: PERCENT MOISTURE BY WEIGHT FROM AUGER HOLES IN PIT #7, Area G

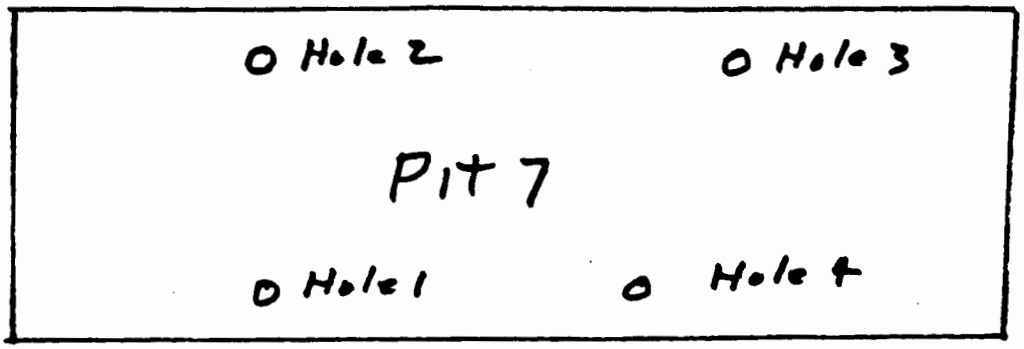
SYMBOL : H8-73-M296

Depth	9-17-73 Hole #1	9-20-73 Hole #4	9-18-73 Hole #2	9-20-73 Hole #3
0-5'	.7	5.5	1.2	1.0
5-10'	.4	.5	.6	.5
10-15'	.7	.1	.3	.6
15-20'	.9	.4	.3	2.1
20-25'	.7	.3	.2	2.4
25-30'	.7	.4	.4	.3
30-35'	.7	.3	.2	.3
35-40'	.3	.4	.5	.5
40-45'	.3	2.0	.3	.5
45-50'	.9	.5	.3	.5
50-55'	1.2			
55-60'	2.3			
60-65'	2.0			
65-70'	.9			
70-75'	1.7			
75-80'	.7			
80-85'	1.4			
85-95'	1.7			
95-107'	3.0			
107-117'	2.5			

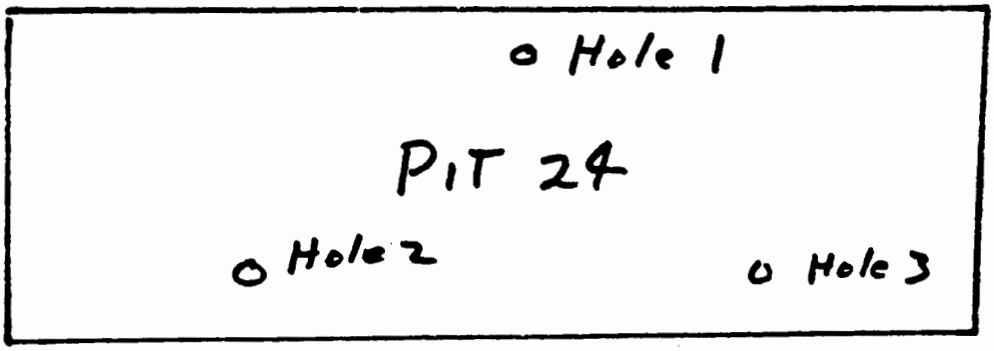
Table 2. - Radiochemical analyses of tuff from test hole 21B.

Description	Depth (feet)	Picocuries per gram					Microgram per gram
		Gross Alpha	Gross Beta	^{238}Pu	^{239}Pu	^{137}Cs	Natural uranium
Unit 2b							
Upper ashflow	0-10	6	2	b/	0.005	c/	0.20
Reworked Material	10-15	8	a/	b/	b/	c/	.28
Lower Ashflow	15-40	7	a/	b/	b/	c/	.24
Unit 2a							
Upper Ashflow	40-60	7	a/	b/	b/	c/	.31

a/ Below limits of detection 1 pCi/g
b/ Below limits of detection 0.002 pCi/g
c/ Below limits of detection 2 pCi/g



Not to scale



Sketch Map showing test Hole in Pits 7 and 24

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544
TELEPHONE:

OFFICE MEMORANDUM

TO : Merlin Wheeler, H-8 DATE: February 7, 1974

FROM : William D. Purtymun, H-8

SUBJECT: MOISTURE CONTENTS OF CUTTINGS FROM AUGER HOLES IN PITS 7, 8 AND 24, AREA G.

SYMBOL : H8-74-M64

Attached is memo H8-73-M296 with the results of data from four test holes in Pit 7. The following table presents data from Pit 24. Moisture contents are in percent by weight. Also attached is a sketch map of locations.

Pit 24

Depth (feet)	Hole 1	Hole 2	Hole 3
0-5	0.9	2.4	0.1
5-10	1.1	2.3	1.9
10-15	0.8	4.2	0.2
15-20	1.0	0.6	0.3
20-25	0.3	0.5	0.5
25-30	0.3	0.5	0.3
30-35	0.5	0.1	0.3
35-40	0.6	0.3	0.5
40-45	3.2	0.3	1.3
45-52	3.4	0.6	1.2

Test holes in Pits 7 and 24 were logged at 2 foot intervals with the neutron moisture sonde for background information. The moisture content of the tuff was below limits of the calibration curve which is ~ 5 percent moisture by volume. My calculations indicate that in the low range of ~ 5 to 10 percent by volume the moisture will be redistributed by diffusion. Above ~ 10 percent distribution would be by diffusion and capillary with some effect of gravity.

As yet I don't have a profile showing bottom elevations of Pits 7 and 24 for correlation purposes; however, drilling breaks were indicated at 15 to 17 feet in Pit 7 and at 19 - 24 feet in Pit 24 which are about the contacts of Unit 2b and Unit 2a. A second drilling break occurred ~ 50±5 feet in both pits. The second contact is between Unit 2a and Unit 1b and is shown by a slight increase in moisture contents in Hole 1 (Pit 7), and Holes 1 and 3 (Pit 24) indicating a change in the hydrologic characteristic of the two ashflow units.

The increase in moisture content of the tuff as the result of water ponding in a pit left open over a period of years is shown in the data from holes drilled in Pit 8 in January 1974. Pit 8 was constructed in the summer of 1971. Background data (Memo H8-MZ371 attached) indicated that the moisture content of cutting from Hole 8A drilled in August 1971 ranged from 0.2 to 1.4 percent by weight. The moisture content of the tuff in cuttings from the three holes drilled in January 1974 ranged from 1.6 to 9.8 percent by weight.

The following table presents the moisture content (in percent by weight) of cuttings from three test holes drilled in January 1974 in the floor of Pit 8.

Pit 8

Depth (feet)	Hole 1	Hole 2	Hole 3
0-5	8.7	8.5	8.2
5-10	9.3	9.8	7.1
10-15	8.6	8.2	8.1
15-20	7.5	4.1	8.1
20-25	6.0	4.0	5.2
25-30	2.8	1.9	2.5
30-35	2.5	1.6	2.2
35-40	3.4	2.4	2.3
40-45	3.6	3.5	3.1
45-50	3.9	3.9	3.7

Note: Hole 1 North Side of Drums - East
Hole 2 North Side of Drums - West
Hole 3 South Side of Drums
Ref - Memo H-8-WM-90

Background data related to radioactivity in cuttings from select test holes in Pits 7 and 24 are being tabulated. Trust this is the information you wanted.

WDP:ET

Attachments 3

CY: J. A. Mohrbacker, H-8, MS-737
Keith Schiager, H-8, MS-490
Margaret Ann Rogers, H-8, MS-522

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

OFFICE MEMORANDUM

TO : J. Mohrbacher, H-8 DATE: February 13, 1974

FROM : M. Wheeler, H-8

SUBJECT : MOISTURE AND TRITIUM CONCENTRATIONS IN FILL MATERIAL, AREA G, TA-54

SYMBOL : H8-WM-112

Abstract

Soil samples were collected from the fill material overlying Pit No. 1 and Pit No. 2, Area G, to depths of 3.8 metres. Moisture contents varied between 3 and 13% but generally showed a similar trend with depth at all sample points. Penetration of annual precipitation appears to occur to depths of two to three metres. The moisture contents were above those observed in undisturbed tuff, and below those occurring in natural soils. Further field investigations will be required to determine actual moisture movement rates.

Tritium concentrations were significantly higher than normal background. Concentration gradients indicate that tritium is diffusing towards and perhaps out of the soil surface. No atmospheric sampling data is available concerning the quantities of tritium in the air above this site.

Sampling Procedures

In early December, 1973, samples were collected of the cover material on Pits 1 & 2, Area G, TA-54. Material was collected by two methods; holes were drilled using a four-inch power auger, and samples of the material brought to the surface were collected at regular depth intervals; a split-spoon sampler was driven into the material with an impact hammer, returned to the surface, and the samples removed from the sampler.

The samples were analyzed for moisture content using standard gravimetric techniques. Moisture samples were removed from the soil by heat distillation and analyzed for tritium content. Selected samples will be analyzed for pl tonium, cesium, and strontium. A summary of the resultant data is summarized in Table 1. The technique used in collecting the samples is indicated in the table. A sketch map of the location of the sample holes is presented as Fig. 1.

The various sample holes are of varying depths, primarily reflecting thickness of cover material in the various locations. Great care was taken to cease penetration at the first indication that waste material was being encountered. A thorough monitoring of the samples and sampling equipment performed by an H-1 monitor, indicated no detectable contamination.

After the drilling was completed, the holes were backfilled a short distance, and a 2-inch plastic pipe placed in the hole. The hole was backfilled around the pipe, and the pipe was capped. These casings will be used as access tubes for a neutron moisture meter to provide further monitoring of moisture movement in the fill material.

Three additional sets of holes have been drilled in tuff material underlying disposal pits which were not in full service.[1] Samples were collected using the power auger described above, and analyzed for moisture content. A summary of data from selected holes in Pits 7, 8, and 24 is presented in Table 2. Analysis for tritium was not performed. However, data from field investigations in 1971 indicated that background tritium concentrations in undisturbed tuff are on the order of 10-20 pico-curies/millilitre.[2]

Discussion

The fill material on Pit No. 1 and Pit No. 2 appears to have been undisturbed since covering was completed in April 1961 and July 1963, respectively. This lack of disturbance is indicated by the presence of mature specimens of Chrysothamnus parrihowardi (rabbitbrush) in the vicinity of the sample holes. This plant species requires ten to twenty years to reach adult size.

In general, a peak in the water content was located at one to two metres depth. Below this interval moisture contents decreased with depth, and then at depths of about three metres remained somewhat constant with depth. This indicates that moisture penetration by precipitation is confined primarily to the upper 2 to 3 metres of material. Penetration below that depth may occur during years of unusually high precipitation, and from slow redistribution of near-surface moisture.

Moisture contents were well below field capacity values (estimated as 15-20% for this material) indicating that moisture movement is primarily caused by capillary forces. No actual movement rates can be inferred from this data without additional field measurements. The variation in moisture contents observed between the fill on Pit No. 1 and that on Pit No. 2 may be due either to variations in soil conductivity or differences in surface slopes. Further work is planned to substantiate this.

It is interesting to compare the moisture content of the fill material with that of the tuff beneath disposal Pits 7, 8, and 24. Pits 7 and 24 were constructed in the fall of 1973, and the bottoms had been exposed to precipitation for only a few months when the moisture samples were collected. The moisture contents are similar to, or lower than those recorded in other, undisturbed portions of the tuff.[3] Pit No. 8 was constructed in August 1971, and was thus exposed to precipitation for more than two years. Water is known to have accumulated in the bottom of the pit on at least one occasion (September, 1973).[4] This increased moisture input is reflected in the higher moisture contents observed beneath Pit No. 8, compared with Pits 7 and 24.

No firm comparison can be made between the moisture transmitting capacity of the fill material (crushed tuff) and the undisturbed tuff. However, the similarity of the moisture regime beneath Pit No. 8 and that in the fill material indicates that the transmission capabilities of the

two materials are in the same range of values. Generally speaking, both material can be characterized as "poor conductors" of moisture. For comparison, moisture contents of undisturbed natural soils range up to 20% by weight at depths of one to two metres.[3]

The recorded tritium concentrations are of considerable interest. Environmental monitoring in the Los Alamos area indicates that background tritium concentrations are in the range of 10-20 pico-curies/millilitre,[2,5] for both soils and near surface tuff. The tritium concentrations observed in the fill on Pit No. 1 are more than three orders of magnitude higher than this. A search of disposal records for that pit did not reveal any single item that would appear to be a source of the tritium. Several entries recorded the disposal of 50-100 curie quantities of tritium, but none were in the near vicinity of the moisture sample holes. The significant concentration gradient towards the surface, indicates that tritium is diffusing towards, and perhaps out of the ground surface. Additional monitoring will be necessary to determine the actual quantities of tritium entering the atmosphere or vegetation at this site.

Conclusion

Moisture sampling data indicates that precipitation is penetrating to a depth of one to two metres in the fill material. The material appears to have about the same moisture transmission capacity as undisturbed tuff, both materials being lower than natural soils in the area.

Unusually high tritium concentrations were observed in the fill on Pit No. 1, but cannot be attributed to any specific source. Tritium appears to be migrating towards the ground surface.

MLW:jb

cc: L. Johnson, H-8
W. Purtymun, H-8
M. A. Rogers, H-8
K. Schiager, H-8

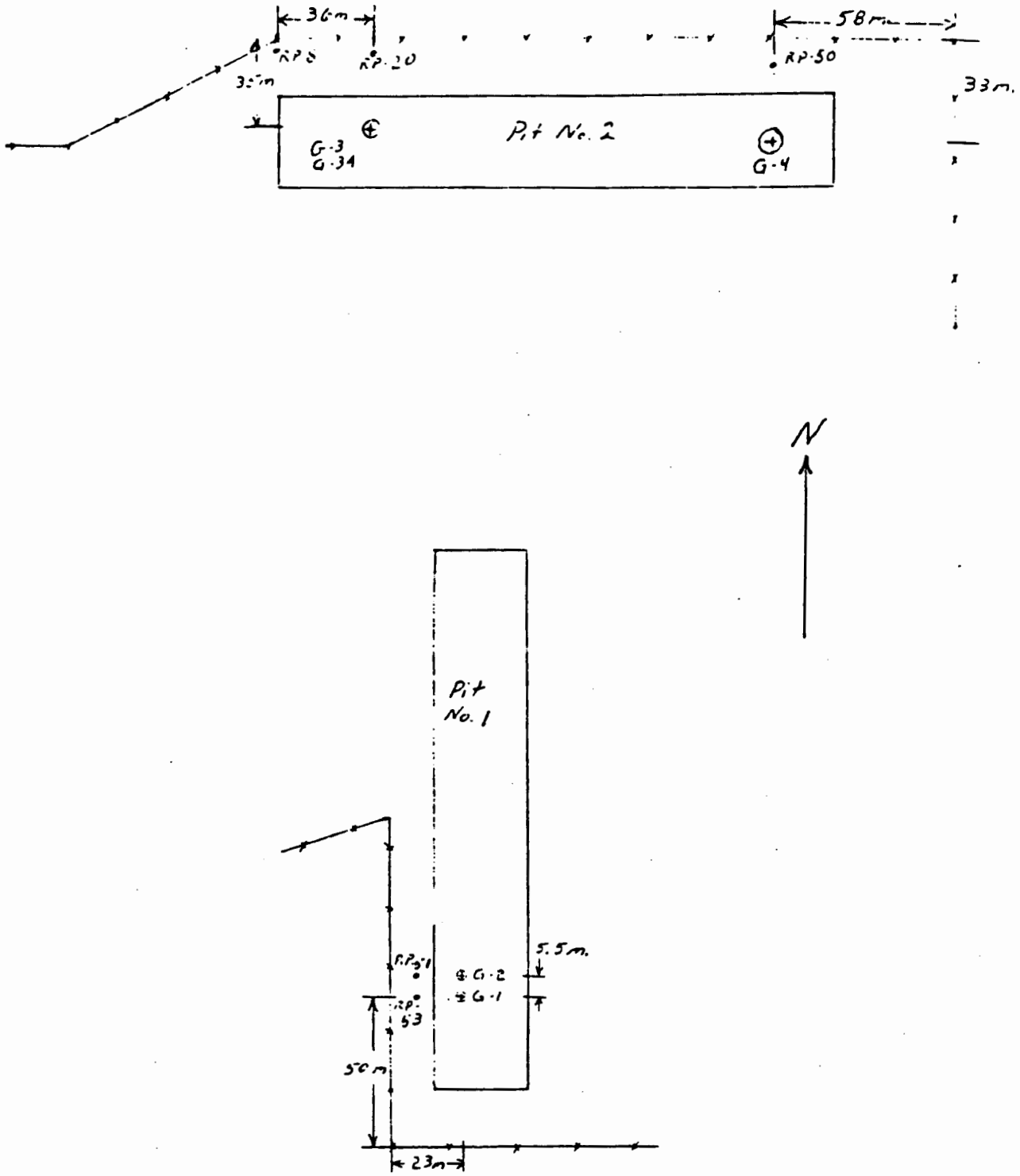


Fig. 1. Location of Sample Holes

Table 1. Data Summary, Moisture Samples, Area G. Auger Holes in Fill Material Covering Pi

Hole No.	Depth Interval m.	Moisture Content % by wt.	Tritium Content pCi/ml Water	Location
G-1 (Split spoon)	0-0.7	10.1	4 246	S.W. End Pit No. 1
	0.7-1.5	13.1	14 823	
	1.5-2.3	10.1	38 207	
	2.3-3.1	8.2	57 850	
	3.1-3.5	8.3	102 042	
G-2 (Auger)	0-0.8	9.5	7 280	S.W. End, Pit No. 1
	0.8-1.5	11.7	6 977	
	1.5-2.3	11.4	19 557	
	2.3-3.1	7.5	130 426	
	3.1-3.8	7.0	297 271	
G-3 (Split spoon)	0-0.8	3.3	685	N.W. End, Pit No. 2
	0.8-1.5	4.8	698	
	1.5-2.0	4.8	835	
G-3A (Auger)	0-0.9	3.3	645	N.W. End, Pit No. 2
	0.9-1.5	5.7	841	
	1.5-2.3	4.7	908	
	2.3-3.1	5.0	935	
G-4 (Auger)	0-0.8	5.0	157	S.W. End, Pit No. 2
	0.8-1.2	3.9	443	

Table 2. Moisture Content of Tuff, Area G

Depth (metres)	Moisture Content, Percent by Weight					
	Pit 24		Pit 7		Pit 8	
	Hole 1	Hole 2	Hole 1	Hole 2	Hole 1	Hole 2
0-1.5	0.9	2.4	0.7	1.2	8.7	8.5
1.5-3	1.1	2.3	0.4	0.6	9.3	9.8
3-4.5	0.8	4.2	0.7	0.3	8.6	8.2
4.5-6	1.0	0.6	0.9	0.3	7.5	4.1
6-7.5	0.3	0.5	0.7	0.2	6.0	4.0
7.5-9	0.3	0.5	0.7	0.4	2.8	1.9
9-10.5	0.5	0.1	0.7	0.2	2.5	1.6
10.5-12	0.6	0.3	0.3	0.5	3.4	2.4
12-13/5	3/2	0.3	0.3	0.3	3.6	3.5
13.5-15	3.4	0.6	0.9	0.3	3.9	3.9

References

1. W. Purtymun, LASL internal document. Memo to M. Wheeler providing data on moisture content of tuff beneath Pits 7, 8, and 24. (Feb. 7, 1974).

2. H. Jordan, LASL internal document. Memo to Dean Meyer detailing moisture and tritium concentrations in tuff beneath disposal areas (Dec. 2, 1971).

3. J. H. Abrahams, Jr., J. E. Weir, Jr., and W. D. Purtymun, "Distribution of Moisture in Soil and Near-Surface Tuff on the Pajarito Plateau, Los Alamos County, New Mexico". U. S. Geological Survey, Prof. Paper 424-D, 1961.

4. M. A. Rogers, Personal communication September 1973.

5. J. E. Herceg, Environmental Monitoring in the vicinity of the Los Alamos Scientific Laboratory, Calendar Year 1972. Los Alamos document, LA-5184, March 1973).

ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544
TELEPHONE:

OFFICE MEMORANDUM

TO : John Finley, ENG-DO

DATE: March 19, 1974

FROM : William D. Purtymun, H-8 WDP

SUBJECT: TEST HOLES AT BLDG. TA-16

SYMBOL : H8-74-126

Three lithologic units were penetrated by test holes at Bldg. 260 at TA-16. They were clays, outwash of sand, gravel, boulders and a moderately welded ashflow tuff.

The clay ranges from dark gray to light orange in color. The darker clays contained some sand and gravel while the light orange clay contained no sand or gravel. The clay in general overlies the outwash of sand, gravel and boulders. The clays are bentonite which have the ability to adsorb and absorb water and swell accordingly.

The sand, gravel and boulders are outwash from intermittent streams that spread alluvial debris from the flanks of the mountains west of TA-16 onto the surface of the plateau. The alluvial debris is of tuff, latite, rhyolite and quartz latite. There are stringers or lenses of clay in the alluvial outwash.

The tuff underlying the outwash is moderately welded. The upper 3 to 4 feet is weathered to a light orange while the underlying unweathered unit is a light pinkish gray.

The outwash sand, gravel and boulders at the time of testing were saturated. In front of Bldg. 260 most of the holes were filled with water. The asphalt formed a confining layer. The recharge is from snowmelt in the drainage ditches cut in the outwash west of the paved areas. Most of the holes flowed after completion. The water in the gravel is seasonal with higher water tables occurring during the spring and summer. Water in the outwash probably dries up in early summer and late fall due to lack of precipitation.

The clay unit that underlies Bays 11, 12, and 13 are subject to a wetting and drying cycle that causes swelling and shrinkage of the clay. Stabilization of the foundation will probably require extension of the foundation into the gravel and drainage of the gravel overlying tuff.

A generalized cross-section and location of test holes is attached as are tables showing logs of the test holes and moisture contents.

Lee Hilton, WX-3 is preparing a map showing exact location of the test holes.

WDP:et

Attachments (3)

Cys: H. E. Ballance, WX-3
W. I. Norwood, WX-3
Tom Chandler, WX-3
Dean Keller, ENG-1

TABLE I

Log of Test Holes

		Interval (in feet)
TH-1	Sand, Gravel and boulders	0 - 2.5
TH-2	Sand, gravel, with minor amounts of clay	0 - 3
	Gravels and boulders	3 - 7.5
	Boulders	7.5
TH-3	Sand, Gravel and Boulders with minor amounts of clay	0 - 9.5
	Tuff, weathered, light orange, weathered	9.5 - 14
	Tuff, light pinkish gray, moderately welded	14 - 19
TH-4	Clay, dark gray	0 - 1
	Clay, light orange	1 - 4.5
	Boulders	4.5
TH-4A	Clay, light orange	0 - 4
	Boulders	4
TH-4B	Clay, light orange	0 - 4
	Boulders	4
TH-5	Clay, light orange	0- 3.5
	Boulders	3.5
TH-6	Clay light orange	0 - 4
	Boulders	4
TH-7	Clay, light orange	0 - 4
	Boulders	4
TH-8	Clay, light orange	0 - 4.5
	Sand, gravel, boulders with some clay lenses	4.5 - 14
	Tuff, weathered, light orange to brownish gray	14 - 19
	Tuff, welded, dark gray	19
TH-9	Clay, light orange	0 - 4.5
	Boulder	4.5
TH-10	Clay, light brown	0 - 3.5
	Sand gravel and boulders	3.5 - 5
	Boulder	5

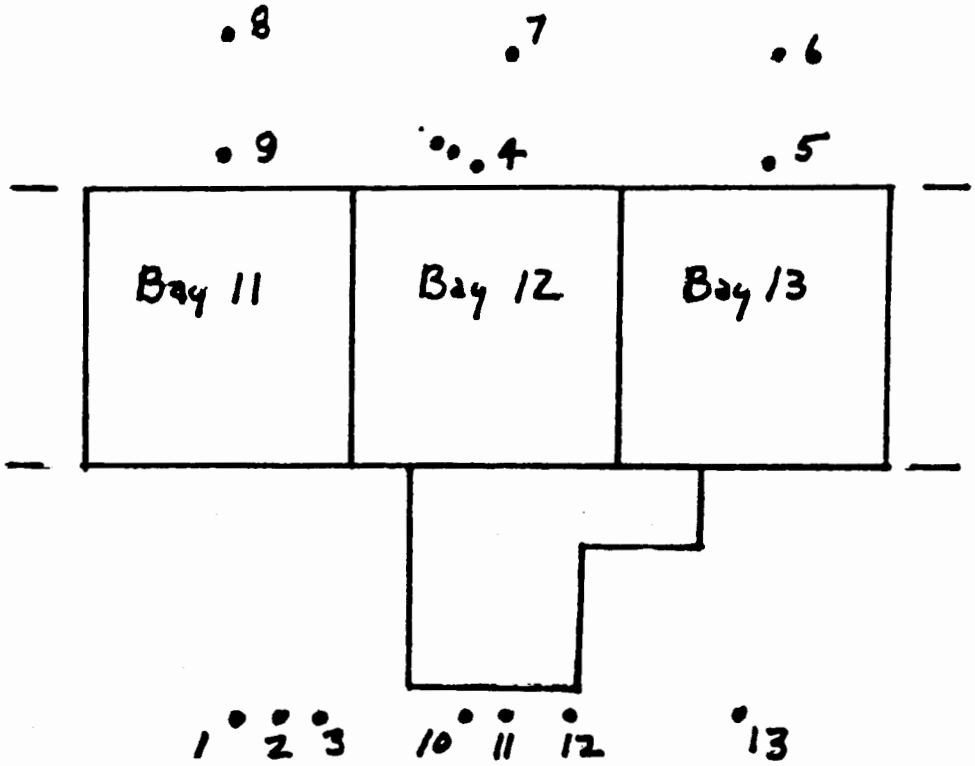
TABLE I Continued

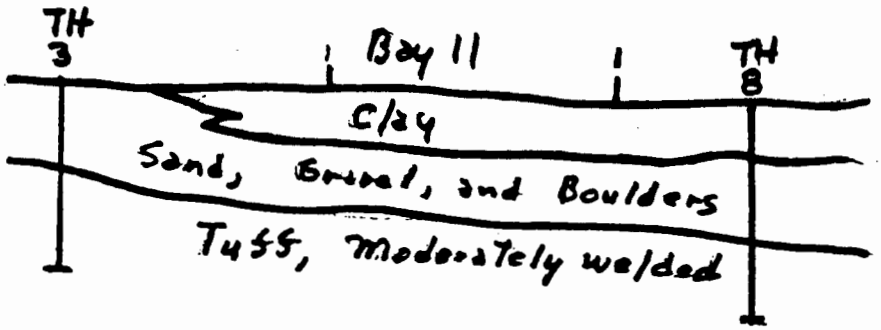
		Interval (in feet)
TH-11	Sand gravel with some clay	0 - 2.5
	Boulder	2.5
TH-12	Sand, gravel with some clay	0 - 2.5
	Sand, gravel and boulders with minor amounts of clay	2.5 - 7
	Boulders	7 - 9
	Tuff, light orange to light pinkish gray	9 - 18
TH-13	Sand and gravels	0 - 6
	Clay, dark gray	6 - 8
	Sand, gravel and boulders	8 - 10
	Tuff, weathered, light orange	10 - 14
	Tuff, light pinkish gray, moderately welded	14 - 17.5

TABLE II

Moisture Content of Cuttings

Interval (feet)	Test Holes												
	1	2	3	4	5	6	7	8	9	10	11	12	13
0 - 2.5	16	8	16	21	20		20	19	20	21	19	18	18
2.5 - 5	9	--	10	19	17		16	17	15	19	--	18	13
5 - 7.5	10		13	19	--		--	13	--	--		22	19
7.5 - 10	--		9	--				18				26	14
10 - 12.5			14					19					14
12.5 - 15			13					18				30	13
15 - 17.5			14					15				25	12
17.5 - 20			12					15				--	--





Generalized Section (not to scale)

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544
TELEPHONE:

OFFICE MEMORANDUM

TO : M. C. Smith, Group Leader, Q-22 DATE: April 2, 1974

FROM : Wm. D. Purtymun, H-8 and Francis West, Q-22

SUBJECT: EXPLORATORY TEST HOLE IN VOLCANICS WITH POSSIBLE COMPLETION AS A SMALL YIELD WATER SUPPLY.

SYMBOL : H8-74-140

The following data was compiled at the request of Don Brown in regards to data obtained during the initial phase of drilling GT-2.

The geophysical and lithologic logs of test hole GT-2, Fenton Hill Site indicated water is perched in the volcanics overlying the Abo Formation. An exploratory hole would be necessary to determine if an adequate water supply could be developed for the site.

The volcanics at the site are about 450 feet thick. The Bandelier Tuff extends from land surface to a depth of about 360 ft. The Paliza Formation from 360 to 410 ft. and the Abiquiu Tuff from 410 to 450 ft. The Bandelier Tuff is composed of a series of moderately welded to welded ash flow tuff that are ryholitic in composition. The Paliza Formation is an andesite basaltic breccia and is underlain by the Abiquiu Tuff that is a tuffaceous sand and conglomerate.

The geophysical logs of GT-2 indicated about 40 feet of saturated thickness in the volcanics (Paliza Canyon and Abiquiu Tuff). The presence of water in this section was noted by drilling condition of GT-2. Water bearing characteristics could not be determined as the hole was drilled using fluids as a cutting carrier.

The velocity log of GT-2 indicated a saturated section from a depth of 410 to 450 feet in the volcanics that is perched on the Abo Formation. The Abo is composed of shales, siltstones, and fine grained sandstones. The Paliza Canyon is a fairly stable formation while the Abiquiu Tuff is loosely consolidated and friable. The caliper log on GT-2 through the Abiquiu section indicated washout while the Paliza Canyon remained stable. The electric log indicated porosity and fresh water in the interval from 410 to 450 feet.

Generalized contours on top of the Abo Formation (using test holes GT-1, GT-2, A and D for control) indicate the surface of the Abo Formation dip to the west south west at about 80 feet per mile (Fig. 1). The water in the volcanic would move down dip perched on

the Abo Formation.

The contours on top of the Abo are generalized as the upper surface is very irregular, forming high and low areas, cut by erosion, that were later filled with volcanics. The water in the volcanics will move down dip filling these low areas while in some of the high areas the Abo may be above the water table.

The springs and seeps in Lake Fork (elevation 7890 ft) and Virgin Canyon (elevation 7750 ft) discharge from the volcanics overlying the Abo. The discharge forms perennial stream that flows in the Rio Guadalupe. The spring at elevation 8120 is perched in the volcanics.

The ground water divide in the volcanics between the Fenton Hill Site and the valley cut by San Antonio Creek occurs along the north-south trending fault that was mapped by Smith and other (1970). The spring at elevation 7950 ft. (Horse Shoe Spring) discharges from the base of the volcanics on the down thrown side of the fault. Along the Jemez River the base of the volcanics are 300 to 500 feet below the base of the volcanics to the south and south east of the Fenton Hill Site. The difference in elevation probably occurs along Virgin Canyon and due in part to erosion and in part to a probable fault that is down thrown to the east. The spring at elevations of 7300 and 7460 ft discharge from the base of the volcanics while the spring at 7560 ft discharges from a perched zone in the volcanics. The springs at elevations 7300 and 7460 ft are used for water supply at Jemez Springs. The ground water divide probably occurs along Virgin Canyon.

Test Hole A (elevation 8329 ft) was reported to have little or no water in the volcanics GT-1 (elevation 8315) was drilled using fluid as a carrier so that no hydrologic observation could be made prior to casing the hole through the volcanic. Test Hole D (elevation 7830) contains water in the volcanic that rose to a depth of ~30 ft below land surface.

The springs in Lake Fork and Virgin Canyon as well as the geophysical logs of GT-2 indicated water in the volcanics. A hole drilled by cable-tool method would be necessary to determine if a supply for this site could be constructed. There is a limited area for recharge to the aquifer in the volcanics east of the site and there is always the possibility of drilling into a high area of the Abo where the volcanics would be dry. Limited ground water storage could occur in the low areas between the highs. Thus due to the geologic and hydrologic conditions in the area a hole drilled into the volcanics at the Fenton Hill Site for a water supply should be considered an exploratory hole

until tested to determine if an adequate ground water supply could be developed.

The specifications for an exploratory hole and possible completion as a water supply well are attached.

SPECIFICATIONS FOR AN EXPLORATORY HOLE AND POSSIBLE COMPLETION AS A WATER WELL

Scope of Work

The contractor shall furnish all labor, material, equipment, and maintenance of equipment to perform all work required to drill, case, test, and develop one exploratory hole to a depth of about 450 ft using cable-tool equipment. The anticipated log of the exploratory hole to be located at TA-57, Fenton Hill Site in Sandoval County is as follows:

	Depth (feet)	
	From	To
Tuff moderately welded and weld ash flows	0	360
Basaltic breccia	360	410
Tuffaceous sand and conglomerate	410	450

Anticipated water level ~360 ft.

The thickness of the saturated thickness of the volcanic rocks penetrated above the Abo Formation (red beds) will determine if the hole will be completed as a well.

Specifications:

1. The drilling contractor must be licensed by the New Mexico State Engineer to drill in the Rio Grande Basin. The contractor shall secure the necessary permit to drill and test the exploratory hole from the State Engineer.

2. The proposed exploratory hole is to be drilled as follows:
   a. Drill a 12 or 14 inch diameter hole to a depth of about 20 ft and set 10 3/4 inch casing (the 10 3/4 inch casing will be furnished by LASL). The 10 3/4 inch casing will be cemented with a slurry grout from top to bottom by the contractor.
   b. Drill an 8 inch diameter hole to a depth of about 450 ft through the volcanics into the top of the Abo Formation (red beds).

c. The saturated thickness of volcanics encountered and hydrologic characteristics of the section will determine further completion of the exploratory hole. This decision will be made by the contractor in agreement with a LASL representative.

2. Casing construction of the exploratory hole is as follows:

a. The length of the screen or perforated (slotted casing) will be determined by the contractor in agreement with a representative of LASL. The type and size of the openings in screen or perforated casing will be determined by the contractor in agreement with a LASL representative to allow minimum entrance of sand to the cased well.

b. The screen or perforated pipe will be run with 6 inch ID standard pipe (welded or threaded) to the required depth of about 450 ft. The screen and/or perforated pipe will be furnished by the contractor. The casing and screen and/or perforated pipe will be set by the contractor.

c. The casing shall be secured at the surface in an approved manner (i. e. welded to I beams) and hung in tension in the hole.

3. Development and test of the exploratory hole is outlined as follows:

a. The contractor will provide bailing tests not to exceed 2 hours in each perched water zone above a depth of 350 feet as requested by a LASL representative chargeable to LASL as an hourly rate.

b. The contractor will provide testing by pumping for a period of at least 24 hours to determine the type and size of the pump and adequacy of the well for water supply.

4. General specifications are as follows:

a. The contractor will provide LASL with cuttings from each 5 foot interval in depth during drilling of the 8 inch diameter hole.

b. during the 24 hour test a representative of LASL will be present. Water levels will be determined prior to, during and after the test. Pumping rates will be determined at hourly intervals during the test.

WDP:et

cc: Don Brown, Q-22
Bob Hendron, Q-22
Francis West, Q-22

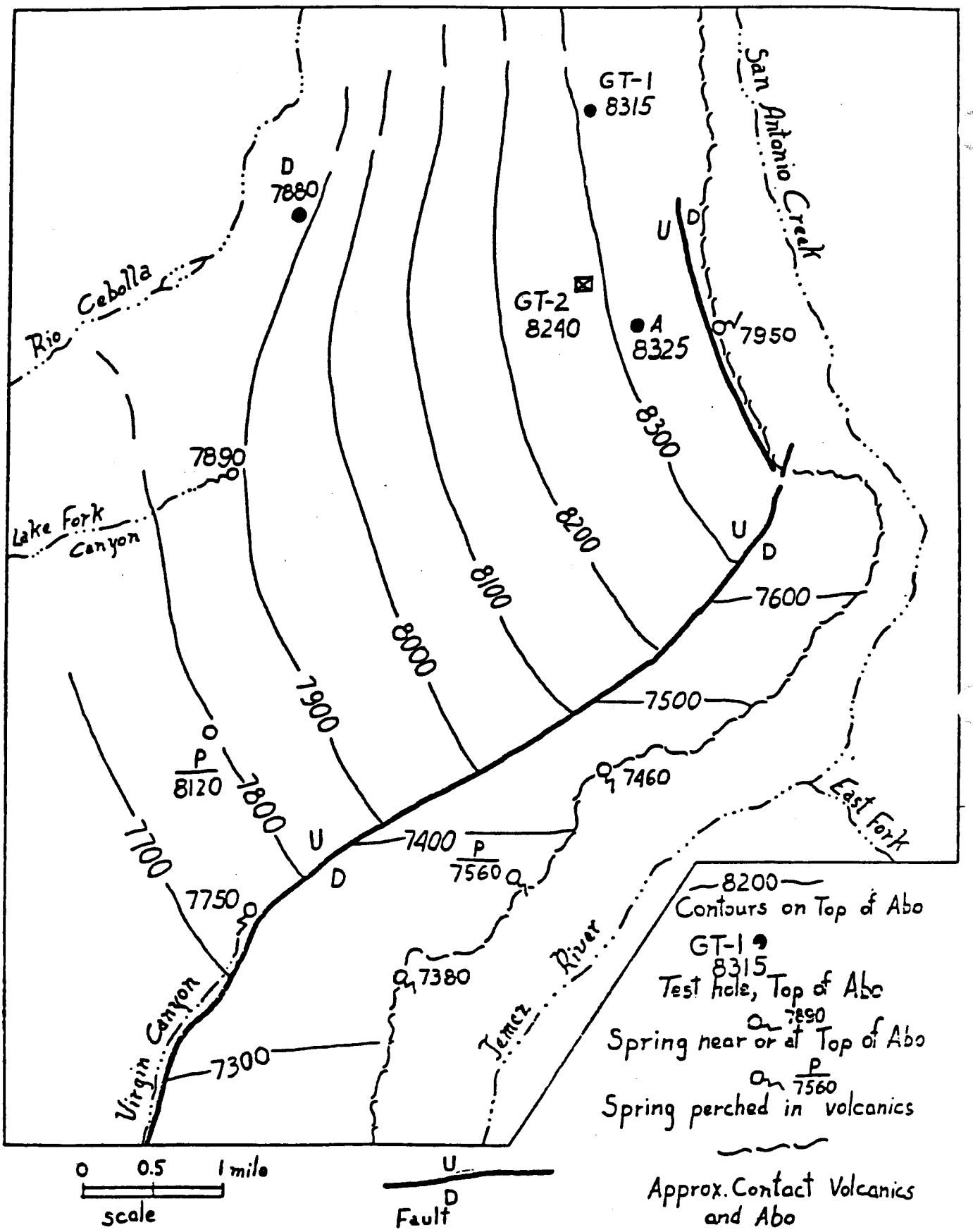


Fig. 1. Structure contours on the top of Abo Formation.

Approximate Cost of the Exploratory Hole

1.	a. Drilling 12 or 14 inch to a depth of about 20 ft and cementing in 10 3/4 inch casing	$300
	b. Drilling 8 inch hole to about 450 ft at $8 a ft.[1/]	3600
2.	a. Casing 6 inch ID standard pipe about 430 ft at $5 a ft.	2150
	b. Stainless steel screen 20 ft at $60 a ft = $1200 OR perforated standard 6 inch ID pipes 20 ft at $12 a ft $240[2/]	1200
3.	a. Hourly rate for testing and development 12 hrs at $25 an hr.	750
	b. Testing by pumping for 24 hours at $30 an hour	720
	Estimated total	$8720

1/ Contract terminates at 1.b if no water encountered
2/ Type of casing depends on sand size in aquifer.

May 1974

FLOOD-FREQUENCY AND MAXIMUM DISCHARGE OF SIXTEEN DRAINAGE AREAS IN THE VICINITY OF LOS ALAMOS

BY

William D. Purtymun

And

Linda Trocki

ABSTRACT

Flood-frequency and maximum discharge were compiled by a theoretical method for 2, 5, 10, 25 and 50 year recurrence intervals. The data for the drainage areas was compiled at the U.S. Atomic Energy Commission Boundary along the eastern edge of the Pajarito Plateau or at the Rio Grande. The data will provide a basis for environment studies and design criteria for facilities. The only areas in which flooding may occur are the canyon floors.

I. INTRODUCTION

Surface water drainage across the Pajarito Plateau is eastward from the Sierra de los Valles to the Rio Grande (Fig. 1). The intermittent streams have cut deep canyons, forming a series of "finger-like" mesas that comprise the surface of the Pajarito Plateau. There are no perennial streams in the Los Alamos area that flow from the mountains to the Rio Grande. Some of the large canyons on the flanks of the mountains contain perennial streams. The stream flow in these canyons is lost to evapotranspiration and into the alluvium and underlying rocks at the western edge of the plateau.

Runoff from the heavy snows on the mountains may reach the Rio Grande in two of the larger canyons, Los Alamos and Pajarito, for several weeks during the spring. Heavy intense thunderstorms cause runoff in the canyons during the summer. These flood conditions occur for only a few hours and only in the vicinity of the stream channel on the canyon floor. The "finger-like" mesas of the plateau are well drained with no possibility of flooding.

The canyons are in a youthful stage of erosion which is characterized by steep canyon walls and V-shaped cross-sectionof the valley profile. There are no flood plains along the channels and intermittent runoff continues down-cutting on the canyon floor. Any excessive runoff or flood flow caused by heavy summer storms will be concentrated in a small cross-section of the existing channel.

Surface water data necessary to evaluate the flood-frequency and maximum discharge in the canyons of the Los Alamos area does not

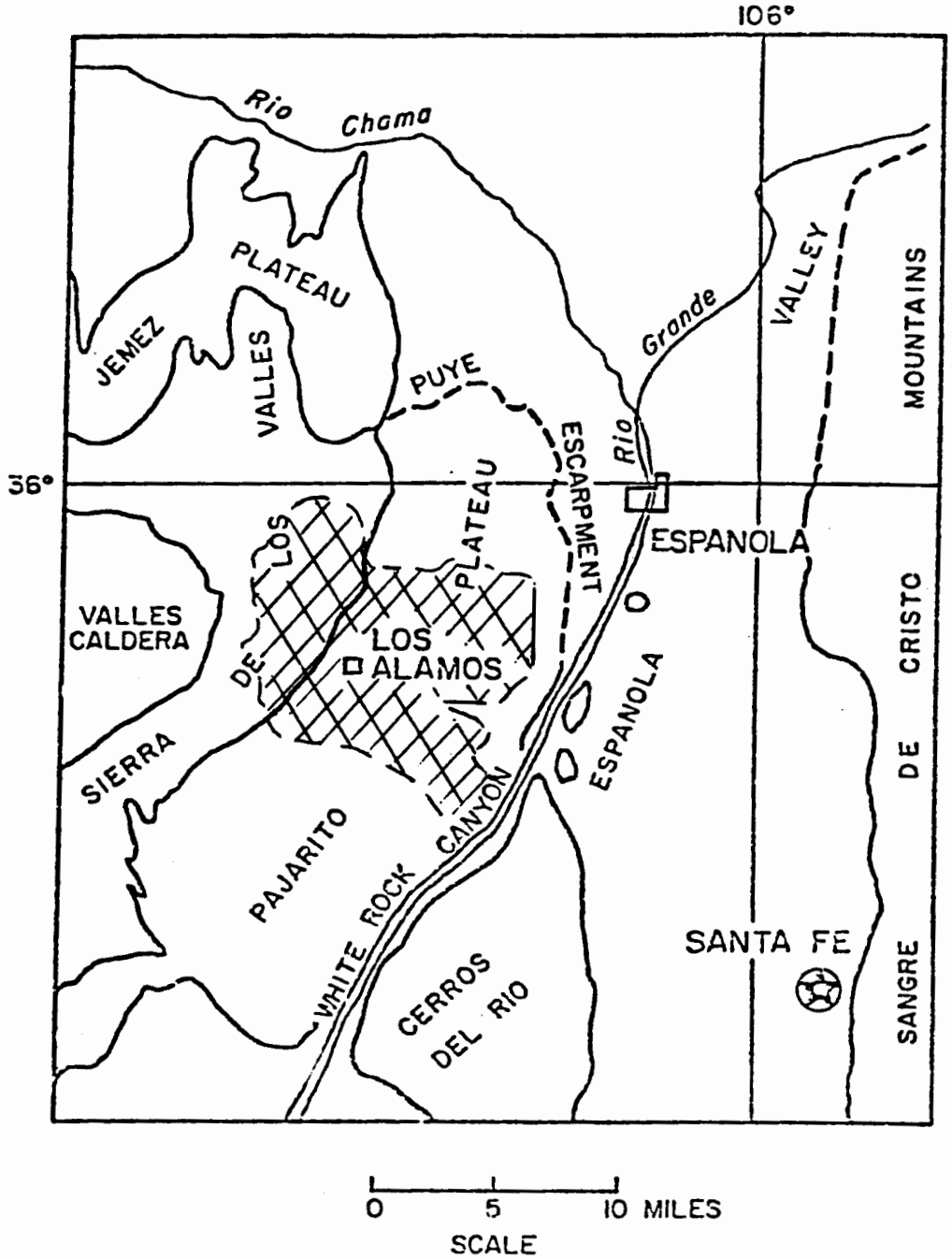
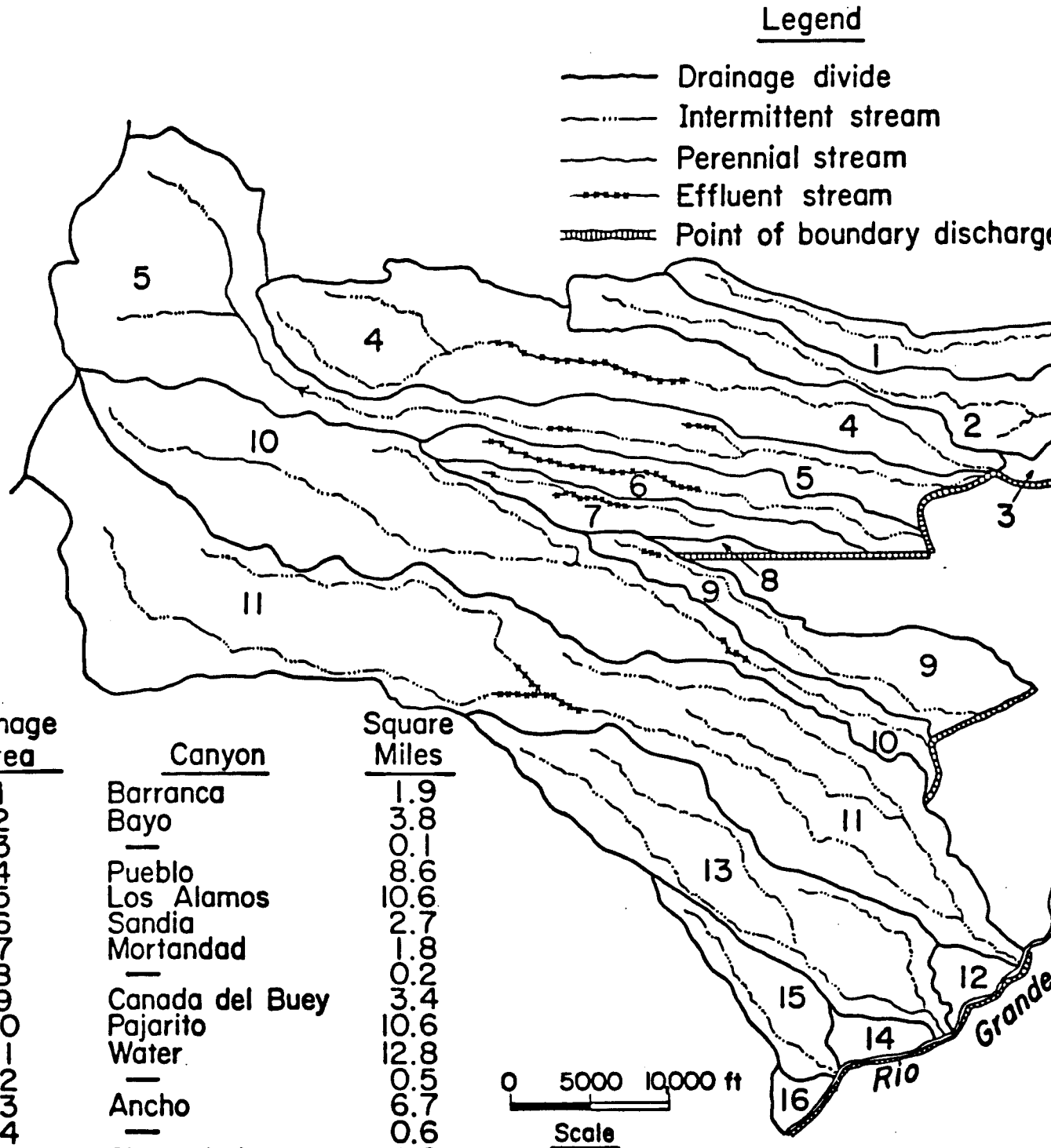


Figure 1. Physiographic features of the Los Alamos area showing drainage investigated.



Drainage Area	Canyon	Square Miles
1	Barranca	1.9
2	Bayo	3.8
3	—	0.1
4	Pueblo	8.6
5	Los Alamos	10.6
6	Sandia	2.7
7	Mortandad	1.8
8	—	0.2
9	Canada del Buey	3.4
10	Pajarito	10.6
11	Water	12.8
12	—	0.5
13	Ancho	6.7
14	—	0.6
15	Chaquehui	1.8
16	—	0.4

Figure 2. Drainage Areas and Points of Boundary Discharges

exist. Thus, theoretical data results have been obtained for 16 drainage areas (Fig. 2). The flood-frequency and maximum discharge have been computed at the U. S. Atomic Energy Commission Boundary along the eastern edge of the Pajarito Plateau or at the Rio Grande.

The data have been compiled to provide a basis for environmental studies and design criteria for facilities which in the future may be located in the canyon bottoms.

II. FLOOD-FREQUENCY AND MAXIMUM DISCHARGE

The flood-frequency and maximum discharge for 16 drainage areas were derived from nomographs devised by Scott.[1] The method uses empirical relationships between existing flood data at gaged sites and the physical and climatic conditions of the corresponding drainage basin. The nomographs are then used to estimate flood frequency from the appropriate physical and climatic conditions in areas where no direct flood data exist.

The peak discharges of 2, 5, 10, 25 and 50 year recurrence intervals were determined for each of the drainage areas containing a well defined channel from nomographs presented by Scott for Region 1 which includes the Rio Grande watershed in North-Central New Mexico.

The climatic data used with the nomographs as determined at Los Alamos were a mean minimum January temperature of 8°F and a maximum 24-hour 2 year rainfall of 1.69 inches. Each drainage area in square miles above the AEC Boundary was determined by use

of a planimeter. The main channel slope, in feet per mile, was computed from topographic maps at points 10 and 85 percent of the distance from discharge point at the boundary and drainage divide. The difference in altitude between those two points divided by the distance between the points was used to compute the main channel slope for drainage areas.

The flood-frequency or "recurrence interval" is the average interval of time during which a flood of a given magnitude is equaled or exceeded once. A flood with a recurrence interval of 50 years is the flood that is equaled or exceeded once in 50 years, on the long term average. The concept implies no regularity in the time of recurrence of a given magnitude flood. It is possible for two or more 50 year floods to occur within a short period of time, or many more than 50 years may elapse before the occurrence for one 50 year flood.

Frequencies may be expressed in terms of probabilities, i. e. the probability of the occurrence of a 10 year flood in any given year is 1 in 10 or 0. 1 ; the probability of a 50 year flood in any given year is 1 in 50 or 0. 02.

A. Drainage Area - (Barranca Canyon)

Barranca Canyon heads on the Pajarito Plateau at an altitude of about 7, 200 ft. The stream in the canyon is intermittent. There is no release of effluent into the canyon. The flood-frequency and maximum discharge are based on the following data:

Drainage Area 1.9 square miles

Main channel slope 205 ft. per mile

Frequency	Maximum Discharge (Cfs)[1]
2-year	55
5-year	145
10-year	235
25-year	430
50-year	500

1/ Cubic feet per second

B. Drainage Area 2 (Bayo Canyon)

Bayo Canyon heads on the Pajarito Plateau at an altitude of about 6,680 ft. The stream in the canyon is intermittent. There is no release of effluent into the canyon.

Drainage Area 3.8 square mile

Main Channel Slope 150 ft. per mile

Frequency	Maximum Discharge (Cfs)
2-year	85
5-year	215
10-year	300
25-year	595
50-year	675

C. Drainage Area 3

Drainage Area 3 consists of an area of 0.1 sq. miles on the south facing wall of Los Alamos Canyon. The flood-frequency and maximum discharge were not computed as no major drainage channel exists.

E. Drainage Area 4 (Pueblo Canyon)

Pueblo Canyon heads on the flanks of the Sierra de los Valles at an altitude of about 9,000 ft. Stream flow in the canyon is intermittent; however, there are two reaches, one near the western edge and the other near the eastern edge of the plateau, that receive treated sewage effluent (fig. 2). The effluent infiltrates into the alluvium or is lost to evapotranspiration prior to reaching the AEC Boundary. There is a small amount of water in the alluvium recharged from the effluents and storm runoff. The amount varies, with seasonal larger volumes occurring in the spring and late summer from snow melt and summer thundershowers.

Drainage Area 8.6 square miles

Main channel slope 175 ft. per mile

Frequency	Maximum Discharge (Cfs)
2-year	110
5-year	250
10-year	370
25-year	590
50-year	740

F. Drainage Area 5 (Los Alamos Canyon)

Los Alamos Canyon heads on the Sierra de los Valles at an altitude of 10,400 ft. The stream in the canyon cuts into the flanks of the mountains and is perennial. Stream flow is impounded at Los

Alamos Reservoir at an altitude of about 7,600 ft. The reservoir has a storage capacity of about 4 acre-feet. Below the reservoir stream flow is intermittent. Minor amounts of effluent are released from a sewage treatment plant and cooling tower blow down near the western edge of the plateau. Sewage and industrial effluents are released into a tributary canyon near the center of the plateau. The effluents do not reach Los Alamos Canyon as they are lost to evapotranspiration and into the alluvium above the confluence. The alluvium contains some water perched on the underlying rock. The volume is seasonal.

Drainage Area 10.6 square miles

Mean Channel Slope 210 ft. per mile

Frequency	Maximum Discharge (Cfs)
2-years	105
5-years	240
10-years	360
25-years	560
50-years	710

G. Drainage Area 6 (Sandia Canyon)

Sandia Canyon heads on the Pajarito Plateau at an altitude of 7,500 ft. Stream flow in the canyon is intermittent. Sewage

effluents and water from a cooling process at the Power Plant are released into the upper reaches of the canyon. Some water in the alluvium probably occurs in the western part of the plateau from the effluent and storm runoff.

Drainage Area 2.7 square miles

Main Channel Slope 145 feet per mile

Frequency	Maximum Discharge (Cfs)
2-years	70
5-years	190
10-years	300
25-years	560
50-years	625

H. Drainage Area 7 (Mortandad Canyon)

Mortandad Canyon heads on the Pajarito Plateau at an altitude of 7,440 ft. Stream flow in the canyon is intermittent. Cooling water from a technical area and industrial effluents are released into the canyon near the center of the plateau. These effluents and storm runoff maintain a body of perched water in the alluvium. The water in the alluvium is of limited extent, terminating about 2 miles west of the AEC Boundary. The loss to evapotranspiration and into the underlying tuff maintains a balance with the surface water recharge. The canyon is unique as the alluvium is over 100 ft. thick at the

boundary. Since hydrologic observation began in the canyon in 1959 surface runoff has not been sufficient to move from the upper canyon to the AEC Boundary, due in part to the large volume of unsaturated alluvium and the low gradient of the channel in the lower part of the canyon. The stream channel in the lower part of the canyon is discontinuous, braiding out on the canyon floor. Thus as a main channel is not well defined, the canyon does not lend itself to the theoretical flood frequencies and maximum discharge analyses.

Drainage Area 1.8 square miles

Main Channel Slope 155 feet per mile.

I. Drainage Area 8

The small segment of a south facing wall of a mesa contains no major drainage channel. The area is about 0.2 square miles.

J. Drainage Area 9 (Canada del Buey)

Canada del Buey heads on the Pajarito Plateau at an altitude of about 7,240 ft. The stream in the canyon is intermittent. A small amount of water from a cooling process is released into the canyon in its upper reach.

Drainage Area 3.4 square miles

Main Channel Slope 110 ft. per mile.

Frequency	Maximum Discharge (Cfs)
2-years	90
5-years	220
10-years	330
25-years	680
50-years	730

K. Drainage Area 10 (Pajarito Canyon)

Pajarito Canyon heads on the Sierra de los Valles at an altitude of about 10,400 ft. Several of the canyons that are confluent with Pajarito contain perennial streams on the flanks of the mountains and the western part of the plateau. Very little effluent is released into the canyon. The surface water from precipitation is sufficient to maintain water in the alluvium. The volume varies and is seasonal, dependent on recharge from snow melt and summer showers.

Drainage Area 10.6 square miles

Main Channel Slope 205 ft. per mile

Frequency	Maximum Discharge (Cfs)
2-years	105
5-years	250
10-years	355
25-years	580
50-years	700

L. Drainage Area 11 (Water Canyon)

Water Canyon heads on the Sierra de los Valles at an altitude of 10,400 ft. Some perennial flow occurs in the main stem of the canyon

on the flanks of the mountains. Treated sewage effluent is released along with waste water from technical areas along the western part of the plateau.

Drainage Area 12.8 square miles

Main Channel Slope 260 ft. per mile

Frequency	Maximum Discharge (Cfs)
2-years	100
5-years	240
10-years	340
25-years	500
50-years	650

M. Drainage Area 12

Drainage Area 12 is a steep canyon wall on the west side of the Rio Grande with an area of 0.5 sq. miles. No main channel exists so the flood frequency and maximum discharge were not computed.

N. Drainage Area 13 (Ancho Canyon)

Ancho Canyon heads on the Pajarito Plateau at an altitude of 7,280 ft. Stream flow in the canyon is intermittent except in the lower reach. In the lower reach to the Rio Grande the stream flow is perennial, fed by a spring discharging from the main aquifer.

Drainage Area 6.7 square miles

Main Channel Slope 235 ft. per mile

Frequency	Maximum Discharge (Cfs)
2-years	80
5-years	190
10-years	290
25-years	480
50-years	600

O. Drainage Area 14

Drainage Area 14 is a steep canyon wall on the west side of the Rio Grande that contains no well defined drainage channel. Drainage area is 0.6 square miles.

P. Drainage Area 15 (Chaquehui Canyon)

Chaquehui Canyon heads on the eastern part of the plateau at an altitude of 6720 ft. The stream in the canyon is intermittent. The main channel drops precipitously from the plateau to the Rio Grande.

Drainage Area 1.8 square miles

Main Channel Slope 410 ft. per mile.

Frequency	Maximum Discharge (Cfs)
2-years	40
5-years	105
10-years	160
25-years	290
50-years	350

Q. Drainage Area 16

Drainage Area 16 forms a steep wall on the west side of the Rio Grande. The basin contains no main channel. The drainage area is about 0.4 sq. mile.

III. CONCLUSION

The only areas subject to flooding are along the existing channels of the canyon floors. The surface of the mesas are well drained and present no flood problems.

Of the sixteen drainage areas investigated, only 10 contained well defined channels that were applicable for theoretical flood frequency and maximum discharge analyses. The following table illustrates the frequency in relation to the range and average of the maximum discharge of the 10 drainage areas.

	Maximum Discharge 1/	
Frequency	Range	Average
2-year	40-110	85
5-year	105-250	205
10-Year	160-370	305
25-year	290-680	525
50-year	350-740	625

REFERENCES

1. Arthur G. Scott, "Preliminary Flood-Frequency Relations and Summary of Maximum Discharges in New Mexico," U.S. Geol. Survey Open-file rept. (1971).

S ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

OFFICE MEMORANDUM

TO : DISTRIBUTION

DATE: September 10, 1974

FROM : Robert W. Turner

SUBJECT : FUSION TEST REACTOR (FTR) - SITE SELECTION STUDY, LJ 5263-3

SYMBOL : ENG-9

All investigation and touring of the eight sites selected for consideration has been completed.

As the result of the tours, investigation, and discussion, I am submitting the following recommendations:

First recommendation - Site 1.
Second recommendation - Site 2.

A draft copy of the study is attached. Please review the draft and submit your comments to me either prior to or during a review meeting which will be held on September 17, 1974, in the ENGINEERING DEPARTMENT conference room, C-246, Building SM-43, to discuss the study draft, and finalize the site selection. Meeting time is 3:00 p.m.

Robert W. Turner
Acting Group Leader
Facilities Planning

Distribution:

R. W. Drake, WX-DO
L. A. Emelity, H-7
G. D. Lemon, ENG-8
E. Cunnington, ENG-8
W. D. Purtymun, H-8
L. L. Bailey, ENG-9
W. A. Bradley, ENG-7
A. M. Valentine, H-1
D. L. Houck, ENG-9
E. L. Brazier, ENG-DO/QA
V. J. Stephens, ENG-DO/DC
R. W. Richardson, ENG-9
R. W. Turner, ENG-9 (Chairman)
E. L. Kemp, CTR-4
G. A. Sawyer, CTR-DO
K. Schiager, H-8
D. J. Keigher, H-3
D. Davidson, H-3
C. D. Montgomery, ENG-9
K. I. Thomassen, CTR-7
T. E. McDonald, CTR-4
R. J. Kingsbury, ENG-DO/PL
C. R. Dyer, ENG-9
L. J. 5263-3

DRAFT

FUSION TEST REACTOR (FTR)

SITE SELECTION STUDY

Prepared by
The Engineering Department
Los Alamos Scientific Laboratory
University of California
Los Alamos, New Mexico

Robert W. Turner, ENG-9
September 6, 1974
LJ 5263-3

FUSION TEST REACTOR (FTR)

SITE SELECTION STUDY

CONTENTS

SECTION 1 - SITE SELECTION STUDY

1.1 GENERAL

1.2 AREA CHARACTERISTICS

1.2.1 Meteorology

1.2.2 Hydrology

1.2.3 Geology

1.2.4 Seismicity

1.2.5 Other Physical Considerations

1.3 SELECTION OF SITES FOR INITIAL STUDY

1.3.1 Population

1.3.2 Hazards

1.3.3 Topography

1.3.4 Accessibility

1.4 DESCRIPTION OF SITES

1.5 SITE ELIMINATION

1.6 POPULATION DISTRIBUTION

1.7 COST EVALUATION

1.8 RECOMMENDATIONS

SECTION 2 - POPULATION DISTRIBUTION CONSIDERATIONS

2.1 SITE EVALUATION ON RADIATION BASIS

2.2 POPULATION DISTRIBUTION

2.3 TRANSPORT WIND FIELDS

A. General Geology and Hydrology

The major geological features of the Los Alamos area are the Valles Caldera and the Sierra de los Valles on the west and the Pajarito Plateau that forms an apron around the eastern flanks of the Sierra de los Valles (Fig. 1). The Valles Caldera was an active volcanic center in early Pleistocene time.[1] Eruptions spread layers of tuff and pumice on the eastern slopes of the Sierra de los Valles. The ashflows from these erruptions resulted in deposition of tuff more than 305 m thick, which form the gently sloping surface of the Pajarito Plateau.

The Pajarito Plateau is on the western margin of the Rio Grande depression which extends from southern Colorado through central New Mexico into Northern Mexico. The depression, a structural feature, range from 40 to 50 km in width at Los Alamos. The depression is filled with 2100 to 3600 m of volcanics and sediments above the basement complex of Precambrian crystalline rocks.

The major structural feature on the Pajarito Plateau is the Pajarito Fault Zone that trends north-south along the western edge of the plateau. The fault zone forms a break in slope between the mountains and the plateau. Several minor faults occur on the plateau and in areas to the north of the community of Los Alamos.

A general description is presented of the rocks that outcrop and are found in the subsurface of the plateau. They are in ascending order, from oldest to youngest, the Tesuque, Tschicoma, and Puye Formations and the Bandelier Tuff.

The Tesuque Formation consists of siltstones, sandstones, with lenses of clay and pebbly conglomerates. Interbedded with the sediments is an occassional basalt flow. Total thickness of the formation is unknown, but exceeds 700 m based on test hole penetration.

The Tschicoma Formation forms the mountain mass of the Sierra de los Valles. It consists of volcanic flow rocks of latite, quartz latites and rhyolite that were extruded as a viscous mass from volcanic centers in the area of the Valles Caldera.

The Puye Formation overlies the Tesuque Formation and interfingers with some of the younger flow rocks of the Tschicoma. The Puye is a conglomerate of volcanic debris eroded from the Tschicoma Formation. Basalts flow interfingers and in places overly the conglomerates.

The Bandelier tuff forms the upper part of the Pajarito Plateau. It consists of three members that in ascending order are: Guaje Member an ashfall pumice; the Otowi Member, a nonwelded ashflow tuff; and the Tshirege Member, a series of nonwelded to welded ashflow tuffs. The Guaje is thin generally less than 15 m while the Otowi may be as much as 65 m thick. The uppermost Tshirege Member as much as 300 m thick. The tuff and pumice are rhyolitic in composition consisting of quartz and sanidine crystals and crystal fragments, with a few small rock fragments of latite and rhyolite in an ash matrix. The porosity of the tuff may range from less than 15 percent for a welded unit to as much as 60 percent in a nonwelded unit.

The surface drainage from the Pajarito Plateau is into southeast trending canyon cut by intermittent stream. The surface of the gently

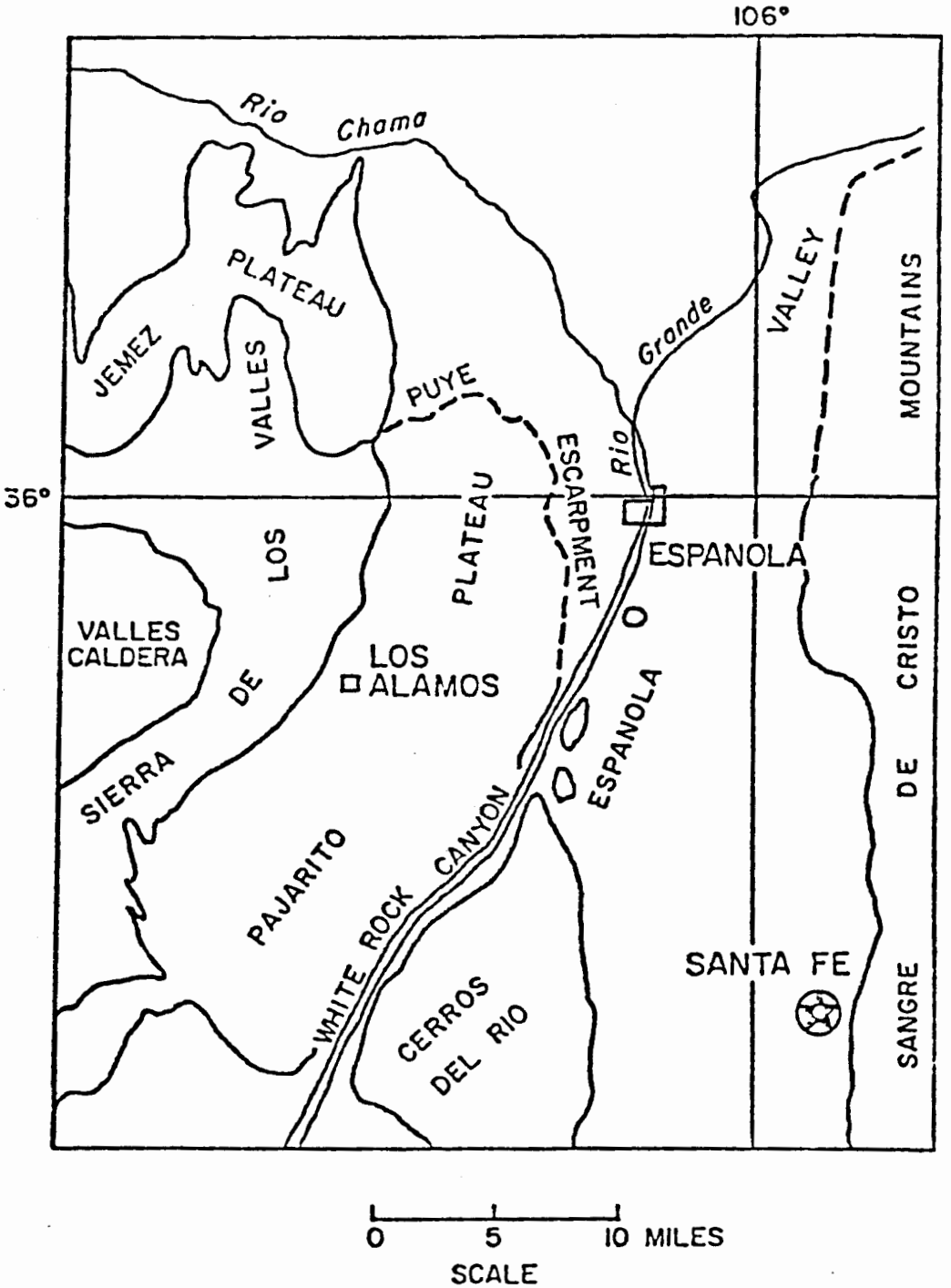


Fig. 1. Geologic features of the Los Alamos Area.

sloping mesas between the canyon are well drained with no possibility of flooding. The intermittent stream flow in the canyons occurs from spring snow melt and summer thunder showers. Drainage in the canyon is into the Rio Grande.

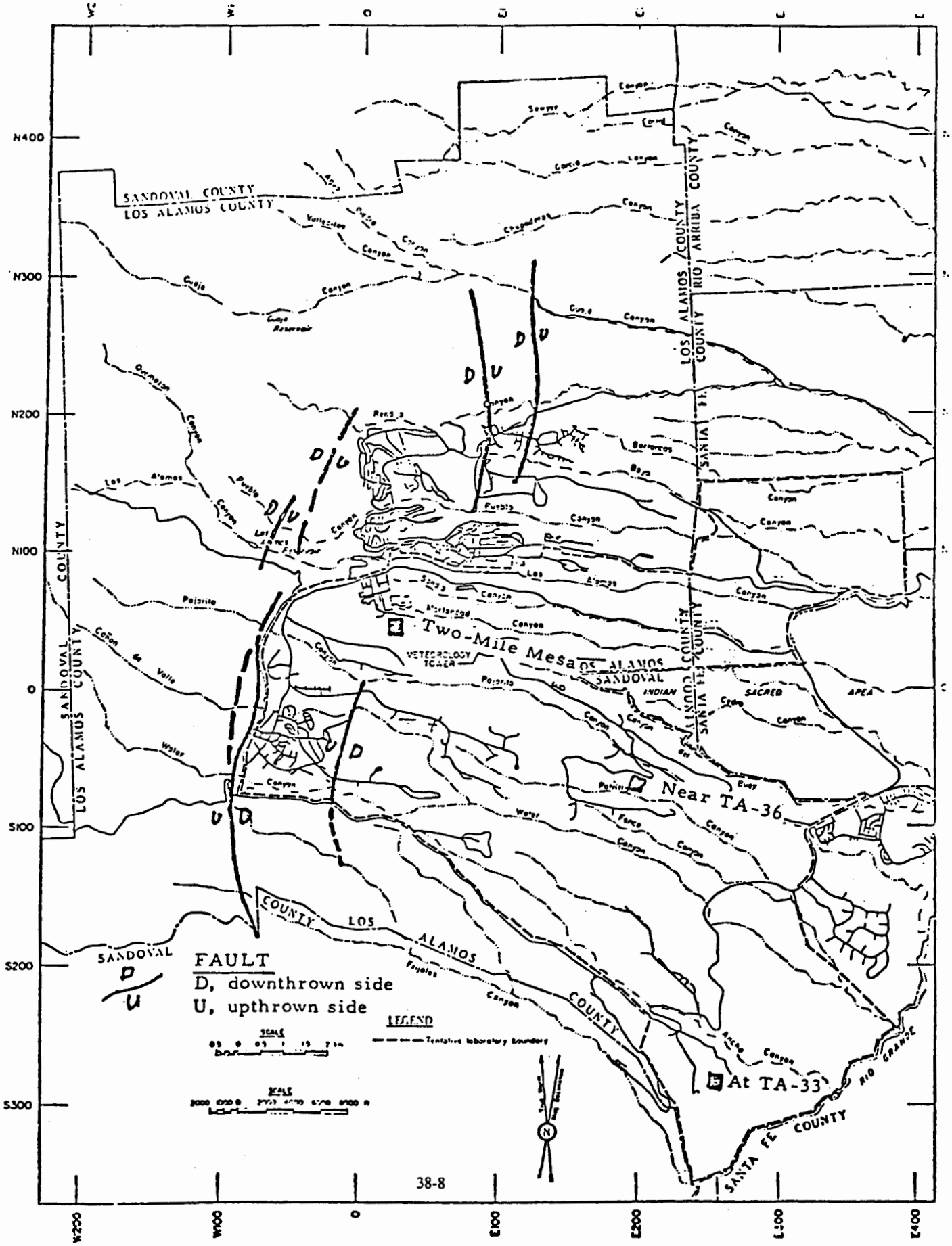
The alluvium in some of the larger canyons contains small bodies of perched water that is periodically recharged from the intermittent stream flow in the canyon.

There are no known bodies of water perch in the tuff or underlying conglomerate of the plateau except along the eastern edge in the vicinity of Los Alamos Canyon. The tuff and conglomerate are essentially dry beneath the alluvium on the canyon floor and the top of the main aquifer.

The main aquifer (source of municipal and industrial water supply) is in the Tesuque Formation and lower part of the Puye Formation beneath the Pajarito Plateau.[2] The main aquifer slopes gently from the area of recharge to the west in the Valles Caldera and Sierra de los Valles to the Rio Grande. The depth to the aquifer is about 380 m along the western edge of the plateau and decreases to about 180 m along the eastern edge. The movement of water in the aquifer is at about 120 m per year toward the Rio Grande where a part is discharged into the river through a series of seeps and springs.

B. Site Locations

The location for the 14 MeV Intense Neutron Source Facility was considered for three locations on the Pajarito Plateau (Fig. 2).


SANDOVAL COUNTY
LOS ALAMOS COUNTY
RIO ARRIBA COUNTY
SANTA FE COUNTY
Two-Mile Mesa
Near TA-36
At TA-33
FAULT
D, downthrown side
U, upthrown side
LEGEND
Tentative laboratory boundary
SCALE
N400
N300
N200
N100
0
S100
S200
S300
W200
W100
0
E100
E200
E300
E400

1. Two Mile Mesa

The location at Two-Mile Mesa is at an altitude of about 2274 m along the western edge of the plateau. The surface of the mesa is capped by the Bandelier Tuff which is about 230 m thick. The tuff is underlain by about 110 m of the Tschicoma Formation that is interbedded with about 120 m of the Puye Formation (Fig. 3). Surface drainage from the location is into Two-Mile Canyon. Stream flow in the canyon is intermittent. The depth to the main aquifer is at about 370 m beneath the surface of the mesa.

2. Near TA-36

The location near TA-36 is at an altitude of about 2100 m near the center of the plateau. The surface of the mesa is capped with the Bandelier Tuff which is about 180 m thick (Fig. 3). The tuff is underlain by about 80 m of basalt resting on about 220 m of the Puye Formation. The top of the Tesuque Formation is at depth of about 480 m at the location.

Surface drainage at the location is into Potrillo Canyon to the southeast. The depth to the main aquifer is about 300 m below the surface of the mesa.

3. At TA-33

The location at TA-33 is at an altitude of 1960 m near the eastern edge of the plateau. The surface of the mesa is capped with about 80 m of Bandelier Tuff which is underlain by about 220 m of basalt and interbedded basalt breccias (Fig. 3).

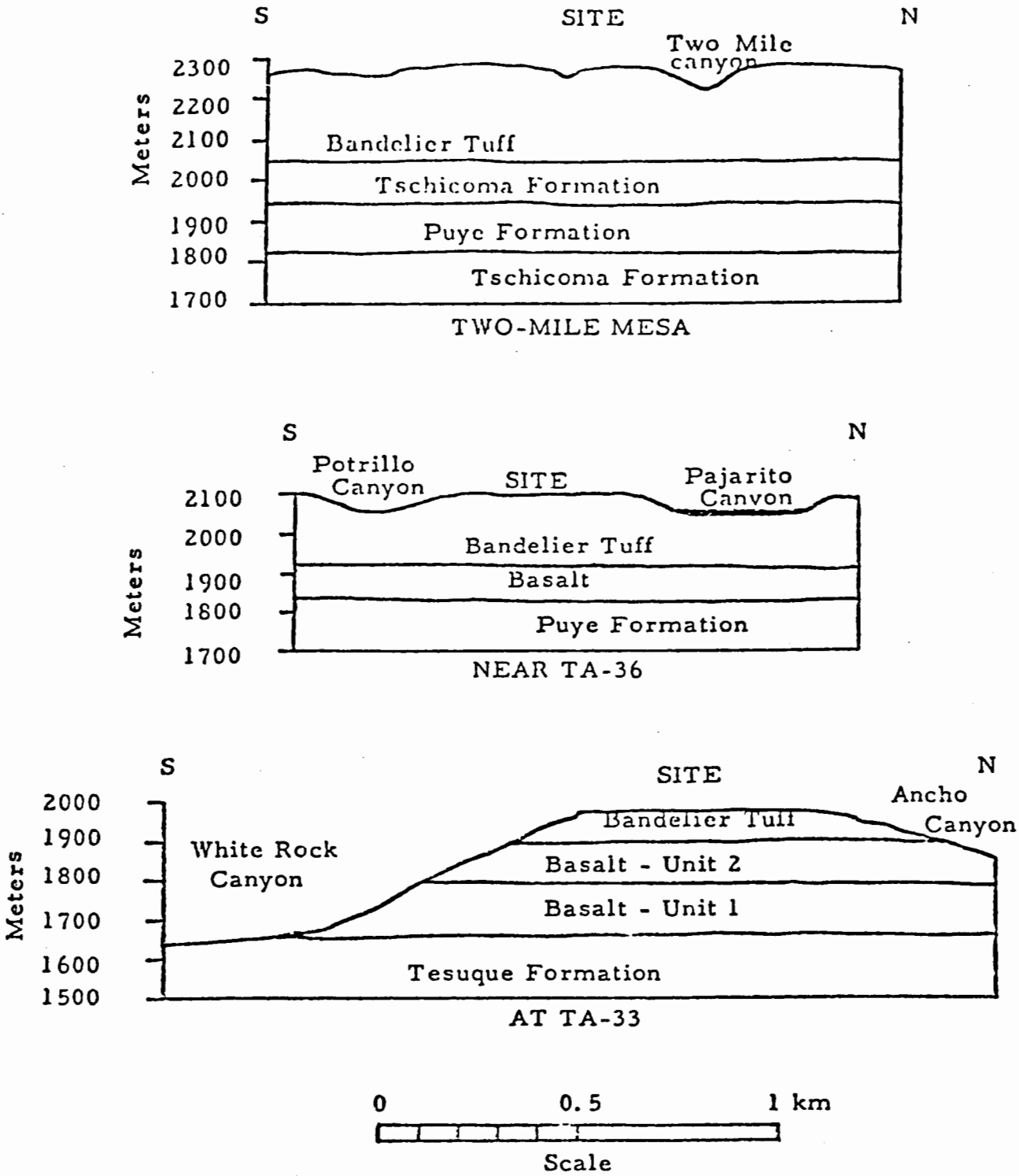


Fig. 3. Geologic sections at Two-Mile Mesa, Near TA-36 and at TA-33.

The Puye Formation is absent at this location. The top of the Tesuque Formation is about a depth of 300 m.

Surface drainage at the location is to the south into Chaquihui Canyon which drops precipitately to the Rio Grande. North of the location Ancho Canyon is cut deep into the eastern edge of the plateau.

Stream flow in Chaquihui Canyon is intermittent, however, several spring discharge from the main aquifer in the lower reach of the canyon. Stream flow in the lower reach of Ancho Canyon is perennial from the discharge from springs in the main aquifer. The main aquifer lies at a depth of about 300 m at the location probably in the lower part of the basalts or at the top of the Tesuque Formation.

C. Geologic Hazards

Geologic hazards considered at the three locations are seismic risk, surface displacement by faulting, landslide, and hydrologic considerations related to geology.

1. Seismic Risk.

The seismic risk for the Los Alamos Area is applicable for the three locations considered. The seismic risk was prepared on geological and seismological evidence. The two methods for evaluating the risks are different and results vary slightly , they are in an accpetable range.

The seismic risk based on geologic evidence relates the length of faults, displacement, and age of faulting. Evaluation

of data from the four faults it was concluded that the Los Alamos area may experience a shock of a magnitude of 5 during a period of 100 years.[3]

The seismic risk based on seismological data was restricted to shocks within 111 km of Los Alamos and included (1) non-instrumental reports of earthquake prior to 1962, and (2) instrumental studies of shocks from 1962 to 1972.

The strongest earthquake within the region of study during the 100 year period, 1872-1972, had a probable magnitude of 5.5. Estimates of the strongest shock to occur in the 100 year period based on extrapolation of earthquake frequency - magnitude relation ranged from 3.9 to 5.4 depending on data set used.

It was concluded that the seismic risk should be based on the reoccurrence of a magnitude 5.5 earthquake once every 100 years somewhere within the Rio Grande depression from Albuquerque to Questa. The seismicity of this part of the depression is (1) less than the Alququerque to Socorro segment of the same structure and (2) substantially less than equivalent areas in southern California.[4]

2. Surface Displacemtnt by Faults

Faults in the Los Alamos area trend north-south (Fig. 2). The faults displace the upper Tshirege Member of the Bandelier tuff which is 1.1 million years old.

The largest fault, the Pajarito Fault Zone lies about 2.6 km

to the west of the Two-Mile Mesa location. A smaller fault terminates in the Tshirege Member about 1.2 km to the southwest of the location. The fault apparently does not off set any ash flow units of the Tshirege Member on the north wall of Pajarito Canyon. There are no apparent lineations indicating extension of the fault through fracture or joint system into Mile-Mile Mesa. If the fault were projected northward on it's present trend it would pass 150 or 200 m west of the location as shown on Fig. 2.

There are no known faults at the locations near TA-36 or at TA-33.

3. Landslides

Landslides except for isolated rock falls from the canyon rim are an unlikely hazard at the three locations considered because of the rock characteristics and deep water table. The locations are at least 50 m from the canyon rims and this distance will allow for isolated rock falls as well as distribution of loads related to foundation design.

4. Hydrologic Consideration

The surface of the mesas at the three sites are well drained with no possibility of flooding by excessive precipitation.

Ground compaction due to the withdrawal of water from the main aquifer is not a significant geologic hazard. There has not been a significant lower of the water-table. The aquifer is of silty sandstone, sandstone and conglomerate and as such is not particularly susceptible to compaction when water is withdrawn.

D. Construction

The three locations are on the upper ashflow units of the Tshirege Member of the Bandelier Tuff. No foundation exploration has been made at the location; however, extrapolation of data from other sites near the location indicate the upper ashflows are of a moderately welded tuff. The porosity of a moderately welded tuff ranges from 30 to 55 percent by volume with a bulk density of 1150 to 1840 kg/m^3.

The moderately welded tuffs are easily excavated with heavy equipment. Foundation design should be no problem after engineering studies.

E. Contaminated - Waste Water

Contaminated waste water at the facilities will be collected through drain lines into a holding tank. The wastes in the tank will be removed as needed and treated at the liquid waste treatment plant.

The holding tank will be dug into the tuff. In case of rupture the wastes will drain into the underlying tuff.

The natural moisture content of a tuff underlying a soil on the plateau is generally less than 5 percent by volume. Pore space in the tuff is mainly capillary in size and at a low moisture below 10 percent by volume moisture will be distributed by diffusion and at a range from 10 to 24 percent the moisture will be redistributed mainly by capillarity and gravity. Above 24 percent the wastes will drain by gravity.

The loss of 1,800 m^3 of wastes over a period of a year from a rupture in the tank would allow wastes to move to a depth of about 60 m with

lobes of moisture in the tuff ranging from 20 to 28 percent immediately below the tank. Capillarity would extend the wastes outward to a radius of about 30 m. In time the wastes would reach equilibrium in the capillary size pores remaining suspended in the tuff. There would be no effect on the main aquifer that lies at depths ranging from 280 to 370 m at the locations.

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

OFFICE MEMORANDUM

TO : R. Jalbert, H-1

DATE: October 22, 1974

FROM : W. D. Purtymun, H-8

SUBJECT : SECTIONS FOR THE FTR DESIGN REPORT

SYMBOL : H8-74-404

Enclosed are sections X.2, X.2.3, X.2.4, and X.4.8 for subject report. Section X.2.4 (Access and Security Aspects of the Site) is taken from site selection study and may need additional data.

WDP:dl
Enc.

X.2 Description of FTR Site

The FTR Site is on the western edge of the Pajarito Plateau adjacent to the flanks of the Sierra de los Valles. The area is at an elevation of about 7 600 feet and contains a heavy cover of pines. The slope of the area is 10 degrees or less eastward with a development of 1 to 3 feet of soil. In place the bedrock of tuff is exposed. The surface is cut by a few small channels that drain into Two-Mile Canyon.

X.2.3. Geologic and Hydrologic Description of the Site

Volcanic flow rock and sediments underly the site at the western edge of the plateau. A generalized section showing rock units and and their thickness is based on a test hole located about one mile to the northeast.

UNIT	THICKNESS (FEET)	DEPT (FEET)
Bandelier Tuff		
Tshirege Member	620	620
Otowi Member	215	835
Guaje Member	60	895
Tschicoma Formation	350	1 245
Puye Formation	390	1 635
Tschicoma Formation	270	1 905
Puye Formation	10	1 915
Tschicoma Formation	510+	2 425+

The Bandelier Tuff consists of three members: Tshirege, Otowi, and Guaje, from youngest to oldest. The Tshirege Member is composed of a series of nonwelded to welded ashflows of rhyolite tuffs. The flow underlying the site is a welded tuff. The Otowi Member is a nonwelded pumicious ashflow of rhyolite tuff while the Guaje Member is made up of an ashfall rhyolite pumice.

The Tschicoma Formation is composed of latite and quartz latite flows and pyroclastic rocks. The Puye Formation is composed of gravels and boulders of latite, quartz latite, rhyolite and pumice in a matrix of silt and sand.

The individual ashflow of the Bandelier Tuff dip gently eastward off the flank of the mountains formed by the Tschicoma Formation. As the tuff are volcanic in origin they are highly jointed due to the cooling. The Pajarito Fault is a north-south

trending fault that lies about 3 500 feet west of the site. It is a normal fault, down-thrown to the east. The displacement is estimated at 400 ft. The Water Canyon Fault also north-south trending terminates about 1 mile to the southeast of the site is also a normal fault with maximum displacement of 80 feet. The movement on both faults has been post-Bandelier.

Drainage from the site is into Two-Mile Canyon thence into Pajarito Canyon that is confluent to the Rio Grande. The stream in the Canyon is intermittent. The alluvium is thin but may contain small amounts of water seasonally. The water is perched on the underlying tuff. There is no water perched in the volcanic rocks and sediments above the main aquifer. The main aquifer of the Los Alamos Area is the only aquifer capable of municipal and industrial water supply. The top of the aquifer at the site lies at a depth of about 1 200 feet in the lower part of the Tschicoma Formation or upper part of the Puye Formation. The aquifer slopes gently eastward from the recharge area in the Jemez Mountains to the discharge area along the Rio Grande.

Los Alamos falls within seismic zone 2 of the Uniform Building Code. Seismic frequency, based on geologic evidence, historical data, and seismic records from instrumentation since 1962, indicate a recurrence interval of a magnitude 5.5 earthquake once every 100 years with the epicenters somewhere in the Rio Grande depression from Questa to Albuquerque, an area 50 miles north as well as 50 miles south of Los Alamos and 20 to 40 miles wide.

The Los Alamos area lies in the Rio Grande depression which was formed by a complex series of faults. The seismicity of this part of the depression is (1) less than the Albuquerque to Socorro segment of the same structure (of recorded earthquakes in New Mexico, 95%, occur in this segment) and (2) substantially less than equivalent areas in Southern California.

Other geological conditions, ground subsidence due to withdrawal of water, landslides and renewed volcanism, at the site have been considered. Ground subsidence is unlikely because of the already low ground water level and physical structure of the water-bearing levels. Landslides, excluding rock falls at the

canyon lip, do not occur because of the geological structure and dry condition of the mesa rock. There are indications that volcanic activity is decreasing. In the past 20 years fumaroles have ceased in activity and thermal springs have become cooler.

X.2.4 Access and Security Aspects of the Site

The site is located on the west edge of the present TA-3 area, and adjacent to the east side of State Road Loop 4. The site is located 0.76 miles from the Administration Building and 0.95 miles from the nearest Fire Station. Direct access to the site does not exist at the present time, necessitating the construction of a paved roadway across Two-Mile Canyon.

The site is located within a chain-link fenced area but is not a security area. A security fence will be required on the southside of the site to exclude technical areas which require security.

X.4.8 Land Usage and Despoilment

The site will use about 4 acres for the building and parking lot. It will require the removal of the trees and underbrush. The pine have not reached a stage for use as lumber. Consideration will be given to leave green belts where possible to enchance the aesthetics of the area and to promote recovery of vegetation.

Leveling of the site will remove excess top soil and tuff. Usable top soil will be stockpiled for rehabilitation of the area around the buildings. The tuff will be used in construction of the access road across Two-Mile Canyon.

The urbanization due to construction of the site will increase the surface runoff in to Two-Mile Canyon. Surface drainage will be maintained during and at completion of construction to minimize erosion in the area and transport of sediments into the canyon.

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

OFFICE MEMORANDUM

TO : Wayne Hanson

DATE: October 23, 1974

FROM : W. D. Purtymun

SUBJECT : STORM RUNOFF MORTANDAD CANYON

SYMBOL : H8-74-380

Hydrologic investigations have been made in Mortandad Canyon since 1960. Two gaging stations (GS-1 and GS-2, attached map) were established in the canyon in 1962. Records from GS-1 are from 1962 to present and from GS-2 from 1962 to 1965.

There has been no runoff out of the canyon disposal area to the county line since hydrologic observation began in 1960. The canyon heads on the Pajarito Plateau and has a small drainage area. Total drainage area west of the county line is about 1.8 sq mi with 0.5 sq mi above GS-1, and an additional 0.8 sq mi from GS-1 to Obs. Hole MCO-8. Observations indicate that most, if not all, surface runoff into the canyon occurs in the 1.3 sq miles west of Obs. Hole MCO-8. The canyons contributing runoff are Mortandad (CMR Complex) Effluent, and Ten-Site canyon. East of MCO-8, the remaining 0.5 sq mi are relatively flat with no major or minor canyons entering from adjacent mesas.

The stream channel east of MCO-6 braids out on the canyon floor as the canyon begins to widen and alluvium thickens. The small drainage area with thick sections of unsaturated alluvium allows rapid infiltration of storm runoff to date.

As the channel is not well defined in the lower section of the canyon, the method for flood-frequency and maximum discharge analyses as discribed by Scott is not applicable. However, as the channel is well defined west of MCO-6, the flood-frequency and maximum discharge was computed at GS-1. The drainage area is 0.5 sq mi with a mean channel slope of 153 ft/mi.

Gaging Station 1

Frequency	Max. Discharge (cfs)
2-year	40
5-year	120
10-year	190
25-year	420
50-year	430

The maximum discharge during the period 1962 through October 11, 1974 was estimated to be about 80 cfs in which 9.2 ac-ft of water passed through the gaging station. This occurred on July 31, 1968 and caused flooding in the canyon which ended

between MCO-10 and MCO-12. The runoff did not reach the county line. The events predicted by use of Scott's method for the 12 years of record appear high.

Three of the larger events for 1974 are listed below. These events did not reach the county line.

Date	Max. Discharge (cfs)
8/5/74	10.5
8/17/74	55
10/11/74	15.4

The increased construction in the area (TA-35, TA-55) will increase the storm runoff into the canyon. At a maximum discharge of 100 to 120 cfs at GS-1, the flood flow will probably reach the county line and move on to Indian land. Channel conditions and characteristics east of the county line are unknown.

Surface flow in the canyon recharges a small body of water in the alluvium that is perched on the underlying tuff. This water body extends from the effluent outfall at TA-50 (400 ft west of GS-1) to east of Obs. Hole MCO-8. The depth to water in the alluvium ranges from near land-surface at GS-1 and MCS-3.8 to about 12 ft at MCO-4 and becomes progressively deeper to about 80 ft at MCO-8. East of MCO-8 to the county line the alluvium is dry.

The use of a dam to prevent transport of radionuclides out of the disposal area by storm runoff could couse additional problems. The radionuclides in the dry reservoir basin would be subject to resuspension by wind. The failure of the structure would release a larger crest than normal runoff. This would disperse radionuclides over a larger area beyond the county line as well as create severe erosion and possible damage to the bridge on State Road 4.

A method to prevent runoff out of the canyon and to fix radionuclides in the disposal area would be to construct infiltration shafts in the channel east of MCO-6 and MCO-8. The shafts, 3-ft in diameter and 30-ft deep, would be dug into unsaturated alluvium and would be completed above the water in the alluvium west of MCO-8. The shafts must be filled with gravel to prevent collapse.

The alluvium in the upper 30 ft is reworked material with a conductivity of about 450 ft/day. A 3-ft dia -- 30-ft deep shaft would allow infiltration at the rate of 5 cfs one minute after flow begins and would decline to about 1.5 cfs at the end of

15 min. Twelve shafts in the channel would have the total capacity to reduce the flood crest some 60 cfs; however, as the shafts will be strung out downgradient, the capacity will be slightly greater. Continued infiltration during the event will reduce the "tail off" (decline from crest) which has a tendency to move further down the canyon than the crest of the event.

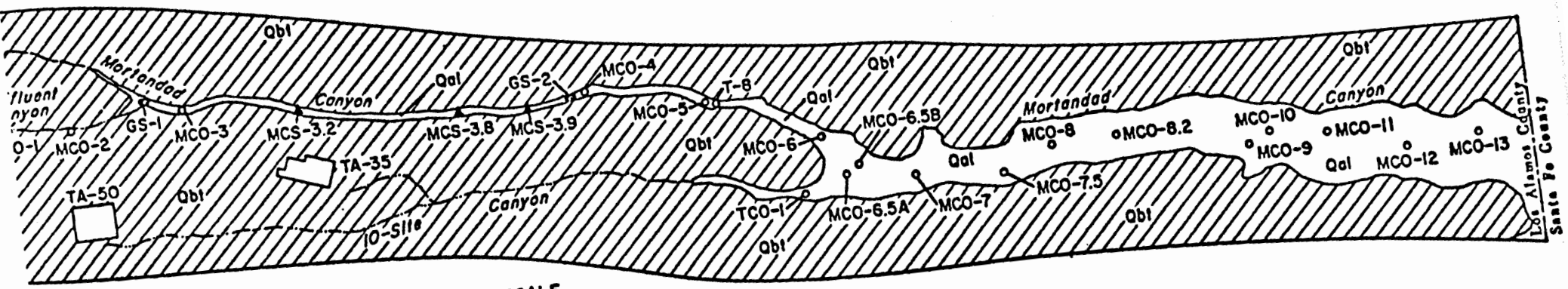
The shafts spacing will allow infiltration of water into the alluvium over a wide section of the canyon. The volume of unsaturated alluvium east of MCO-6 will absorb all infiltration of water from the shafts causing no problem with transport of radionuclides by water in the alluvium past the county line.

There will be considerable transport of suspended and bed load sediments with the storm runoff. These sediments will decrease the infiltration rates of the shafts; however, location of most of the shafts in the lower section of the canyon will result in possible use of the shafts three or four times in the next 10 years.

The estimated cost of the three ft dia, 30 ft deep shafts filled with gravel are about $665 each. The twelve shafts needed would cost = $8000.

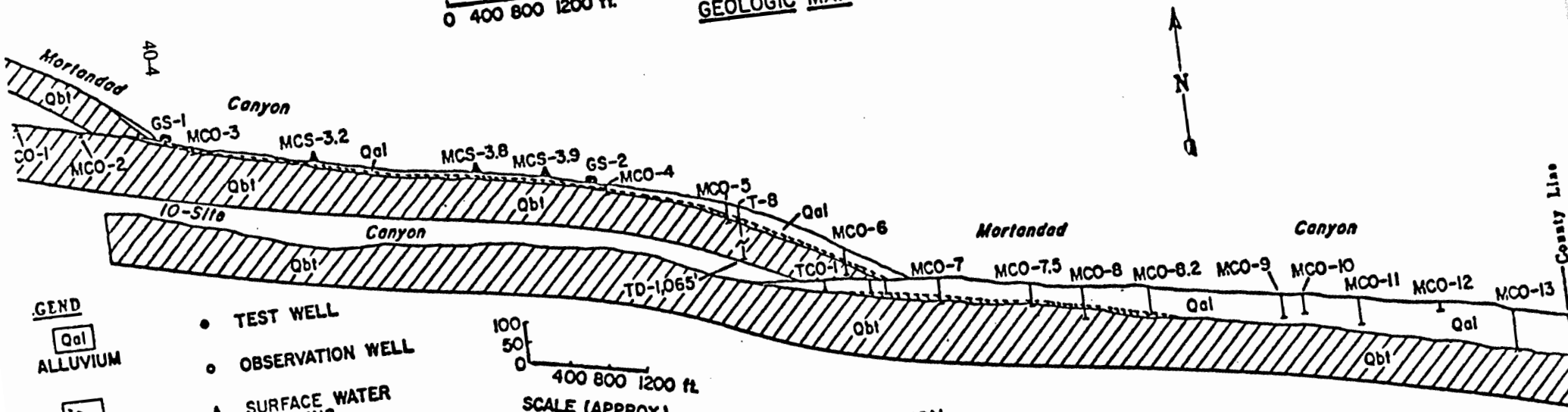
If the shaft method is used, it is planned to use three of the twelve shafts between MCO-6 and MCO-7 for a study to monitor the infiltration rate, movement of water and radionuclides in the unsaturated alluvium, the effect of sediments on infiltration rates and volume of runoff handled by the three shafts under different runoff events.

WDP:lmh



SCALE
0 400 800 1200 ft.

GEOLOGIC MAP



GEND

- Qal — ALLUVIUM
- WATER IN ALLUVIUM
- Qbt — IDELIER TUFF
- TEST WELL
- OBSERVATION WELL
- SURFACE WATER SAMPLING
- GAGING STATION

100
50
0
400 800 1200 ft.
SCALE (APPROX.)

DIAGRAMMATIC SECTION

MORTANDAD -CANYON

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

OFFICE MEMORANDUM

TO : Wayne Hanson

DATE: October 25, 1974

FROM : W. D. Purtymun WDP

SUBJECT : INFILTRATION SHAFTS AND SEDIMENT TRAPS, MORTANDAD CANYON

SYMBOL : H8-74-410

I wish to revise Memo H8-74-300 in regard to construction of flood control structures in the canyon.

Six-ft dia shafts about 20 ft deep will be more effective for infiltration of storm runoff than the 3-ft dia shafts. In view of the large volume of channel bed load carried in the runoff, sediment traps will be necessary to prevent excessive sedimentation in the shafts.

Shafts and Sediment Traps

Nine (9) shafts - 6 ft dia - 20 ft deep filled with washed gravel (Not base coarse).

Two (2) sediment traps, 10 ft wide, 100 ft long, dug to a depth of 6 ft below the stream channel. Side rounded and smoothed off to prevent walls from sluffing. Channel entrance and exit riprap at channel level. It may be advisable to construct two (2) cross-cuts (at right angles) across the traps about 50 ft in length, 20 and 60 ft from channel entrace. These would increase capacity of the traps and serve as clean-out areas when trap is partially filled.

The alluvium in the canyon is quite friable and unconsolidated. It will easily removed by the bucket-auger, and heavy equipment. The width of traps can be adjusted to type of equipment used in excavation.

WDP:lmh

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

OFFICE MEMORANDUM

TO : LaMar J. Johnson, H8 Group Leader DATE: November 14, 1974

FROM : W. D. Purtymun, H8 WDP-T.L.M

SUBJECT : INVENTORY AND MOVEMENT OF PLUTONIUM IN ACID-PUEBLO, DP-LOS ALAMOS, AND MORTANDAD CANYON

SYMBOL : H8-74-424

The inventory is based on (1) mass of sediments in a section of the channel, and (2) the average concentration of Pu in sediments in that section. This method of inventory leaves a lot to be desired, but considering the limited data it appears to be the best method at this time.

The mass of sediments is compiled from channel width, length of section, a thickness of 0.15 m, and a specific gravity of 1.57. The physical characteristics of the sections considered in each canyon is presented on Table I.

The mass of the sediments and concentration of Pu were used to compute the amount of Pu in the section. The concentrations at the stations considered and average concentrations are presented in Table II. Location of stations and sections are shown on Figures 1, 2 and 3.

The annual amounts of Pu released from the Treatment Plants into the canyon were compiled from records furnished by H-7. The estimate from the TA-45 Plant 1943-1950 was taken from LA-5282-MS. In general there was good agreement in the amounts derived from H-7 records and the LA-5282-MS tabulation of Pu released.

The inventory in the canyon used data collected in 1968, 1970, and 1972. Pu analyses for 1973 have not been completed. The 1972 data utilizes tabulations from the Ecology Section.

Pu in the waste when released is adsorbed or retained with the finer material in the channel alluvium. The concentrations of Pu tend to buildup at the point of effluent discharge in the channel during the fall through the spring. This large concentration is reduced by transport during storm runoff, especially the heavy summer showers.

The fine particle in the alluvium in the channel have the greater affinity for the Pu; however, most of the Pu is in the coarser alluvium as it is more abundant. The finer sediments in the alluvium are carried out of the canyons (Acid-Pueblo and DP-Los Alamos) as suspended sediments with the storm runoff,

while the larger materials are being transported as bed material. The bed material lags behind, moving short distances with each succeeding runoff event.

Storm runoff reaches the Rio Grande from Acid-Pueblo and DP-Los Alamos Canyons. There has been no runoff in the drainage area of Mortandad Canyon to the Laboratory boundary (Santa Fe-Los Alamos County Line) since hydrologic investigation began in the canyon in 1960. This is due to the small drainage area and the thickness of unsaturated alluvium in the canyon.

The Pu inventories in the canyons is presented in the following sections.

I. Acid-Pueblo Canyon

	Total Plutonium (mCi)	
	Feb.	Oct.
Section (m)	1970	1972
0- 480	4.6	2.4
480- 2 600	8.7	4.3
2 600- 6 800	2.3	2.3
6 800-10 280	2.5	2.6
Total	18.1	11.6

The inventory in Acid-Pueblo Canyon indicates that from the outfall to the confluence with Los Alamos Canyon, in February, 1970 only 18.1 or 11% of the 170 mCi of Pu released into the canyon remains in the sediments. In October, 1972, only 11.6 mCi or 7% remained of the 170 mCi. The largest change occur in the upper sections of the canyon (0- 2600 m) which contain the greatest amounts of Pu. The amounts in the lower section (2600 to 10 280 m) appear to be somewhat in equilibrium, with the input transport equal to output. For the two years of data the transport is about 3.25 mCi per year.

The average Pu concentration in the sediments in each section of the canyon for 1970 and 1972 is presented in Figure 4.

II. DP-Los Alamos Canyon

	Total Plutonium (mCi)				
	May	July	Aug.	Feb.	Oct.
Section (m)	1968	1968	1968	1970	1972
0-1 800	3.9	-	.4	4.6	3.2
1 800-6 600	1.1	0.4	1.1	1.1	.5
	5.0	-	1.5	5.7	3.7

The inventory in DP-Los Alamos Canyon for 1968 reflects the transport by storm runoff. The May concentration is buildup from fall through spring. These concentrations decrease through August as the material containing Pu moves out into Los Alamos Canyon with summer runoff. The channel in this reach (0-1800) has a very thin alluvium cover and a steep gradient. Runoff is above normal due to the developed area. In the lower reach (May, 1968, February, 1970 and October, 1972), the transport appears to have equalized, with input equal to output.

The inventory in the canyon in May, 1968, indicates that from the outfall to the confluence with Pueblo only 5.0 mCi or 21% of the 24.1 mCi (1952-1967) released remains in the Canyon. In August, only 1.5 m/Ci or 6% of the 24.1 mCi remained. Transport out of this reach of the canyon by storm runoff for the year was about 3.5 mCi. In February, 1970 about 5.7 mCi or 21% of the 27.3 mCi (1952-1969) of Pu remained in this reach. The October 1972 sampling indicated about 3.7 mCi or 8% of 30.8 mCi (1952-1972) remained in the canyon.

The average Pu concentration in the sections of the canyon is presented on Figure 5.

III. Los Alamos Canyon from Junction with Pueblo to Rio Grande

	Total Plutonium (mCi)		
Section (m)	May 1968	Aug. 1968	Feb. 1970
0-4 800	1.6	1.0	2.0
4 800-7 200	1.0	< .02	1.1
Total	2.6	~1.0	3.1

The inventory in Los Alamos Canyon from the confluence of Pueblo to the Rio Grande in May 1968 was 2.6 mCi which decreased to ~1.0 in August with the transport of Pu with summer runoff.

The inventory of February 1970, combining both DP-Los Alamos (5.7 mCi) and Acid-Pueblo (18.1 mCi) and below the confluence (3.1 mCi), indicates a total of 26.9 mCi of Pu in the three separate reaches ~14% of the amounts released into DP-Los Alamos (27.3 mCi, 1952-1969) and Acid-Pueblo (170 mCi, 1943-1964). If one considers the inventory in each of the three segments of the three canyons or combinations of segments and assumes all Pu is tied up in the sediments, the loss of Pu or transport to the Rio Grande is about 80 to 90% of all Pu released from the treatment plants.

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

IV. Mortandad Canyon

Section	Total Plutonium (mCi) Feb. 1970	Total Plutonium (mCi) Oct. 1972
0-1 460	15.8	28.2
1 460-3 040	1.5	5.1
Total	17.0	33.3

The inventory in Mortandad Canyon for February 1970 shows about 17.0 mCi of Pu in the reach from 0 to 3 040 m. The total release from 1963 through 1969 was 21.9 mCi. The remaining 4.9 mCi has been carried past MCO-8 by storm runoff, but not to MCO-12 where the sediments contained only background amounts of Pu. The inventory in October, 1972 shows about 33.3 mCi of Pu in the reach from 0-3 040 m. The release during the period 1964 to 1972 was 42.1 mCi. The remaining 8.8 mCi were carried east of MCO-8 by storm runoff but not to MCO-12.

The average Pu concentration in sediments in the canyon is presented on Figure 6.

The 30.4 mCi of Pu in the sediments of Mortandad Canyon represents the largest amounts available for transport by storm runoff. Due to the small drainage area and thickness of unsaturated alluvium runoff in the canyon has not reached the county line; however, the development and construction at TA-35 and TA-55 will increase the runoff into the Canyon. This increase may be sufficient to transport the Pu to the County line or into Indian land. Attached as an appendix are three memos dealing with storm runoff, infiltration shafts and sediment traps, and infiltration shafts for flood reduction in Mortandad Canyon.

WDP:dl
Enc.

xc: Wayne C. Hanson, H8
Tom Hakonson, H8
Jack Nyhan, H8

TABLE I

Physical Characteristics of Channels

A. Acid Pueblo Canyon

1. *0 to 480 m (Acid Canyon)*
   Width 1.5 m Depth 0.15 m
   Sp. g. 1.57 Weight 170 x 10^6g

2. *480 m to 2 600 m*
   Width 2.5 m Depth 0.15 m
   Sp. g. 1.57 Weight 1 790 x 10^6g

3. *2 600 m to 6 800 m*
   Width 3 m Depth 0.15 m
   Sp. g. 1.57 Weight 2 967 x 10^6g

4. *6 800 m to 10 280 m (Confluence)*
   Width 4 m Depth 0.15 m
   Sp. g. 1.57 Weight 3 278 x 10^6g

B. DP-Los Alamos Canyon

1. *0 to 1 800 m*
   Width 1.5 m Depth 0.15 m
   Sp. g. 1.57 Weight 459 x 10^6g

2. *1 800 m to 6 600 m*
   Width 2.5 m Depth 0.15 m
   Sp. g. 1.57 Weight 2 832 x 10^6g

C. Confluence Pueblo-Los Alamos to Rio Grande

1. *Confluence to 4 800 m*
   Width 3 m Depth 0.15 m
   Sp. g. 1.57 Weight 3 408 x 10^6g

2. *4 800 m to 7 2 00 m (Rio Grande)*
   Width 4 m Depth 0.15 m
   Sp. g. 1.57 Weight 2 261 x 10^6g

D. Mortandad Canyon

1. *0 to 1 460 m*
   Width 1 m Depth 0.15 m
   Sp. g. 1.57 Weight 344 x 10^6g

2. *1 460 m to 3 040 m*
   Width 2 m Depth 0.15 m
   Sp. g. 1.57 Weight 744 x 10^6g

TABLE II

Computations Showing Concentrations and Amounts of Pu in Sections of the Canyon

A. Acid-Pueblo Canyon (February, 1970)

Section	Station	Concentration pCi/g	Concentration Ave.	Total Pu mCi	% of Total Pu
0- 480	AC4	29.1			
	Acid Weir	24.8	27.0	4.6	25
480- 2 600	PC-2	4.98			
	PC-5	4.71	4.84	8.7	48
2 600- 6 800	PC-7	1.15			
	PC-9	.398	.775	2.3	13
6 800-10 280	PC-9	.398			
	SR-4	1.14	.770	2.5	14
TOTAL		-	-	18.1	100

B. Acid-Pueblo Canyon (October, 1972)[1/]

Section	Station	Concentration pCi/g	Concentration Ave.	Total Pu mCi	% of Total Pu
0- 480	AP-1	2.5			
	AP-2	2.3			
	AP-3	6.9			
	AP-4	50			
	AP-5	13			
	AP-6	12			
	AP-7	11	14.0	2.4	21
480- 2 600	AP-8	2.1			
	PC-5	2.6	2.4	4.3	37
2 600- 6 800	AP-9	.36			
	AP-10	1.2	.78	2.3	20
6 800-10 280	AP-10	1.2			
	SR-4	.37	.78	2.6	22
TOTAL		-	-	11.6	100

1/ AP-Series Stations Ecology Section

C. DP-Los Alamos Canyon (May, 1968)

Section	Station	Concentration pCi/g	Concentration Ave.	Total Pu mCi	% of Total Pu
0- 1 800	DPS-1	16.20			
	DPS-4	.84	8.5	3.9	78
1 800- 6 600	LAS-3	.65			
	LAS-5	.15	.40	1.1	22
TOTAL		-	-	5.0	100

D. Los Alamos Canyon (July, 1968)

Section	Station	Concentration µCi/g	Concentration Ave.	Total Pu mCi	% of Total Pu
1 800- 6 600	LAS-2	4.39			
	LAS-3	.72			
	LAS-4	.68			
	LAS-5	.22	1.5	0.4	-
TOTAL		-	-	0.4	-

E. DP-Los Alamos Canyon (August, 1968)

Section	Station	Concentration µCi/g	Concentration Ave.	Total Pu mCi	% of Total Pu
0- 1 800	DPS-1	0.41			
	DPS-2	1.44			
	DPS-3	.91			
	DPS-4	.88	0.91	.4	27
1 800- 6 600	LAS-2	.60			
	LAS-3	.37			
	LAS-4	.30			
	LAS-5	.23	.38	1.1	73
TOTAL		-	-	1.5	100

F. DP-Los Alamos Canyon (February, 1970)

Section	Station	Concentration µCi/g	Concentration Ave.	Total Pu mCi	% of Total Pu
0- 1 800	DPS-1	18.4			
	DPS-4	1.62	10.1	4.6	81
1 800- 6 600	LAS-2	.198			
	LAS-3	.156			
	LAS-4	.396			
	LAS-5	.848	~~4.0~~ 0.7	1.1	19
TOTAL		-	-	5.7	100

G. DP-Los Alamos Canyon (October, 1972)[1/]

Section	Station	Concentration µCi/g	Concentration Ave.	Total Pu mCi	% of Total Pu
0- 1 800	DP-5	0.76			
	DP-6	19			
	DP-7	.93	6.9	3.2	86
1 800- 6 600	DP-9	.20			
	DP-10	.30			
	SR-4	.01	.17	.5	14
TOTAL		-	-	3.7	100

1/ DP Series Ecology Section

H. Los Alamos Canyon [Confluence LA-Pueblo To Rio Grande] (May, 1968)

Section	Station	Concentration µCi/g	Concentration Ave.	Total Pu mCi	% of Total Pu
Confluence-	LAS-6	.62			
4 800	LAS-8	.34	.48	1.6	62
4 800- 7 200	LAS-8	.34			
	LAS-9	.24	.29	1.0	38
TOTAL		-	-	2.6	100

I. Los Alamos Canyon [Confluence LA-Pueblo to Rio Grande], (August, 1968)

Section	Station	Concentration µCi/g	Concentration Ave.	Total Pu mCi	% of Total Pu
Confluence-	LAS-6	.53			
4 800	LAS-8	.02	.28	1.0	100
4 800- 7 200	LAS-8	.02			
	LAS-9	<.01	.01	<.02	-
TOTAL		-	-	≃1.0	100

J. Los Alamos Canyon [Confluence LA-Pueblo to Rio Grande] (February, 1970)

Section	Station	Concentration µCi/g	Concentration Ave.	Total Pu mCi	% of Total Pu
Confluence-	LAS-6	.860			
4 800	LAS-7	.338	.60	2.0	65
4 800- 7 200	LAS-8	.591			
	LAS-9	.364	.48	1.1	35
TOTAL		-	-	3.1	100

K. Mortandad Canyon (February, 1970)

Section	Station	Concentration µCi/g	Concentration Ave.	Total Pu mCi	% of Total Pu
0- 1 460	GS-1	87.9			
	MCS-3.8	3.8	45.8	15.8	93
1 460- 3 040	MCO-5	2.8			
	MCO-7	.40	1.6	1.2	7
TOTAL		-	-	17.0	100

L. Mortandad Canyon (October, 1972)

Section	Station	Concentration µCi/g	Concentration Ave.	Total Pu mCi	% of Total Pu
0- 1 460	M-1	223			
	M-2	117			
	M-3	91			
	M-4	48			
	M-5	124			
	M-6	24			
	M-7	21			
	M-8	9.1	82	28.2	85
1 460- 3 040	MCO-5	2.8			
	M-9	11	6.9	5.1	15
TOTAL		-	-	33.3	100

TABLE III

Annual Amounts of Plutonium Released From Waste Treatment Plants

	Millicuries		
Year	Acid-Pueblo	DP-Los Alamos	Mortandad
1943-1950	143	-	-
1951	1.3	-	-
1952	1.1	.3	-
1953	1.2	1.1	-
1954	2.2	1.0	-
1955	2.2	.9	-
1956	1.0	.8	-
1957	.9	1.0	-
1958	.9	.6	-
1959	1.2	.8	-
1960	2.6	1.7	-
1961	5.2	5.4	-
1962	3.9	2.9	-
1963	3.0	2.2	1.6
1964	.04	1.1	1.9
1965	-	1.0	3.5
1966	-	.9	1.6
1967	-	2.4	4.2
1968	-	1.6	2.6
1969	-	1.6	6.5
1970	-	1.5	5.0
1971	-	.7	6.8
1972	-	1.3	8.4
	170	30.8	42.1

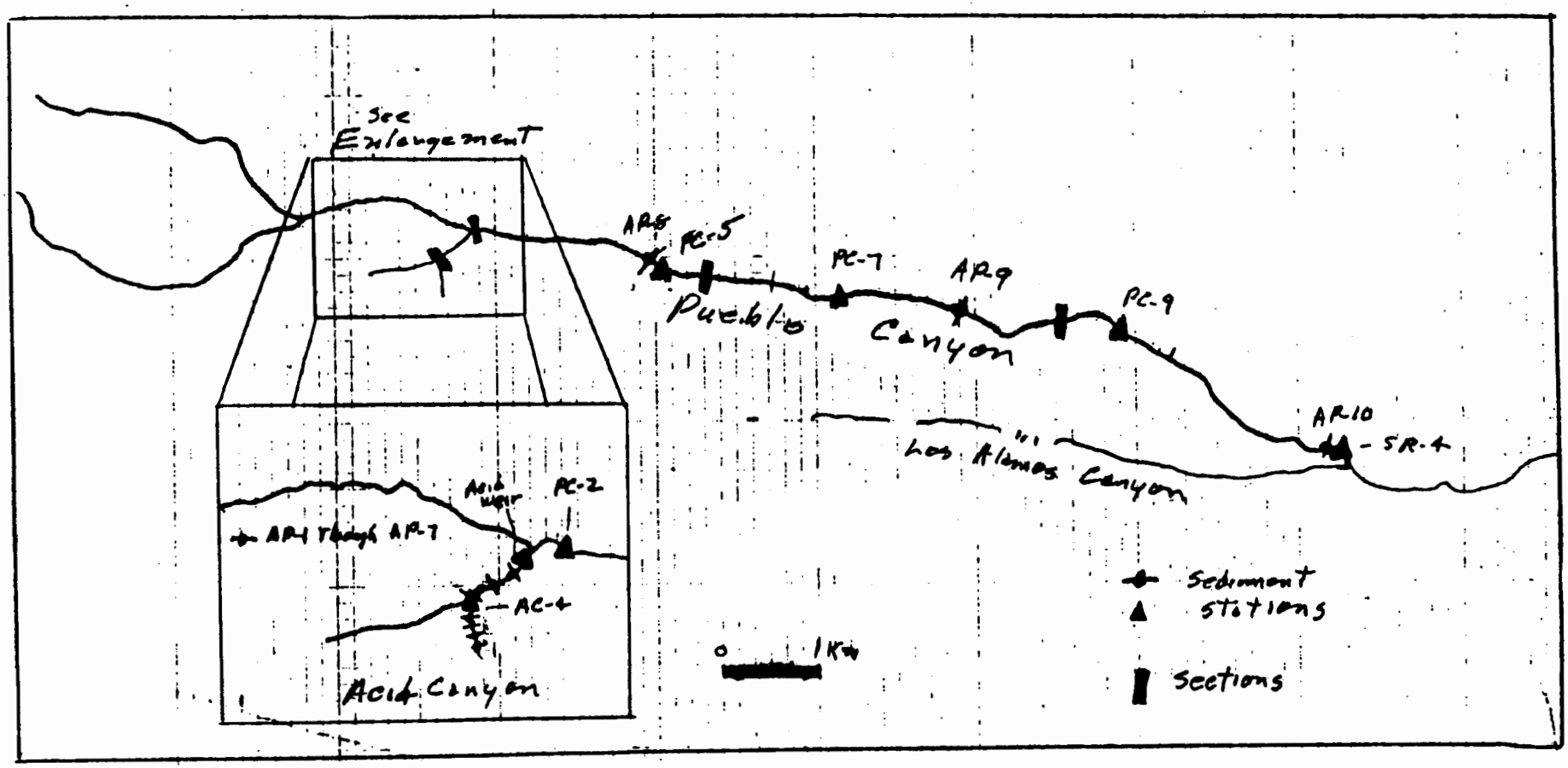


Figure 1.- Sampling stations and sections in Acid - Pueblo Canyon

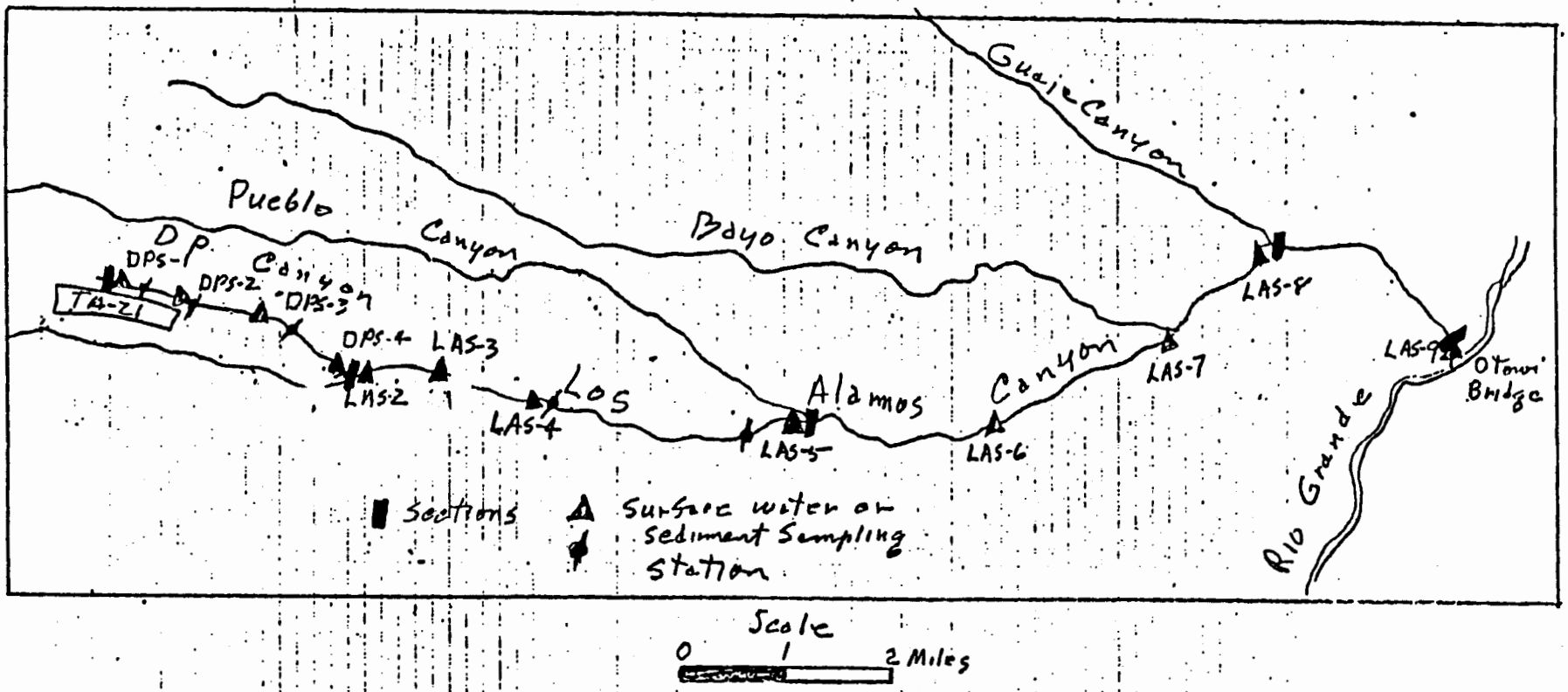


Figure 2.- Sampling stations and sections in Los Alamos Canyon.

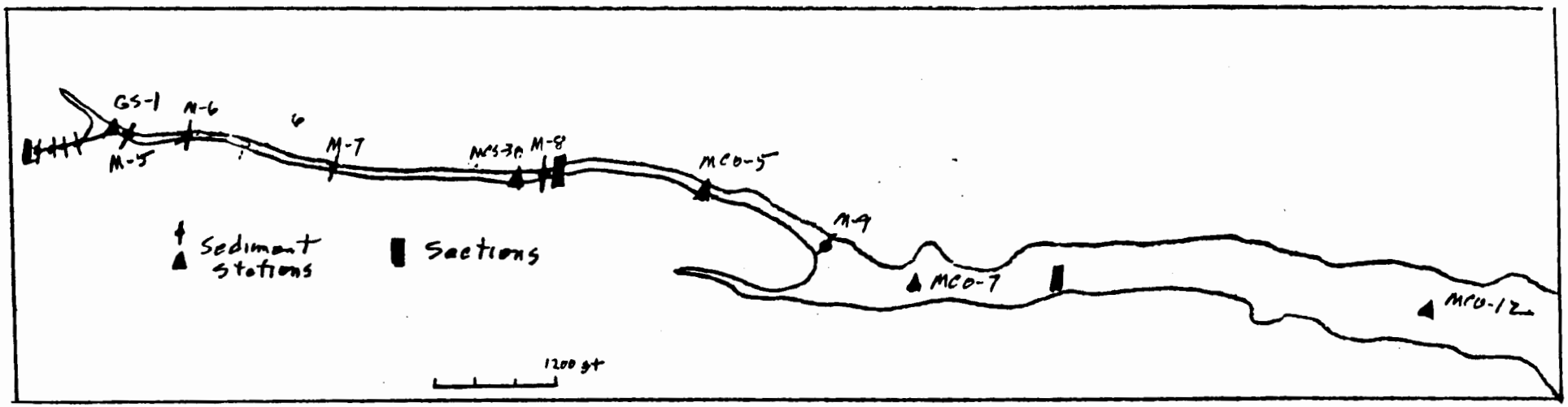


Figure 3 - Sampling stations and section in Mortandad Canyon.

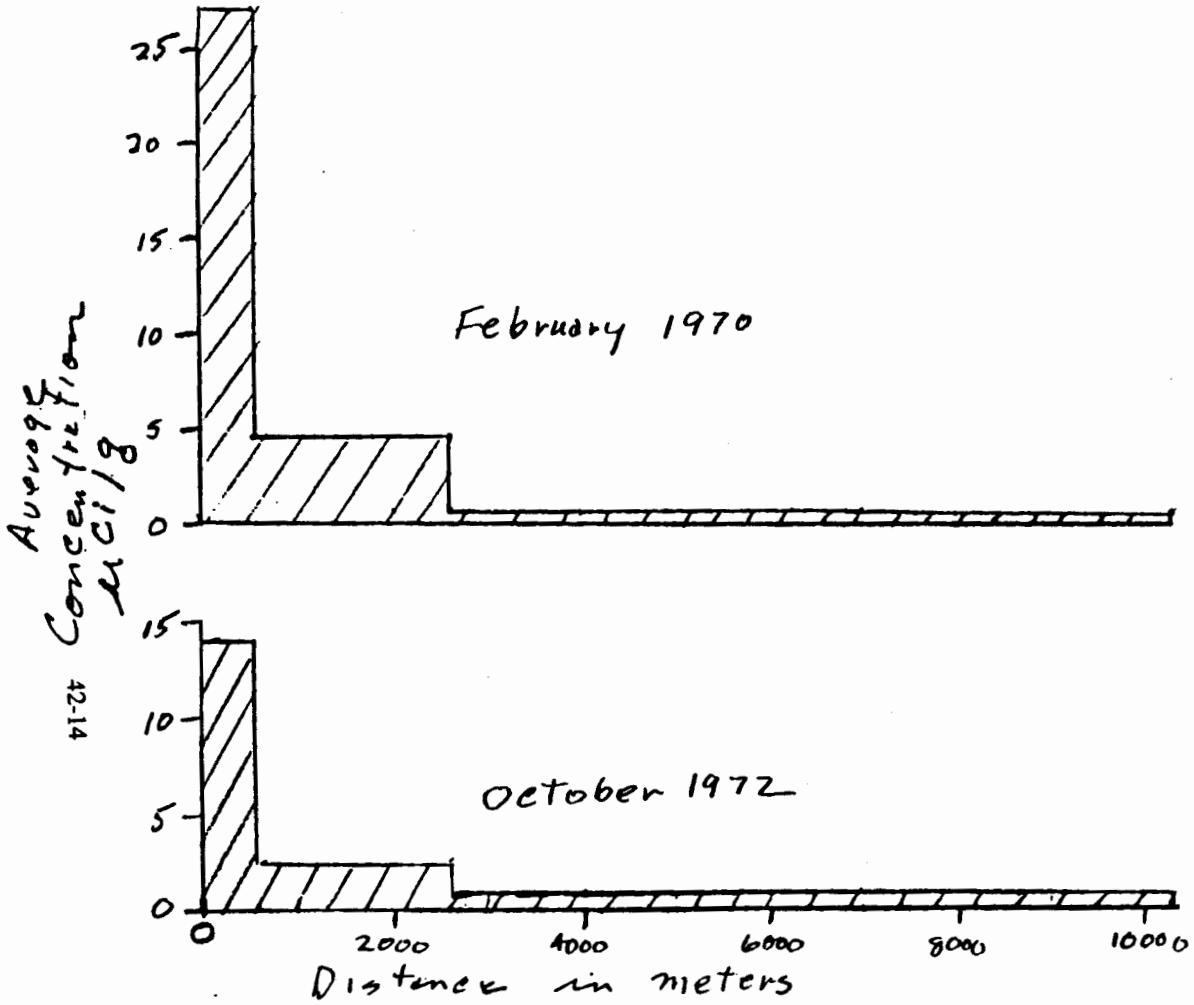


Figure 4.- Average Sediment Concentration in each section of Acid-Pueblo Canyon, 1970 and 1972.

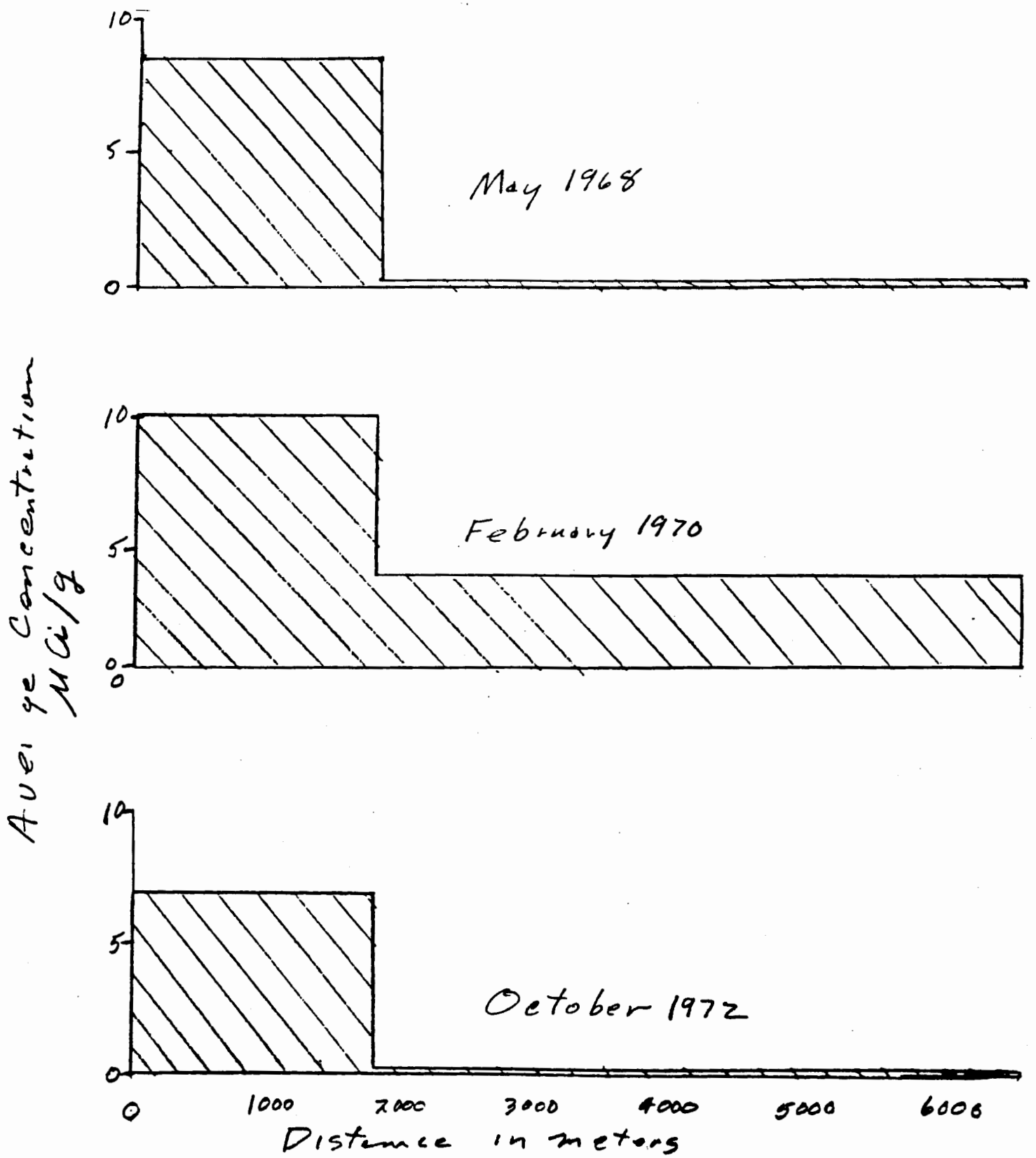


Figure 5.– Average Pu Sediment Concentrations in each section of DP-Los Alamos Canyon 1968, 1970, and 1972

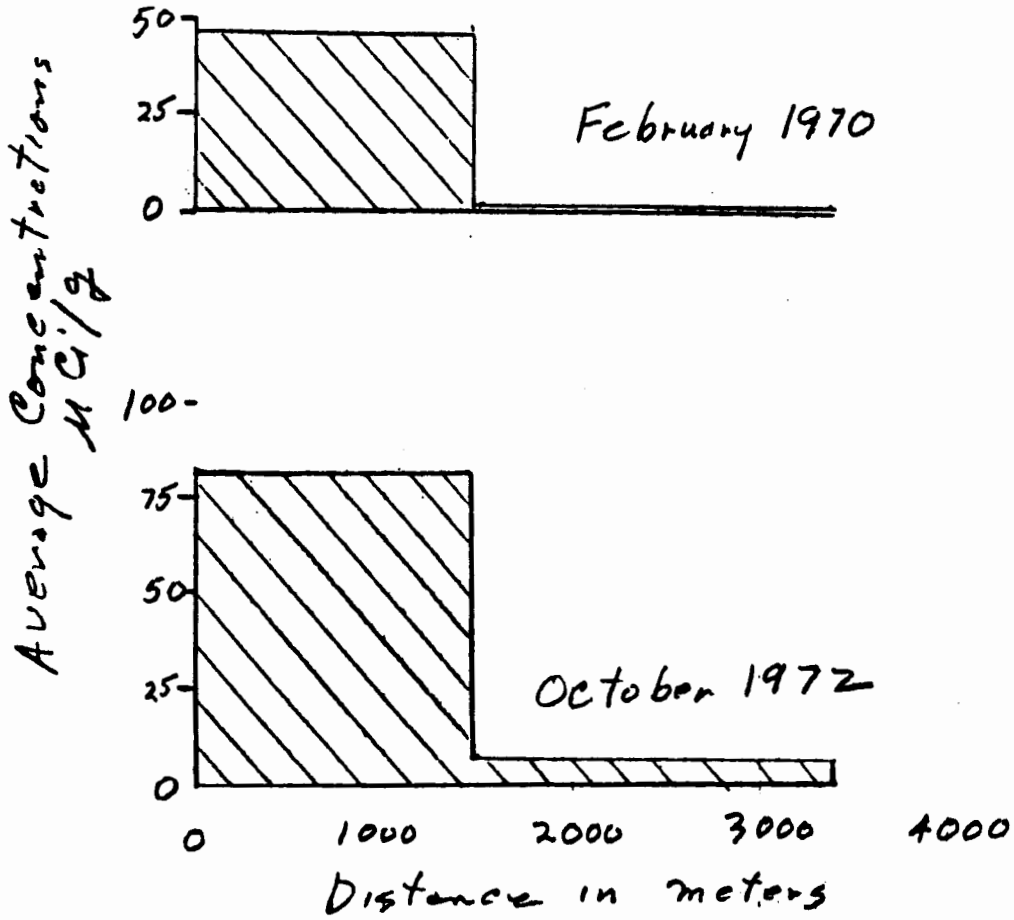


Figure 6.– Average Pu Concentration in sediments in sections of Montandad Canyon, 1970 and 1972

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

OFFICE MEMORANDUM

TO : LaMar J. Johnson, HS Group Leader DATE: December 3, 1974

FROM : W. D. Purtymun, H-8 T. E. Hakonson, H-8

SUBJECT : INVENTORY AND MOVEMENT OF PLUTONIUM IN ACID-PUEBLO, DP-LOS ALAMOS, AND MORTANDAD CANYON

SYMBOL : H8-74-430

Introduction

The purpose of this report is to document current knowledge on the amounts of 137Cs and Pu which the Laboratory released into Acid-Pueblo, DP-Los Alamos and Mortandad Canyons over the last 31 years and to present our estimates of residual inventories of these materials, based on sediment radionuclide concentrations. It must be recognized that the information presented herein is not definitive but may be modified as further data become available. Some of the assumptions made in estimating radionuclide release and inventory are arguable; however, they represent a best estimate based on our combined field experience in the canyons themselves.

Radionuclide Input

The three canyons used as liquid waste disposal areas have received contaminated wastes for varying lengths of time. Acid-Pueblo Canyon was used for a period of 20 years during 1944-1964 but has not been used for at least 9 years. The DP Canyon area is one which has been used for about 20 years and still receives discharges from TA-21. It is expected, however, that use of this canyon for disposal of plutonium wastes will be eliminated within the next few years when a new Plutonium Research Facility becomes operational. Mortandad Canyon has been used for about 10 years as the disposal area for wastes from the TA-50 plant.

This plant processes industrial wastes from the major portion of the Laboratory.

It is evident from data which are presented later and from discussions with the few personnel (Dean Meyer, Jim Sattizan) who were here when Laboratory operations began, that ^{3}H, ^{137}Cs, ^{238}Pu, ^{241}Am, $^{89-90}Sr$, and ^{235}U were discharged into some or all of the liquid waste disposal areas. Unfortunately, the lack of comprehensive records on the radionuclide content of treated effluent (with the exception of plutonium) was not maintained until just recently. Therefore, it was impossible to estimate the quantities of these radionuclides which were released to the canyon areas. Sufficient data were available to crudely estimate plutonium input to the canyons by utilizing gross alpha activity measurements on the treated effluent. All the alpha activity in the effluent was assumed to be ^{239}Pu; consequently the estimated input to the canyons was in terms of ^{239}Pu "equivalents". In reality the "Pu" in liquid effluents released to DP and Mortandad Canyons after 1959 consisted of a mixture of ^{238}Pu and ^{239}Pu. Recent analyses for ^{238}Pu and ^{239}Pu in liquid effluents indicate that about 50% of the Pu in DP Canyon effluents is ^{239}Pu while over 90% of the Pu in Mortandad Canyon effluents is ^{238}Pu.

Records on the amounts of ^{239}Pu in the untreated effluent from TA-1 were not maintained during the 1944-1950 period. Consequently, estimates of additions of this radionuclide into AP Canyon are without a quantitative basis. A crude estimate was made by assuming that the amount of ^{239}Pu in the effluent increased linearly through the 1944-1950 time period. The first year that complete records were available (1952), pretreatment liquid effluents designated for disposal in AP Canyon contained 45 mCi Pu.

A linear extrapolation from 45 mCi Pu released in 1952 to 0 released in 1943 (a year prior to plutonium processing) followed by numerical integration resulted in an estimated plutonium input of about 143 mCi into AP Canyon (Table 1). Robeck (TID-460), utilizing some data on the Pu content of TA-1 effluent, estimated that as much as 63 mCi Pu was released to Acid-Pueblo Canyon during 1949 whereas our estimate (i.e. based on the linear extrapolation) was about 20 mCi during that year. The descrepancy between the two values demonstrates the need for caution in applying the value of 143 mCi. The actual value may be higher as evidenced by Robecks paper, or it may be lower, as Group H-7 contends.

During the 13.5 year period when the TA-45 plant was operational (1951-1964), an additional 27 mCi was released into AP Canyon which brings the total estimated additions to 170 mCi Pu.

The TA-21 facility which became operational in 1952 has released an estimated 32 mCi Pu to DP Canyon through 1973 (Table 1). The possibility exists that prior to 1952, additional Pu (and other radionuclides) seeped into DP-Los Alamos Canyon from disposal pits and drains located on the adjacent mesa. Elevated Pu concentrations were measured in Los Alamos Canyon water and soils as early as 1946 (Kingsley, LA-516). There is no way of assessing the quantities of radioactivity involved.

The TA-50 waste treatment facility became operational in 1964 and as of 1973 had released an estimated 51 mCi Pu to Mortandad Canyon (Table 1). The input of Pu to this canyon is expected to increase after the new Plutonium Research Facility becomes operational.

As mentioned previously, ^{137}Cs release to the canyons could not be estimated due to a lack of records.

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

TO: LaMar Johnson 4 DATE: December 3, 1974

Inventory Model

The radionuclide inventory estimates presented in this memo were calculated from the following equations:

$$I = (C)\ (L)\ (W)\ (D)\ (S) \qquad (1)$$

where,

I = calculated inventory (mCi) for segment L
C = average radionuclide concentrations (mCi/g) in sediments.
L = length of stream channel segment (meter) over which C applied.
W = average width (meters) of stream
D = depth (meters) of sediment to which C applied.
S = specific gravity (g/m^3) of sediment.

D was taken as 0.15 m and S as 1.57×10^6 g/m^3. The total inventory (TI) was;

$$TI = \sum_{1}^{n} I$$

Where n equals the number of individual stream channel segments considered in each canyon.

The errors associated with the model ~~is~~ are obviously of the same order as those associated with the input data. The radionuclide concentration data ~~is~~ are likely the largest source of error in the inventory estimates for both Pu and ^{137}Cs. The coefficient of variation ($\frac{S.\ D.}{mean} \times 100$) for triplicate samples averaged about 80 percent for Pu and 40 percent for ^{137}Cs.

Model Input

The Pu and ^{137}Cs data used in equation I are presented in Tables II, III and IV. The location of sampling stations and stream channel sections for which calculations were made, are

shown in Figs. 1-3. Plutonium inventories in each canyon were estimated from data collected in 1968, 1970 and 1972. The 1972 data utilizes tabulations from the Ecology Section (LA-5586), and Environmental Monitoring Report for 1972 (LA-5184). The ^{137}Cs data were gathered in 1972 and were partially reported in LA-5282-ms.

TABLE I

SUMMARY OF PLUTONIUM ADDITIONS TO THE LIQUID WASTE DISPOSAL AREAS FROM 1943 THROUGH 1973

YEAR	TA-45[a] mCi Pu in Effluent	TA-21 mCi Pu in Effluent	TA-50 mCi Pu in Effluent
1943-50	143.		
1951	0.4		
1952	0.3	0.1	
1953	0.9	1.6	
1954	2.0	0.5	
1955	2.2	1.1	
1956	1.1	0.8	
1957	0.9	1.0	
1958	0.9	0.5	
1959	1.2	0.9	
1960	2.2	1.7	
1961	5.7	5.0	
1962	3.9	3.2	
1963	5.1	2.5	1.5
1964	0.04	1.1	2.0
1965		1.0	3.5
1966		0.8	1.7
1967		3.4	4.2
1968		1.6	2.6
1969		1.6	6.8
1970		1.5	5.1
1971		0.7	6.0
1972		1.1	8.1
1973		0.4	8.8
TOTALS	170.	32.1	51.3

[a] TA-45, TA-21, and TA-50 released liquid effluent into Acid-Pueblo, DP-Los Alamos and Mortandad Canyons, respectively.

TABLE II

Physical Characteristics of Channels

A. Acid Pueblo Canyon

1. 0 to 480 m (Acid Canyon)
   Width 1.5 m Depth 0.15 m
   Sp. g. 1.57 Weight 170 x 10^6g

2. 480 m to 2 600 m
   Width 2.5 m Depth 0.15 m
   Sp. g. 1.57 Weight 1 790 x 10^6g

3. 2 600 m to 6 800 m
   Width 3 m Depth 0.15 m
   Sp. g. 1.57 Weight 2 967 x 10^6g

4. 6 800 m to 10 280 m (Confluence)
   Width 4 m Depth 0.15 m
   Sp. g. 1.57 Weight 3 278 x 10^6g

B. DP-Los Alamos Canyon

1. 0 to 1 800 m
   Width 1.5 m Depth 0.15 m
   Sp. g. 1.57 Weight 459 x 10^6g

2. 1 800 m to 6 600 m
   Width 2.5 m Depth 0.15 m
   Sp. g. 1.57 Weight 2 832 x 10^6g

C. Confluence Pueblo-Los Alamos to Rio Grande

1. Confluence to 4 800 m
   Width 3 m Depth 0.15 m
   Sp. g. 1.57 Weight 3 408 x 10^6g

2. 4 800 m to 7 2 00 m (Rio Grande)
   Width 4 m Depth 0.15 m
   Sp. g. 1.57 Weight 2 261 x 10^6g

D. Mortandad Canyon

1. 0 to 1 460 m
   Width 1 m Depth 0.15 m
   Sp. g. 1.57 Weight 344 x 10^6g

2. 1 460 m to 5100 m
   Width 2 m Depth 0.15 m
   Sp. g. 1.57 Weight 1714 x 10^6g

TABLE III

Computations Showing Concentrations and Amounts of Pu in Sections of the Canyon

A. Acid-Pueblo Canyon (February, 1970)

Section	Station	Concentration x 10^{-9} mCi/g	Ave.	Total Pu mCi
0- 480	AC4	29.1		
	Acid Weir	24.8	27.0	4.6
480- 2 600	PC-2	4.98		
	PC-5	4.71	4.84	8.7
2 600- 6 800	PC-7	1.15		
	PC-9	.398	.775	2.3
6 800-10 280	PC-9	.398		
	SR-4	1.14	.770	2.5
TOTAL		-	-	18.1

B. Acid-Pueblo Canyon (October, 1972)[1/]

Section	Station	Concentration x 10^{-9} mCi/g	Ave.	Total Pu mCi
0- 480	AP-1	2.5		
	AP-2	2.3		
	AP-3	6.9		
	AP-4	50		
	AP-5	13		
	AP-6	12	8.4	
	AP-7	11	~~14.0~~	2.4
480- 2 600	AP-8	2.1	4.8	
	PC-5	2.6	2.4	4.3
2 600- 6 800	AP-9	.36		
	AP-10	1.2	.95 ~~.78~~	2.3
6 800-10 280	AP-10	1.2		
	SR-4	.37	.61 .78	2.6
TOTAL		-	-	11.6

1/ AP-Series Stations Ecology Section

C. DP-Los Alamos Canyon (May, 1968)

Section	Station	Concentration x 10^{-9} mCi/g	Ave.	Total Pu mCi
0- 1 800	DPS-1	16.20		
	DPS-4	.84	8.5	3.9
1 800- 6 600	LAS-3	.65		
	LAS-5	.15	40	1.1
TOTAL		-	-	5.0

Table III (con't.)

G. Lower Los Alamos Canyon [Confluence LA-Pueblo To Rio Grande] (May, 1968)

Section	Station	Concentration x 10^{-9} mCi/g	Ave.	Total Pu mCi
Confluence-	LAS-6	.62	0.53	
4 800	LAS-8	.34	.48	1.6
4 800- 7 200	LAS-8	.34		
	LAS-9	.24	.18 .29	0.7
TOTAL		-	-	2.3

H. Lower Los Alamos Canyon [Confluence LA-Pueblo to Rio Grande], (August, 1968)

Section	Station	Concentration x 10^{-9} mCi/g	Ave.	Total Pu mCi
Confluence-	LAS-6	.53		
4 800	LAS-8	.02	.28	1.0
4 800- 7 200	LAS-8	.02		
	LAS-9	<.01	.01	<.02
TOTAL		-	-	~1.0

I. Lower Los Alamos Canyon [Confluence LA-Pueblo to Rio Grande] (February, 1970)

Section	Station	Concentration x 10^{-9} mCi/g	Ave.	Total Pu mCi
Confluence-	LAS-6	.860		
4 800	LAS-7	.338	.60	2.0
4 800- 7 200	LAS-8	.591		
	LAS-9	.364	.48	1.1
TOTAL		-	-	3.1

J. Mortandad Canyon (February, 1970)

Section	Station	Concentration x 10^{-9} mCi/g	Ave.	Total Pu mCi
0- 1 460	GS-1	87.9		
	MCS-3.8	3.8	45.8	15.8
1 460- 5 100	MCO-5	2.8		
	MCO-7	.40	1.6	2.7
TOTAL		-	-	18.5

Table III (con't.)

D. DP-Los Alamos Canyon (August, 1968)

Section	Station	Concentration x 10^{-9} mCi/g	Ave.	Total Pu mCi
0- 1 800	DPS-1	0.41		
	DPS-2	1.44		
	DPS-3	.91		
	DPS-4	.88	0.91	.4
1 800- 6 600	LAS-2	.60		
	LAS-3	.37		
	LAS-4	.30		
	LAS-5	.23	38	1.1
TOTAL		-	-	1.5

E. DP-Los Alamos Canyon (February, 1970)

Section	Station	Concentration x 10^{-9} mCi/g	Ave.	Total Pu mCi
0- 1 800	DPS-1	18.4		
	DPS-4	1.62	10.1	4.6
1 800- 6 600	LAS-2	.198		
	LAS-3	.156		
	LAS-4	.396		
	LAS-5	.848	0.4	1.1
TOTAL		-	-	5.7

F. DP-Los Alamos Canyon (October, 1972)[1/]

Section	Station	Concentration x 10^{-9} mCi/g	Ave.	Total Pu mCi
0- 1 800	DP-5	0.76		
	DP-6	19		
	DP-7	.93	6.9	3.2
1 800- 6 600	DP-9	.20		
	DP-10	.30		
	SR-4	.01	.17	.5
TOTAL		-	-	3.7

1/ DP Series Ecology Section

Table III (con't.)

K. *Mortandad Canyon (October, 1972)*

Section	Station	Concentration x 10^{-9} mCi/g	Ave.	Total Pu mCi
0- 1 460	M-1	223		
	M-2	117		
	M-3	91		
	M-4	48		
	M-5	124		
	M-6	24		
	M-7	21		
	M-8	9.1	82	28.2
1 460- 5 100	MCO-5	2.8		
	M-9	11	6.9	11.8
TOTAL				40.0

TABLE IV

Concentrations and Amounts of ^{137}Cs in Sections of the Canyons

A. Acid-Pueblo Canyon (October, 1972)

Section (m)	Station	Concentration x 10^{-9} mCi/g	Avg.	Total ^{137}Cs (mCi)
0-480	Ap-1	0.53		
	Ap-2	0.05		
	Ap-3	1.5		
	Ap-4	0.74		
	Ap-5	14		
	Ap-6	1.1		
	Ap-7	1.5	2.8	0.48
480-2600	Ap-8	1.1	1.1	2.0
2600-6800	Ap-9	0.31	0.31	0.92
6800-10280	Ap-10	0.20	0.20	0.66
Total				4.1

B. DP-Los Alamos Canyon (October, 1972)

Section (m)	Station	Concentration x 10^{-9} mCi/g	Avg.	Total ^{137}Cs (mCi)
0-1800	m-1	1654		
	m-2	187		
	m-3	5.9		
	m-4	49		
	m-5	24	33	
	m-6	15		
	m-7	51	284	130
1800-6600	m-9	13		
	m-10	3.6	8.3	24
Total				154

C. Lower Los Alamos Canyon (October, 1972)

Section (m)	Station	Concentration x 10^{-9} mCi/g	Avg.	Total ^{137}Cs (mCi)
Confluence-4800	m-10	0.20		1.1
4800-7200	m-11	1.6	0.9	9.1
Total				10.2

Table IV (con't)

D. Mortandad Canyon (October, 1972)

Section (m)	Station	Concentration $\times 10^{-9}$ mCi/g	Avg.	Total ^{137}Cs (mCi)
0-1460	m-1	2022		
	m-2	506		
	m-3	527		
	m-4	629		
	m-5	285		
	m-6	1191		
	m-7	315		
	m-8	90	696	240
1460-5100	m-9	91		
	m-10	0.6	46	79
Total				319

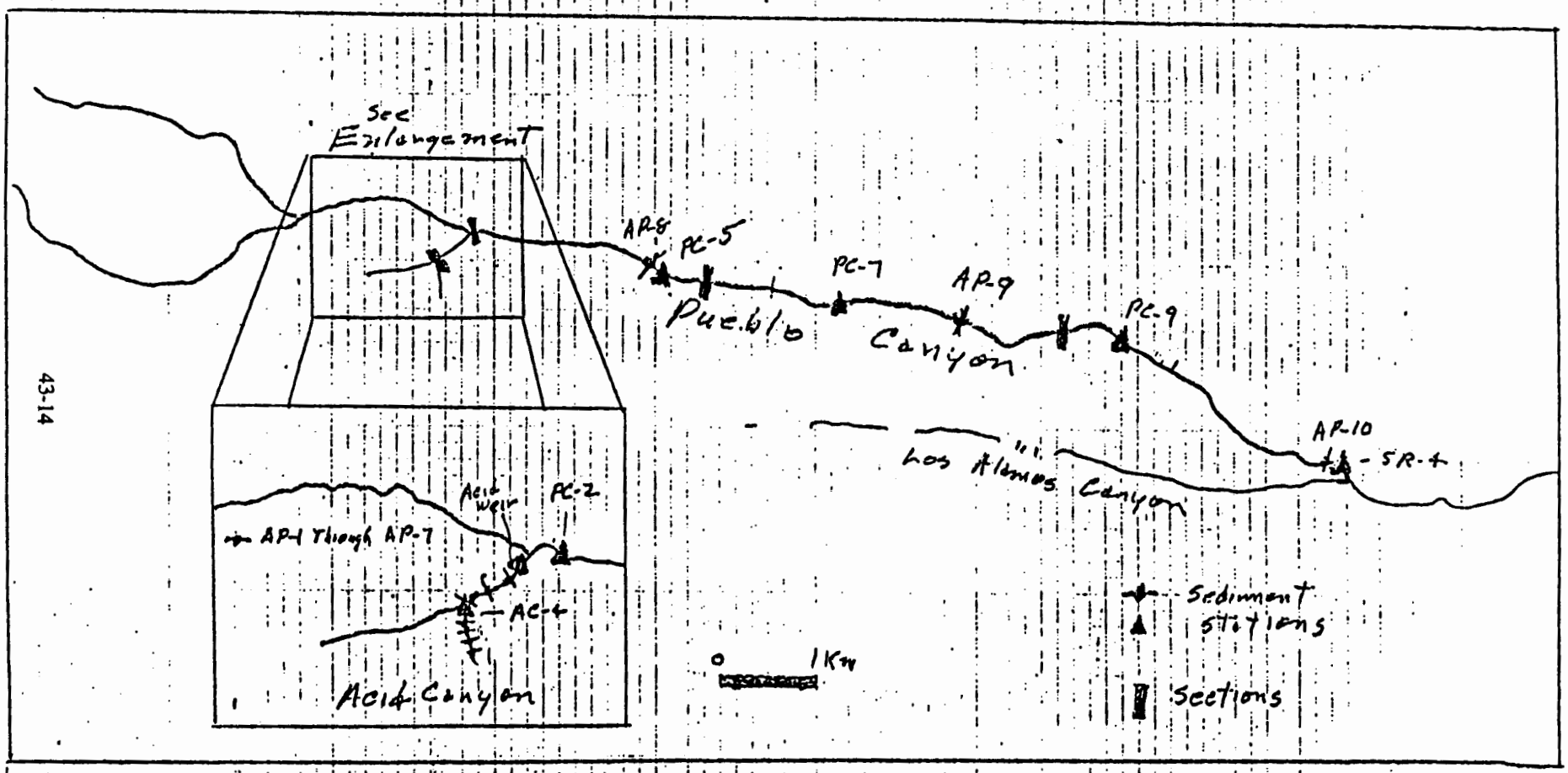


Figure 1.—Sampling stations and sections in Acid-Pueblo Canyon

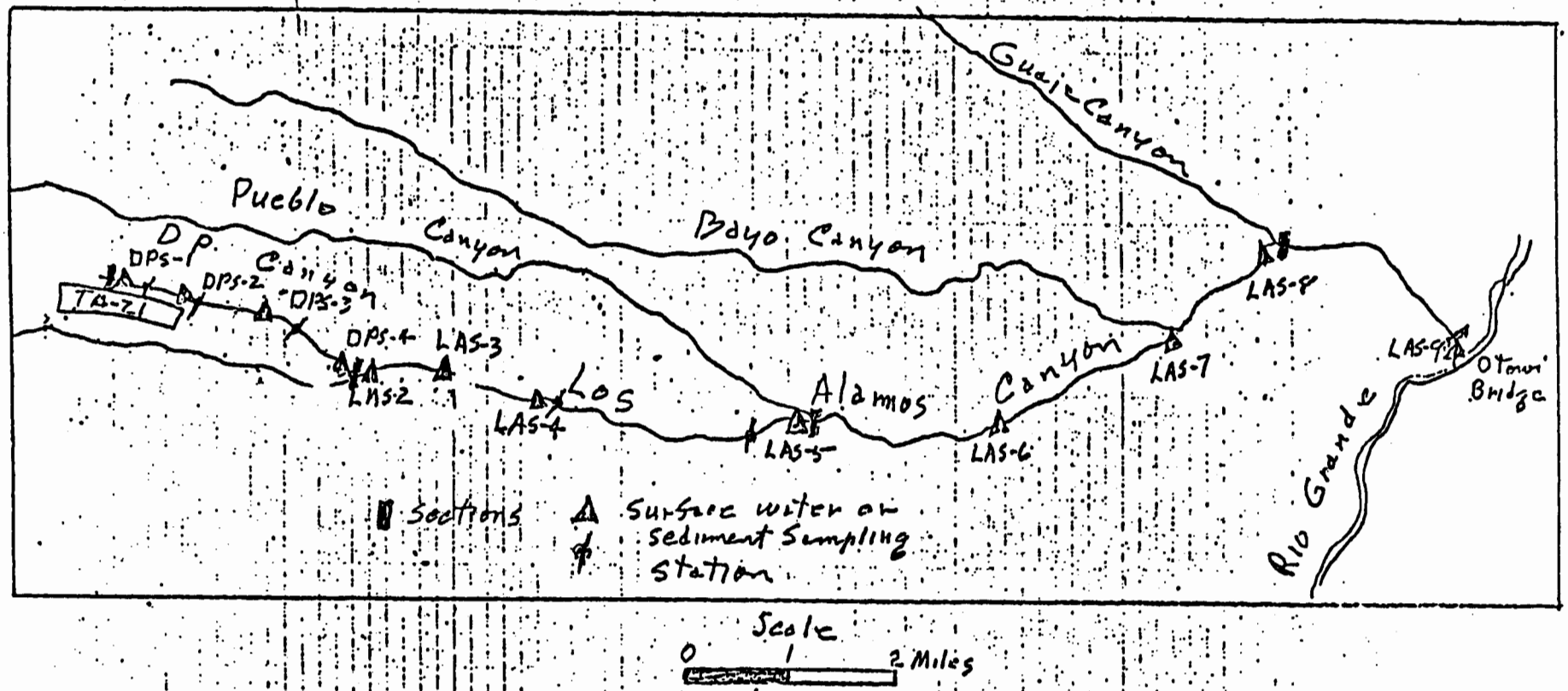


Figure 21 — Sampling stations and sections in Los Alamos Canyon

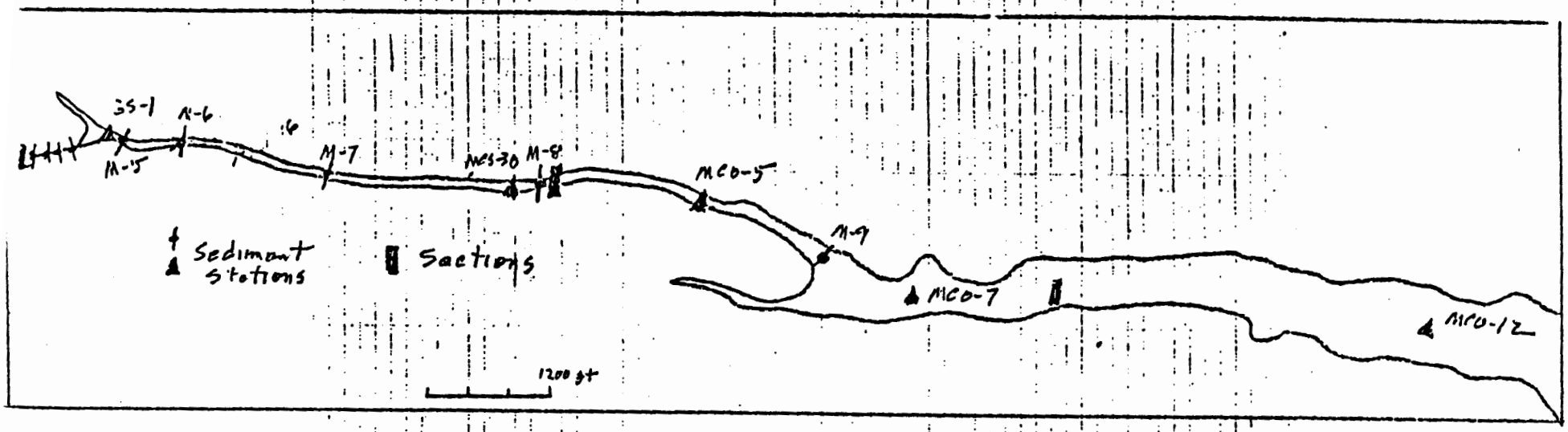


Figure 3.- Sampling stations and section in Montandon Canyon.

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

TO: LaMar Johnson

DATE: December 3, 1974

Pu Inventory

Acid-Pueblo Canyon

The inventory and relative distribution of Pu in four segments of Acid-Pueblo Canyon are presented below:

	Total Pu (mCi)			
Section (m)	Feb. 1970	% Total	Oct. 1972	% Total
0-480	4.6	25	2.4	21
480-2600	8.7	48	4.3	37
2600-6800	2.3	13	2.3	20
6800-10280	2.5	14	2.6	22
Total	18.1	100	11.o	100

Calculations based on Feb. 1970 samples indicate that about 18.1 mCi remain in the 10280 m section of stream channel downstream from the waste-outfall. This value represents about 11% of the estimated input of 170 mCi. In October, 1972, 11.6 mCi was the calculated inventory for the same sections of stream channel. If the difference between 1970 and 1972 estimates are real, then the annual loss from this stream section was about 2.2 mCi/year or roughly 13% of the current inventory per year. The latter figures were based on a 6.5 mCi loss over three summer rainfall seasons. The loss appears to have been from the upper reaches of the canyon where the stream channel is narrow, precipitous and easily scoured. The flux of Pu in the lower sections (2600-10280 m) apparently is in equilibrium, with gains equaling losses.

Data on the vertical distribution of the Pu in Acid-Pueblo sediments indicate that the radionuclide is relatively well mixed to sampling depths of 30 cm throughout the entire 10280 meter section. Snow and rain runoff and sewage effluent are all at least partially responsible for the redistribution of sediment Pu with distance and depth.

The ratio of $^{239-241}Pu/^{238}Pu$ in Acid-Pueblo Canyon sediments averaged 17, reflecting the laboratories early work with ^{239}Pu.

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

TO: LaMar Johnson DATE: December 3, 1974

The discrepancy between our inventory estimates and the amount of Pu released to the canyon measured about 150-160 mCi. There are several possible explanations for the discrepancy and these include:

1. The removal of significant amounts of Pu from the upper 160 meters of the canyon during the dismantling and clean-up of TA-45 and,
2. The flushing of Pu downstream during snow melt and/or rain runoff events.

It is impossibe to assess the amount of Pu removed during the TA-45 clean-up operation. Records compiled by J. Enders show that 504 truck loads of material were removed from the TA-45 area and were buried in Area G and C. Personal communications with C. Blackwell, J. Enders and C. Christenson lead us to believe that a very small amount of the rubble actually came from the canyon, per se. This contention is further substantiated by the physical appearance of the canyon today. There is little evidence of soil and/or rock removal from the stream channel other than one or two isolated spots where chisel marks are visible in the Tuffe. Most of the material which was removed from the canyon consisted of the cliff face immediately below the TA-45 waste outfall. According to Blackwell and Enders, a road was built to the bottom of the cliff where front end loaders scooped up about 94 truck loads of rubble for burial in Area C. The waste outfall area from TA-1, which is immediately adjacent to the TA-45 outfall, also bears no evidence of clean-up. The soils are well developed and heavily vegetated.

Unfortunatley, recollections from the past and opinions based on field observations, provide little bases for deriving a quantitative estimate of the amount of Pu removed from the canyon. It is our belief, however, that relatively small amount of the radioactivity was removed from the canyon during the clean-up operation.

TO: LaMar Johnson DATE: December 3, 1974

In our opinion, the most likely explanation for the relatively small residual Pu inventory is that the material was transported downstream during runoff events. Such a process was noted in Pueblo and Los Alamos Canyons as early as 1946, when Kingsley (LA-516, LA-516A) measured elevated Pu levels in soils and water about 10000 m below the respective waste outfalls and that levels in stagnant pools in the stream were much lower following spring rains than in late fall. Robeck (TID-460) in 1950, also suggested runoff transport phenomena as a mechanism of Pu redistribution in Pueblo Canyon.

Sediment radionuclide concentrations from the confluence of Pueblo and Los Alamos Canyon to the Rio Grande, demonstrate that Pu has been transported downstream from the waste outfalls (Schnap and Tribley, LAMS-709; Dodd, LAMS-2038; Hakonson, LA-5586; Purtymun, LA-4561). Three studies in DP Canyon (Purtymun, LA-5744) and in Mortandad Canyon (Hakonson, in preparation; Purtymun, Johnson, and John, U.S. Geol. Survey Prof. Paper 550-D) demonstrated that runoff is an operative mechanism in the transport of radioactivity down the canyons.

Determining the rate of Pu movement downstream in Acid-Pueblo Canyon is difficult with the data presently available. We have attempted to do so, however, utilizing 1970 and 1972 data. As mentioned previously, the loss of Pu from 1970 to 1972 was about 2.2 mCi/year or about 13% of the current inventory each year. The curves in Fig. 4 show the accumulative input of Pu to the canyon from 1943-1964 (upper curve) and the residual remaining each year through 1972 assuming a 13% annual loss (lower curve). The calculating formula along with an example calculation also appear in the Figure.

The Pu inventory in 1972 as estimated by equation 1 was 11.6 mCi which compares very well with a predicted inventory, based on a 13% annual loss, of 8 mCi. The use of the 13% annual decrement model assumes that Pu transport out of the 10280 m section began the first year wastes entered the canyon (1943) and that the flushing process proceeded at a

continuous rate through each succeeding year. The validity of these assumptions is questionable. However, the data presented by Kingsley (LA-516, LA-516A) demonstrate that by 1946, Pu had moved several thousand meters downstream. In addition, hydrologic observations over the past 16 years indicate that 3-4 runoff events in the Acid-Pueblo watershed reach the Rio Grande each year. Regardless of the validity of the assumptions, the exercise demonstrates the need for continuing long-term observations and special studies to provide a sound bases for predicting annual losses and transport mechanisms of the radioactivity.

At a 13% annual loss the Pu inventory in Acid-Pueblo Canyon would approach background levels (0.82 mCi over the 10280 m segment) by 1988. Pu concentrations in Acid-Pueblo sediments above the waste outfall in 1972, averaged 0.1 pCi/g in 5 samples.

DP-Los Alamos Canyon

The results of the inventory estimates for two sections of DP-Los Alamos Canyon are presented below:

Section (m)	May 1968	% Total	Aug. 1968	% Total	Feb. 1970	% Total	Oct. 1972	% Total
0-1800	3.9	78	0.4	27	4.6	81	3.2	86
1800-6600	1.1	22	1.1	73	1.1	19	0.5	14
Total	5.0	100	1.5	100	5.7	100	3.7	100

The Pu inventories in May and August 1968, reflect the storm transport phenomena that we believe is operative in Pu redistribution. The inventory in May 1968 represents build up of Pu during the Fall-Winter-Spring months, while the August inventory represents the residual after the summer rainfall season. The loss in the 0-1800 segment during the 3 month period was about 90% of the residual inventory while the overall loss from both segments was about 70% of the inventory. The stream

channel in the 0-1800 m segment has a thin (< 30 cm) alluvial cover and has a steep gradient (182 m fall/1800 m stream). Run-off is above normal due to the large areas of paved landscape (townsite) which drain into DP canyon. Losses from the lower section (1800-6600 m) apparently equaled gains since the inventory remained relatively constant.

The 5 mCi inventory in May 1968 represent about 20% of the 25.2 mCi (1952-1967) released to the canyon while the August 1968 inventory of 1.5 mCi represent 6% of the input.

The 1968 data suggest that Pu losses from the canyon are cyclic, with buildup occurring during the Fall-Winter-Spring months and losses occurring during the summer months when storm runoff periodically fills the streams.

The inventory estimate in February 1970 was 5.7 mCi which represents 20% of the 28.4 mCi released to the canyon. About 12% (3.7 mCi) of the 31.7 mCi input remained in October 1972.

The inventory estimates for all three years indicate that year to year losses approximately equal gains, even though within year losses may occur within a short time period. The overall loss of Pu from May 1968 to February 1970, was about 2.5 mCi. This value was derived as follows:

Net Pu loss = 5 mCi (May 1968 inventory)
+ 3.2 mCi (additions during 1968-1969) — 5.7 mCi (February 1970 inventory)
= 2.5 mCi, or 1.25 mCi/year

The loss of 1.25 mCi/year, represents about 19% of the 6.6 mCi present in the canyon in 1968 (i.e. 1.6 mCi input + 5 mCi inventory). The net loss from February, 1970 to October, 1972 was 5.3 mCi (i.e. 5.7 mCi inventory in Feb. 1970 + 3.3 mCi input-3.7 mCi inventory in Oct. 1972), which represents an annual loss over the three summer seasons of 1.8 mCi/year.

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

TO: LaMar Johnson DATE: December 3, 1974

The relative loss, based on an input of 1.8 mCi/year and 1970 inventory and annual input total of 6.8 mCi (i.e. 5.7 mCi + 1.1 mCi) was 26% per year. The average of the two relative loss rates was 23% per year. Applying this value to the estimated input (Fig. 5, upper curve), analogous to the presentation in Fig. 4, yields the predicted inventory (lower curve, Fig. 5) based on a 23 % annual loss.

Purtymun's estimate of the inventory in October, 1972 was 3.7 mCi, which compares with a predicted value of 4.7 mCi, assuming a 23% annual loss. The model predicted that background levels (0.17 mCi for the 6600 m segment) would be achieved by 1987, assuming that wastes continue to be released into DP Canyon until 1976 at a rate of 0.4 mCi/year. Pu concentrations in sediments from above the outfall in DP canyon averaged 0.05 pCi/g for 6 samples.

The average ratio of $^{239}Pu/^{238}Pu$ in DP-Los Alamos sediments was 5.2. The ratio in effluent from TA-21 during 1972 averaged 0.5 reflecting increased Laboratory use of ^{238}Pu since 1958. Data on the vertical distribution of the Pu to maximum sampling depths of 30 cm indicate that the radionuclide has mixed with depth throughout the 6600 m segment.

Lower Los Alamos Canyon to Rio Grande

This section of stream channel which lies below the confluence of Acid-Pueblo and DP-Los Alamos Canyon has received all of the radioactivity transported out of the two upper canyons. Based on the estimates presented earlier, about 160 mCi Pu from Acid-Pueblo and 30 mCi Pu from DP-Los Alamos may have washed into this stream segment over the past 30 years. The inventory estimates and relative distribution of Pu in Lower Los Alamos Canyon in 1968 and 1970 appear below

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

TO: LaMar Johnson DATE: December 10, 1974

Segment (m)	Total Pu (mCi) May 1968	% Total	Aug. 1968	% Total	Feb. 1970	% Total
0-4800	1.6	62	1.0	∿98	2.0	65
4800-7200	0.7	38	< .02	∿ 2	1.1	35
Total	2.3	100	∿1.0		3.1	100

It is apparent that little of the 190 mCi Pu from the upper portions of Acid-Pueblo and DP-Los Alamos remains in the lower segment. The May and August 1968 data reflect summer storm transport, analagous to the data for the upper 6600 m in DP-Los Alamos Canyon. The estimated inventory was 2.3 mCi in May and about 1 mCi in August. The inventory in February 1970 was 3.1 mCi.

The data in Figs. 4 and 5 were used to estimate the annual Pu addition to lower Los Alamos Canyon over the past 30 years. Recall that a 13% annual loss was calculated for Acid-Pueblo Canyon, while the average annual loss from DP-Los Alamos Canyon was 23%. The upper curve in Fig. 6 shows the accumulative Pu additions from 1943 to 1973. The average annual Pu loss, as calculated by the method described earlier, was 53%/year. The lower curve in Fig. 6 show the resulting inventories based on the 53% annual loss. Calculated inventories (equation I) in May 1968 and in February 1970 were 2.3 mCi and 3.1 mCi, while corresponding predicted values based on a 53% annual loss were 3.9 mCi and 3.4 mCi. The 53% annual decrement model predicted background levels (0.48 mCi for the 7200 m segment) would be achieved in the late 1980's.

Sediment loads passing Otowi bridge on the Rio Grande River average 2.2×10^9 kg/year over the last 21 years (U.S. Geological Survey, Water Quality Records). Obviously the capacity for dilution of radioactivity with suspended sediments as it enters the Rio Grande is large.

Sediment samples from the Rio Grande in 1973 did not

contain elevated amounts of plutonium. Studies of the river will be expanded, especially in the newly constructed Cochiti Reservior.

The $^{239}Pu/^{238}Pu$ ratio in sediments from lower Los Alamos Canyon averaged 29, which more nearly corresponds to the high $^{239}Pu/^{238}Pu$ ratio observed in Acid-Pueblo Canyon.

Based on the data presented above, lower Los Alamos Canyon receives about 2 mCi/year from Acid-Pueblo and about 0.5 mCi/year from the DP-Los Alamos branch.

Mortandad Canyon

The A.E.C. owns the land in Mortandad Canyon to about 5100 m below the TA-50 waste outfall. The San Ildefonso Indians own the remaining portion of the canyon down to the Rio Grande. Sediment samples have not been taken on indian land, however, some were taken in 1972 at the Laboratories east boundary in the canyon and at the point where Mortandad Canyon crosses State Road 4.

The inventory estimates for 1970 and 1972 are presented below:

	Total Pu (mCi)			
Section (m)	Feb. 1970	% Total	Oct. 1972	% Total
0-1460	15.8	85	28.2	71
1460-5100	2.7	15	11.8	29
Total	18.5	100	40	100

The Feb. 1970 inventory estimate was 18.5 mCi, which compares with an input of 22.3 mCi through 1969. The October estimate was 40 mCi, which compares with an input of 41.5 mCi through 1972. The 21.8 mCi increase in Pu from 1970 to 1972 reflects additions of the radionuclide from TA-50. During this period, records show that 19.2 mCi were released into the canyon.

Changes in the relative distribution of the Pu within the

two sections may be indicative of relocation by storm runoff. None of the radioactivity has reached Indian land as evidenced by background concentrations in the sediments immediately upstream and at the State Road 4 crossing (Hakonson, LA-5586).

The physical characteristics of Mortandad Canyon are the primary reason for the relatively small downstream movement of the Pu. The drainage area is small, at about 6 km^2 and the lower reaches of the canyon (i.e. >1200 m post-outfall) broaden and are covered with alluvial deposits to a depth of as much as 25 m. The alluvium is unsaturated, and thus far, has had the capacity to absorb all the water (i.e. effluent, storm runoff and etc.) which reaches the area. Observations over the last 16 years indicate that runoff from the upper canyon has never reached post-outfall distances in excess of about 3500 m. However, The development and construction at TA-35 and TA-55 has increased runoff into the canyon. This increase may be sufficient to transport the Pu to off-site areas in the event that corrective measures are not implemented.

The $^{239}Pu/^{238}Pu$ ratio favors ^{238}Pu at 0.28. Concentrations are relatively uniform with depth in the upper 1200 m of the canyon and become increasingly concentrated in the surface 2.5 cm below this point. Surface water is always in the channel to about 1200 m post-outfall, but soaks into the alluvium at distances beyond 1200 m. The lower portion, from about 1200-3500 m, flows water periodically during summer storm runoff events.

Cesium-137 Inventory

Acid-Pueblo Canyon

The cesium-137 inventory for the four segments of Acid-Pueblo Canyon appears below.

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

TO: LaMar Johnson DATE:

^{137}Cs In Acid-Pueblo Canyon (October 1972)

Segment (m)	Total ^{137}Cs (mCi)	% Total
0-480	0.48	12
480-2600	2.0	49
2600-6800	0.92	22
6800-10280	0.66	16
Total	4.1	100

The estimated inventory of 4.1 mCi compares with a background value of 3.1 mCi based on average pre-outfall concentrations of 0.38 pCi/g.

Few sediment samples from this canyon contained above-background levels of ^{137}Cs. Thus, the amount of ^{137}Cs released to the canyon was either small or it has since been transported downstream by storm runoff.

The ^{137}Cs inventory of 4.1 mCi in October 1972, compares with an estimated Pu inventory of 11.6 mCi. The highest percentage of both ^{137}Cs and Pu occurred in the 480-2600 m segment.

DP-Los Alamos Canyon

The DP-Los Alamos Canyon inventory to 6600 m post-outfall was as follows:

^{137}Cs In DP-Los Alamos Canyon (October 1972)

Segment (m)	Total ^{137}Cs (mCi)	% Total
0-1800	130	84
1800-6600	24	16
Total	154	100

About 84% of the estimated 154 mCi ^{137}Cs was located in the upper 1800 m of the canyon while the remaining 16% was distributed in the lower segment (1800-6600 m). In 1973, the only year specific analyses for ^{137}Cs were made on effluent, 1.1 mCi

TO: LaMar Johnson DATE:

was released into DP-Los Alamos Canyon from TA-21 (LA-5586). It seems likely that release levels in previous years were larger, since the TA-21 plant has received steadily less radioactivity in the past few years.

There appeared to be a distributional relationship between the Pu and ^{137}Cs in October 1972 samples. A least squares regression of ln ^{137}Cs vs ln Pu for 25 post-outfall sediment samples was highly significant ($r = 0.74$, $\alpha < 0.01$).

The ^{137}Cs inventory of 154 mCi in October 1972 compares with an estimated Pu inventory of 3.7 mCi. On an activity basis, there is about 42 times as much ^{137}Cs as Pu. The highest percentages of both ^{137}Cs and Pu occurred in the upper 1800 m of the canyon.

Lower Los Alamos Canyon

The inventory estimate from the confluence of Pueblo and Los Alamos Canyons to the Rio Grande appears below:

^{137}Cs in Lower Los Alamos Canyon (October 1972)

Segment (m)	Total ^{137}Cs (mCi)	% Total
Confluence-4800	1.1	11
4800-7200	9.1	89
Total	10.2	100

The total inventory for the Acid-Pueblo-DP-Los Alamos Canyon system, including lower Los Alamos Canyon, was about 168 mCi. About 92% was in the upper reaches of DP-Los Alamos Canyon (0-6600 m), less than 3% in upper Acid-Pueblo Canyon (0-10280 m) and about 6% in Lower Los Alamos Canyon.

Mortandad Canyon

The ^{137}Cs inventory in Mortandad Canyon to 5100 m post-outfall is presented on the following page:

LOS ALAMOS SCIENTIFIC LABORATOR
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

TO: LaMar Johnson DATE:

^{137}Cs In Mortandad Canyon (Oct. 1972)

Segment (m)	Total ^{137}Cs (mCi)	% Total
0-1460	240	75
1460-5100	79	25
Total	319	100

The ^{137}Cs inventory of 319 mCi for Mortandad Canyon was the largest of any of the three canyons; the value being twice the total for DP-Los Alamos and Acid-Pueblo.

Release of ^{137}Cs to Mortandad Canyon totaled 293 mCi in 1973 (LA-5586). Assuming that a similar quantity was released from 1963-1972 (no records are available), then the estimated inventory of 319 mCi accounts for about 1/10 of the total which was released in the canyon.

The ^{137}Cs concentrations were at background levels in sediments just above (∿ 5200 m) Indian land and at State Road 4. Consequently, the material must lie somewhere within the first 5100 m post-outfall.

There are at least two possible areas where the unaccounted ^{137}Cs might be found. The first is in the deeper alluvium (> 30 cm) of the lower portion of the 1460-5100 m segment. The coring device used to collect sediment in 1972, reached into the profile a maximum of 30 cm. The runoff water which soaks into the alluvium in this segment may carry the ^{137}Cs to depths exceeding the 30 cm limit of the sampler. The other possible location for the ^{137}Cs is that at some time during the past, the stream channel over flowed and carried much of the ^{137}Cs along with it. We know that such an event has occurred several times in the past, but as yet have not studied the matter sufficiently to comment.

A runoff event in Mortandad Canyon on September 15, 1974 carried an estimated 7 mCi ^{137}Cs past the 1200 m post-outfall

TO: LaMar Johnson DATE:

location. About 97% of the ^{137}Cs was associated with suspended particulates greater than 0.45 μ; whereas, only 3% was associated with the water. The 7 mCi ^{137}Cs transported during this event represents about 2% of the estimated inventory.

There was a highly significant correlation ($r = 0.91$, $\alpha < 0.01$) between ln ^{137}Cs and ln Pu in sediments, based on 33 samples from the canyon. The presence of this relationship strengthens the argument that a physical transport mechanism (i.e. storm runoff) is operative in redistributing both Pu and ^{137}Cs, since the two are chemically disimilar.

Discussion and Summary

The following tabulation lists our estimate of Pu and ^{137}Cs in all the canyons as of 1972.

Canyon	Total Pu (mCi)	Total ^{137}Cs (mCi)
Acid-Pueblo	11.6	4.1
DP-Los Alamos	3.7	154
Lower Los Alamos	3.1*	10.2
Mortandad	40	319
Total	58.4	487.3

* Based on February 1970 samples

The amount of Pu and ^{137}Cs associated with biological organisms is very small (< a few percent) based on the observed concentrations in plants and animals (LA-5586), and on the relatively small area which has been contaminated. Sediments are definitely the major reservior of the Pu and ^{137}Cs.

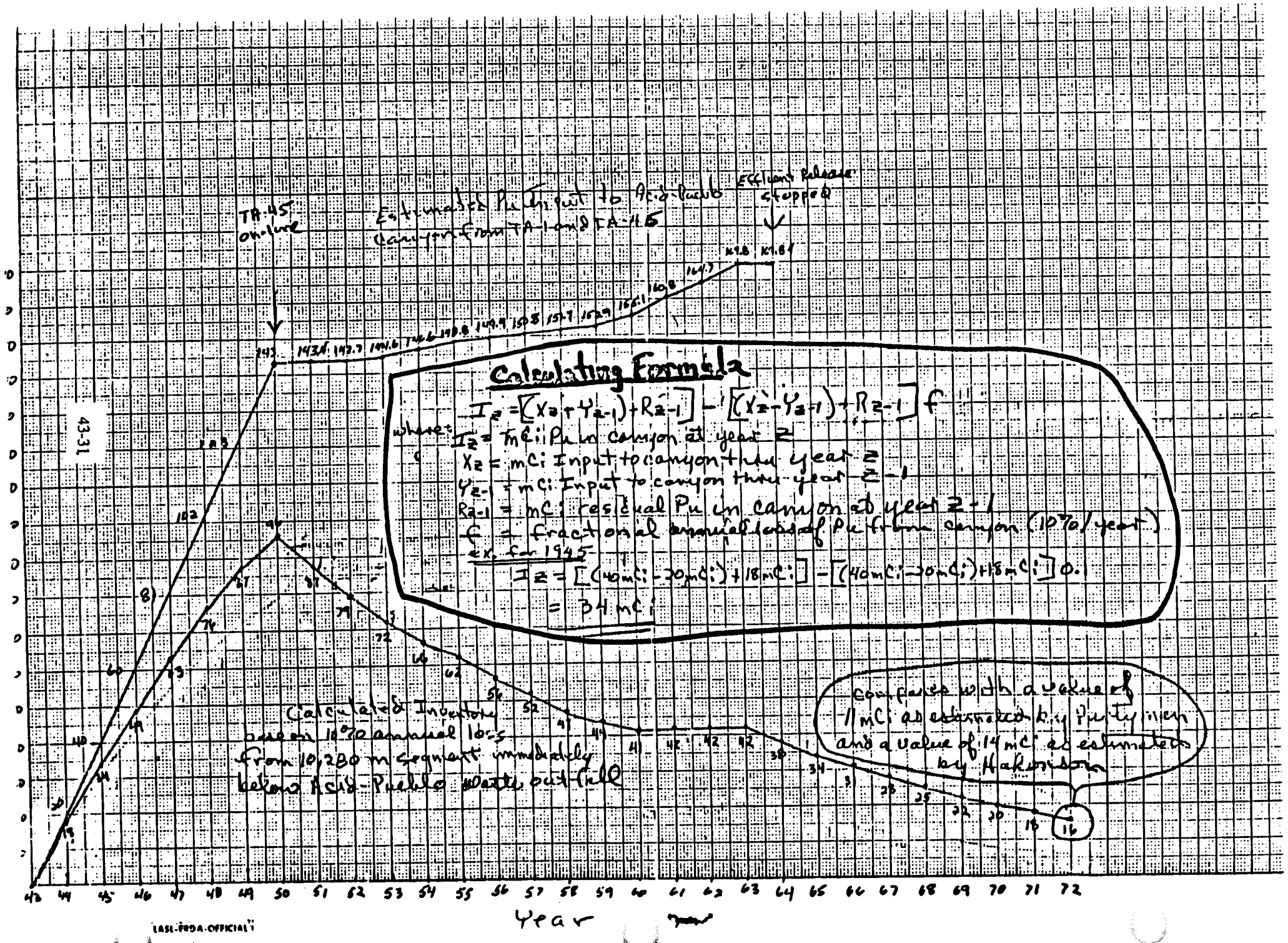
As a consequence, sediment transport processes are primal in redistributing the radionuclides. Storm runoff seems to be the major vector in all three canyons. Fine particulates, which contain higher concentration, are transported the furtherest during any particular event. However, coarser materials which comprise 90 plus percent of the alluvium, carries the bulk of

TO: LaMar Johnson DATE:

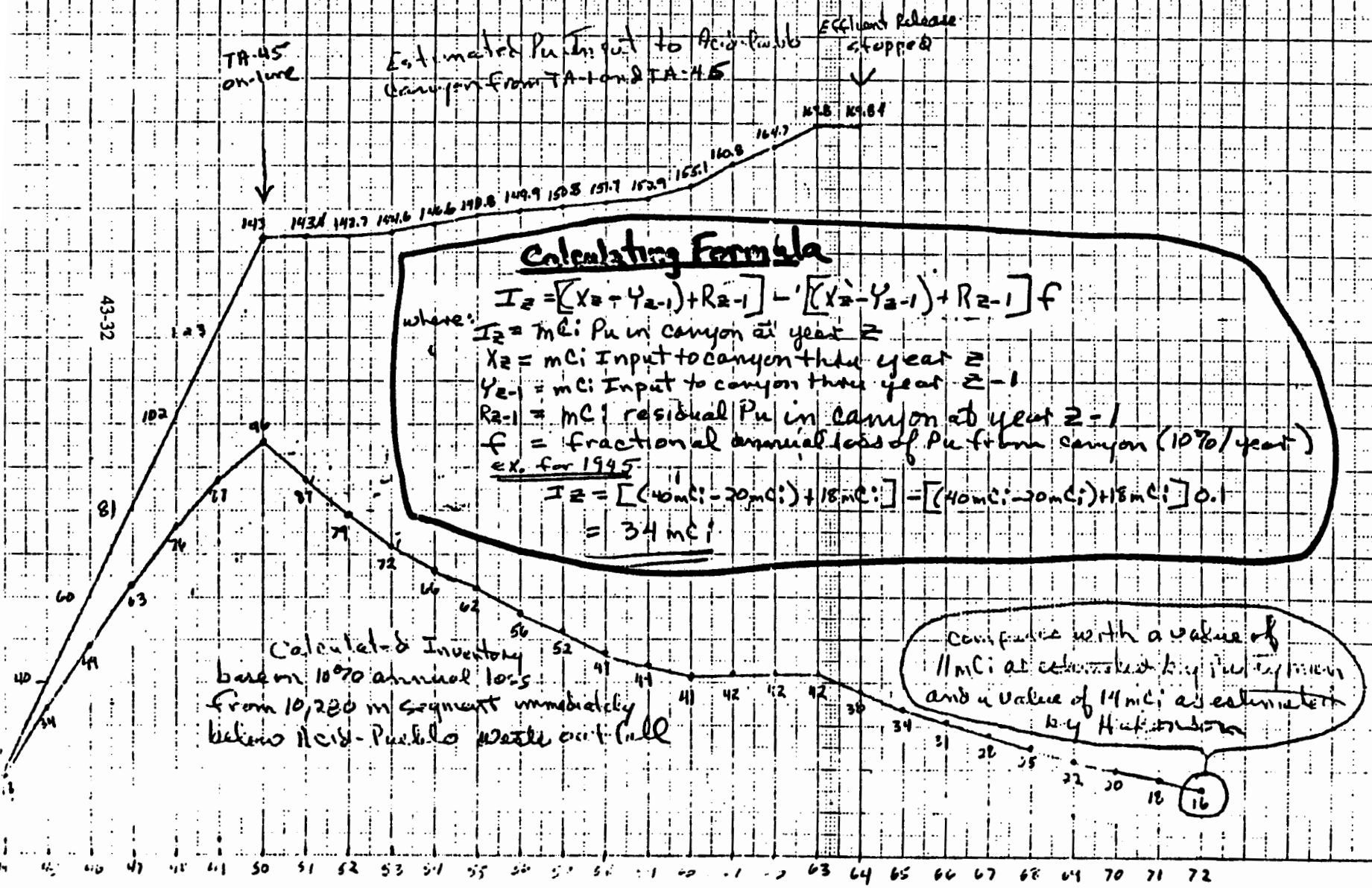
the radioactivity downstream. One study in Mortandad Canyon determined that a relatively small runoff event moved about 7 mCi ^{137}Cs downstream during a 4 hour period.

Pu, and probably ^{137}Cs, has been carried completely out of the Acid-Pueblo and DP-Los Alamos canyon system. Estimates show that as much as 180 mCi Pu may have entered the Rio Grande River. Average annual losses of 13% (Acid-Pueblo) and 23% (DP-Los Alamos) were estimated for the two upper sections of the canyon system, whereas, a 53% annual loss appeared to adequately predict on hand inventories in Lower Los Alamos Canyon. Pu from liquid effluent in Mortandad Canyon is confined exclusively to the 5100 m section immediately below the waste outfall. Prospects for the material remaining there are dim, in light of construction activities on the upper Mortandad Canyon watershed.

The amounts of ^{137}Cs present in the canyons in 1972 were about 10 times greater than the Pu. A considerable amount of ^{137}Cs is believed unaccounted for by the inventory estimate in Mortandad Canyon.



LASL-DOE-OFFICIAL



Calculating Formula

$$I_z = [(X_z + Y_{z-1}) + R_{z-1}] - [(X_z - Y_{z-1}) + R_{z-1}]f$$

where:

I_z = mCi Pu in canyon at year z

X_z = mCi Input to canyon this year z

Y_{z-1} = mCi Input to canyon three year z-1

R_{z-1} = mCi residual Pu in canyon at year z-1

f = fractional annual loss of Pu from canyon (10%/year)

ex. for 1945

$$I_z = [(40\,mCi - 20\,mCi) + 18\,mCi] - [(40\,mCi - 20\,mCi) + 18\,mCi]\,0.1$$

$$= 34\,mCi$$

Calculating Formula

$$I_z = [(X_z - Y_{z-1}) + R_{z-1}] - [(X_z - Y_{z-1}) + R_{z-1}]f$$

where:

I_z = mCi Pu in canyon at year z
X_z = mCi Input to canyon thru year z
Y_{z-1} = mCi Input to canyon thru year z-1
R_{z-1} = mCi residual Pu in canyon at year z-1
f = Fractional annual loss of Pu from canyon (0.1/year)

ex for year 1995

$$I_{(1995)} = [(40mCi - 20mCi) + 13mCi] - [(40mCi - 20mCi) + 13mCi]0.13$$
$$= 33\ mCi$$

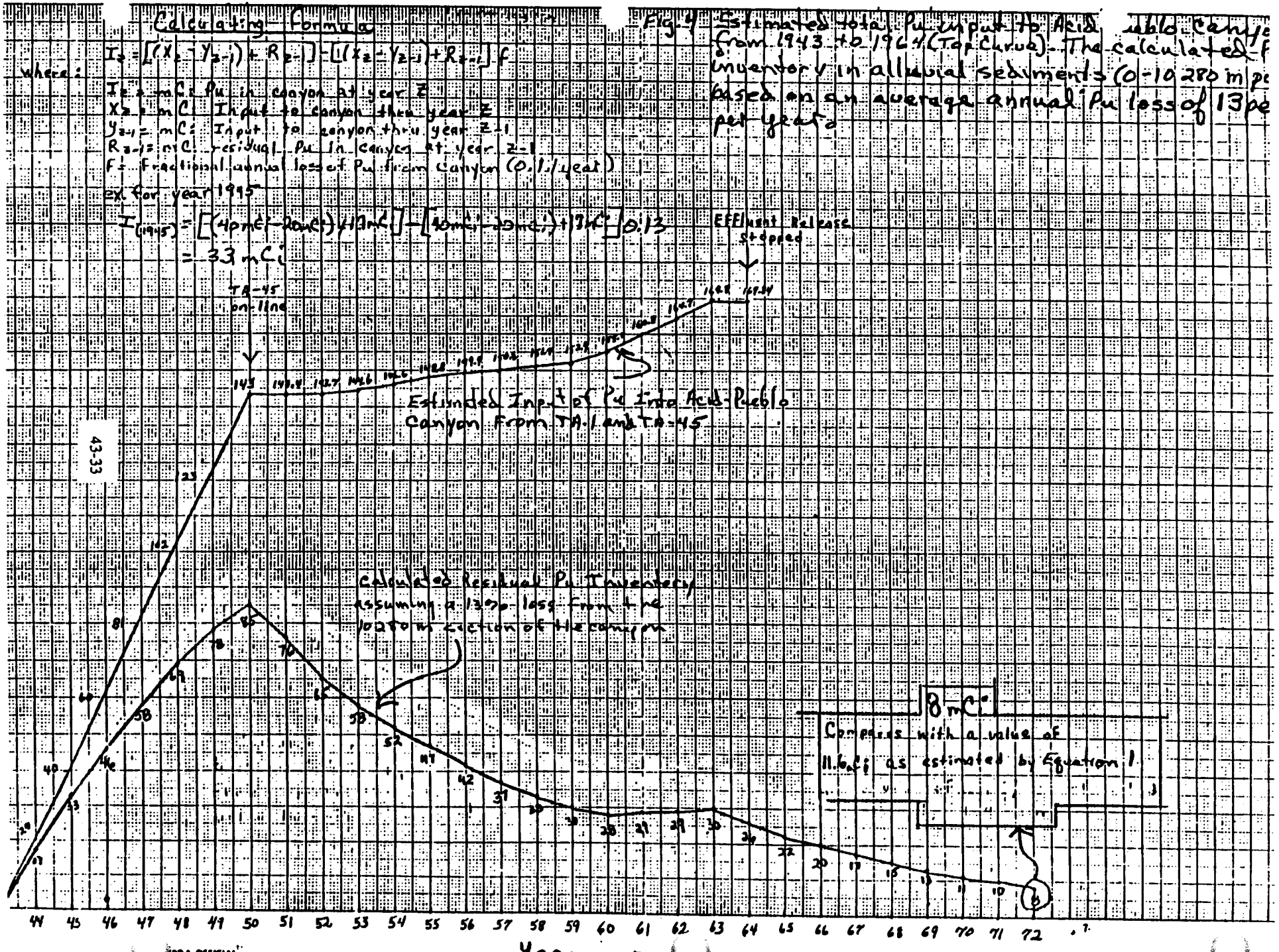


Fig. 4 Estimated total Pu input to Acid-Pueblo Canyo from 1943 to 1964 (Top Chart). The calculated F inventory in alluvial sediments (0-10 280 m pe based on an average annual Pu loss of 13 pe per year.

ERDA-OFFICIAL

Calculating Formula

$$I_z = [(X_z - Y_{z-1}) + R_{z-1}] - [(X_z - Y_{z-1}) + R_{z-1}]f$$

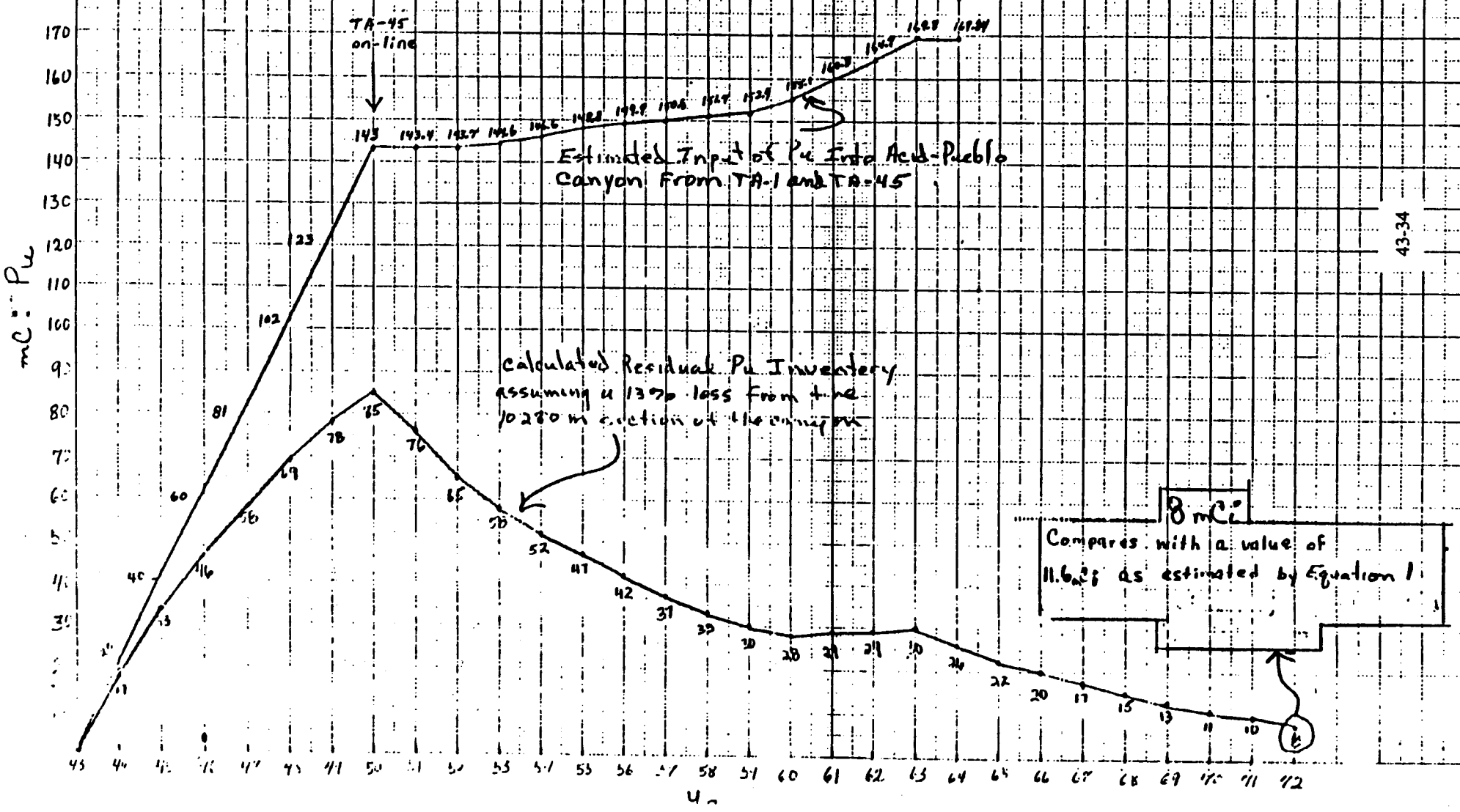
where:

I_z = mCi Pu in canyon at year Z
X_z = mCi Input to canyon thru year Z
Y_{z-1} = mCi Input to canyon thru year Z-1
R_{z-1} = mCi residual Pu in canyon at year Z-1
f = fractional annual loss of Pu from canyon (0.13/year)

ex. for year 1945

$$I_{(1945)} = [(40\,mCi - 20\,mCi) + 17.7\,mCi] - [(40\,mCi - 20\,mCi) + 17.7\,mCi]\,0.13$$
$$= 33\,mCi$$

from 1943 to 1964 (Top Curve). The calcula
inventory in alluvial sediments (0-10 2
based on an average annual Pu loss o
per year.



43-34

Calculating formula

$$I_z = [(X_z - Y_{z-1}) + R_{z-1}] - [(X_z - Y_{z-1}) + R_{z-1}]F$$

where:

I_z = mCi Pu in canyon at year Z

Y_z = mCi Input to canyon thru year Z

Y_{z-1} = mCi Input to canyon thru year Z-1

R_{z-1} = mCi residual Pu in canyon at year Z-1

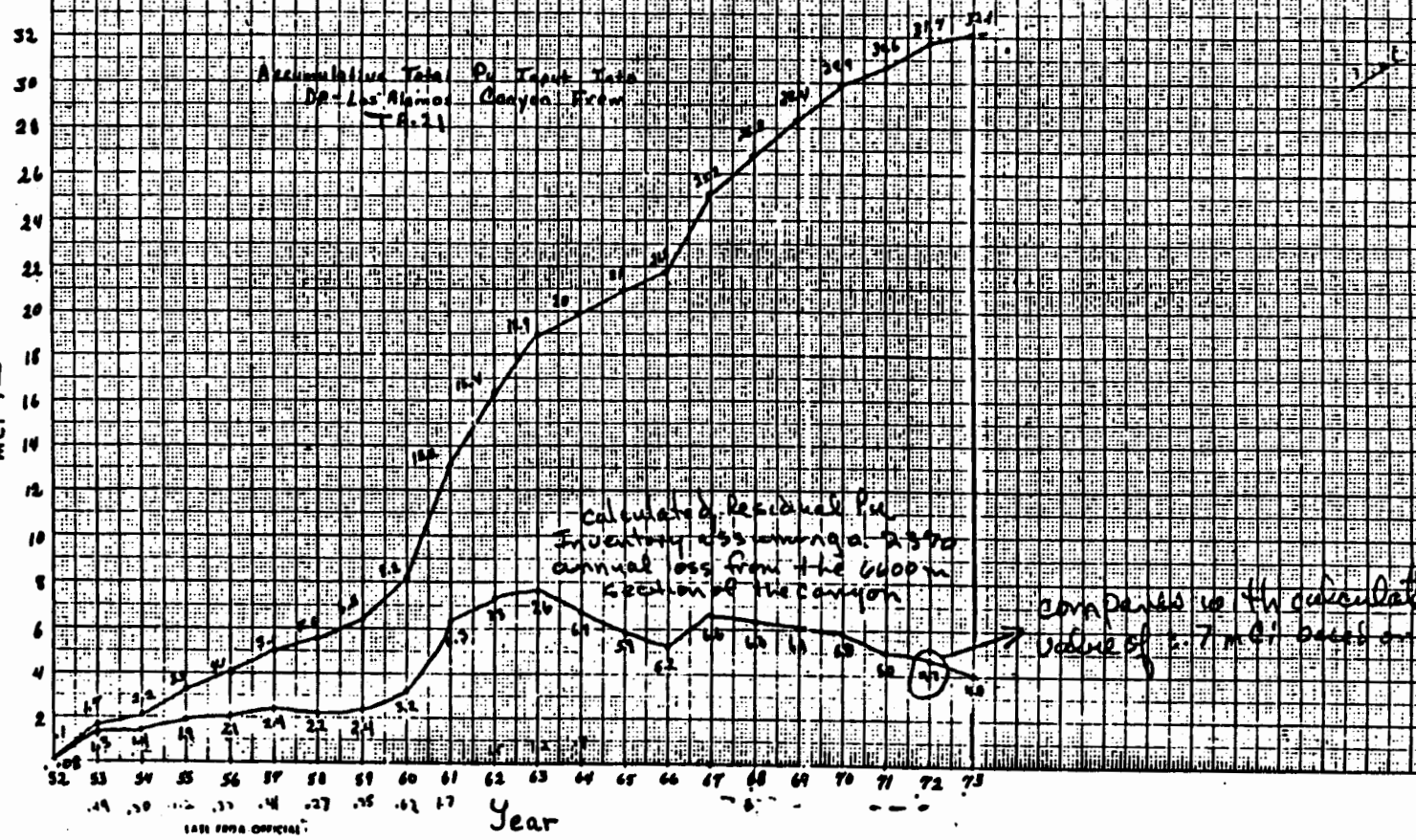
F = fractional annual loss of Pu from canyon (.29/year)

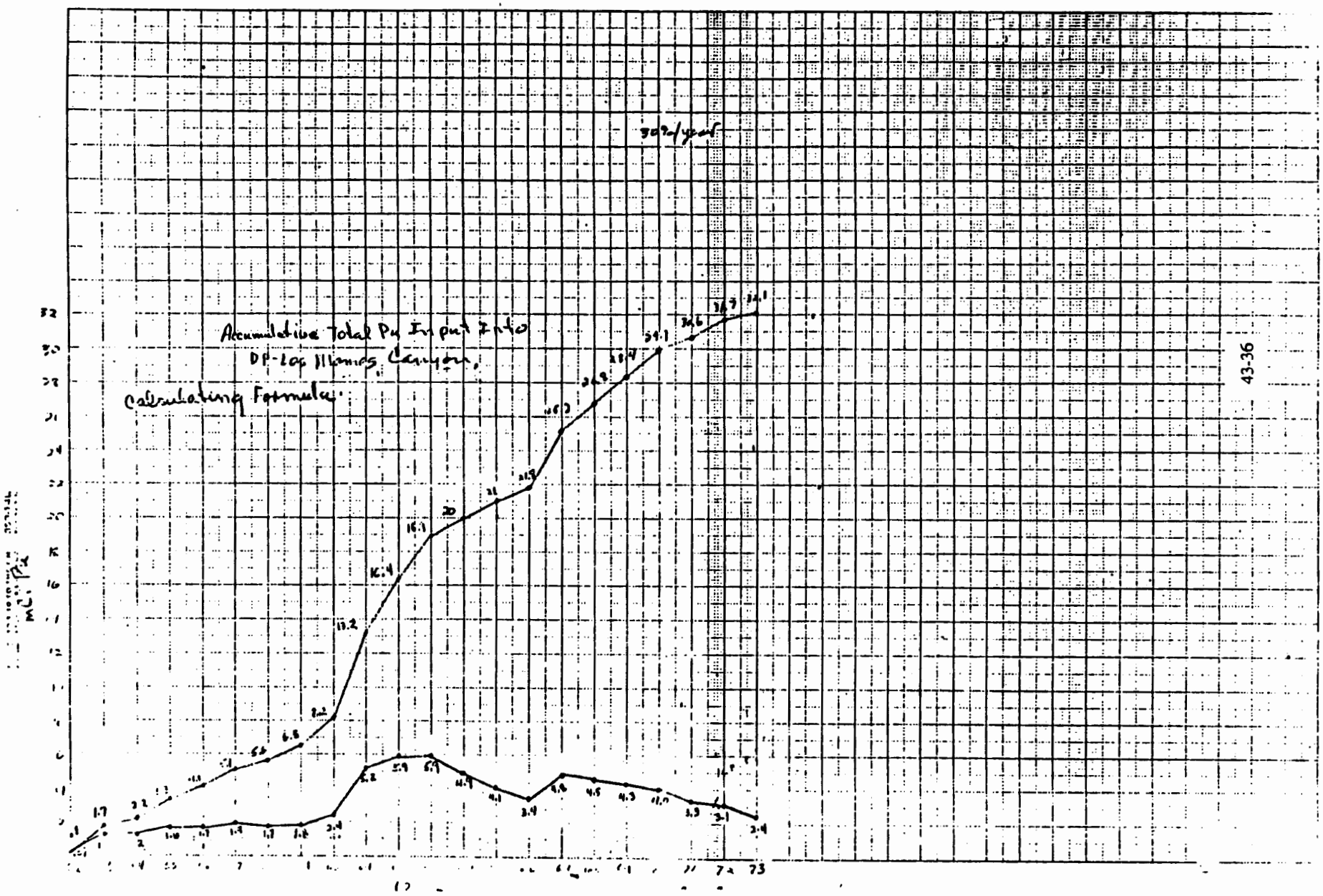
ex. for Z = 1953

$$I_Z = [(1.7 - 0.1) + 0.0] - [(1.7 - 0.1) + 0.0]\,0.29$$

$$= 1.2 \text{ mCi}$$

Fig. 5 Estimated total Pu input into DP-Los Los Alamos Canyon from 1952 - 1973 (Top curve). The calculated Pu inventory in alluvial sediments (0-6600 m post-outfall) based on an average annual Pu loss of 29 percent per year.




Accumulative Total Pu Input Ratio
DP-Log Illinois Canyon,
Calculating Formula:
302/year

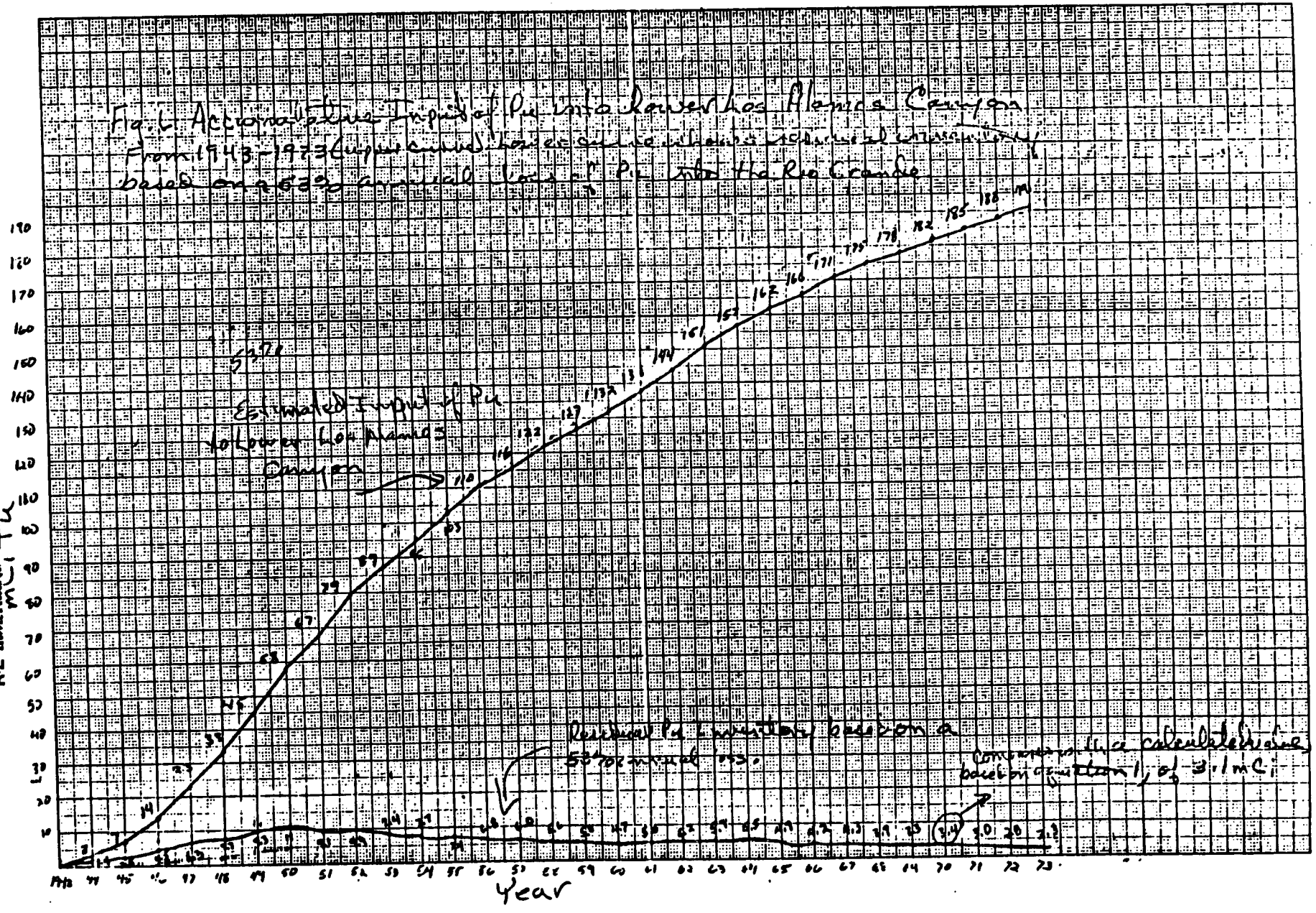
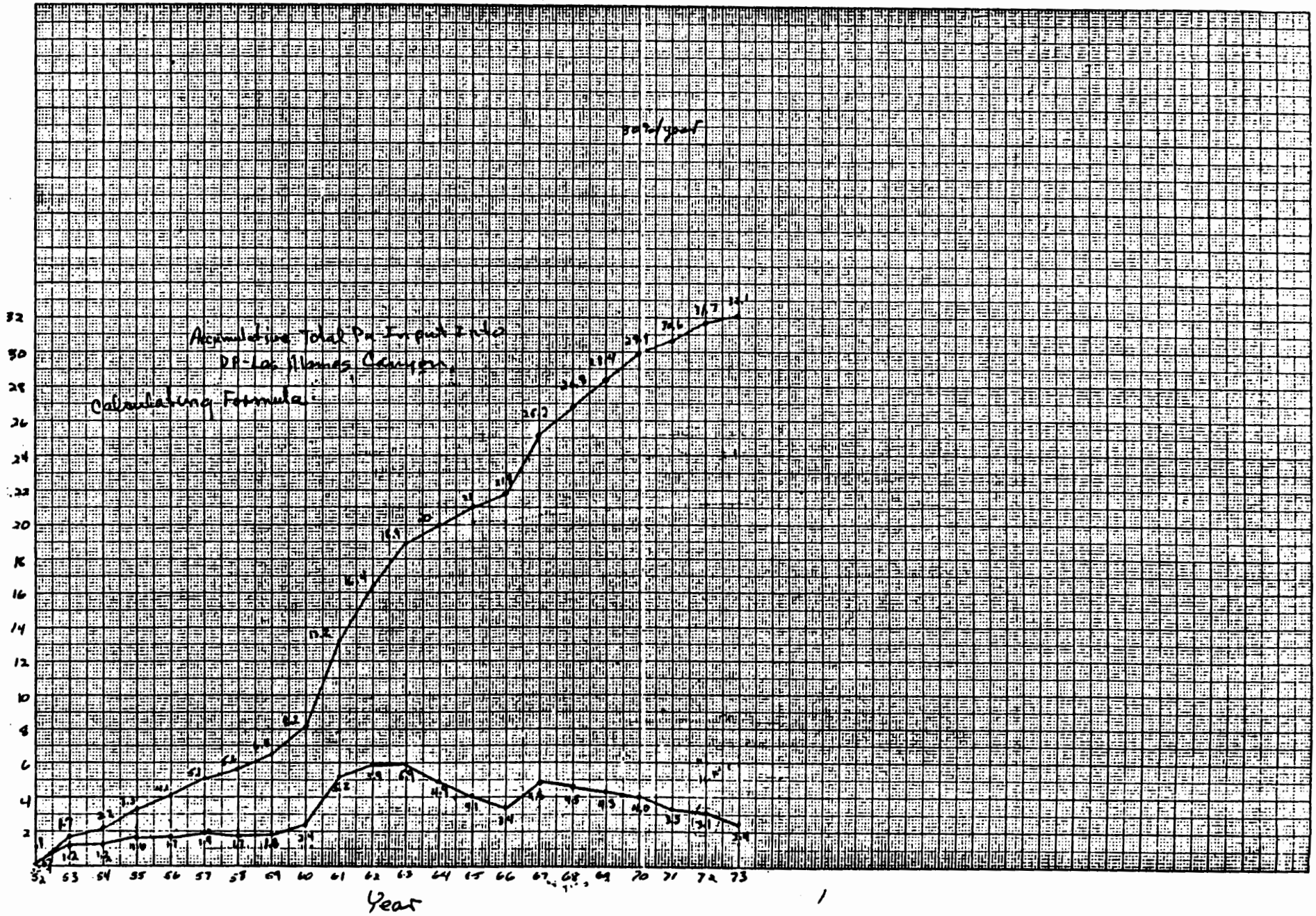


Fig. 6 Accumulative Input of Pu into Lower Los Alamos Canyon
From 1943-1973 (upper curve) based on the indicated measurements
based on a 6.2% annual loss of Pu into the Rio Grande
Estimated Input of Pu to Lower Los Alamos Canyon
Residual Pu based on a 5.2% annual loss.
Comparison with calculated values based on equation 1, of 3.1 mCi
mCi
Year


Accumulative Total Production
DP-Lake Illinois Canyon
Calculating Formula:
Year

UNIVERSITY OF CALIFORNIA
LOS ALAMOS SCIENTIFIC LABORATORY
(CONTRACT W-7405-ENG-36)
P. O. Box 1663
Los Alamos, New Mexico 87544

IN REPLY REFER TO: H8-74-265

December 10, 1974

Frank Trainer
U.S.G.S.-WRD
P.O. Box 4369
Albuquerque, New Mexico 87106

Dear Frank:

Listed below are the results of radiochemical analyses of water from USGS test holes in the Jemez Mountains.

	Gross Alpha	Gross Beta	Total Uranium
	pCi/l		μg/l
Near Jemez Sprs.	6.6 ± .5	23.2 ± 1.5	.9
Near Battleship Rock	1.4 ± .3	40.2 ± 1.6	1.7
Near Porter	0.3 ± .2	8.9 ± 1.5	.1
Guadalupe Box	1.5 ± .3	10.9 ± 1.5	.06

Also enclosed is a copy of LA-5780-MS, as you requested.

Sincerely,

Bill Purtymun
Group H-8
Environmental Studies

WDP:pb
Enclosure

AN EQUAL OPPORTUNITY EMPLOYER

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

OFFICE MEMORANDUM

TO : Jim Owens, H-8 DATE: November 12, 1974

THRU : Stewart M. Lombard, H-8 SML

FROM : W. D. Purtymun, H-8 T.L.M.

SUBJECT : FLUOROMETER ANALYSIS OF JEMEZ MOUNTAINS SAMPLES

SYMBOL : H8-74-423

There are 40 samples from 4 locations in the Jemez Mountains taken at various dates between 11-29-73 and 7-30-74 to be analyzed in a fluorometer to determine the presence or absence of fluoroscene dye (a marker). These samples are to be returned, as they belong to the U.S.G.S. The 40 samples are numbered one to 40 as follows:

1.	11-29-74	Soda Dam	21.	5-10-74	Soda Dam
2.	11-29-74	Jemez Springs	22.	5-10-74	Jemez Springs
3.	1-18-74	Test Hole #1	23.	5-10-74	L. S. Spring
4.	1-25-74	Jemez Springs	24.	5-16-74	Soda Dam
5.	1-25-74	Soda Dam	25.	5-16-74	Jemez Springs
6.	1-25-74	L. S. Spring	26.	5-16-74	Test Hole #1
7.	2- 7-74	Test Well #1	27.	5-16-74	L. S. Spring
8.	3-18-74	Soda Dam	28.	5-28-74	Soda Dam
9.	3-18-74	Test Well #1	29.	5-28-74	Jemez Springs
10.	3-18-74	L. S. Spring	30.	5-28-74	L. S. Springs
11.	3-21-74	Jemez Springs	31.	6-11-74	Soda Dam
12.	4- 2-74	Test Well #1	32.	6-11-74	Jemez Springs
13.	4- 2-74	L. S. Spring	33.	6-11-74	Test Hole #1
14.	4- 8-74	Test Well #1	34.	6-11-74	L. S. Spring
15.	4- 8-74	L. S. Spring	35.	7-12-74	Soda Dam
16.	4-23-74	Test Well #1	36.	7-12-74	Jemez Springs
17.	4-23-74	L. S. Spring	37.	7-12-74	Test Well #1
18.	5- 3-74	Soda Dam	38.	7-12-74	L. S. Spring
19.	5- 3-74	Jemez Springs	39.	7-30-74	Soda Dam
20.	5- 3-74	L. S. Spring	40.	7-30-74	Jemez Springs

SML:WDP:dl

.OS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

OFFICE MEMORANDUM

TO : Ed Williams, Q-23 DATE: March 3, 1975

FROM : Wm. D. Purtymun WDP

SUBJECT : MOISTURE AND DENSITY LOGGING OF BASALT HOLE

SYMBOL : H8-75-76

Attached is the moisture log (Table I) and density log (Table II) of the 97.5 ft (29.7 m) hole in basalt at TA-56.

The moisture content were run using a sonde with slightly different calibration than logs run on 10-25-74. The logs are compatible. There appears to be some increase in moisture content at the 11 ft depth due to snow melt into a fracture. The lower part of the hole (depth 90 to 97.5 ft) appears to contain some moisture (apparently free water in an interflow) that is cased out of the hole by the rock melt around the bore hole.

I went over the calibration for the density log and found that the decay factor for the source in the sonde had been corrected. I also found that the density calibration I used for the October 1974 logs were based on a specific gravity of basalt of 3.0. The standard calibration (set dia.of hole cased with steel tubing) could not be used in the basalt with the larger diameter coupled with rock melt on the hole wall. A new calibration based on a 2.6 specific gravity was prepared. For comparison the log of 10-25-74 was correct from this calibration and is shown on Table II. The density shown is wet density, for correction to dry density use Table I to determine lbs of moisture per cu ft and adjust. The density log, until we can make a precise calibration, should be used too as an indication of relative changes of the basalt penetrated by the hole.

The density data indicates that the hole penetrated two interflow zones between basalts of slightly different ages, one from 42 to 50 ft and the other from 88 to 97.5 ft (TD).

WDP:bh
Enclosures

Table I Moisture Content (Neutron Log) 1/

Depth (ft)	10-25-74	2-19-75	Depth (cont'd) (ft)	2-19-75
1	3.5	-	33	4
2	3	-	35	4
3	3.5	-	37	3.5
4	3	-	39	4
5	3.5	-	41	5.5
6	3.5	-	44	4.5
7	3.5	-	48	6
8	3	-	52	4
9	3.5	-	56	4
10	2	-	60	4
11	2	8.5	64	4
12	2	-	67	4.5
13	3	-	70	4.5
14	3	-	73	4.5
15	3	-	76	4.5
16	3	-	79	4.5
17	3.5	-	82	4.5
18	3.5	-	85	4.5
19	3	-	88	4.5
20	3	3.5	90	16
21	3	-	92	23.5
22	3	-	94	15
23	2	-	95	9
24	2	-	96	9
25	3	-	97	9
26	3	4	97.5	10
27	3	-		
29	-	4		

1/ Moisture Content (Percent by Volume)

Table II Density (Gamma Log) 1/

Depth (ft)	10-25-74	2-19-75	Depth (cont'd) (ft)	2-19-75
1	153	-	39	160
2	157	-	40	155
3	158	-	41	160
4	155	-	42	150
5	158	-	44	149
6	155	-	46	151
7	156	-	48	151
8	157	-	50	152
9	159	-	52	154
10	155	-	53	157
11	157	-	56	159
12	158	-	58	157
13	158	-	60	157
14	158	158	62	156
15	157	-	64	158
16	158	-	67	158
17	158	-	70	157
18	159	-	73	160
19	158	-	76	160
20	159	-	79	158
21	159	-	82	159
22	159	-	85	160
23	156	-	88	154
24	158	-	90	152
25	158	-	92	141
26	157	158	93	144
27	157	-	94	148
28	158	-	95	151
29	156	155	96	148
32	-	160	97	148
33	-	154	97.5	149
34	-	158		
35	-	157		
36	-	162		
37	-	163		
38	-	160		

1/ Density (lbs per cubic ft)
Note: Calibration based ona specific gravity of 2.6; 10-25-74 Log Adjusted for 2.6 sp. g.

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

OFFICE MEMORANDUM

TO : Ed Williams, Q-23, ms-572

DATE: September 19, 1975

FROM : W. D. Purtymun, H-8 WDP

SUBJECT : ANTICIPATED GEOLOGIC SECTION AT TA-56

SYMBOL : H8-75-308

Mail Stop : 522

Approximate Elevation of Site; 1890 m

Geologic Section	Thickness (m)	Depth (m)
Basaltic rocks of Chino Mesa		
Unit 2	105	105
Unit 1	70	175
Santa Fe Group		
Totavi Lentil	15	190
Tesuque Formation	>600	>790

Lithologic Description

Unit 2

Consists mainly of flows of basalt and basaltic andesite with a few local beds of basaltic breccia and sediments. The colors range from gray to dark gray. The basalt contains phenocrysts of olivine, pyroxene, and plagioclase. The gound mass is composed of plagioclase, clinopyroxene and some magnetite. The individual flows may be as much as 15.5 m thick and separated by a thin section of breccia and sediment.

Unit 1

Consists of basalt flows, breccia and interbedded sediments. The individual flows are generally thin (i.e. not more than 8 m thick). The major phenocrysts are olivine which may be altered to saponite and celadonite. The groundmass is labradorite, chinopyroxene, and some magnetite. The color ranges from dark gray to black. The interbedded sediments are arkosic sandstones and conglomerates containing some volcanic debris. The interbedded sediments and basaltic breccias may attain thickness of 6 to 8 m between the basalt flows.

Totavi Lentil

The Totavi Lentil is a gray, poorly consolidated channel fill conglomerate composed of quartz, quartzite, schists, gneiss and granite that range in size from sand to boulders. Well-sorted lenses of silt and sand are present sporadically.

Tesuque Formation

The Tesuque is a sequence of light-colored arkosic siltstones and sandstones that contain lenses of clay and pebbly conglomerate. The beds are friable to moderately well-cemented. Bedding is poorly developed except in the fine-grained materials.

Hydrology

Units 1 and 2 of the basaltic rocks of Chino Mesa may contain small quantities of perched water locally. This occurrence is generally in the lower part of the flow with the interbedded sediments acting as a perching layer.

The main zone of saturation will occur a depth of about 180 to 190 m below the site. A part of the Totavi and underlying Tesuque Formation are saturated.

WDP:pb

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

OFFICE MEMORANDUM

TO : File

DATE: September 19, 1975

FROM : W. D. Purtymun, H-8 WDP

SUBJECT : STOCKPILE AND STAGING AREA FOR PROPOSED LASER BUILDING, TA-35

SYMBOL : H8-75-307

Mail Stop: 522

The site for the building was visited with Dave Kirby, Eng-9, on 9/15/75. The site lies east of TA-50 and adjoins the other laser facilities to the east. The areas north, west, and south of the site are small and slope off rapidly into adjacent canyonsor drainage to the canyons.

The soil and tuff excavated will be used at the site. The soil and tuff, until used, will be stockpiled with similar materials at TA-55. The staging area for equipment and construction material is to be located in an open area north of TA-50.

Using the existing area at TA-55 for stockpiling the soil and tuff and the staging area north of TA-50, will have minimum effect on the native vegetation in the area, and will not introduce a new area for erosion and sedimentation.

WDP:pb
cy : Dave Kirby, Eng-9, ms 702

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

OFFICE MEMORANDUM

TO : File - Mail Stop 490

DATE: October 3, 1975

FROM : William D. Purtymun, H-8 WDP

SUBJECT : DESIGNATION OF SAMPLING STATIONS, JEMEZ AREA (GTE)

SYMBOL : H8-75-349

Designation	Description
U	Redondo Creek at SR 4
V	Sulphur Creek at SR 4
F (U + V)	Sulphur Creek below Redondo
N	Rio San Antonio above Sulphur
J	Jemez River near Battleship
S	Jemez River above Rio Guadalupe
Q	Rio Guadalupe above Jemez River
R	Jemez River below Rio Guadalupe
T	Rio Cebolla
JF-1	Limestone Spr. near Battleship
JF-5	Soda Dam, Hot Springs
31	Cold Spring Lake Fork Canyon
4	LaCueva WS-Spring and/or Well
27	Hofheins Flowing Well
JS-2 and JS-3	Jemez WS, FS Trailer
JS-4 and JS-5	Jemez WS, FS Office

WDP:pb

CY: Howard Adams, H-7 ms 518
Alan Stoker, H-8 ms 490
Max Maes, H-8 ms 522

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

OFFICE MEMORANDUM

TO : John Alquist, H-8 MS 490

DATE: November 7, 1975

FROM : W. D. Purtymun, H-8

SUBJECT : LOGS OF TEST HOLES AT TA-1

SYMBOL : H8-75-404

Mail Stop : 522

During drilling of holes at TA-1 it was not possible to distinguish soil weathered in place or fill, thus these two zones on the following table are logged as fill. The tuff penetrated by the test-hole appears to have a greater moisture content and weathered to a greater depth than other areas of the plateau.

Samples were collected at 2 ft intervals to a depth of 20 ft and at 5 ft intervals from depths of 20 to 30 ft in holes drilled with the auger.

Split-spoon samples were collected at 0.5 ft intervals except in the upper 4 ft of the first hole (DRD-5) where thay were at 1 ft intervals. The split-spoon was driven through the fill in the top of the tuff.

WDP:pb

Attachment: Log of Test Holes at TA-1 (Table)

CY: LaMar Johnson, H-8 Group Leader, MS 490
Alan Stoker, H-8, MS 490

LOG OF TEST HOLES AT TA-1

November 6, 1975

Hole[a]	Log	Depth (ft) From	To
DRD-1	Fill	0	5
	Tuff, grey	5	19
	Tuff, reddish brown	19	21
	Tuff, grey	21	30
DRD-2	Fill	0	6
	Tuff, grey	6	15
	Hole caved, abandoned		
DRD-3	Fill	0	4
	Tuff, grey	4	16
	Tuff, reddish brown	16	17
	Tuff, grey	17	30
DRD-4	Fill	0	6
	Clay-reddish brown	6	18
	Tuff, grey, weathered	18	30
DRD-5[b]	Fill	0	6
	Tuff, weathered	6	13
DRD-6	Fill	0	13
	Tuff, weathered	13	30
DRD-7	Fill	0	9
	Tuff	9	30
DRD-8[b]	Fill	0	9.5
DRD-9[b]	Fill	0	10
	Concrete ≈ 9.5'		

LOG OF TEST HOLES AT TA-1

November 6, 1975.

(Continued)

Hole	Log	Depth (ft) From	To
DRD-10[b/]	Fill	0	10
DRD-11	Fill	0	10
	Tuff	10	30
DRD-12	Fill	0	4
	Tuff	4	30
	Tuff wet to 22'		
DRD-13	Fill	0	3
	Tuff	3	30
	Fracture at ≈16' filled with clay		
DRD-14	Fill	0	8
	Hit concrete at 6', hole abandon, out of line		
DRD-14A	Fill	0	10
	Tuff	10	30
DRD-15	Fill	0	7
	Tuff	7	30
DRD-16	Fill	0	7
	Tuff	7	18
	Hole drilled to 28'. No cutting return, clay on bit.		
DRD-17	Fill	0	3
	Tuff	3	30
DRD-18	Fill	0	7
	Tuff	7	30

LOG OF TEST HOLES AT TA-1

November 6, 1975

(Continued)

Hole	Log	Depth (ft) From	To
DRD-19	Fill	0	3
	Tuff, grey	3	10
	Tuff, reddish brown	10	13
	Tuff, grey	13	30
DRD-20	Fill	0	4
	Tuff	4	30
DRD-21	Fill	0	9
	Tuff, weathered	9	26
	Clay, brown	26	30
DRD-22	Fill	0	9
	Concrete	9	10
	Tuff	10	30
DRD-23	Fill	0	9
	Tuff	9	30
DRD-24	Tuff	0	9
	Fill	9	30
	Hole offset ≈4' south of DRD-22		-
DRD-25	Fill	0	5
	Tuff	5	30
	Tuff wet at 16'		

a/ Auger hole except as noted

b/ Split-spoon, Drive hammer

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

OFFICE MEMORANDUM

TO : John Ahlquist, H-8 MS 490

DATE: November 12, 1975

FROM : W. D. Purtymun, H-8 WDP/ph

SUBJECT : LOGS OF TEST HOLES AT TA-1, November 12, 1975

SYMBOL : H8-75-447

Mail Stop : 522

Hole	Log	Depth (ft) From	To
DRD-26	Fill	0	9
	Tuff, light brown	9	14
	Tuff, weathered, clay	14	22
	Tuff, brown, weathered	22	30
DRD-27	Fill	0	9
	Tuff, light grey	9	12
	Tuff, weathered	12	28
	Poor cutting return from 12 to 23', No returns below 23'		
DRD-28	Fill	0	9
	Tuff, grey, weathered	9	30
DRD-29	Fill	0	9
	Tuff, weathered	9	30
DRD-30	Fill	0	10
	Tuff, grey, some weathering	10	30
DRD-31	Fill	0	10
	Concrete at 6 to 7', hole abandon		
DRD-32	Fill	0	11
	Tuff, grey	11	30
	8-inch pipe at 6'		

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

Hole	Log	Depth (ft) From	To
DRD-33	Fill	0	4
	Tuff, light grey	4	28
	Wet at 16'		
DRD-34	Fill	0	3
	Tuff, light grey	3	13
	Tuff, reddish brown	13	16
	Tuff, dark grey	16	28
DRD-35	Fill	0	3
	Tuff, light grey	3	28
DRD-36	Fill	0	9
	Tuff, dark grey, wet, weathered	9	21
	Tuff, grey, wet	21	28
DRD-37	Fill	0	5
	Tuff, light grey	5	28
DRD-38	Fill	0	6
	Tuff, light grey	6	28
DRD-39	Fill	0	7
	Tuff, light grey	7	28
DRD-40	Fill	0	8
	Tuff, light grey	8	12.5
DRD-41	Fill	0	9
	Tuff, light grey, wet	9	16
	Tuff, dark grey, wet	16	17
	Tuff, grey, wet	17	28

TO: John Ahlquist DATE: November 12, 1975

Hole	Log	Depth (ft) From	To
DRD-42	Fill	0	8
	Tuff, dark grey, wet	8	12.5
DRD-43	Fill	0	8
	Tuff, light grey	8	12.5

WDP:pb

CY: LaMar Johnson, H-8 Group Leader, MS 490
Alan Stoker, H-8 MS 490

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

OFFICE MEMORANDUM

TO : John Ahlquist, H-8 MS 490 DATE: November 24, 1975

FROM : William D. Purtymun, H-8 WDP

SUBJECT : LOGS OF TEST HOLES AT TA-1, November 20, 1975

SYMBOL : H8-75-448

Hole	Log	Depth (ft) From	To
DRD-44	Fill	0	10
	Tuff, grey, weathered	10	28
DRD-45	Fill	0	10
	Tuff, grey, some weathering	10	28
	Concrete ≈ 6 ft		
DRD-46	Fill	0	10
	Tuff, grey	10	28
DRD-47	Fill	0	9
	Tuff,grey	9	18
	Tuff, dark grey, wet	18	28
DRD-48	Fill	0	9
	Tuff, light grey	9	17
	Tuff, dark grey, wet	17	28
DRD-49	Fill	0	11
	Tuff, grey	11	28
	Sample recovery poor below 20 ft		
DRD-50	Fill	0	10
	Tuff, grey, weathered	10	18

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
OS ALAMOS, NEW MEXICO 87544

Hole	Log	Depth (ft) From	To
DRD-51	Fill	0	6
	Tuff, dark grey, weathered	6	12
	Tuff, light grey	12	18
DRD-52	Fill	0	4
	Tuff, dark brown, weathered, wet	4	15
	Tuff, light grey	15	18
DRD-53	Fill	0	6
	Tuff, dark brown, weathered	6	15
	Tuff, grey	15	18
DRD-54	Fill	0	3
	Tuff, dark grey, wet	3	12
	Tuff, grey	12	18
DRD-55	Fill	0	3
	Tuff, dark grey, wet	3	11
	Tuff, grey	11	18
DRD-56	Fill	0	6
	Tuff, light grey	6	10
	Tuff, dark grey	10	18
DRD-57	Fill	0	9
	Tuff, light grey	9	16
	Tuff, dark grey	16	18
DRD-58	Fill	0	9
	Tuff, light grey	9	15
	Tuff, dark grey	15	18

LO LAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

November 24, 1975

Hole	Log	Depth (ft) From	To
DRD-59	Fill	0	9
	Tuff, grey	9	28
	Gravel or concrete 8 ft		
DRD-60	Fill	0	9
	Tuff, grey	9	28
DRD-61	Fill	0	10
	Tuff, grey	10	28
	Concrete ≈9 ft		
DRD-62	Fill	0	10
	Tuff, grey	10	18
	Tuff, brown, some weathering	18	28
	Concrete ≈9 ft		

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

Note: Log of holes DRD-1 through DRD-25 reported H8-75-404; Holes DRD-26 through DRD-43 reported H8-75-447.

WDP:pb
CY: LaMar Johnson, H-8 Group Leader, MS 490
Alan Stoker, H-8 MS 490

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

OFFICE MEMORANDUM

TO : John Ahlquist, H-8 ms 490 DATE: November 26, 1975

FROM : William D. Purtymun, H-8

SUBJECT : LOGS OF HOLES AT TA-1, November 25, 1975

SYMBOL : H8-75-451

Mail Stop: 522

Hole	Log	Depth (ft) From	To
DRD-63	Fill	0	10
	Tuff, grey	10	18
	Gravel or Concrete 8 to 10 ft		
DRD-64	Fill	0	9
	Tuff, brown, weathered	9	15
	Tuff, grey	15	18
DRD-65	Fill	0	11
	Tuff, grey	11	18
	Concrete 10-11 ft		
DRD-66	Fill	0	9
	Tuff, grey, weathered	9	16
	Tuff, brown, weathered	16	18
DRD-67	Fill	0	10
	Tuff, grey some weathering	10	18

Preceeding logs reported in Memos H8-75-404, H8-75-447, and H8-75-448.

WDP:pb
CY: LaMar Johnson, H-8 ms 490
Alan Stoker, H-8 ms 490

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

OFFICE MEMORANDUM

TO : John Ahlquist, H-8

DATE: December 16, 1975

FROM : W. D. Purtymun, H-8

SUBJECT : LOGS OF HOLES AT TA-1, December 12, 1975

SYMBOL : H8-75-457

Mail Stop: 490

File

Hole	Log	Depth (ft) From	To
DRD-68	Fill	0	2
	Tuff, gray	2	4.5
DRD-69	Fill	0	2
	Tuff, brown, weathered (wet)	2	4.5
DRD-70	Fill	0	3
	Tuff, brown, weathered (wet)	3	4.5
DRD-71	Fill	0	2
	Tuff, brown, weathered (wet)	2	4.5
DRD-72	Fill (gravel)	0	3
	Tuff, brown, weathered (wet)	3	4.5
DRD-73	Fill	0	3
	Tuff, brown, weathered (wet)	3	4.5
DRD-74	Fill	0	3
	Tuff, brown, weathered (wet)	3	4.5
DRD-75	Fill	0	3
	Tuff, brown	3	4.5
DRD-76	Fill	0	4.5
DRD-77	Fill	0	3
	Tuff, brown weathered	3	4.5
DRD-78	Fill	0	3
	Tuff, gray (wet)	3	4.5

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

Hole	Log	Depth (ft) From	To
DRD-79	Fill	0	3
	Tuff, brown, weathered (wet)	3	4.5
DRD-80	Fill	0	3
	Tuff, brown, weathered (wet)	3	4.5
DRD-81	Fill	0	3
	Tuff, brown, weathered (wet)	3	4.5
DRD-82	Fill	0	4.5
DRD-83	Fill	0	3
	Tuff, gray	3	4.5
DRD-84	Fill	0	2
	Tuff, brown, weathered	2	4.5
DRD-85	Fill	0	2
	Tuff, brown	2	4.5
DRD-86	Fill	0	2
	Tuff, gray	2	4.5

Preceeding logs reported in Memos H8-75-404, H8-75-447, H8-75-448, and H8-75-451.

WDP:pb

CY: LaMar Johnson, H-8 MS 490
Alan Stoker, H-8 MS 490

UNIVERSITY OF CALIFORNIA
LOS ALAMOS SCIENTIFIC LABORATORY
(CONTRACT W-7405-ENG-36)
P. O. Box 1663
Los Alamos, New Mexico 87544

IN REPLY REFER TO: H8-7-76

January 5, 1976

Charles Shields
U. S. Forest Service
Jemez Springs, New Mexico 87025

Dear Charlie:

I am enclosing the following data on the test holes drilled by LASL in 1972 as you requested.

Test Hole A
Location - NE 1/4, NW 1/4, SW 1/4, Sec 18, T19N, R3E
Elevation - 8450 ft

Log	Thickness (ft)	Depth (ft)
Bandelier Tuff	30	30
Abiquiu Tuff	125	155
Abo Formation	335	590

Length of 4.5 in - OD Casing: 578 ft
Water levels - 1972, 490 ft; 1975, 485 ft
Water in Hole A occurs within the fine sediments of the Abo Formation. The drilling contractor who set the casing does not believe the well capable of yielding enough water for a stock well.

Test Hole B
Location - NE 1/4, NW 1/4, NE 1/4, Sec 31, T20N, R3E
Elevation - 8625 ft

Log	Thickness (ft)	Depth (ft)
Bandelier Tuff	380	380
Tschicoma Formation	60	440
Abo Formation	210	650

Length of 4.5 in - OD casing: 566 ft
Water levels - 1972, 451 ft; 1975, 453 ft.
Hole B is completed in the Abo Formation and water levels indicate the aquifer is in the fine sediments of the Abo; however, the aquifer extends up into the lower part of the Tschicoma Formation. The

AN EQUAL OPPORTUNITY EMPLOYER

lower end of the blank casing is sealed with clay or fine sediments reflecting a water level below the base of the Tschicoma Formation. The drilling contractor who set the casing believes that the well would yield 2 to 5 gpm.

Test Hole C
Location - SE 1/4, SW 1/4, SE 1/4, Sec 9, T20N, R3E
Elevation - 8800 ft

Log	Thickness (ft)	Depth (ft)
Bandelier Tuff	240	240
Abiquiu Tuff	340	580
Abo Formation	170	750

Length of 4.5 in - OD casing: 750 ft
Water Levels - 1972, 328 ft; 1975, 316 ft.
The water levels indicate the aquifer is in the Abiquiu Tuff, in part, which is quite permeable. The water from the hole did not clear when the hole was bailed after the casing was installed. This may be due to water in the Abiquiu Tuff causing a positive pressure and entering the casing at the bottom of the hole, thus eroding fine sediments from the Abo. The hole could possibly yield 3 to 5 gpm from the Abiquiu.

Test Hole D
Location - SW 1/4, NW 1/4, SE 1/4, Sec 10, T19N, R2E
Elevation - 7900 ft

Log	Thickness (ft)	Depth (ft)
Bandelier Tuff	120	120
Abo Formation	380	500

Length of 4.5 in - OD casing: 500 ft
Water Levels - 1972, 70 ft; 1975, 61 ft.
The water levels indicate the aquifer is in the lower part of the Bandelier Tuff and Abo Formation. The hole would yield 2 to 5 gpm.

Note: The test holes were drilled for heat flow measurements. The 4.5 in. OD casing is blank (contains no slots). The holes indicated could be completed as stock wells by slotting the casing in place or by removing it from the hole and replacing it with slotted pipe. The casings are connected by thread coupling.

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

The Abo Formation is made up of sediments which are mostly fine-grained (siltstones, shales and clays), thus the development of water for stock use from the Abo is slight. The best development for stock wells is in the base of volcanics (Bandelier Tuff, Abiquiu Tuff, or Tschicoma Formation) overlying the Abo. The top of the Abo forms a semi-impermeable barrier which perches water in the lower part of the overlying volcanics. However, the upper surface of the Abo is very irregular. Completing a well on a topographic high in the Abo would result in a dry hole while several hundred feet away a low in the Abo could contain water.

Based on experience in the area and discussion with the drilling contractor who set the blank casing (Don Laughlin, Shamrock Drilling Co., Espanola) low yield stock wells could probably be completed in Holes B, C, and D with a greater part of the yield coming from the volcanics.

The Forest Service stock well (Windmill) in Lake Fork Canyon was measured in August. The water level in the 210 ft. deep well was at 161 ft.

Attached is a map showing location of the test holes.

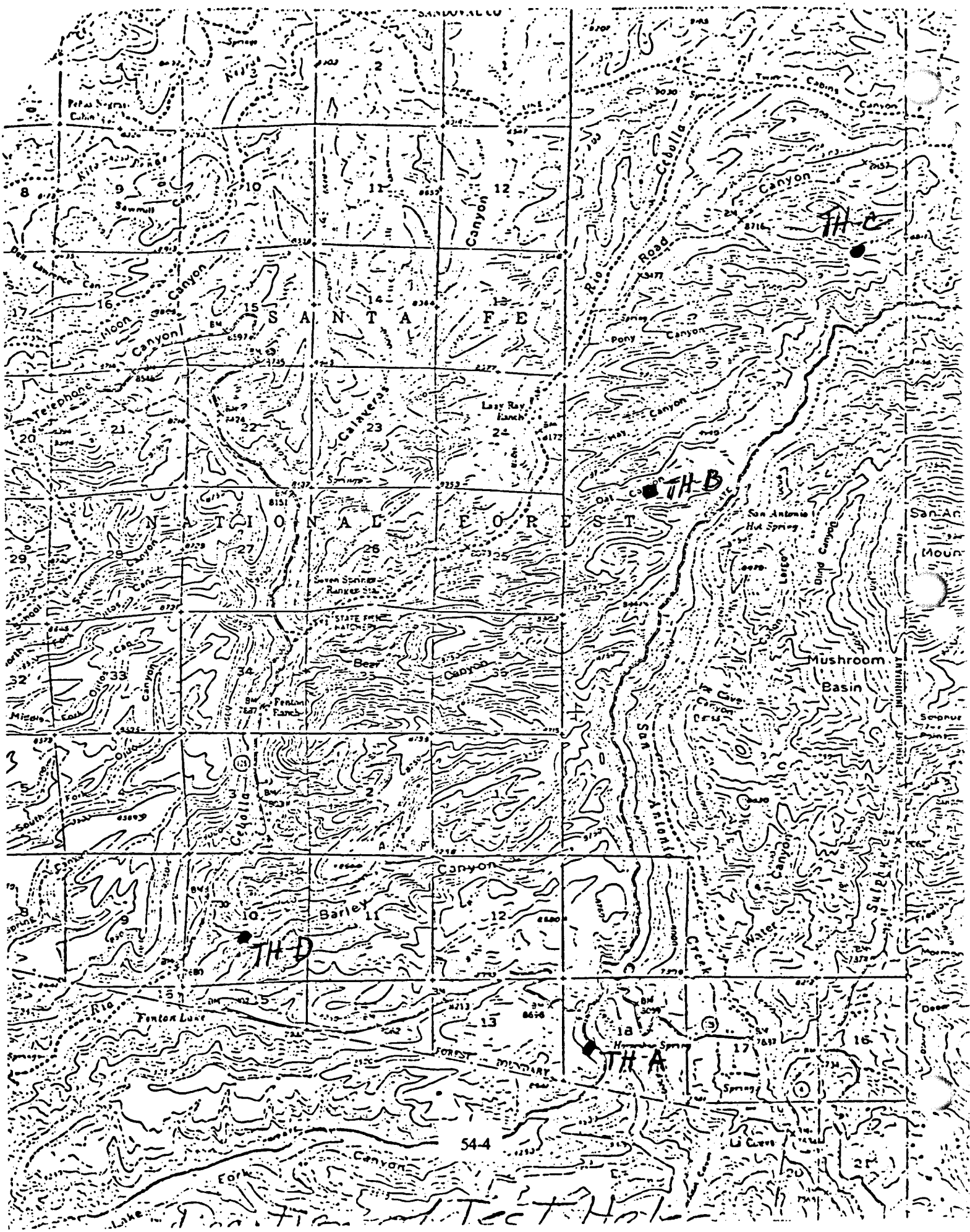
For additional information, please contact us.

Sincerely,

Bill

W. D. Purtymun
Group H-8
Environmental Studies

WDP:pb
CY: Mort Smith, Q-22
Robert Hendron, Q-22
Ken Rea, H-8


SANDOVAL CO
S A N T A F E
N A T I O N A L F O R E S T
Moon Canyon
Telephone Canyon
Calaveras
Canyon
Rio Cebolla
Road
Pony Canyon
Lazy Ray Ranch
Oak Canyon
Seven Springs Ranger Sta.
STATE FISH HATCHERY
Bear Canyon
Fenton Ranch
Cebolla
Barley Canyon
Fenton Lake
FOREST BOUNDARY
San Antonio Hot Spring
Dinah Canyon
Mushroom Basin
Water Canyon
Creek
TH-A
TH-B
TH-C
TH-D
54-4

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

OFFICE MEMORANDUM

TO : John Ahlquist, H-8

DATE: January 5, 1976

FROM : W. D. Purtymun, H-8

SUBJECT : LOGS OF HOLES AT TA-1, DECEMBER 17-23, 1975

SYMBOL : H8-3-76

Mail Stop : 490

Hole	Log	Depth (ft) From	To
DRD-87	Fill (wet)	0	4.5
DRD-88	Fill	0	3
	Tuff, gray (dry)	3	4.5
DRD-89	Fill	0	1
	Tuff, gray (dry)	1	4.5
DRD-90	Fill	0	3.5
	Tuff, gray (dry)	3.5	4.5
DRD-91	Fill	0	4.5
	(Concrete 3-4.5 ft)		
DRD-92	Fill	0	1
	(Concrete at 1 ft)		
DRD-92A	Fill	0	1
	(Concrete at 1 ft)		
DRD-92B	Fill	0	4
	Concrete	4	4.5
DRD-93	Fill	0	3
	Tuff, brown, weathered	3	4.5
DRD-94	Fill	0	3.5
	Tuff, gray	3.5	4.5

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

Hole	Log	Depth (ft) From	To
DRD-95	Fill	0	4.5
DRD-96	Fill	0	4
	Tuff, dark gray	4	4.5
DRD-97	Fill	0	2
	Tuff, gray	2	4.5
DRD-98	Fill	0	3
	Tuff, dark gray	3	4.5
DRD-99	Fill (gravel & asphalt)	0	8
	Tuff, gray	8	10
DRD-99A	Fill (gravel & asphalt)	0	8
	Tuff, gray	8	13
DRD-100	Fill (wet)	0	4
	Tuff, dark gray, weathered	4	13
DRD-101	Fill	0	2
	Tuff, dark gray	2	8
DRD-102	Fill	0	6
	(Concrete at 6 ft)		
DRD-103	Fill	0	3
	Tuff, gray	3	8
DRD-104	Fill (wet)	0	6
	Tuff, gray	6	13
DRD-105	Fill	0	4
	Tuff, gray	4	10

55.2

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
OS ALAMOS, NEW MEXICO 87544

Hole	Log	Depth (ft) From	To
DRD-106	Fill	0	6
	Tuff, gray	6	13
DRD-107	Fill	0	5
	Tuff, brown, weathered	5	14
	Tuff, dark gray	14	18
DRD-108	Fill	0	5
	Tuff, gray	5	11
	Tuff, brown	11	15
	Tuff, dark gray	15	20
DRD-109	Fill	0	4
	Tuff, brown (wet)	4	8
	Tuff, dark gray (wet)	8	10
DRD-110	Fill	0	3
	(Concrete at 3 ft)		
DRD-110A	Fill	0	4
	Tuff, gray	4	10
DRD-111	Fill	0	6
	Tuff, reddish brown (wet)	6	13
DRD-112	Fill	0	4
	Tuff, dark gray (wet)	4	11
	Tuff, reddish brown (wet)	11	13

Preceeding logs reported in Memo H8-404-75, 447, 448, 451, and 457.

WDP:pb
CY: LaMar Johnson, H-8, MS 490
Alan Stoker, H-8, MS 490

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

OFFICE MEMORANDUM

TO : LaMar Johnson, H-8 Group Leader, MS 490 DATE: January 7, 1976

FROM : W. D. Purtymun, H-8 WDP

SUBJECT : SEEPAGE PITS DP-East (TA-21-DPE-164)

SYMBOL : H8-6-76

A reconnaissance was made of the seepage pits at DP-East in reference to contamination reported by Group H-7. The pits received about 2.5 curies of ^{227}Ac and an unknown amount of ^{210}Po in 1951 and 1952. On December 18, 1975 water from a cooling process was being released into the west pit from a near-by building. There appears to be permanent water in the west pit, but there is no overflow into the adjacent drainage at this time. The pits are within a fenced area that is posted. Outside the fence are two drains that carry small amounts of water from the near-by building. Flow is through culverts into DP Canyon.

Group H-7 collected seven soil and water samples in the area. The analytical results and locations are shown on Fig. 1. The high concentrations of gross alpha reported are in the pits inside the fenced area.

Five soil samples were collected and screened by the ZnS Alpha Detection System at TA-1. The results and locations of stations are also shown on Fig. 1. The samples were collected outside the fence. Only one sample (drain 2) was above 44 d/m/g which is the detection limits of the instrument.

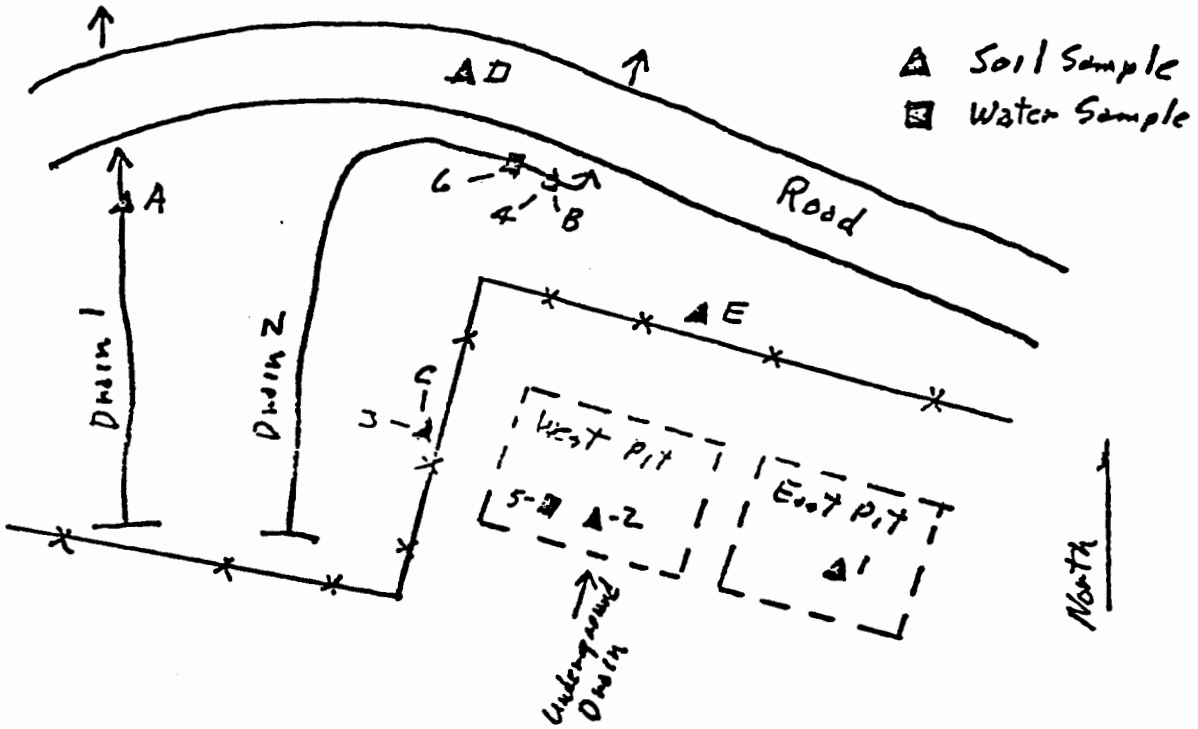
A survey (Group H-1) was made of the area outside the fence (road, drains, ditches, and slope) and the berm area inside the fence adjacent to the pits using a Phoswick Survey Instrument. The results were below the limits of detection of the instrument which is about 2200 d/m/g.

Water in Drain 2 (Location 6, 148 d/m/ℓ) and soil from Drain 2 (Locations 4, 7.4 d/m/g; and B, 120 d/m/g) are above natural background for soil and water. Overflow from the pits has probably occurred from the West Pit during periods of heavy precipitation or release of water into the pits carrying contaminates into Drain 2. It is also possible that there is some release of contaminates from the near-by building into Drain 2.

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
S ALAMOS, NEW MEXICO 87544

The survey indicates that there is low-level alpha contamination in the area outside the fence, which is not as great as occurs in the release area in DP Canyon from Building 257 at DP-West. Studies with greater detail may be considered in the future. Also consideration should be given to end release of water into the pits from the near-by buildings.

WDP:pb
CY: Wayne Hanson, H-8 MS 490
Kenneth Apt, H-8 MS 490
Tom Gunderson, H-8 MS 490
Jerry Buchholz, H-7 MS 518



Group H-7 Analyses (12-12-75)

Location	Description	Gross Alpha[a]
1	Soil 0 - 2" (East Pit)	7860 d/m/g
1	Soil 2 - 4" (East Pit)	730 d/m/g
2	Muck Surface (West Pit)	1990 d/m/g
3	Soil Surface (Outside Fence)	12.5 d/m/g
4	Soil Surface (Drain 2)	7.4 d/m/g
5	Water (West Pit)	40 d/m/ℓ
6	Water (Drain 2)	148 d/m/ℓ

[a]Acid Leach

Group H-8 Soil Analyses (12-22-75)

Location	Description	Gross Alpha[b]
A	Surface (Drain 1)	<44 d/m/g
B	Surface (Same H-7 Loc. 4)	120 d/m/g
C	Surface (Same H-7 Loc. 3)	<44 d/m/g
D	Surface (Composite Road)	<44 d/m/g
E	Surface (Slope)	<44 d/m/g

[b]Direct counting ZnS alpha detection system

Figure 1 Location of sampling stations and table of results.

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

OFFICE MEMORANDUM

TO : John Ahlquist, H-8 MS 490 DATE: February 3, 1976

FROM : W. D. Purtymun, H-8

SUBJECT : LOGS OF HOLES AT TA-1

SYMBOL : H8-76-45

Hole	Log	Depth (ft) From	Depth (ft) To
TU-RD-1	Fill	0	18
	Tuff, brown, weathered	18	28
TU-RD-2	Fill	0	6
	Hole caved abandoned		
TU-RD-2A	Fill	0	8
	Fill (?), no cuttings recovered	8	16
TU-RD-2B	Fill	0	16
	Tuff, dark gray, wet	16	27
TU-RD-3	Fill	0	9
	Tuff, gray, wet	9	27
TU-RD-4	Fill	0	15
	Tuff, gray, wet	15	27
TU-RD-5	Fill	0	12
	Tuff, gray, wet	12	17
	Tuff, dark gray, dry	17	24
TU-RD-6	Fill	0	4
	Tuff, gray	4	12

COPY

Hole	Log	Depth (ft) From	To
TU-RD-7	Fill	0	5
	Tuff, brown, weathered	5	13
TU-RD-8	Fill	0	4
	Tuff, dark gray, some brown weathering	4	13
TU-RD-9	Fill	0	5
	Tuff, gray	5	13

Note:

Holes TR-UD-1 to TR-UD-5 are located on fill overlying a channel cut in the tuff. Hole TR-UD-3 contained free water in the fill above the tuff the day after it was completed.

Hole	Log	Depth (ft) From	To
RD-1	Fill, wet	0	10
	Tuff, brown, weathered, wet	10	12
	Tuff, gray, dry	12	18
RD-2	Fill, wet	0	8
	Tuff, brown, weathered, wet	8	12
	Tuff, gray, dry	12	18
RD-3	Fill	0	4
	Tuff, gray	4	13
RD-4	Fill	0	3
	Tuff, gray	3	10
RD-5	Fill	0	2
	Tuff, gray	2	10

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

Hole	Log	Depth (ft) From	To
RD-6	Fill	0	7
	Tuff, reddish brown weathered	7	18
RD-7	Fill	0	8
	Tuff, brown, weathered	8	13
	Tuff, gray	13	18
RD-8	Fill	0	2
	Tuff, dark gray	2	13
RD-9	Fill	0	1
	Tuff, gray	1	8
RD-10	Asphalt and Fill	0	1
	Tuff, gray	1	8
RD-11	Fill	0	1
	Tuff, gray	1	8
RD-12	Tuff, gray	0	8
RD-13	Fill	0	7
	Tuff, gray	7	13
RD-14	Fill	0	5
	Tuff, brown weathered, joint red clay ≈9 ft	5	13
RD-15	Fill	0	2
	Tuff, light gray	2	10
RD-16	Fill	0	8
	Tuff, reddish brown	8	18

WDP:pb
CY: LaMar Johnson, H-8 MS 490
Alan Stoker, H-8 MS 490

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

OFFICE MEMORANDUM

TO : File

DATE: April 15, 1976

FROM : W. D. Purtymun, H-8

SUBJECT : FIELD NOTES HOLE M-1, TA-54

SYMBOL : H-8

Hole M-1 was drilled at an angle of about one (1) degree above horizontal at an elevation of 6626.1 ft about 175 ft east of Pit 3. The hole became horizontal at a distance of 40 to 50 ft and then assumed a negative angle the remaining length of the hole (287 ft).

The hole was collared in Unit 2A and penetrated about 114 ft of the Unit before entering the interflow pumice above the top of Unit 1B (see sketch on page 2 of notes). The hole penetrated the top of Unit 1B at 143 ft and continued a downward pitch in this unit to 287 ft.

Unit 2A is a moderately welded tuff, light pinkish gray with a few small inclusions of rhyolite and dark gray devitrified pumice fragments. The number of joints observed in the core in the 114 ft section was twenty (20). Of these, five (5) contained white filling or precipitate plating and fifteen (15) were filled or plated with brown clay. The joint frequency was about one joint for every 6 ft of the unit penetrated. Amount of core recovered was about 103 ft for a core recovery of about 90%.

The interflow zone at the base of Unit 2A, from 114 to 143 ft, was a light gray nonwelded tuff with large dark gray pumice fragments. The vertical thickness of the interflow zone was about 1.7 ft. At the base was a well sorted friable sand made up of sanidine and quartz crystals and crystal fragments in a light gray ash. No joints were observed in the core recovered. Core recovery was about 8 ft for the interflow section for a core recovery of about 29%.

The upper section of Unit 1B is a moderately welded grading downward into a nonwelded tuff. The tuff is light gray, pumiceous, containing large devitrified pumice fragments and small rock fragments of rhyolite in an ash matrix. The hole penetrated the moderately welded section from 143 ft to about 185 ft (vertical section about 4 ft). Three (3) joints filled or plated with brown clay were observed in the core. Joint frequency in this section was about one joint for 14 ft of penetration. Core recovery from 143 to 185 ft was about 29 ft or about 69%.

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

TO: FILE DATE: April 15, 1976

The tuff of Unit 1B became more friable (nonwelded) with increasing size of pumice fragments from 185 to 287 ft (vertical thickness about 11.5 ft). Core recovery in the 102 ft of penetration was 21 ft or about 20%. No joints were observed in the core recovered.

Attached are field notes showing joints observed in core, core run number, distance cored, amount of core recovered, general lithology of core and sketch of geologic units and trace of Hole M-1.

Core recovery in Unit 2A which underlies the pit is good in the order of 90%. It is necessary to over core (barrel 10 ft) to about 11 or 11.5 ft to retain core in the barrel. Unit 2A extends to a depth of 10 ft below the pit in the area of principal interest.

Core recovery in the interflow zone at the base of Unit 2A and non-to-moderately welded section of Unit 1A ranged from 20 to 69%. Various techniques were tried to improve core recovery such as short core runs, over core as much as 5 ft, pushing barrel through tuff, varying speed of rotation as well as rate of penetration. The major problem is the physical characteristics of the tuff nonwelded (friable) with large pumice fragments causes the core to break up into small pieces which are blown out or fall out of inter-barrel as it is pulled from the hole. The core retainer is to small to hold the broken core in the barrel. If additional coring in the nonwelded units is contemplated, a "basket type" retainer should be obtained.

A sampling system to collect cutting during a core run is being plumbed into the air-exhaust system to back up monitoring as well as study if core recovery is poor.

WDP:pb
cc: LaMar Johnson, MS 490
Merlin Wheeler, MS 737
M. A. Rogers, MS 737

Field Notes M-1 4-13-76

Note J 25W = Joint ≈ 25° white pumiceous
J 30B = Joint ≈ 30° Brown clay

Distance from Collar in feet

0 10 20 30 40 50 60 70 80 90 100

J25W J60W CF CF J30B J20B J80B CF CF CF J5B J5B

J20W J30W J10B CF J20B J5B J10B CF J5B J5B CF

Core Run

#1 - 5.4 | #2 - 5.0 | #3 - 5.2 | #4 - 5.0 | #5 - 10.1 | #6 - 10.7 | #7 - 11.8 | #8 - 10.5 | #9 - 11.5 | #10 11.6 | #11 10.9

5.2 5.2 4.6 4.2 10.0 9.0 9.0 5.9 10.0 10.0 10.0

Core Recovery

Tuff, Moderately welded, light pinkish gray

Distance from Collar in feet

100 110 120 130 140 150 160 170 180 190 200

58.3

J20W J10B J10B J20B J15B J60B

J60B J45B J60B CF CF CF

Core Run

#12 11.8 | #13 10.5 | #14 12.2 | #15 12.0 | #16 14.0 | #17 14.0 | #18 - 14.0 | #19 - 10.5

10.0 10.0 8.0 0.0 11.0 10.0 10.0 5.5

Core Recovery

Tuff, light pinkish gray | Interflow pumiceous nonwelded | Tuff, nonwelded to moderately weld, light gray pumiceous

Elevation 6622.6

Elevation 6620.9

Edge of pit Elev 6617.8

Elevation 6615.9

Field Note M-1 Cont.

Distance from Collar in Feet

200 210 220 230 240 250 260 270 280 290 300

← No or poor core recovery – no obs. joints in core recovered →

Core Run

#20 – 13.5	#21 – 11.5	#22 – 14.5	#24 – 11.0	#25 – 14.5	#26 – 16.5	#27 – 7.5
0.4	0.0	1.5	0.0	6.0	1.0	7.0

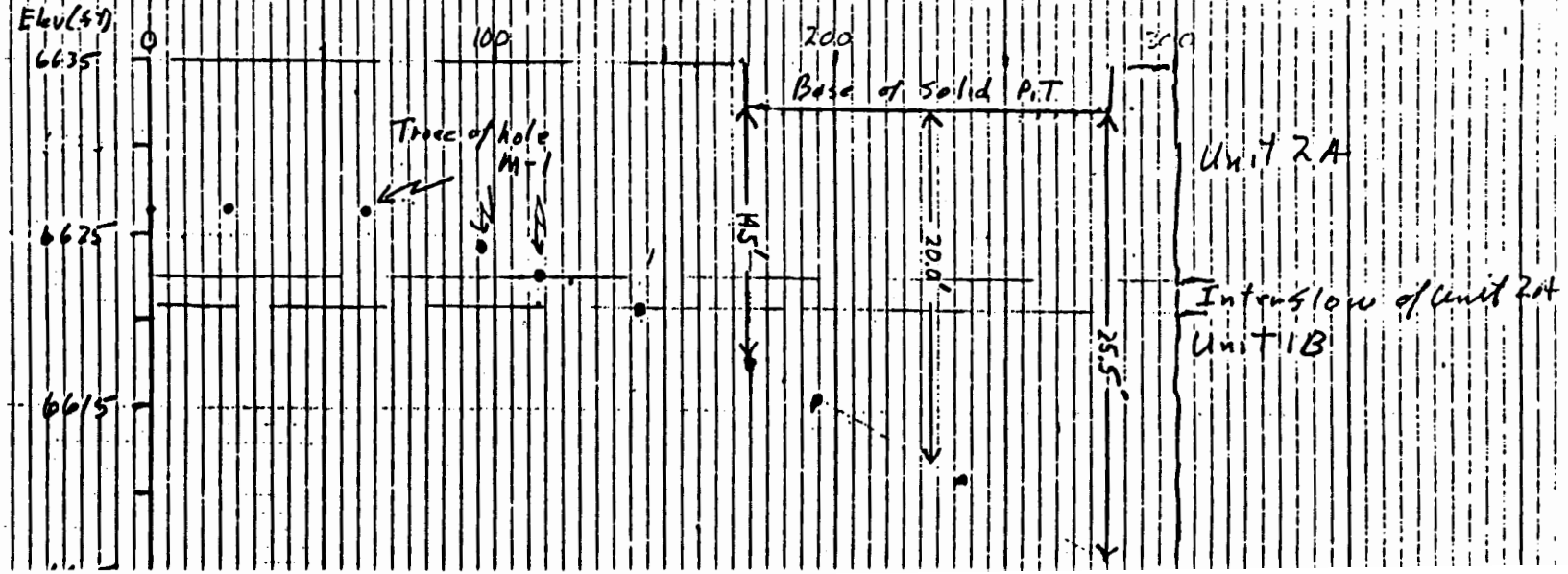
West edge of Pit

Tuff, nonwelded, light gray, large pumice fragments

Elevation 6611.4

58-4

Sketch Showing Geologic Units and Hole M-1



LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

OFFICE MEMORANDUM

TO : Al Blair, Q-DO MS 570 DATE: April 30, 1976.
THRU : Alan Stoker and LaMar Johnson, H-8

FROM : W. D. Purtymun, H-8

SUBJECT : U. S. GEOL. SURVEY SURFACE WATER GAGING STATIONS ON THE JEMEZ RIVER NEAR BATTLESHIP ROCK AND ON THE RIO GUADALUPE.
SYMBOL : H8-76-180

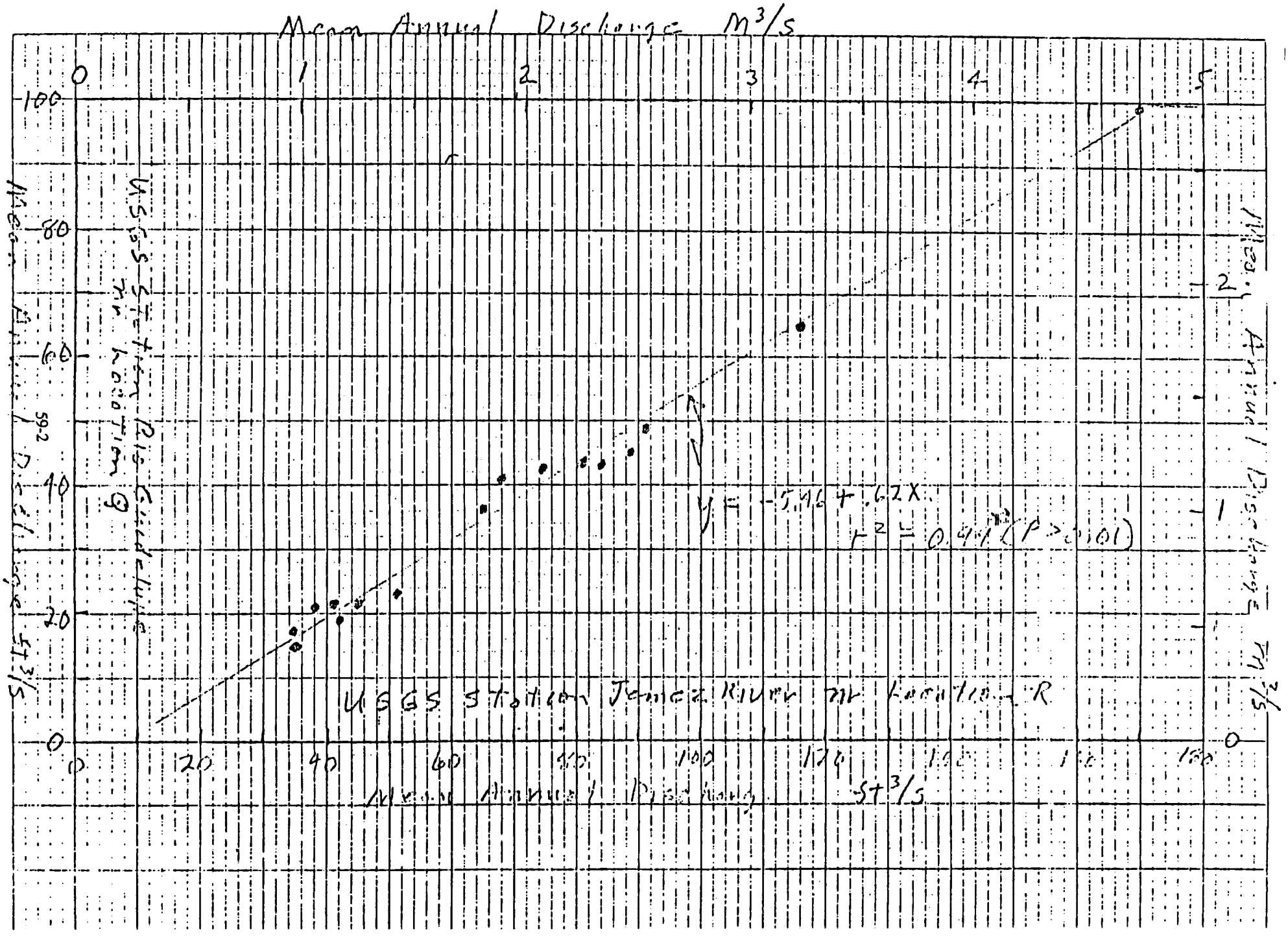
Stream characteristics at both gaging stations are well defined with over 18 years of continuous records. The discharge for the Jemez River near Battleship has ranged from 3 to 1030 CFS and that for the Rio Guadalupe from 3 to 1350 CFS. The station ratings are only good for ±10 percent, thus any small increase or decrease in flow would be impossible to determine.

A linear regression of the mean annual discharge of both stations (y variable) versus station near Jemez Pueblo (x variable), a permanent USGS gaging station indicates a very good correlation (attached). Annual volume of water at Jemez near Battleship Rock and the Rio Guadalupe can be estimated from the station near Jemez Pueblo. Records from the station are available for public inspection and use.

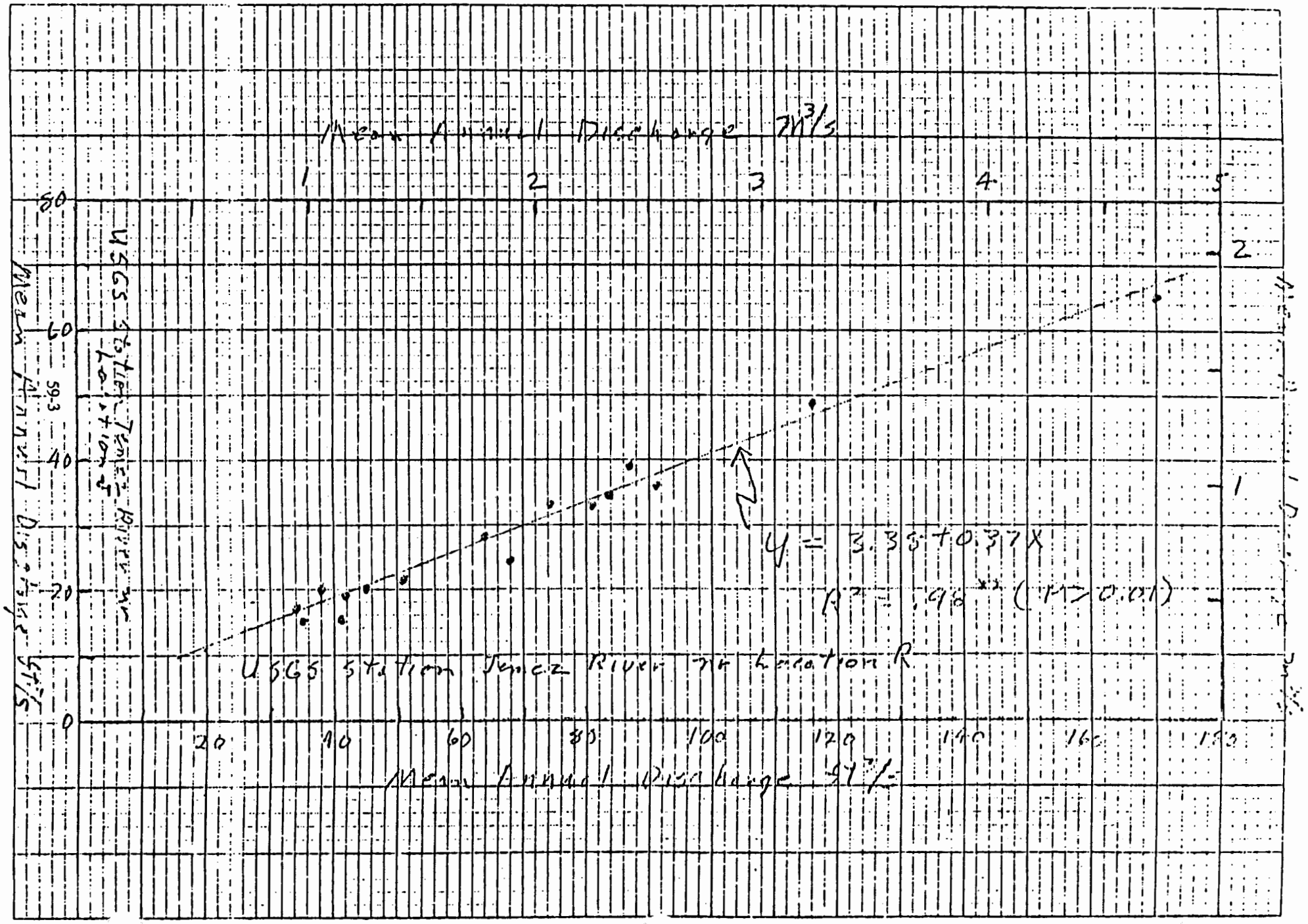
The station near Jemez Pueblo is equipped with a digital as well as a standard water-stage recorder, thus peak flows day and hour can be determined.

The basic hydrologic characteristics at the two stations, maintained with Laboratory funds by the U. S. Geol. Survey, are well established. No additional data can be obtained by continued operation of the stations (near Battleship Rock and the Rio Guadalupe) at this time.

WDP:pb
Attachment


Mean Annual Discharge m³/s
0
1
2
3
4
5
100
80
60
40
20
0
Mean Annual Discharge ft³/s
0
2
1
1
0
Mean Annual Discharge m³/s
y = -5.464 + .62X
r² = 0.41 (P > 0.01)
USGS Station Jones River nr Kenton R
USGS Station Pis Guadelupe
nr Lompoc
0
20
40
60
100
Mean Annual Discharge ft³/s

59-2


Mean Annual Discharge m³/s
1
2
3
4
5
80
60
40
20
0
Mean Annual Discharge m³/s
59-3
USGS Station Jemez River nr Location R
y = 3.35 + 0.37x
R² = .98** (P > 0.01)
20
40
60
80
100
120
140
160
180
Mean Annual Discharge m³/s

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

OFFICE MEMORANDUM

TO : Alan K. Stoker, H-8

DATE: May 19, 1976

FROM : W. D. Purtymun, H-8

SUBJECT : USE OF IODINE 131 AT TA-57

SYMBOL : H8-76-253

MAIL STOP: 490

Iodine 131 is used as a tracer in standard oil field work. The tracer is placed in the logging tool, lowered to the depth in the hole for study, and then released. The tracer in the hole is then followed by the standard gamma logging tool.

Iodine was used in hole EE-1 in June 1975 to locate a hole in the casing. It was released at a depth of about 4600 ft. and traced upward to the hole at about 300 ft.

It was also used in March 1976 in both holes, GT-2 and EE-1, in an effort to determine the shape and orientation of the fracture between the two holes (memos H-1T-76-116, H-1T-76-4445). The tracer was released at a depth of about 9600 ft. Hole EE-1 was pressurized and fluids and tracer moved through the fracture into GT-2. Subsequent pressurization and pumpage moved the tracer upward in GT-2 where it was collected into two ponds adjacent to the hole.

Most of the tracer reaching the ponds was retained as no overflow from the ponds has occurred. Some of the tracer may have been lost by infiltrating into the underlying tuff but the volume was probably small due to fine sediment accumulation in the base of the pond. The top of the aquifer perched in the lower part of the volcanics on top of sediments of the Abo Formation is at 380 to 400 ft. Water in the aquifer moves to the southwest where it is discharged through seeps and springs into Lake Fork Canyon and Rio Cebolla.

The losses when pumpage into EE-1 with return through GT-2 are about 20% (i.e., 10 gpm at EE-1, return 8 gpm at GT-2) apart of which is later recovered when pumpage ends. If leakage occurs in GT-2 above the granite in the sediment section of the hole it would be into a limestone aquifer that discharges along the Jemez River from Battleship Rock to Jemez Springs. The estimated transit time for water in the aquifer from GT-2 to the discharge area along the Jemez River is about 6 years (LA-5780-MS). There would be little if any movement if leakage of fluids should occur in the natural occurring fractures in the granitic section of the hole. Based on five aquifer tests to a depth of 6500 ft. the coefficient of transmissibility of the fractures were extremely low, ranging from 2.2 to 4.4 gpd/ft.

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

It appears that the March 1976 use of iodine will have very little if any effect on the environment. The short half-life of iodine coupled with dilution with natural water would decrease the concentrations. Transport in aquifers is slow allowing for decay before reaching discharge areas. Further dilution will occur in the Rio Cebolla and Jemez River.

WDP:mar

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

OFFICE MEMORANDUM

TO : LaMar Johnson, H-8 Group Leader MS 490 DATE: May 27, 1976

FROM : T. C. Gunderson, W. D. Purtymun, and T. E. Hakonson TH

SUBJECT : RESPONSE TO MEMO #H7-76-LAE-229

SYMBOL : H8-76-229

Your memo (H8-76-215) and the one from Emelity (H7-76-LAE-229) are viewed by this committee as two separate requests that are related only indirectly. This memo is in response to H7-76-LAE-229.

Of concern to this committee is that by supplying H-7 with a number representing a "safe" level of alpha activity in the evaporation pond, we will condoning what we feel from an environmental view point is an undesireable solution, to the liquid waste disposal problem.

The question, "what is a safe level of alpha activity in pond water?" is not particularly relevant to the radioactive waste treatment and associated environmental problems that could result from the proposed system. A number of studies demonstrate that the loss of radioactivity from water to sediments, algae, pond sides, etc. is both rapid and virtually complete (copies of various papers are in our files). The problem, then, becomes one of what constitutes a safe level of radioactivity in pond substrate, not one of what is safe for water.

What is of further concern to this committee is the presence of a variety of other radioactive and stable elements in the liquid effluents, some of which may have considerably greater environmental impact than alpha emittors. Setting a standard (e.g. a "safe" concentration for water) for many of these materials is extremely risky due to the lack of appropriate environmental data for many of them.

Consequently, we feel that the question posed the committee is not appropriate and should certainly not serve as a basis for pursuing this program.

We offer the following comments as support of our position, recognizing that such comments may exceed our charter as outlined by H7-76-LAE-229.

We question the use of solar evaporation ponds under

any conditions without supportive data justifying their feasibility and advantages over other, potentially more desirable systems. The implication from Emelity's memo is that evaporation ponds would require less energy in meeting "zero" discharge goals than say a gas or coal-fired total evaporation system. Until a complete comparative cost analysis has been conducted such an assumption is unfounded. The energy (dollars) required for environmental protection measures and for periodic and final cleanup of a pond area may be equivalent or exceed the energy demands of a closed evaporative system over the life of the respective systems.

Based upon 1975 data from H-7, about 20 mCi Pu, 7 mCi ^{90}Sr and 200 mCi ^{137}Cs would accumulate on pond sides, sediments, algae, etc. each year so that periodic cleanup would be necessary. Consideration must be given to the cost (i.e., energy) of such a cleanup, and more importantly to final cleanup upon facility decommissioning.

There is a lack of very crucial information which would indicate whether the pond system would work at all. For example, no one has measured the evaporation rate at Los Alamos. Figures on evaporation rates are quoted from data obtained in Santa Fe over 22 years ago. Consequently, we strongly urge that a pilot study using a small scale plant be conducted before rushing into an ill-conceived waste treatment program. A pilot study would determine actual evaporation rates as well as the effect of different chemical combinations on algal growth. Different pond designs could be tested to reduce wave action, resulting spray and suspended particulate transport.

Several major nuclear laboratories have, in the past, used small impoundments for short term disposition of radioactive liquids. Virtually everyone had problems with the control of radioactivity in such structures. These previous experiences must be carefully reviewed, before committing the LASL resources to such a facility.

Some of the problems that require consideration include leakage of water and radioactivity into surrounding strata, and physical and biological transport of radioactivity away from the pond (e.g., by wind, birds and other large and small animals). Such problems were encountered in the operation of solar evaporative ponds at Rocky Flats (conversation with M. A. Thompson at Rocky Flats by T. Gunderson). Although such problems represent a very minor health problem, they do represent a potentially

significant political problem.

Another factor which merits consideration is the odor resulting from the effluent. Current wastes have an acrid disagreeable odor which would likely emanate from a pond. Such an odor may limit certain uses of landscape surrounding a pond. The visual aesthetics of the estimated 10 acres of evaporation pond also must be considered in evaluating the impact of the program.

The land area currently contaminated in Mortandad Canyon amounts to about 1.7 acres while the proposed evaporation pond would contaminate 10 acres. It is difficult to see the advantages of contaminating an area nearly 6 times larger eventhough control of radioactivity may be better.

Our opinion is that total evaporation of effluent in a closed system provides the most desireable method of meeting zero release to the environment. Until comparative cost data are available, we recommend this approach be taken. Prior to doing a cost analysis, a study should be conducted to determine how much influent waste is absolutely necessary. Reduction of liquid and radioactive waste quantities at their sources may greatly reduce the cost (i.e., energy) required to solve our liquid waste problem, and may provide more options for meeting the zero release criterion.

One lesson of TA-1 is that long term planning is absolutely essential to avoid problems in the future.

TEH:pm

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

OFFICE MEMORANDUM

TO : J. R. Buchholz, H-7

DATE: June 24, 1976

THRU : L. J. Johnson

FROM : W. D. Purtymun, A. K. Stoker

SUBJECT : DISPOSAL OF WASTE SULFURIC ACID FROM CMC-4 AT TA-46

SYMBOL : H8-76-301

REF : Memo H7-76-331 dated June 11, 1976
To: B.B. McInteer CNC-4

In reference to the proposal to dispose of 100-150 gal./day of H_2SO_4 by reacting with crushed limestone in an 8' diam. by 60' deep shaft we have certain reservations. We are not able to predict the effects of the disposal of that much acid by an untested method.

The method as outlined has not been used at Los Alamos for the disposal of large quanities of acid. As a consequence, we are not prone to approve of such a method of disposal with out a small pilot study. The break down of limestone will decrease the permeability of the tuff. The effect of acid or dilute acid on the tuff and movement of fluids and associated chemicals from the shaft are unknown. Another unknown is what other chemicals or radio-chemicals are associated with the acids.

Therefore we strongly recommend that a pilot study be conducted which will provide an opportunity to evaluate any potential environmental problems. It would also seem to be a good opportunity to work out some engineering problems which may arise. The pilot study will also permit the interim disposal of the waste acid solution.

Our suggestion is to construct a small shaft about 12-in. in diameter and 15 ft. deep. Adjacent to the shaft would be constructed 4 or 5, 3-in. diameter monitoring holes to a depth of 50 ft. These holes could be constructed with H-8 equipment.

The engineering design of the shaft drop line for acid, size of limestone, characteristics of limestone fill (interbeded with sand or gravel, etc.) and actual testing of the shaft by release of acid we would leave to H-7 and CNC-4.

After starting disposal of acid, H-8 would monitor for the movement of fluids in the tuff from the shaft. H-7 and CNC-4 would conduct tests necessary to determine engineering design of the proposed large shaft, i.e. volume of acid, pressure build-up if contained or fluid level if uncontained. At termination of the experiment, cores or cutting will be taken of tuff ajacent to the shaft to determine chemical properties associated with fluid movement.

These results together with other data taken during the pilot study could be evaluated to determine the overall feasibility and safety of the disposal method, as well as any long-range measures that might be found necessary.

xc:B.B. McInteer, CNC-4
J.L. Warren, H-7, MS 517
R.A. Penneman, CNC-4, MS 346
H.S. Jordan, H-DO, MS 690

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

OFFICE MEMORANDUM

TO : Bill Dunne, H-7

DATE: October 28, 1976

THRU : Alan Stoker, H-8

FROM : W. D. Purtymun, H-8

SUBJECT : ESTIMATE SIZE OF DISPOSAL PONDS OR SHAFTS

SYMBOL : H8-76-490

MAIL STOP: 490

The ponds or shaft to facilitate the infiltration of waste water at each Technical Area will probably be completed into a tuff. The coefficient of permeability of the tuff varies according to degrees of welding as shown by the table.

Tuff	Porosity Range (%)	Coefficient of Permeability ($g\ pd/st^2$)[a]
Welded	15-35	<0.01 - 0.10
Moderately Welded	30-55	.05 - 5.0
Non-Welded	40-60	2.0 - 20

a) Estimated from Laboratory Analyses (Vertical Permeability) of tuff (Abrahams, 1963 and Weir and Purtymun, 1964).

The vertical and horizontal permeabilities will vary slightly. The coefficient of permeability is defined as the number of gpd that will flow through a cross-section of one sq. ft under a hydrologic gradient of 1 ft at prevailing water temperatures. Laboratory analyses are corrected to 60°F.

The sites for disposal waste water were not visited. Identification of the possible tuff units present were made from a general knowledge of the geology of the area. Prior to construction of ponds or shafts a preliminary investigation should be made to define the type of tuff and its hydrologic characteristics. Suspended particles in waste water, growth of algae, and wind blown dust into ponds or shafts will decrease the permeability.

It has also been noted that after long periods of injection or release of water into the tuff the permeability decreases due to the pore-size of the ash matrix. Water is held in tension as the pod of injected fluids becomes larger. The intermittent release of fluids to the tuff can cause an "air-lock" which also decreases the permeability. These are some of the factors that will affect release of waste water in a tuff unit.

The following table presents a generalized description, estimates of permeability, and estimated surface area exposed to waste water necessary for the approximate volumes of flow. It is to be used for planning purposes only. Detailed field studies should be made prior to construction of infiltration ponds or shafts.

Attachment
(1) Table

WDP:kr

Structure No.	Probably Tuff Unit Present	Approximate (gpd) Flow	Estimated Permeability gpd/ft^2	Estimated surface area (ft^2)	Contaminant
TA-8-21[a]					Photo proc.
TA-8-22[a]	Welded	1500	0.05	30,000	Cooling, photo proc.
TA-15-183	Mod. Welded	3000	1.0	3,000	Photo rinse
TA-16-222	" "	700	1.0	700	Mixed HE; Cooling water
TA-16-260	" "	4500	1.0	4,500	H.E. Machining, Cooling, Wash
TA-16-280	" "	9000	1.0	9,000	H.E. Wash
TA-16-430	" "	5000	1.0	5,000	H.E. Machining, Cooling
TA-22-52	Welded (?)	4800[b]	.05	96,000	Photo, $FeCl_2$ -Organic Solvents
TA-9-21[a]	Welded	?	.05	-	H.E. Wash, (?)
TA-9-40[a]	Welded	?	.05	-	H.E. Wash, (?)
TA-36-1	Mod. Welded	?	1.0	-	Photo proc.
TA-33-86	Mod. Welded	1500[c]	1.0	1,500	Cooling

[a]Welded Tuff precluded use of septic tanks in area - const. evaporation pond.

[b]Intermittent Release 8-hr day at 10 gpm.

[c]Est ≈1 gpm

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

OFFICE MEMORANDUM

TO : R. L. Henning, ENG-2, MS 984 DATE: December 8,1976

THRU : A. K. Stoker, H-8

FROM : W. D. Purtymun, H-8

SUBJECT : TEST BORING PROPOSED BUILDING RD-33, TA-52 (Lab. Job 5654-52).

SYMBOL : H8-76-473

Five (5) test holes 22 feet deep were drilled near each corner and at the center of the proposed site for building RD-33 at TA-52. The thickness of soil or fill at the site ranges from 1 to 2 ft (Table 1). It is underlain by a light gray moderately welded tuff that has been mapped as Unit 3b of the Tshirege Member of the Bandelier Tuff.[1,2] The tuff is described as a ledge-forming crystal-fragment tuff containing numerous pebble size fragments of hard igneous rock. The tuff penetrated by the test holes was uniform over the area. Weathering of tuff beneath the fill or soil was generally less than one (1) ft. No water was encountered and moisture content of the tuff appeared to be less than 6% by volume.

The tuff can be described as a competent rock although no penetration tests were made at the site. About one mile west of the site, at TA-55, design recommendations for bearing pressures were 5×10^3 lb/sq ft for compacted soil or fill and 12×10^3 lb/sq ft for the tuff or Unit 3b.[1]

The average altitude at the site is 7184 ft. Test boring with penetration tests at the main UHTREX building, 200 ft to the east, were made in 1960 at a hole altitude of about 7172 ft or 12 ft lower than the proposed site. The penetration tests of 8 holes (≈7172 ft) at UHTREX for depths of 5 and 10 ft with N = 50 had a D that ranged 1 to 6 inches (note: "N" is equal to the number of blows of a drive hammer required to drive a 2 inch O.D., 1.375-inch ID, standard split spoon sampler through a vertical distance of "D" inches using a 140-lb hammer with a free fall of 30 inches). Interpretation of data based on experience indicates with N = 50 and D = 12 inches or less, the bearing capacity of the tuff is in the range of 50×10^3 lb/sq ft. The bearing capacity should be reduced by a factor of 5 for dead loads and a factor of 10 for live loads.

No bearing capacities of the tuff were made at the site. The preceding descriptions of bearing capacities are presented for ENG-1 and 2 evaluation.

TABLE 1

LOG OF TEST HOLES

	Thickness (ft)	Depth (ft)
Northeast Hole (8.5 ft west of corner)		
Soil or Fill	2	2
Tuff, light gray, moderately welded	20	22
Southeast Hole (5.5 ft west of corner)		
Soil or Fill	1	1
Tuff, light gray moderately welded	21	22
Northwest Hole (2 ft SE of corner)		
Soil or Fill	1	1
Tuff, light gray, moderately welded	21	22
Southwest Hole (7 ft east of corner)		
Soil or Fill	1	1
Tuff, light gray, moderately welded	21	22
Center Hole (67 ft west of SE corner and 20 ft north)		
Soil or Fill	1	1
Tuff, light gray, moderately welded	21	22

Note: No pumice zone or lenses were detected during drilling. The southeast hole encountered some hard igneous rocks (probably less than 2-in diam.) at various depths in the tuff.

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544
Telephone Ext:

OFFICE MEMORANDUM

TO : FILE

DATE: April 6, 1977

FROM : W. D. Prutymun, H-8 WDP

SUBJECT : Log of Test Hole TA-45

SYMBOL : H8-77-217

MAIL STOP: 522

		Depth (ft) From	Depth (ft) To
Hole C-7	Fill	0	9
	Tuff, wet	9	28
Hole D-7	Fill	0	6
	Tuff, wet	6	13
Hole C-6	Fill	0	3
	Tuff, moist	3	8
Hole B-6	Asphalt	0	1
	Tuff, dry	1	6
Hole B-5	Fill	0	1
	Tuff	1	6
Hole B-4	Fill	0	1
	Tuff	1	6
Hole B-3	Fill	0	1
	Tuff	1	6
Hole C-5	Fill	0	4
	Tuff	4	6
	Weathered to Clay	6	8
	Tuff	8	10
Hole SP-2A	Fill	0	14
	Tuff	14	22

Hole SP-2B	Fill	0	12
	Concrete at 12'		
Hole Cor. F	Fill	0	8
	Tuff	8	17
Hole Cor. EA	Fill	0	3
	concrete at 3'		
Hole Cor. EB	Fill	0	3
	Tuff	3	8
Hole Cor. D	Fill	0	4
	Tuff	4	9.5
Hole HB-1	Fill	0	3
	Tuff	3	8
Hole Cor C	Fill	0	4
	Tuff	4	12
Hole SB-1	Fill	0	4
	Tuff	4	12
Hole SP-1	Fill	0	7
	Tuff	7	12
Hole Cor. B	Fill	0	4
	Tuff	4	13
Hole Cor A	Fill	0	3
	Tuff	3	12

cc: Jack Purson
Don Mayfield
Corey Cate

WDP:fd

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

OFFICE MEMORANDUM

TO : M. Dean Keller, Eng. 1 MS 624 DATE: November 3, 1977

FROM : W. D. Purtymun WDP and Ed Sagon ES.

SUBJECT : Test Borings East of TA-48

SYMBOL : H8-77-816

Five test holes were completed in Unit 3 of the Tahinege Member of the Bandelier Tuff at a depth of 52 ft. (See attached sketch for location). The holes penetrated two subunits of Unit 3, the lower 3a and upper 3b. The tuff penetrated contained three drilling breaks representing different ashflows within the unit. The drilling breaks occured about 10 to 12 ft.; 22 to 24 ft.; and 37 to 42 ft. The flow from about 22 to 37 ft. was much harder than the flows above or below that interval. The contact between subunits 3b and 3a occured at the 37 to 42 ft. drilling break.

Unit 3 is a moderately welded ashflow unit. The tuff can be described as a compentent rock although no penetration tests were made at the site. About 0.25 mi. to the southeast at TA-55, design recommendations for bearing pressures for the tuff was 12 X 10^3 lbs/sq. ft. The tuff is moderately welded, excavation can be made using heavy equipment. No explosives will be needed.

Moisture content in TH-1 appeared to be excessive to a depth of about 7 ft. and probably reflects infiltration of run off into the soil and fill from the paned area around the main building. Moisture contents of the tuff determined from TH-3 and TH-5 were not excessive though slightly higher than found in undisturbed areas. This is due to runoff from paved areas and discharge to near by ponds that hold cooling water. Moisture contents of tuff from two test holes are shown below:

Depth (ft.)	Moisture Content (p/o by weight) TH-3	TH-5
0-7	7.6	7.7
7-12	8.1	9.2
12-17	8.9	9.3
17-22	8.4	9.6
22-27	7.6	7.9
27-32	7.5	7.7
32-37	6.7	8.0
37-42	7.1	7.3
42-47	7.3	8.6
47-52	6.8	7.3

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

TO: M. Dean Keller, Eng. 1 MS 624

DATE: November 3, 1977

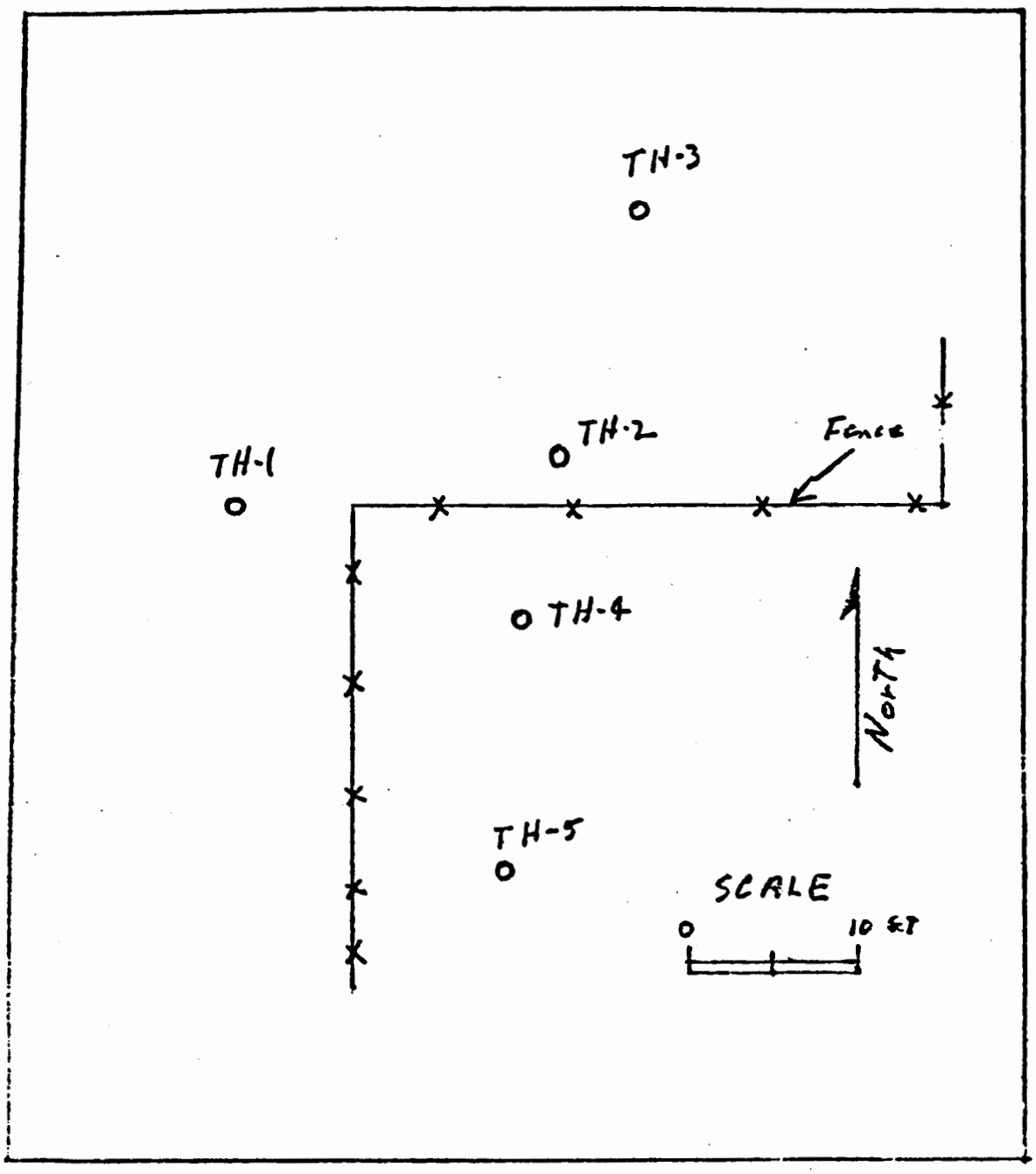
The following table presents a log of the upper sections of the test holes. The holes were completed in the tuff at a depth of 52 ft.

Test Hole	Description	From (St)	To (St)	Thickness (St)
TH-1	Fill and weathered soil and tuff wet	0	7	7
TH-2	Fill and weathered soil and tuff	0	4	4
TH-3	Fill and weathered soil and tuff, some gravel near surface	0	3	3
TH-4	Weathered soil and tuff	0	1	1
TH-5	Weathered soil and tuff	0	3	3

WDP&ES:pdb

cc: John Balagna CNC-11
Dave Kirby Eng-9

Enc.



Location of Test Holes- East side of TA-48

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

OFFICE MEMORANDUM

TO : Joe Repa, Eng-2, MS-M984 DATE: November 16, 1977

FROM : W. D. Purtymun and Ed Sagon

SUBJECT : TEST BORINGS AT PROPOSED STRUCTURE OCCUPATIONAL HEALTH LABORATORY OFFICE BUILDING

SYMBOL : H8-77-857

Twelve test borings were made in the area of the proposed building and adjacent parking area. The holes were augered 4-inches in diameter with the exception of hole 11 which was 12-inches in diameter. The depth ranged from 17 to 32 ft.

The holes were drilled into unit 3 of the Tshirege Member of the Bandelier Tuff. Unit 3 is composed of several ashflows of rhyolite tuff. The tuff is moderately welded made up of quartz and sanidine crystals and crystal fragements, small inclusions of rhyolite and latite rack fragments in a ash matrix. The tuff encountered in most of the borings was light gray. Holes 2, 7, and 9 encountered light pinkish gray and light red tuff which is the result alteration by gasses escaping along joints as the ashflows colled. Joints and fracture in the tuff are common. They are generally vertical or near vertical and have a frequency that varies from one joint from every 6 to 10 ft. of horizonal exposure.

Unit 3 is a moderately welded tuff that has a density that ranges from 70 to 115 lbs/cu. ft. with a porosity that ranges from 30 to 55 percent by volume. No penetration tests were made in the borings; however, based on past experience the design recommendations for bearing pressures are in the range of 10×10^3 to 12×10^3 lbs/sq. ft. Compacted soil and fill derived from the tuff generally have design recommendation for bearing pressures of about 5×10^3 lbs/sq. ft.

The tuff is a compentent rock that stands well in vertical cuts; however, due to jointing, the cuts should be made on a 1 to 5 slope to prevent stabbing. This refers to excavation of depth in which workmen will enter. The joints and altered tuff encountered in holes 2, 7, and 9 will not effect the compentency of the rock. Excavation can be made with heavy equipment. No explosive will be necessary.

The tuff is well above the main water table, at a depth of 1200 ft. below the mesa surface. The tuff is about 800 ft. thick at the site and is dry. On the plateau, the Bandelier tuff does not contain any known perched water.

The moisture content of soil and fill from the bore holes ranged from 5.7 to 9.9% by weight while that of the tuff ranged from 0.9 to 5.3% by weight (Table 2). This is within the normal range found on the plateau.

Table 1

LOG OF HOLES

	St From	St To
Hole 1		
Tuff, light gray	0	22
Hole 2		
Tuff, light red	0	3
Tuff, light reddish gray	3	22
Hole 3 (≈ 34' East of SW Cor of bldg.)		
Tuff, light gray	0	22
Hole 4 (≈ 30' East of NW Cor of bldg.)		
Tuff, light gray	0	22
Hole 5		
Tuff, light gray	0	17
Hole 6		
Fill or Soil	0	2
Tuff, light gray	2	17
Hole 7 (17' N of stake 7)		
Tuff, light reddish gray	0	3
Tuff, light gray	3	22
Hole 8 (South edge of parking lot)		
Fill	0	14
Tuff, light brown	14	17
Tuff, light gray	17	32
Hole 9		
Fill	0	1
Tuff, light pink, weathered	1	10
Tuff, light brown	10	12
Tuff, light brown, drilling break, soft	12	17
Tuff, light gray	17	32
Hole 10		
Fill	0	6
Tuff, weathered	6	7
Tuff, light gray	7	22
Hole 11 (12' dia≈ 25' west of hole 6)		
Tuff, light gray	0	22
Hole 12 (≈ 65' SW of stake 7)		
Tuff, light gray, drilling break 28 to 32 ft, softer	0	32

Table 2

MOISTURE CONTENTS OF BORE HOLE CUTTINGS

(percent by weight)

	Depth (ft)					
	0-7	7-12	12-17	17-22	22-27	27-32
Hole 1	1.8	1.5	1.6	2.4	-	-
2	4.3	4.0	4.1	4.0	-	-
3	2.0	2.9	2.4	2.2	-	-
4	2.6	2.5	2.7	3.1	-	-
5	3.6	3.5	3.0	-	-	-
6	2.8	2.9	3.2	-	-	-
7	2.8	3.3	4.0	3.8	-	-
8	9.7[a]	9.9[a]	3.9	2.9	1.9	0.9
9	6.6[a]	5.7[a]	5.0	3.3	3.5	3.3
10	8.5[a]	5.3	4.9	3.4	-	-

[a] Soil, fill, or weathered tuff

LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

OFFICE MEMORANDUM

TO : Alan Stoker

DATE: December 28, 1977

FROM : W. D. Purtymun

SUBJECT : ROCKFALLS AT PROPOSED LOCATION FOR NEW TRITIUM HANDING FACILITY AT TA-41

SYMBOL : H8-77-871

Los Alamos Canyon at TA-41 trends nearly east west and is cut into the Bandelier Tuff. The proposed addition to Building 4 is located on the north side of the stream adjacent to the lower slope of the canyon. The lower slope of the canyon is formed by the non-welded ashflows of the Otowi Member which is overlain by the cliff forming units of moderately welded tuff of the Tshirege Member. There is a small break in the north canyon wall forming a northwest trending spur in the area of the proposed building (See attached sketch). The slope is steep, about 40°, containing a sparse growth of pines and oaks. It is broken by two narrow benches (one man made, the other natural) immediately above the fence. The slope is strewn with boulders which range in size from a few feet to more than 15 ft. in diameter. The upper cliff forming unit contain numerous near vertical joints which will result in additional rockfalls onto the talus of the lower slopes.

There have been numerous rock falls on the lower slopes as shown by scars on the trunks of trees. The scars for the most part are near slope level; however, one tree contained a scar about 6 ft. from the base from a boulder that bounced as it came down the slope. The presence of the highly jointed near vertical cliff and the talus on the lower slope constitute a rockfall potential that could be a hazard to the proposed facility. It is not possible to quantify the magnitude or frequency of any particular rock fall in the area of the slope or cliff. The extensive fracturing of the cliff unit makes it impractical to eliminate the problem at the source by stabilization. Construction of barriers at the base of the slope should be considered as a means of mitigating or eliminating damage to the facility when rockfalls occur. Barriers to contain rockfalls should be included with the construction of the building. This is necessary to answer recurring questions of possible rockfall damage which will be asked during the life of the facility.

The topography makes it very unlikely that any large rocks could reach the proposed location other than by rolling down the slope. Thus, energy absorbing barriers could effectively be employed to stop such rocks from striking the new building.

The barriers should be located at the base of the slope and be constructed of 5-in dia steel pipe 18 ft in length, spaced 6 ft apart and

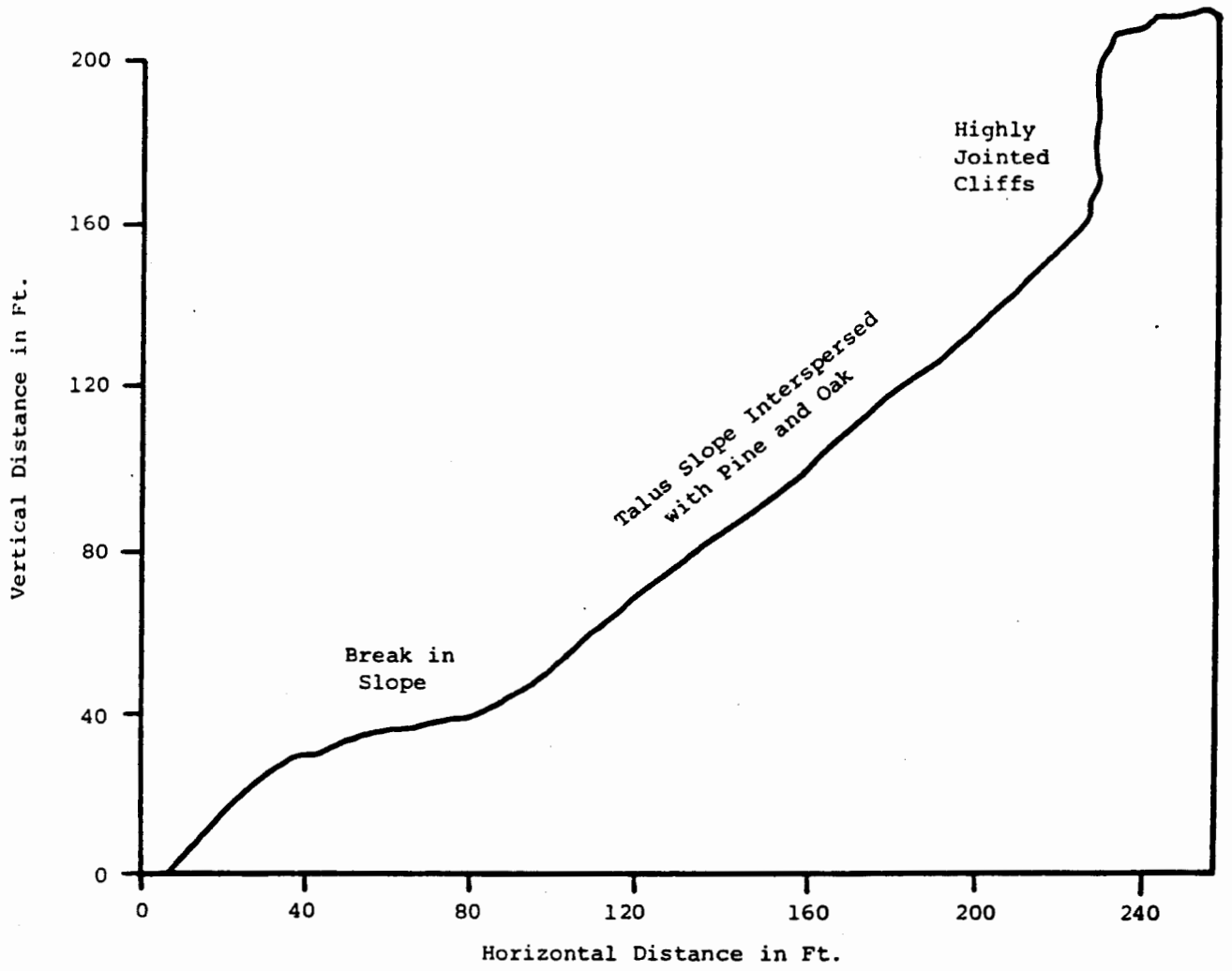
LOS ALAMOS SCIENTIFIC LABORATORY
UNIVERSITY OF CALIFORNIA
LOS ALAMOS, NEW MEXICO 87544

TO: Alan Stoker DATE: December 28, 1977

cemented upright in 6 ft deep holes. The steel pipes should be filled with cement and coupled together with 1-in steel cable on 2-ft centers. The outer face of the barrier should be covered with chain link fence. The pipes of the second barrier, located 8 to 10 ft away and parallel to the first barrier, should be off-set to the pipes of the first barrier. The barrier nearest the base of the slope must be located to provide access for a front-end loader to periodically remove talus, which will continue to creep down the slope and reduce the height of the barrier.

The part of the building exposed to possible rock damage will be the north and west walls. Consideration should be given to construct these walls of reinforced concrete.

WDP:pdb



Profile of Northwest Trending Spur above Proposed Building

UNIVERSITY OF CALIFORNIA
LOS ALAMOS SCIENTIFIC LABORATORY
(CONTRACT W-7405-ENG-36)
P.O. BOX 1663
LOS ALAMOS, NEW MEXICO 87545

IN REPLY REFER TO: H8-78-87
MAIL STOP: 490

January 31, 1978

Mr. C. E. Bingham
Asst. Area Manager for Engineering
US Department of Energy
Los Alamos Area Office
Los Alamos, NM 87544

Dear Mr. Bingham:

Attached is a table showing the results of two aquifer tests run on the Fenton Hill Water Supply Well for transmittal to Don Akins of the State Engineers Office. Test one was run with airline in operation and test two with airline closed. This resulted in slightly different static water levels in the two tests. Mr. Akins will review data and set up a meeting for about the second week of February to discuss the results of the tests.

Sincerely,

W. D. Purtymun

WDP:pdb

Enc: (1) Table

xc: Robert Hendron, G-4, MS-980
Dan Miles, G-4, MS-980

An Affirmative Action/Equal Opportunity Employer

Date (1978)	Hour	Lapse Time (Min)	Cumulative Time (Min.)	Production (Gal.)	Rate (gpm)	Water Level a/ (Meas. ft)	Remarks	
Test 1								
1-18	11:15	0	0	0			Pump On	
	12:15	60	60	2,618	43.6	-	"	
	13:15	60	120	2,620	43.7	-	"	
	15:15	120	240	5,239	43.7	-	"	
							"	
1-19	09:15	1,080	1,320	47,558	44.0	-	"	
	13:00	225	1,545	9,350	41.6	-	"	
	13:50	275	1,595	-	-	365.48	"	
1-20	10:00	1,260	2,805	55,300	43.9	-	"	
							"	
1-21	09:25	1,225	4,210	61,200	43.6	-	"	
							"	
1-23	10:00	2,915	7,125	127,100	43.6	-	"	Maximum Drawdown 0.32 ft.
	10:25	25	7,150	-	-	365.36	"	Specific Capacity
	12:40	135	7,285	-	-	365.33	"	137 gpm/ft of drawdown
	13:00	180	7,305	7,860	43.7	-	Pump Off	
	13:15	15	7,320	-	-	365.18	Recovery	
	13:30	15	7,335	-	-	365.41	"	
	14:00	30	7,365	-	-	365.26	"	
	14:25	25	7,390	-	-	365.23	"	
	14:40	15	7,405	-	-	365.16	"	
	14:55	15	7,420	-	-	365.38	"	
	15:00	5	7,425	111 b/	-	365.22	"	
	15:15	15	7,440	-	-	365.22	"	
1-25	12:00	2,595	10,015			365.32	"	Static WL Airline on
				TOTAL 118,837	Av. 43.7			
Test 2								
1-25	13:50					366.66		Static WL Airline Close
	13:55			1,430 b/		366.67		"
	14:00	0	0	0	0	-	Pump On	
	14:08	8	8	-	-	367.76	"	
	14:15	7	15	-	-	367.35	"	
	14:25	10	25	-	-	366.87	"	
	14.32	7	32	-	-	366.76	"	
	14:37	5	37	-	-	366.80	"	
	14:50	13	50	1,900	38.0	-	"	Drawdown after 25 min of
	15:05	15	65	-	-	366.76	"	pumping 0.20 ft. Specific Capacity
	15:07	2	67	650	38.2	-	Pump Off	191 gpm/ft of drawdown.
	15:20	13	80	-	-	366.67	Recovery	
				TOTAL 2,550	Av. 38.1			

a/ No change in airpressure during test 1 on contineous recorder
b/ Volume of water pumped during recovery and between the two tests.

Note: Water level reported on completion July 1976, 365 ft. Airline pressure at recorder 21 psi, apparent length of airline at recorder 413 ft, at MP in casing 408 ft. Test 1 run with airline on. Test 2 airline shut off resulting in slightly different water levels.

*U.S. GOVERNMENT PRINTING OFFICE 1994-0-573-024/87079