INFORMATION ON WELLS AND BOREHOLES, LOS ALAMOS NATIONAL LABORATORY AND SURROUNDING AREA

INTRODUCTION

This report presents responses to a letter request for information from the New Mexico Environment Department (NMED 2009, 107559) pertaining to abandoned or potentially abandoned wells and boreholes at and near Los Alamos National Laboratory (the Laboratory).

LOCATIONS

Information was requested for the following wells or boreholes:

1. Beta Hole
2. Distillation holes at Technical Area 21 (TA-21) and TA-46
3. DT-5, DT-5P, and all other TA-49 wells/boreholes
4. H-19
5. Layne Western
6. Sigma Mesa EGH-LA-1
7. SHB-1
8. SHB-2
9. SHB-3
10. SHB-4
11. TH-5
12. TH-6
13. TH-7
14. USGS Test Hole east of Material Disposal Area (MDA) C

TYPES OF INFORMATION REQUESTED

The following types of information were requested:

1. Identifiers and construction details for the wells
2. Well logs for each well or borehole
3. Current condition of the wells
4. If abandoned, the methods used to plug and abandon the well
5. Water-bearing zone(s) intersected and/or screened by each well
6. Depth or vertical distance to nearest water-bearing zone and top of regional aquifer.

The requested information is presented in three tables with appendixes that document graphical details related to the wells or boreholes. Figure 1 is a base map showing the location of TAs referred to in this report. Information about wells or boreholes listed in location 2 and locations 4 through 14 above is presented in Table 1, which includes all locations other than those in TA-49. Information for locations 1 and 3, dealing with TA-49, is presented separately in Table 2 because of the number of wells and boreholes in TA-49. Table 3 is an overview of perched water and regional groundwater occurrences in the vicinity of each well or group of wells listed in the information request, as listed under "Types of Information" items 5 and 6. Tables 1 and 2 are color-coded to easily identify the sources of information for individual details related to the boreholes and wells. Appendixes A through I are keyed to the tables, with each appendix covering a specific location. Each appendix contains a location map and a geologic log.

The documentation presented in the tables is to the best of our knowledge. The information presented was obtained through an extensive literature search and discussions with subject matter experts for the different TAs. The tables and appendixes represent the most accurate and comprehensive information from available source documents. Where information was not available, the tables state "unknown."

REFERENCE

NMED (New Mexico Environment Department), October 7, 2009. "Request for Information, Abandoned Wells and Boreholes, Los Alamos National Laboratory and Surrounding Areas," New Mexico Environment Department letter to D. Gregory (DOE-LASO) and D. McInroy (LANL) from J.P. Bearzi (NMED-HWB), Santa Fe, New Mexico. (NMED 2009, 107559)

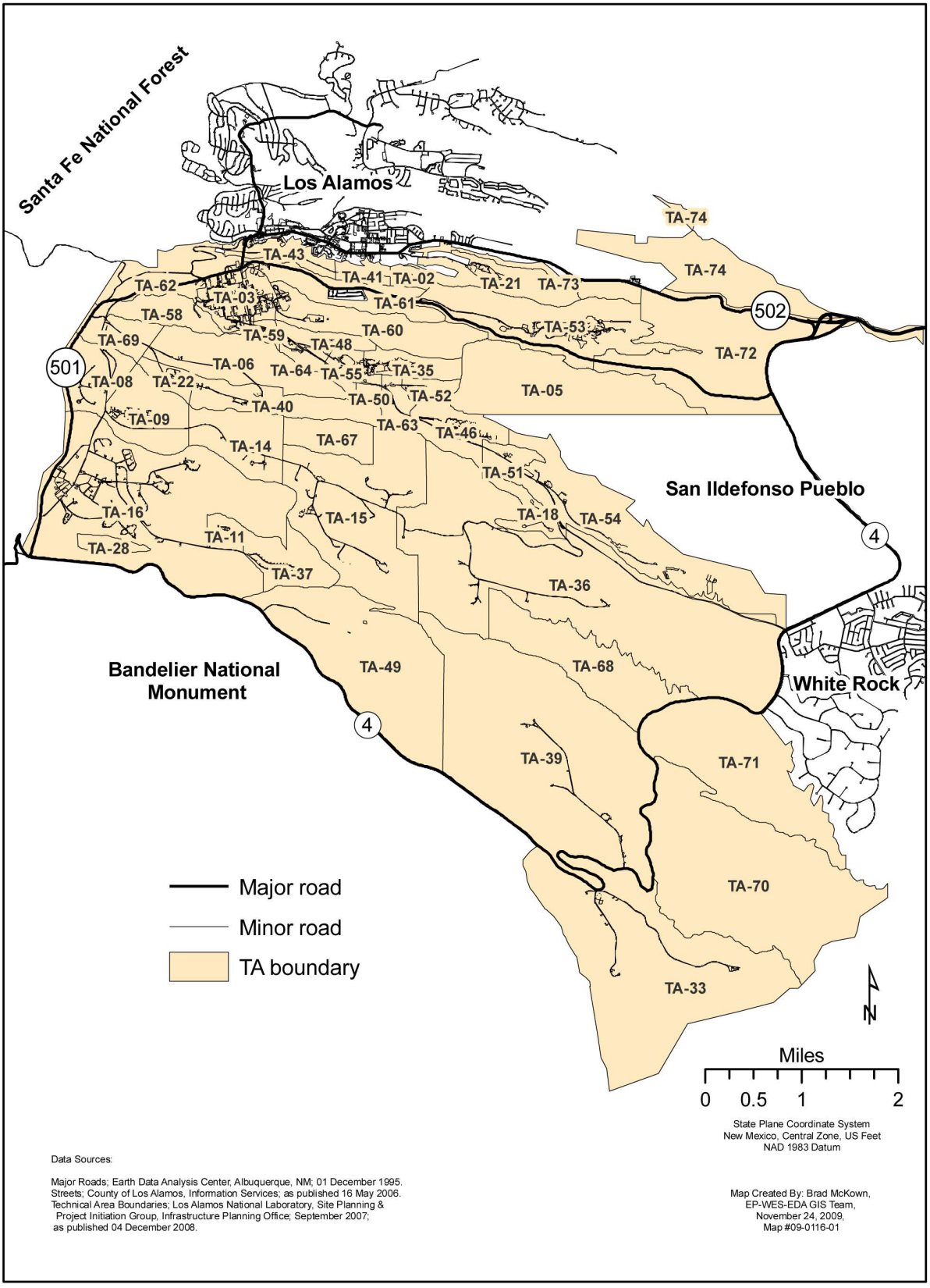

Figure 1 Map of Los Alamos National Laboratory showing technical areas

Table 1
Status of Wells and Boreholes

Well Or Borehole	Location/ Elevation (ft)	Date Drilled (yr)	Total Depth Drilled (ft)	Borehole Diameter (in.)	Casing Information	Geology and Well Log	Screen and Filter Pack	Seal Placement	Status	Water-Bearing Zones	Notes
21-SM-3 TA-21 Distillation hole	TA-21-3 N 1,774,500 E 492,000 El 7150	1969	125	36	18-in. casing cemented to bottom of borehole and 15 ft above ground level	Tshirege Mbr of the Bandelier Tuff – no log *See App. A*	n/a	n/a	Bldg 3 has been removed; 21-SM-3 still exists w/15-ft casing sticking up out of ground. Lines observed inside of casing. Casing appears to be capped at grade.	Dry	n/a
46-SM-88 TA-46 Distillation hole(s)	TA-46-88 N 1,765,500 E 499,500 El 7105	1971	~747	16	13 3/8-in. steel cemented to total depth	Bandelier Tuff, Puye Conglomerate *See App. B*	n/a	n/a	*Bldg. TA-46-88 still in use; borehole(s) believed still in place.*	Dry	*Purtymun (1995, 045344) states "The holes…had a spacing of about 20 ft."*
Pajarito Canyon TH-5	N 1,756,515 E 503,312 El 6591.6	1950	263	24	24-in. casing 0–24 ft; open 24–263 ft	Alluvium, Bandelier Tuff, Basalt *See App.C*	n/a	n/a	Well present as of 1998; otherwise unknown.	Dry	n/a
Pajarito Canyon TH-6	N 1,757,818 E 500,272 El 6642.1	1950	300	6	8-in. casing to 120 ft; open 120–300 ft	Alluvium, Bandelier Tuff, Puye Fm *See App. C*	n/a	n/a	Well present as of 1998; otherwise unknown.	Dry	n/a
Ancho Canyon TH-7	N 1,740,400 E 600,500 El 6224	1950	55	unknown	n/a	Alluvium, Bandelier Tuff, Basalt *See App. C*	n/a	n/a	Plugged and abandoned	Dry	n/a
H-19	Los Alamos Canyon (Near Ice Skating Rink) N 1,775,462 E 1,618,444 El 7178	1949	2,000	unknown	12-in. casing to 10 ft; open 10–2000 ft	Bandelier Tuff, Tschicoma Fm (w/ Puye Formation and Totavi Lentil) *See App. D*	n/a	n/a	Well present as of 1998; hole reported to be caved in at 67 ft in 1992	Perched and regional aquifer encountered. *See Table 3.*	Casing does not extend through alluvium and standing water has been observed in the casing, indicating that alluvial groundwater in LA Canyon has entered the borehole.
Layne Western	Guaje Canyon N 1,783,200 E 516,000 El 5971	1950	157	12–14-in. at surface; ~10 in. to total depth	8-in. casing 0–147 ft, screen 127–147 ft	Alluvium, Puye Fm, Totavi Lentil, Santa Fe Gp. *See App. E*	Screened from 127–147 ft; however, the 8-in. screen from 147–157 ft was welded on the end of the casing.	n/a	Pump removed in 1950. Open as of 1998.	Set as water well. *See Table 3.*	Not hydraulically connected with water-bearing zone in regional aquifer at former supply well Guaje-1 (100 ft away).
Sigma Mesa EGH-LA-1	Sigma Mesa N 1,771,800 E 484,100 El 7215	1979	2,292	36-in. 0–85 ft; 26-in. 85–2292 ft.	30-in casing 0–85 ft; 20-in. 0–1,627 ft	Bandelier Tuff, Puye Fm, Basalt, Totavi Lentil, Santa Fe Gp. *See App.F*	n/a	n/a	Hole filled with cement from 2,292 ft to 1,425 ft extending up into 20-in. casing. Well abandoned in 1979.	Depth to water 1330 ft based on geophysical log.	n/a

Table 1 (continued)

Well Or Borehole	Location/ Elevation (ft)	Date Drilled (yr)	Total Depth Drilled (ft)	Borehole Diameter (in.)	Casing Information	Geology and Well Log	Screen and Filter Pack	Seal Placement	Status	Water-Bearing Zones	Notes
SHB-1 TA-55	TA-55 Upper Pajarito Canyon El 7314 *See App. G for map.*	1991	700	6	2.8-in. PVC casing to total depth	Bandelier Tuff, Cerro Toledo Rhyolite, Cerros del Rio lava *See App. G*	n/a	n/a	*unknown*	Dry	*Well reported damaged in 2008; status unknown.*
SHB-2 TA-3	*See App. G for map.* El 7436	1991	200	6	2.8-in. PVC casing to total depth	Bandelier Tuff *See App. G*	n/a	n/a	Well reported to be plugged and abandoned before construction of building 3-2322 at TA-3	Dry	*TA-3 building 2322 constructed near site of well; status unknown.*
SHB-3 TA-16	*See App. G for map.* El 7607 Upper Water Canyon	1991	860	6	2.8-in. PVC casing to total depth	Bandelier Tuff, Cerro Toledo Rhyolite, Puye Fm *See App.G*	*Screen not installed but well perforated with high explosives to monitor groundwater*	n/a	*unknown*	Perched water encountered at ~663 ft to bottom of hole. *See Table 3.*	*Well originally capped at bottom and filled with water, later perforated.*
SHB-4 TA-18	*See App. G for map.* Pajarito Canyon El 6701	1991	200	6	2.8-in. PVC casing to total depth	Bandelier Tuff *See App. G*	n/a	n/a	Casing sticking up out of ground at TA-18	Perched water encountered during drilling. *See Table 3.*	n/a
USGS Test Hole east of MDA C, TA-50	N 1,768,500 E 486,500	1983	210	4.5	Installed as a vadose monitoring well. Six screened intervals for vadose zone monitoring *See App. H*	Bandelier Tuff. *See App. H*	*See App. H for screened intervals in vadose zone.*	0–22 ft sealed with cement; intervals between screens filled with cement/ cuttings.	Not cited in MDA C Phase II Investigation Report; apparently not in use.	Dry	Corehole drilled to test core recovery with wireline-rotary air coring technique in the Bandelier Tuff. Completed as a vadose zone monitoring hole.

Notes:
Colors in cells correspond to references listed below.
n/a = Not applicable.
Grayed rows indicate plugged and abandoned boreholes.
Geophysical logs noted in Purtymun (1995, 045344) were not located.
Italics indicate notes for this report.
Northings and eastings are based on the 1983 North American Datum.

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Table 2
Status of Wells and Boreholes at Technical Area-49

Well or Borehole at TA-49 (>10 ft deep)	Location	Date Drilled (yr)	Total Depth Drilled (ft)	Borehole Diameter	Casing Information	Geology and Well Log	Screen and Filter Pack Dimensions	Annular Seal	Status	Water-Bearing Zones	Notes
1M-1	Area 1 N1755531 E1624583	1960	49	2-in.	2-in. plastic tubing	4.5 ft soil, 44.5 ft Bandelier Tuff	n/a	n/a	*inactive*	Dry	*Coordinates from LANL ER GIS database.*
1M-2	Area 1 N1755642 E1624363	1960	19	2-in.	2-in. plastic tubing	1 ft soil, 18 ft Bandelier Tuff	n/a	n/a	*inactive*	Dry	*Coordinates from LANL ER GIS database.*
1M-3	Area 1 N1755381 E1624508	1960	19	2-in.	2-in. plastic tubing	4 ft soil, 15 ft Bandelier Tuff	n/a	n/a	*inactive*	Dry	*Coordinates from LANL ER GIS database.*
1M-3A	Area 1 N1755381 E1624530	1960	49	2-in.	2-in. plastic tubing	3 ft soil, 46 ft Bandelier Tuff	n/a	n/a	*inactive*	Dry	*Coordinates from LANL ER GIS database.*
2M-1	Area 2 N1755442 E1625960	1960	49	2-in.	2-in. plastic tubing	1 ft soil, 48 ft Bandelier Tuff	n/a	n/a	*inactive*	Dry	*Coordinates from LANL ER GIS database.*
2M-2	Area 2 N1755207 E1626012	1960	10	2-in.	2-in. plastic tubing	5 ft soil, 5 ft Bandelier Tuff	n/a	n/a	*inactive*	Dry	*Coordinates from LANL ER GIS database.*
2M-3	Area 2 N1755258 E1625610	1960	19	2-in.	2-in. plastic tubing	5 ft soil, 14 ft Bandelier Tuff	n/a	n/a	*inactive*	Dry	*Coordinates from LANL ER GIS database.*
3M-1	Area 3 N1754501 E1624241	1960	50	2-in.	2-in. plastic tubing	1ft soil, 49 ft Bandelier Tuff	n/a	n/a	*inactive*	Dry	*Coordinates from LANL ER GIS database.*
3M-2	Area 3 N1754501 E1624241	1960	19	2-in.	2-in. plastic tubing	2.5 ft soil, 16.5 ft Bandelier Tuff	n/a	n/a	*inactive*	Dry	*Coordinates from LANL ER GIS database.*
3M-3	Area 3 N1754538 E1623989	1960	20	2-in.	2-in. plastic tubing	7 ft soil, 13 ft Bandelier Tuff	n/a	n/a	*inactive*	Dry	*Coordinates from LANL ER GIS database.*
4M-1	Area 4 N1753799 E1625609	1960	49	2-in.	2-in. plastic tubing	2 ft soil, 47 ft Bandelier Tuff	n/a	n/a	*inactive*	Dry	*Coordinates from LANL ER GIS database.*
4M-2	Area 4 N1753878 E1625438	1960	20	2-in.	2-in. plastic tubing	1.5 ft soil, 18.5 ft Bandelier Tuff	n/a	n/a	*inactive*	Dry	*Coordinates from LANL ER GIS database.*
4M-3	Area 4 N1753646 E1625632	1960	19	2-in.	2-in. plastic tubing	3 ft soil, 16 ft Bandelier Tuff	n/a	n/a	*inactive*	Dry	*Coordinates from LANL ER GIS database.*
4M-4	Area 4 N1754058 E1625450	1960	19	2-in.	2-in. plastic tubing	3 ft soil, 16 ft Bandelier Tuff	n/a	n/a	*inactive*	Dry	*Coordinates from LANL ER GIS database.*
5M-1	Area 5 N1754804 E1625442	1960	39	2-in.	2-in. plastic tubing	2.5 ft soil, 36.5 ft Bandelier Tuff	n/a	n/a	*inactive*	Dry	*Coordinates from LANL ER GIS database.*

Table 2 (continued)

Well or Borehole at TA-49 (>10 ft deep)	Location	Date Drilled (yr)	Total Depth Drilled (ft)	Borehole Diameter	Casing Information	Geology and Well Log	Screen and Filter Pack Dimensions	Annular Seal	Status	Water-Bearing Zones	Notes
5M-2	Area 5 N1754836 E1625228	1960	19	2-in.	2-in. plastic tubing	3 ft soil, 16 ft Bandelier Tuff	n/a	n/a	*inactive*	Dry	*Coordinates from LANL ER GIS database.*
6M-1	Area 6 N1755828 E1622914	1960	19	2-in.	2-in. plastic tubing	9ft soil, 10 ft Bandelier Tuff	n/a	n/a	*inactive*	Dry	*Coordinates from LANL ER GIS database.*
9M-1	Area 9 N1754291 E1624810	1960	19	2-in.	2-in. plastic tubing	6 ft soil, 13 ft Bandelier Tuff	n/a	n/a	*inactive*	Dry	*Coordinates from LANL ER GIS database.*
9M-2	Area 9 N1754576 E16275794	1960	19	2-in.	2-in. plastic tubing	6.5 ft soil, 12.5 ft Bandelier Tuff	n/a	n/a	*inactive*	Dry	*Coordinates from LANL ER GIS database.*
9M-3	Area 9 N1754186 E1626420	1960	19	2-in.	2-in. plastic tubing	4 ft soil, 15 ft Bandelier Tuff	n/a	n/a	*inactive*	Dry	*Coordinates from LANL ER GIS database.*
9M-4	Area 9 N1754513 E1626017	1960	19	2-in.	2-in. plastic tubing	12.5 ft soil, 6.5 ft Bandelier Tuff	n/a	n/a	*inactive*	Dry	*Coordinates from LANL ER GIS database.*
10M-1	Area 10 N1755374 E1627061	1960	29	2-in.	2-in. plastic tubing	2 ft soil, 27 ft Bandelier Tuff	n/a	n/a	*inactive*	Dry	*Coordinates from LANL ER GIS database.*
10M-2	Area 10 N1755423 E1626901	1960	20	2-in.	2-in. plastic tubing	4 ft soil, 16 ft Bandelier Tuff	n/a	n/a	*inactive*	Dry	*Coordinates from LANL ER GIS database.*
Area 1- 22 shafts	Area 1 *See App. I*	1959-1960	31-80	3-6 ft	n/a	Bandelier Tuff	n/a	n/a	Shafts backfilled with crushed tuff/sand	Dry	*Shafts installed for high explosives and radioactive (hydronuclear) experiments.*
Area 2 23 shafts	MDA AB Area 2 *See App. I*	1959-1960	30-78	3-6 ft	n/a	Bandelier Tuff	n/a	n/a	Shafts backfilled with crushed tuff/sand	Dry	*Shafts installed for high explosives and radioactive (hydronuclear) experiments.*
Area 2A 6 shafts	MDA AB Area 2A *See App. I*	1959-1960	57-58	3-6 ft	n/a	Bandelier Tuff	n/a	n/a	Shafts backfilled with crushed tuff/sand	Dry	*Shafts installed for high explosives and radioactive (hydronuclear) experiments.*
Area 2B 11 shafts	MDA AB Area 2B *See App. I*	1959-1960	57-78	3-6 ft	n/a	Bandelier Tuff	n/a	n/a	Shafts backfilled with crushed tuff/sand	Dry	*Shafts installed for high explosives and radioactive (hydronuclear) experiments.*
Area 3 12 shafts	Area 3 *See App. I*	1959-1960	57-142	3-6 ft	n/a	Bandelier Tuff	n/a	n/a	Shafts backfilled with crushed tuff/sand	Dry	*Shafts installed for high explosives and radioactive (hydronuclear) experiments.*
Area 4 18 shafts	Area 4 *See App. I*	1959-1960	58-108	3-6 ft	n/a	Bandelier Tuff	n/a	n/a	Shafts backfilled with crushed tuff/sand	Dry	*Shafts installed for high explosives and radioactive (hydronuclear) experiments.*
Area 11 13 shafts	Area 11 *See App. I*	1959	12	unknown	Steel casing to total depth	Bandelier Tuff	n/a	n/a	Shafts backfilled with crushed tuff/sand	Dry	First hydronuclear experiments at TA-49 were conducted in these shafts.

Table 2 (continued)

Well or Borehole at TA-49 (>10 ft deep)	Location	Date Drilled (yr)	Total Depth Drilled (ft)	Borehole Diameter	Casing Information	Geology and Well Log	Screen and Filter Pack Dimensions	Annular Seal	Status	Water-Bearing Zones	Notes
Bottle House shaft	Area 12 *See App. I*	1959	30	6 ft 10 ft	unknown	Bandelier Tuff	n/a	n/a	Shaft filled with sand in late 1960s.	Dry	Shaft housed a 17.5-ft tall by 5.4-ft diameter steel "bottle" that was used to conduct confinement experiments. Shaft was inside the Bottle House (TA-49-23).
Alpha Hole	East of MDA AB N1754807 E1625769	1960	189	24-in.	24-in. diam. corrugated metal pipe set from 0–7 ft; open hole 7–189 ft.	*See App. I for Log*	n/a	n/a	Grouted and abandoned	Dry	n/a
Beta Hole	Floor of Water Canyon N1757577 E1625322	1960	180	24-in.	24-in. diam. corrugated metal pipe set from 0–13 ft; open hole 13–189 ft.	*See App. I for Log*	n/a	n/a	Open as of 1998	Dry	n/a
Gamma Hole	Floor of Ancho Canyon N1752630 E1626278	1960	54	4-in.	Cased 0–8 ft; open 8–54 ft	*See App. I for Log*	n/a	n/a	Grouted and abandoned	Dry	n/a
DT-5	N1754842 E1625310 El 7143	1959	962 927	8-in.	8-in.-diam. steel casing set 0–180 ft; open hole 180–962 ft	*See App. I for Log*	n/a	n/a	Plugged and abandoned ~1998	Dry	*Geophysical logs are available.*
DT-5P	N1625442 E1754804 El 7144	1959	692	unknown	n/a	*See App. I for Log*	n/a	n/a	Plugged and abandoned 1959	Dry	n/a
DT-5A	N 1754789 E 1625310 El 7144	1960	1821	12-in.	*See App. I*	*See App. I for Log*	*See App. I*	*See App. I*	Active monitoring well	wl 1186 ft (04/08)	*Geophysical logs are available.*
DT-9	N 1751431 E 488,750 El 6935	1960	1501	8-in.	*See App. I*	*See App. I for Log*	*See App. I*	*See App. I*	Active monitoring well	wl 1020 ft (10/08)	*Geophysical logs are available.*
DT-10	N 1754448 E 1628994 El 7020	1960	1409	8-in.	*See App. I*	*See App. I for Log*	*See App. I*	*See App. I*	Active monitoring well	wl 1102 ft (0/09)	*Geophysical logs are available.*
CH-1	Area 1 N1755478 E1624469	1959	501	4.5-in.	2-in. galvanized pipe to 500 ft	*See App. I for Log*	unknown	unknown	Open	Dry	n/a
CH-2	Area 2 N1755344 E1625826	1959	507	4.5-in.	2-in. pipe to bottom of hole; bottom 20 ft is slotted	*See App. I for Log*	unknown	unknown	Plugged and abandoned 1998	Dry	n/a
CH-3	Area 3 N1754493 E1624196	1960	300	4.5-in.	2-in. galvanized pipe to 300 ft	*See App. I for Log*	unknown	unknown	Open	Dry	n/a
CH-4	Area 4 N1753898 E1625537	1960	303	4.5-in.	2-in. galvanized pipe to 303 ft	*See App. I for Log*	unknown	unknown	Open	Dry	n/a

Table 2 (continued)

Well or Borehole at TA-49 (>10 ft deep)	Location	Date Drilled (yr)	Total Depth Drilled (ft)	Borehole Diameter	Casing Information	Geology and Well Log	Screen and Filter Pack Dimensions	Annular Seal	Status	Water-Bearing Zones	Notes
TH-1	Area 2 N1755200 E485700	1980	123	5-in.	Surface casing only	*See App. I for Log and neutron log.*	n/a	n/a	Open	Dry	*Drilled in 1980 to aid in determining the source of water that was noted in CH-2 in 1975. Borehole was used for neutron logging that was discontinued in 2006.*
TH-2	Area 2 N1755500 E485600	1980	123	5-in.	Surface casing only	*See App. I for Log and neutron log.*	n/a	n/a	Open	Dry	*Drilled in 1980 to aid in determining the source of water that was noted in CH-2 in 1975. Borehole was used for neutron logging that was discontinued in 2006.*
TH-3	Area 2 N1755300 E485400	1980	123	5-in.	Surface casing only	*See App. I for Log and neutron log.*	n/a	n/a	Open	Dry	*Drilled in 1980 to aid in determining the source of water that was noted in CH-2 in 1975. Well was used for neutron logging that was discontinued on 2006.*
TH-4	Area 2 N1755100 E485400	1980	123	5-in.	Surface casing only	*See App. I for Log and neutron log.*	n/a	n/a	Open	Dry	*Drilled in 1980 to aid in determining the source of water that was noted in CH-2 in 1975. Borehole was used for neutron logging that was discontinued in 2006.*
TH-5	Area 2 N1755200 E485500	1980	123	5-in.	Surface casing only	*See App. I for Log and neutron log.*	n/a	n/a	Open	Dry	*Drilled in 1980 to aid in determining the source of water that was noted in CH-2 in 1975. Borehole was used for neutron logging that was discontinued in 2006.*
2A-O	Area 2 - in Shaft 2A-O N1755360 E1625730	1980	74	2-in.	Cased to 56-ft; slough below	59 ft of sand; 15 ft of Bandelier Tuff	n/a	n/a	Open	Dry	*Moisture monitoring hole drilled in unused shaft that had been backfilled with crushed tuff or sand. Borehole was used for neutron logging that was discontinued in 2006.*
2A-Y	Area 2 – in Shaft 2A-Y N1755312 E1625727	1980	80	2-in.	Cased to 29 ft; slough below	58 ft of sand; 22 ft of Bandelier Tuff	n/a	n/a	Open	Dry	*Moisture monitoring hole drilled in unused shaft that had been backfilled with crushed tuff or sand. Borehole was used for neutron logging that was discontinued in 2006.*
2B-Y	Area 2 – in Shaft 2B-Y N1755134 E1625839	1980	80	2-in.	Cased to 30 ft; slough below	58 ft of sand; 22 ft of Bandelier Tuff	n/a	n/a	Open	Dry	*Moisture monitoring hole drilled in unused shaft that had been backfilled with crushed tuff or sand. Borehole was used for neutron logging that was discontinued in 2006.*
TBM-1	Area 10 N 1754534 E 488302	1993	139	7.25-in.	*See App. I*	Bandelier Tuff *See App. I for Log*	n/a	n/a	6-in. thick, 8-ft square concrete well pad was installed above the corehole.	Dry	Installed to measure the effects of barometric changes on the tuff.
TBM-2	Area 10 N 1754534 E 488302	1993	64	7.25-in.	4-in. plastic pipe set in sand to 40 ft; capped on bottom. *See App. I*	Bandelier Tuff *See App. I for Log*	n/a	n/a	6-in. thick, 8-ft square concrete well pad was installed above the corehole.	Dry	Installed to measure deformation of the tuff by seismic events.
49-02901	Area 12 (100 ft east of Area 2) N1755209 E1625985	1994	700	8-in.	0–40 ft surface casing; open hole below	Bandelier Tuff *See App. I*	n/a	n/a	Open	Dry	n/a

Table 2 (continued)

Well or Borehole at TA-49 (>10 ft deep)	Location	Date Drilled (yr)	Total Depth Drilled (ft)	Borehole Diameter	Casing Information	Geology and Well Log	Screen and Filter Pack Dimensions	Annular Seal	Status	Water-Bearing Zones	Notes
49-02906	Area 2 N1755319 E1625814	1994	150	8-in.	n/a	Bandelier Tuff	n/a	n/a	Casing removed and hole grouted 1998	Dry	n/a
49-02907	Area 2 N1755369 E1625790	1994	150	8-in.	n/a	Bandelier Tuff	n/a	n/a	Casing removed and hole grouted 1998	Dry	n/a
49-10046	Area 2 N1755327 E1625813	2000	15	2-in.	Casing to 15 ft	Bandelier Tuff	n/a	n/a	Open	Dry	*Borehole was used for neutron logging that was discontinued in 2006.*
49-10047	Area 2 N1755368 E1625803	2000	15	2-in.	Casing to 15 ft	Bandelier Tuff	n/a	n/a	Open	Dry	*Borehole was used for neutron logging that was discontinued in 2006.*
49-10048	Area 2 N1755355 E1625883	2000	15	2-in.	Casing to 15 ft	Bandelier Tuff	n/a	n/a	Open	Dry	*Borehole was used for neutron logging that was discontinued in 2006.*

Notes:
Colors in cells correspond to references listed below.
n/a = Not applicable; wl = water level.
Grayed rows indicate plugged and abandoned boreholes/wells; details regarding abandonment procedures were not located.
unknown = Information could not be located.
Italics indicate notes made for this report.
Northings and eastings are based on the 1983 North American Datum.

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Table 3
Perched Water and Groundwater Occurrence at Subject Sites

Location	Depth of Borehole/Well (ft bgs); Elevation (ft)	Perched Water	Regional Aquifer
TA-21, Distillation hole 21-SM-3	125 El 7150	An east-west trending perched water body is present beneath Los Alamos Canyon, south of TA-21, in the Guaje Pumice Bed (Robinson et al. 2005, 091682). Perched water is also encountered in the underlying Puye Formation at R-6i, east of TA-21, and R-7, south of TA-21. However, "Little is known about the extent of perched groundwater beneath the adjacent mesas, but paired *(Los Alamos)* canyon–*(DP)* mesa boreholes (R-7/21-2523, Fig. 2) suggest that saturation does not extend beneath the mesa north of Los Alamos Canyon" (Robinson et al. 2005, 091682). Two wells drilled to the north of TA-21 did not encounter perched groundwater. LADP-4 was drilled north of TA-21 in DP Canyon to investigate the presence of perched water; no perched water was encountered even though the borehole penetrated 227 ft below ground surface (bgs) into the Puye Formation (Broxton and Eller 1995, 058207). Borehole LADP-5, located between R-6i and LADP-4, was designed to intersect perched groundwater encountered at R-6i; however, it was dry even though it was drilled to a depth of 720 ft in the DP Canyon channel.	Depth to the regional aquifer from the top of DP Mesa is approximately 1273 ft bgs (Koch and Schmeer 2009, 105181); therefore, the regional aquifer would be encountered at approximately 1148 ft below the bottom of 21-3.
TA-46, Distillation hole 46-SM-88	747 El 7105	No water was encountered during drilling (Purtymun 1995, 045344).	The depth to the regional aquifer at TA-46 is approximately 1230 ft (LANL 2009, 106047). Therefore, the bottom of hole 46-SM-88 is approximately 48 ft above the regional aquifer.
H-19, Upper Los Alamos Canyon	2000 El 7178	Perched water was encountered from 450–472 ft in the Guaje Pumice Bed; yield was insufficient for water well (Purtymun 1995, 045344).	Regional aquifer was encountered in H-19 in Tschicoma Fm at approximately 970 ft. A well was not installed because of low-permeability formation (Purtymun 1995, 045344).

Table 3 (continued)

Location	Depth of Borehole/Well (ft bgs); Elevation (ft)	Perched Water	Regional Aquifer
Layne Western, Guaje Canyon	157 El 5971	Depth to water after well installation (screen from 127–147 ft bgs) was 104.88 ft in 1950. Water was apparently produced from a perched zone in the upper part of the Santa Fe Gp above the top of the regional aquifer (Purtymun and Swanton 1998, 099096).	The elevation of the top of the regional aquifer in nearby water-supply well G-1A is approximately 5710 ft; however, this is the level recorded between pumping intervals. The true surface of the regional aquifer might be higher if the well were allowed to recover after pumping. But based on this elevation, the depth to the regional aquifer in the vicinity of the Layne Western well would be approximately 280 ft or 123 ft below the bottom of the well.
Sigma Mesa EGH-LA-1, Sigma Mesa	2292 El 7215	No perched water zones were noted (Purtymun 1995, 045344).	The regional aquifer was encountered in the borehole at 1330 ft based on a geophysical log (Purtymun 1995, 045344), near the contact of the Totavi Lentil with the underlying Santa Fe Gp.
SHB-1, TA-55	700 El 7314	No perched water was encountered during drilling of SHB-1 and no perched water was encountered at boreholes drilled nearby to characterize MDA C at TA-50, southeast of TA-55 (LANL 2009, 106047).	Depth to regional groundwater should be about 1330 ft based on groundwater information presented in a LANL report (LANL 2009, 106047); this depth is about 630 ft below the bottom of SHB-1. Well was reported damaged in 2008; its status is unknown.
SHB-2, TA-3	200 El 7436	SHB-2 did not encounter perched groundwater. H-19, approximately 0.6 mi north northeast of SHB-3, did encounter perched water, but it is located in Los Alamos Canyon. Robinson et al. (2005, 091682), indicate that perched zones tend to be present under wet canyon areas and absent beneath mesas.	The depth to the regional aquifer near SHB-2 is approximately 940 ft (LANL 2009, 106047), indicating that it would be approximately 740 ft below the bottom of SHB-2.
SHB-3, TA-16 Upper Water Canyon	860 El 7607	Perched water was encountered at ~663 ft in the lower Bandelier Tuff and the underlying Puye Fm; confining layer was not reached in the borehole (Robinson et al. 2005, 091682).	Depth to regional aquifer in R-26 (surface elevation 7642 ft), approximately 0.6 mi to the northeast, along strike of the Pajarito fault zone, is approximately 1100 ft (Koch and Schmeer 2009, 105181) or 240 ft below the bottom of SHB-3.

Table 3 (continued)

Location	Depth of Borehole/Well (ft bgs); Elevation (ft)	Perched Water	Regional Aquifer
SHB-4, TA-18 Pajarito Canyon	200 El 6701	Perched water may have been encountered from 125–145 ft in the Tsankawi pumice unit at the base of the Tshirege Mbr of the Bandelier Tuff (Gardner et al. 1993, 012582).	The depth to the regional aquifer is approximately 880 ft below TA-18 ground surface (Koch and Schmeer 2009, 105181); this depth is approximately 680 ft below the bottom of SHB-4.
TH-5, Pajarito Canyon	263 El 6591.6	No water was encountered during drilling of TH-5. Perched water was encountered in nearby R-23 (to the southeast in lower Pajarito Canyon) in the Cerros del Rio basalt at a depth of approximately 450 ft. However, perched water was not encountered at nearby wells R-22, R-39, R-41, and R-49, indicating that perched zones in this area, if present, are likely of limited extent.	Depth to regional aquifer is approximately 870 ft bgs, or 600 ft below the bottom of TH-5 (LANL 2009, 106047).
TH-6, Pajarito Canyon	300 El 6642.1	No water was encountered during drilling of TH-6. Perched water was encountered in nearby R-23 (to the southeast in lower Pajarito Canyon) in the Cerros del Rio basalt at a depth of approximately 450 ft. However, perched water was not encountered at nearby wells R-22, R-39, R-41, and R-49, indicating that perched zones in this area, if present, are likely of limited extent.	Depth to regional aquifer is approximately 890 ft or 590 ft below the bottom of TH-6 (LANL 2009, 106047).
TH-7, Ancho Canyon	55 El 6224	No water was encountered during drilling of TH-7. The only well drilled in the vicinity of TH-7 is regional well R-31, approximately 1 mi to the northwest, also in Ancho Canyon. A thin perched zone was encountered in the Cerros del Rio basalt during drilling, but it did not sustain water production once the well was installed.	Depth to regional aquifer is approximately 525 ft or 470 ft below the bottom of TH-7 (LANL 2009, 106047).
USGS Test Hole east of MDA C, TA-50	210 El 7229	Perched water has not been identified in any of the boreholes drilled at MDA C to a depth of 653 ft (LANL 2009, 106047). Additionally, perched water was not encountered in regional aquifer well R-46, approximately 0.25 mi east of MDA C.	The regional aquifer is located approximately 1330 ft bgs at MDA C (LANL 2009, 106047), or approximately 1120 ft below the bottom of the USGS Test Hole.

Table 3 (continued)

Location	Depth of Borehole/Well (ft bgs); Elevation (ft)	Perched Water	Regional Aquifer
TA-49 Various boreholes	15–507	According to the 2008 outside nuclear environmental site investigation work plan (LANL 2008, 102215), perched water was not encountered during the drilling of three deep test wells that reached the regional aquifer and moisture monitoring has not detected the presence of perched water zones at TA-49. Water encountered periodically between 1975 and 1991 in CH-2 was apparently the result of surface water that infiltrated and remained beneath a cracked asphalt pad installed in 1961 (Levitt et al. 2003, 107563). Perched water was not present during the drilling of CH-2 or in the period from 1960 when it was installed to 1975. Since the removal of the asphalt pad in 1998 and the installation of an evapotranspiration cover over the area, free water has not been detected by moisture monitoring in the area.	Based on the depth to groundwater measured at the three deep test wells at TA-49 (Koch and Schmeer 2009, 105181), the regional aquifer is present approximately 1200 ft beneath the top of Frijoles Mesa and the TA-49 site.

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APPENDIX A

TA-21 Distillation Borehole

References for Appendix A Information

Borehole	MAP	GEOLOGIC LOG	CONSTRUCTION DIAGRAM	OTHER
TA-21 Distillation borehole	1	not found – see general geologic cross section - 2	not found	na

1. Purtymun, W.D., 1995, Geologic and Hydrologic Records of Observation Wells, Test Holes, Test Wells, Supply Wells, Springs, and Surface Water Stations in the Los Alamos Area, Los Alamos National Laboratory Report LA-12883-MS, Los Alamos National Laboratory, Los Alamos, New Mexico, January 1995.

2. Broxton, D.E. and Eller, P.G., 1995, Earth Science Investigations for Environmental Restoration – Los Alamos National Laboratory Technical Area 21, Los Alamos National Laboratory report LA-12934-MS, Los Alamos National Laboratory, Los Alamos, New Mexico, June 1995.

XVI. CARBON ISOTOPE PRODUCTION HOLES AT TA-21 AND TA-46

Carbon isotope production holes were drilled at TA-21 and TA-46 (Fig. XVI-A). The holes were used as part of a carbon 13 production plant using carbon monoxide distillation (Armstrong et al. 1970).

The preliminary testing and production of carbon 13 occurred at TA-21 building SM-3. In 1969 a hole to hold the distillation column was drilled in the northwest stairwell. The 36-in.-diam hole was augered to a depth of 125 ft. An 18-in.-diam casing was cemented in the hole. The casing extended about 15 ft above the floor level. The hole was completed in the Tshirege Member of the Bandelier Tuff. The hole was dry.

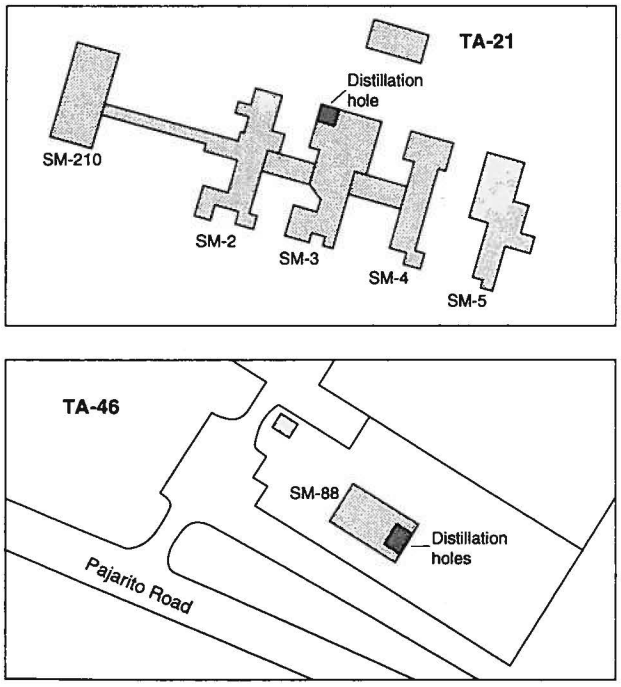


Fig. XVI-A. Distillation holes at TA-21 and TA-46.

A production plant was built at TA-46 in building SM-88 in 1971. The eastern end of the building contained a large bay about 38 ft in height. The holes were drilled in the bay with a spacing of about 20 ft. The holes were reamed out to a 16-in. diameter to a depth of about 747 ft using a mud rotary. A 13 3/8-in.-diam casing was cemented in the holes.

The holes at TA-46 penetrated the total thickness of the Bandelier Tuff and were completed into the top of the Puye Conglomerate. The holes were dry (Purtymun 1994).

Geologic Log of TA-46 Holes

Elevation 7105 ft

	Thickness (ft)	Depth
Bandelier Tuff		
Tshirege Member	360	360
Otowi Member	335	695
Guaje Member	32	727
Puye Conglomerate		
Sand, gravel, and boulders	20	747

REFERENCES

D. E. Armstrong, A. C. Briesmeister, B. B. McInteer, and R. M. Potter, "A Carbon 13 Production Plant Using Carbon Monoxide Distillation," Los Alamos Scientific Laboratory report LA-4391 (1970).

W. D. Purtymun, "Source Document Compilation: Los Alamos Investigations Related to the Environment, Engineering, Geology, and Hydrology, 1961–1990," Los Alamos National Laboratory report LA-12733-MS (1994), chapters 21 and 76.

TABLE XVI-A. Locations and Elevations (NAD 1927)

TA-21	N 1,774,500	E 492,000	7150 ft
TA-46	N 1,765,500	E 499,500	7105 ft

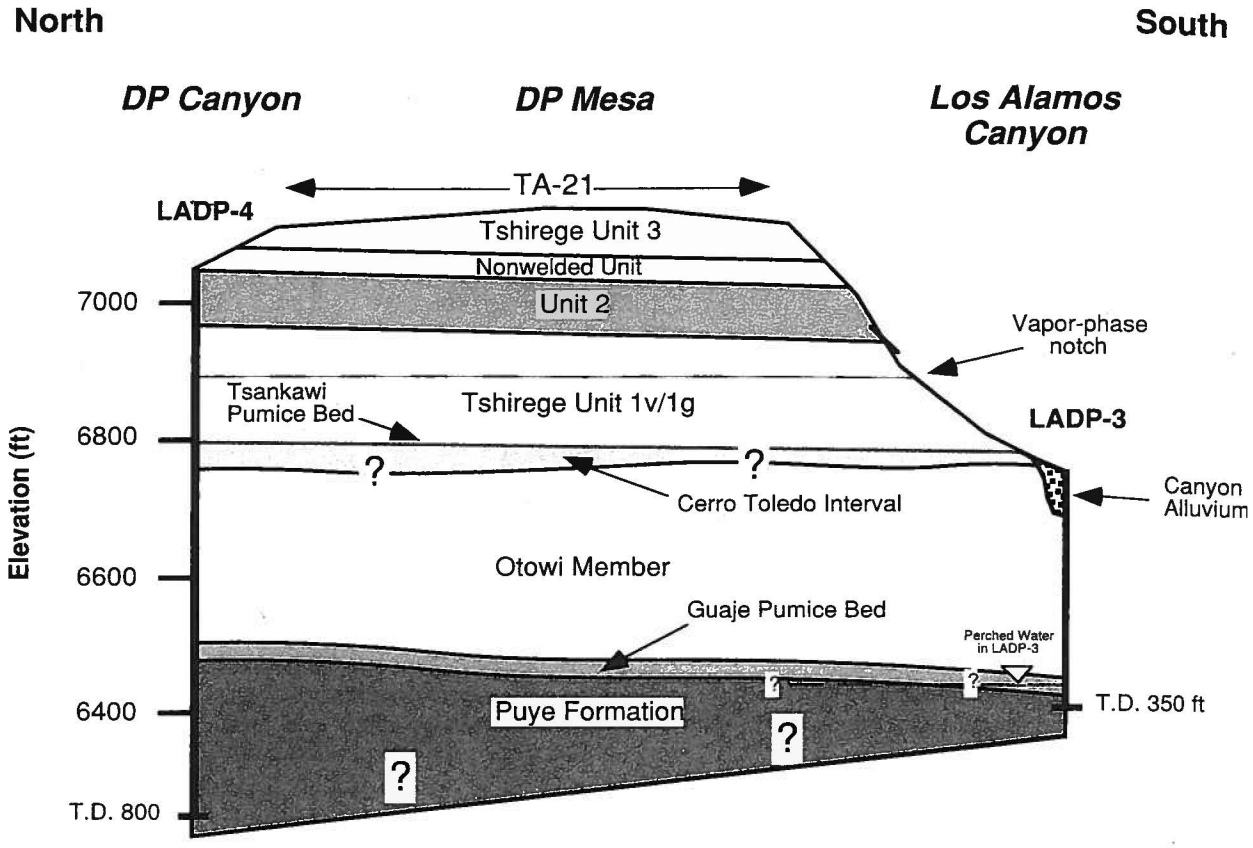


Fig. 12. N-S geologic cross section of TA-21 showing the distribution of principal stratigraphic units. Perched groundwater occurs in the Guaje Pumice Bed under Los Alamos Canyon, but its extent northward under the industrialized areas of DP Mesa is not known.

Pumice Bed at LADP-3 may flow downgradient into the Puye Formation in other parts of Los Alamos Canyon. In the geologic log for well Otowi-4, Stoker *et al.* (1992) observed, *"Some perched water was visible in a video log of the 48-in. hole at about 253 ft where the water cascaded in from large gravel."* The perched groundwater in Otowi-4 occurs in the Puye Formation 0.75 miles downcanyon and 64 ft lower in elevation than the Guaje Pumice Bed groundwater in LADP-3 (Fig. 13). Although these occurrences of perched groundwater may be related, this hypothesis cannot be demonstrated with certainty using the data currently available.

At this point in the investigation, the source of tritium in the Guaje Pumice Bed groundwater in Los Alamos Canyon has not been determined. The Laboratory's TA-2 and TA-41 are located on the floor of Los Alamos Canyon upgradient of the tritium contamination detected at LADP-3. TA-2 is a possible contamination source because it was the source of tritium releases in the past. In January 1992, it was determined that tritium-laden primary coolant water from the Omega West Reactor at TA-2 was leaking into the alluvial groundwater. Surface water and alluvial groundwater from the canyon bottom are possible sources of recharge to the Guaje Pumice Bed groundwater. TA-21 is a less likely source for the tritiated groundwater because thick, unsaturated tuffs, lack of available surface and groundwater, and low recharge rates could serve as effective barriers to contaminant transport from the mesa top.

APPENDIX B

TA-46 Distillation Boreholes

References for Appendix B Information

Borehole	MAP	GEOLOGIC LOG	CONSTRUCTION DIAGRAM
TA-46 Distillation boreholes	1, 2	1, 3	not found

1. Purtymun, W.D., 1995, Geologic and Hydrologic Records of Observation Wells, Test Holes, Test Wells, Supply Wells, Springs, and Surface Water Stations in the Los Alamos Area, Los Alamos National Laboratory Report LA-12883-MS, Los Alamos National Laboratory, Los Alamos, New Mexico, January 1995.

2. Los Alamos National Laboratory Engineering Drawing Number C-39824-003-C-0, 1971, Expanded Carbon 13 Facility Floor Plan, Building WA-88, TA-46, Los Alamos National Laboratory, Los Alamos, New Mexico, October 1971.

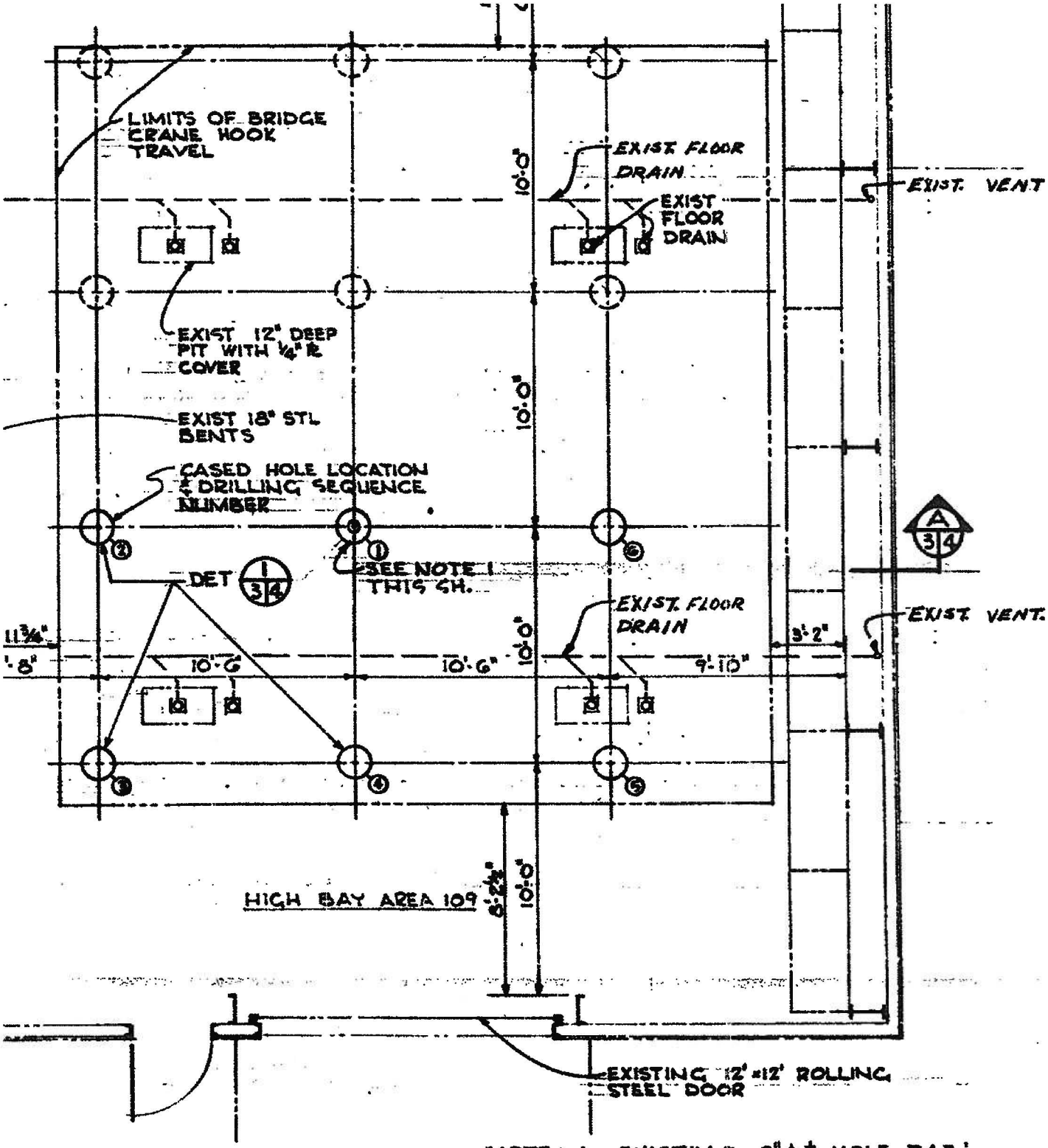
3. Los Alamos National Laboratory, 1993, LANL, RCRA Facility Investigation Work Plan for Operable Unit 1140, Environmental Restoration Program, Los Alamos National Laboratory report LA-UR-93-1940, Los Alamos National Laboratory, Los Alamos, New Mexico, August 1993.

TA-46 DISTILLATION BOREHOLES

Purtymun (1994, 1995) indicates that there were several boreholes drilled inside the east high bay of building SM-88 at TA-46 (now called TA-46-88), but he did not state explicitly the number of boreholes drilled and cased for the carbon monoxide distillation process.

Engineering drawing C-39824-003 from October 1971 (on following page) shows six 8-in. diameter boreholes, 747 ft deep. A drawing note (#1) states that the boreholes were to be reamed out to larger 16-in. diameter holes and fitted with 14-in. casing to total depth in order to conduct carbon monoxide distillation . The boreholes are spaced at 10-ft intervals in the southern end of the high bay.

According to Purtymun's 1994 writeup, any fluids that might be released from a failure in the distillation system would be contained in the cased holes.



NOTE: 1. EXISTING 8"ϕ ± HOLE 747' DEEP TO BE REAMED OUT TO 18"ϕ AND 14"ϕ CASING INSTALLED TO T.D. GROUT BETWEEN EXIST CMP & CASING AND BACKFILL BETWEEN CMP & SOIL.

2. THE BLDG. 5 TON CAPACITY BRIDGE CRANE IS AVAILABLE FOR USE BY THE CONTRACTOR. CONTRACTOR SHALL BE RESPONSIBLE FOR ANY DAMAGE TO THE CRANE.

3. PROTECT FLOOR DRAINS & PITS FROM DRILLING MUD.

3

DWG C-39824-003

GRAPHIC SCALE

XVI. CARBON ISOTOPE PRODUCTION HOLES AT TA-21 AND TA-46

Carbon isotope production holes were drilled at TA-21 and TA-46 (Fig. XVI-A). The holes were used as part of a carbon 13 production plant using carbon monoxide distillation (Armstrong et al. 1970).

The preliminary testing and production of carbon 13 occurred at TA-21 building SM-3. In 1969 a hole to hold the distillation column was drilled in the northwest stairwell. The 36-in.-diam hole was augered to a depth of 125 ft. An 18-in.-diam casing was cemented in the hole. The casing extended about 15 ft above the floor level. The hole was completed in the Tshirege Member of the Bandelier Tuff. The hole was dry.

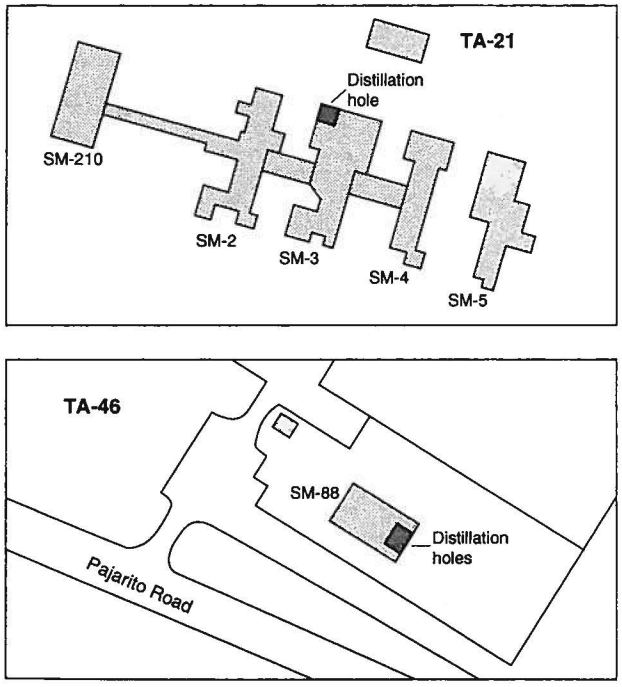


Fig. XVI-A. Distillation holes at TA-21 and TA-46.

A production plant was built at TA-46 in building SM-88 in 1971. The eastern end of the building contained a large bay about 38 ft in height. The holes were drilled in the bay with a spacing of about 20 ft. The holes were reamed out to a 16-in. diameter to a depth of about 747 ft using a mud rotary. A 13 3/8-in.-diam casing was cemented in the holes.

The holes at TA-46 penetrated the total thickness of the Bandelier Tuff and were completed into the top of the Puye Conglomerate. The holes were dry (Purtymun 1994).

Geologic Log of TA-46 Holes

Elevation 7105 ft

	Thickness (ft)	Depth
Bandelier Tuff		
Tshirege Member	360	360
Otowi Member	335	695
Guaje Member	32	727
Puye Conglomerate		
Sand, gravel, and boulders	20	747

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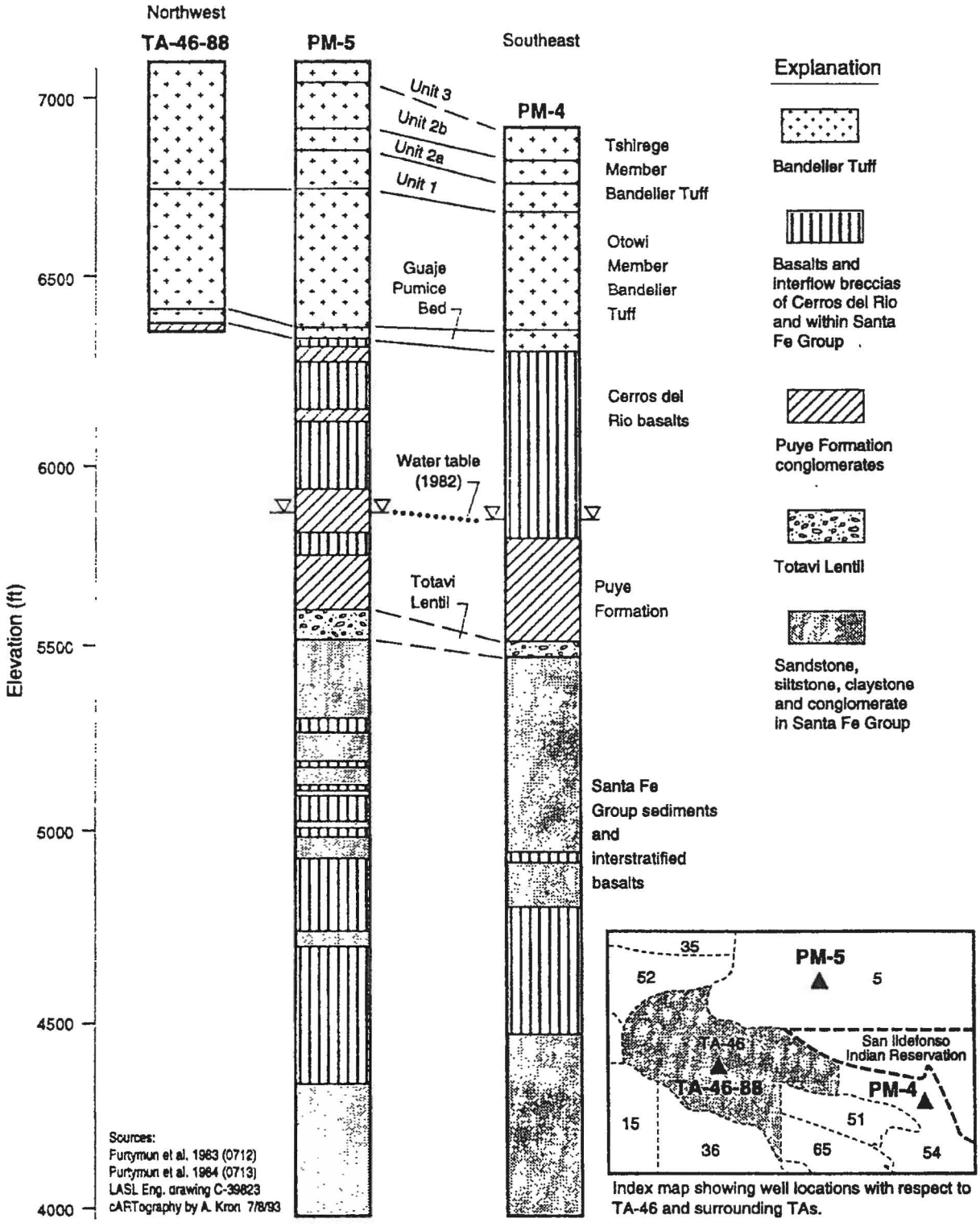
TABLE XVI-A. Locations and Elevations (NAD 1927)

TA-21	N 1,774,500	E 492,000	7150 ft
TA-46	N 1,765,500	E 499,500	7105 ft



Index map showing well locations with respect to TA-46 and surrounding TAs.

Fig. 3-4. Lithologic logs for borings near TA-46.

APPENDIX C

Boreholes TH-5, TH-6 AND TH-7

References for Appendix C Information

Boreholes	MAP	GEOLOGIC LOG	CONSTRUCTION DIAGRAM
TH-5, TH-6, TH-7	1	1	not found

1. Purtymun, W.D., 1995, Geologic and Hydrologic Records of Observation Wells, Test Holes, Test Wells, Supply Wells, Springs, and Surface Water Stations in the Los Alamos Area, Los Alamos National Laboratory Report LA-12883-MS, Los Alamos National Laboratory, Los Alamos, New Mexico, January 1995.

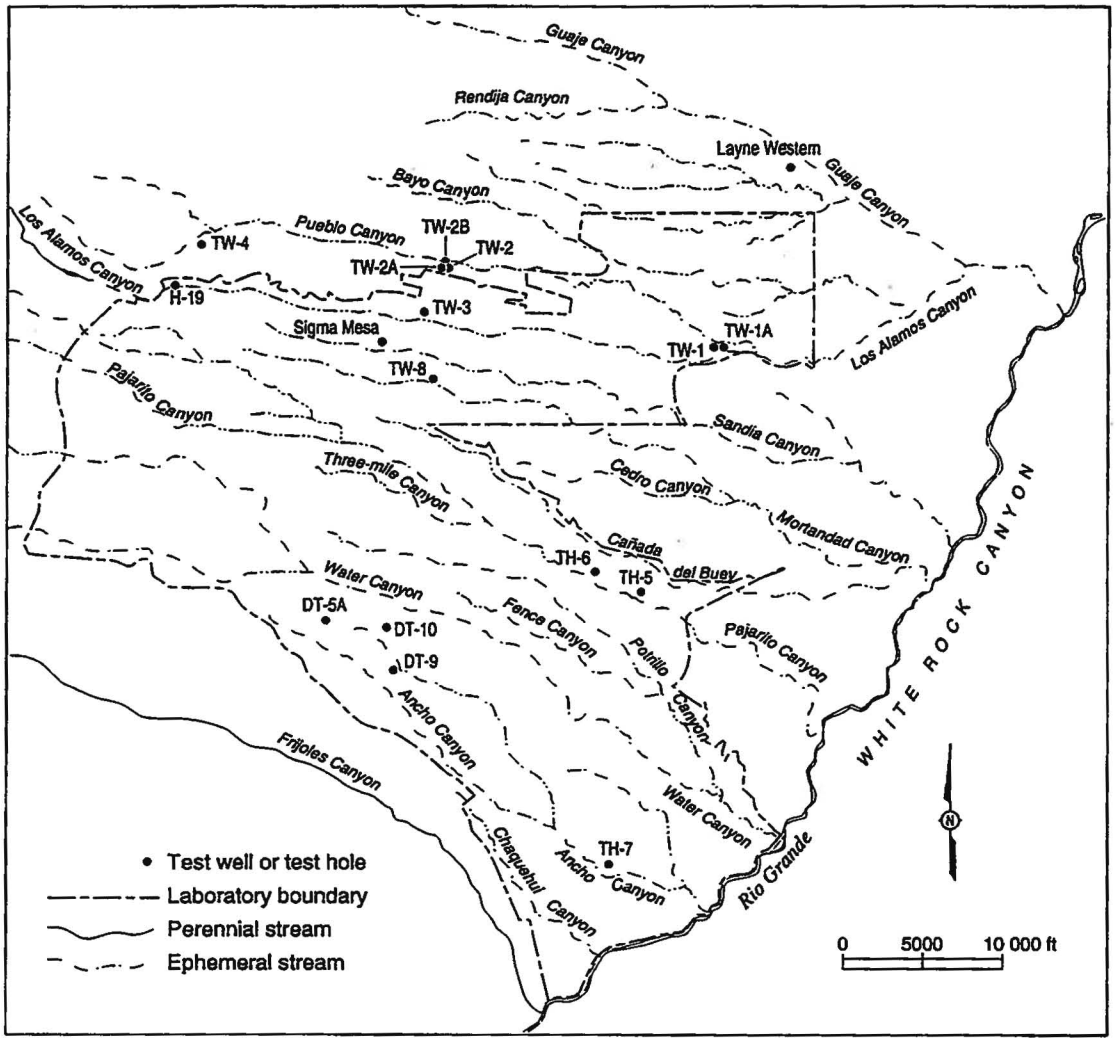


Fig. XVII-A. Test wells and test holes on the Pajarito Plateau.

REFERENCES

E. H. Baltz, J. H. Abrahams, and W. D. Purtymun, "Preliminary Report on the Geology and Hydrology of Mortandad Canyon, Los Alamos, New Mexico, with Special Reference to Disposal of Liquid Low-Level Radioactive Wastes," U.S. Geological Survey Open-File Report (1963).

Black and Veatch (Consulting Engineers), "Ground-Water Observation Wells, Los Alamos, New Mexico," Administrative Report prepared for the U.S. Atomic Energy Commission (1950).

R. L. Griggs, "Geology and Ground-Water Resources of the Los Alamos Area, New Mexico," U.S. Geol. Survey Admin. Report to the U.S. Atomic Energy Commission (1955).

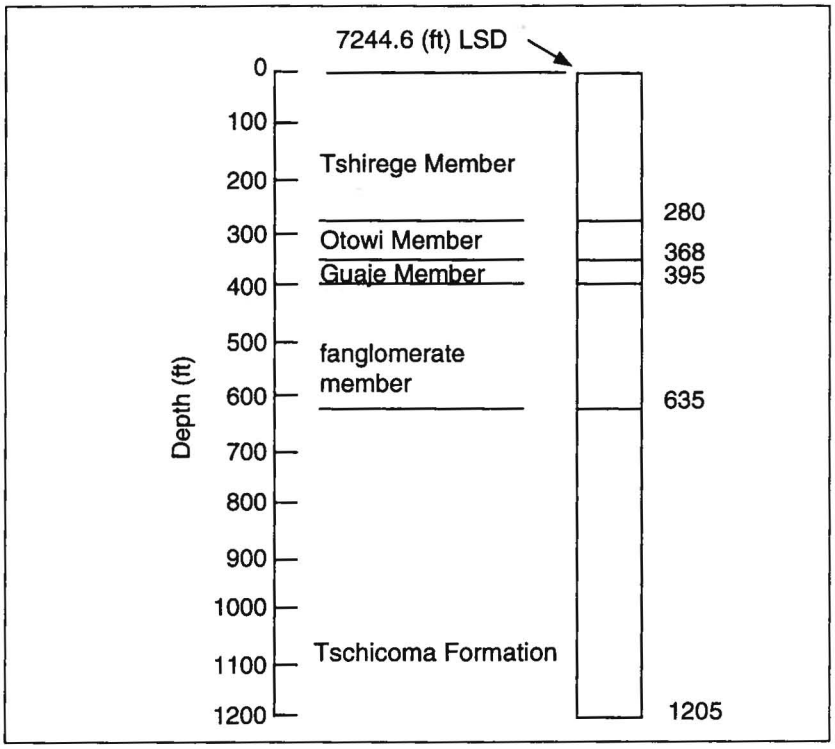


Fig. XVII-E. Geologic log of test well TW-4, completed March 1950, water level 1171 ft (Griggs 1955).

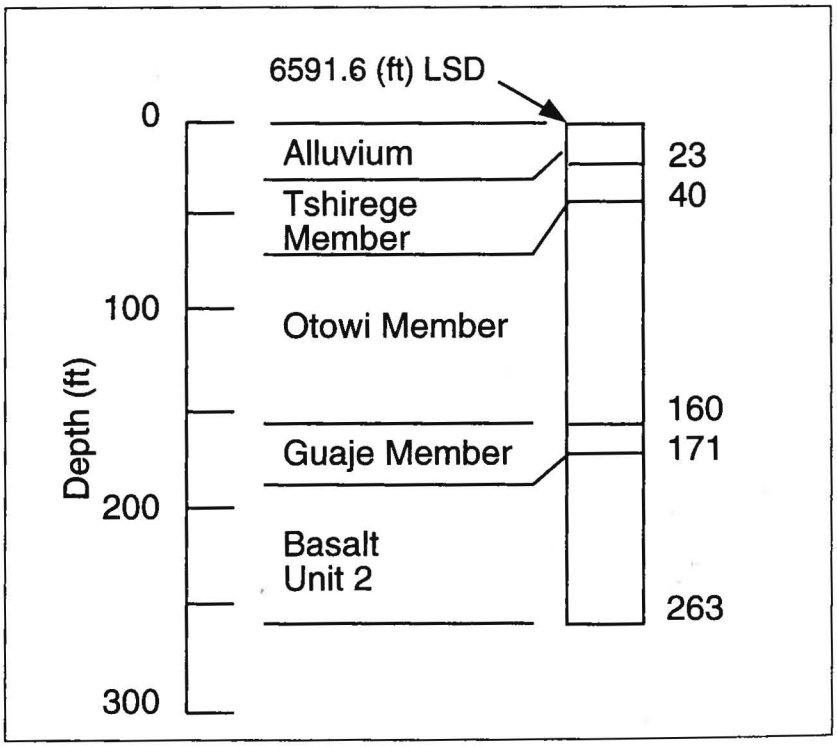


Fig. XVII-F. Geologic log of test hole TH-5, completed March 1950, dry (Griggs 1955).

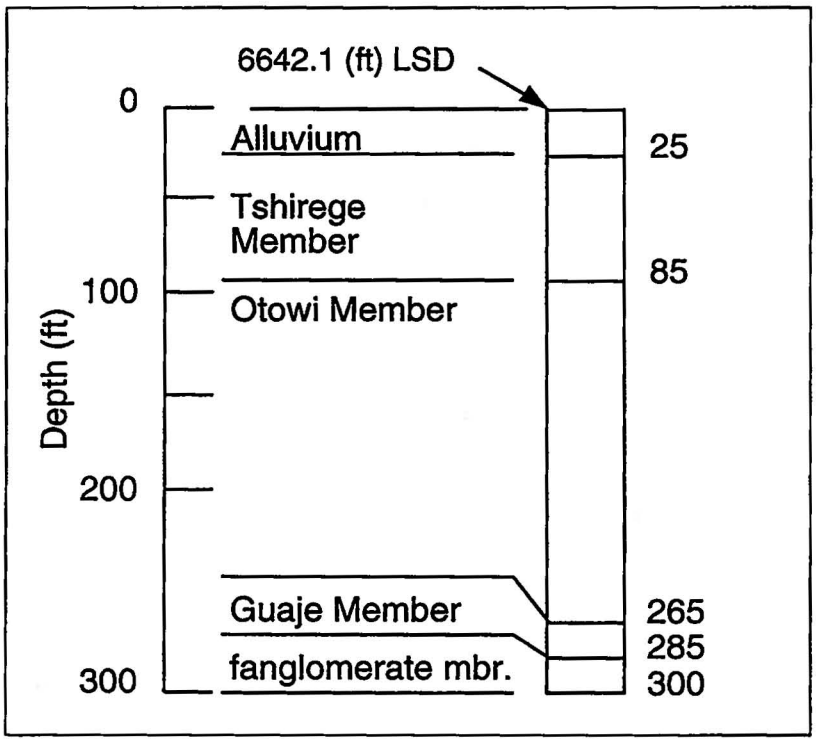


Fig. XVII-G. Geologic log of test hole TH-6, completed March 1950, dry (Griggs 1955).

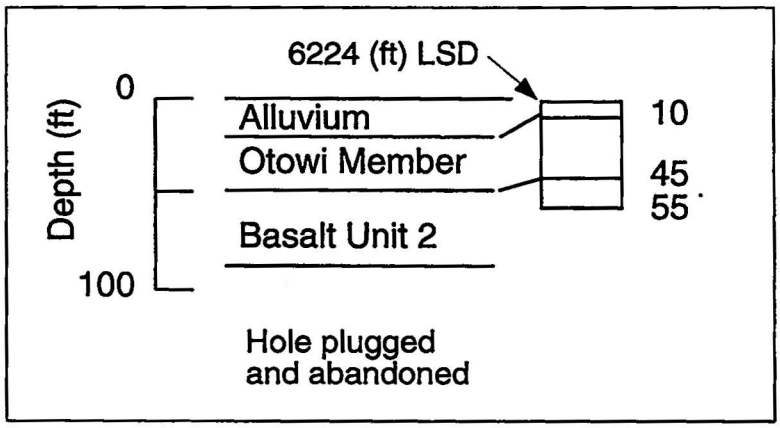


Fig. XVII-H. Geologic log of test hole TH-7, completed April 1950, dry (Griggs 1955).

TABLE XVII-B. Geologic Logs and Construction Data for Test Wells and Test Holes on the Pajarito Plateau (15 Test Wells and Test Holes) (Continued)

7. Test Well TW-4 (Continued)

Casing Schedule

Inner Diam (in.)	Depth (ft)
16	0–109
12	0–288
10	0–633
6	0–1195

10 ft of 6-in.-diam screen run from the bottom of the 6-in. casing, from 1195 to 1205 ft.

Geophysical Log
Gamma-ray (5-7-60), Files ESH-18.
Note: Water level 1168.9 ft (5-7-60); water level 1172 ft (7-20-92).

8. Test Hole TH-5

Elevation (LSD): 6591.6 ft — Water Level: Dry (1950)

Geologic Log	Thickness (ft)	Depth (ft)
Alluvium	23	23
Bandelier Tuff		
Tshirege Member	17	40
Otowi Member	120	160
Guaje Member	11	171
Basaltic Rocks of Chino Mesa		
Unit 2	92	263

Casing Schedule

Outer Diam (in.)	Depth (ft)
24	0–24
Open Hole	24–163

Note: Water in alluvium cased out of hole.

9. Test Hole TH-6

Elevation (LSD): 6642.1 ft — Water Level: Dry (1950)

Geologic Log	Thickness (ft)	Depth (ft)
Alluvium	25	25
Bandelier Tuff		
Tshirege Member	60	85
Otowi Member	180	265
Guaje Member	20	285
Puye Conglomerate		
Fanglomerate member	15	300

Casing Schedule

Outer Diam (in.)	Depth (ft)
8	0–120
Open Hole	120–300

Note: Water in alluvium cased out of hole.

TABLE XVII-B. Geologic Logs and Construction Data for Test Wells and Test Holes on the Pajarito Plateau (15 Test Wells and Test Holes) (Continued)

10. Test Hole TH-7

Elevation (LSD): 6224 ft

Water Level: Dry (1950)

Geologic Log	Thickness (ft)	Depth (ft)
Alluvium	10	10
Bandelier Tuff		
Otowi Member	35	45
Basaltic Rocks of Chino Mesa		
Unit 2	10	55

Hole plugged and abandoned.

11. Test Well TW-8

Elevation (LSD): 6877.62 ft

Water Level: 968 ft (1960)

Geologic Log	Thickness (ft)	Depth (ft)
Alluvium	40	40
Bandelier Tuff		
Tshirege Member	20	60
Otowi Member	385	445
Guaje Member	45	490
Puye Conglomerate		
Fanglomerate member	90	580
Basalt Unit 2	145	725
Fanglomerate member	340	1065

Casing Schedule
44 ft of 20-in. corrugated metal pipe from 0 to 44 ft; 64 ft of 14-in.-outside-diam steel casing 0 to 64 ft cemented in; 1065 ft of 8-in.-inside-diam steel casing from 0 to 1065 ft with the lower 112 ft slotted.

Geophysical Log
Gamma-ray (11-29-61), files available from the ESH-18 Geohydrology section.

12. Test Hole H-19

Elevation (LSD): 7178 ft

Water Level: 950 ft (1950)

Geologic Log	Thickness (ft)	Depth (ft)
Alluvium	27	27
Bandelier Tuff		
Tshirege Member	173	200
Otowi Member	215	415
Guaje Member	57	472
Tschicoma Formation	347	819
Puye Conglomerate		
Fanglomerate member	391	1210
Tschicoma Formation	270	1480
Puye Conglomerate		
Totavi Lentil	10	1490
Tschicoma Formation	510	2000

APPENDIX D

Borehole H-19

References for Appendix D Information

Borehole	MAP	GEOLOGIC LOG	CONSTRUCTION DIAGRAM
H-19 Borehole	1	1	not found

1. Purtymun, W.D., 1995, Geologic and Hydrologic Records of Observation Wells, Test Holes, Test Wells, Supply Wells, Springs, and Surface Water Stations in the Los Alamos Area, Los Alamos National Laboratory Report LA-12883-MS, Los Alamos National Laboratory, Los Alamos, New Mexico, January 1995.

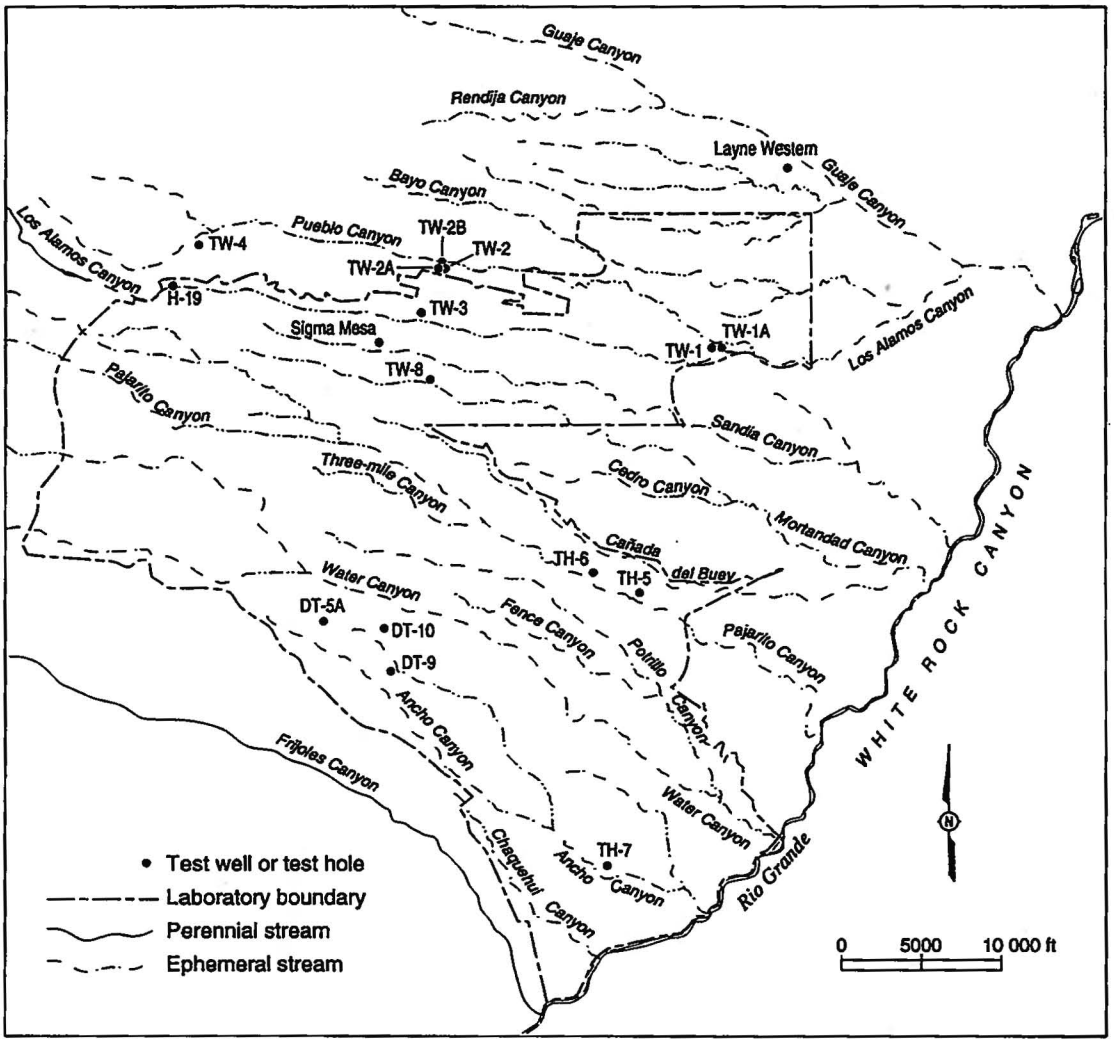


Fig. XVII-A. Test wells and test holes on the Pajarito Plateau.

REFERENCES

E. H. Baltz, J. H. Abrahams, and W. D. Purtymun, "Preliminary Report on the Geology and Hydrology of Mortandad Canyon, Los Alamos, New Mexico, with Special Reference to Disposal of Liquid Low-Level Radioactive Wastes," U.S. Geological Survey Open-File Report (1963).

Black and Veatch (Consulting Engineers), "Ground-Water Observation Wells, Los Alamos, New Mexico," Administrative Report prepared for the U.S. Atomic Energy Commission (1950).

R. L. Griggs, "Geology and Ground-Water Resources of the Los Alamos Area, New Mexico," U.S. Geol. Survey Admin. Report to the U.S. Atomic Energy Commission (1955).

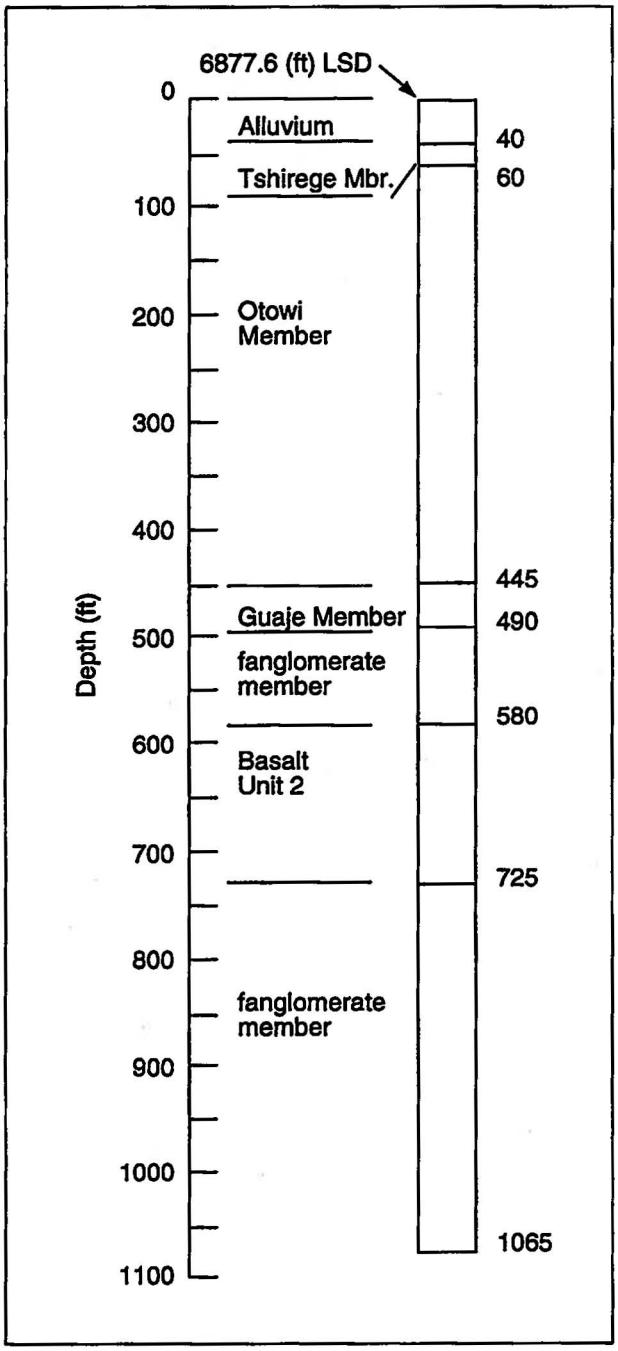


Fig. XVII-I. Geologic log of test well TW-8, completed December 1960, water level 968 ft (Baltz et al. 1963).

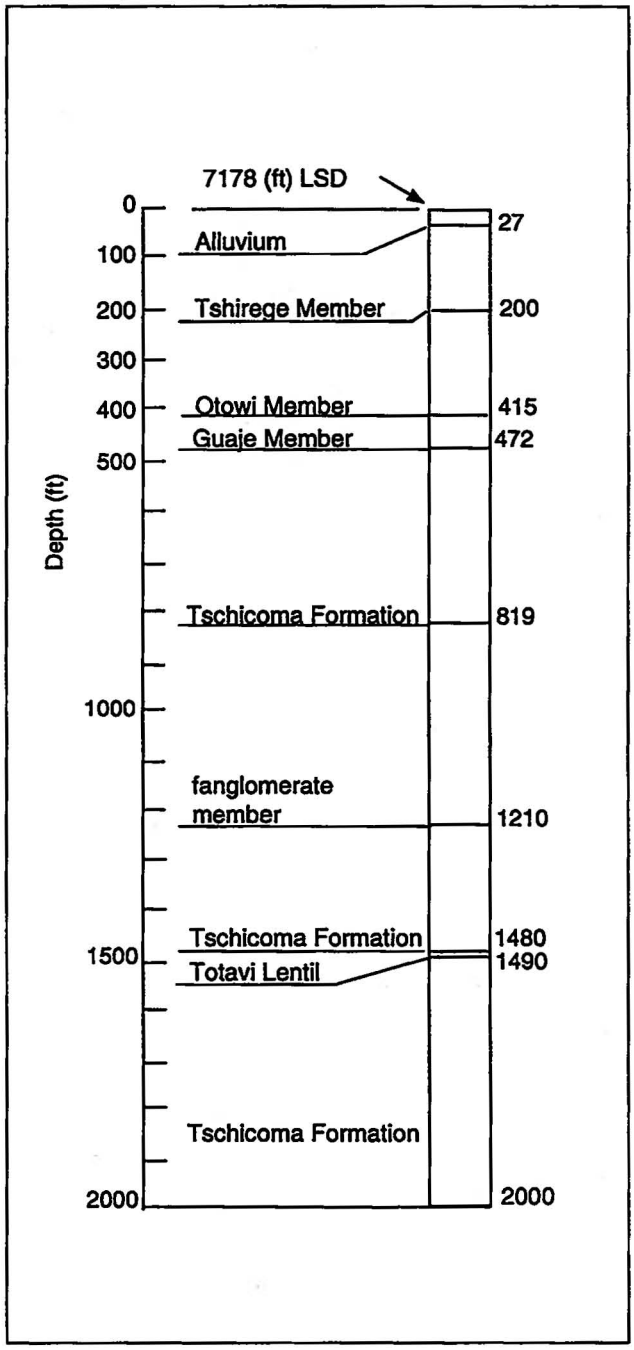


Fig. XVII-J. Geologic log of test hole H-19, completed September 1949, water level 950 ft (Griggs 1955).

TABLE XVII-B. Geologic Logs and Construction Data for Test Wells and Test Holes on the Pajarito Plateau (15 Test Wells and Test Holes) (Continued)

10. Test Hole TH-7

Elevation (LSD): 6224 ft

Water Level: Dry (1950)

Geologic Log	Thickness (ft)	Depth (ft)
Alluvium	10	10
Bandelier Tuff		
Otowi Member	35	45
Basaltic Rocks of Chino Mesa		
Unit 2	10	55

Hole plugged and abandoned.

11. Test Well TW-8

Elevation (LSD): 6877.62 ft

Water Level: 968 ft (1960)

Geologic Log	Thickness (ft)	Depth (ft)
Alluvium	40	40
Bandelier Tuff		
Tshirege Member	20	60
Otowi Member	385	445
Guaje Member	45	490
Puye Conglomerate		
Fanglomerate member	90	580
Basalt Unit 2	145	725
Fanglomerate member	340	1065

Casing Schedule

44 ft of 20-in. corrugated metal pipe from 0 to 44 ft; 64 ft of 14-in.-outside-diam steel casing 0 to 64 ft cemented in; 1065 ft of 8-in.-inside-diam steel casing from 0 to 1065 ft with the lower 112 ft slotted.

Geophysical Log

Gamma-ray (11-29-61), files available from the ESH-18 Geohydrology section.

12. Test Hole H-19

Elevation (LSD): 7178 ft

Water Level: 950 ft (1950)

Geologic Log	Thickness (ft)	Depth (ft)
Alluvium	27	27
Bandelier Tuff		
Tshirege Member	173	200
Otowi Member	215	415
Guaje Member	57	472
Tschicoma Formation	347	819
Puye Conglomerate		
Fanglomerate member	391	1210
Tschicoma Formation	270	1480
Puye Conglomerate		
Totavi Lentil	10	1490
Tschicoma Formation	510	2000

TABLE XVII-B. Geologic Logs and Construction Data for Test Wells and Test Holes on the Pajarito Plateau (15 Test Wells and Test Holes) (Continued)

12. Test Hole H-19 (Continued)

Casing Schedule

10 ft of 12-in.-diam surface casing set 0 to 10 ft. Exploratory hole drilled by cable tool, casing pulled at end of tests in 1949. Hole open to 265 ft (5-7-60); to 69 ft (7-20-92).

Geophysical Log

Gamma-ray (5-7-60), files available from the ESH-18 Geohydrology section.

13A. Test Hole Sigma Mesa EGH-LA-1 (1979)

Elevation (LSD): 7215 ft LSD

Geologic Log[a]	Thickness (ft)	Depth (ft)
Tshirege Member Bandelier Tuff	270	270
Ash flow of Otowi Member Bandelier Tuff	430	700
Guaje Pumice Bed	35	735
Puye Conglomerate with interbedded basalt	110	845
Aphyric Tschicoma Flow	80	925
Hornblende-bearing Tschicoma Flow	45	970
Fanglomerate member of Puye Conglomerate	365	1335
Totavi Lentil of the Puye Formation	65	1400
Chamita Formation of the Santa Fe Group	500	1900
Tschicoma Flow	35	1935
Chamita Formation of the Santa Fe Group	60	1995
Tschicoma Flow	297	2292

13B. Test Hole Sigma Mesa EGH-LA-1 (1992)

Elevation (LSD): 7215 ft LSD — Water Level: 1330 ft (1979, geophysical log)

Geologic Log[b]	Thickness (ft)	Depth (ft)
Bandelier Tuff		
Tshirege Member	345	345
Otowi Member	350	695
Guaje Member	30	725
Puye Conglomerate		
Fanglomerate member	185	910
Basalt Unit 2	140	1050
Fanglomerate member	255	1305
Totavi Lentil	25	1330
Santa Fe Group		
Chaquehui Formation	250	1580
Basalt and basalt breccias	135	1715
Chaquehui Formation	180	1895
Basalt and basalt breccias	397	2292

[a] Logged by Carolyn Potzich.

[b] Revised log by W. D. Purtymun from geophysical logs, comparision with logs of nearby supply and test wells, and R. F. Smith Corp. Geothermal Data Log.

APPENDIX E

Layne Western Well

References for Appendix E Information

Well	MAP	GEOLOGIC LOG	CONSTRUCTION DIAGRAM
Layne Western Well	1	1	not found

1. Purtymun, W.D., 1995, Geologic and Hydrologic Records of Observation Wells, Test Holes, Test Wells, Supply Wells, Springs, and Surface Water Stations in the Los Alamos Area, Los Alamos National Laboratory Report LA-12883-MS, Los Alamos National Laboratory, Los Alamos, New Mexico, January 1995.

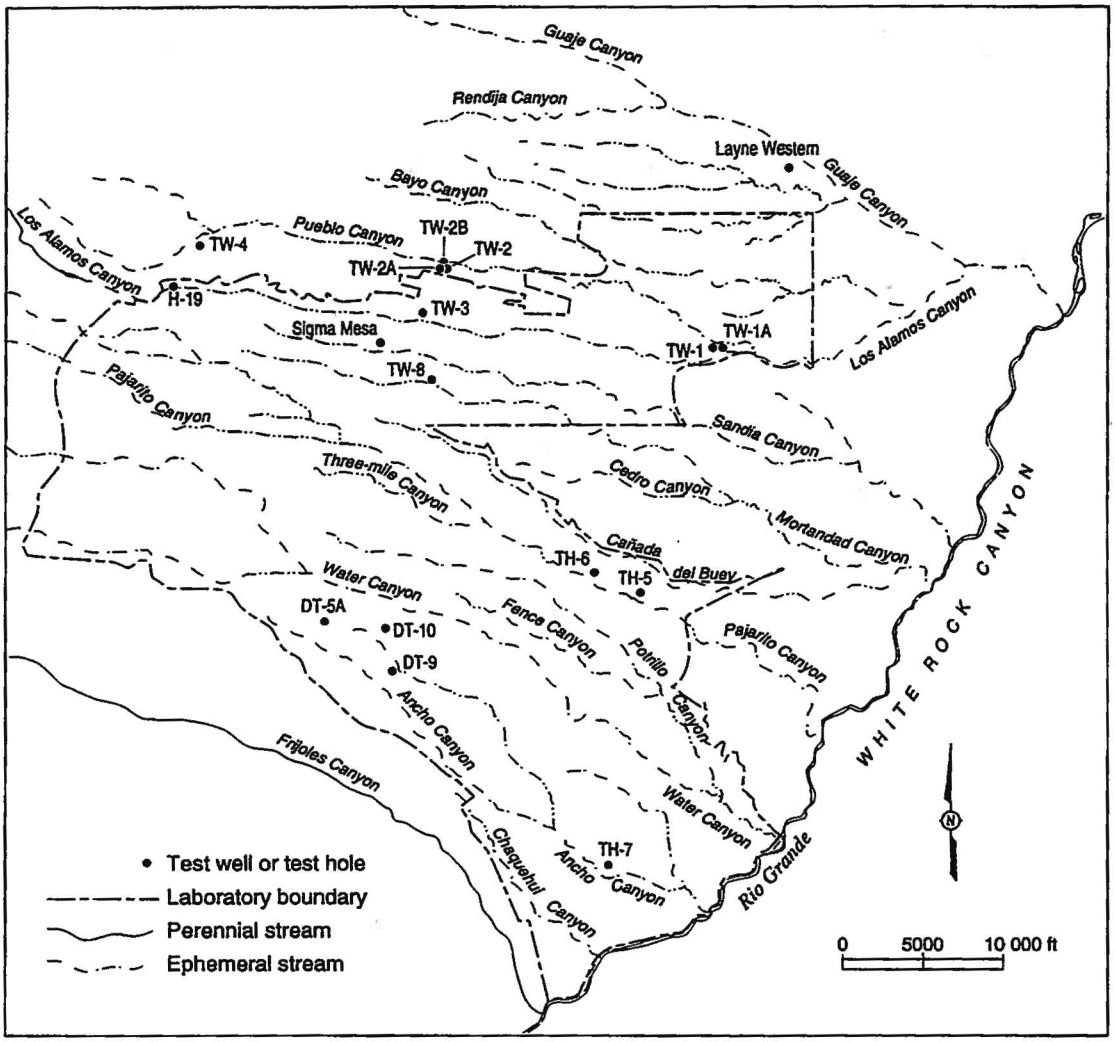


Fig. XVII-A. Test wells and test holes on the Pajarito Plateau.

REFERENCES

E. H. Baltz, J. H. Abrahams, and W. D. Purtymun, "Preliminary Report on the Geology and Hydrology of Mortandad Canyon, Los Alamos, New Mexico, with Special Reference to Disposal of Liquid Low-Level Radioactive Wastes," U.S. Geological Survey Open-File Report (1963).

Black and Veatch (Consulting Engineers), "Ground-Water Observation Wells, Los Alamos, New Mexico," Administrative Report prepared for the U.S. Atomic Energy Commission (1950).

R. L. Griggs, "Geology and Ground-Water Resources of the Los Alamos Area, New Mexico," U.S. Geol. Survey Admin. Report to the U.S. Atomic Energy Commission (1955).

TABLE XVII-B. Geologic Logs and Construction Data for Test Wells and Test Holes on the Pajarito Plateau (15 Test Wells and Test Holes) (Continued)

13B. Test Hole Sigma Mesa EGH-LA-1 (1992) (Continued)

Casing Schedule
Hole size: 36-in. diam to 85 ft, 26-in. diam to 2292 ft; casing size 30-in. diam to 85 ft, 20-in. diam to 1627 ft. Hole plugged with cement at about 1425 ft; unknown length of drill stem, drill collars, and bit lost in the bottom of the hole. The hole had a bad history of lost circulation throughout the entire depth drilled; large volumes of water, drilling mud, lost circulation materials, and cement were pumped into the hole. The hole was abandoned in December 1979.

Geophysical Logs
Temperature, compensated neutron-formation density; dual induction–SFL with linear correlation log; and R.F. Smith Corp. Geothermal Data Log (files available from the ESH-18 Geohydrology section).

14. Layne Western

Elevation (LSD): 5971 ft — Water Level: 100 ft (1950)

Geologic Log	Thickness (ft)	Depth (ft)
Alluvium	12	12
Puye Conglomerate		
Fanglomerate member	13	25
Totavi Lentil	50	75
Tesuque Formation		
Siltstone and sandstone	82	157

Casing Schedule
147 ft of 8-in.-diam casing set from 0 to 147 ft, screen from 127 to 147 ft.

15. Ski Basin Well

Elevation (LSD): 9310 ft — Water Level: 245 ft (June 1985)

Geologic Log	Thickness (ft)	Depth (ft)
Tough sandstone (probably Tshirege Member Bandelier Tuff, welded unit)	35	35
Lost circulation: same formation throughout, probably Tschicoma Formation latite and rhyolite flow, water perched on interflow breccia of pebbly cobbles in a matrix of silt and clay	365	400

Casing Schedule
392 ft of 4 1/2-in. plastic casing with perforations from 332 to 352 ft and 372 to 392 ft. Data from drillers' log.

APPENDIX F

Sigma Mesa Well EGH-LA-1

References for Appendix F Information

Well	MAP	GEOLOGIC LOG	CONSTRUCTION DIAGRAM
Sigma Mesa Well EGH-LA-1	1	1	not found

1. Purtymun, W.D., 1995, Geologic and Hydrologic Records of Observation Wells, Test Holes, Test Wells, Supply Wells, Springs, and Surface Water Stations in the Los Alamos Area, Los Alamos National Laboratory Report LA-12883-MS, Los Alamos National Laboratory, Los Alamos, New Mexico, January 1995.

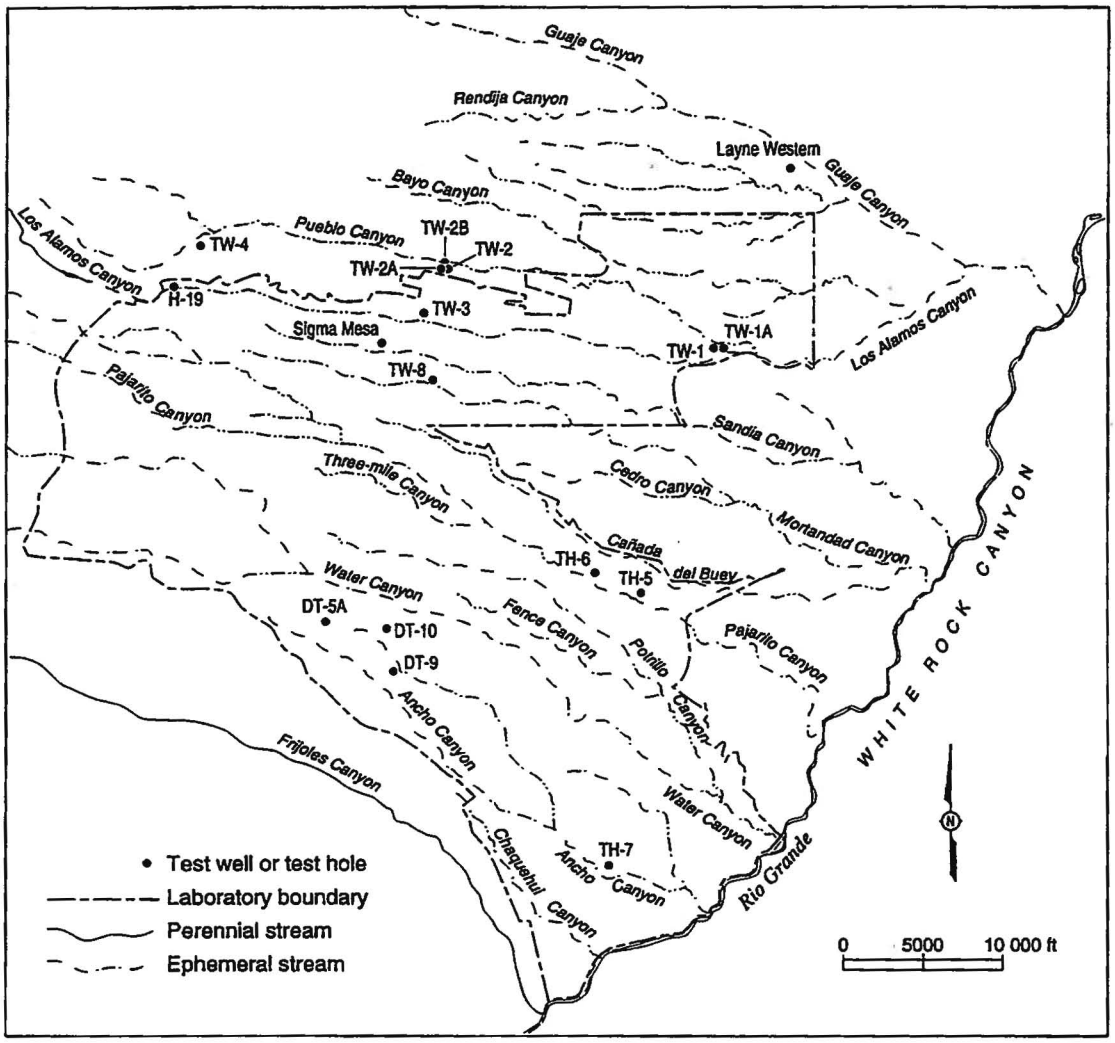


Fig. XVII-A. Test wells and test holes on the Pajarito Plateau.

REFERENCES

E. H. Baltz, J. H. Abrahams, and W. D. Purtymun, "Preliminary Report on the Geology and Hydrology of Mortandad Canyon, Los Alamos, New Mexico, with Special Reference to Disposal of Liquid Low-Level Radioactive Wastes," U.S. Geological Survey Open-File Report (1963).

Black and Veatch (Consulting Engineers), "Ground-Water Observation Wells, Los Alamos, New Mexico," Administrative Report prepared for the U.S. Atomic Energy Commission (1950).

R. L. Griggs, "Geology and Ground-Water Resources of the Los Alamos Area, New Mexico," U.S. Geol. Survey Admin. Report to the U.S. Atomic Energy Commission (1955).

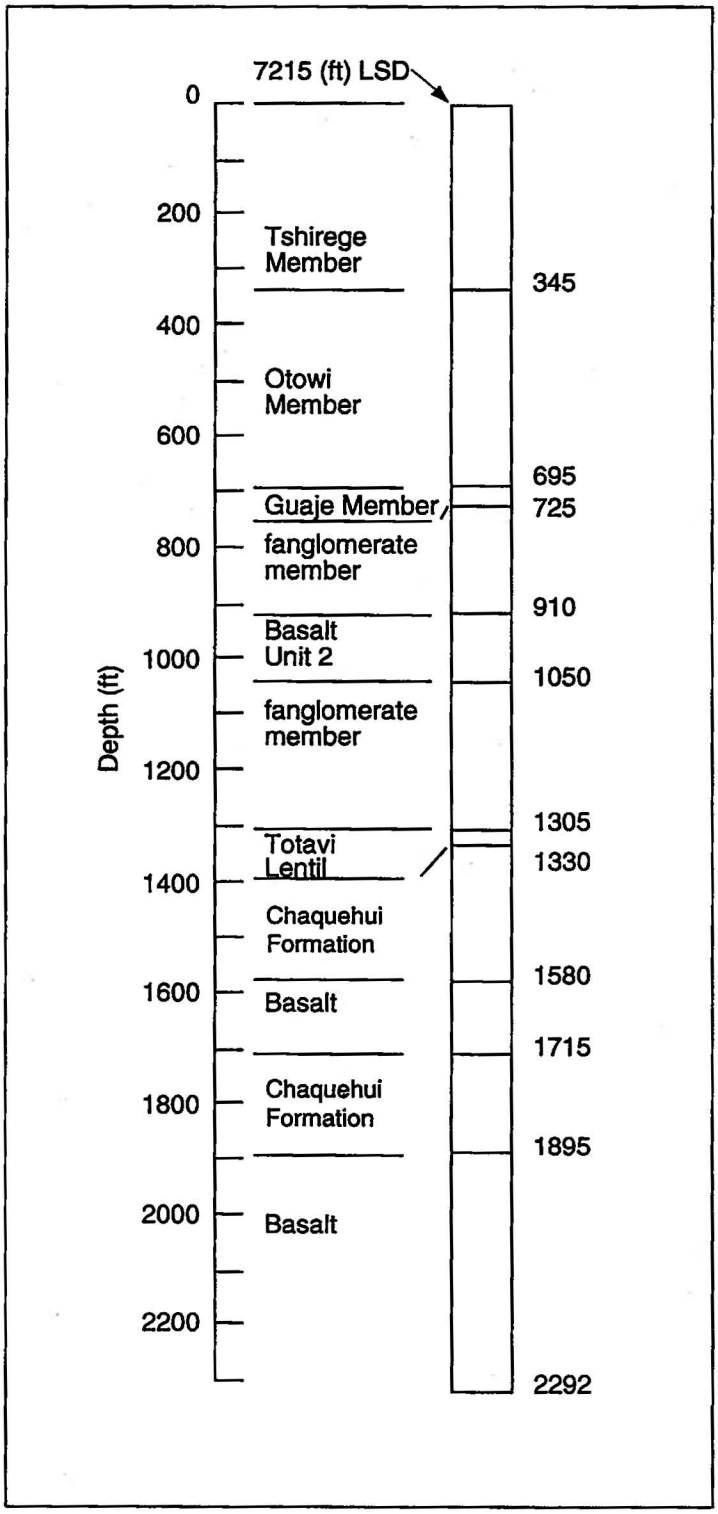


Fig. XVII-K. Geologic log of test hole Sigma Mesa, drilled July–November 1979, water level about 1330 ft (data from unpublished log by Carolyn Potzich modified by Purtymun; see text and Table XVII-B).

TABLE XVII-B. Geologic Logs and Construction Data for Test Wells and Test Holes on the Pajarito Plateau (15 Test Wells and Test Holes) (Continued)

12. Test Hole H-19 (Continued)

Casing Schedule

10 ft of 12-in.-diam surface casing set 0 to 10 ft. Exploratory hole drilled by cable tool, casing pulled at end of tests in 1949. Hole open to 265 ft (5-7-60); to 69 ft (7-20-92).

Geophysical Log

Gamma-ray (5-7-60), files available from the ESH-18 Geohydrology section.

13A. Test Hole Sigma Mesa EGH-LA-1 (1979)

Elevation (LSD): 7215 ft LSD

Geologic Log[a]	Thickness (ft)	Depth (ft)
Tshirege Member Bandelier Tuff	270	270
Ash flow of Otowi Member Bandelier Tuff	430	700
Guaje Pumice Bed	35	735
Puye Conglomerate with interbedded basalt	110	845
Aphyric Tschicoma Flow	80	925
Hornblende-bearing Tschicoma Flow	45	970
Fanglomerate member of Puye Conglomerate	365	1335
Totavi Lentil of the Puye Formation	65	1400
Chamita Formation of the Santa Fe Group	500	1900
Tschicoma Flow	35	1935
Chamita Formation of the Santa Fe Group	60	1995
Tschicoma Flow	297	2292

13B. Test Hole Sigma Mesa EGH-LA-1 (1992)

Elevation (LSD): 7215 ft LSD — Water Level: 1330 ft (1979, geophysical log)

Geologic Log[b]	Thickness (ft)	Depth (ft)
Bandelier Tuff		
Tshirege Member	345	345
Otowi Member	350	695
Guaje Member	30	725
Puye Conglomerate		
Fanglomerate member	185	910
Basalt Unit 2	140	1050
Fanglomerate member	255	1305
Totavi Lentil	25	1330
Santa Fe Group		
Chaquehui Formation	250	1580
Basalt and basalt breccias	135	1715
Chaquehui Formation	180	1895
Basalt and basalt breccias	397	2292

[a] Logged by Carolyn Potzich.

[b] Revised log by W. D. Purtymun from geophysical logs, comparision with logs of nearby supply and test wells, and R. F. Smith Corp. Geothermal Data Log.

TABLE XVII-B. Geologic Logs and Construction Data for Test Wells and Test Holes on the Pajarito Plateau (15 Test Wells and Test Holes) (Continued)

13B. Test Hole Sigma Mesa EGH-LA-1 (1992) (Continued)

Casing Schedule

Hole size: 36-in. diam to 85 ft, 26-in. diam to 2292 ft; casing size 30-in. diam to 85 ft, 20-in. diam to 1627 ft. Hole plugged with cement at about 1425 ft; unknown length of drill stem, drill collars, and bit lost in the bottom of the hole. The hole had a bad history of lost circulation throughout the entire depth drilled; large volumes of water, drilling mud, lost circulation materials, and cement were pumped into the hole. The hole was abandoned in December 1979.

Geophysical Logs

Temperature, compensated neutron-formation density; dual induction–SFL with linear correlation log; and R.F. Smith Corp. Geothermal Data Log (files available from the ESH-18 Geohydrology section).

14. Layne Western

Elevation (LSD): 5971 ft

Water Level: 100 ft (1950)

Geologic Log	Thickness (ft)	Depth (ft)
Alluvium	12	12
Puye Conglomerate		
Fanglomerate member	13	25
Totavi Lentil	50	75
Tesuque Formation		
Siltstone and sandstone	82	157

Casing Schedule

147 ft of 8-in.-diam casing set from 0 to 147 ft, screen from 127 to 147 ft.

15. Ski Basin Well

Elevation (LSD): 9310 ft

Water Level: 245 ft (June 1985)

Geologic Log	Thickness (ft)	Depth (ft)
Tough sandstone (probably Tshirege Member Bandelier Tuff, welded unit)	35	35
Lost circulation: same formation throughout, probably Tschicoma Formation latite and rhyolite flow, water perched on interflow breccia of pebbly cobbles in a matrix of silt and clay	365	400

Casing Schedule

392 ft of 4 1/2-in. plastic casing with perforations from 332 to 352 ft and 372 to 392 ft. Data from drillers' log.

APPENDIX G

Boreholes SHB-1, SHB-2, SHB-3 AND SHB-4

References for Appendix G Information

Boreholes	MAP	GEOLOGIC LOG	CONSTRUCTION DIAGRAM
SHB-1, SHB-2, SHB-3, SHB-4	1, 2	2	not found

1. Purtymun, W.D., 1995, Geologic and Hydrologic Records of Observation Wells, Test Holes, Test Wells, Supply Wells, Springs, and Surface Water Stations in the Los Alamos Area, Los Alamos National Laboratory Report LA-12883-MS, Los Alamos National Laboratory, Los Alamos, New Mexico, January 1995.

2. Gardner, J.N., Kolbe, T., and Chang, S., 1993, Geology, Drilling, and Some Hydrologic Aspects of Seismic Hazard Program Boreholes, Los Alamos National Laboratory report LA-12460-MS, Los Alamos National Laboratory, New Mexico.

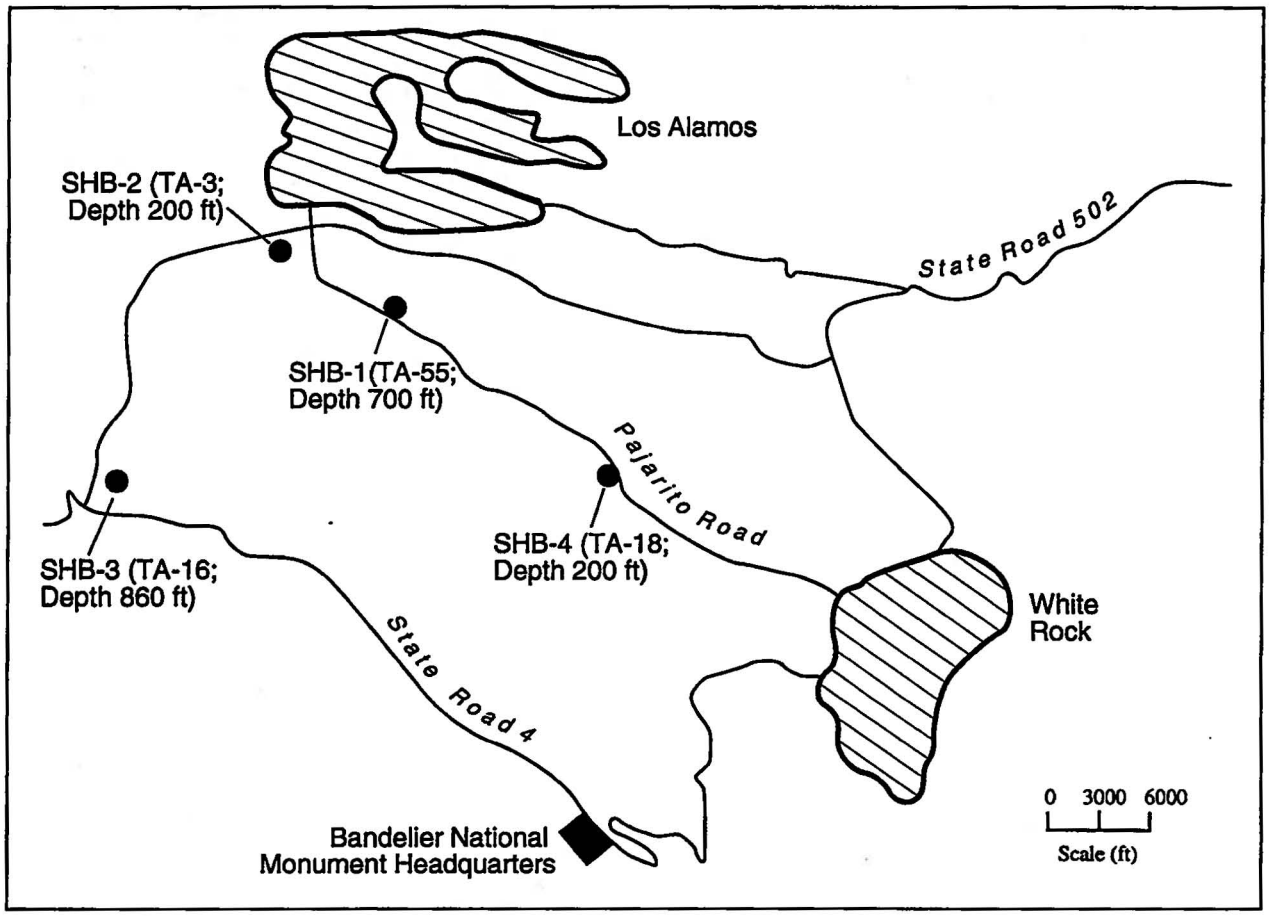


Fig. XXIII-B. Locations of test holes for seismic investigation.

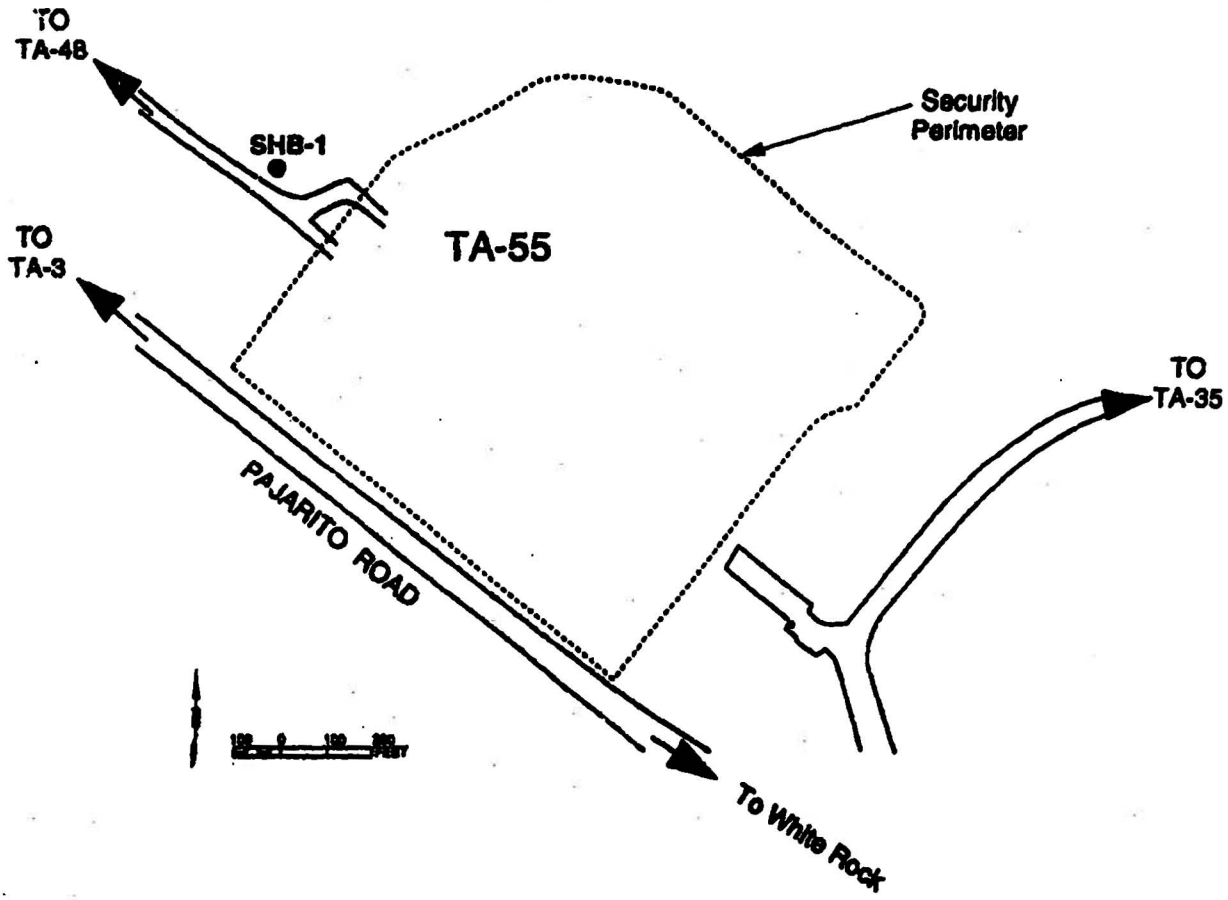


Figure 2: Map of the TA-55 area showing main roads, security perimeter, and location of core hole SHB-1.

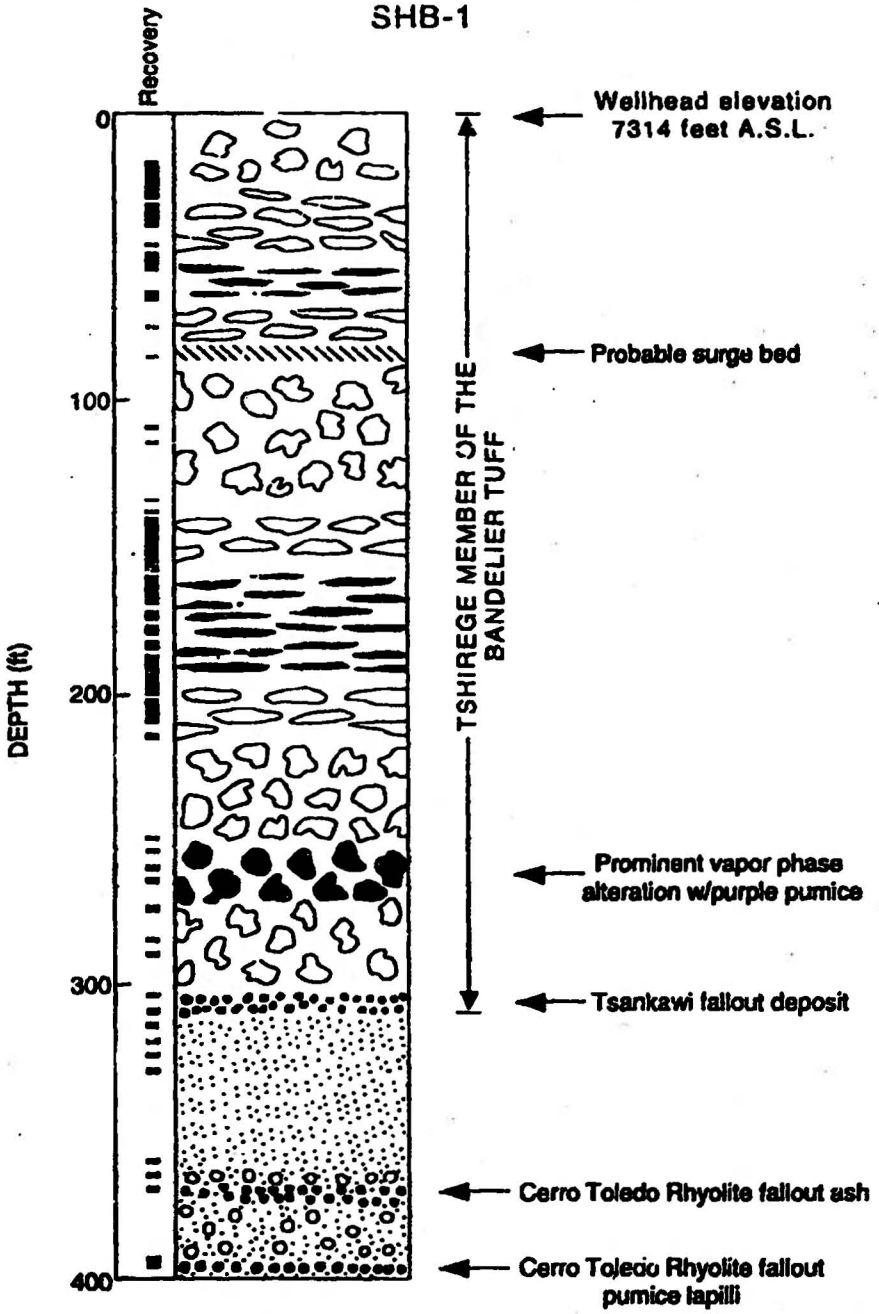


Figure 6a: Graphic lithology log for core hole SHB-1. Log is continued on next page. Black marks in recovery column indicate where core was recovered. See Table II for explanation of symbols.

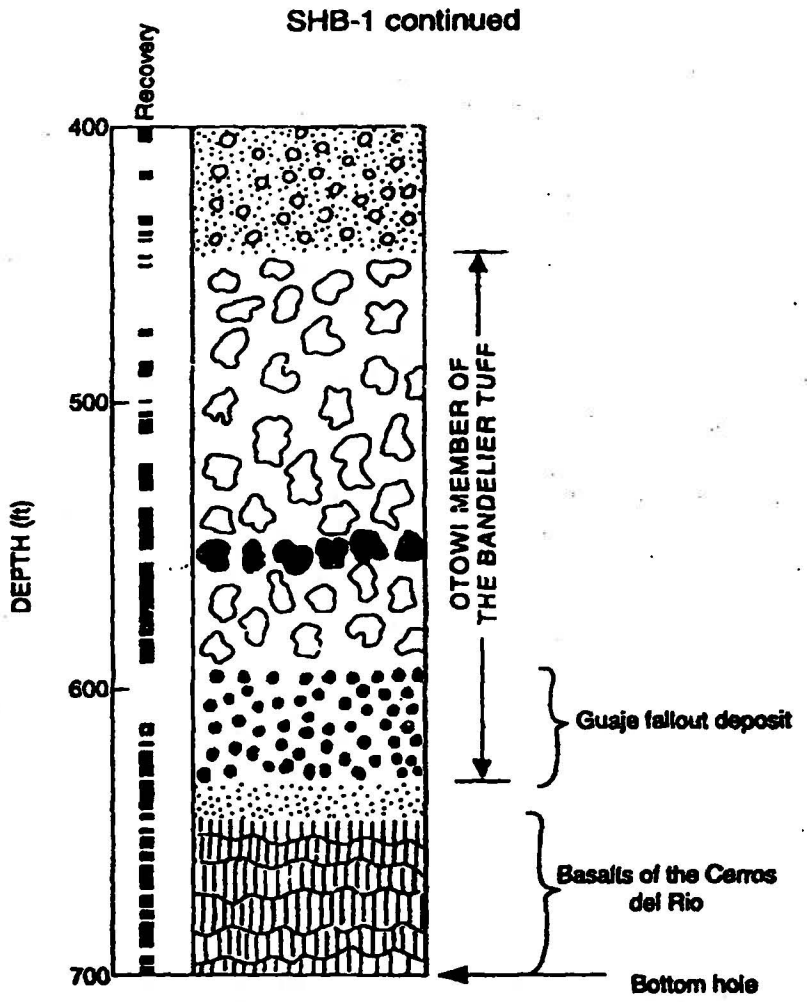


Figure 6b: Graphic lithology log for core hole SHB-1. Black marks in recovery column indicate where core was recovered. See Table II for explanation of symbols.

VI. SHB-3 (TA-16)

SHB-3 was drilled west of the new tritium facility in TA-16 (S-site) (see Figures 1 and 4) with a total drilled depth of 848 feet and an accessible depth of 860 feet (the depth discrepancy is explained below). In spite of the fact that about 70% of the section penetrated consisted of nonwelded tuff and unconsolidated sediments (Figure 8), core recovery from SHB-3 was nearly 70%, indicating both the advantages of drilling with mud and the results of lessons learned during the drilling of SHB-1.

After the hole was cored to 848 feet, the reaming operation proceeded to 790 feet with the use of a down-hole air hammer. At this point there was a breakdown on the rig and the hammer was pulled up about 40 feet to 750 feet while repairs were made. After about 45 hours from last air injection, air was resupplied to the reaming hammer to resume operations. Within a minute of the resupplying of air to the

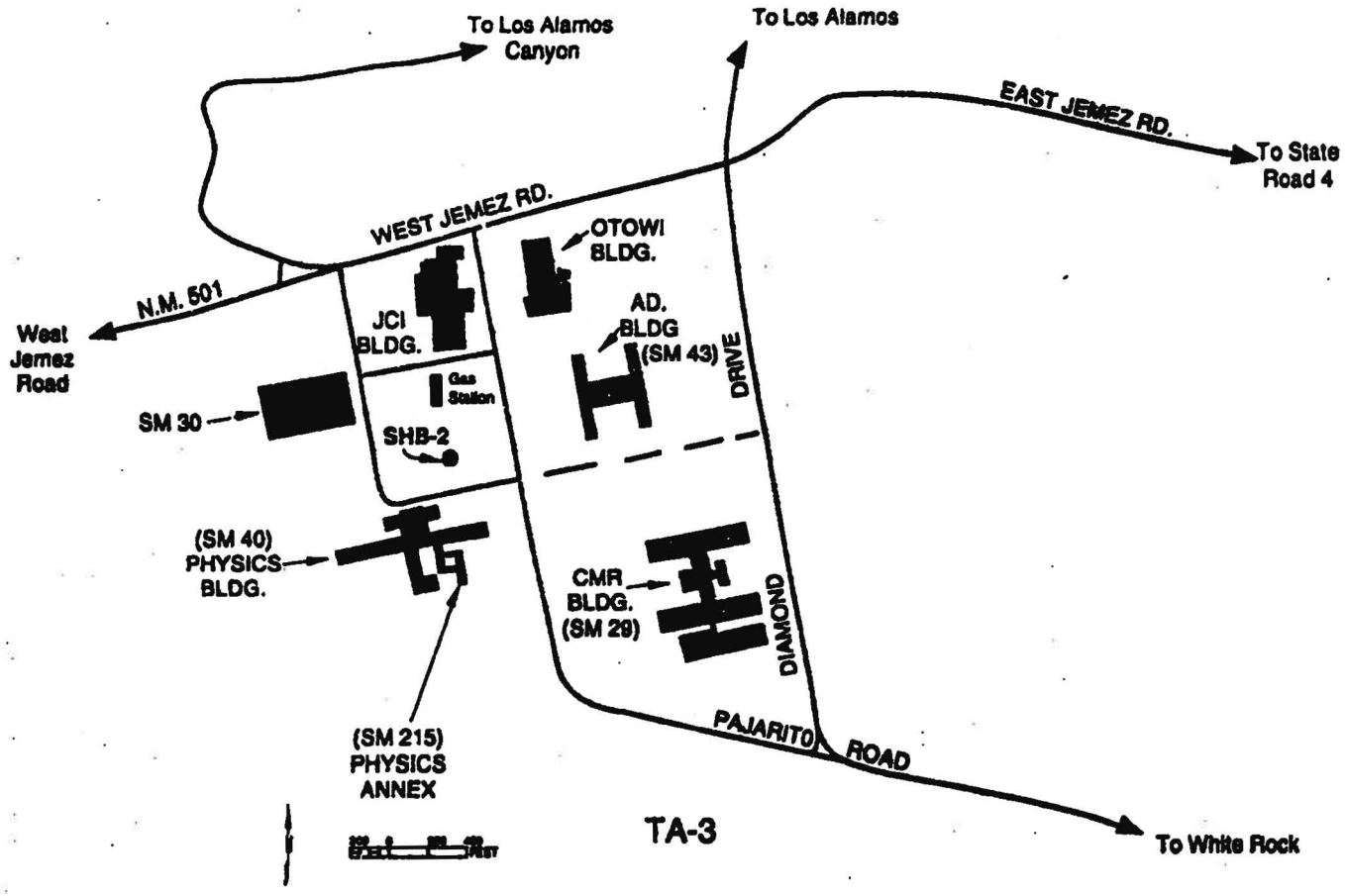


Figure 3: **Map of the TA-3 area showing main roads, selected buildings, and location of core hole SHB-2.**

hammer, SHB-3 erupted a spout of water at least 40 feet into the air (40 feet is the height of the derrick on the drill rig). The spout lasted for less than 10 seconds, and, while air was supplied to the down-hole hammer for the remainder of the reaming operation, SHB-3 continued to make water at a rate of about 10 to 15 gallons per minute. Reaming proceeded without further incident to 852 feet where air was supplied for about 10 more minutes after reaming to remove sand and other loose material from the hole. By this time, the discharging water was clear; furthermore, the discharge water never appeared to contain bentonite or other drilling mud additives. When the PVC casing was inserted into the core hole, it dropped to 860 feet. Apparently, the loose bottom hole material (see below) was extensively eroded during the flowing of the hole.

From the surface to about 335 feet, SHB-3 penetrates the Tshirege Member of the Bandelier Tuff. The Tshirege at this locality, closer to the caldera source, is over 95% welded tuff, most of which is densely welded (Figure 8). Cooling breaks are few, with one in the top 60 feet of the hole and another around 230 feet. From about 320 to about 335 feet core recovery was poor, but this interval apparently includes the nonwelded base of the ignimbrite and an unknown thickness of Tsankawi fallout pumice.

From roughly 335 to 424 feet is a sequence of unconsolidated sands and sandy gravels very similar to the sequence between the Tshirege and Otowi members encountered in SHB-1. Lithologically identical to the older Puye Formation, these epiclastic sediments represent alluvium shed off of the Sierra de los Valles dacite highlands to the west. Interbedded with this epiclastic sequence at about 385 to 388 feet is a coarse sand-sized pumice fall deposit. Some of the pumice contain obsidian fragments. It is likely that this pyroclastic interbed is related to the Rabbit Mountain tuff of the Cerro Toledo Rhyolite (Goff et al., 1990).

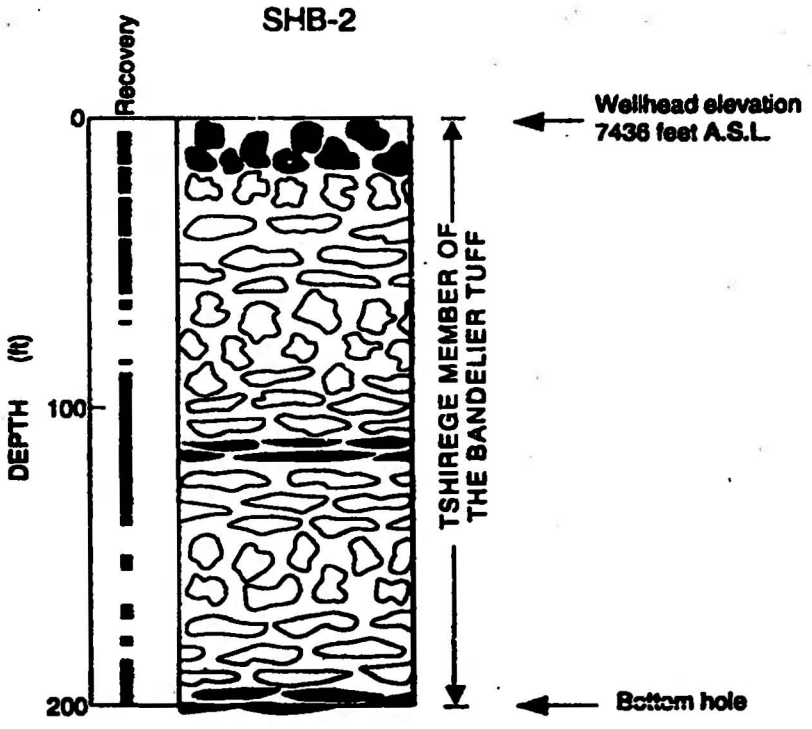


Figure 7: **Graphic lithology log for core hole SHB-2. See Table II and Figure 6 for explanation of symbols.**

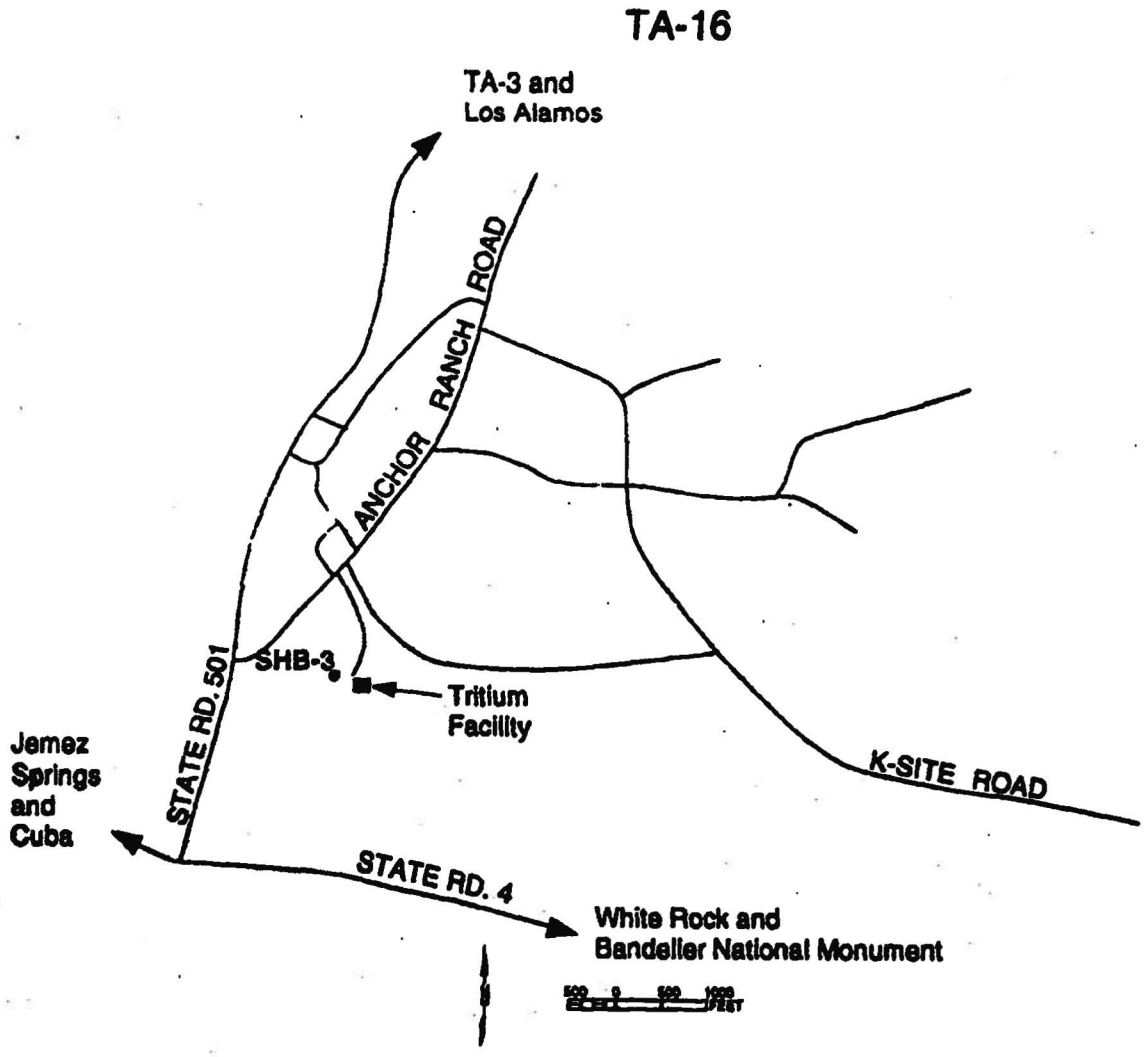


Figure 4: **Map of the TA-16 area showing main roads, the Tritium Facility, and location of core hole SHB-3.**

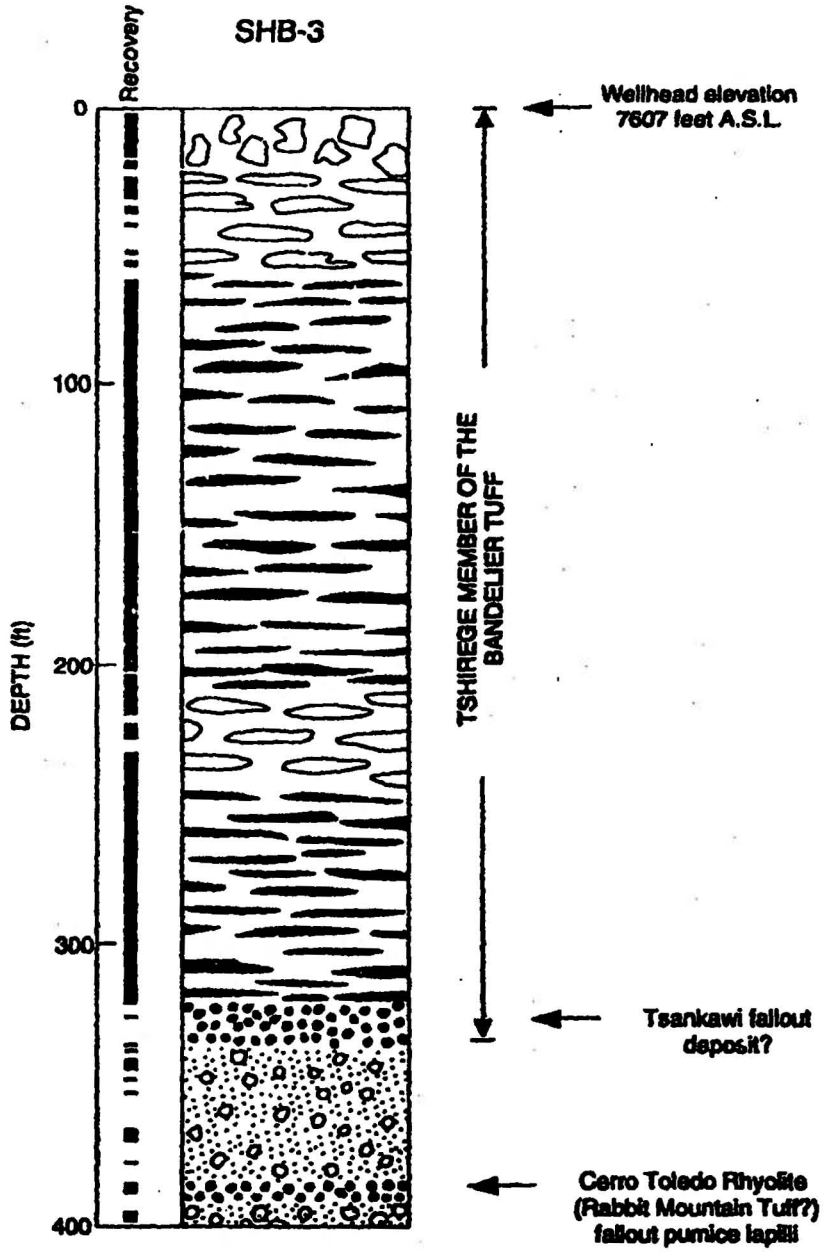


Figure 8a: Graphic lithology log for core hole SHB-3. Log is continued on next page. See Table II and Figure 6 for explanation of symbols.

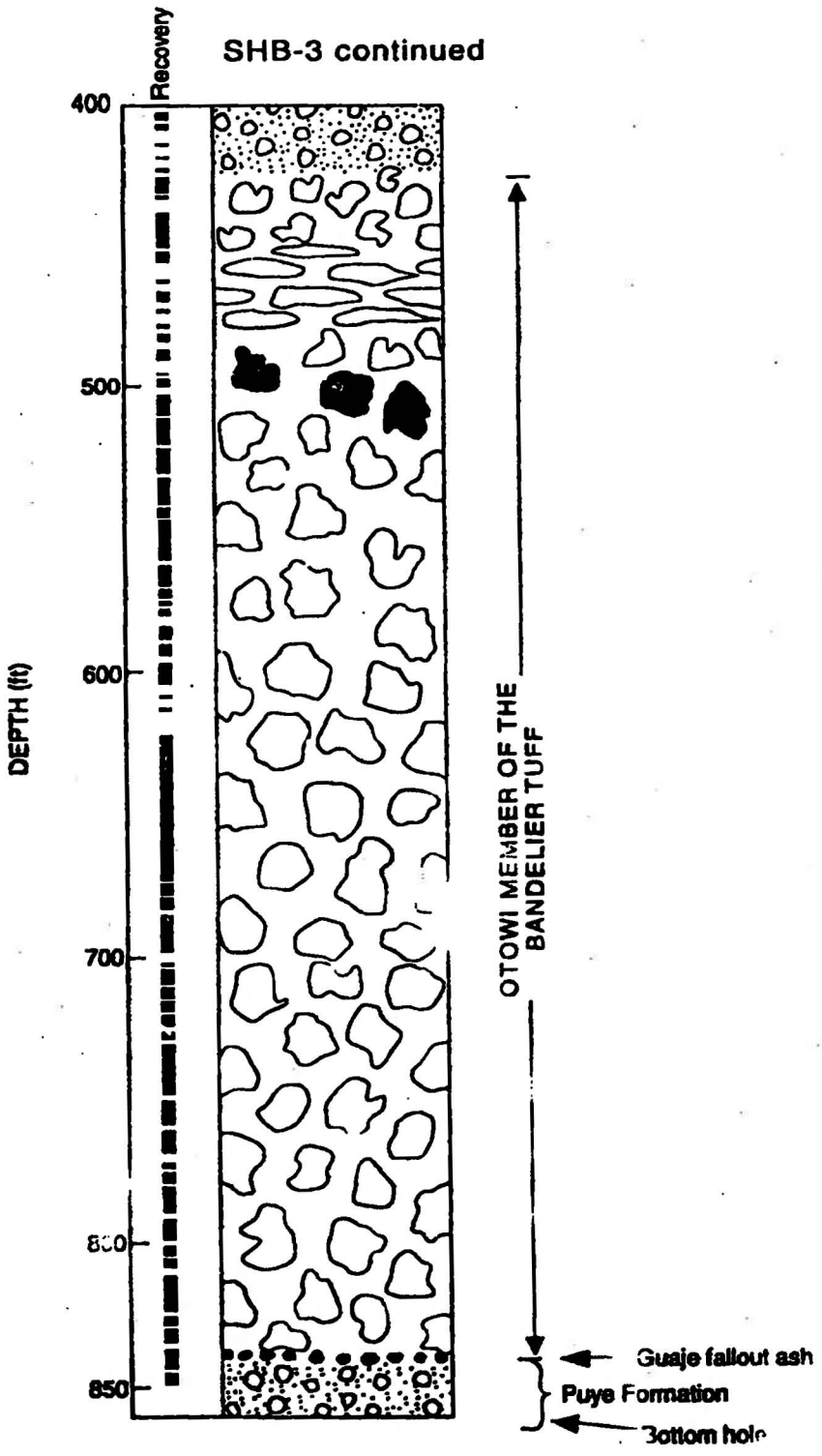


Figure 8b: **Graphic lithology log for core hole SHB-3. See Table II and Figure 6 for explanation of symbols.**

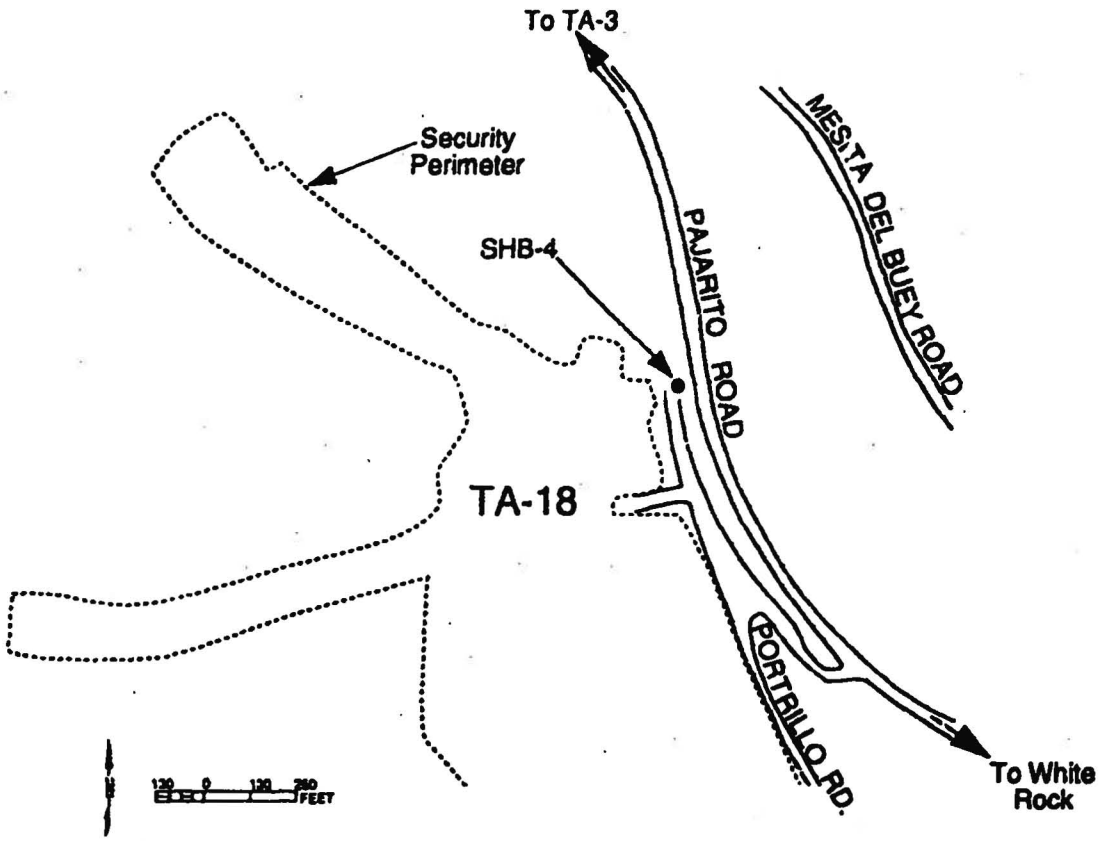


Figure 5: Map of the TA-18 area showing main roads, security perimeter, and location of core hole SHB-4.

core holes (SHB-1) penetrates basalts and related sediments of the Cerros del Rio, and another (SHB-3) penetrates sands and gravels that must, because of their lithology and stratigraphic position, be considered part of the Puye Formation.

We have avoided, in this report, use of the subdivisions of the Tshirege Member of previous workers (for example, Wier and Purtymun, 1962; Baltz et al., 1963; Crowe et al., 1978; Vaniman and Wohletz, 1990). We have done this for two main reasons: first, the units used in the aforementioned works are inconsistent; and, second, we note that the sub-units are useful only within localized areas, and without geologic mapping between these areas correlations are dubious at best. Thus, we make only the most general stratigraphic correlations, and emphasize descriptions of the rocks and deposits. Another difference in our nomenclature from that of some previous workers at the Laboratory is in our use of the term surge. Surges are a kind of pyroclastic flow that leave deposits of sorted pyroclasts which commonly exhibit bedforms typical of high energy flow regimes, such as plane beds or low-angle cross-beds. Previous workers (for example, Wier and Purtymun, 1962; Purtymun and Stoker, 1987) have called the surges of the Pajarito Plateau fluvial sandstones. However, in that the surges of the Bandelier Tuff are rather famous in the earth science community (for example, Fisher, 1979; Fisher and Schmincke, 1984), their description as sandstones should be discontinued.

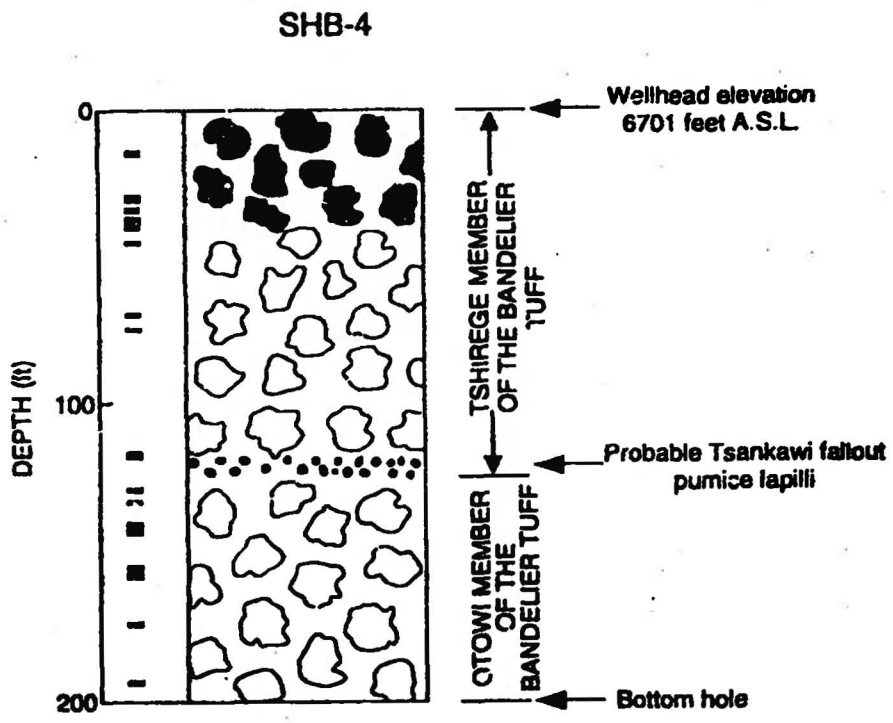


Figure 9: Graphic lithology log for core hole SHB-4. See Table II and Figure 6 for explanation of symbols.

The Otowi Member of the Bandelier Tuff extends from about 424 to 839 feet in SHB-3. It is almost entirely nonwelded tuff with a zone of slightly flattened pumices from about 450 to 480 feet.

Beneath the Otowi in SHB-3 is a sequence of sands and boulder-rich gravels that must be correlative to the Puye Formation (see Discussion, below). The cobbles and clasts of these epiclastic, alluvial deposits are dominantly dacite lithologies that can be found exposed in the Tschicoma Formation in the Sierra de los Valles immediately west of the drill site. As with the similar epiclastic deposits encountered between the Otowi and Tshirege members higher in SHB-3 and in SHB-1, the alternating unconsolidated sands and hard dacite boulders caused very difficult drilling conditions.

VII. SHB-4 (TA-18)

SHB-4 was drilled exclusively with air, north and east of entrance road to TA-18 in Pajarito canyon (see Figures 1 and 5), to a total depth of 200 feet. Core recovery was only about 12.5%, so our interpretations of stratigraphy must be considered to be constrained speculation (see Figure 9).

The top 40 feet of SHB-4 appears to penetrate nonwelded, vapor phase altered ignimbrite of the Tshirege Member. Spotty recovery from 40 to about 117 feet suggests this interval consists of nonwelded ignimbrite. At about 117 feet, the samples recovered were discrete pebble-sized pumices, which may represent a fallout deposit equivalent to the Tsankawi pumice. From about 120 to 200 feet, the remainder of SHB-4 appears to have penetrated nonwelded ignimbrite of the Otowi Member.

Cuttings and core samples from 32 to at least 125 feet came out of SHB-4 damp and moist. The core tube and rock samples from about 125 feet and 145 feet came out of the hole wet. From about 55 feet to total depth SHB-4 would steadily discharge air while drilling was stopped.

APPENDIX H

USGS Test Hole near MDA C

References for Appendix H Information

Borehole	MAP	GEOLOGIC LOG	CONSTRUCTION DIAGRAM
USGS Test Hole near MDA-C	1	1	not found

1. Purtymun, W.D., 1995, Geologic and Hydrologic Records of Observation Wells, Test Holes, Test Wells, Supply Wells, Springs, and Surface Water Stations in the Los Alamos Area, Los Alamos National Laboratory Report LA-12883-MS, Los Alamos National Laboratory, Los Alamos, New Mexico, January 1995.

XV. U.S. GEOLOGICAL SURVEY TEST HOLE NEAR TA-52

The U.S. Geological Survey cored an experimental hole to test the use of wireline-rotary air-coring techniques in the Bandelier Tuff. A modified standard wireline core-barrel system was used. The hole was located just east of Waste Disposal Area C (Fig. XV-A). The modified equipment was used to collect uncontaminated cores of unconsolidated ash and indurated tuff to a depth of 210 ft. Core recovery was 92%. The hole was completed to study the characteristics of the vadose zone (Table XV-A).

REFERENCE

W. E. Teasdale and R. E. Pemberton, "Wireline-Rotary Air Coring of the Bandelier Tuff, Los Alamos, New Mexico," U.S. Geol. Survey Water Resources Investigation Report 84-4176 (1984).

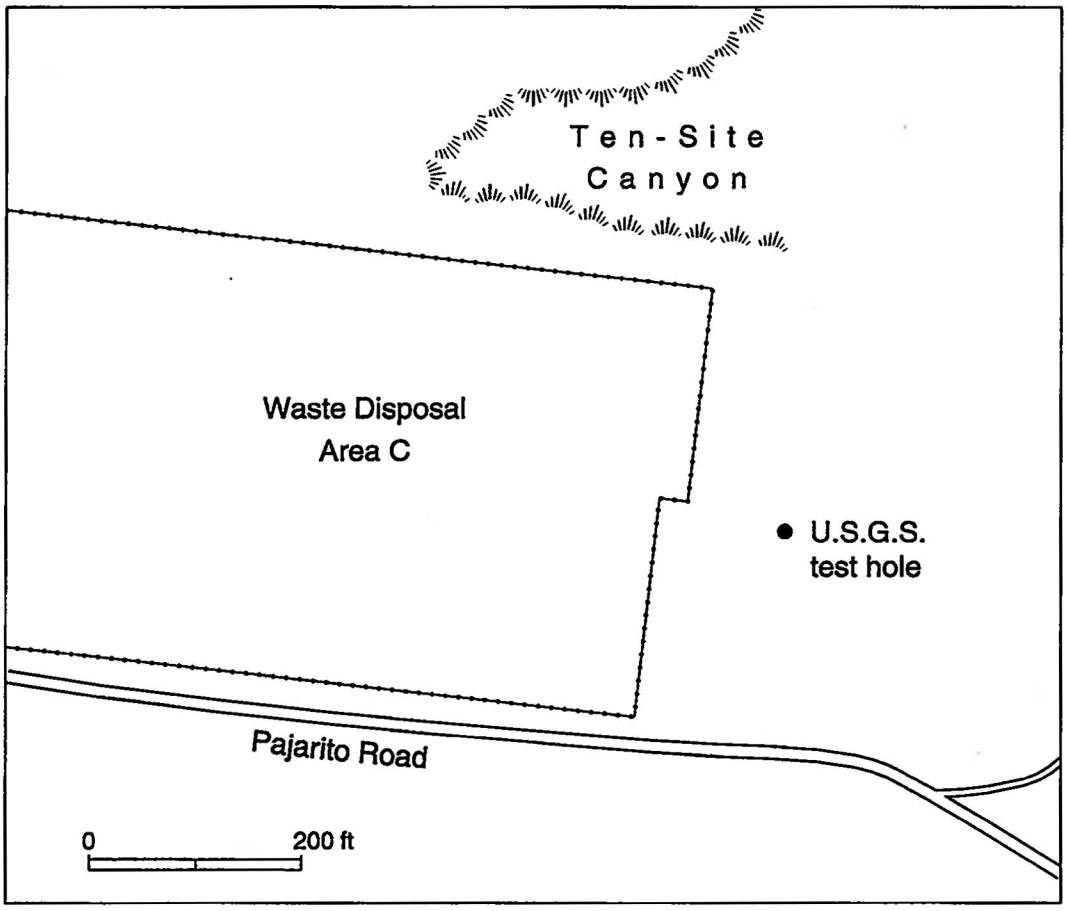


Fig. XV-A. Location of U.S. Geological Survey test hole east of Waste Disposal Area C.

TABLE XV-A. Geologic Log and Construction Data for U.S. Geological Survey Test Hole near Waste Disposal Area C

Elevation (LSD) 7220 ft

Drilled: September 1983

Water Level: Dry

Geologic Log	Thickness (ft)	Depth (ft)
Bandelier Tuff		
Tshirege Member		
Unit 3, light gray moderately welded tuff	110	110
Unit 2, dark gray welded tuff	100	210

Construction

Completed as a vadose monitoring test hole.

Screen 1 190 to 195 ft
Screen 2 140 to 145 ft
Screen 3 105 to 110 ft
Screen 4 78 to 83 ft
Screen 5 50 to 55 ft.
Screen 6 25 to 30 ft

Instruments were set in screen sections, each section of screen sealed off with a mixture of grout (cement) and dry cuttings. Surface to 22 ft sealed with cement. Heat dissipation probe set in cuttings 118 to 122 ft. Electrical leads extend from instruments in screen section to land surface.

Geophysical Logs

Bulk density, neutron, gamma-ray, and caliper. Files available from the ESH-18 Geohydrology section.

TABLE XV-B. Locations and Elevations (NAD 1927)

U.S.G.S.TH	N 1,768,500	E 486,500	7220 ft

APPENDIX I

Wells and Boreholes at TA-49

References for Appendix I Information

Well Or Borehole at TA-49 (>10 ft deep)	MAP	GEOLOGIC LOG	CONSTRUCTION DIAGRAM	OTHER
Moisture Access Holes	5	not found	not found	na
Shafts-Areas 1, 2, 2A, 2B, 3, 4	2	See logs for coreholes drilled in each area (CHs 1-4)	not found	na
Area 11 - 13 shafts	2	not found	not found	na
Bottle House shaft	7	not found	not found	na
Alpha Hole	5	3	P&A'd	Borehole abandonment description - 1
Beta Hole	5	3	not found	na
Gamma Hole	5	3	P&A'd	Borehole abandonment description - 1
DT-5	5	5	P&A'd	na
DT-5P	5	3	P&A'd	na
DT-5A	5	3	3	na
DT-9	5	3	3	na
DT-10	5	3	3	na
CH-1, CH-2, CH-3, CH-4	5	3	not found	na
TH-1, TH-2, TH-3, TH-5	5	5	not found	Neutron logs for THs 1-5 – 4; Moisture logs for all Test Holes - 4
2A-O, 2A-Y, 2B-Y	2	See CH-2 log	not found	na
TBM-1, TBM-2	5	5	5	Construction diagrams - 5
49-02901	7	6	not found	na
49-02906	2	not found	P&A'd	na
49-02907	2	not found	P&A'd	na
49-10046	3	not found	not found	na
49-10047	3	not found	not found	na
49-10048	3	not found	not found	na

1. Los Alamos National Laboratory, 2005, Annual Moisture Monitoring Report for Material Disposal Area AB at Technical Area 49, Los Alamos National Laboratory report LA-UR-05-8256, Los Alamos National Laboratory, Los Alamos, New Mexico, 2005.

2. Los Alamos National Laboratory, 2007, Historical Investigation Report for Sites at Technical Area 49 Inside the Nuclear Environmental Site Boundary, Los Alamos National Laboratory report LA-UR-07-6078, Los Alamos National Laboratory, Los Alamos, New Mexico, October 2007.

3. Los Alamos National Laboratory, 2008, Investigation Work Plan for Sites at Technical Area 49 Outside the Nuclear Environmental Site Boundary, Revision 1, Los Alamos National Laboratory report LA-UR-08-0449, Los Alamos National Laboratory, Los Alamos, New Mexico, January 2008.

4. Purtymun, W.D., 1994, Source Document Compilation: Los Alamos Investigations Related to the Environment, Engineering, Geology, and Hydrology, 1961- - 1990. Los Alamos National Laboratory Report LA-12733-MS, Los Alamos National Laboratory, Los Alamos, New Mexico, January 1994.

5. Purtymun, W.D., 1995, Geologic and Hydrologic Records of Observation Wells, Test Holes, Test Wells, Supply Wells, Springs, and Surface Water Stations in the Los Alamos Area, Los Alamos National Laboratory Report LA-12883-MS, Los Alamos National Laboratory, Los Alamos, New Mexico, January 1995.

6. Stimac, J.A., D.E. Broxton, E.C. Kluk, and S.J. Chipera, 2002, Stratigraphy of the tuffs from Borehole 49-2-700-1 at Technical Area 49, Los Alamos National Laboratory, New Mexico, Los Alamos National Laboratory report LA-13969-MS, Los Alamos National Laboratory, Los Alamos, New Mexico, July 2002.

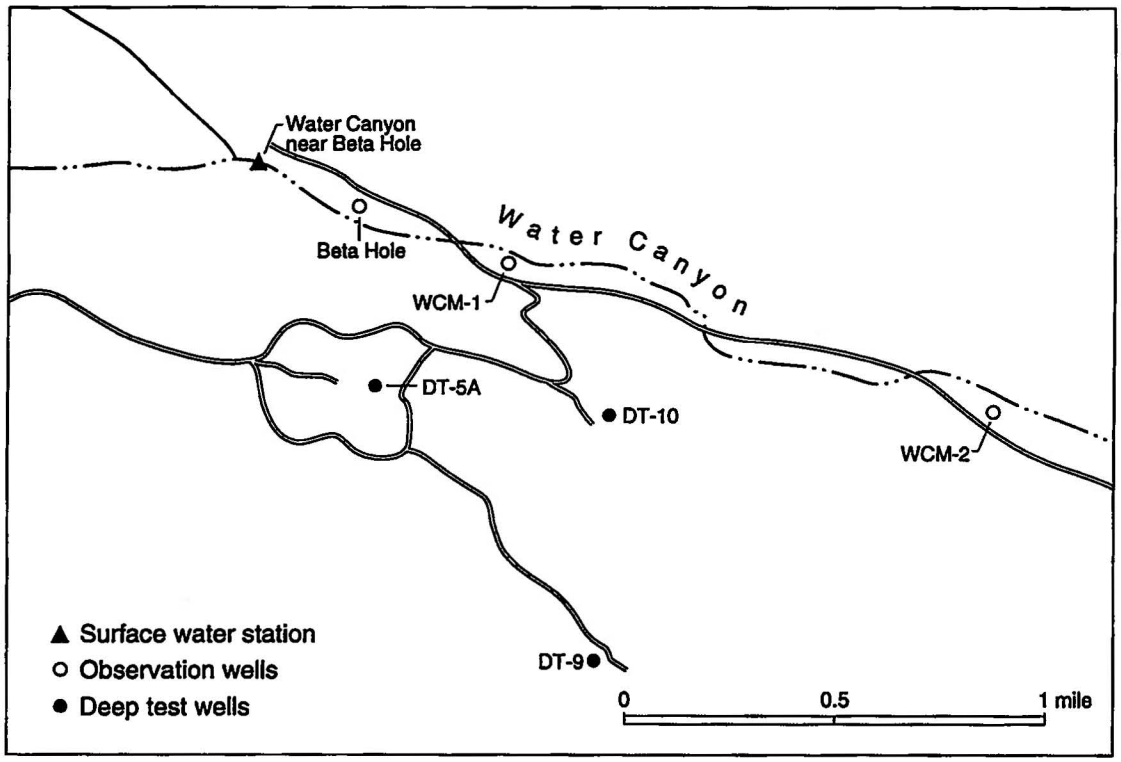


Fig. IX-U. Locations of wells, holes, and a surface water sampling station in Water Canyon north of TA-49.

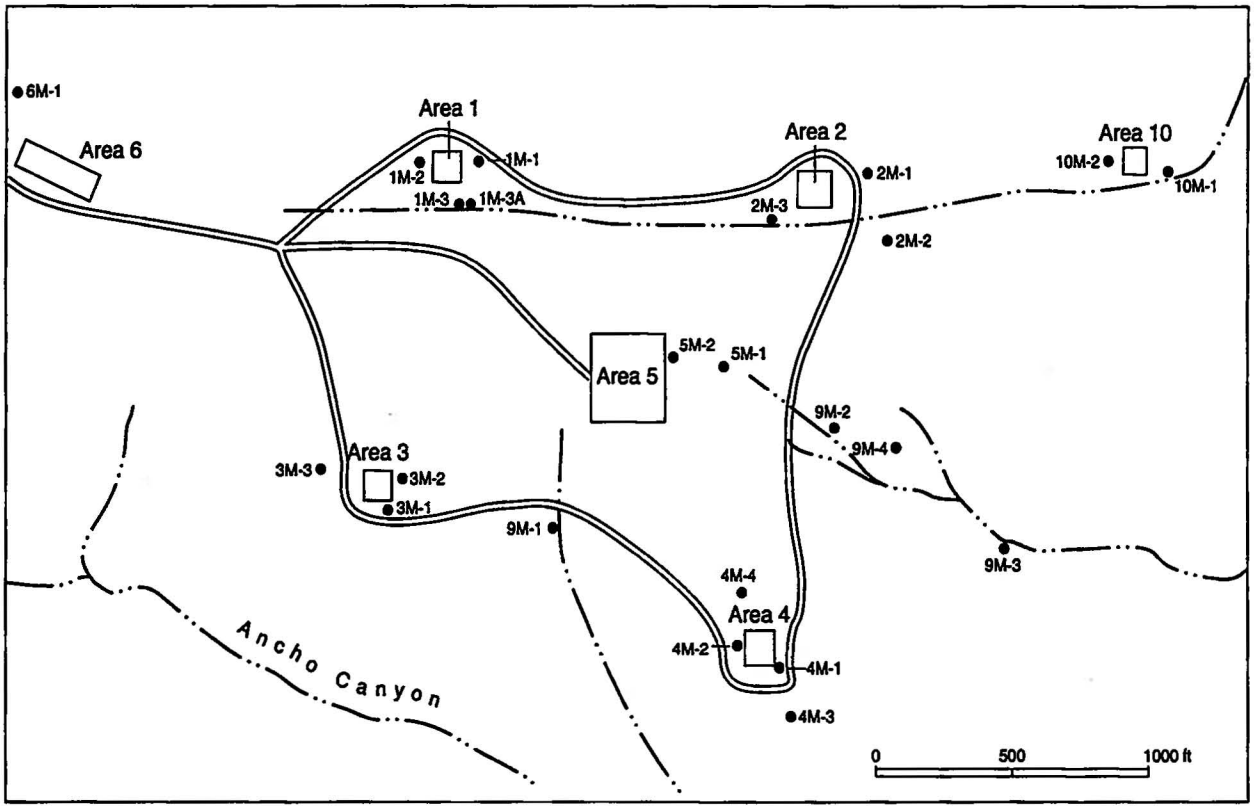


Fig. IX-V. Locations of moisture-access holes at TA-49.

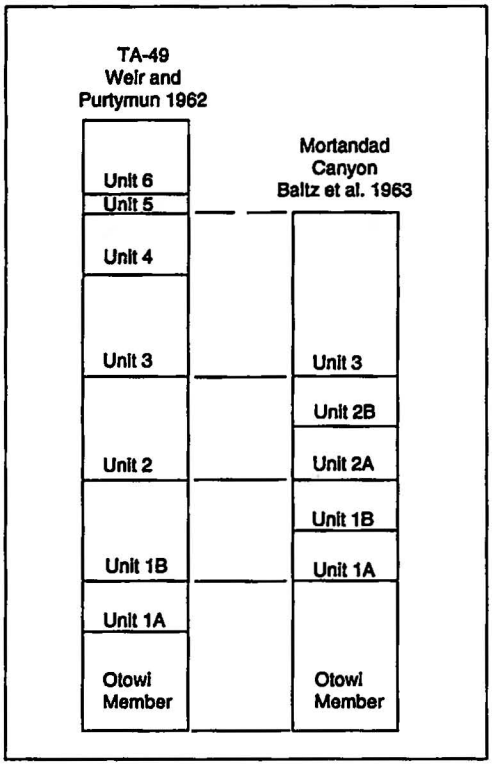


Fig. IX-B. Correlation of the units of the Tshirege Member of the Bandelier Tuff at TA-49 with the type section in Mortandad Canyon.

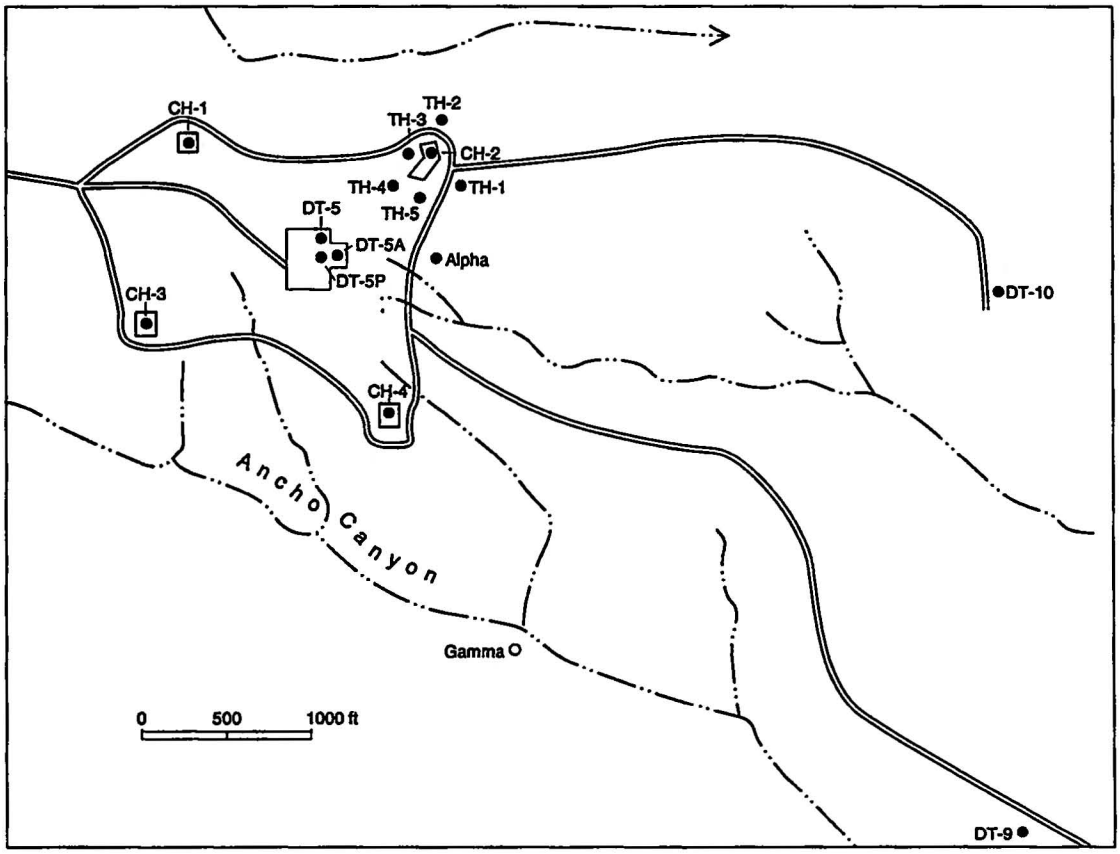


Fig. IX-C. Location of deep test wells (DT-series), core holes (CH-series), and test holes (TH-series) (Purtymun 1994).

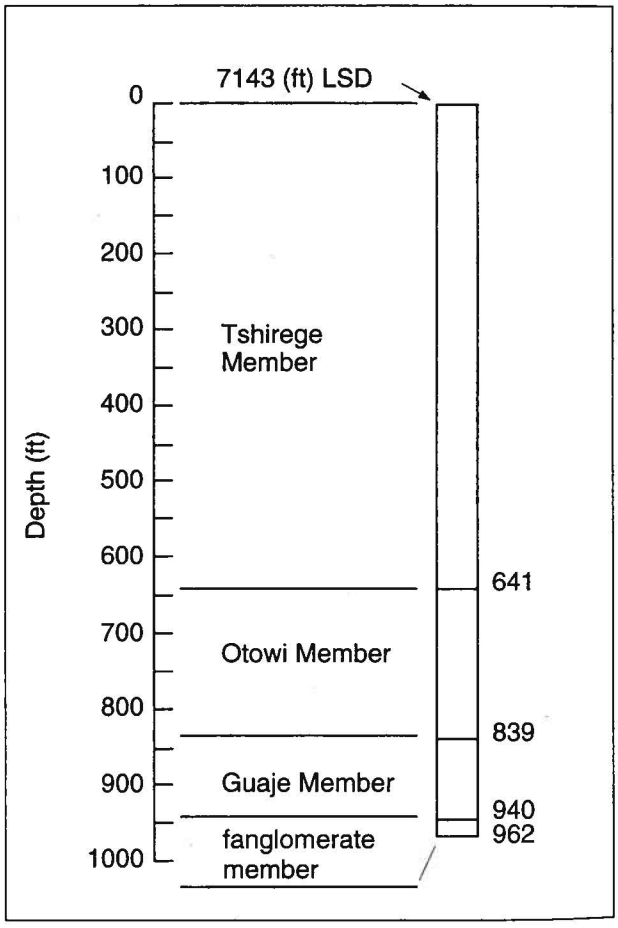
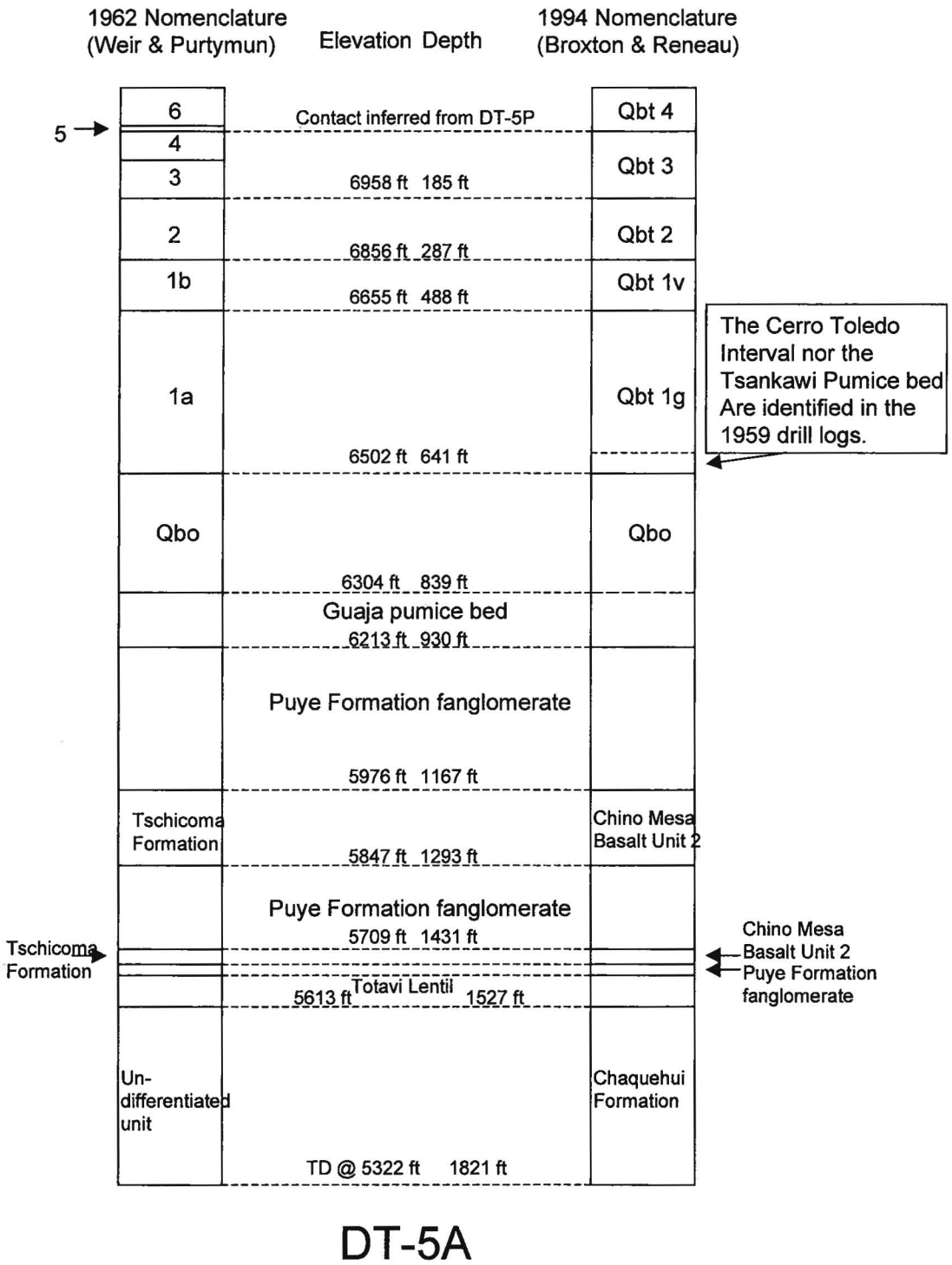
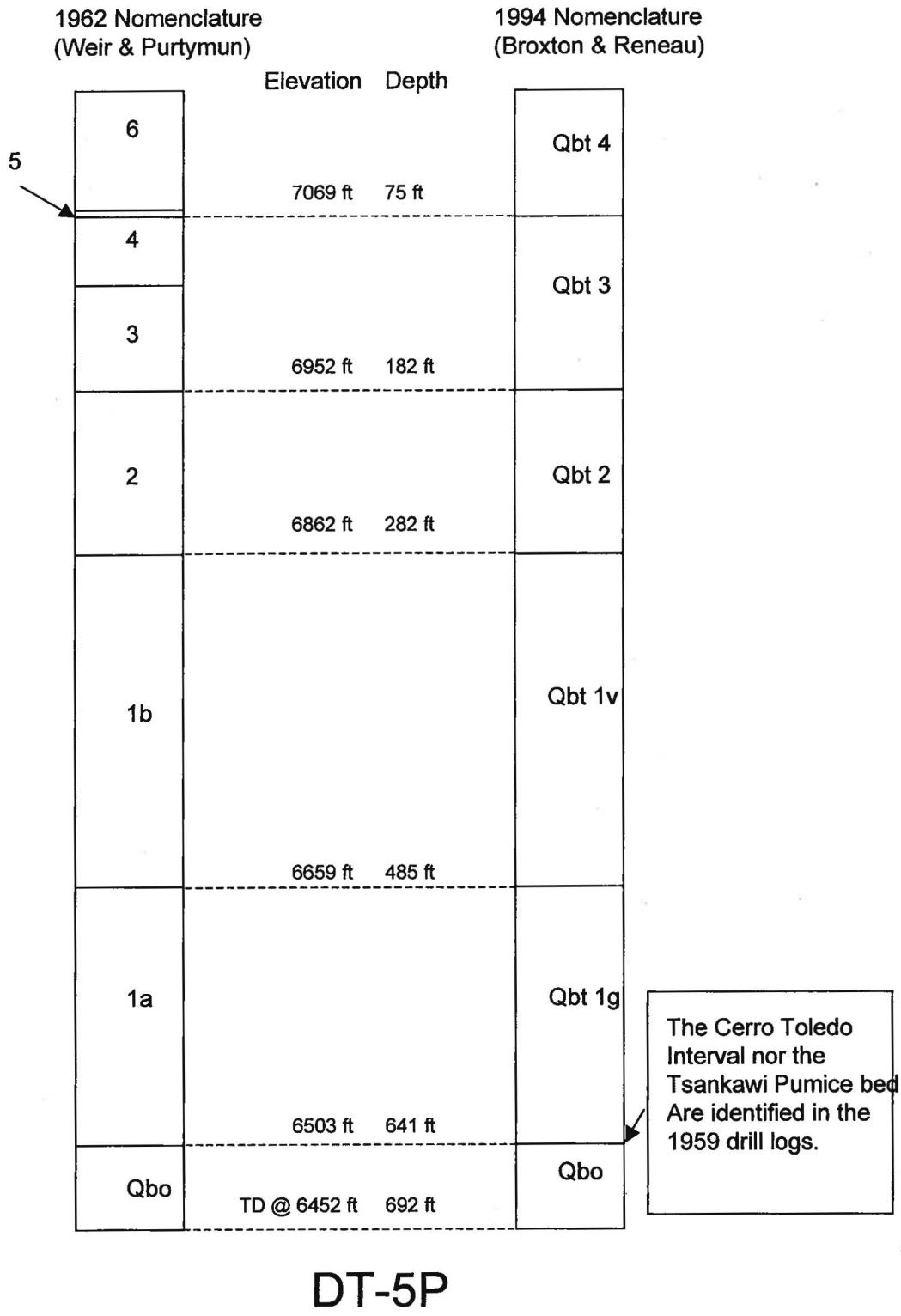


Fig. IX-E. Geologic log of test hole DT-5, completed November 1959, dry (Weir and Purtymun 1962).



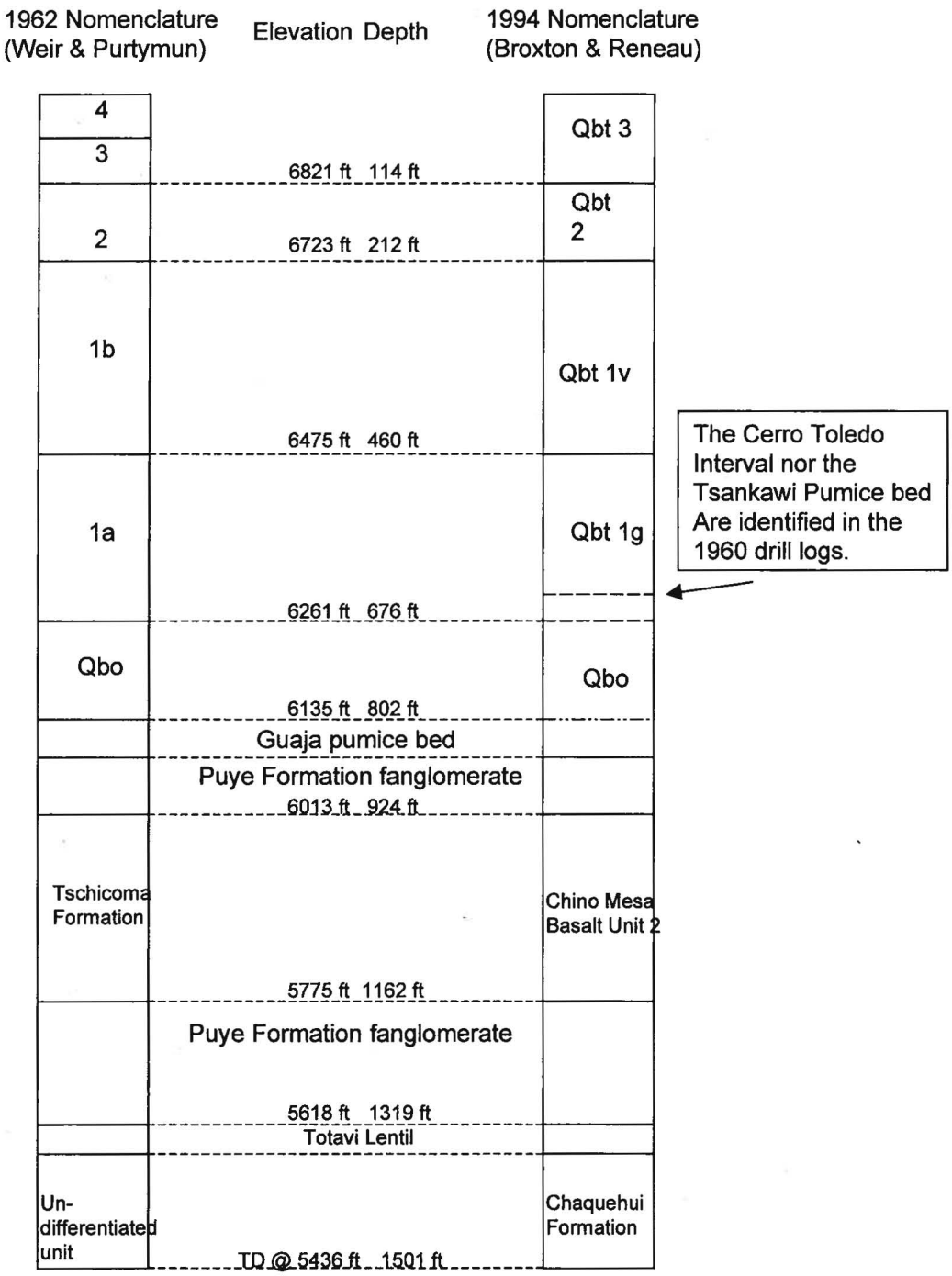
Adapted from Weir and Purtymun (1962, 011890) and Broxton and Reneau (1995, 049726)

Figure 3.2-2 Stratigraphic units of DT-5A



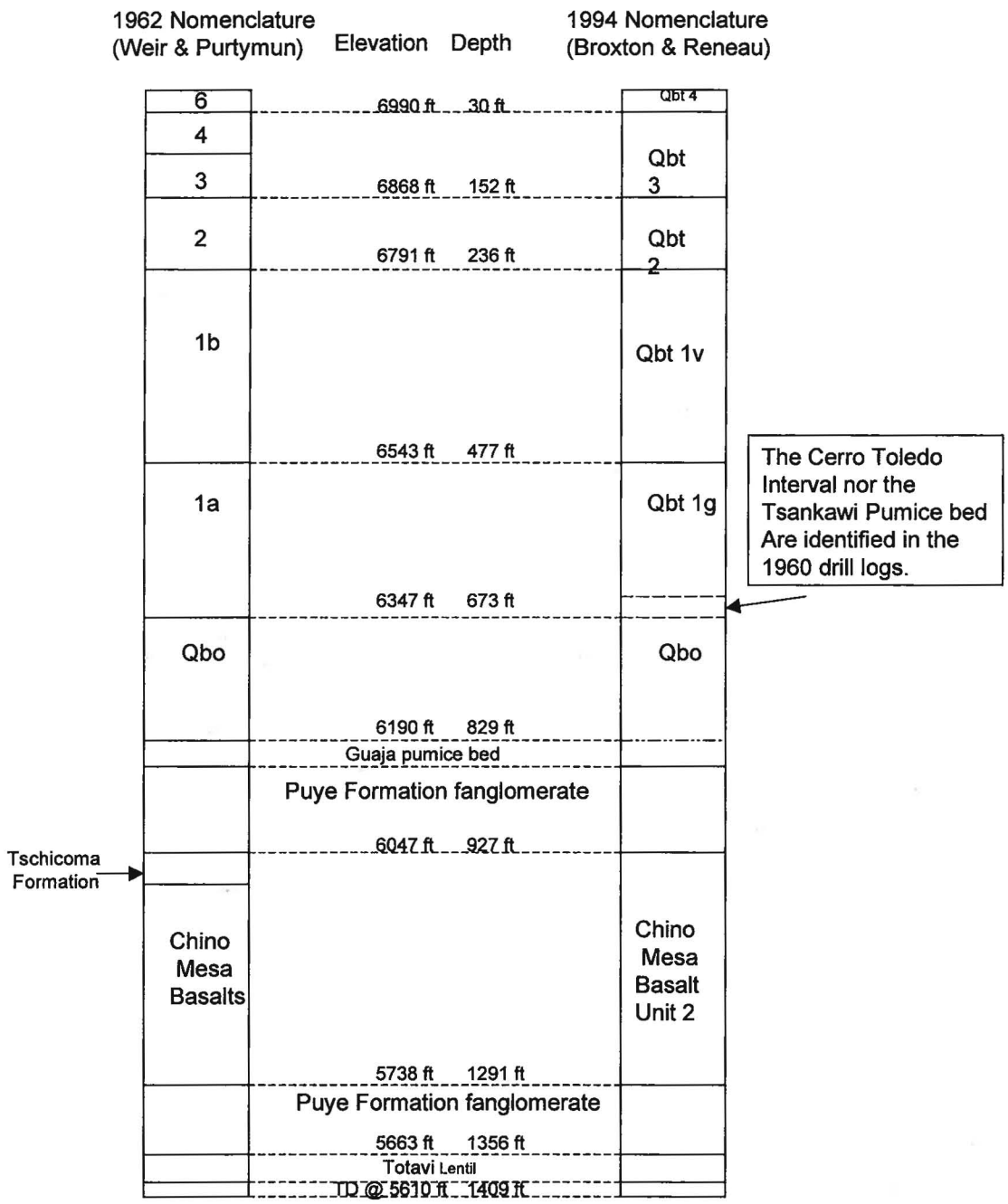
Adapted from Weir and Purtymun (1962, 011890) and Broxton and Reneau (1995, 049726)

Figure 3.2-3 Stratigraphic units of DT-5P



Adapted from Weir and Purtymun (1962, 011890) and Broxton and Reneau (1995, 049726)

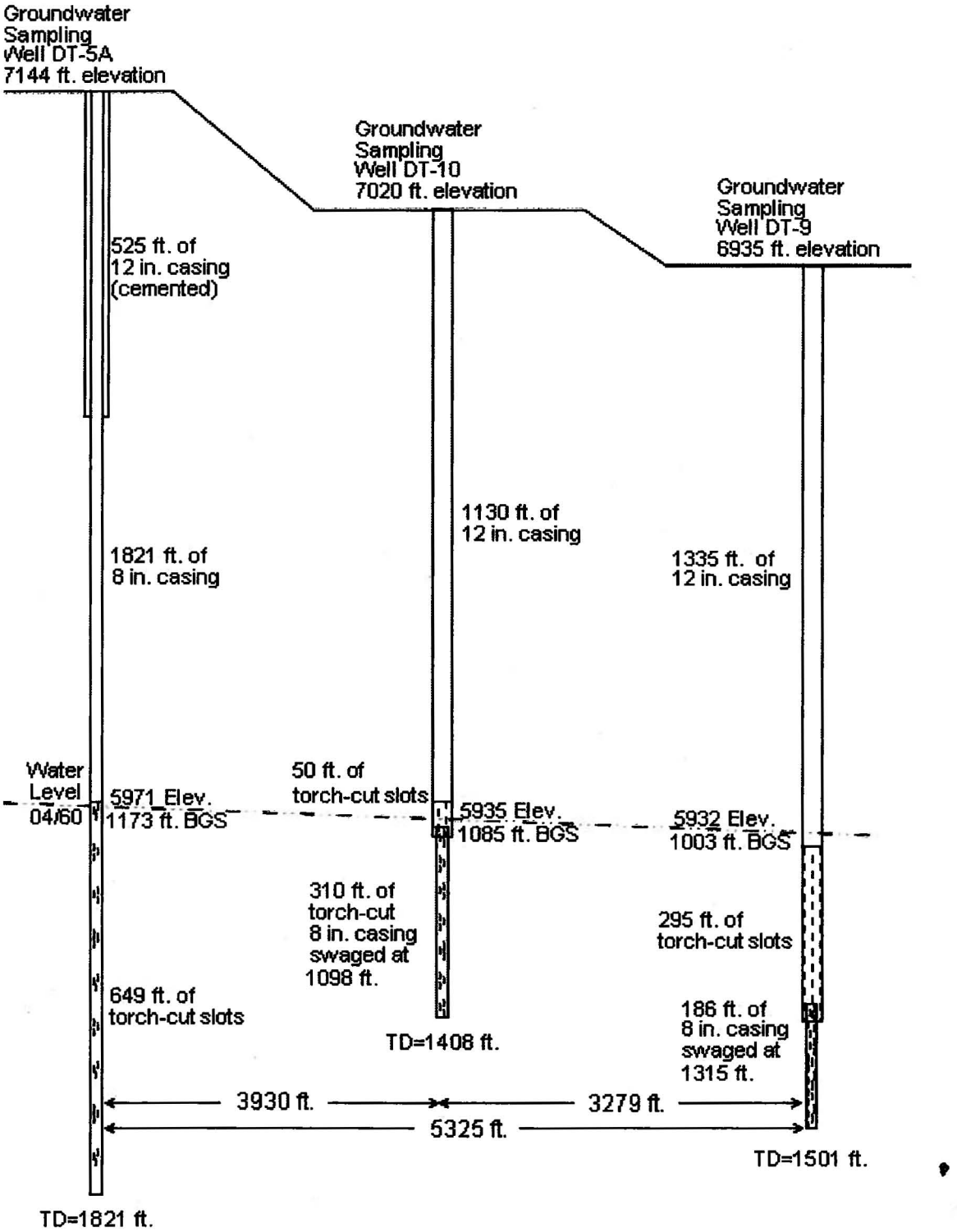
Figure 3.2-4 Stratigraphic units of DT-9



DT-10

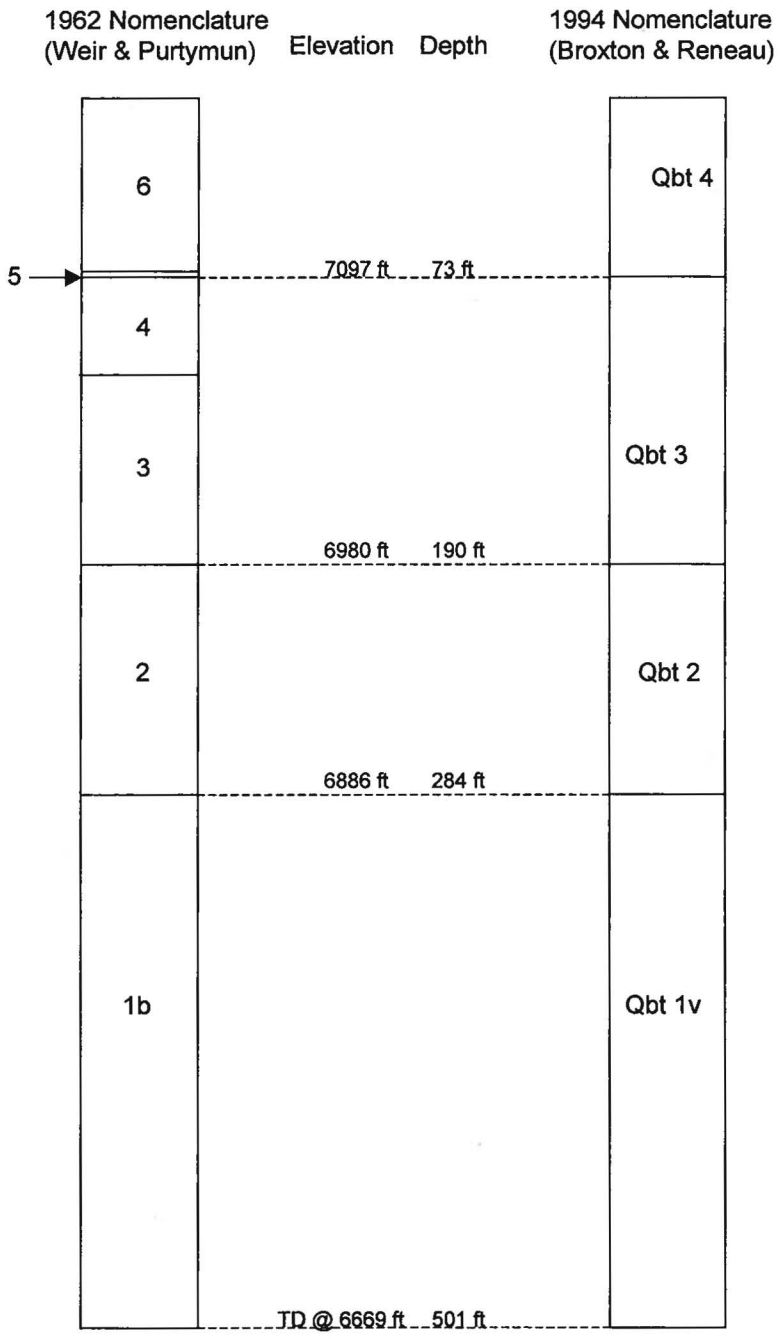
Adapted from Weir and Purtymun (1962, 011890) and Broxton and Reneau (1995, 049726)

Figure 3.2-5 Stratigraphic units of DT-10



Adapted from Weir and Purtymun (1962, 011890)

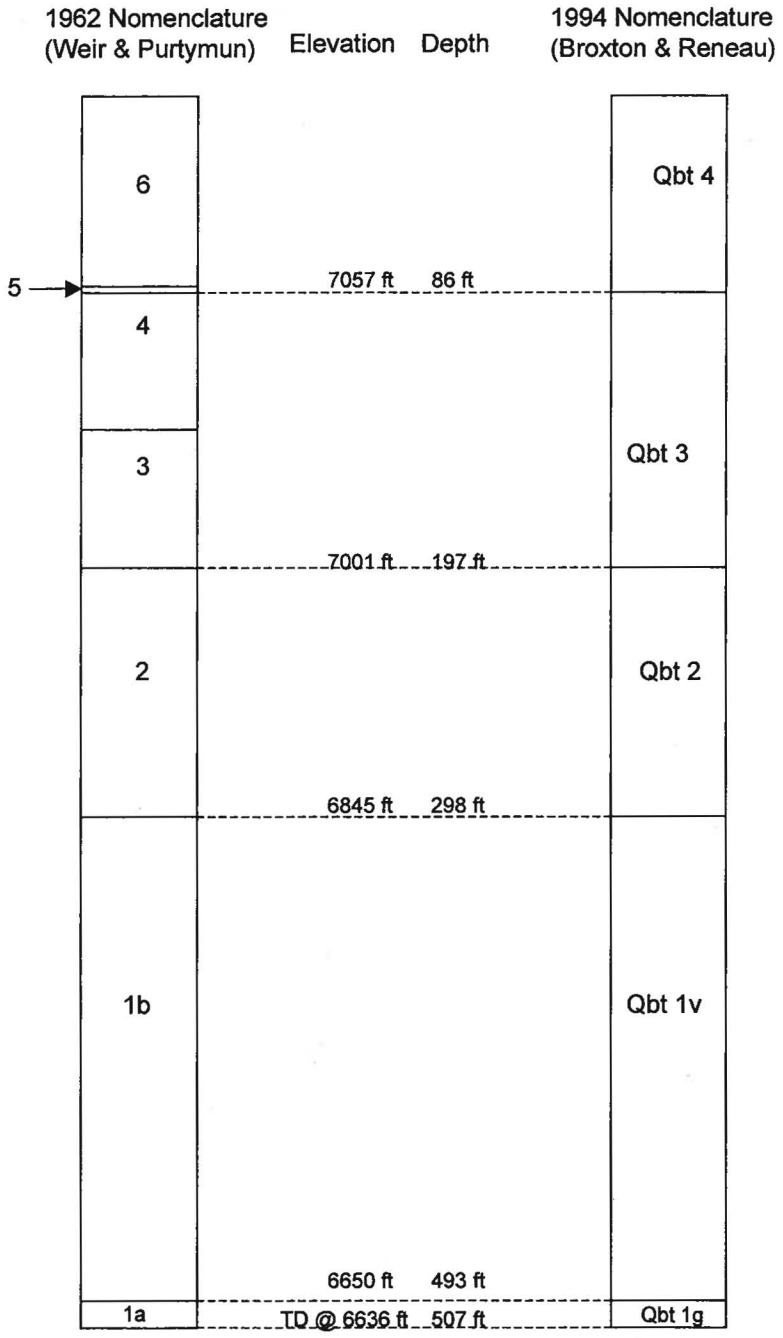
Figure 3.3-3 Construction details for groundwater wells DT-5A, DT-10, and DT-9



Core hole -1

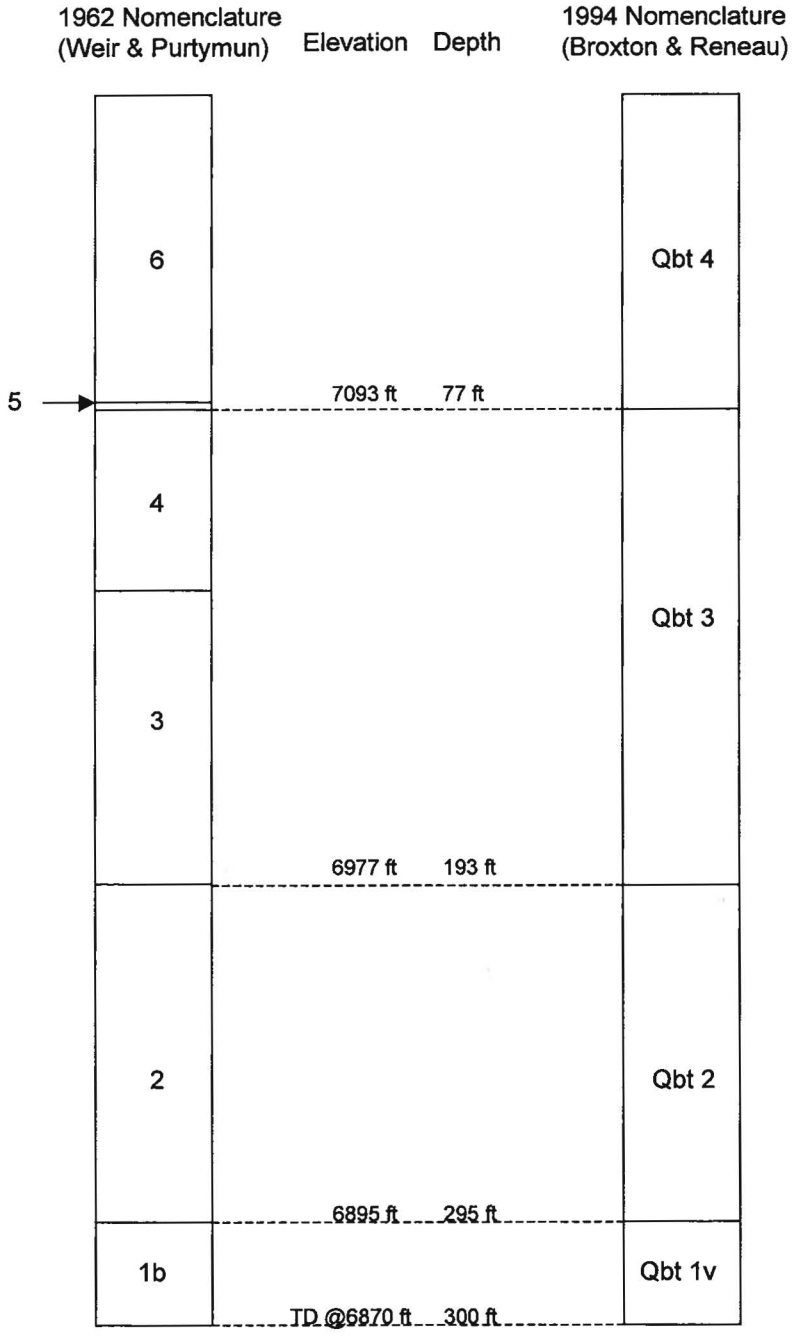
Adapted from Weir and Purtymun (1962, 011890) and Broxton and Reneau (1995, 049726)

Figure 3.2-6 Stratigraphic units of CH-1



Adapted from Weir and Purtymun (1962, 011890) and Broxton and Reneau (1995, 049726)

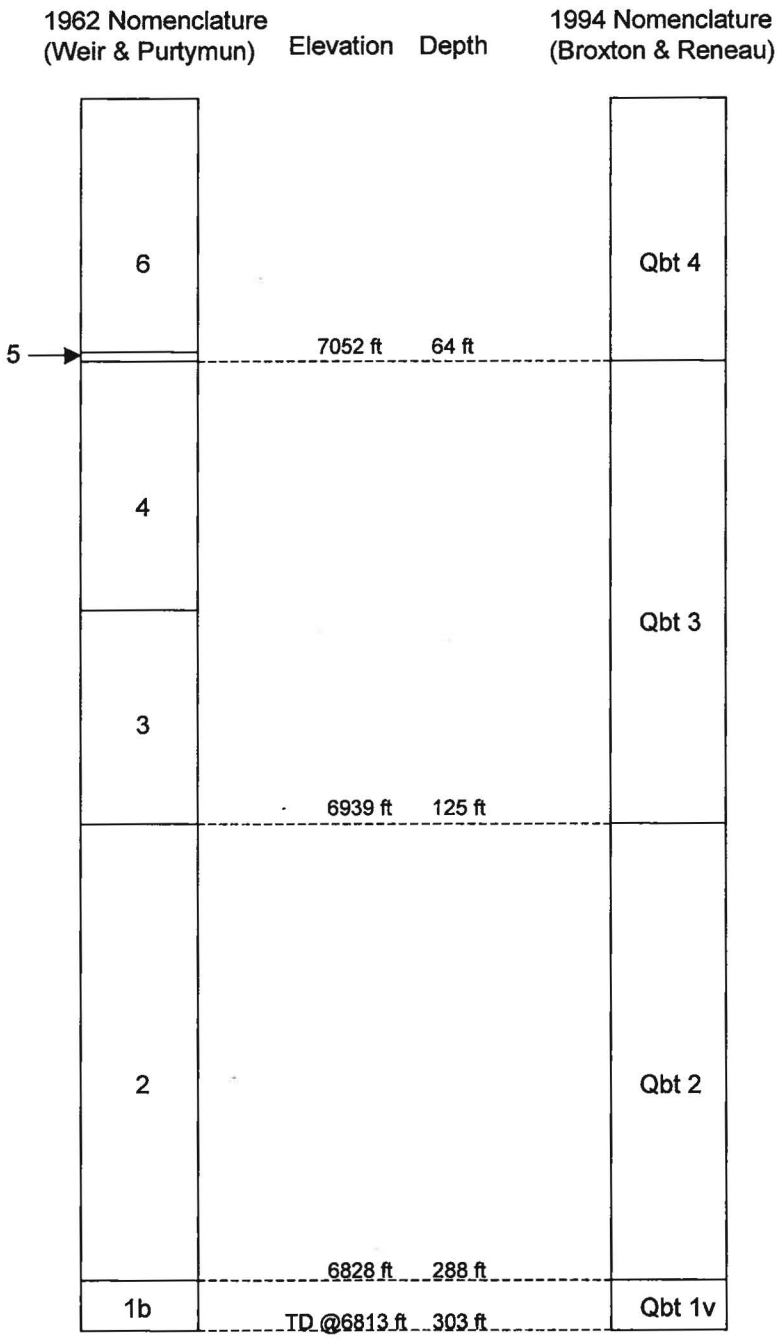
Figure 3.2-7 Stratigraphic units of CH-2



Core hole -3

Adapted from Weir and Purtymun (1962, 011890) and Broxton and Reneau (1995, 049726)

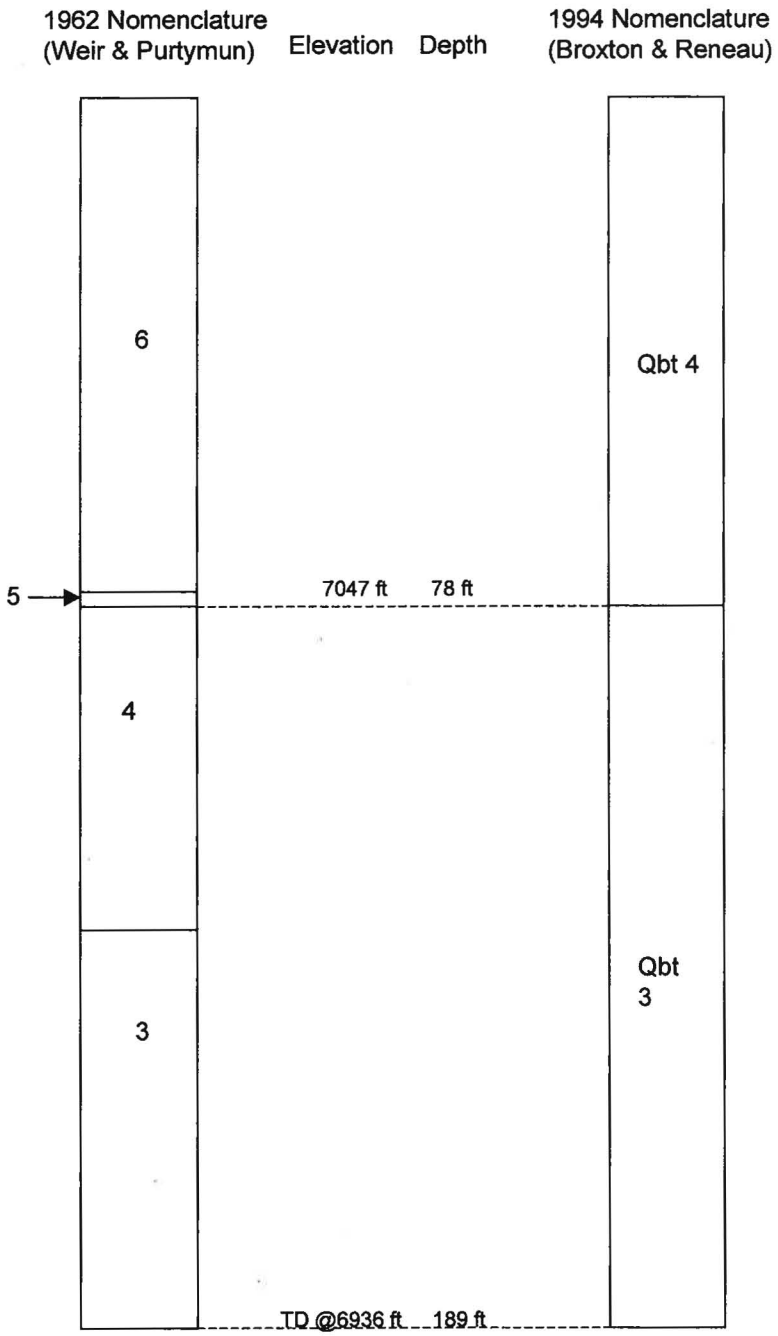
Figure 3.2-8 Stratigraphic units of CH-3



Core hole -4

Adapted from Weir and Purtymun (1962, 011890) and Broxton and Reneau (1995, 049726)

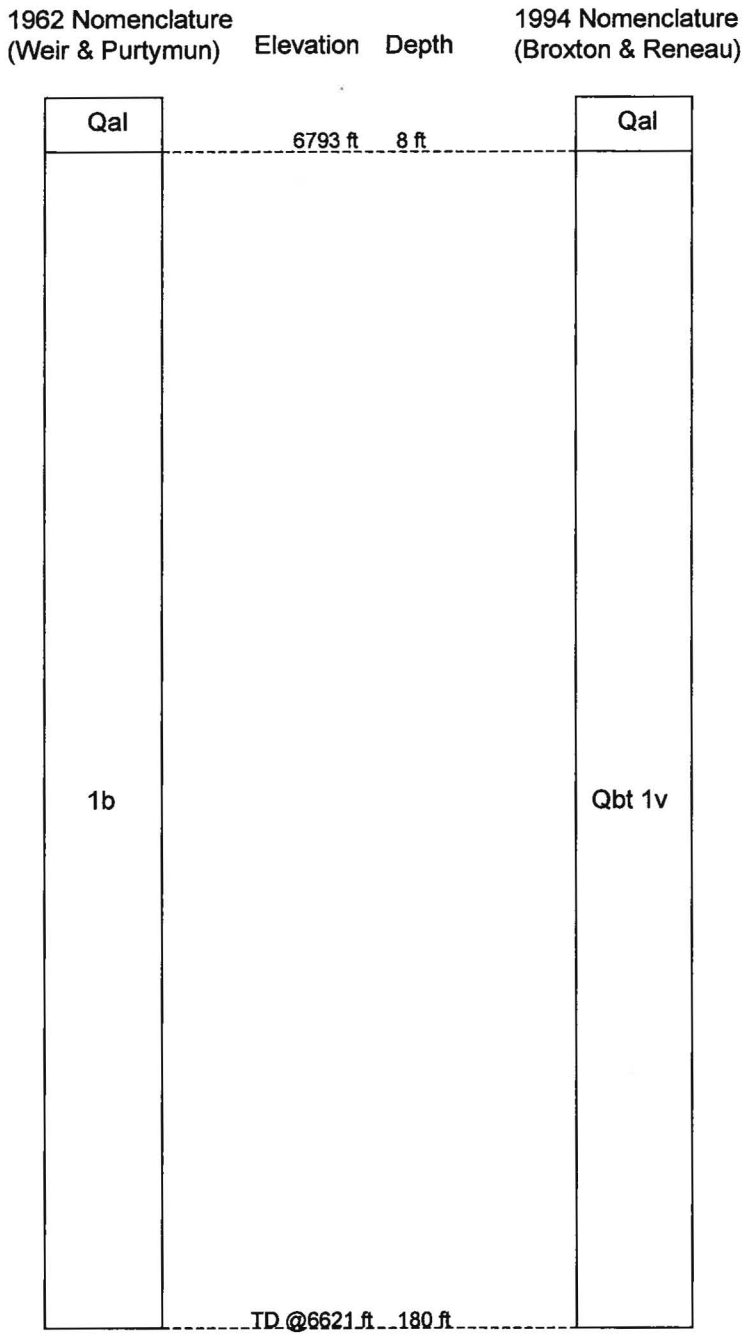
Figure 3.2-9 Stratigraphic units of CH-4



Alpha hole

Adapted from Weir and Purtymun (1962, 011890) and Broxton and Reneau (1995, 049726)

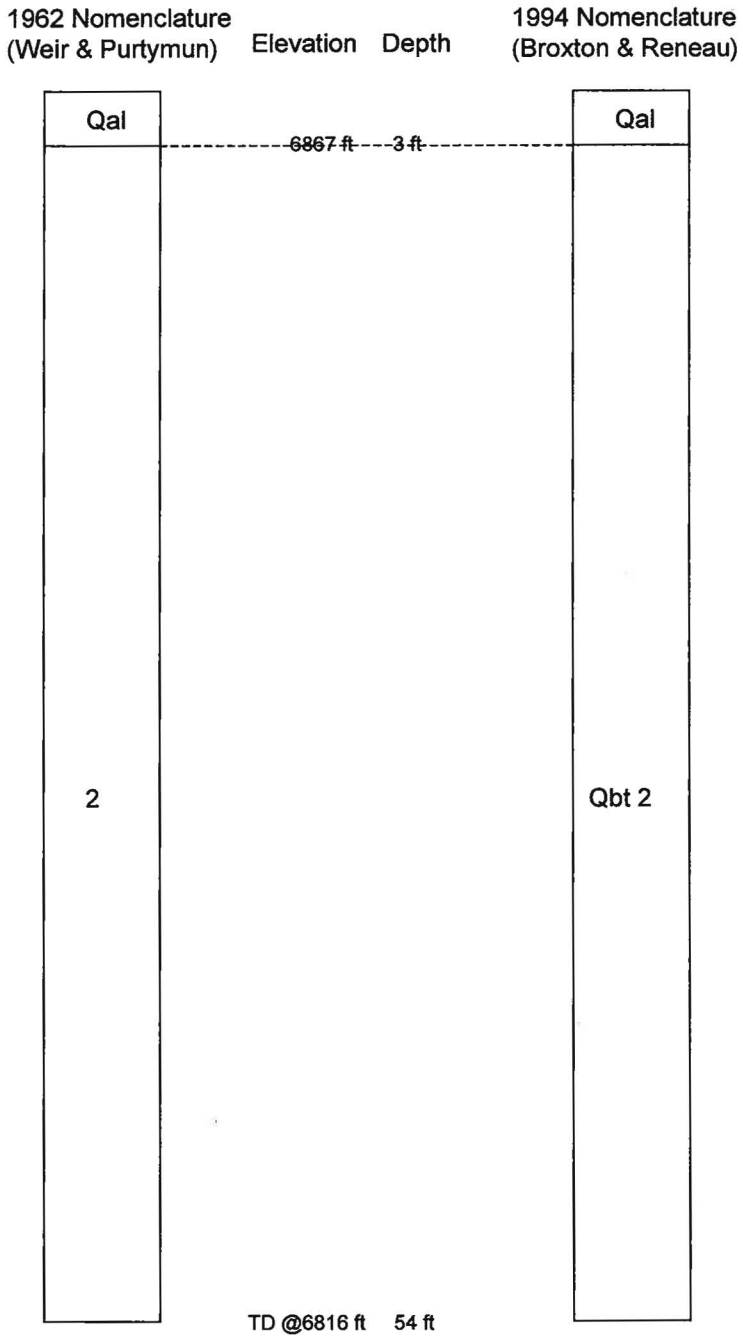
Figure 3.2-10 Stratigraphic units of Alpha hole



Beta hole

Adapted from Weir and Purtymun (1962, 011890) and Broxton and Reneau (1995, 049726)

Figure 3.2-11 Stratigraphic units of Beta hole



Gamma hole

Adapted from Weir and Purtymun (1962, 011890) and Broxton and Reneau (1995, 049726)

Figure 3.2-12 Stratigraphy of Gamma hole

Table 5.1-1
Summary of Analytical Results for Water Sample from Neutron Access Hole 2A-Y

Analyte	Media	Number of Analyses	Number of Detects	Concentration Range (pCi/L)	Frequency of Detects above Background Value
Americium-241	Groundwater, intermediate depth, perched	1	0	[5.813707 to 5.813707]	0/1
Cesium-134	Groundwater, intermediate depth, perched	1	0	[-3.288532 to -3.288532]	0/1
Cesium-137	Groundwater, intermediate depth, perched	1	0	[-3.160709 to -3.160709]	0/1
Cobalt-60	Groundwater, intermediate depth, perched	1	0	[1.48568 to 1.48568]	0/1
Europium-152	Groundwater, intermediate depth, perched	1	0	[-4.195175 to -4.195175]	0/1
Sodium-22	Groundwater, intermediate depth, perched	1	0	[8.693627 to 8.693627]	0/1
Uranium-235	Groundwater, intermediate depth, perched	1	0	[0.7775123 to 0.7775123]	0/1
Gross alpha	Groundwater, intermediate depth, perched	1	0	[5.98 to 5.98]	0/1
Gross beta	Groundwater, intermediate depth, perched	1	1	37.01 to 37.01	1/1

5.2 Biobarrier Repair

On September 28, 2004, it was discovered that a gopher had penetrated the biobarrier adjacent to the concrete pad surrounding neutron access hole 49-10046. An inadequate number of clips between biobarrier sheets had allowed the gopher to slip through and dig into the ET cover. Following this discovery, the gopher's spoil pile was screened by a Health, Safety, and Radiation Protection Group radiation control technician and deemed to be at or below instrument background for the surface of the site. The soil was then spread across the cover and the biobarrier repaired. No further signs of gopher intrusion have been observed since the barrier was repaired.

5.3 Borehole Abandonment

Boreholes Alpha and Gamma A were abandoned during the fourth quarter of FY2005. These boreholes were advanced in 1960 as hydrogeological test holes. Alpha was located west of Areas 2 and 4, with a diameter of 2 ft and a depth of 189 ft. Gamma A was located in Ancho Canyon to the south of Area 4, with a diameter of 4 in. and a depth of 56 ft. The borehole locations are shown in Figure 3.2-1. These boreholes were not used for periodic testing or monitoring; nor were there any foreseeable future uses for these boreholes. The exploratory boreholes were abandoned for the following reasons:

- The exploratory boreholes provided a potential rapid conduit for moisture or other unwanted constituents into the subsurface.
- No construction diagrams or records exist.

- Large diameter boreholes cannot be utilized for vadose zone monitoring.
- Gamma A was located in a canyon-bottom flood plain.
- Neither borehole encountered saturated intervals at time of drilling, nor did any contain water at the time of abandonment.
- These boreholes are not required for future remediation projects.

Borehole abandonment activities began on September 26, 2005, and were completed on October 3, 2005. Boreholes Alpha and Gamma A, drilled for a hydrogeologic investigation in 1960, were abandoned per SOP-5.03, Rev. 3, "Monitor Well and RFI Borehole Abandonment." The constructions are described below.

Alpha

The corrugated steel casing was cut flush at ground surface, with 7.5 ft left in the borehole. This borehole was sealed in three stages.

- *Stage 1:* A cement/sand slurry was placed from total depth to a level of 10.5 ft bgs. The slurry consisted of water, cement, and sand at a ratio of approximately 1:2:8 by weight that had been prepared and delivered by Los Alamos Transit Mix.
- *Stage 2:* A soft bentonite grout was placed on top of the cement/sand slurry over the interval of 10.5 ft bgs to 2 ft bgs. The soft bentonite grout consisted of water, cement, and bentonite at a ratio of 10:3:1 by weight. Type I/II Portland cement and Baroid Aquagel Gold Seal (200 mesh bentonite powder) were used.
- *Stage 3:* A concrete cap constructed of standard 4000 pounds per square inch concrete was placed over the soft bentonite grout and domed over the former borehole. A brass cap was placed in the center of this dome for future identification and geographic reference.

Gamma A

The 4-in.-diameter steel casing was removed, and the borehole was sealed in two stages.

- *Stage 1:* Bentonite pellets (1/4 in.) were placed from total depth to 1 ft bgs and hydrated in 5-ft lifts.
- *Stage 2:* A cement seal consisting of Type I/II Portland cement was placed from 1 ft bgs to the surface.

Appendix C, "2005 Borehole Abandonment Constructions," presents diagrams of the construction described above.

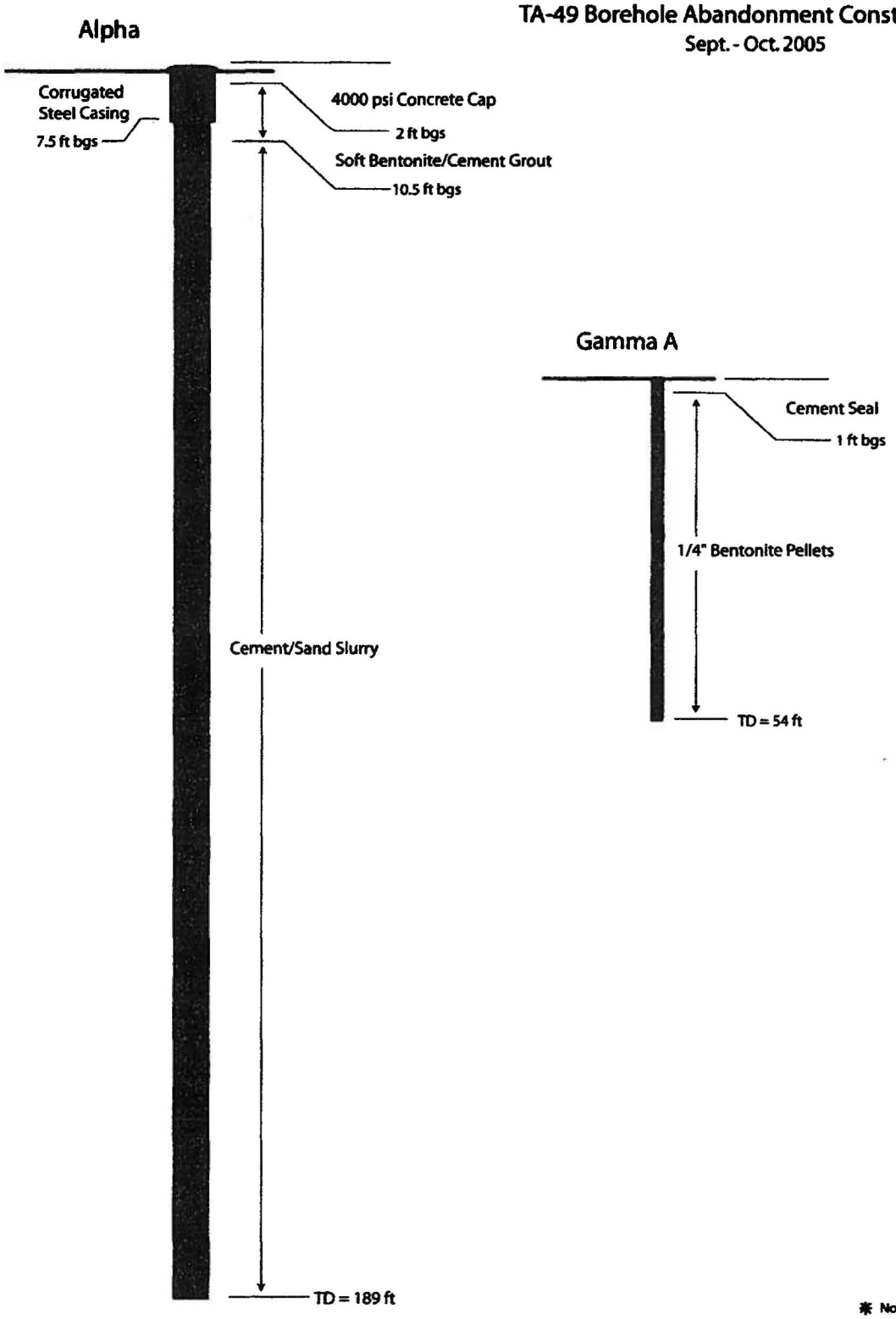
6.0 CONCLUSIONS

Analysis of the moisture monitoring data collected over the past year leads to the following conclusions:

- The neutron log and TDR data indicate that subsurface moisture levels fluctuate in the near surface (<10 ft) and remain constant at greater depth, as expected in a moisture-limited, semiarid climate.

TA-49 Borehole Abandonment Constructions*

Sept. - Oct. 2005



* Not to Scale

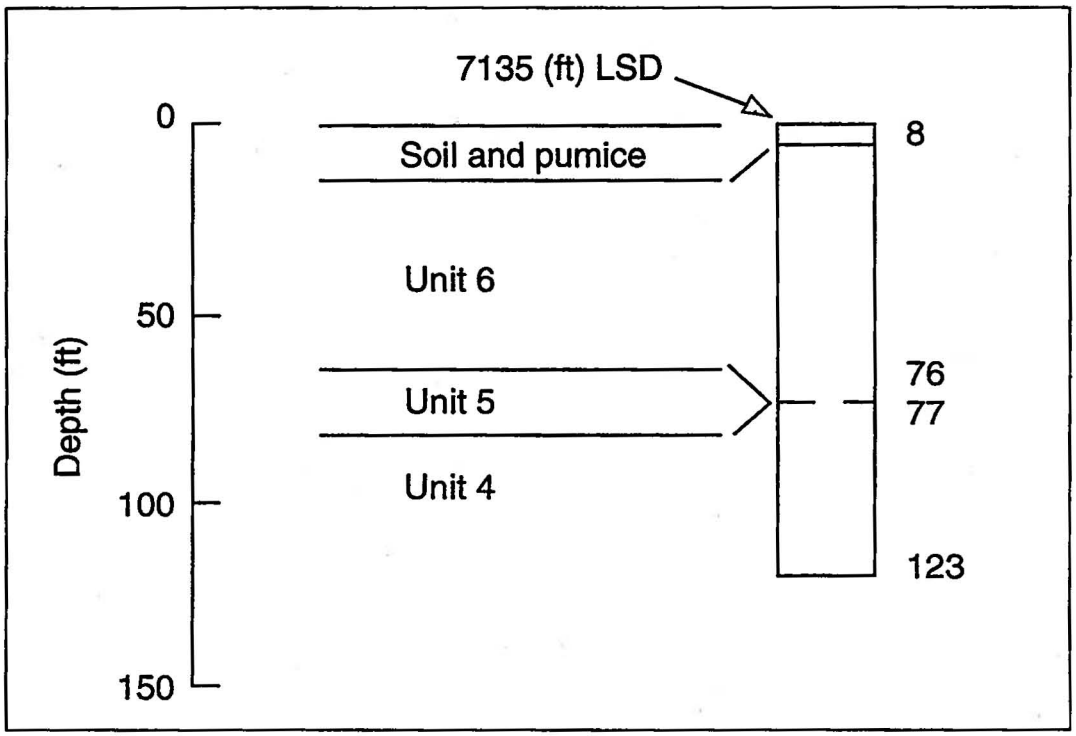


Fig. IX-P. Geologic log of Area 2 Test Hole 1, completed May 1980, dry (Purtymun 1994).

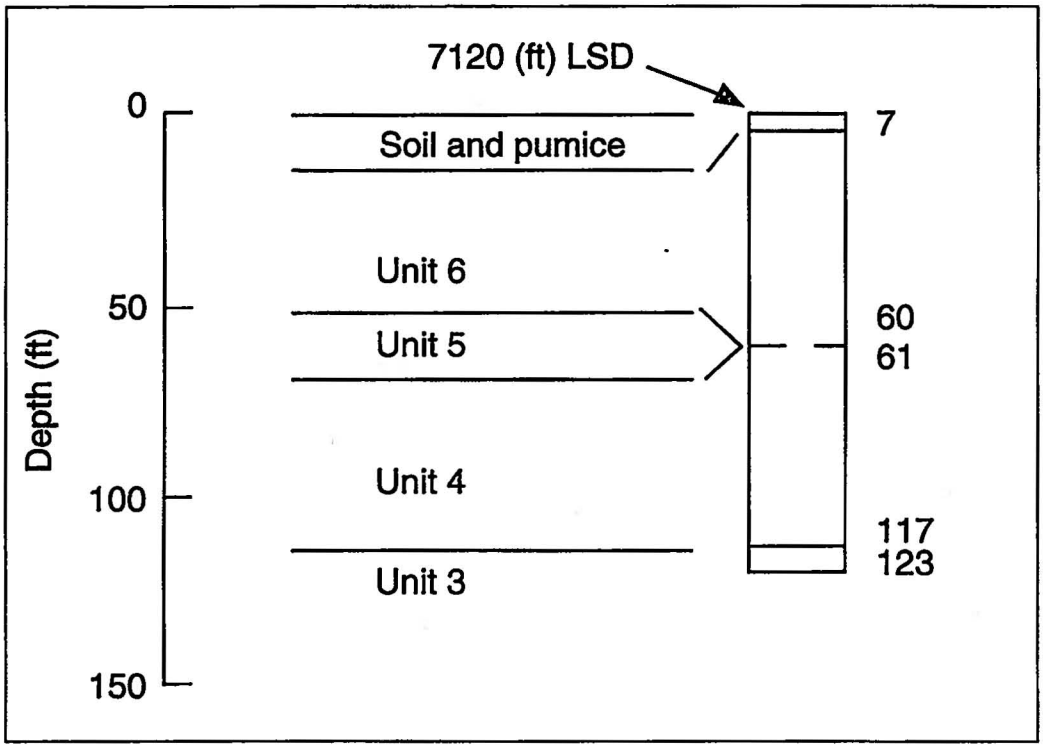


Fig. IX-Q. Geologic log of Area 2 Test Hole 2, completed May 1980, dry (Purtymun 1994).

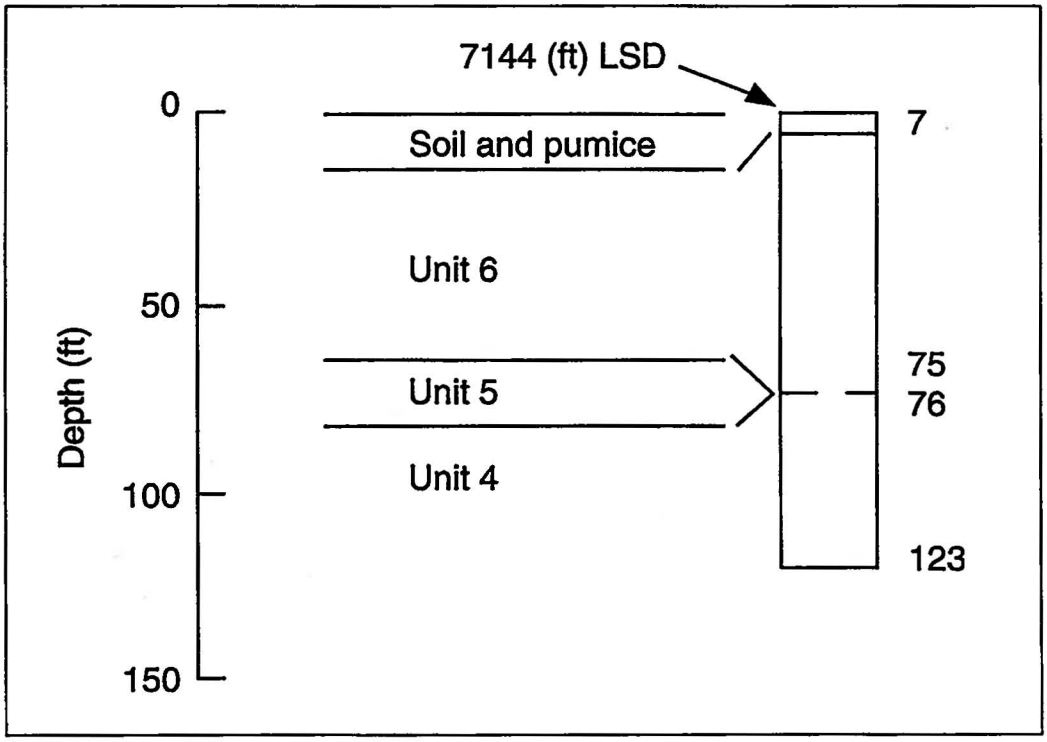


Fig. IX-R. Geologic log of Area 2 Test Hole 3, completed May 1980, dry (Purtymun 1994).

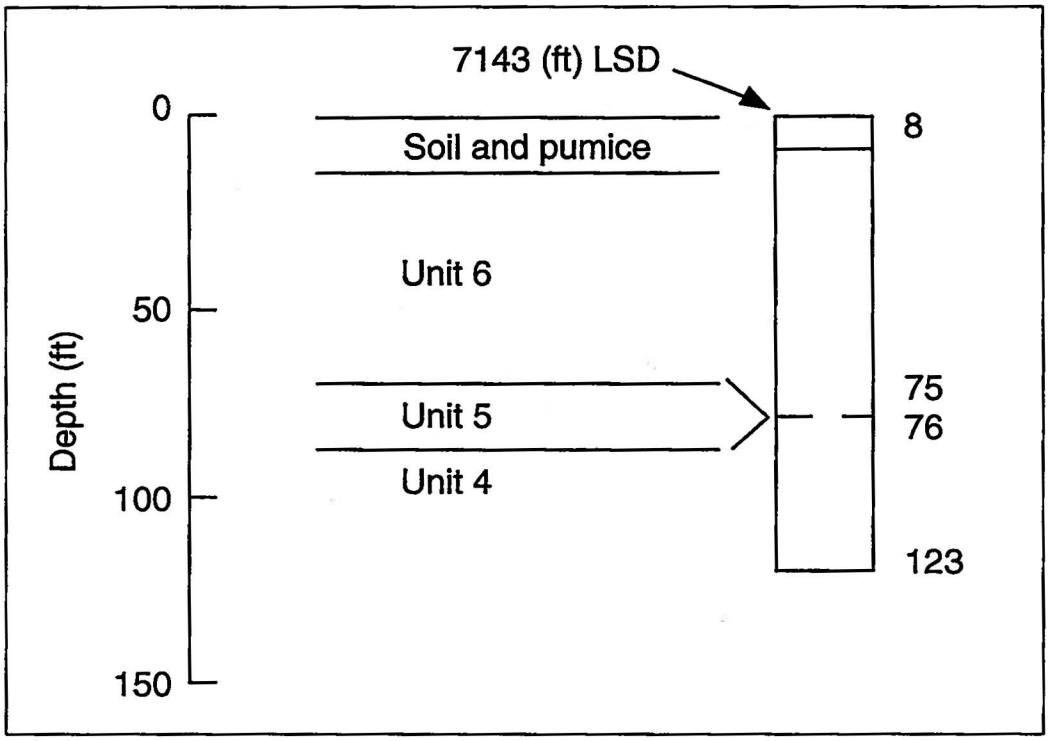


Fig. IX-S. Geologic log of Area 2 Test Hole 4, completed May 1980, dry (Purtymun 1994).

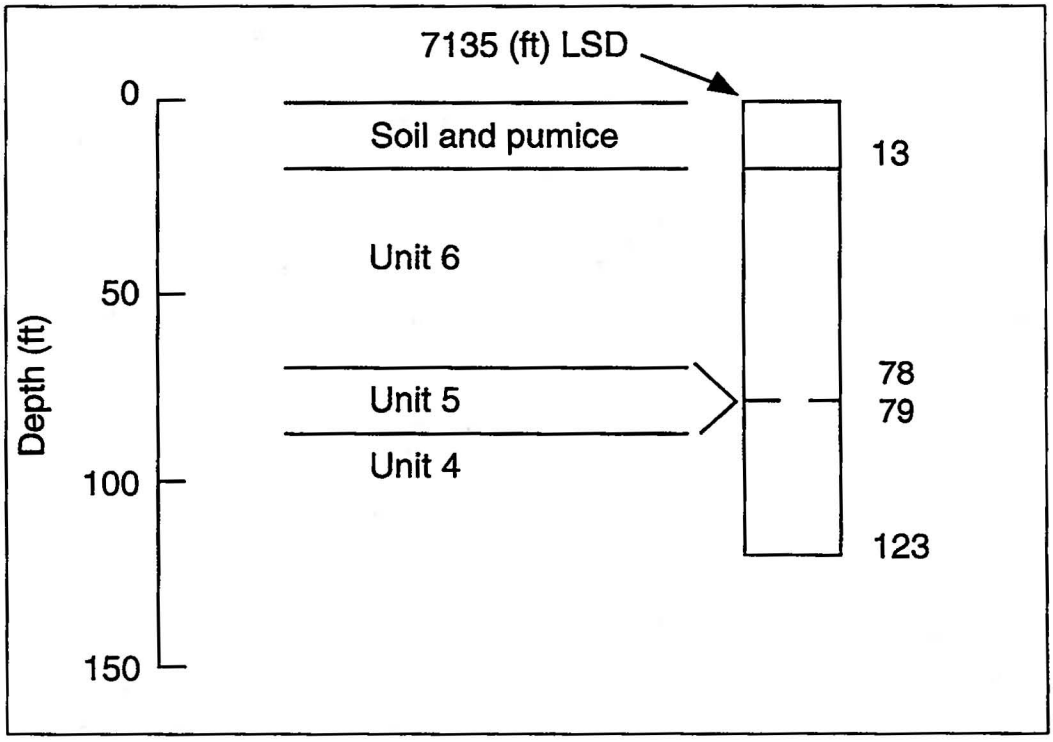


Fig. IX-T. Geologic log of Area 2 Test Hole 5, completed May 1980, dry (Purtymun 1994).

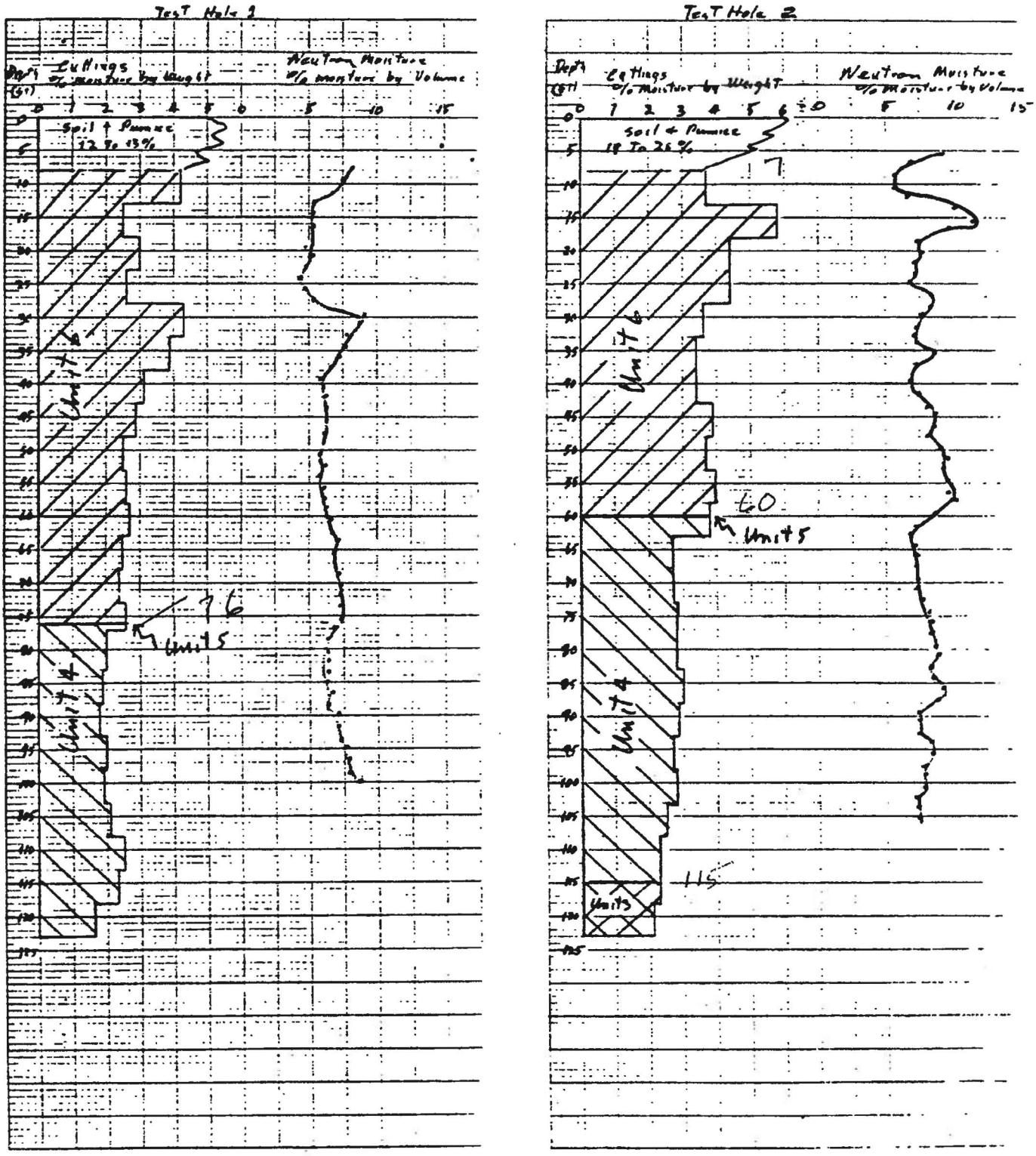


Fig. 2. Geologic and neutron logs of Test Holes TH-1 and TH-2.

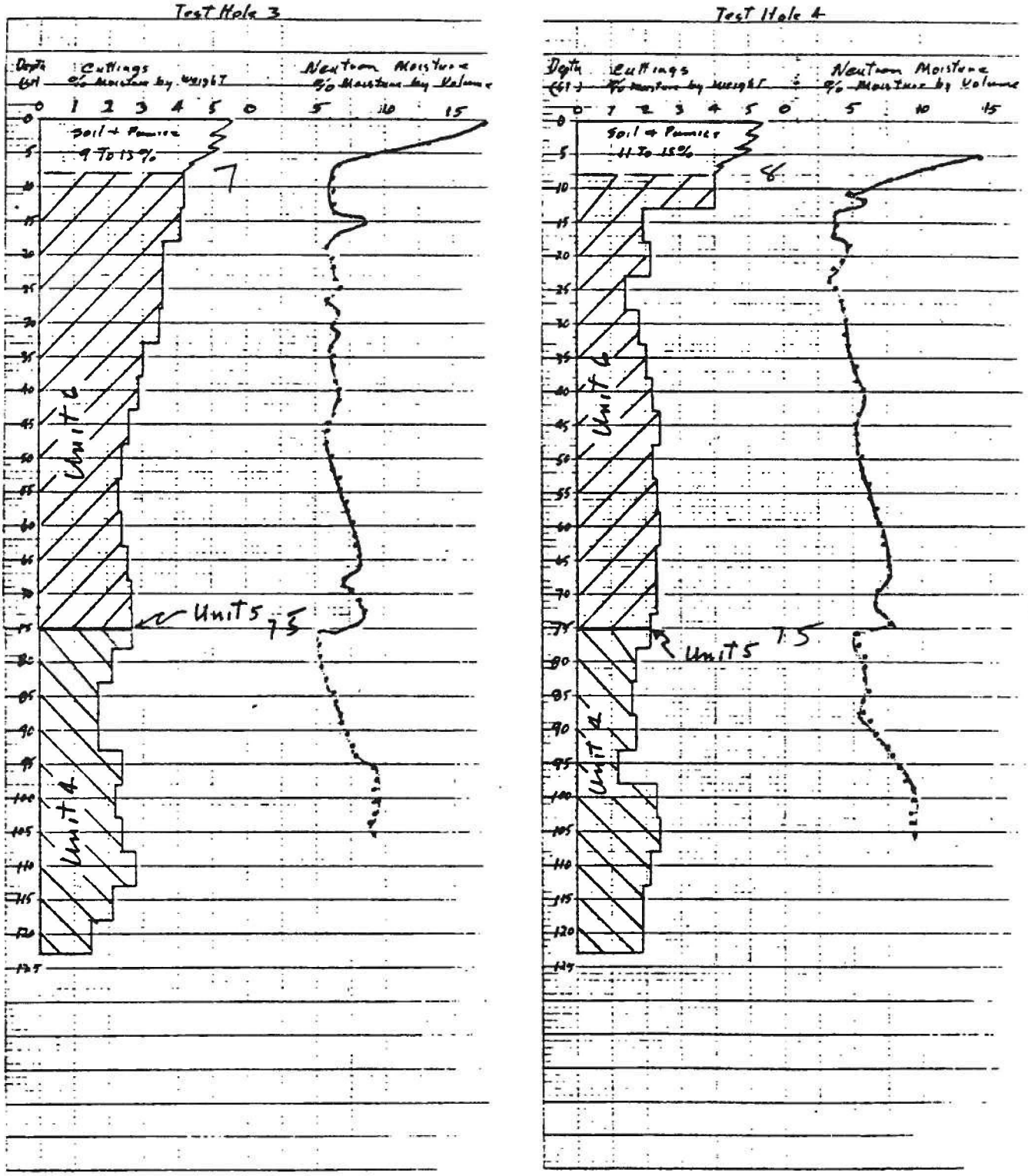


Fig. 3. Geologic and neutron logs of Test Holes TH-3 and TH-4.

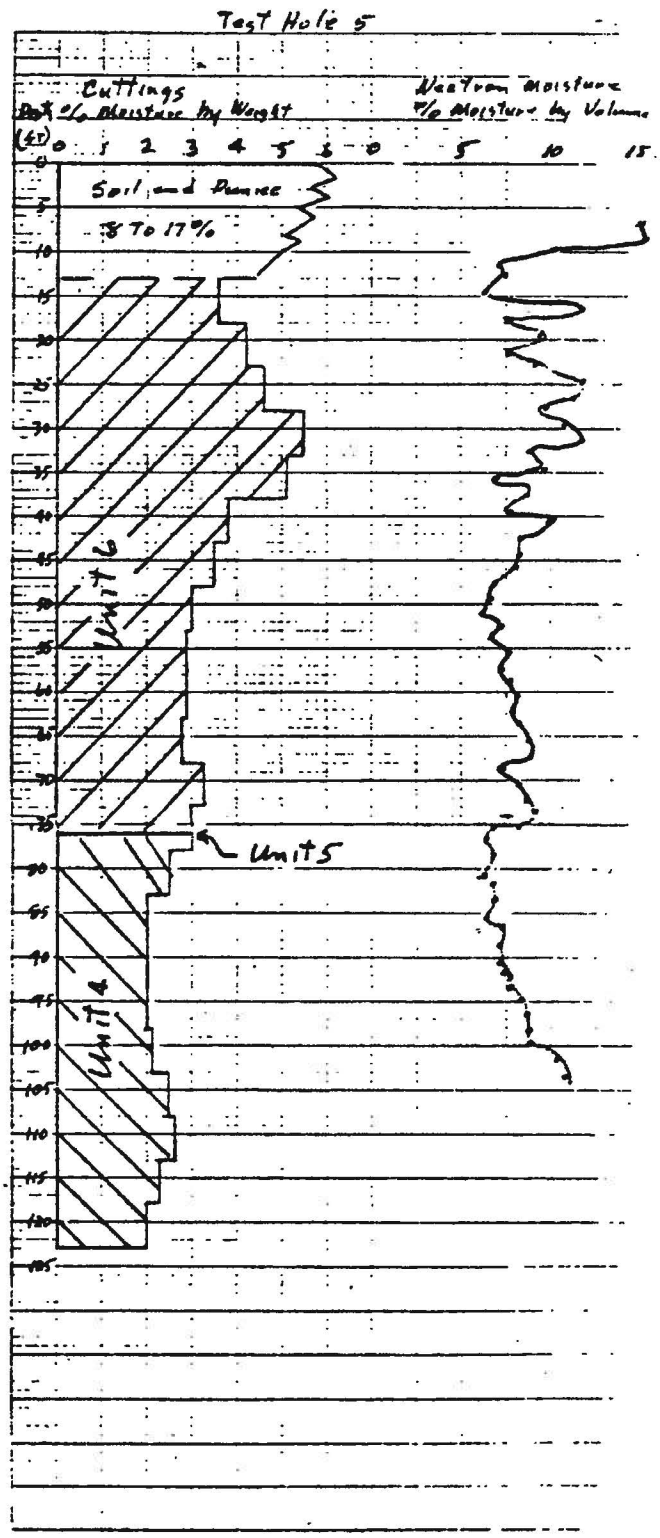


Fig. 4. Geologic and neutron logs of Test Hole TH-5.

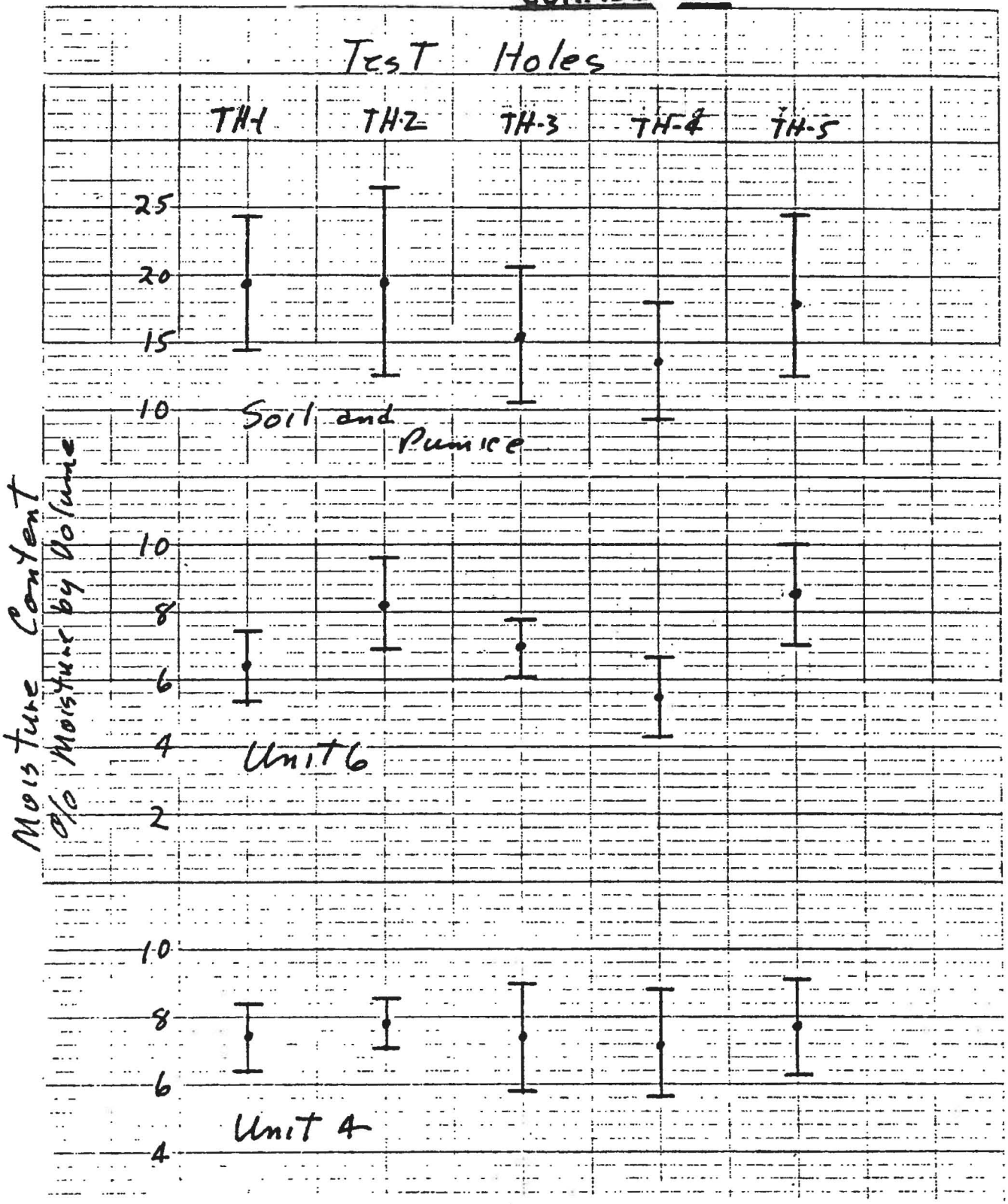


Fig. 5. Average moisture content of pumice and soil and tuff of Unit 4 and 6 in test holes.

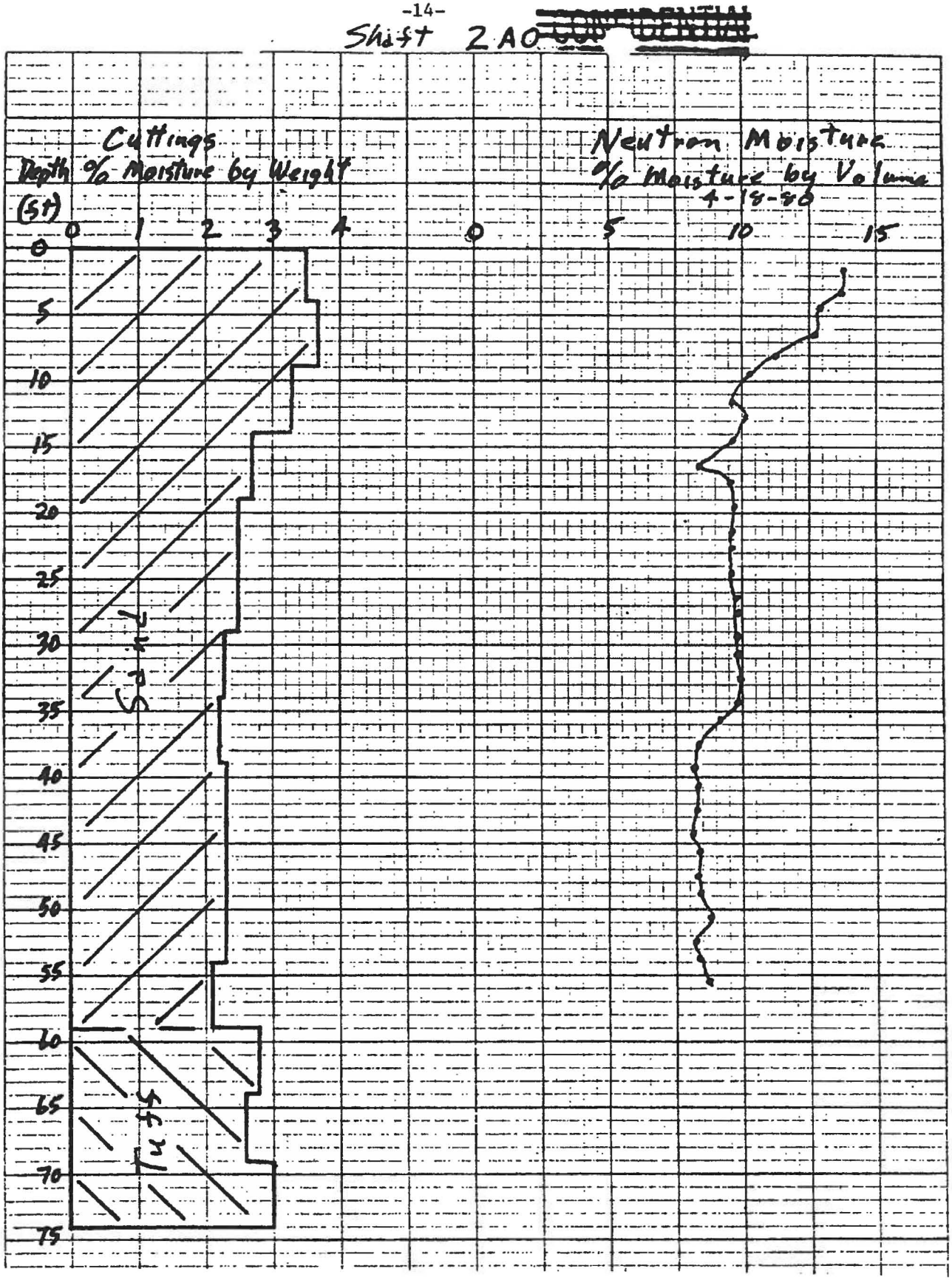


Fig. 6. Geologic and neutron logs of Shaft 2A-0.

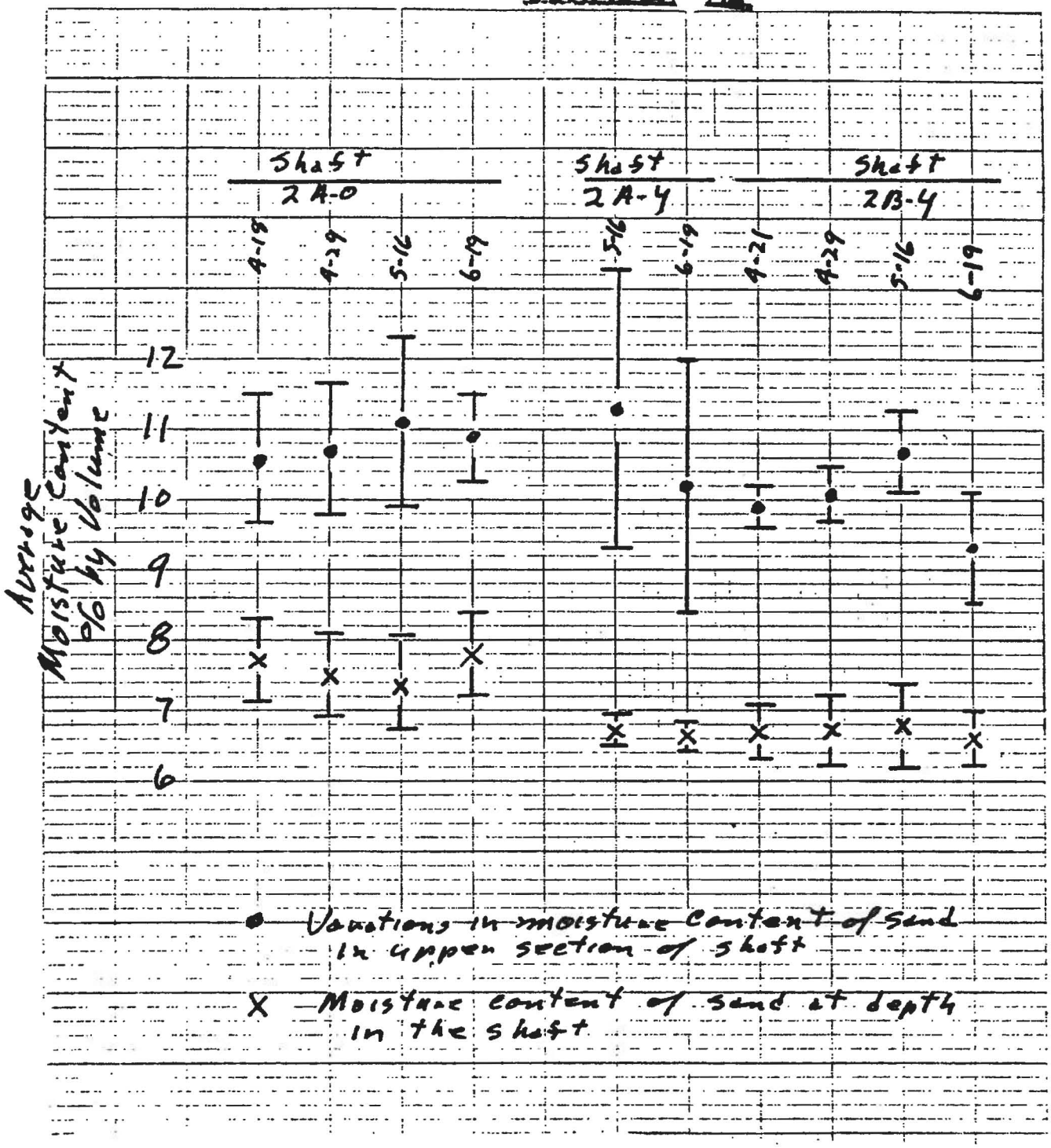


Fig. 7. Average moisture content of sand in Shafts 2A-0, 2A-Y, and 2B-Y.

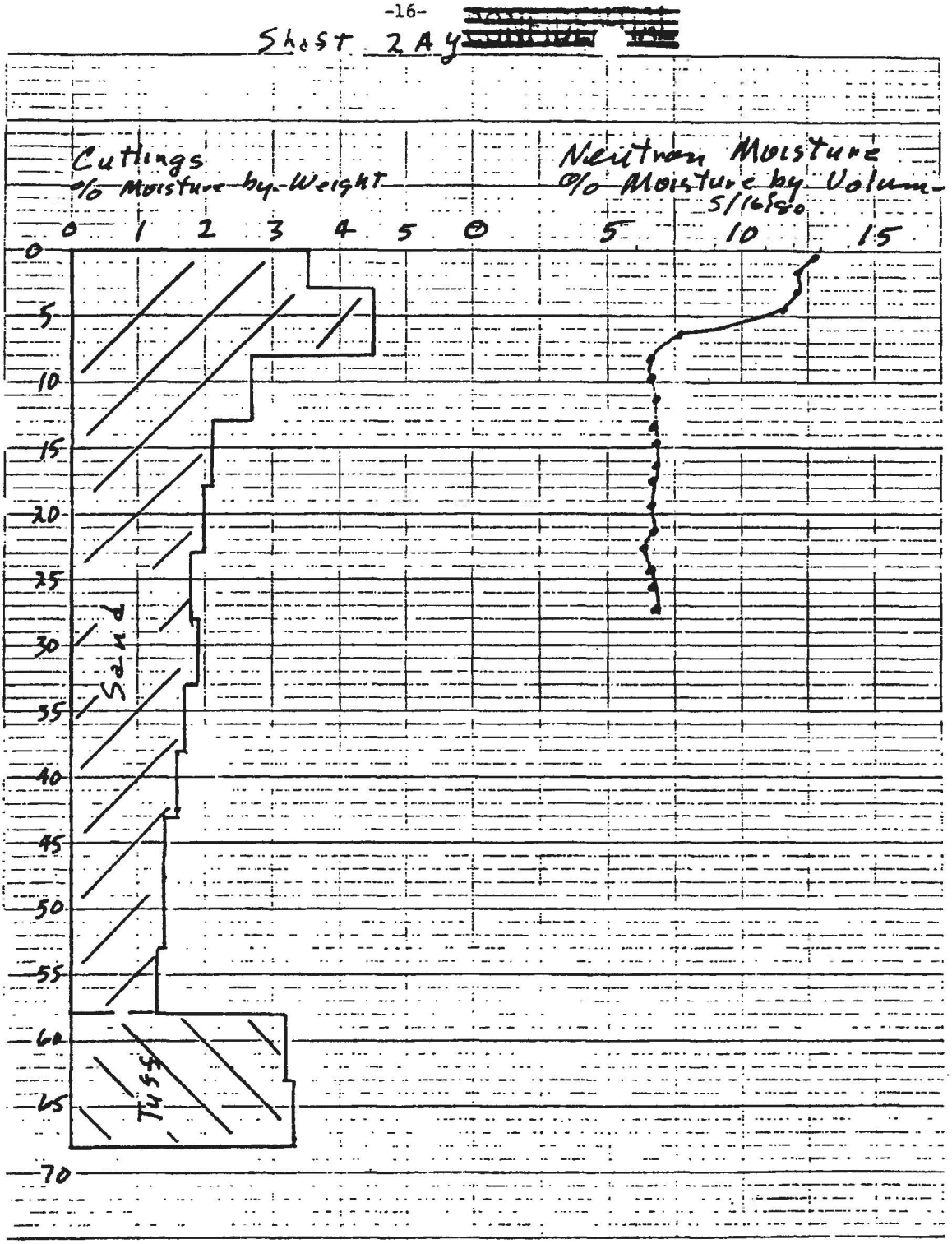


Fig. 8. Geologic and neutron logs of Shaft 2A-Y.

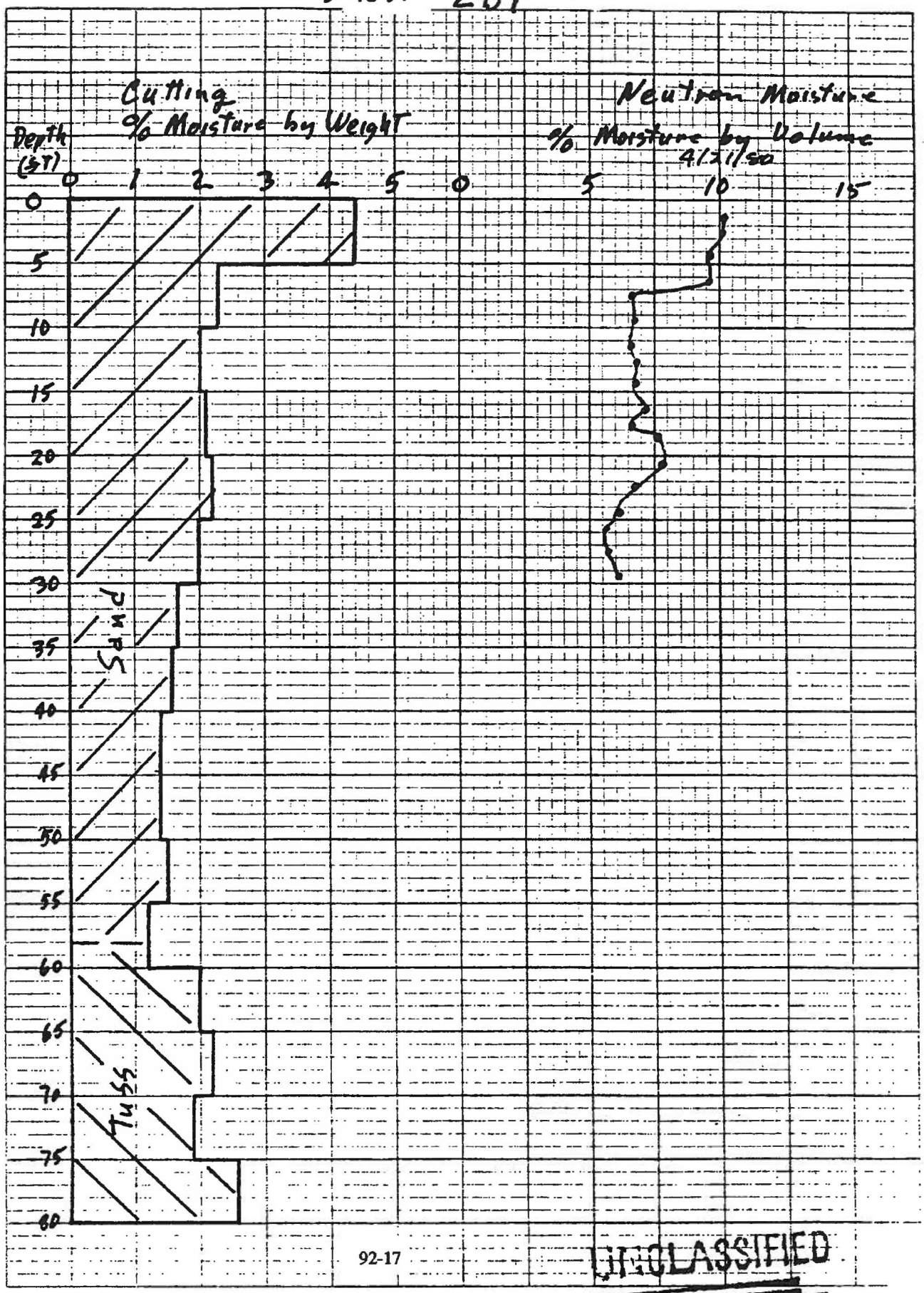


Fig. 9. Geologic and neutron logs of Shaft 2B-Y.

XXXII. SPECIAL TEST HOLES AT TA-49 TO MEASURE BAROMETRIC EFFECTS AND DEFORMATION OF THE TUFF

Two test holes were cored (7 1/4-in. diam) near the eastern edge of TA-49 near well DT-10 (Fig. XXXII-A). The holes were completed in the upper units of the Tshirege Member of the Bandelier Tuff (Fig. XXXII-B). Geologic units are those described by Weir and Purtymun (1962).

Test hole TBM-1 was constructed to measure the barometric effect in the tuff caused by atmospheric pressure changes (Fig. XXXII-C). Test hole TBM-2 was equipped with a Geodetic Biaxial Tiltmeter to determine the deformation of the tuff caused by seismic events. The wellheads for both holes have an 8-ft-sq concrete slab about 6 in. thick. Location is N 1,754,534 E 488,302 (NAD 1927) at an elevation of 7038 ft.

REFERENCES

W. D. Purtymun, Los Alamos National Laboratory, unpublished data (EM-8 field notes), 1993.

J. E. Weir and W. D. Purtymun, "Geology and Hydrology of Technical Area 49, Frijoles Mesa, Los Alamos County, New Mexico," U.S. Geol. Survey Admin. Report (1962).

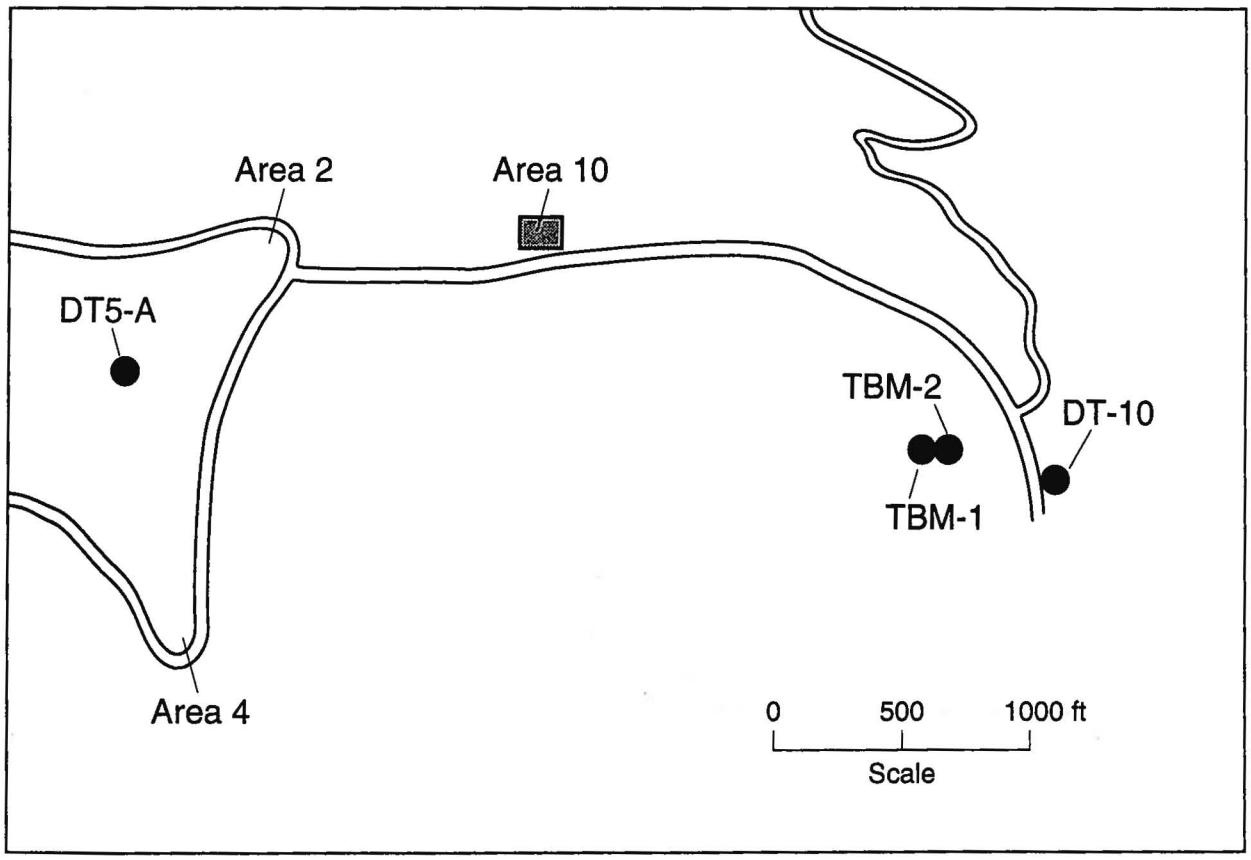


Fig. XXXII-A. Locations of test holes TBM-1 and TBM-2 at TA-49 (Purtymun 1993).

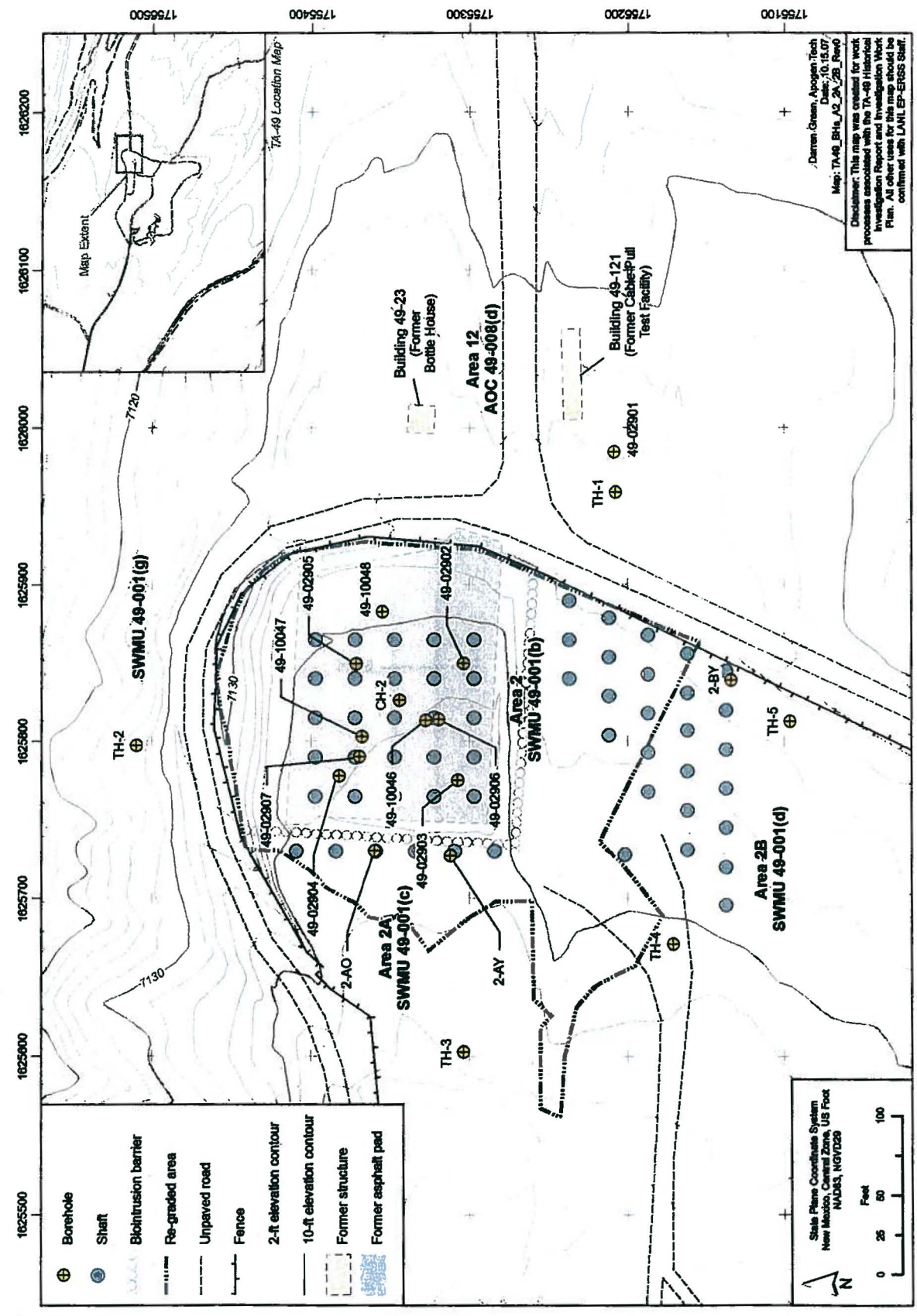


Figure 2.3-3 Areas 2, 2A, 2B, and 12 borehole locations

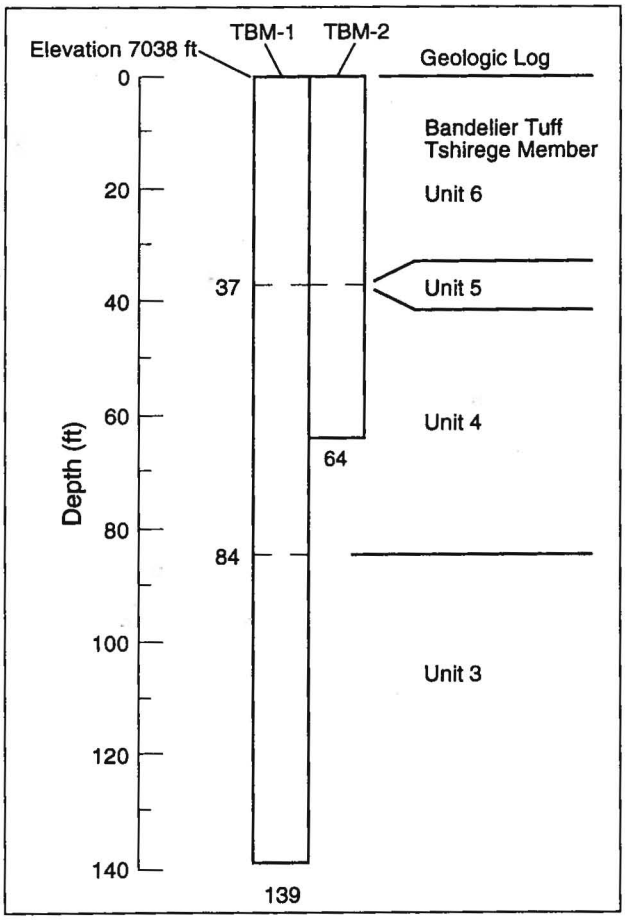


Fig. XXXII-B. Geologic logs of test holes TBM-1 and TBM-2 at TA-49 (Purtymun 1993).

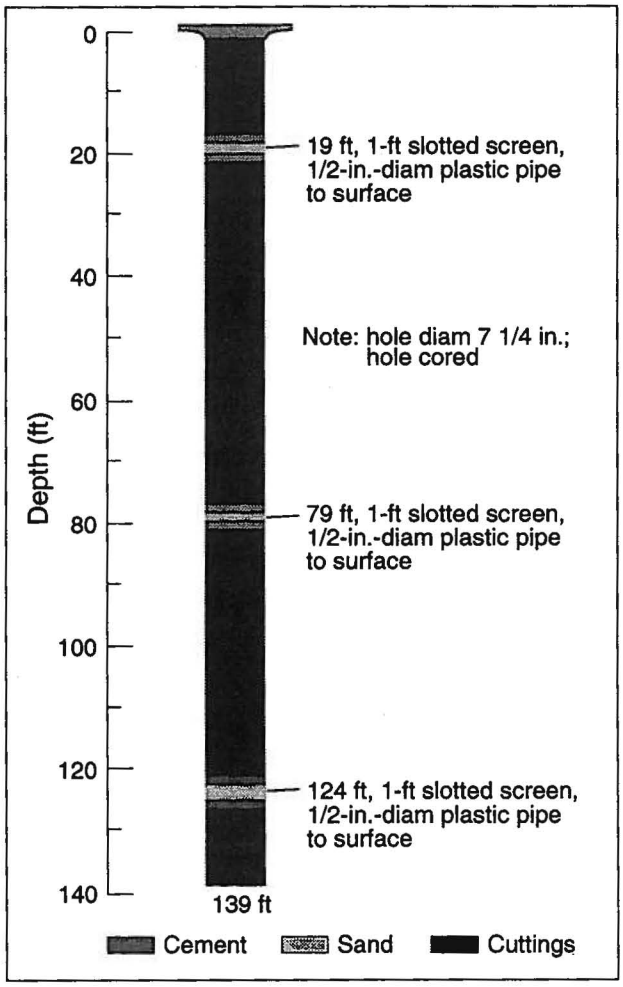


Fig. XXXII-C. Test hole TBM-1 constructed with three zones to measure barometric pressures in the tuff at depths of 19, 79, and 124 ft.

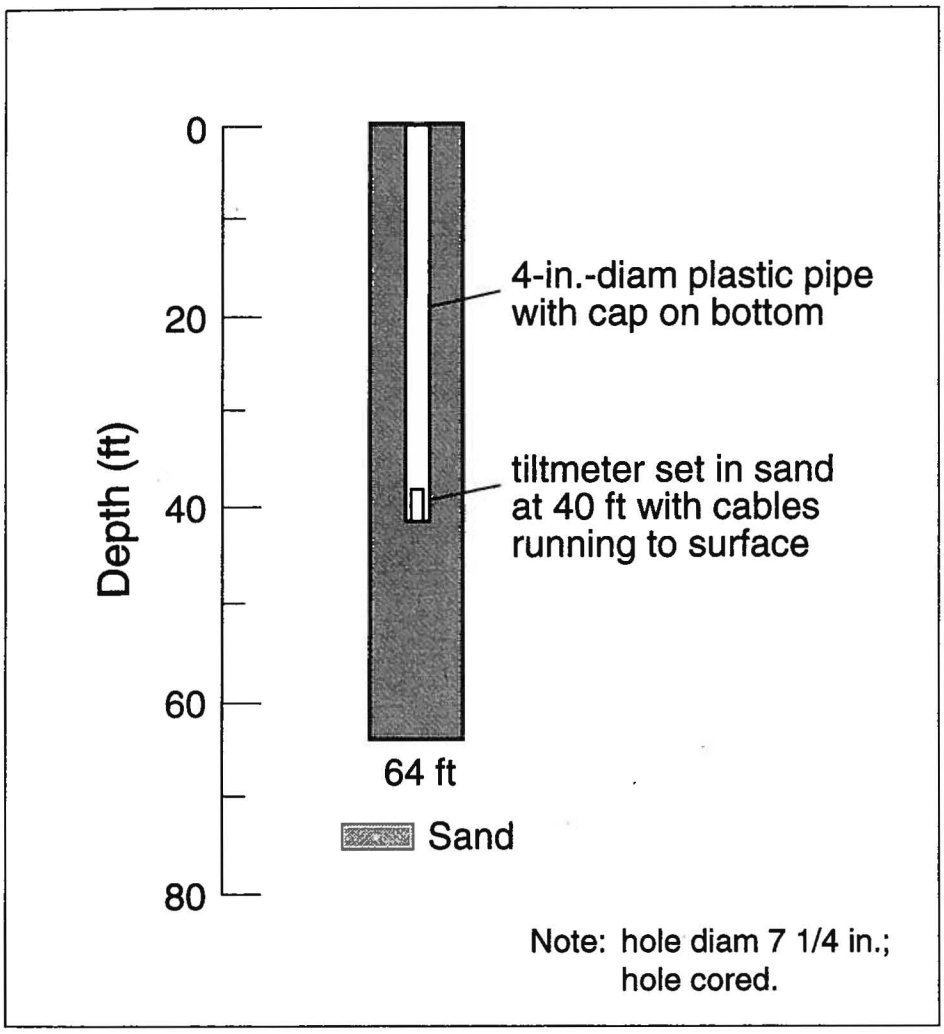


Fig. XXXII-D. Test hole TBM-2 equipped with a biaxial tiltmeter to measure deformation of the tuff at 40 ft.

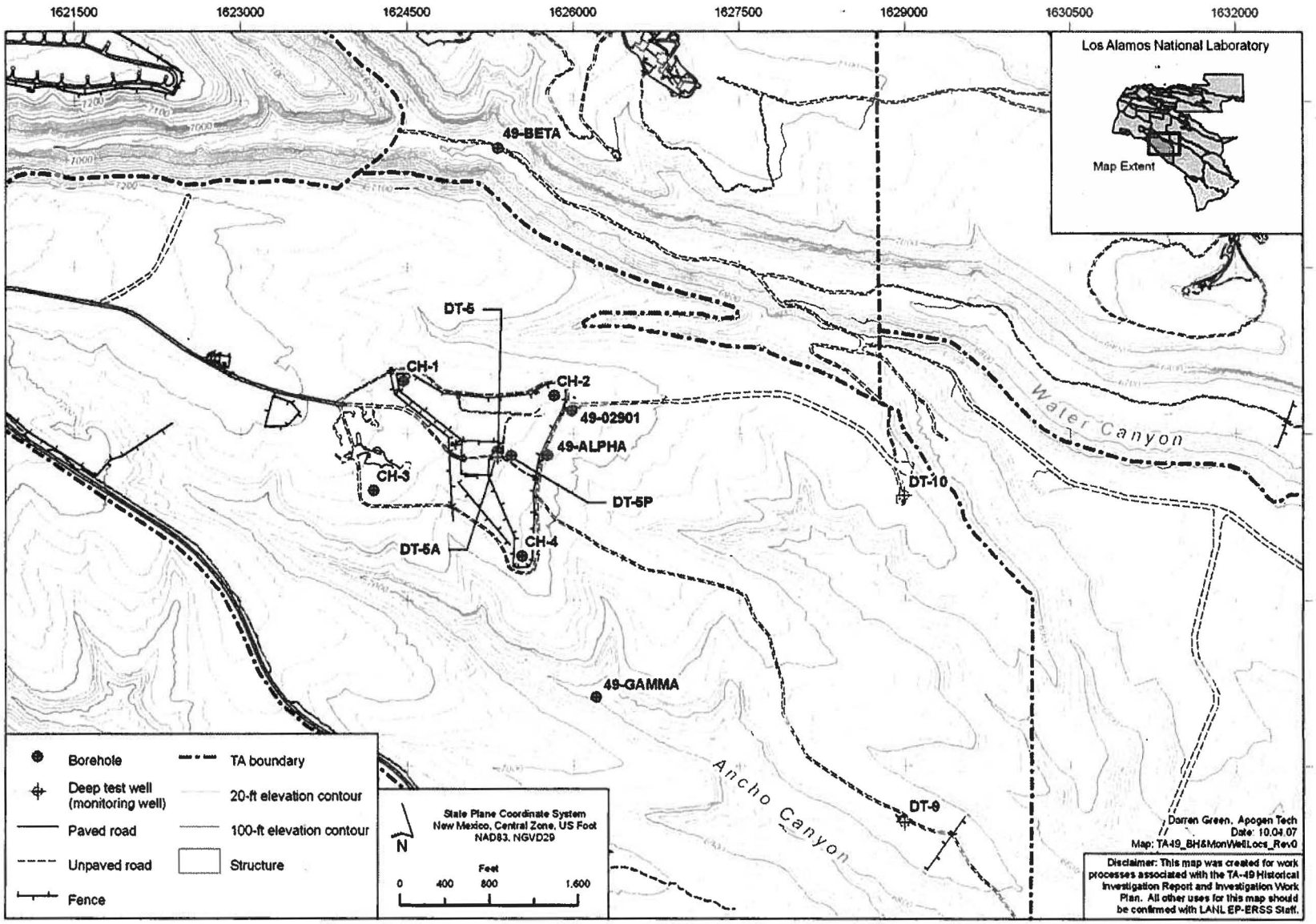
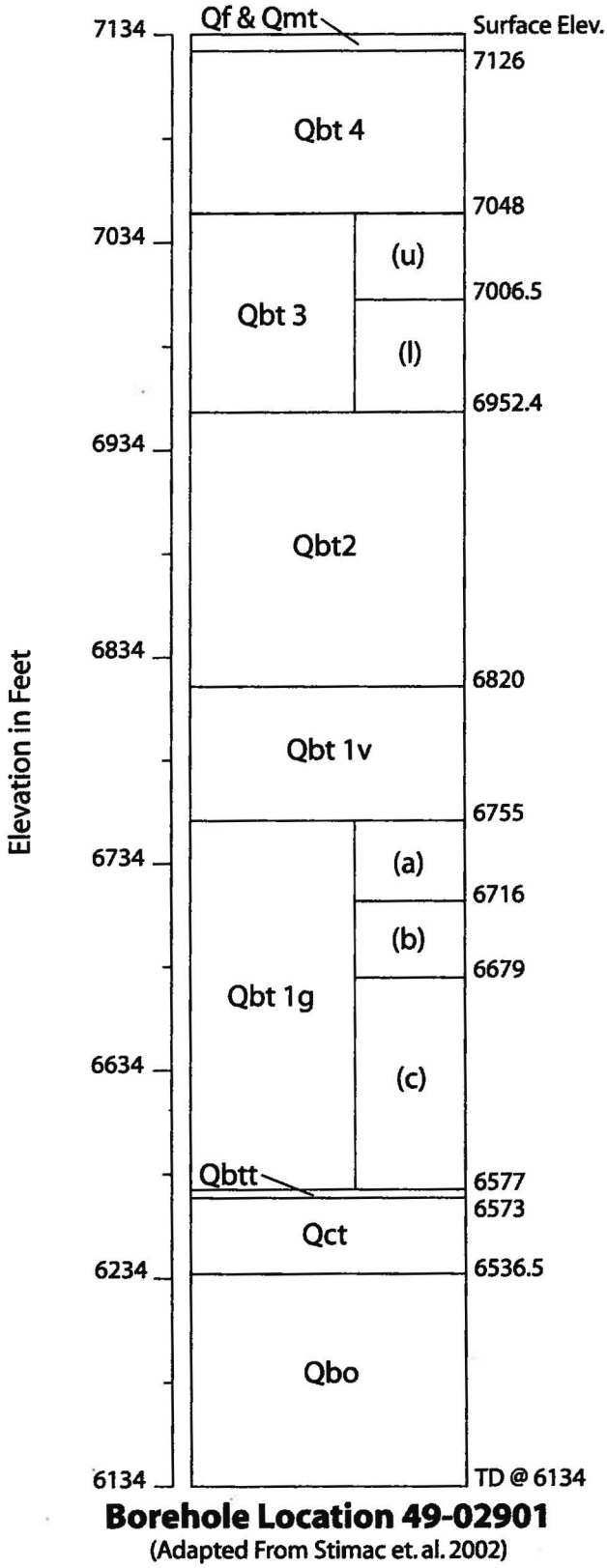


Figure 3.3-1 Locations of deep test wells and select boreholes at TA-49



Source: Adapted from Stimac et al. 2002, 073391.

Figure 2.5-3 Stratigraphy of borehole location 49-02901

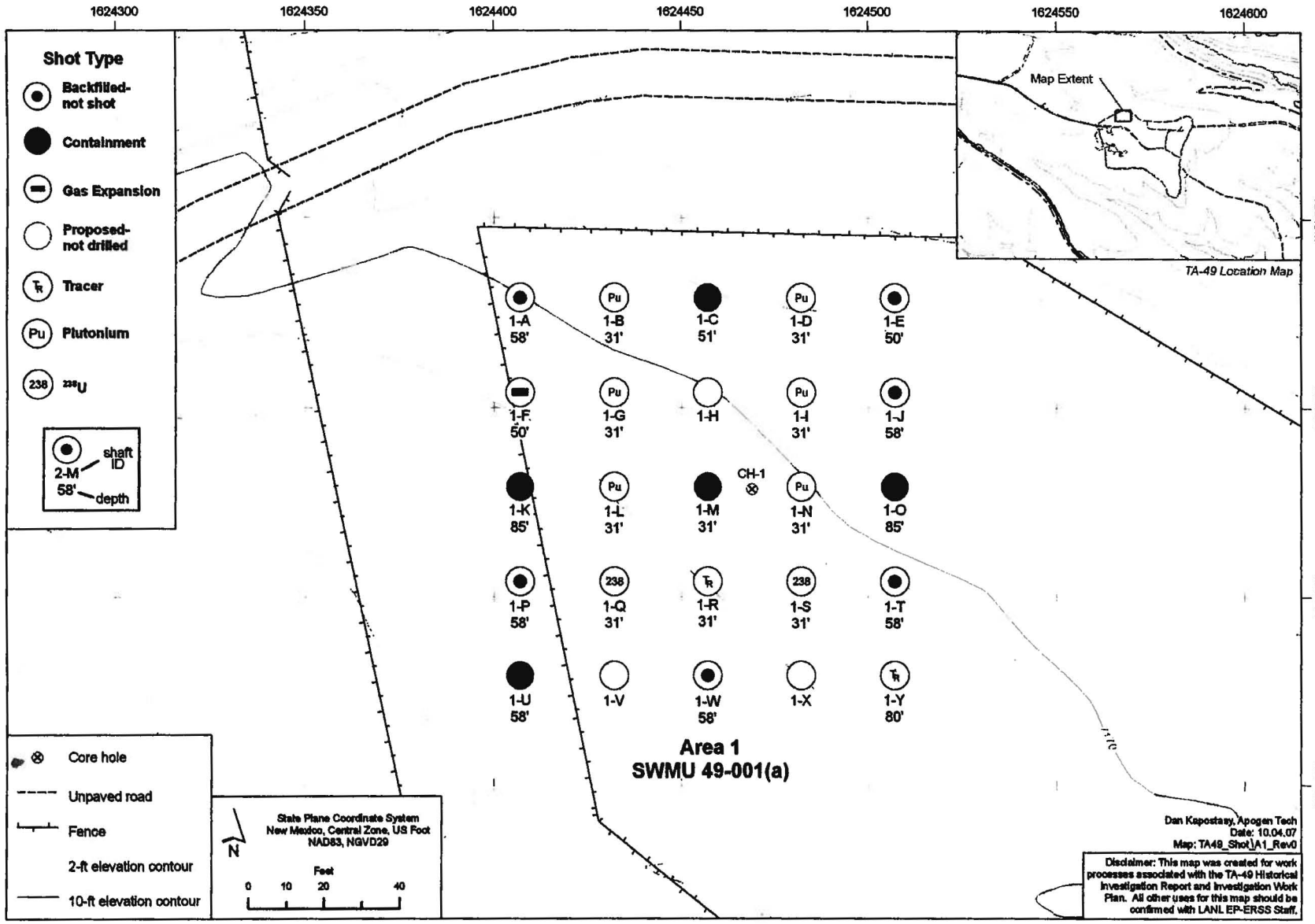


Figure 1.0-3 Area 1 experimental shaft details

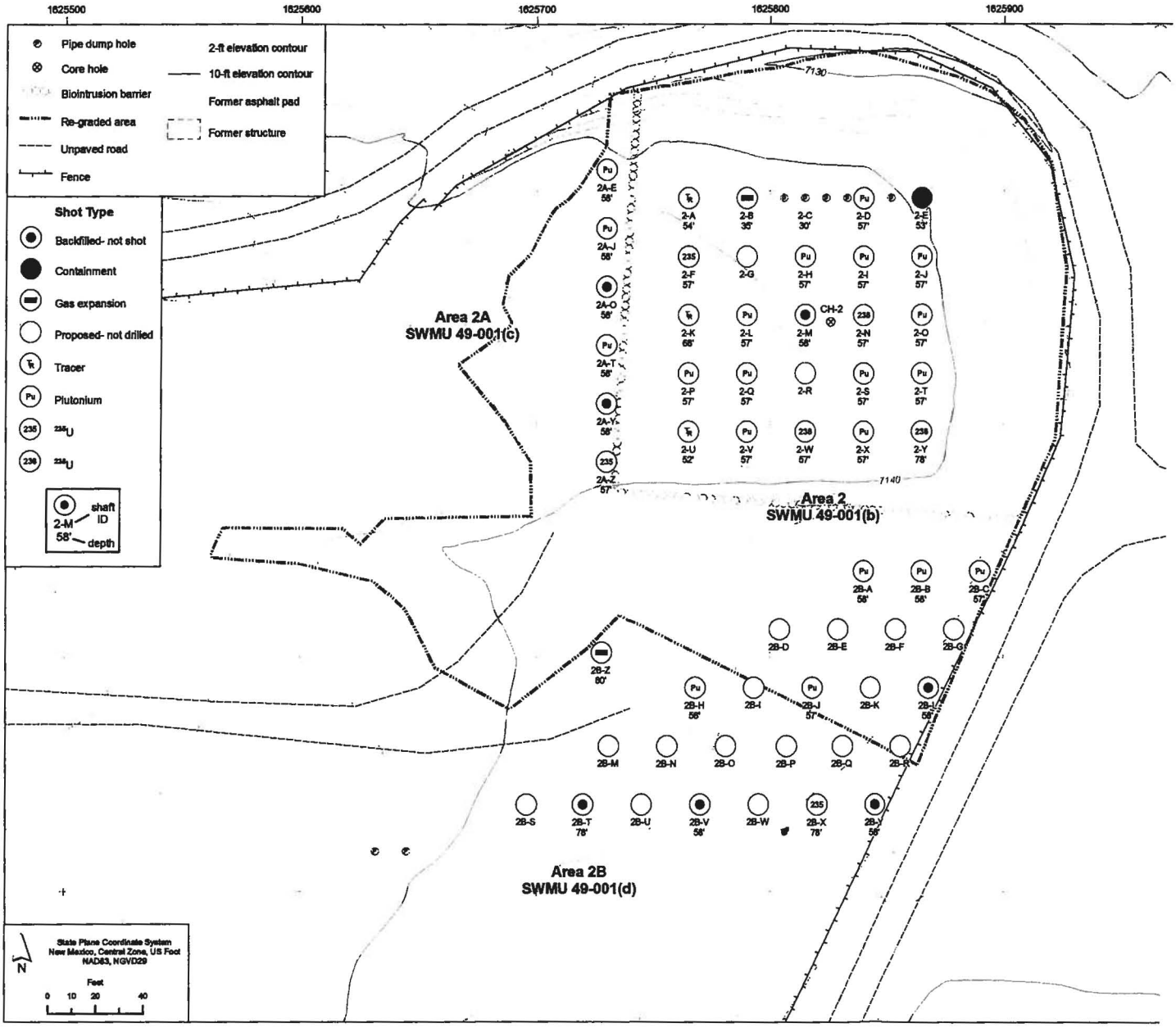


Figure 1.0-4 Area 2, Area 2A, and Area 2B experimental shaft details

EP2007-0552

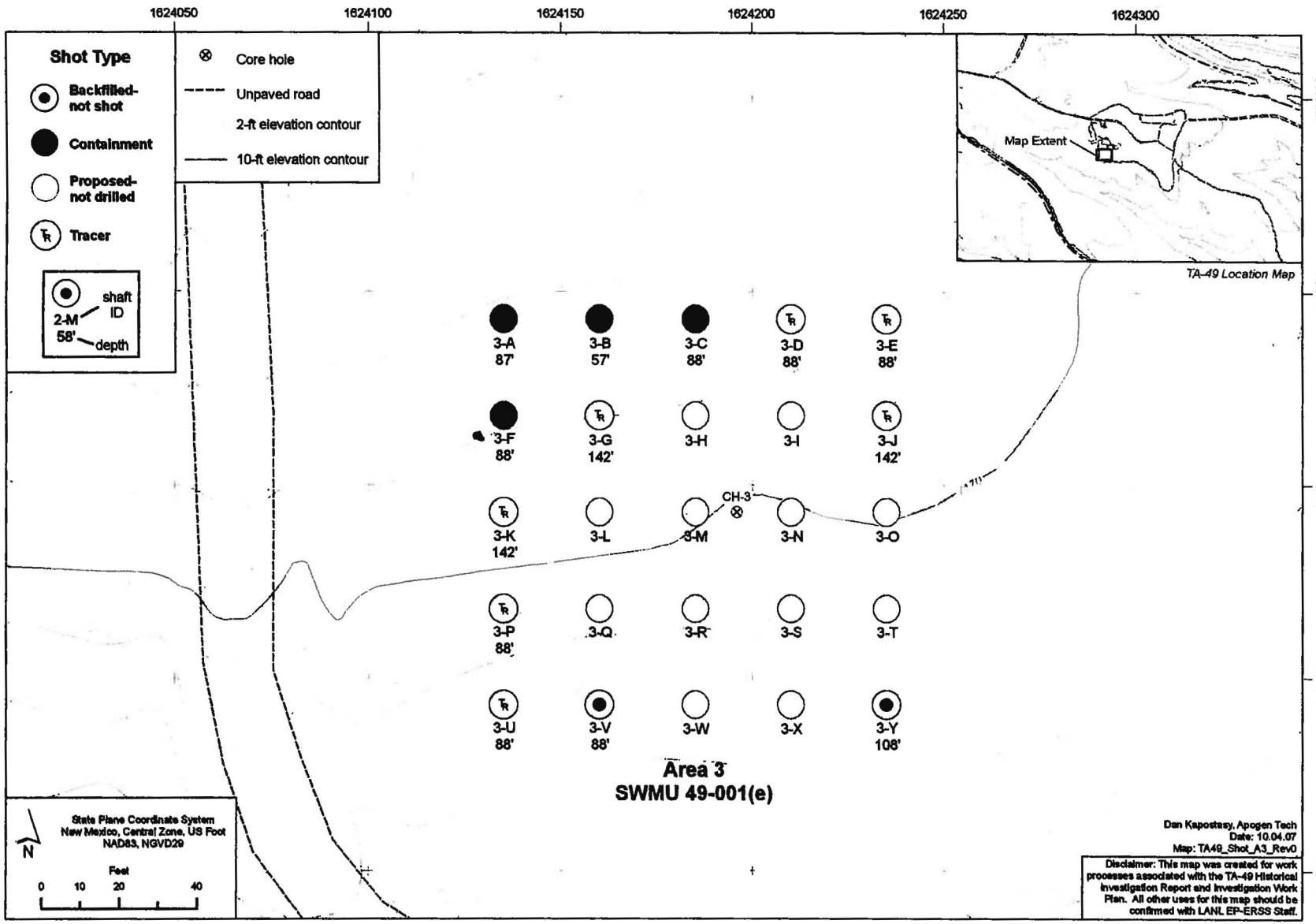


Figure 1.0-5 Area 3 experimental shaft details

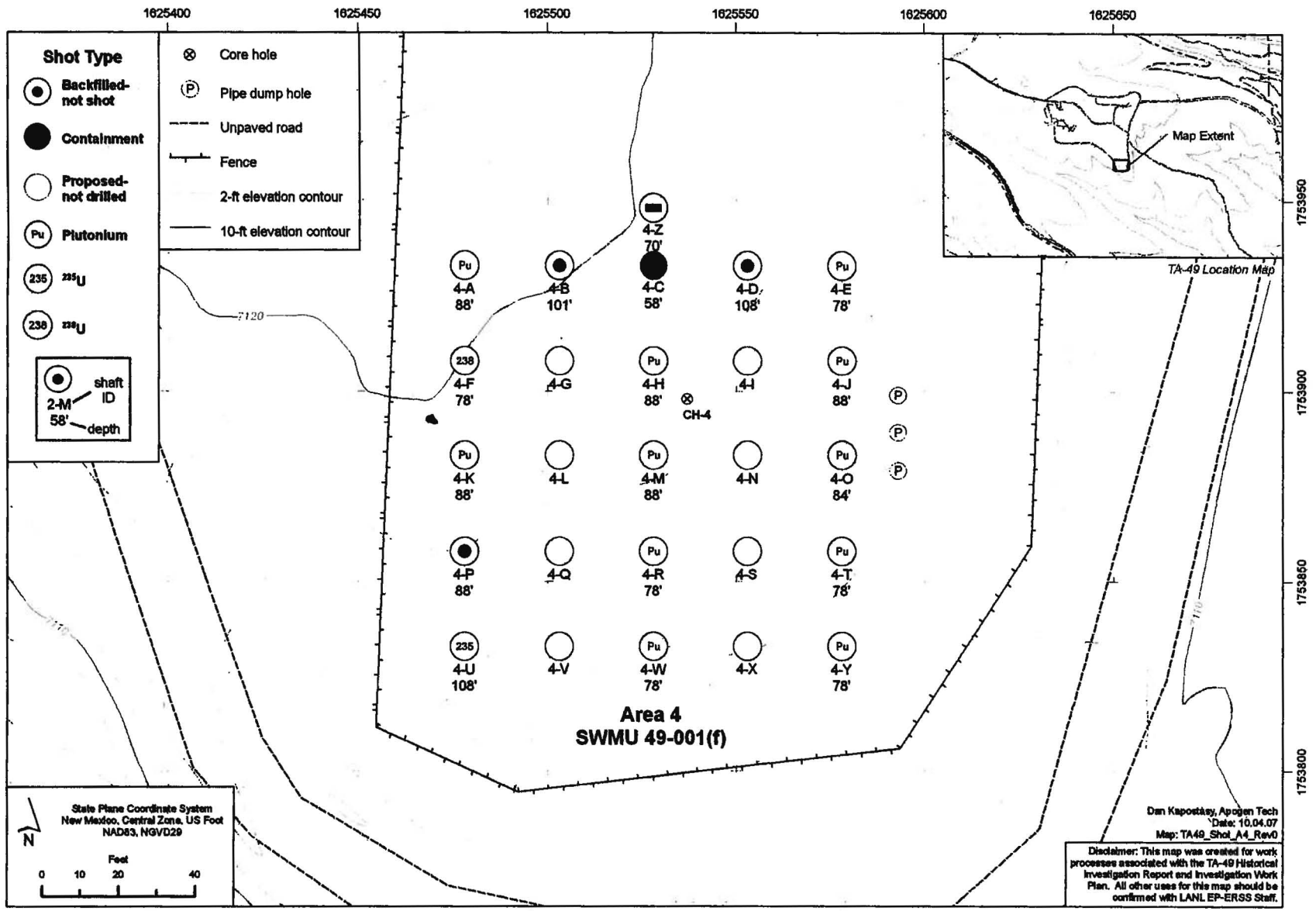


Figure 1.0-6 Area 4 experimental shaft details

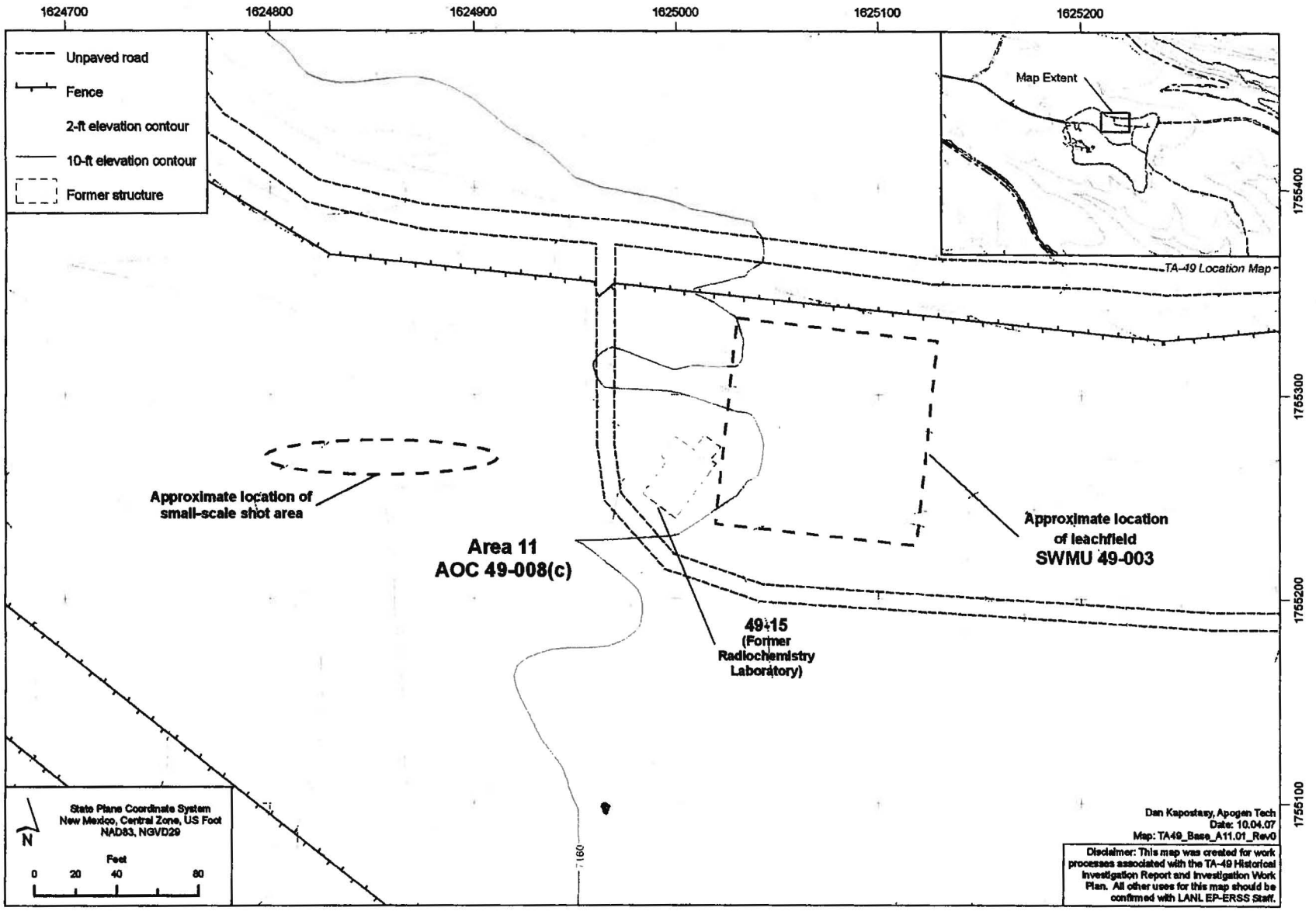


Figure 2.4-2 General site layout of Area 11

APPENDIX A

TA-21 Distillation Borehole

References for Appendix A Information

Borehole	MAP	GEOLOGIC LOG	CONSTRUCTION DIAGRAM	OTHER
TA-21 Distillation borehole	1	not found – see general geologic cross section - 2	not found	na

1. Purtymun, W.D., 1995, Geologic and Hydrologic Records of Observation Wells, Test Holes, Test Wells, Supply Wells, Springs, and Surface Water Stations in the Los Alamos Area, Los Alamos National Laboratory Report LA-12883-MS, Los Alamos National Laboratory, Los Alamos, New Mexico, January 1995.

2. Broxton, D.E. and Eller, P.G., 1995, Earth Science Investigations for Environmental Restoration – Los Alamos National Laboratory Technical Area 21, Los Alamos National Laboratory report LA-12934-MS, Los Alamos National Laboratory, Los Alamos, New Mexico, June 1995.

XVI. CARBON ISOTOPE PRODUCTION HOLES AT TA-21 AND TA-46

Carbon isotope production holes were drilled at TA-21 and TA-46 (Fig. XVI-A). The holes were used as part of a carbon 13 production plant using carbon monoxide distillation (Armstrong et al. 1970).

The preliminary testing and production of carbon 13 occurred at TA-21 building SM-3. In 1969 a hole to hold the distillation column was drilled in the northwest stairwell. The 36-in.-diam hole was augered to a depth of 125 ft. An 18-in.-diam casing was cemented in the hole. The casing extended about 15 ft above the floor level. The hole was completed in the Tshirege Member of the Bandelier Tuff. The hole was dry.

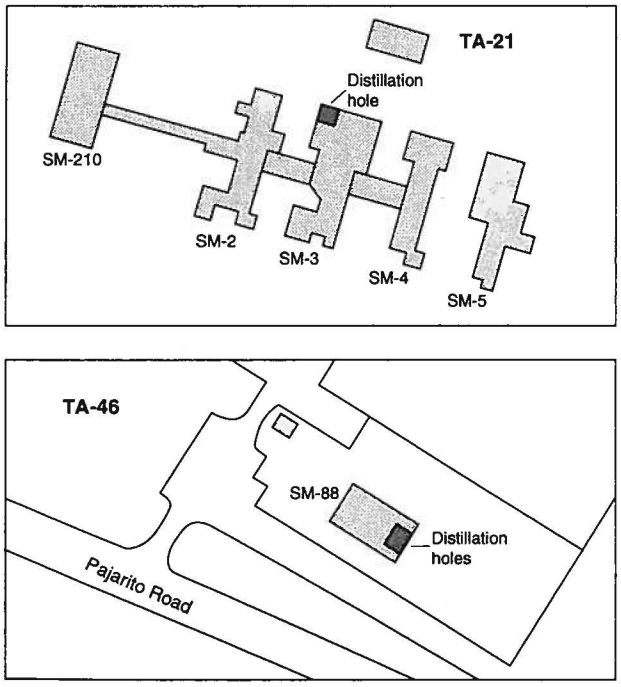


Fig. XVI-A. Distillation holes at TA-21 and TA-46.

A production plant was built at TA-46 in building SM-88 in 1971. The eastern end of the building contained a large bay about 38 ft in height. The holes were drilled in the bay with a spacing of about 20 ft. The holes were reamed out to a 16-in. diameter to a depth of about 747 ft using a mud rotary. A 13 3/8-in.-diam casing was cemented in the holes.

The holes at TA-46 penetrated the total thickness of the Bandelier Tuff and were completed into the top of the Puye Conglomerate. The holes were dry (Purtymun 1994).

Geologic Log of TA-46 Holes

Elevation 7105 ft

	Thickness (ft)	Depth
Bandelier Tuff		
Tshirege Member	360	360
Otowi Member	335	695
Guaje Member	32	727
Puye Conglomerate		
Sand, gravel, and boulders	20	747

REFERENCES

D. E. Armstrong, A. C. Briesmeister, B. B. McInteer, and R. M. Potter, "A Carbon 13 Production Plant Using Carbon Monoxide Distillation," Los Alamos Scientific Laboratory report LA-4391 (1970).

W. D. Purtymun, "Source Document Compilation: Los Alamos Investigations Related to the Environment, Engineering, Geology, and Hydrology, 1961–1990," Los Alamos National Laboratory report LA-12733-MS (1994), chapters 21 and 76.

TABLE XVI-A. Locations and Elevations (NAD 1927)

TA-21	N 1,774,500	E 492,000	7150 ft
TA-46	N 1,765,500	E 499,500	7105 ft

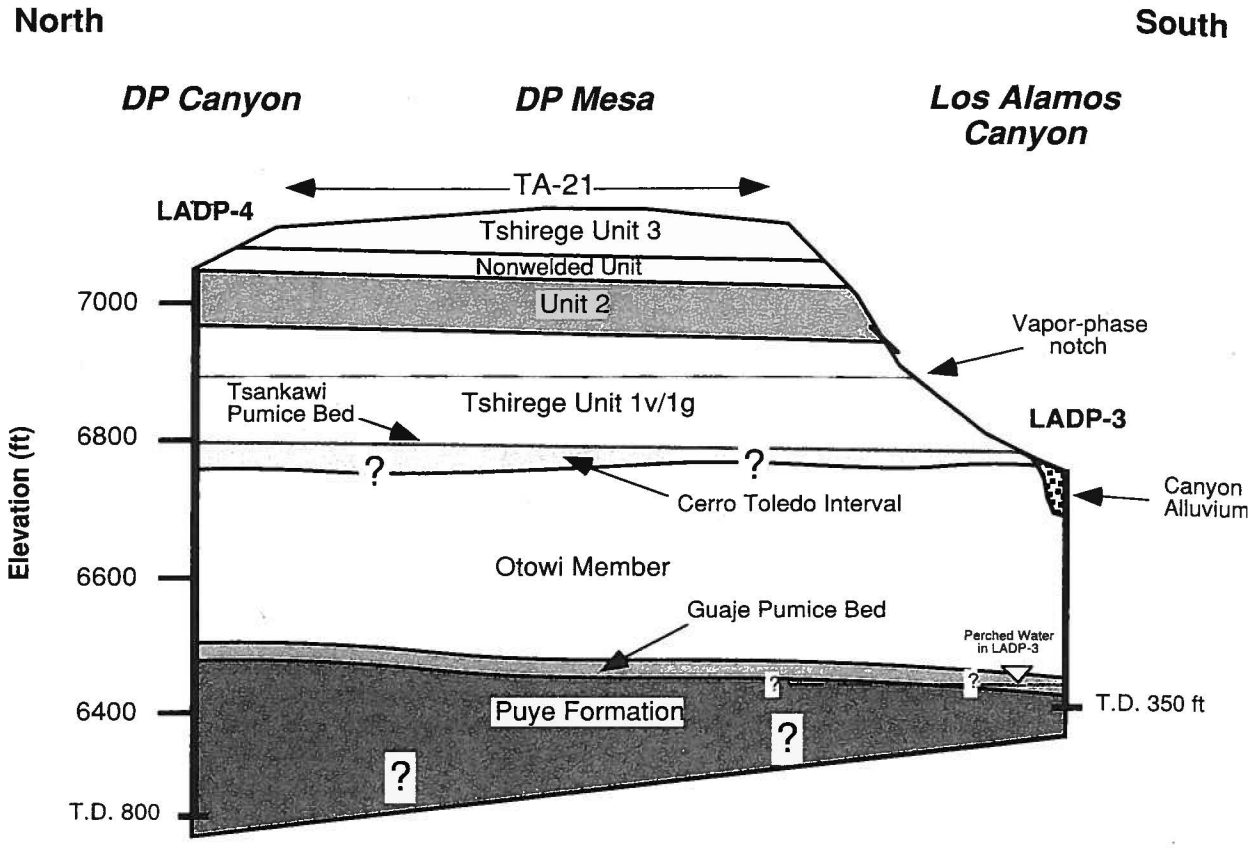


Fig. 12. N-S geologic cross section of TA-21 showing the distribution of principal stratigraphic units. Perched groundwater occurs in the Guaje Pumice Bed under Los Alamos Canyon, but its extent northward under the industrialized areas of DP Mesa is not known.

Pumice Bed at LADP-3 may flow downgradient into the Puye Formation in other parts of Los Alamos Canyon. In the geologic log for well Otowi-4, Stoker *et al.* (1992) observed, *"Some perched water was visible in a video log of the 48-in. hole at about 253 ft where the water cascaded in from large gravel."* The perched groundwater in Otowi-4 occurs in the Puye Formation 0.75 miles downcanyon and 64 ft lower in elevation than the Guaje Pumice Bed groundwater in LADP-3 (Fig. 13). Although these occurrences of perched groundwater may be related, this hypothesis cannot be demonstrated with certainty using the data currently available.

At this point in the investigation, the source of tritium in the Guaje Pumice Bed groundwater in Los Alamos Canyon has not been determined. The Laboratory's TA-2 and TA-41 are located on the floor of Los Alamos Canyon upgradient of the tritium contamination detected at LADP-3. TA-2 is a possible contamination source because it was the source of tritium releases in the past. In January 1992, it was determined that tritium-laden primary coolant water from the Omega West Reactor at TA-2 was leaking into the alluvial groundwater. Surface water and alluvial groundwater from the canyon bottom are possible sources of recharge to the Guaje Pumice Bed groundwater. TA-21 is a less likely source for the tritiated groundwater because thick, unsaturated tuffs, lack of available surface and groundwater, and low recharge rates could serve as effective barriers to contaminant transport from the mesa top.

APPENDIX B

TA-46 Distillation Boreholes

References for Appendix B Information

Borehole	MAP	GEOLOGIC LOG	CONSTRUCTION DIAGRAM
TA-46 Distillation boreholes	1, 2	1, 3	not found

1. Purtymun, W.D., 1995, Geologic and Hydrologic Records of Observation Wells, Test Holes, Test Wells, Supply Wells, Springs, and Surface Water Stations in the Los Alamos Area, Los Alamos National Laboratory Report LA-12883-MS, Los Alamos National Laboratory, Los Alamos, New Mexico, January 1995.

2. Los Alamos National Laboratory Engineering Drawing Number C-39824-003-C-0, 1971, Expanded Carbon 13 Facility Floor Plan, Building WA-88, TA-46, Los Alamos National Laboratory, Los Alamos, New Mexico, October 1971.

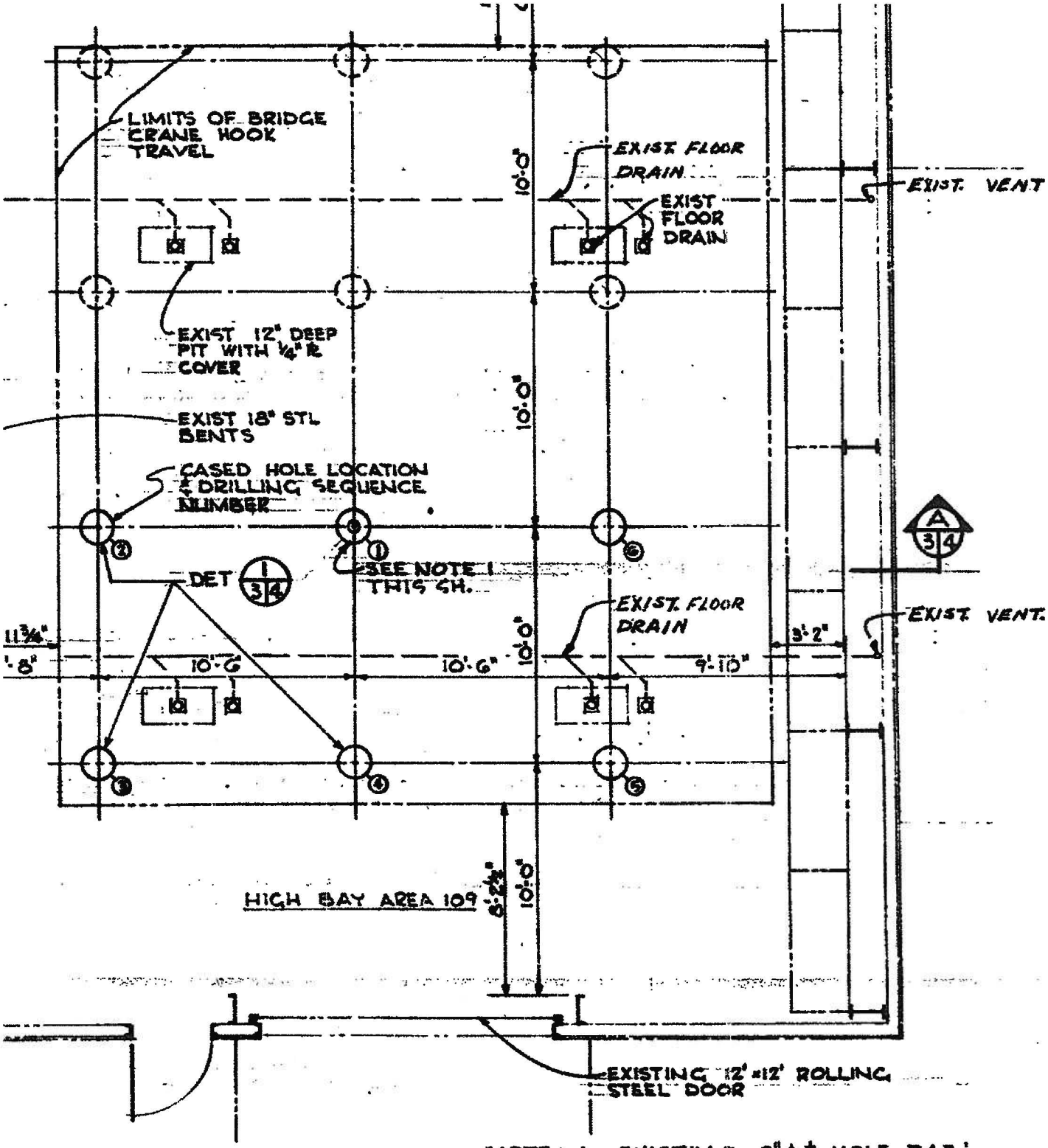
3. Los Alamos National Laboratory, 1993, LANL, RCRA Facility Investigation Work Plan for Operable Unit 1140, Environmental Restoration Program, Los Alamos National Laboratory report LA-UR-93-1940, Los Alamos National Laboratory, Los Alamos, New Mexico, August 1993.

TA-46 DISTILLATION BOREHOLES

Purtymun (1994, 1995) indicates that there were several boreholes drilled inside the east high bay of building SM-88 at TA-46 (now called TA-46-88), but he did not state explicitly the number of boreholes drilled and cased for the carbon monoxide distillation process.

Engineering drawing C-39824-003 from October 1971 (on following page) shows six 8-in. diameter boreholes, 747 ft deep. A drawing note (#1) states that the boreholes were to be reamed out to larger 16-in. diameter holes and fitted with 14-in. casing to total depth in order to conduct carbon monoxide distillation . The boreholes are spaced at 10-ft intervals in the southern end of the high bay.

According to Purtymun's 1994 writeup, any fluids that might be released from a failure in the distillation system would be contained in the cased holes.



NOTE: 1. EXISTING 8"ϕ ± HOLE 747' DEEP TO BE REAMED OUT TO 18"ϕ AND 14"ϕ CASING INSTALLED TO T.D. GROUT BETWEEN EXIST CMP & CASING AND BACKFILL BETWEEN CMP & SOIL.

2. THE BLDG. 5 TON CAPACITY BRIDGE CRANE IS AVAILABLE FOR USE BY THE CONTRACTOR. CONTRACTOR SHALL BE RESPONSIBLE FOR ANY DAMAGE TO THE CRANE.

3. PROTECT FLOOR DRAINS & PITS FROM DRILLING MUD.

3

DWG C-39824-003

GRAPHIC SCALE

XVI. CARBON ISOTOPE PRODUCTION HOLES AT TA-21 AND TA-46

Carbon isotope production holes were drilled at TA-21 and TA-46 (Fig. XVI-A). The holes were used as part of a carbon 13 production plant using carbon monoxide distillation (Armstrong et al. 1970).

The preliminary testing and production of carbon 13 occurred at TA-21 building SM-3. In 1969 a hole to hold the distillation column was drilled in the northwest stairwell. The 36-in.-diam hole was augered to a depth of 125 ft. An 18-in.-diam casing was cemented in the hole. The casing extended about 15 ft above the floor level. The hole was completed in the Tshirege Member of the Bandelier Tuff. The hole was dry.

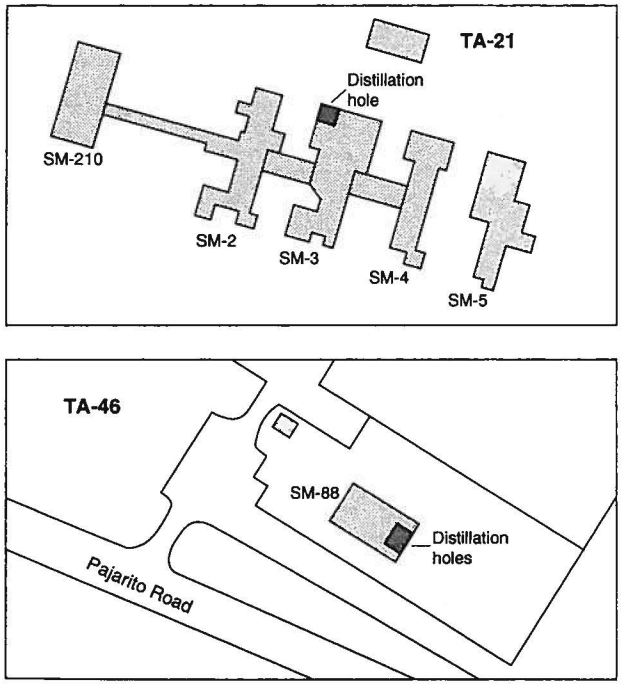


Fig. XVI-A. Distillation holes at TA-21 and TA-46.

A production plant was built at TA-46 in building SM-88 in 1971. The eastern end of the building contained a large bay about 38 ft in height. The holes were drilled in the bay with a spacing of about 20 ft. The holes were reamed out to a 16-in. diameter to a depth of about 747 ft using a mud rotary. A 13 3/8-in.-diam casing was cemented in the holes.

The holes at TA-46 penetrated the total thickness of the Bandelier Tuff and were completed into the top of the Puye Conglomerate. The holes were dry (Purtymun 1994).

Geologic Log of TA-46 Holes

Elevation 7105 ft

	Thickness (ft)	Depth
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W. D. Purtymun, "Source Document Compilation: Los Alamos Investigations Related to the Environment, Engineering, Geology, and Hydrology, 1961–1990," Los Alamos National Laboratory report LA-12733-MS (1994), chapters 21 and 76.

TABLE XVI-A. Locations and Elevations (NAD 1927)

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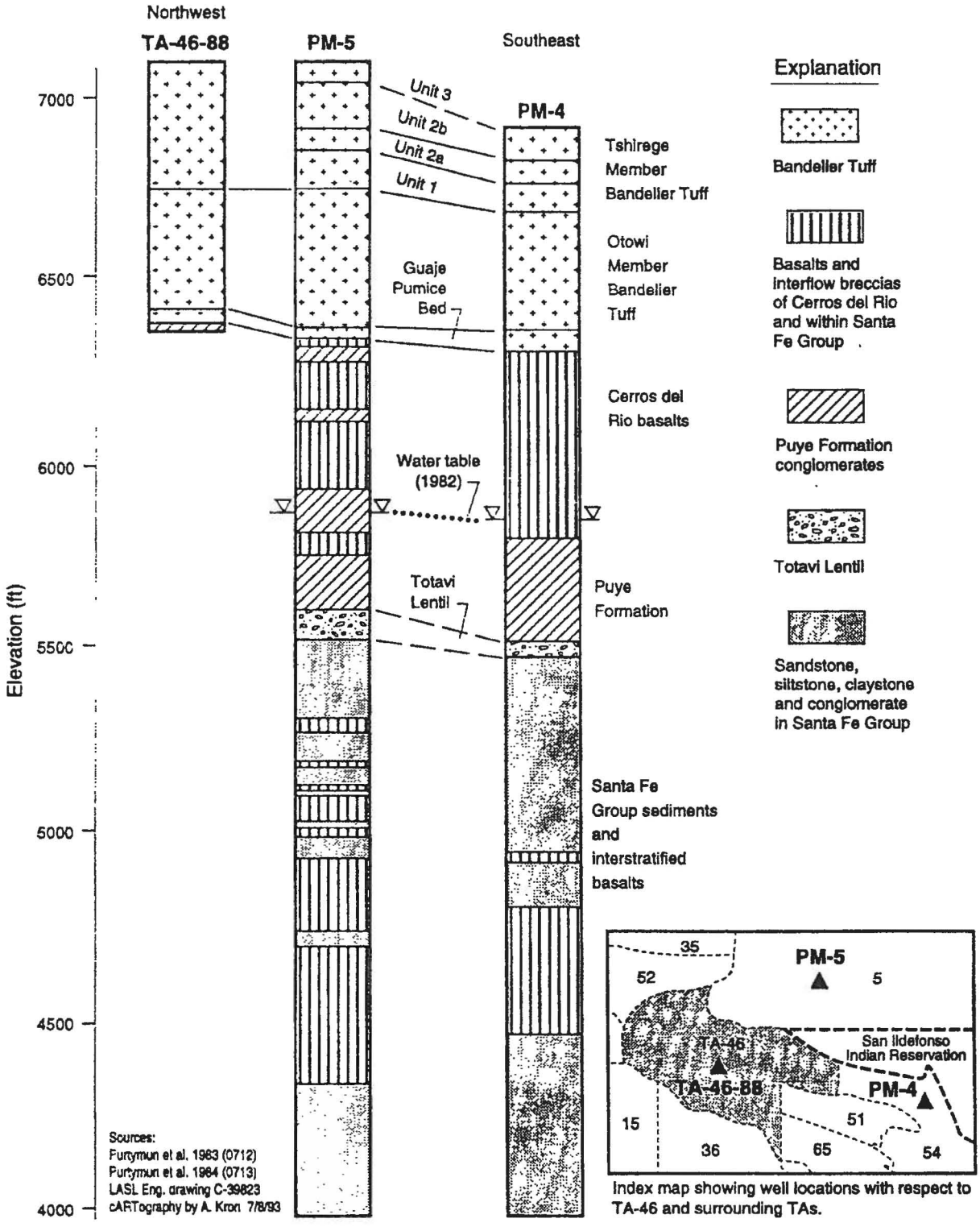

Index map showing well locations with respect to TA-46 and surrounding TAs.

Fig. 3-4. Lithologic logs for borings near TA-46.

APPENDIX C

Boreholes TH-5, TH-6 AND TH-7

References for Appendix C Information

Boreholes	MAP	GEOLOGIC LOG	CONSTRUCTION DIAGRAM
TH-5, TH-6, TH-7	1	1	not found

1. Purtymun, W.D., 1995, Geologic and Hydrologic Records of Observation Wells, Test Holes, Test Wells, Supply Wells, Springs, and Surface Water Stations in the Los Alamos Area, Los Alamos National Laboratory Report LA-12883-MS, Los Alamos National Laboratory, Los Alamos, New Mexico, January 1995.

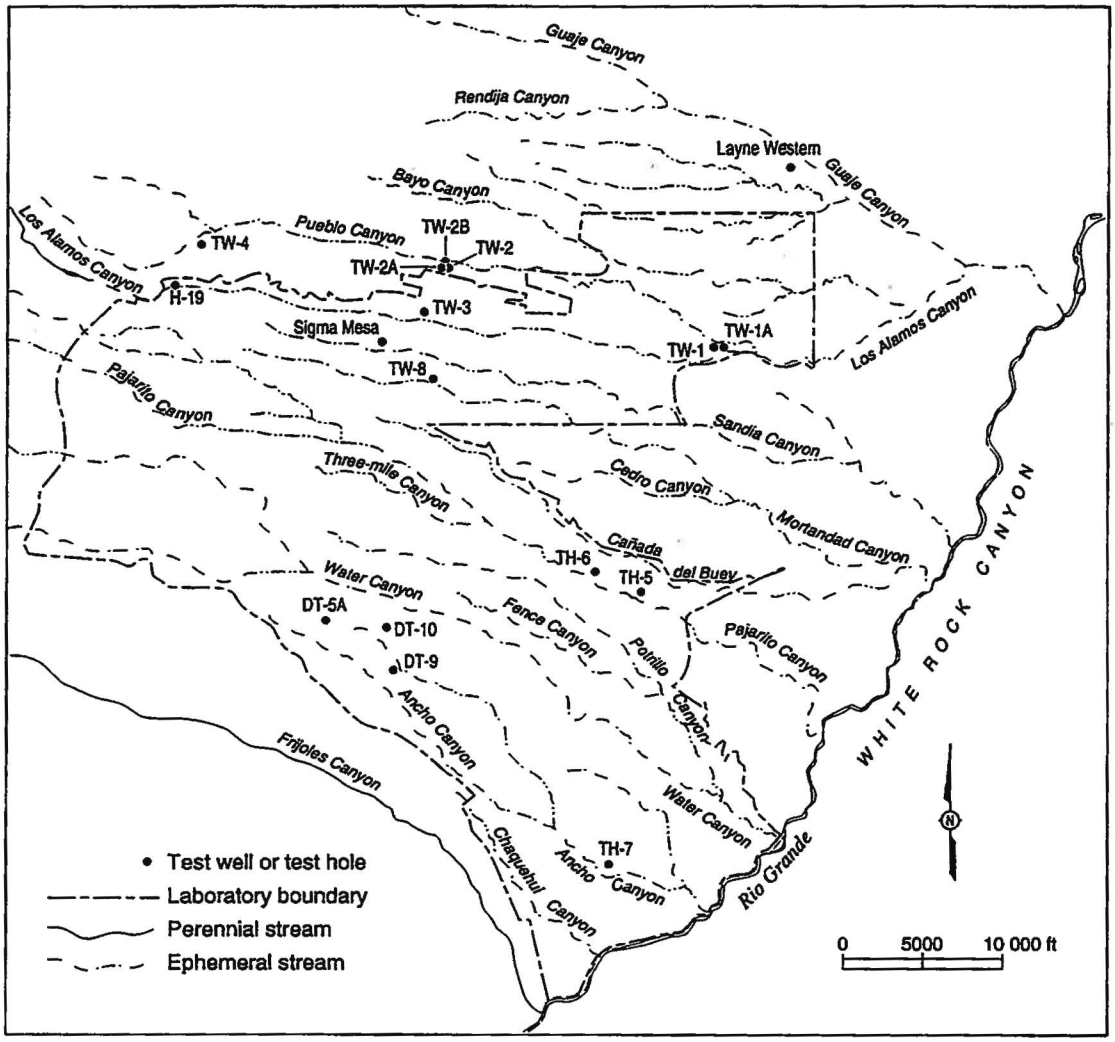

Fig. XVII-A. Test wells and test holes on the Pajarito Plateau.

REFERENCES

E. H. Baltz, J. H. Abrahams, and W. D. Purtymun, "Preliminary Report on the Geology and Hydrology of Mortandad Canyon, Los Alamos, New Mexico, with Special Reference to Disposal of Liquid Low-Level Radioactive Wastes," U.S. Geological Survey Open-File Report (1963).

Black and Veatch (Consulting Engineers), "Ground-Water Observation Wells, Los Alamos, New Mexico," Administrative Report prepared for the U.S. Atomic Energy Commission (1950).

R. L. Griggs, "Geology and Ground-Water Resources of the Los Alamos Area, New Mexico," U.S. Geol. Survey Admin. Report to the U.S. Atomic Energy Commission (1955).

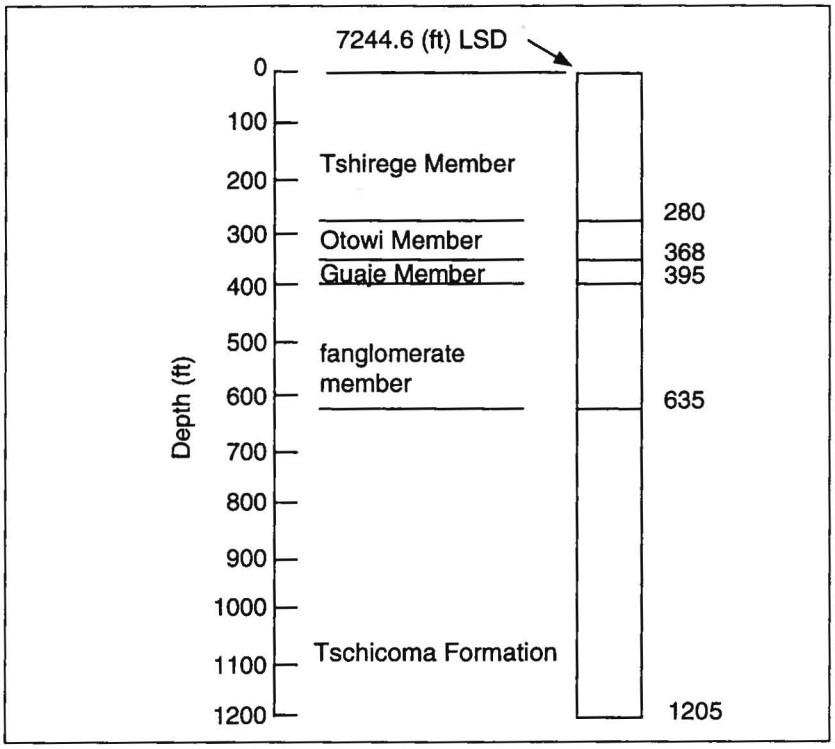

Fig. XVII-E. Geologic log of test well TW-4, completed March 1950, water level 1171 ft (Griggs 1955).

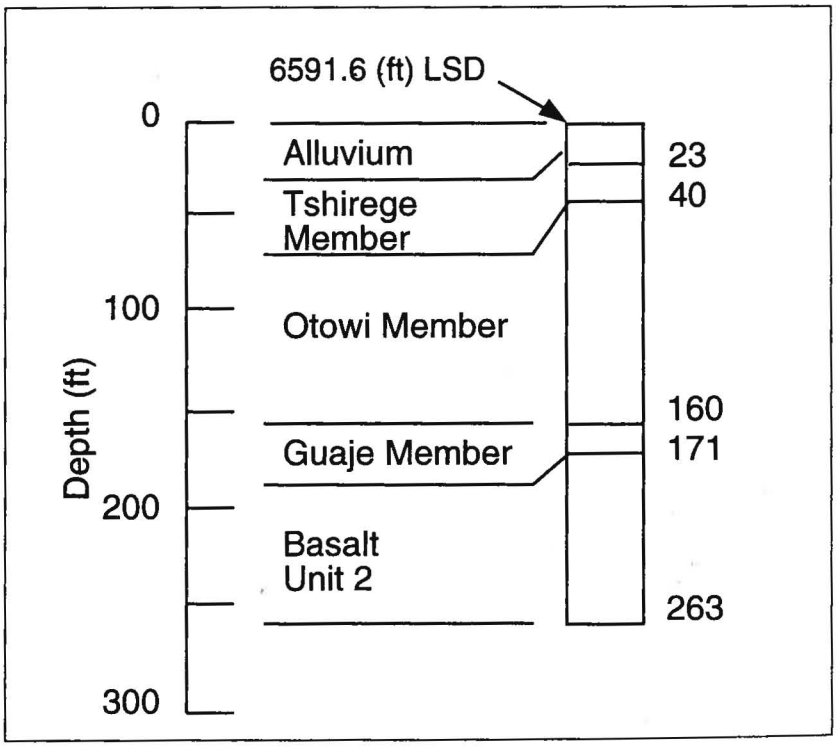

Fig. XVII-F. Geologic log of test hole TH-5, completed March 1950, dry (Griggs 1955).

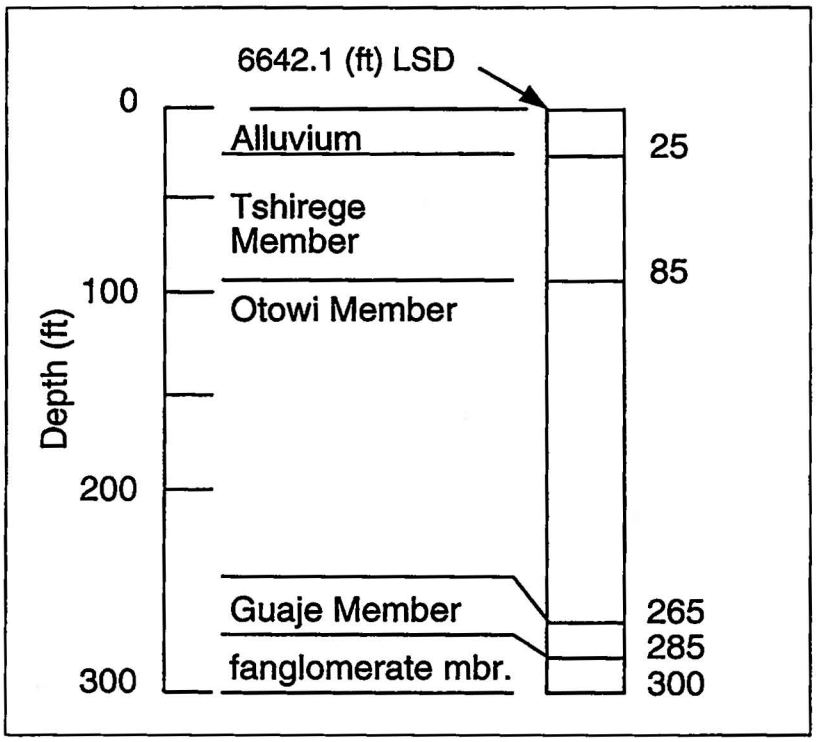

Fig. XVII-G. Geologic log of test hole TH-6, completed March 1950, dry (Griggs 1955).

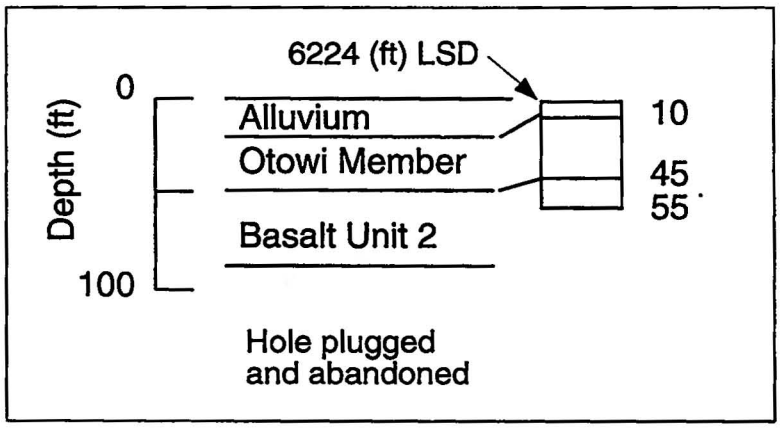

Fig. XVII-H. Geologic log of test hole TH-7, completed April 1950, dry (Griggs 1955).

TABLE XVII-B. Geologic Logs and Construction Data for Test Wells and Test Holes on the Pajarito Plateau (15 Test Wells and Test Holes) (Continued)

7. Test Well TW-4 (Continued)

Casing Schedule

Inner Diam (in.)	Depth (ft)
16	0–109
12	0–288
10	0–633
6	0–1195

10 ft of 6-in.-diam screen run from the bottom of the 6-in. casing, from 1195 to 1205 ft.

Geophysical Log
Gamma-ray (5-7-60), Files ESH-18.
Note: Water level 1168.9 ft (5-7-60); water level 1172 ft (7-20-92).

8. Test Hole TH-5

Elevation (LSD): 6591.6 ft — Water Level: Dry (1950)

Geologic Log	Thickness (ft)	Depth (ft)
Alluvium	23	23
Bandelier Tuff		
Tshirege Member	17	40
Otowi Member	120	160
Guaje Member	11	171
Basaltic Rocks of Chino Mesa		
Unit 2	92	263

Casing Schedule

Outer Diam (in.)	Depth (ft)
24	0–24
Open Hole	24–163

Note: Water in alluvium cased out of hole.

9. Test Hole TH-6

Elevation (LSD): 6642.1 ft — Water Level: Dry (1950)

Geologic Log	Thickness (ft)	Depth (ft)
Alluvium	25	25
Bandelier Tuff		
Tshirege Member	60	85
Otowi Member	180	265
Guaje Member	20	285
Puye Conglomerate		
Fanglomerate member	15	300

Casing Schedule

Outer Diam (in.)	Depth (ft)
8	0–120
Open Hole	120–300

Note: Water in alluvium cased out of hole.

TABLE XVII-B. Geologic Logs and Construction Data for Test Wells and Test Holes on the Pajarito Plateau (15 Test Wells and Test Holes) (Continued)

10. Test Hole TH-7

Elevation (LSD): 6224 ft

Water Level: Dry (1950)

Geologic Log	Thickness (ft)	Depth (ft)
Alluvium	10	10
Bandelier Tuff		
Otowi Member	35	45
Basaltic Rocks of Chino Mesa		
Unit 2	10	55

Hole plugged and abandoned.

11. Test Well TW-8

Elevation (LSD): 6877.62 ft

Water Level: 968 ft (1960)

Geologic Log	Thickness (ft)	Depth (ft)
Alluvium	40	40
Bandelier Tuff		
Tshirege Member	20	60
Otowi Member	385	445
Guaje Member	45	490
Puye Conglomerate		
Fanglomerate member	90	580
Basalt Unit 2	145	725
Fanglomerate member	340	1065

Casing Schedule
44 ft of 20-in. corrugated metal pipe from 0 to 44 ft; 64 ft of 14-in.-outside-diam steel casing 0 to 64 ft cemented in; 1065 ft of 8-in.-inside-diam steel casing from 0 to 1065 ft with the lower 112 ft slotted.

Geophysical Log
Gamma-ray (11-29-61), files available from the ESH-18 Geohydrology section.

12. Test Hole H-19

Elevation (LSD): 7178 ft

Water Level: 950 ft (1950)

Geologic Log	Thickness (ft)	Depth (ft)
Alluvium	27	27
Bandelier Tuff		
Tshirege Member	173	200
Otowi Member	215	415
Guaje Member	57	472
Tschicoma Formation	347	819
Puye Conglomerate		
Fanglomerate member	391	1210
Tschicoma Formation	270	1480
Puye Conglomerate		
Totavi Lentil	10	1490
Tschicoma Formation	510	2000

APPENDIX D

Borehole H-19

References for Appendix D Information

Borehole	MAP	GEOLOGIC LOG	CONSTRUCTION DIAGRAM
H-19 Borehole	1	1	not found

1. Purtymun, W.D., 1995, Geologic and Hydrologic Records of Observation Wells, Test Holes, Test Wells, Supply Wells, Springs, and Surface Water Stations in the Los Alamos Area, Los Alamos National Laboratory Report LA-12883-MS, Los Alamos National Laboratory, Los Alamos, New Mexico, January 1995.

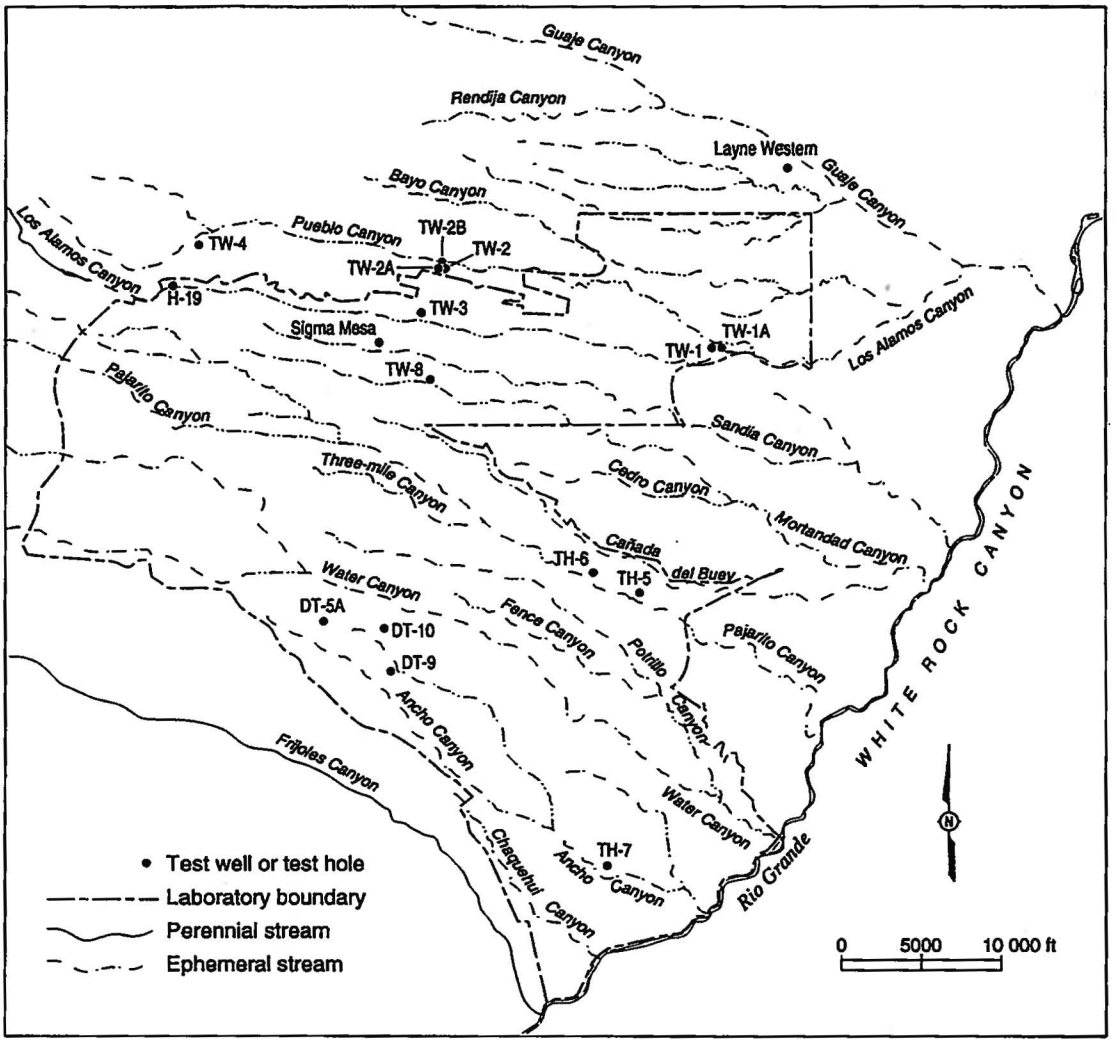

Fig. XVII-A. Test wells and test holes on the Pajarito Plateau.

REFERENCES

E. H. Baltz, J. H. Abrahams, and W. D. Purtymun, "Preliminary Report on the Geology and Hydrology of Mortandad Canyon, Los Alamos, New Mexico, with Special Reference to Disposal of Liquid Low-Level Radioactive Wastes," U.S. Geological Survey Open-File Report (1963).

Black and Veatch (Consulting Engineers), "Ground-Water Observation Wells, Los Alamos, New Mexico," Administrative Report prepared for the U.S. Atomic Energy Commission (1950).

R. L. Griggs, "Geology and Ground-Water Resources of the Los Alamos Area, New Mexico," U.S. Geol. Survey Admin. Report to the U.S. Atomic Energy Commission (1955).

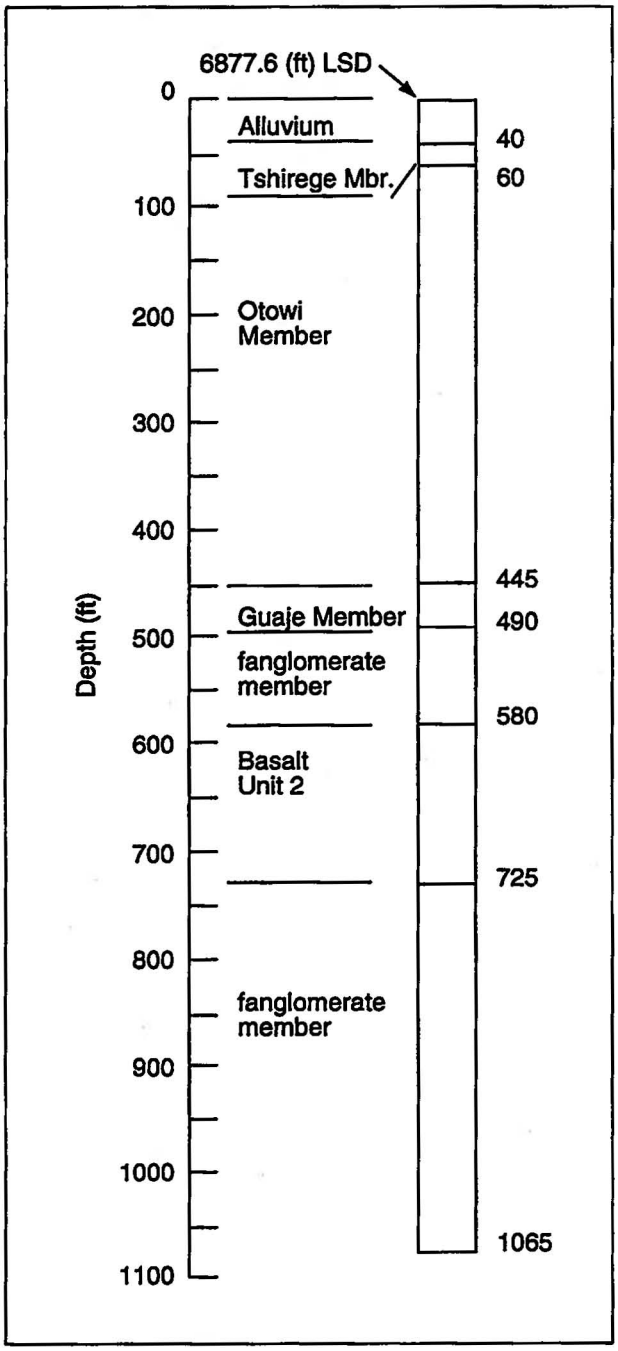

Fig. XVII-I. Geologic log of test well TW-8, completed December 1960, water level 968 ft (Baltz et al. 1963).

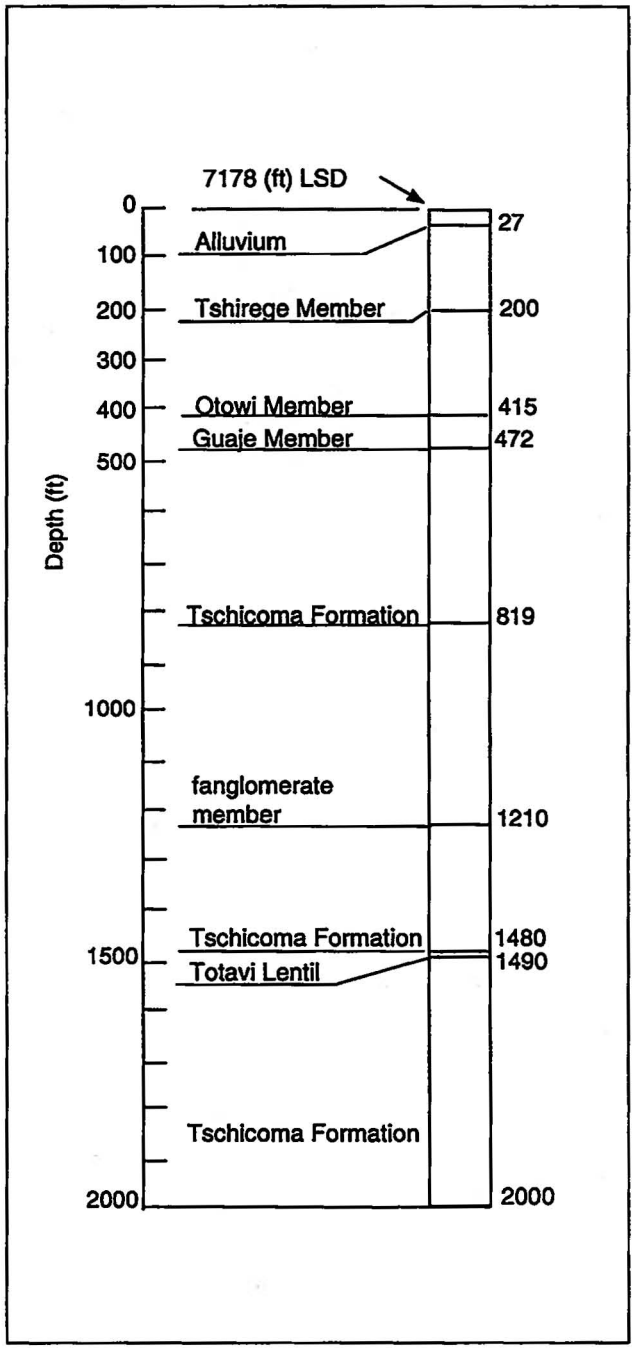

Fig. XVII-J. Geologic log of test hole H-19, completed September 1949, water level 950 ft (Griggs 1955).

TABLE XVII-B. Geologic Logs and Construction Data for Test Wells and Test Holes on the Pajarito Plateau (15 Test Wells and Test Holes) (Continued)

10. Test Hole TH-7

Elevation (LSD): 6224 ft

Water Level: Dry (1950)

Geologic Log	Thickness (ft)	Depth (ft)
Alluvium	10	10
Bandelier Tuff		
Otowi Member	35	45
Basaltic Rocks of Chino Mesa		
Unit 2	10	55

Hole plugged and abandoned.

11. Test Well TW-8

Elevation (LSD): 6877.62 ft

Water Level: 968 ft (1960)

Geologic Log	Thickness (ft)	Depth (ft)
Alluvium	40	40
Bandelier Tuff		
Tshirege Member	20	60
Otowi Member	385	445
Guaje Member	45	490
Puye Conglomerate		
Fanglomerate member	90	580
Basalt Unit 2	145	725
Fanglomerate member	340	1065

Casing Schedule

44 ft of 20-in. corrugated metal pipe from 0 to 44 ft; 64 ft of 14-in.-outside-diam steel casing 0 to 64 ft cemented in; 1065 ft of 8-in.-inside-diam steel casing from 0 to 1065 ft with the lower 112 ft slotted.

Geophysical Log

Gamma-ray (11-29-61), files available from the ESH-18 Geohydrology section.

12. Test Hole H-19

Elevation (LSD): 7178 ft

Water Level: 950 ft (1950)

Geologic Log	Thickness (ft)	Depth (ft)
Alluvium	27	27
Bandelier Tuff		
Tshirege Member	173	200
Otowi Member	215	415
Guaje Member	57	472
Tschicoma Formation	347	819
Puye Conglomerate		
Fanglomerate member	391	1210
Tschicoma Formation	270	1480
Puye Conglomerate		
Totavi Lentil	10	1490
Tschicoma Formation	510	2000

TABLE XVII-B. Geologic Logs and Construction Data for Test Wells and Test Holes on the Pajarito Plateau (15 Test Wells and Test Holes) (Continued)

12. Test Hole H-19 (Continued)

Casing Schedule

10 ft of 12-in.-diam surface casing set 0 to 10 ft. Exploratory hole drilled by cable tool, casing pulled at end of tests in 1949. Hole open to 265 ft (5-7-60); to 69 ft (7-20-92).

Geophysical Log

Gamma-ray (5-7-60), files available from the ESH-18 Geohydrology section.

13A. Test Hole Sigma Mesa EGH-LA-1 (1979)

Elevation (LSD): 7215 ft LSD

Geologic Log[a]	Thickness (ft)	Depth (ft)
Tshirege Member Bandelier Tuff	270	270
Ash flow of Otowi Member Bandelier Tuff	430	700
Guaje Pumice Bed	35	735
Puye Conglomerate with interbedded basalt	110	845
Aphyric Tschicoma Flow	80	925
Hornblende-bearing Tschicoma Flow	45	970
Fanglomerate member of Puye Conglomerate	365	1335
Totavi Lentil of the Puye Formation	65	1400
Chamita Formation of the Santa Fe Group	500	1900
Tschicoma Flow	35	1935
Chamita Formation of the Santa Fe Group	60	1995
Tschicoma Flow	297	2292

13B. Test Hole Sigma Mesa EGH-LA-1 (1992)

Elevation (LSD): 7215 ft LSD — Water Level: 1330 ft (1979, geophysical log)

Geologic Log[b]	Thickness (ft)	Depth (ft)
Bandelier Tuff		
Tshirege Member	345	345
Otowi Member	350	695
Guaje Member	30	725
Puye Conglomerate		
Fanglomerate member	185	910
Basalt Unit 2	140	1050
Fanglomerate member	255	1305
Totavi Lentil	25	1330
Santa Fe Group		
Chaquehui Formation	250	1580
Basalt and basalt breccias	135	1715
Chaquehui Formation	180	1895
Basalt and basalt breccias	397	2292

[a] Logged by Carolyn Potzich.

[b] Revised log by W. D. Purtymun from geophysical logs, comparision with logs of nearby supply and test wells, and R. F. Smith Corp. Geothermal Data Log.

APPENDIX E

Layne Western Well

References for Appendix E Information

Well	MAP	GEOLOGIC LOG	CONSTRUCTION DIAGRAM
Layne Western Well	1	1	not found

1. Purtymun, W.D., 1995, Geologic and Hydrologic Records of Observation Wells, Test Holes, Test Wells, Supply Wells, Springs, and Surface Water Stations in the Los Alamos Area, Los Alamos National Laboratory Report LA-12883-MS, Los Alamos National Laboratory, Los Alamos, New Mexico, January 1995.

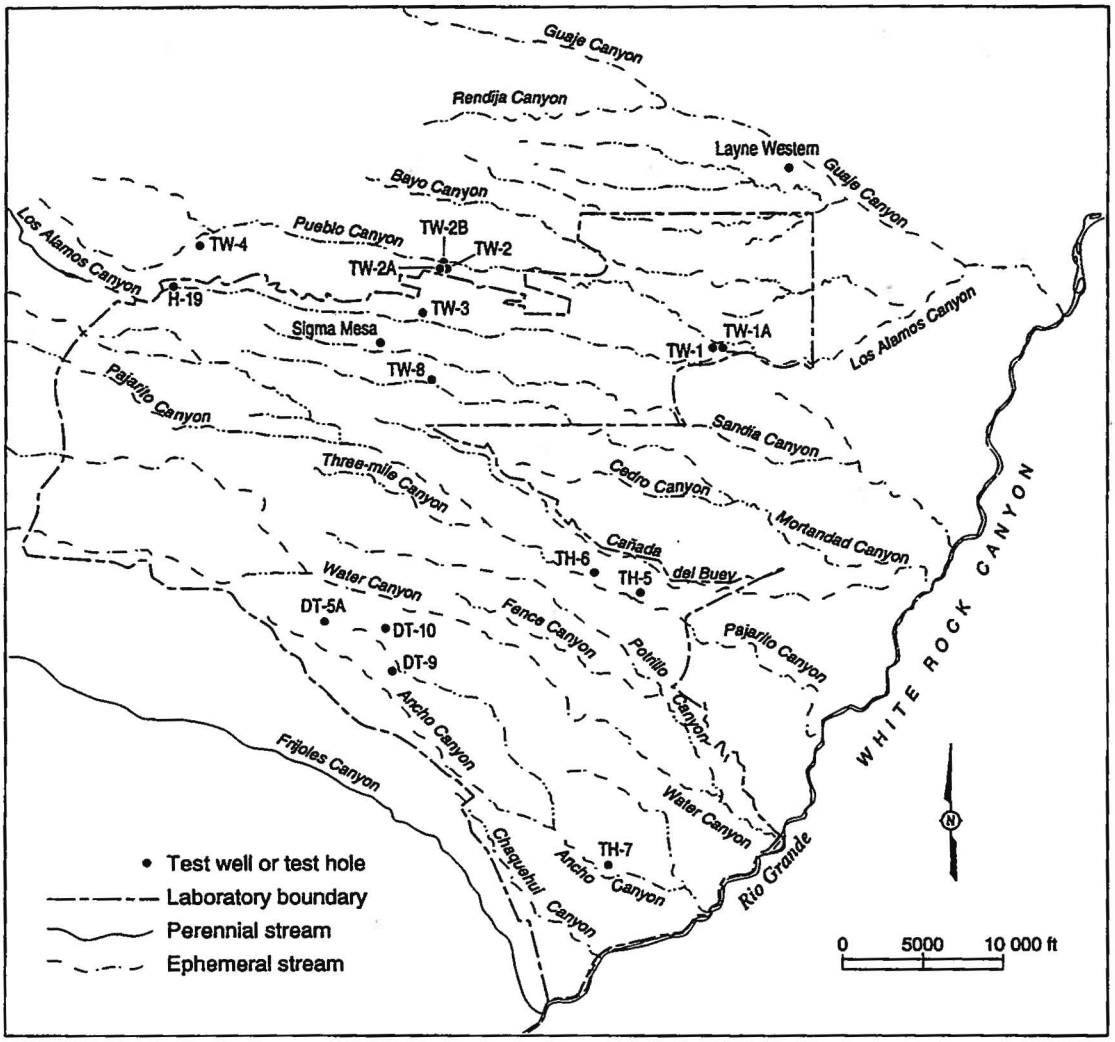

Fig. XVII-A. Test wells and test holes on the Pajarito Plateau.

REFERENCES

E. H. Baltz, J. H. Abrahams, and W. D. Purtymun, "Preliminary Report on the Geology and Hydrology of Mortandad Canyon, Los Alamos, New Mexico, with Special Reference to Disposal of Liquid Low-Level Radioactive Wastes," U.S. Geological Survey Open-File Report (1963).

Black and Veatch (Consulting Engineers), "Ground-Water Observation Wells, Los Alamos, New Mexico," Administrative Report prepared for the U.S. Atomic Energy Commission (1950).

R. L. Griggs, "Geology and Ground-Water Resources of the Los Alamos Area, New Mexico," U.S. Geol. Survey Admin. Report to the U.S. Atomic Energy Commission (1955).

TABLE XVII-B. Geologic Logs and Construction Data for Test Wells and Test Holes on the Pajarito Plateau (15 Test Wells and Test Holes) (Continued)

13B. Test Hole Sigma Mesa EGH-LA-1 (1992) (Continued)

Casing Schedule
Hole size: 36-in. diam to 85 ft, 26-in. diam to 2292 ft; casing size 30-in. diam to 85 ft, 20-in. diam to 1627 ft. Hole plugged with cement at about 1425 ft; unknown length of drill stem, drill collars, and bit lost in the bottom of the hole. The hole had a bad history of lost circulation throughout the entire depth drilled; large volumes of water, drilling mud, lost circulation materials, and cement were pumped into the hole. The hole was abandoned in December 1979.

Geophysical Logs
Temperature, compensated neutron-formation density; dual induction–SFL with linear correlation log; and R.F. Smith Corp. Geothermal Data Log (files available from the ESH-18 Geohydrology section).

14. Layne Western

Elevation (LSD): 5971 ft — Water Level: 100 ft (1950)

Geologic Log	Thickness (ft)	Depth (ft)
Alluvium	12	12
Puye Conglomerate		
Fanglomerate member	13	25
Totavi Lentil	50	75
Tesuque Formation		
Siltstone and sandstone	82	157

Casing Schedule
147 ft of 8-in.-diam casing set from 0 to 147 ft, screen from 127 to 147 ft.

15. Ski Basin Well

Elevation (LSD): 9310 ft — Water Level: 245 ft (June 1985)

Geologic Log	Thickness (ft)	Depth (ft)
Tough sandstone (probably Tshirege Member Bandelier Tuff, welded unit)	35	35
Lost circulation: same formation throughout, probably Tschicoma Formation latite and rhyolite flow, water perched on interflow breccia of pebbly cobbles in a matrix of silt and clay	365	400

Casing Schedule
392 ft of 4 1/2-in. plastic casing with perforations from 332 to 352 ft and 372 to 392 ft. Data from drillers' log.

APPENDIX F

Sigma Mesa Well EGH-LA-1

References for Appendix F Information

Well	MAP	GEOLOGIC LOG	CONSTRUCTION DIAGRAM
Sigma Mesa Well EGH-LA-1	1	1	not found

1. Purtymun, W.D., 1995, Geologic and Hydrologic Records of Observation Wells, Test Holes, Test Wells, Supply Wells, Springs, and Surface Water Stations in the Los Alamos Area, Los Alamos National Laboratory Report LA-12883-MS, Los Alamos National Laboratory, Los Alamos, New Mexico, January 1995.

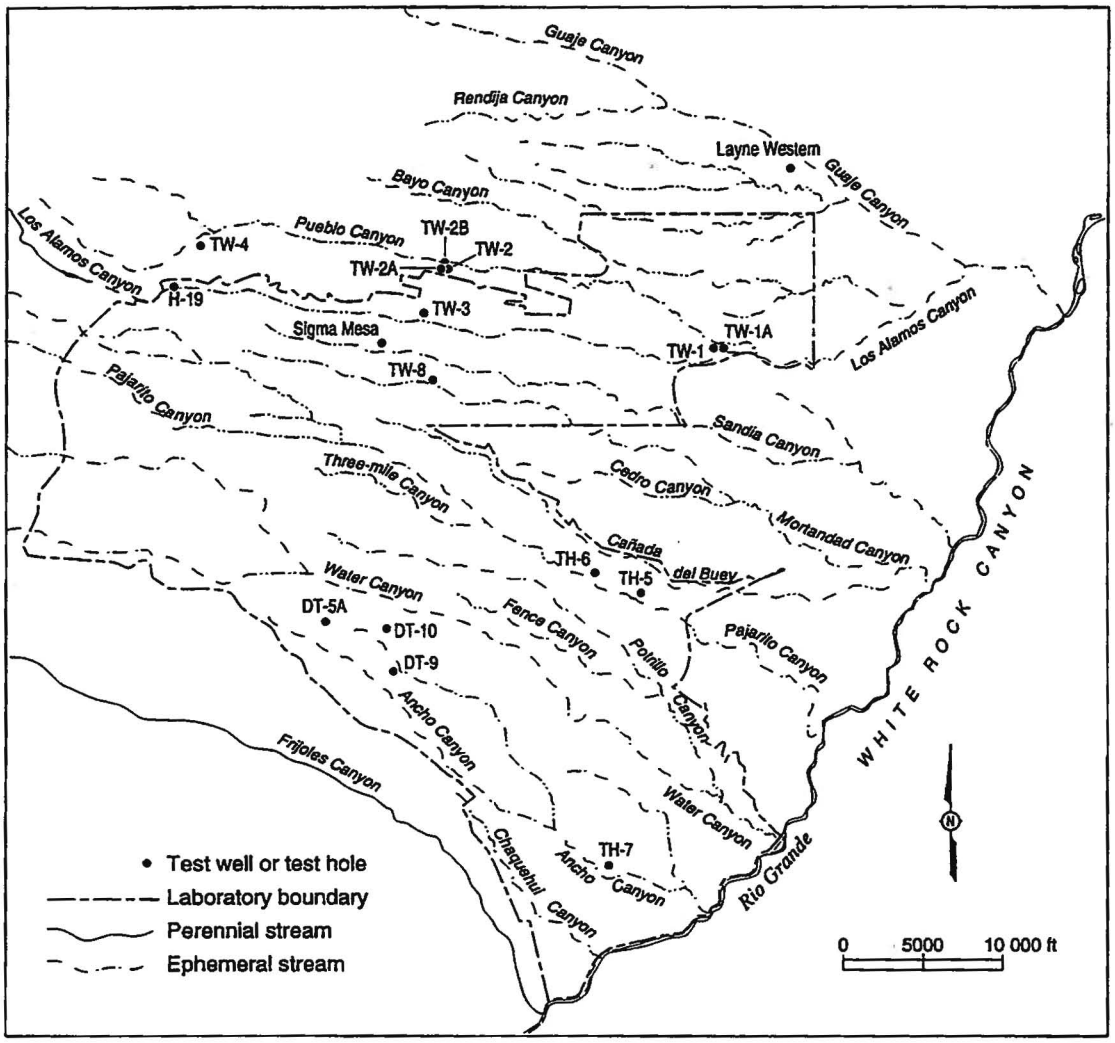

Fig. XVII-A. Test wells and test holes on the Pajarito Plateau.

REFERENCES

E. H. Baltz, J. H. Abrahams, and W. D. Purtymun, "Preliminary Report on the Geology and Hydrology of Mortandad Canyon, Los Alamos, New Mexico, with Special Reference to Disposal of Liquid Low-Level Radioactive Wastes," U.S. Geological Survey Open-File Report (1963).

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R. L. Griggs, "Geology and Ground-Water Resources of the Los Alamos Area, New Mexico," U.S. Geol. Survey Admin. Report to the U.S. Atomic Energy Commission (1955).

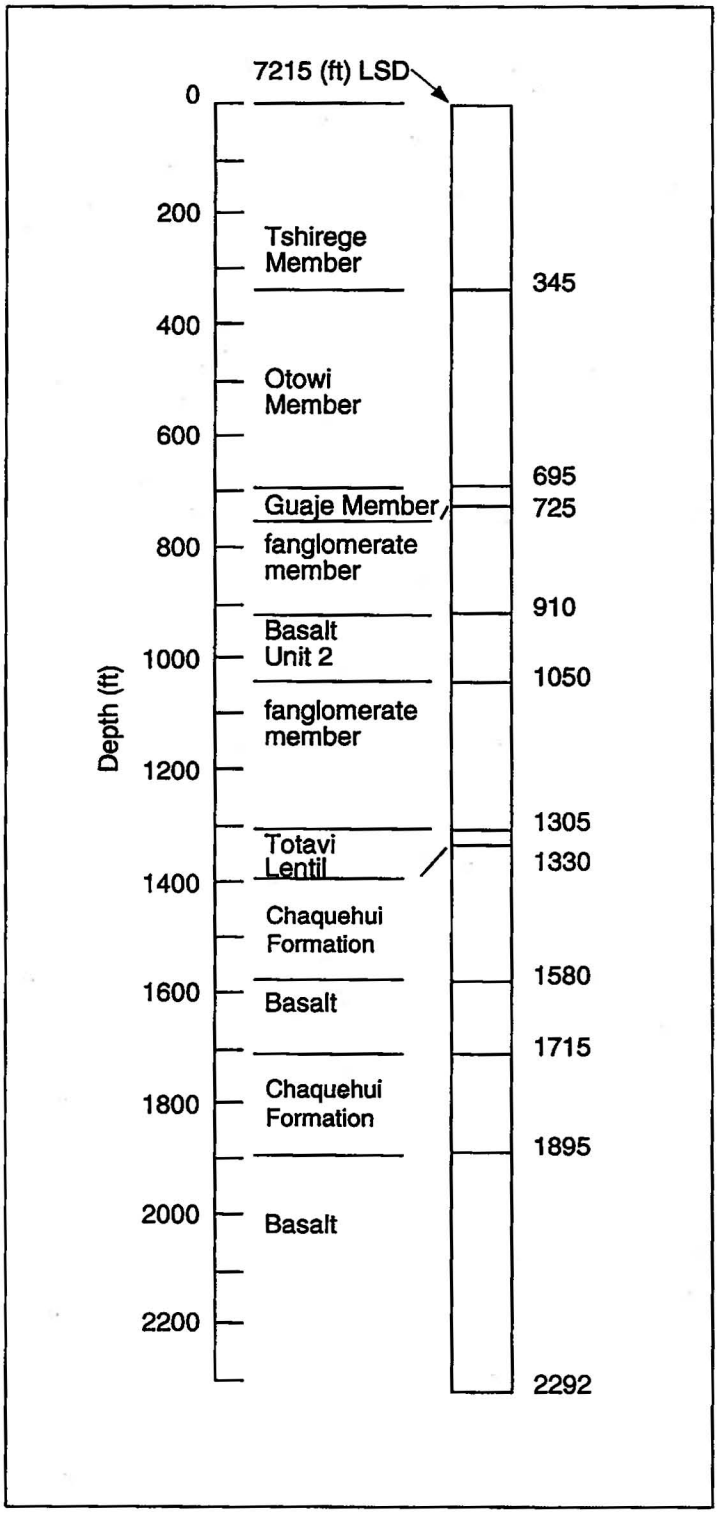


Fig. XVII-K. Geologic log of test hole Sigma Mesa, drilled July–November 1979, water level about 1330 ft (data from unpublished log by Carolyn Potzich modified by Purtymun; see text and Table XVII-B).

TABLE XVII-B. Geologic Logs and Construction Data for Test Wells and Test Holes on the Pajarito Plateau (15 Test Wells and Test Holes) (Continued)

12. Test Hole H-19 (Continued)

Casing Schedule

10 ft of 12-in.-diam surface casing set 0 to 10 ft. Exploratory hole drilled by cable tool, casing pulled at end of tests in 1949. Hole open to 265 ft (5-7-60); to 69 ft (7-20-92).

Geophysical Log

Gamma-ray (5-7-60), files available from the ESH-18 Geohydrology section.

13A. Test Hole Sigma Mesa EGH-LA-1 (1979)

Elevation (LSD): 7215 ft LSD

Geologic Log[a]	Thickness (ft)	Depth (ft)
Tshirege Member Bandelier Tuff	270	270
Ash flow of Otowi Member Bandelier Tuff	430	700
Guaje Pumice Bed	35	735
Puye Conglomerate with interbedded basalt	110	845
Aphyric Tschicoma Flow	80	925
Hornblende-bearing Tschicoma Flow	45	970
Fanglomerate member of Puye Conglomerate	365	1335
Totavi Lentil of the Puye Formation	65	1400
Chamita Formation of the Santa Fe Group	500	1900
Tschicoma Flow	35	1935
Chamita Formation of the Santa Fe Group	60	1995
Tschicoma Flow	297	2292

13B. Test Hole Sigma Mesa EGH-LA-1 (1992)

Elevation (LSD): 7215 ft LSD — Water Level: 1330 ft (1979, geophysical log)

Geologic Log[b]	Thickness (ft)	Depth (ft)
Bandelier Tuff		
Tshirege Member	345	345
Otowi Member	350	695
Guaje Member	30	725
Puye Conglomerate		
Fanglomerate member	185	910
Basalt Unit 2	140	1050
Fanglomerate member	255	1305
Totavi Lentil	25	1330
Santa Fe Group		
Chaquehui Formation	250	1580
Basalt and basalt breccias	135	1715
Chaquehui Formation	180	1895
Basalt and basalt breccias	397	2292

[a] Logged by Carolyn Potzich.

[b] Revised log by W. D. Purtymun from geophysical logs, comparision with logs of nearby supply and test wells, and R. F. Smith Corp. Geothermal Data Log.

TABLE XVII-B. Geologic Logs and Construction Data for Test Wells and Test Holes on the Pajarito Plateau (15 Test Wells and Test Holes) (Continued)

13B. Test Hole Sigma Mesa EGH-LA-1 (1992) (Continued)

Casing Schedule

Hole size: 36-in. diam to 85 ft, 26-in. diam to 2292 ft; casing size 30-in. diam to 85 ft, 20-in. diam to 1627 ft. Hole plugged with cement at about 1425 ft; unknown length of drill stem, drill collars, and bit lost in the bottom of the hole. The hole had a bad history of lost circulation throughout the entire depth drilled; large volumes of water, drilling mud, lost circulation materials, and cement were pumped into the hole. The hole was abandoned in December 1979.

Geophysical Logs

Temperature, compensated neutron-formation density; dual induction–SFL with linear correlation log; and R.F. Smith Corp. Geothermal Data Log (files available from the ESH-18 Geohydrology section).

14. Layne Western

Elevation (LSD): 5971 ft

Water Level: 100 ft (1950)

Geologic Log	Thickness (ft)	Depth (ft)
Alluvium	12	12
Puye Conglomerate		
Fanglomerate member	13	25
Totavi Lentil	50	75
Tesuque Formation		
Siltstone and sandstone	82	157

Casing Schedule

147 ft of 8-in.-diam casing set from 0 to 147 ft, screen from 127 to 147 ft.

15. Ski Basin Well

Elevation (LSD): 9310 ft

Water Level: 245 ft (June 1985)

Geologic Log	Thickness (ft)	Depth (ft)
Tough sandstone (probably Tshirege Member Bandelier Tuff, welded unit)	35	35
Lost circulation: same formation throughout, probably Tschicoma Formation latite and rhyolite flow, water perched on interflow breccia of pebbly cobbles in a matrix of silt and clay	365	400

Casing Schedule

392 ft of 4 1/2-in. plastic casing with perforations from 332 to 352 ft and 372 to 392 ft. Data from drillers' log.

APPENDIX G

Boreholes SHB-1, SHB-2, SHB-3 AND SHB-4

References for Appendix G Information

Boreholes	MAP	GEOLOGIC LOG	CONSTRUCTION DIAGRAM
SHB-1, SHB-2, SHB-3, SHB-4	1, 2	2	not found

1. Purtymun, W.D., 1995, Geologic and Hydrologic Records of Observation Wells, Test Holes, Test Wells, Supply Wells, Springs, and Surface Water Stations in the Los Alamos Area, Los Alamos National Laboratory Report LA-12883-MS, Los Alamos National Laboratory, Los Alamos, New Mexico, January 1995.

2. Gardner, J.N., Kolbe, T., and Chang, S., 1993, Geology, Drilling, and Some Hydrologic Aspects of Seismic Hazard Program Boreholes, Los Alamos National Laboratory report LA-12460-MS, Los Alamos National Laboratory, New Mexico.

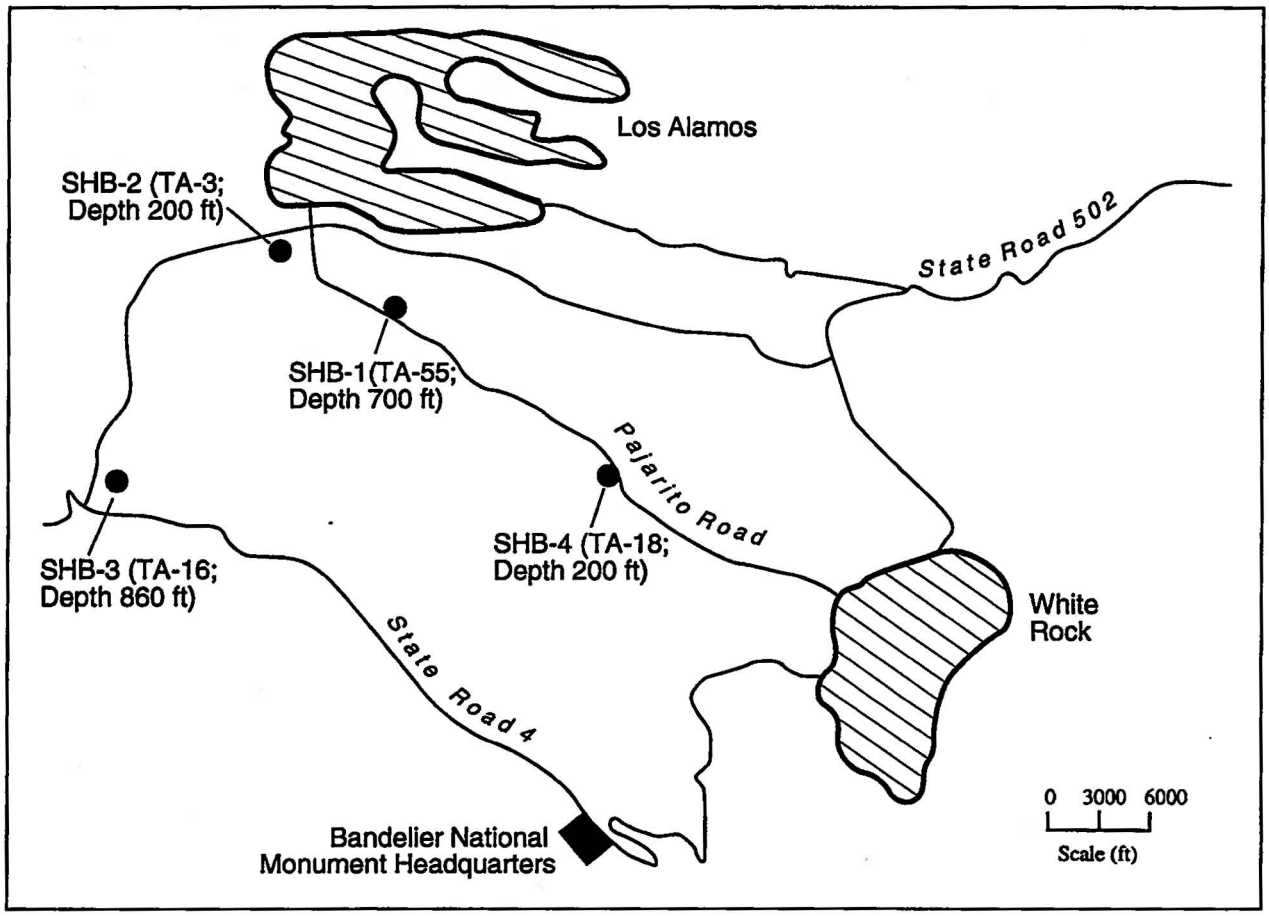


Fig. XXIII-B. Locations of test holes for seismic investigation.

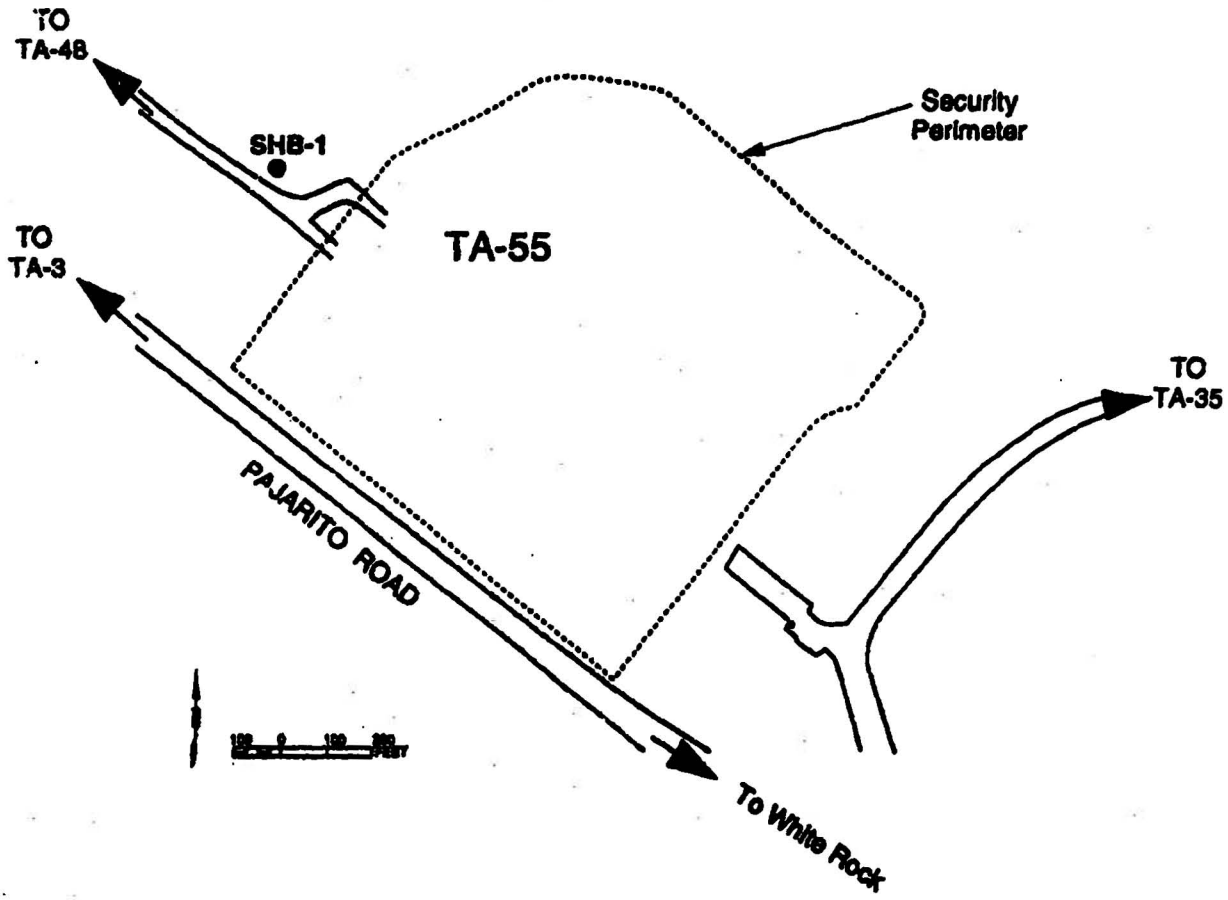


Figure 2: Map of the TA-55 area showing main roads, security perimeter, and location of core hole SHB-1.

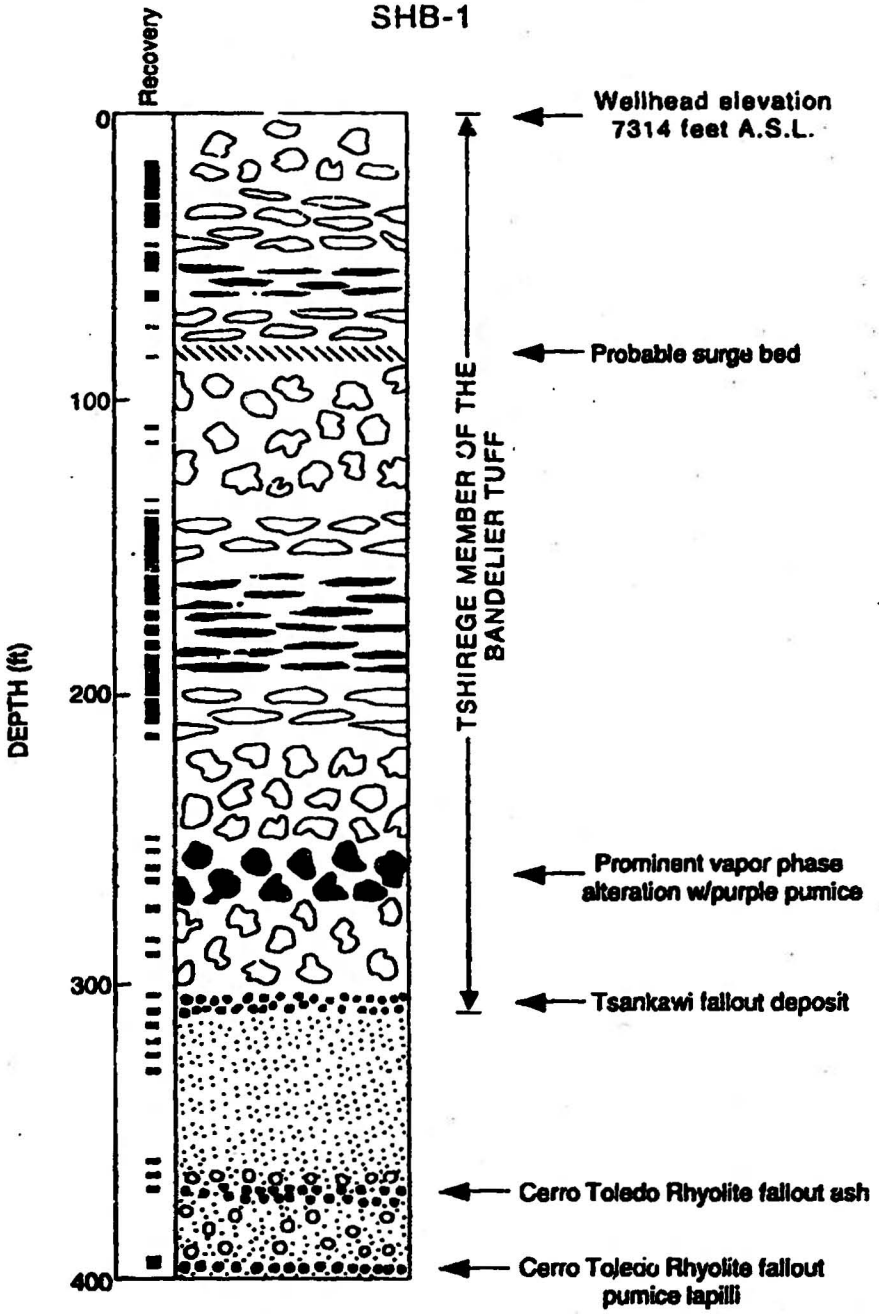


Figure 6a: Graphic lithology log for core hole SHB-1. Log is continued on next page. Black marks in recovery column indicate where core was recovered. See Table II for explanation of symbols.

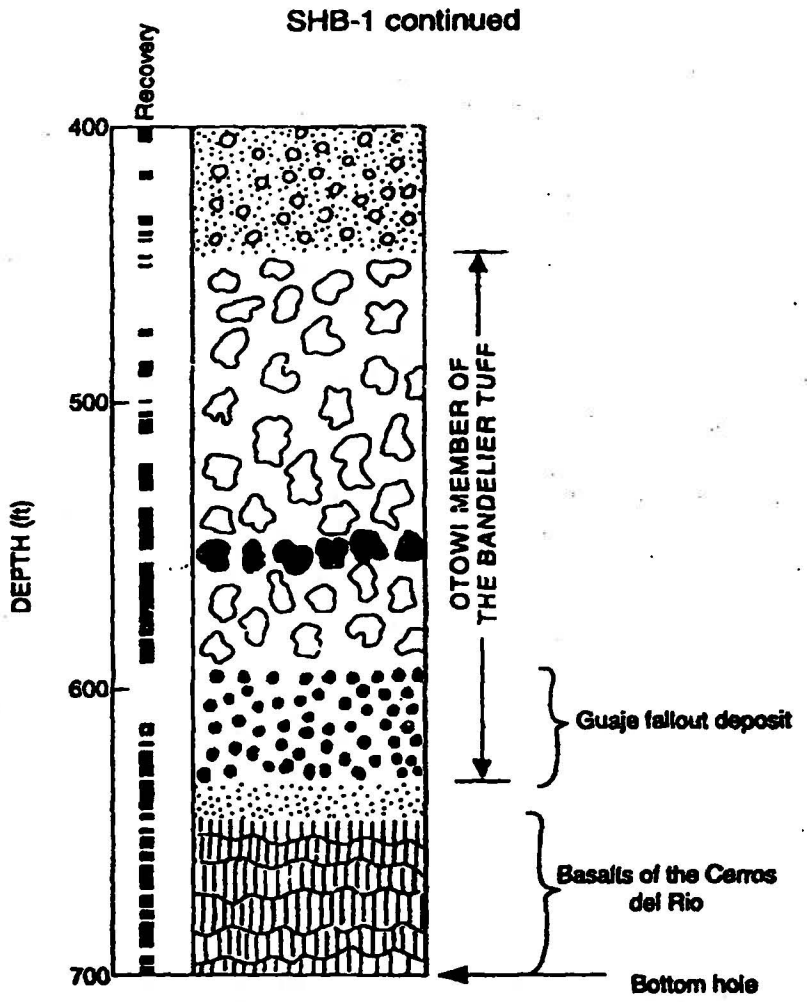


Figure 6b: Graphic lithology log for core hole SHB-1. Black marks in recovery column indicate where core was recovered. See Table II for explanation of symbols.

VI. SHB-3 (TA-16)

SHB-3 was drilled west of the new tritium facility in TA-16 (S-site) (see Figures 1 and 4) with a total drilled depth of 848 feet and an accessible depth of 860 feet (the depth discrepancy is explained below). In spite of the fact that about 70% of the section penetrated consisted of nonwelded tuff and unconsolidated sediments (Figure 8), core recovery from SHB-3 was nearly 70%, indicating both the advantages of drilling with mud and the results of lessons learned during the drilling of SHB-1.

After the hole was cored to 848 feet, the reaming operation proceeded to 790 feet with the use of a down-hole air hammer. At this point there was a breakdown on the rig and the hammer was pulled up about 40 feet to 750 feet while repairs were made. After about 45 hours from last air injection, air was resupplied to the reaming hammer to resume operations. Within a minute of the resupplying of air to the

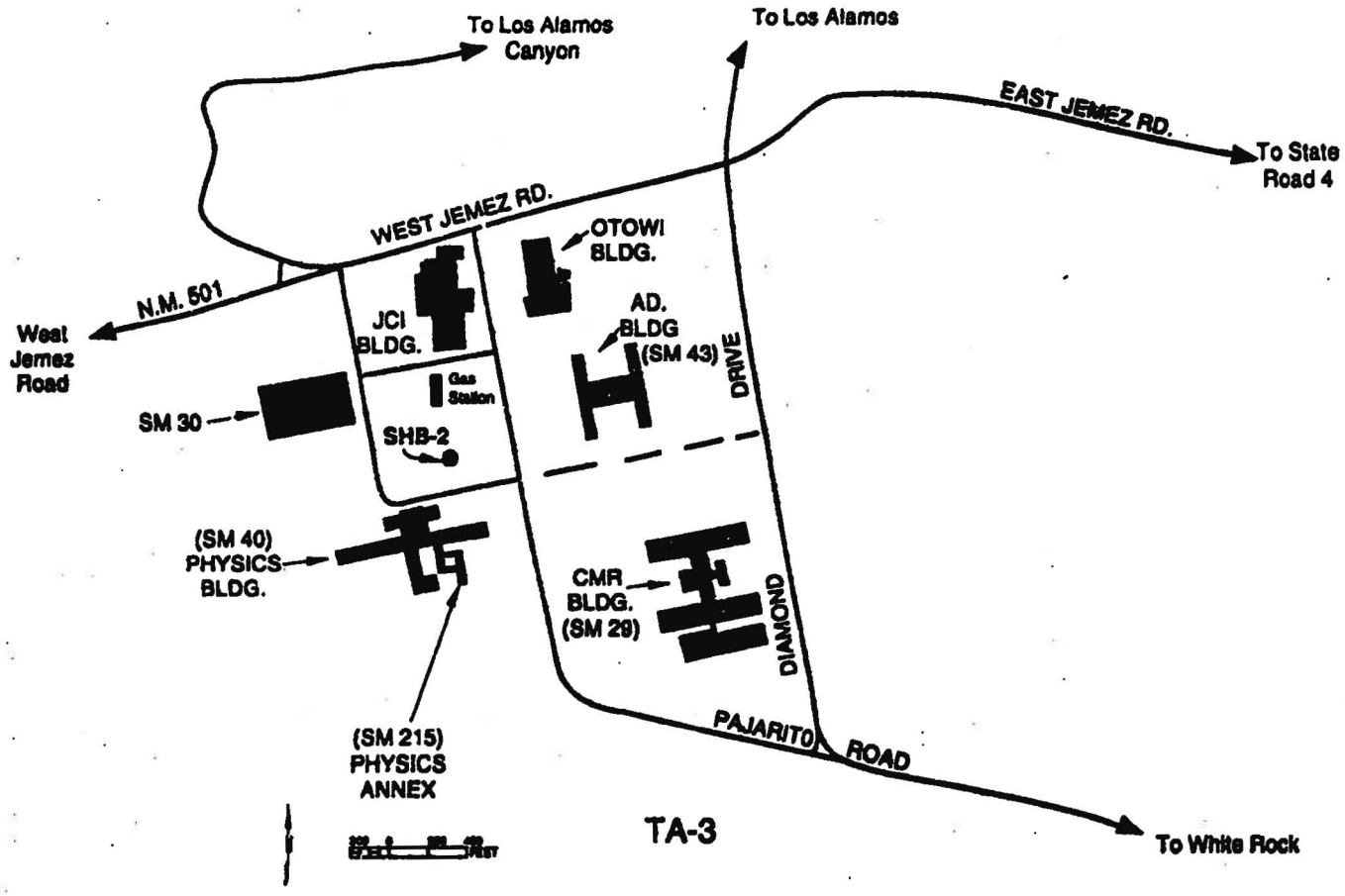


Figure 3: **Map of the TA-3 area showing main roads, selected buildings, and location of core hole SHB-2.**

hammer, SHB-3 erupted a spout of water at least 40 feet into the air (40 feet is the height of the derrick on the drill rig). The spout lasted for less than 10 seconds, and, while air was supplied to the down-hole hammer for the remainder of the reaming operation, SHB-3 continued to make water at a rate of about 10 to 15 gallons per minute. Reaming proceeded without further incident to 852 feet where air was supplied for about 10 more minutes after reaming to remove sand and other loose material from the hole. By this time, the discharging water was clear; furthermore, the discharge water never appeared to contain bentonite or other drilling mud additives. When the PVC casing was inserted into the core hole, it dropped to 860 feet. Apparently, the loose bottom hole material (see below) was extensively eroded during the flowing of the hole.

From the surface to about 335 feet, SHB-3 penetrates the Tshirege Member of the Bandelier Tuff. The Tshirege at this locality, closer to the caldera source, is over 95% welded tuff, most of which is densely welded (Figure 8). Cooling breaks are few, with one in the top 60 feet of the hole and another around 230 feet. From about 320 to about 335 feet core recovery was poor, but this interval apparently includes the nonwelded base of the ignimbrite and an unknown thickness of Tsankawi fallout pumice.

From roughly 335 to 424 feet is a sequence of unconsolidated sands and sandy gravels very similar to the sequence between the Tshirege and Otowi members encountered in SHB-1. Lithologically identical to the older Puye Formation, these epiclastic sediments represent alluvium shed off of the Sierra de los Valles dacite highlands to the west. Interbedded with this epiclastic sequence at about 385 to 388 feet is a coarse sand-sized pumice fall deposit. Some of the pumice contain obsidian fragments. It is likely that this pyroclastic interbed is related to the Rabbit Mountain tuff of the Cerro Toledo Rhyolite (Goff et al., 1990).

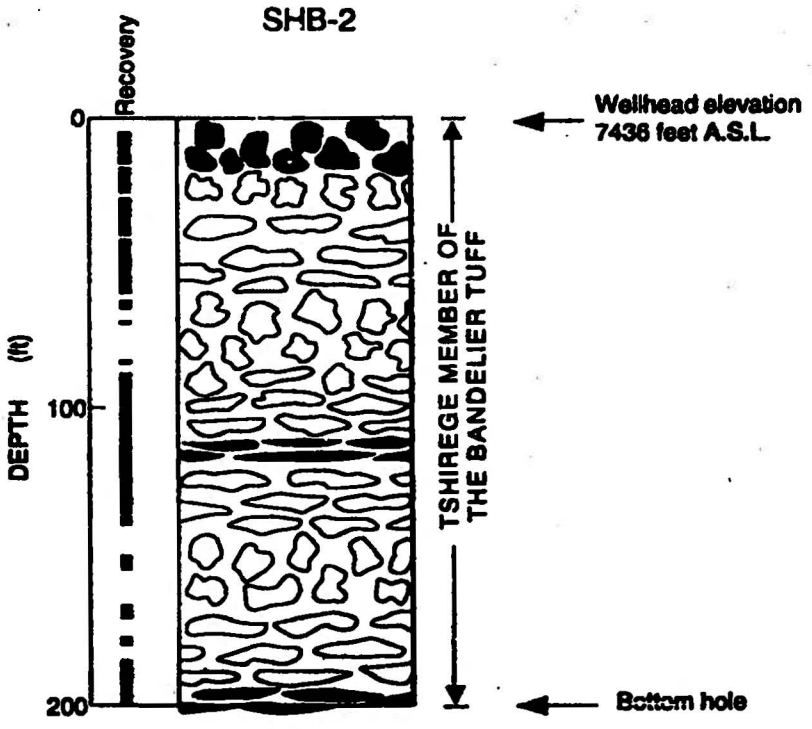


Figure 7: **Graphic lithology log for core hole SHB-2. See Table II and Figure 6 for explanation of symbols.**

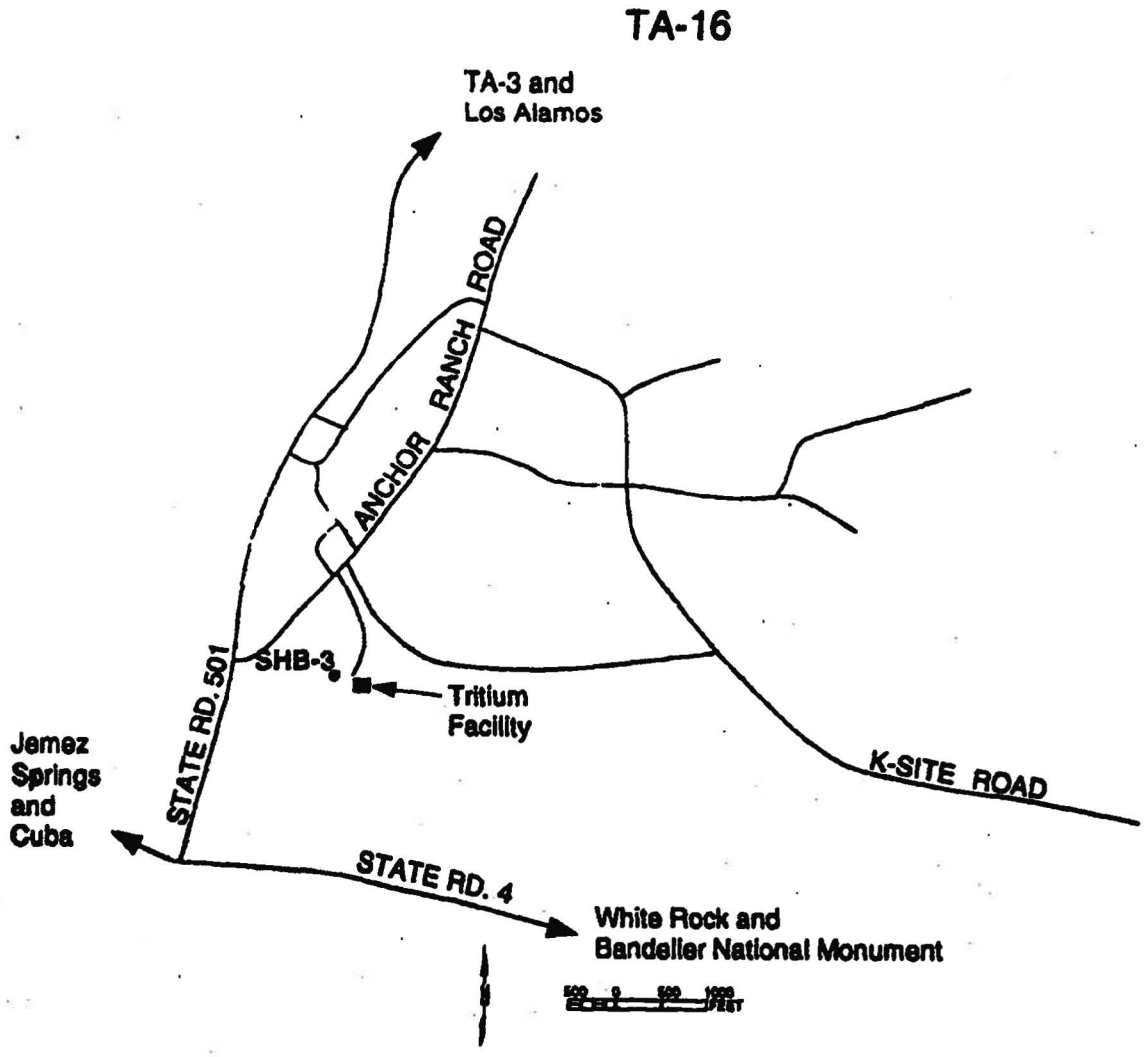


Figure 4: **Map of the TA-16 area showing main roads, the Tritium Facility, and location of core hole SHB-3.**

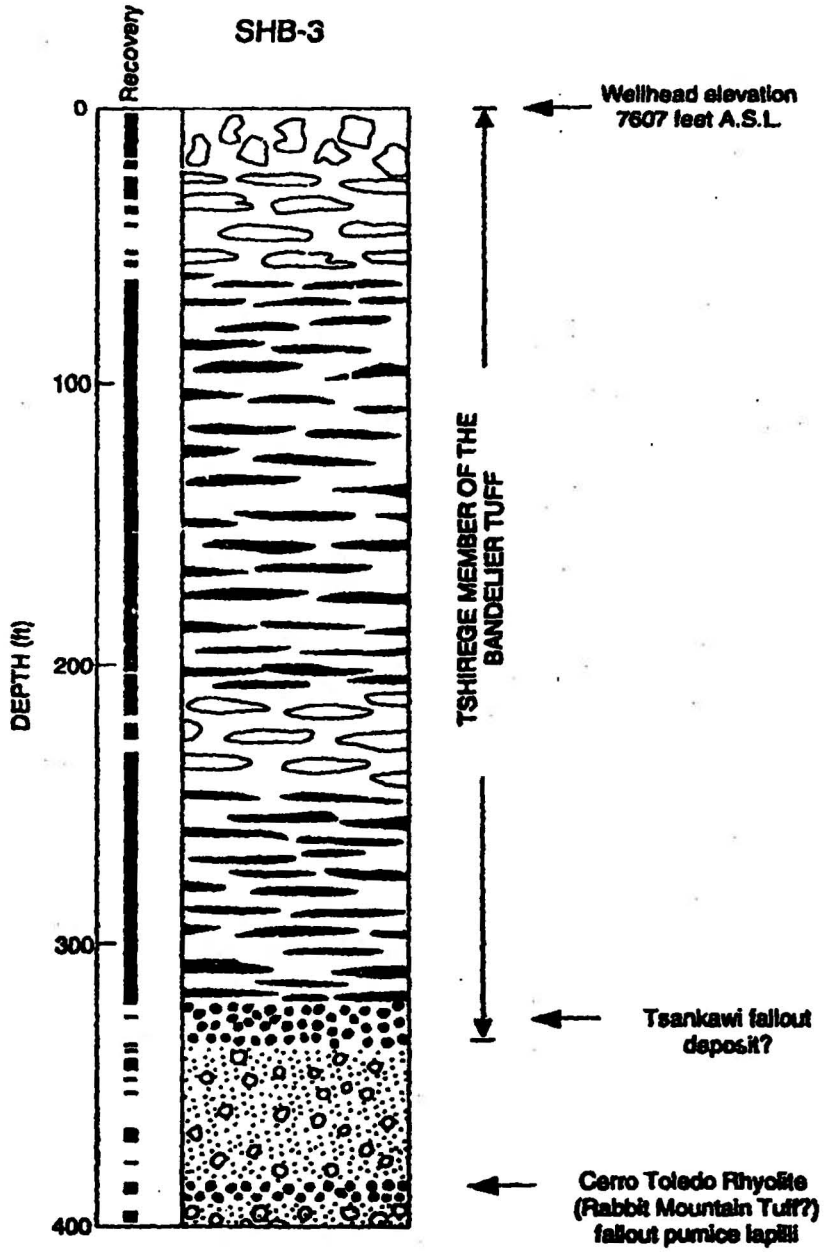


Figure 8a: Graphic lithology log for core hole SHB-3. Log is continued on next page. See Table II and Figure 6 for explanation of symbols.

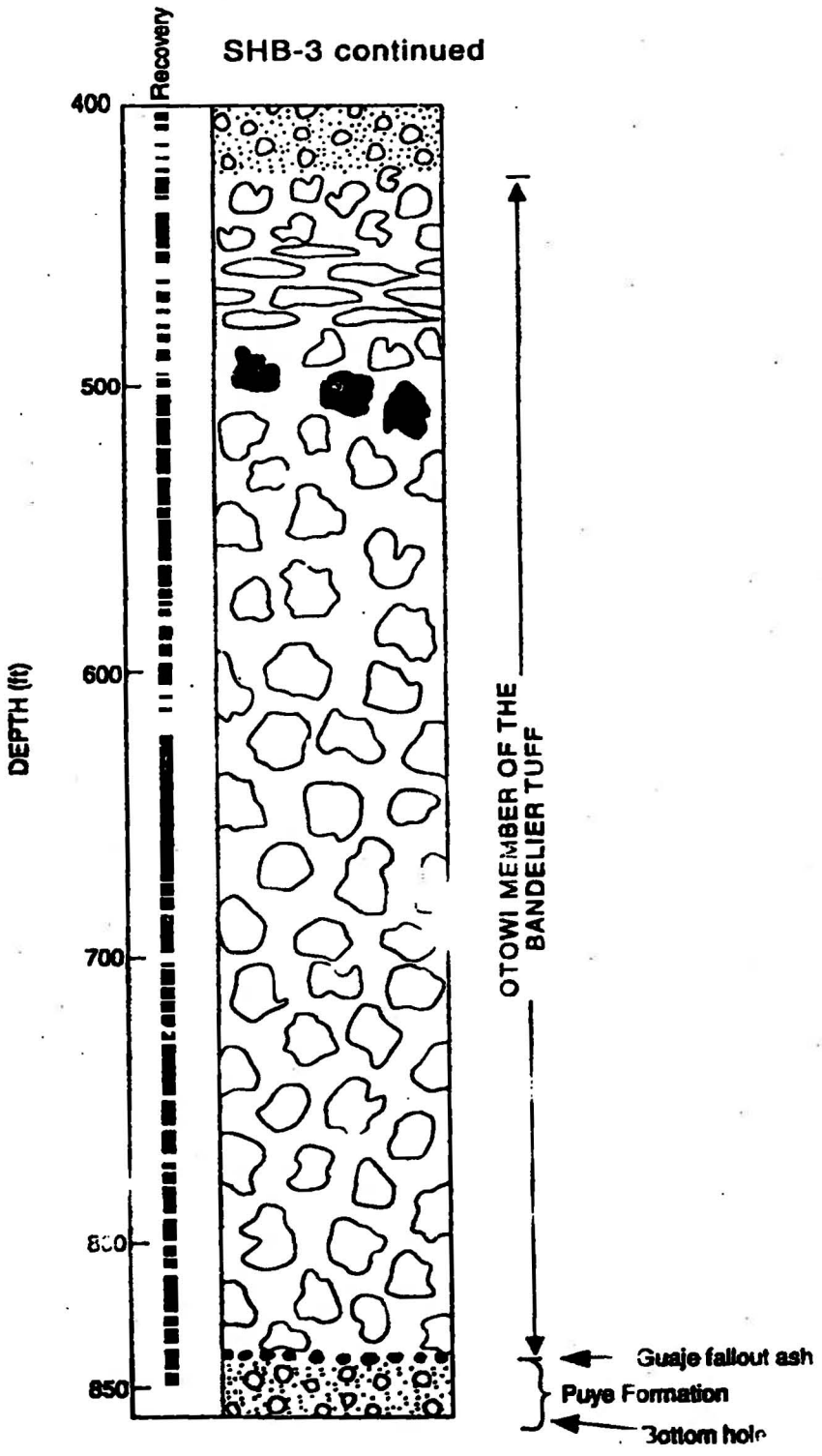


Figure 8b: **Graphic lithology log for core hole SHB-3. See Table II and Figure 6 for explanation of symbols.**

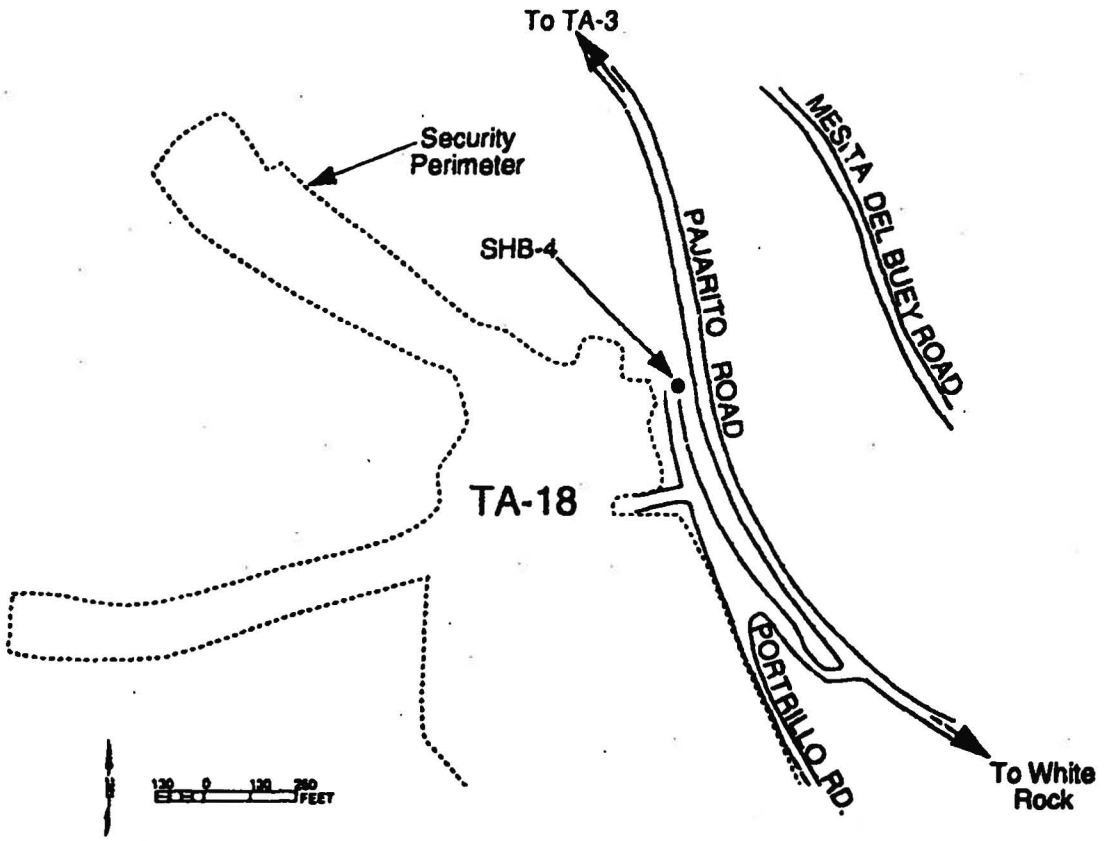


Figure 5: Map of the TA-18 area showing main roads, security perimeter, and location of core hole SHB-4.

core holes (SHB-1) penetrates basalts and related sediments of the Cerros del Rio, and another (SHB-3) penetrates sands and gravels that must, because of their lithology and stratigraphic position, be considered part of the Puye Formation.

We have avoided, in this report, use of the subdivisions of the Tshirege Member of previous workers (for example, Wier and Purtymun, 1962; Baltz et al., 1963; Crowe et al., 1978; Vaniman and Wohletz, 1990). We have done this for two main reasons: first, the units used in the aforementioned works are inconsistent; and, second, we note that the sub-units are useful only within localized areas, and without geologic mapping between these areas correlations are dubious at best. Thus, we make only the most general stratigraphic correlations, and emphasize descriptions of the rocks and deposits. Another difference in our nomenclature from that of some previous workers at the Laboratory is in our use of the term surge. Surges are a kind of pyroclastic flow that leave deposits of sorted pyroclasts which commonly exhibit bedforms typical of high energy flow regimes, such as plane beds or low-angle cross-beds. Previous workers (for example, Wier and Purtymun, 1962; Purtymun and Stoker, 1987) have called the surges of the Pajarito Plateau fluvial sandstones. However, in that the surges of the Bandelier Tuff are rather famous in the earth science community (for example, Fisher, 1979; Fisher and Schmincke, 1984), their description as sandstones should be discontinued.

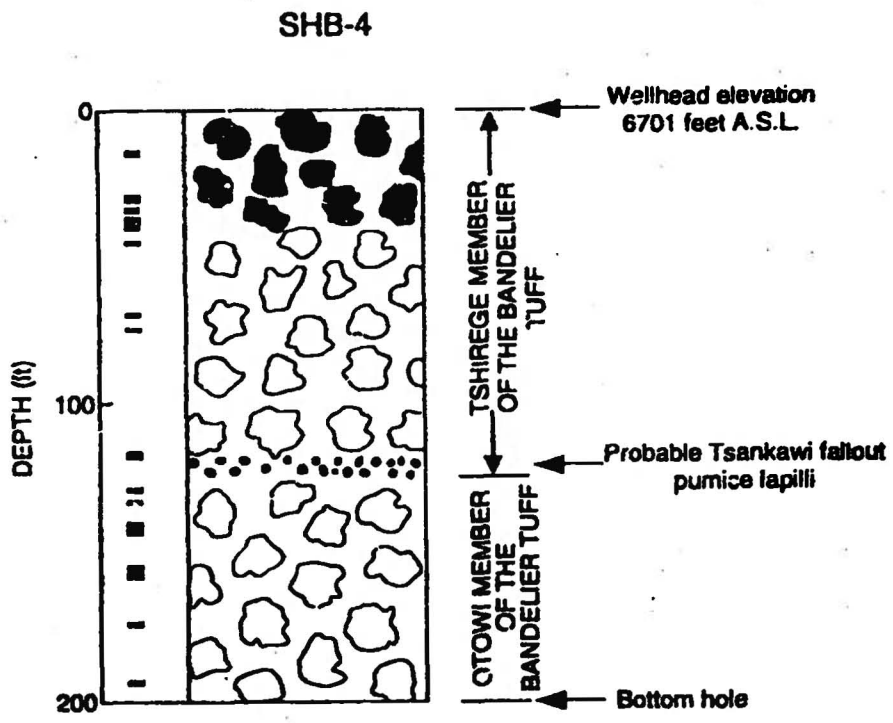


Figure 9: Graphic lithology log for core hole SHB-4. See Table II and Figure 6 for explanation of symbols.

The Otowi Member of the Bandelier Tuff extends from about 424 to 839 feet in SHB-3. It is almost entirely nonwelded tuff with a zone of slightly flattened pumices from about 450 to 480 feet.

Beneath the Otowi in SHB-3 is a sequence of sands and boulder-rich gravels that must be correlative to the Puye Formation (see Discussion, below). The cobbles and clasts of these epiclastic, alluvial deposits are dominantly dacite lithologies that can be found exposed in the Tschicoma Formation in the Sierra de los Valles immediately west of the drill site. As with the similar epiclastic deposits encountered between the Otowi and Tshirege members higher in SHB-3 and in SHB-1, the alternating unconsolidated sands and hard dacite boulders caused very difficult drilling conditions.

VII. SHB-4 (TA-18)

SHB-4 was drilled exclusively with air, north and east of entrance road to TA-18 in Pajarito canyon (see Figures 1 and 5), to a total depth of 200 feet. Core recovery was only about 12.5%, so our interpretations of stratigraphy must be considered to be constrained speculation (see Figure 9).

The top 40 feet of SHB-4 appears to penetrate nonwelded, vapor phase altered ignimbrite of the Tshirege Member. Spotty recovery from 40 to about 117 feet suggests this interval consists of nonwelded ignimbrite. At about 117 feet, the samples recovered were discrete pebble-sized pumices, which may represent a fallout deposit equivalent to the Tsankawi pumice. From about 120 to 200 feet, the remainder of SHB-4 appears to have penetrated nonwelded ignimbrite of the Otowi Member.

Cuttings and core samples from 32 to at least 125 feet came out of SHB-4 damp and moist. The core tube and rock samples from about 125 feet and 145 feet came out of the hole wet. From about 55 feet to total depth SHB-4 would steadily discharge air while drilling was stopped.

APPENDIX H

USGS Test Hole near MDA C

References for Appendix H Information

Borehole	MAP	GEOLOGIC LOG	CONSTRUCTION DIAGRAM
USGS Test Hole near MDA-C	1	1	not found

1. Purtymun, W.D., 1995, Geologic and Hydrologic Records of Observation Wells, Test Holes, Test Wells, Supply Wells, Springs, and Surface Water Stations in the Los Alamos Area, Los Alamos National Laboratory Report LA-12883-MS, Los Alamos National Laboratory, Los Alamos, New Mexico, January 1995.

XV. U.S. GEOLOGICAL SURVEY TEST HOLE NEAR TA-52

The U.S. Geological Survey cored an experimental hole to test the use of wireline-rotary air-coring techniques in the Bandelier Tuff. A modified standard wireline core-barrel system was used. The hole was located just east of Waste Disposal Area C (Fig. XV-A). The modified equipment was used to collect uncontaminated cores of unconsolidated ash and indurated tuff to a depth of 210 ft. Core recovery was 92%. The hole was completed to study the characteristics of the vadose zone (Table XV-A).

REFERENCE

W. E. Teasdale and R. E. Pemberton, "Wireline-Rotary Air Coring of the Bandelier Tuff, Los Alamos, New Mexico," U.S. Geol. Survey Water Resources Investigation Report 84-4176 (1984).

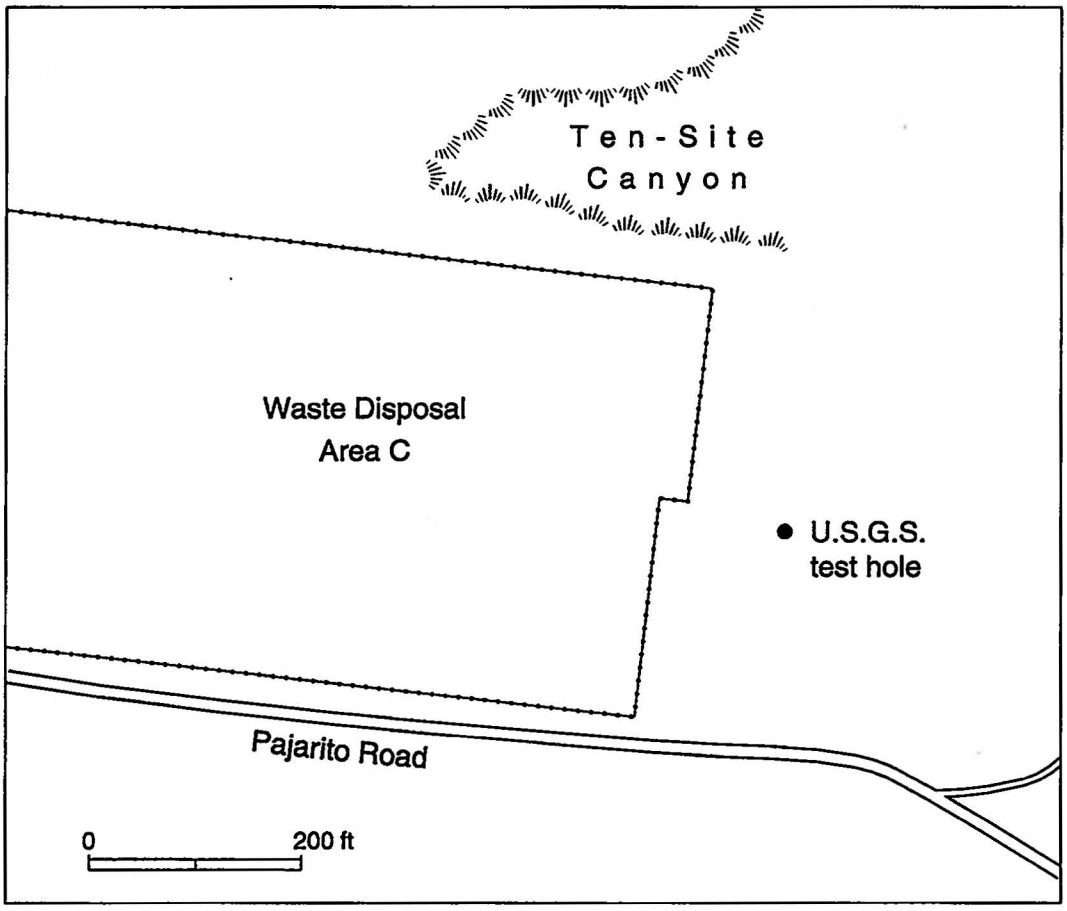


Fig. XV-A. Location of U.S. Geological Survey test hole east of Waste Disposal Area C.

TABLE XV-A. Geologic Log and Construction Data for U.S. Geological Survey Test Hole near Waste Disposal Area C

Elevation (LSD) 7220 ft

Drilled: September 1983

Water Level: Dry

Geologic Log	Thickness (ft)	Depth (ft)
Bandelier Tuff		
Tshirege Member		
Unit 3, light gray moderately welded tuff	110	110
Unit 2, dark gray welded tuff	100	210

Construction

Completed as a vadose monitoring test hole.

Screen 1 190 to 195 ft
Screen 2 140 to 145 ft
Screen 3 105 to 110 ft
Screen 4 78 to 83 ft
Screen 5 50 to 55 ft.
Screen 6 25 to 30 ft

Instruments were set in screen sections, each section of screen sealed off with a mixture of grout (cement) and dry cuttings. Surface to 22 ft sealed with cement. Heat dissipation probe set in cuttings 118 to 122 ft. Electrical leads extend from instruments in screen section to land surface.

Geophysical Logs

Bulk density, neutron, gamma-ray, and caliper. Files available from the ESH-18 Geohydrology section.

TABLE XV-B. Locations and Elevations (NAD 1927)

U.S.G.S.TH	N 1,768,500	E 486,500	7220 ft

APPENDIX I

Wells and Boreholes at TA-49

References for Appendix I Information

Well Or Borehole at TA-49 (>10 ft deep)	MAP	GEOLOGIC LOG	CONSTRUCTION DIAGRAM	OTHER
Moisture Access Holes	5	not found	not found	na
Shafts-Areas 1, 2, 2A, 2B, 3, 4	2	See logs for coreholes drilled in each area (CHs 1-4)	not found	na
Area 11 - 13 shafts	2	not found	not found	na
Bottle House shaft	7	not found	not found	na
Alpha Hole	5	3	P&A'd	Borehole abandonment description - 1
Beta Hole	5	3	not found	na
Gamma Hole	5	3	P&A'd	Borehole abandonment description - 1
DT-5	5	5	P&A'd	na
DT-5P	5	3	P&A'd	na
DT-5A	5	3	3	na
DT-9	5	3	3	na
DT-10	5	3	3	na
CH-1, CH-2, CH-3, CH-4	5	3	not found	na
TH-1, TH-2, TH-3, TH-5	5	5	not found	Neutron logs for THs 1-5 – 4; Moisture logs for all Test Holes - 4
2A-O, 2A-Y, 2B-Y	2	See CH-2 log	not found	na
TBM-1, TBM-2	5	5	5	Construction diagrams - 5
49-02901	7	6	not found	na
49-02906	2	not found	P&A'd	na
49-02907	2	not found	P&A'd	na
49-10046	3	not found	not found	na
49-10047	3	not found	not found	na
49-10048	3	not found	not found	na

1. Los Alamos National Laboratory, 2005, Annual Moisture Monitoring Report for Material Disposal Area AB at Technical Area 49, Los Alamos National Laboratory report LA-UR-05-8256, Los Alamos National Laboratory, Los Alamos, New Mexico, 2005.

2. Los Alamos National Laboratory, 2007, Historical Investigation Report for Sites at Technical Area 49 Inside the Nuclear Environmental Site Boundary, Los Alamos National Laboratory report LA-UR-07-6078, Los Alamos National Laboratory, Los Alamos, New Mexico, October 2007.

3. Los Alamos National Laboratory, 2008, Investigation Work Plan for Sites at Technical Area 49 Outside the Nuclear Environmental Site Boundary, Revision 1, Los Alamos National Laboratory report LA-UR-08-0449, Los Alamos National Laboratory, Los Alamos, New Mexico, January 2008.

4. Purtymun, W.D., 1994, Source Document Compilation: Los Alamos Investigations Related to the Environment, Engineering, Geology, and Hydrology, 1961- - 1990. Los Alamos National Laboratory Report LA-12733-MS, Los Alamos National Laboratory, Los Alamos, New Mexico, January 1994.

5. Purtymun, W.D., 1995, Geologic and Hydrologic Records of Observation Wells, Test Holes, Test Wells, Supply Wells, Springs, and Surface Water Stations in the Los Alamos Area, Los Alamos National Laboratory Report LA-12883-MS, Los Alamos National Laboratory, Los Alamos, New Mexico, January 1995.

6. Stimac, J.A., D.E. Broxton, E.C. Kluk, and S.J. Chipera, 2002, Stratigraphy of the tuffs from Borehole 49-2-700-1 at Technical Area 49, Los Alamos National Laboratory, New Mexico, Los Alamos National Laboratory report LA-13969-MS, Los Alamos National Laboratory, Los Alamos, New Mexico, July 2002.

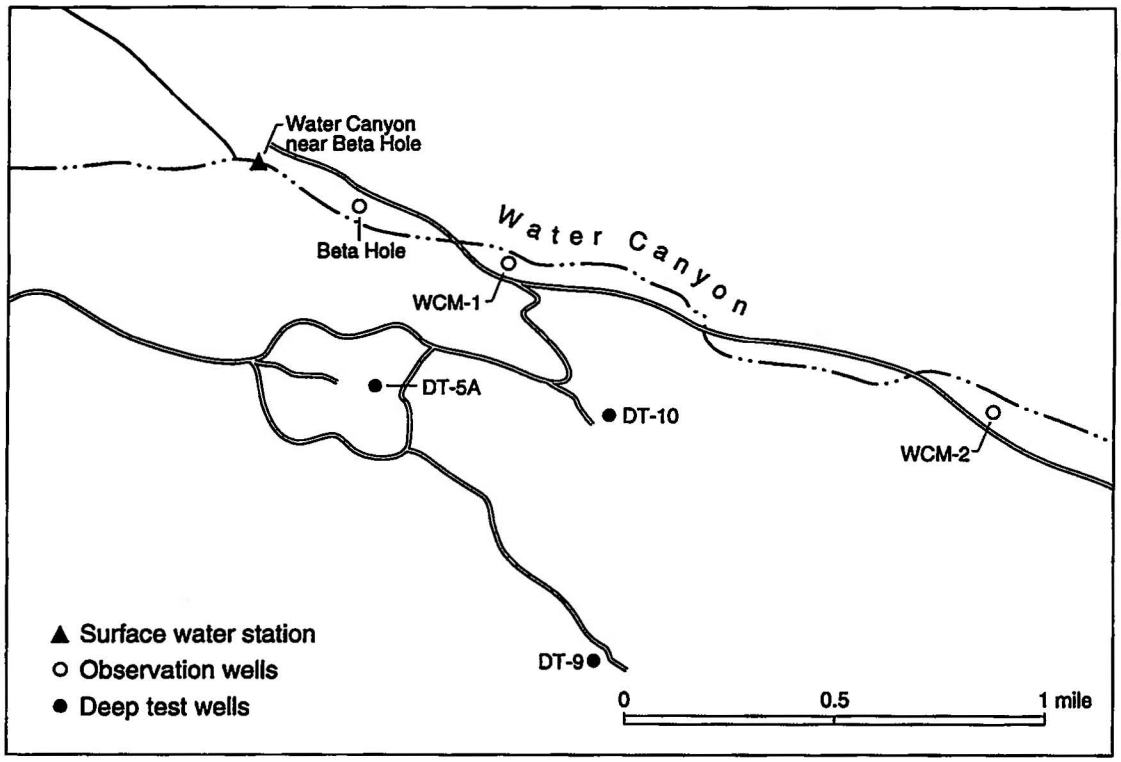


Fig. IX-U. Locations of wells, holes, and a surface water sampling station in Water Canyon north of TA-49.

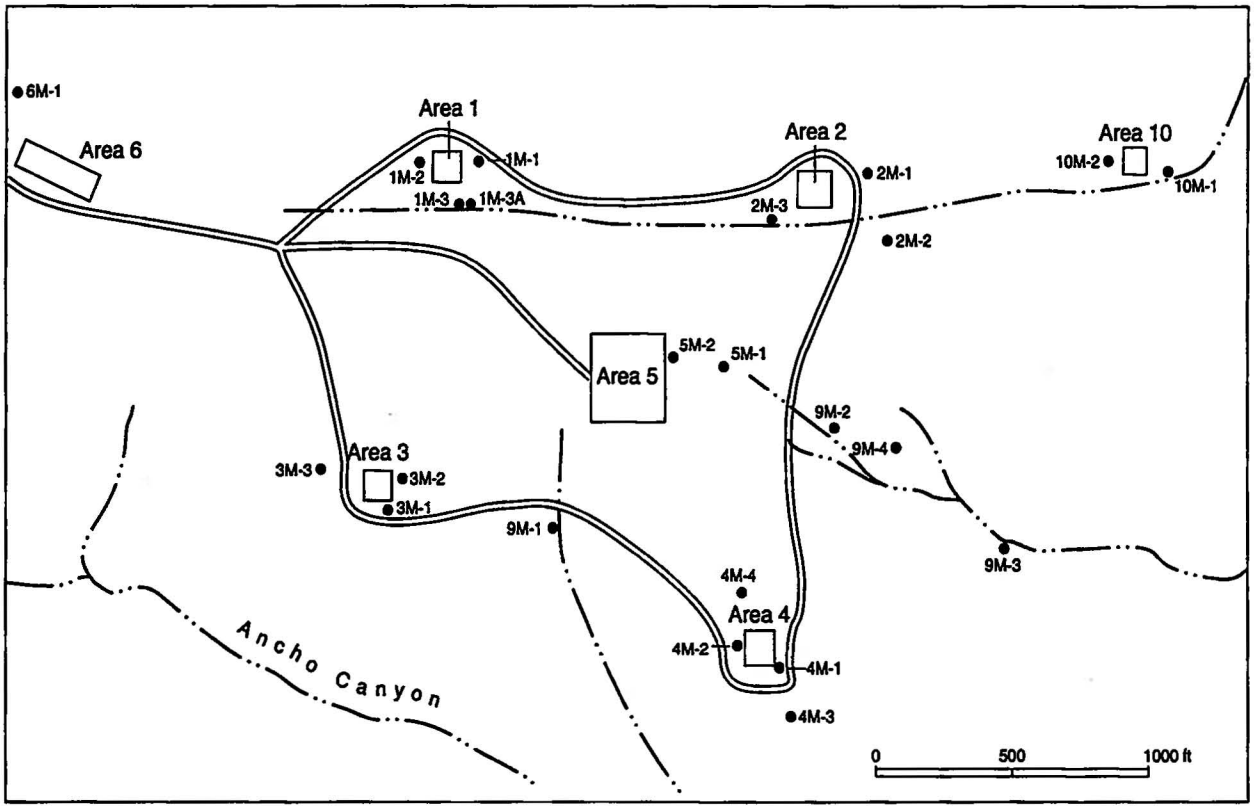


Fig. IX-V. Locations of moisture-access holes at TA-49.

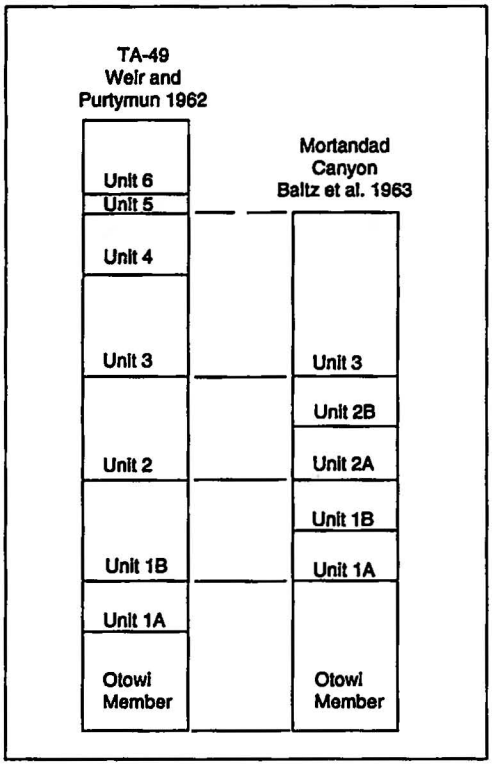


Fig. IX-B. Correlation of the units of the Tshirege Member of the Bandelier Tuff at TA-49 with the type section in Mortandad Canyon.

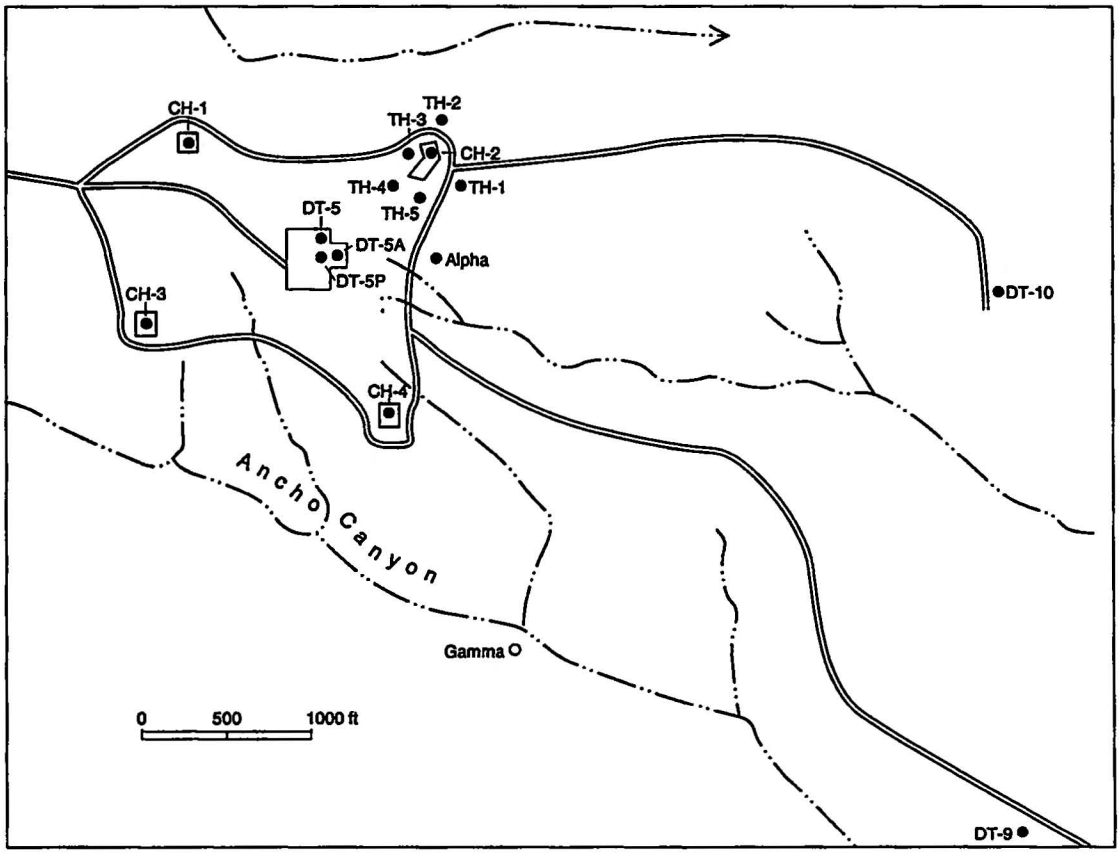


Fig. IX-C. Location of deep test wells (DT-series), core holes (CH-series), and test holes (TH-series) (Purtymun 1994).

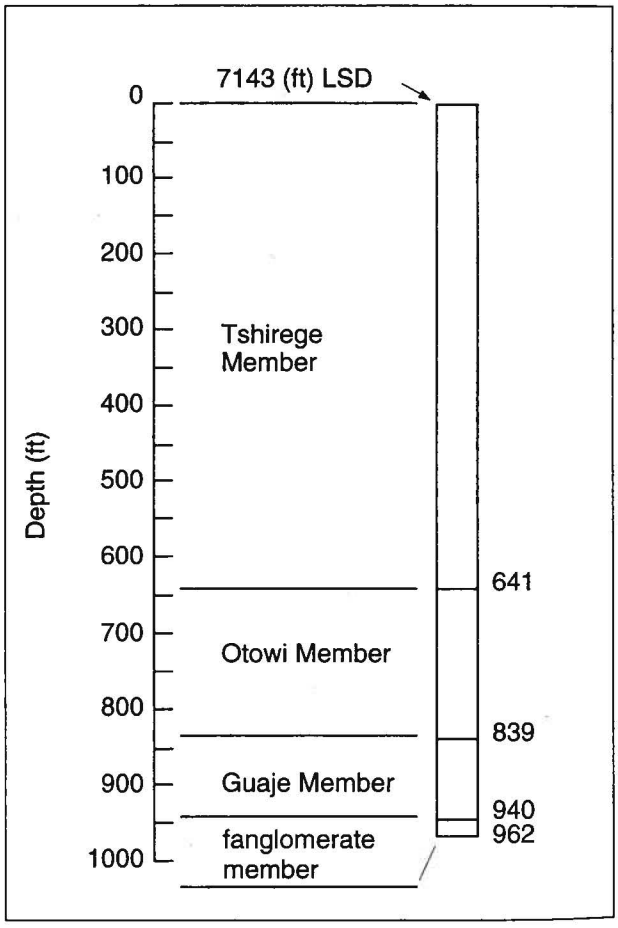
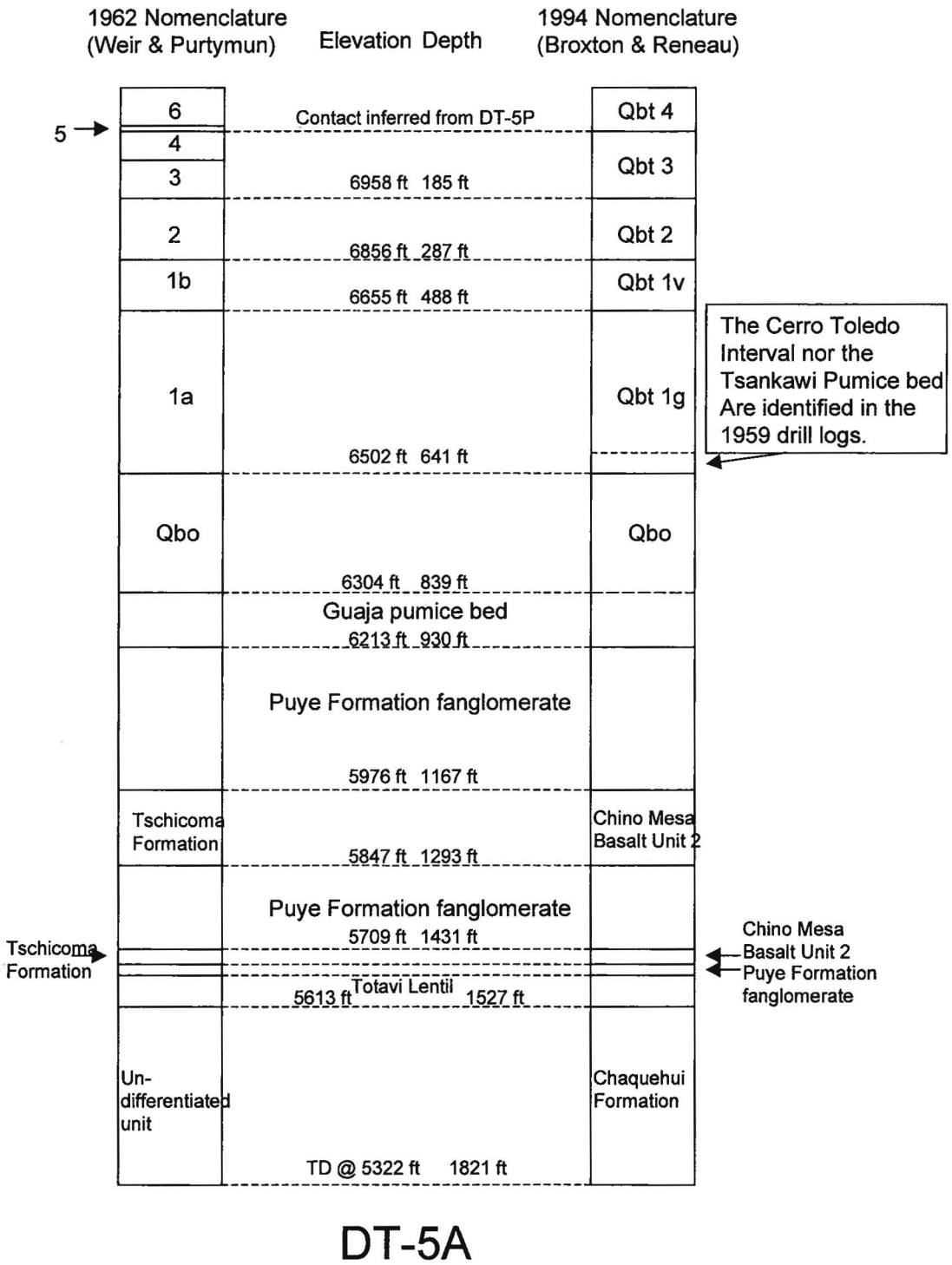
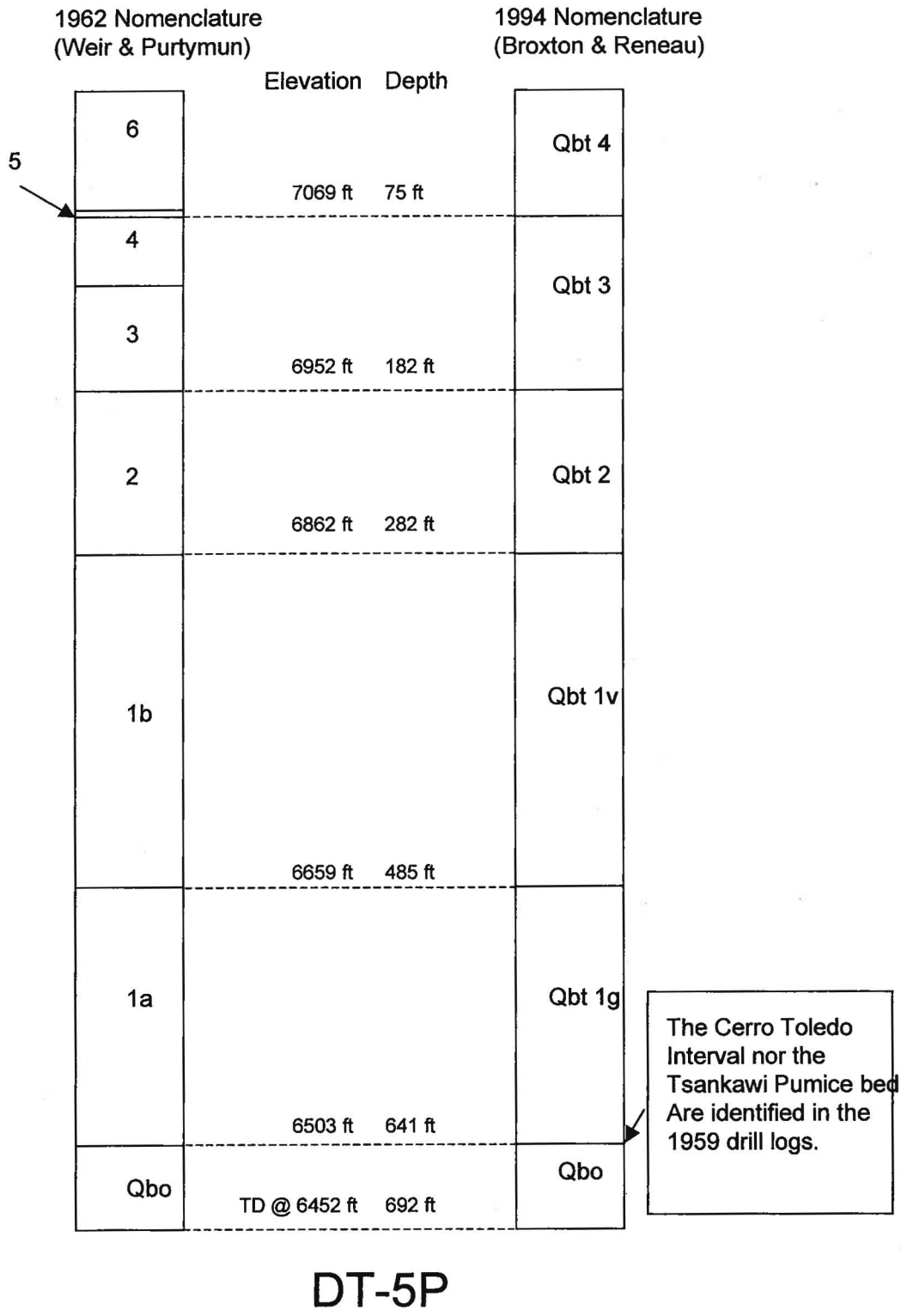


Fig. IX-E. Geologic log of test hole DT-5, completed November 1959, dry (Weir and Purtymun 1962).



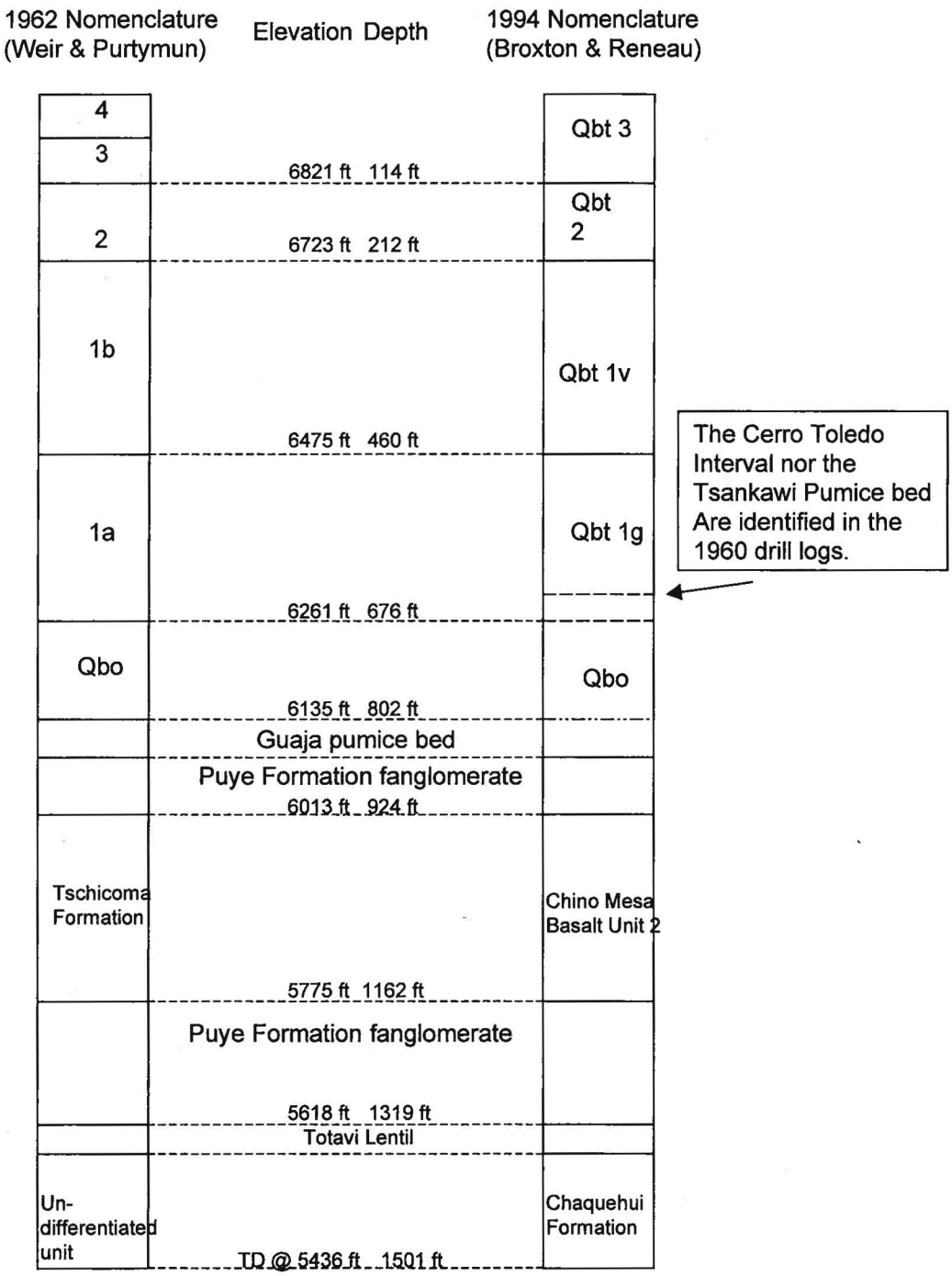
Adapted from Weir and Purtymun (1962, 011890) and Broxton and Reneau (1995, 049726)

Figure 3.2-2 Stratigraphic units of DT-5A



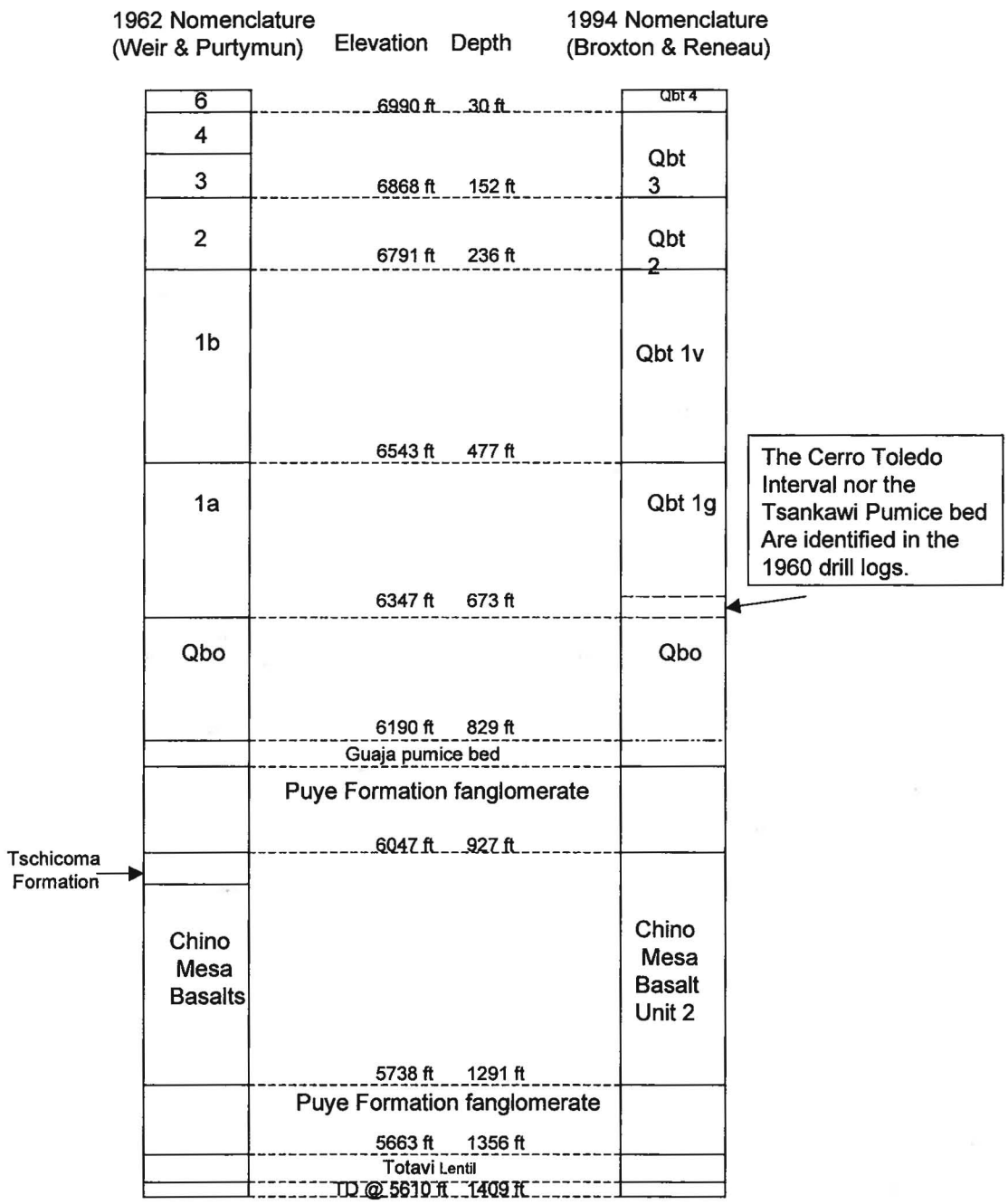
Adapted from Weir and Purtymun (1962, 011890) and Broxton and Reneau (1995, 049726)

Figure 3.2-3 Stratigraphic units of DT-5P



Adapted from Weir and Purtymun (1962, 011890) and Broxton and Reneau (1995, 049726)

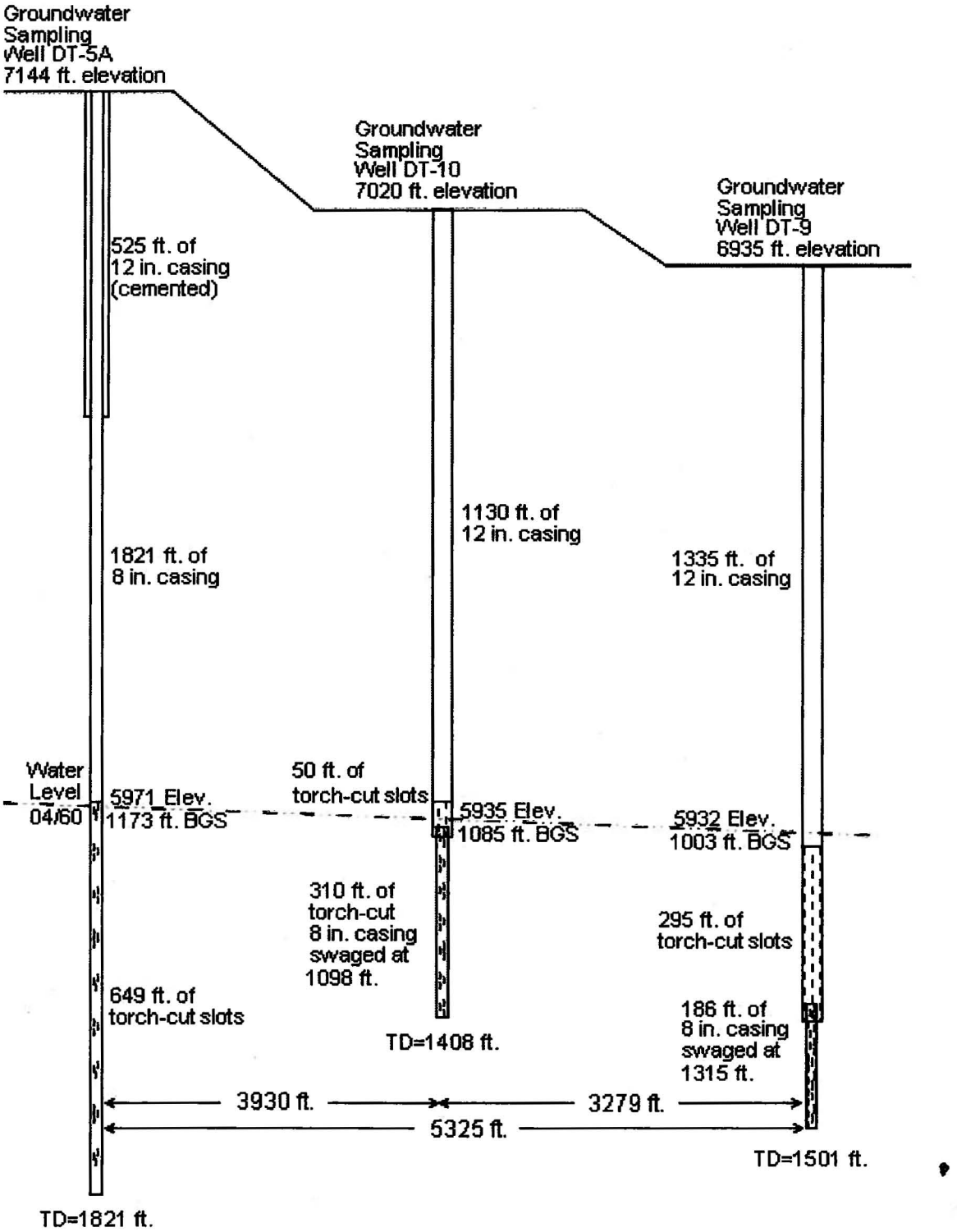
Figure 3.2-4 Stratigraphic units of DT-9



DT-10

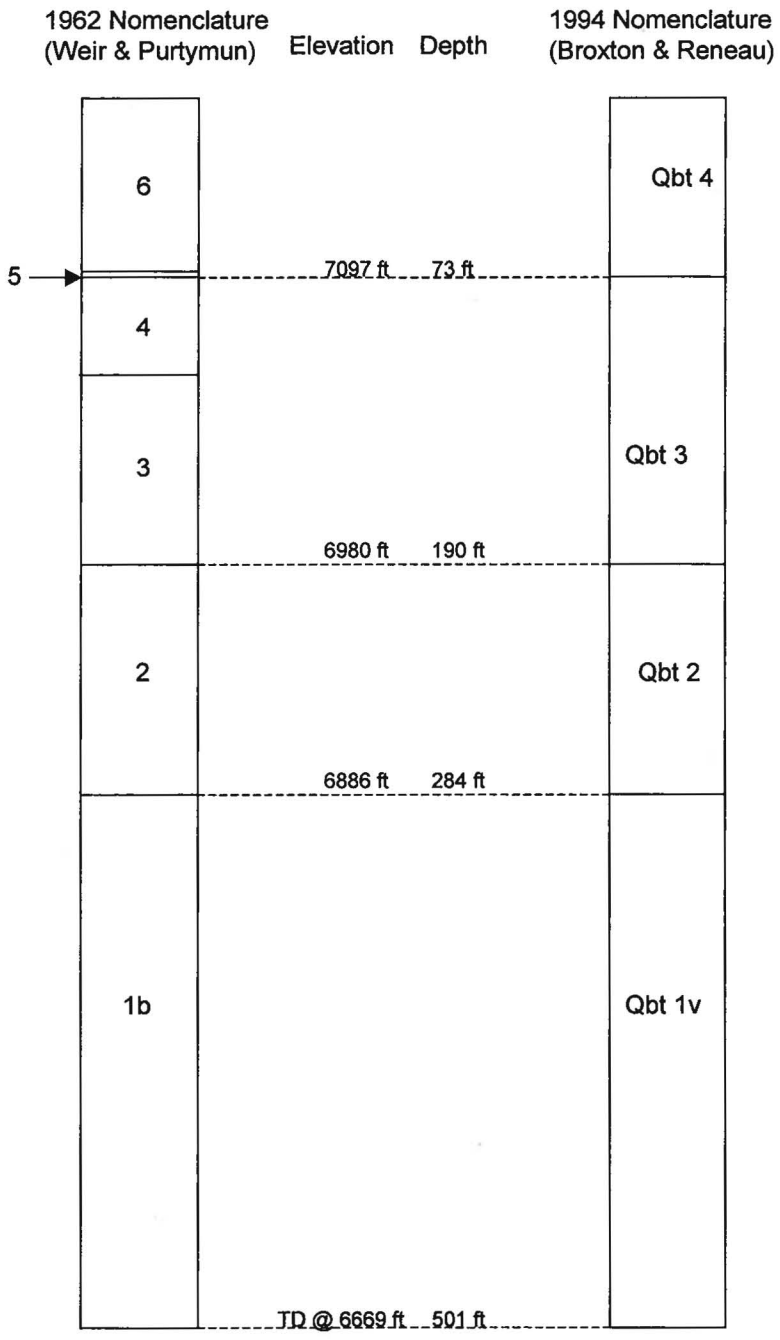
Adapted from Weir and Purtymun (1962, 011890) and Broxton and Reneau (1995, 049726)

Figure 3.2-5 Stratigraphic units of DT-10



Adapted from Weir and Purtymun (1962, 011890)

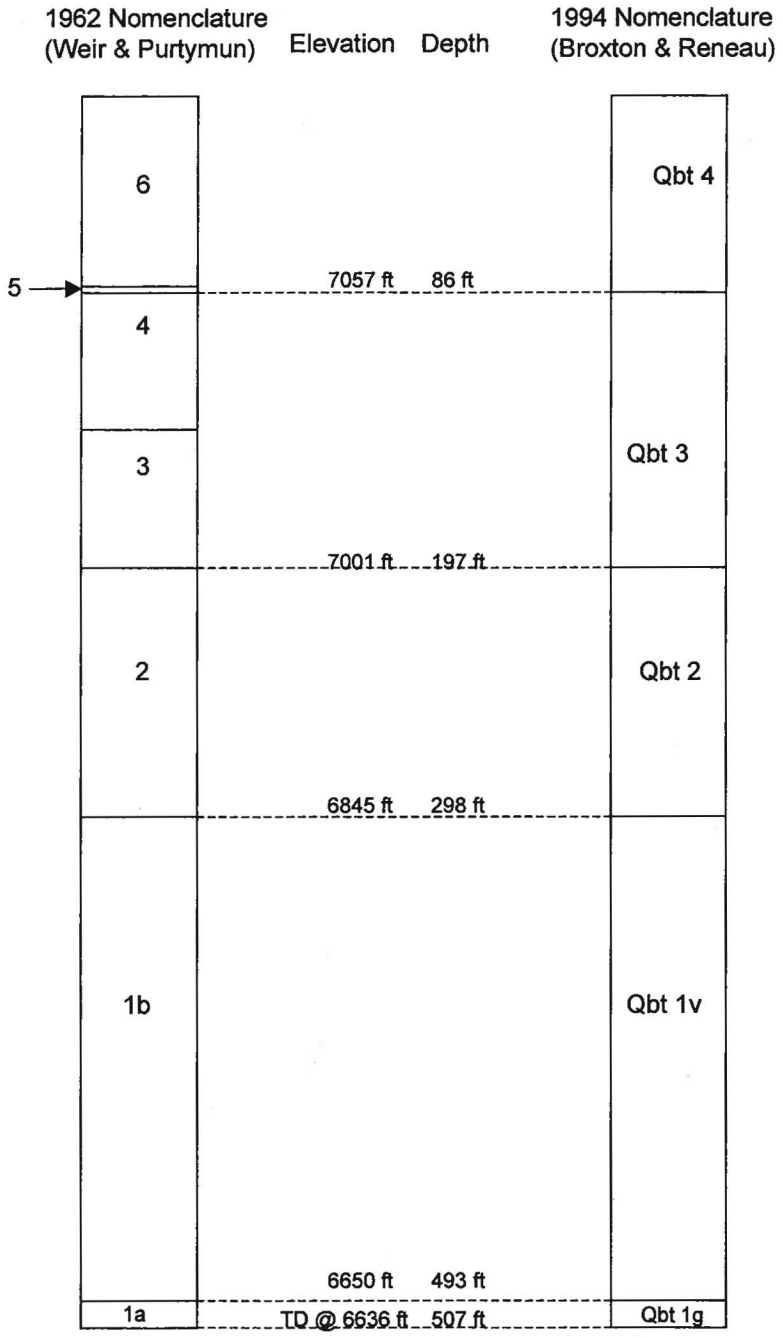
Figure 3.3-3 Construction details for groundwater wells DT-5A, DT-10, and DT-9



Core hole -1

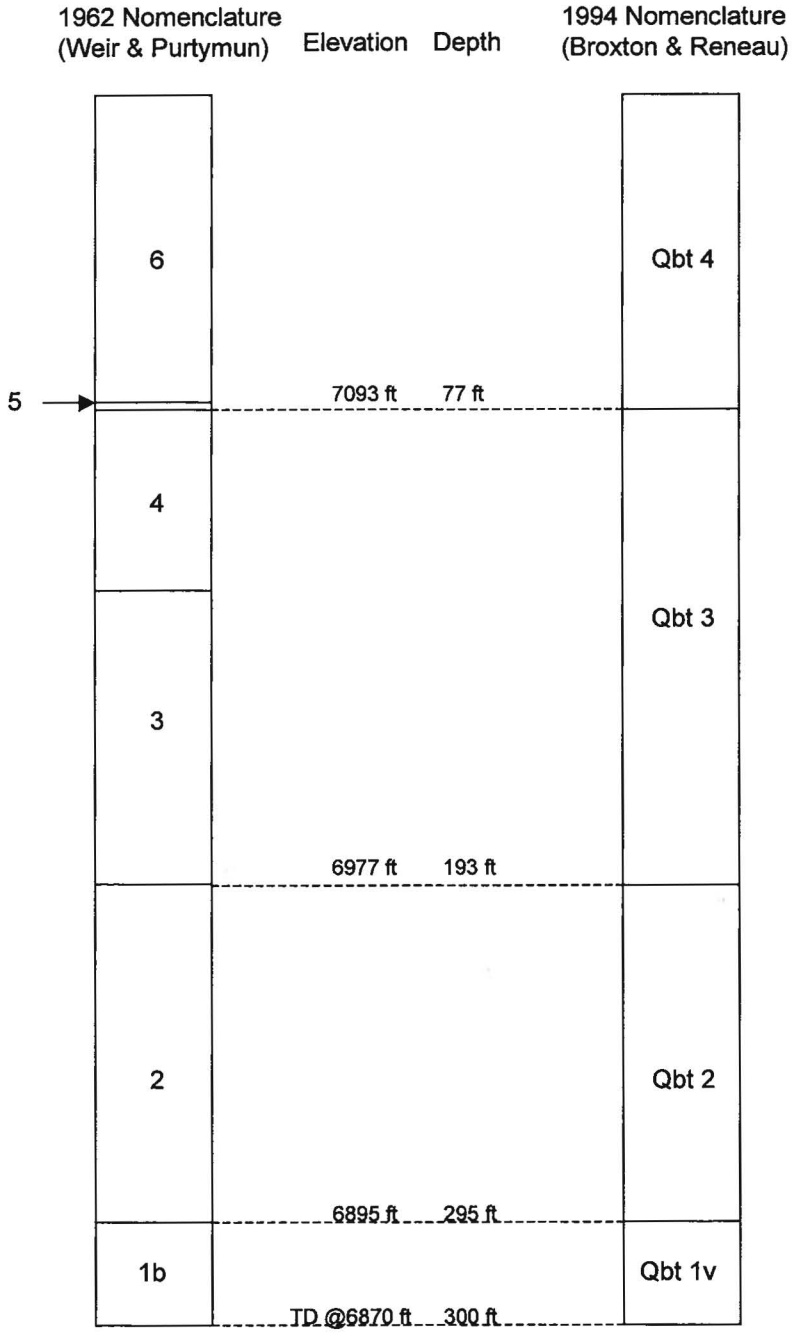
Adapted from Weir and Purtymun (1962, 011890) and Broxton and Reneau (1995, 049726)

Figure 3.2-6 Stratigraphic units of CH-1



Adapted from Weir and Purtymun (1962, 011890) and Broxton and Reneau (1995, 049726)

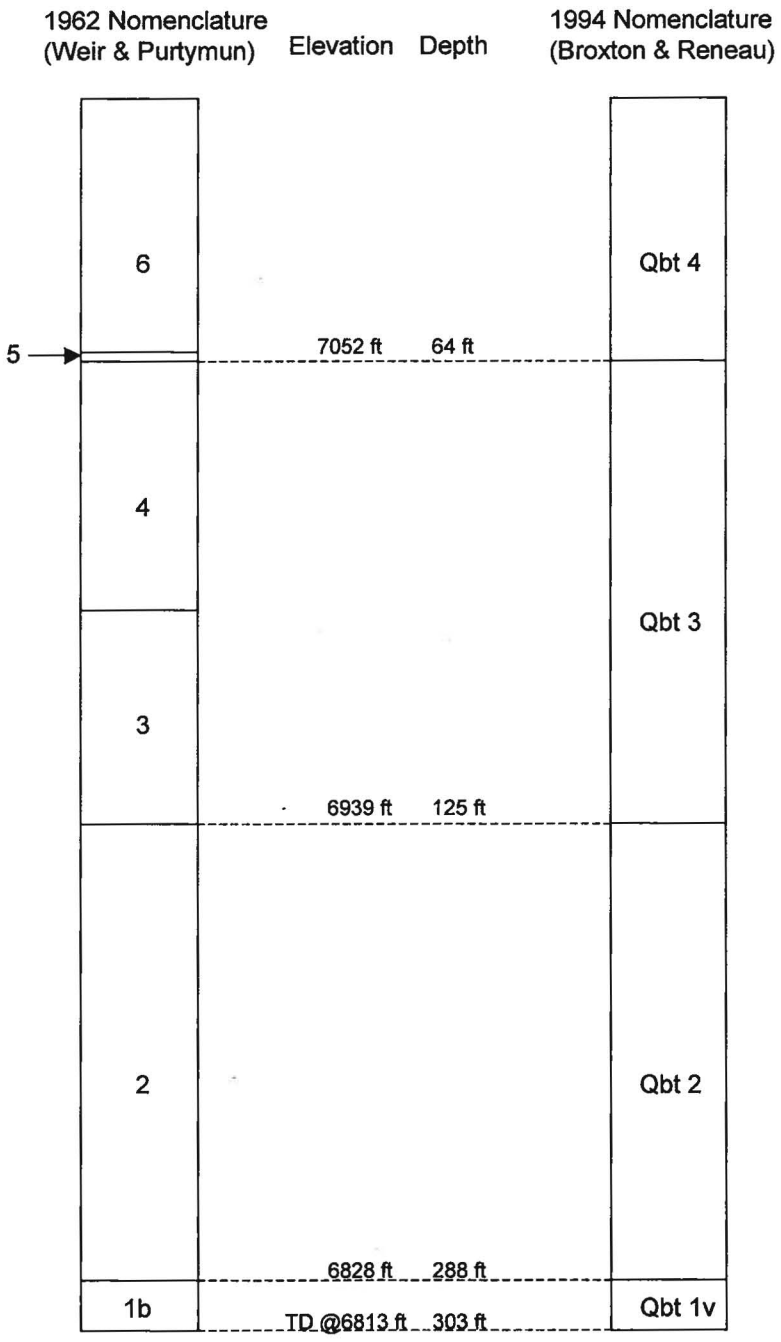
Figure 3.2-7 Stratigraphic units of CH-2



Core hole -3

Adapted from Weir and Purtymun (1962, 011890) and Broxton and Reneau (1995, 049726)

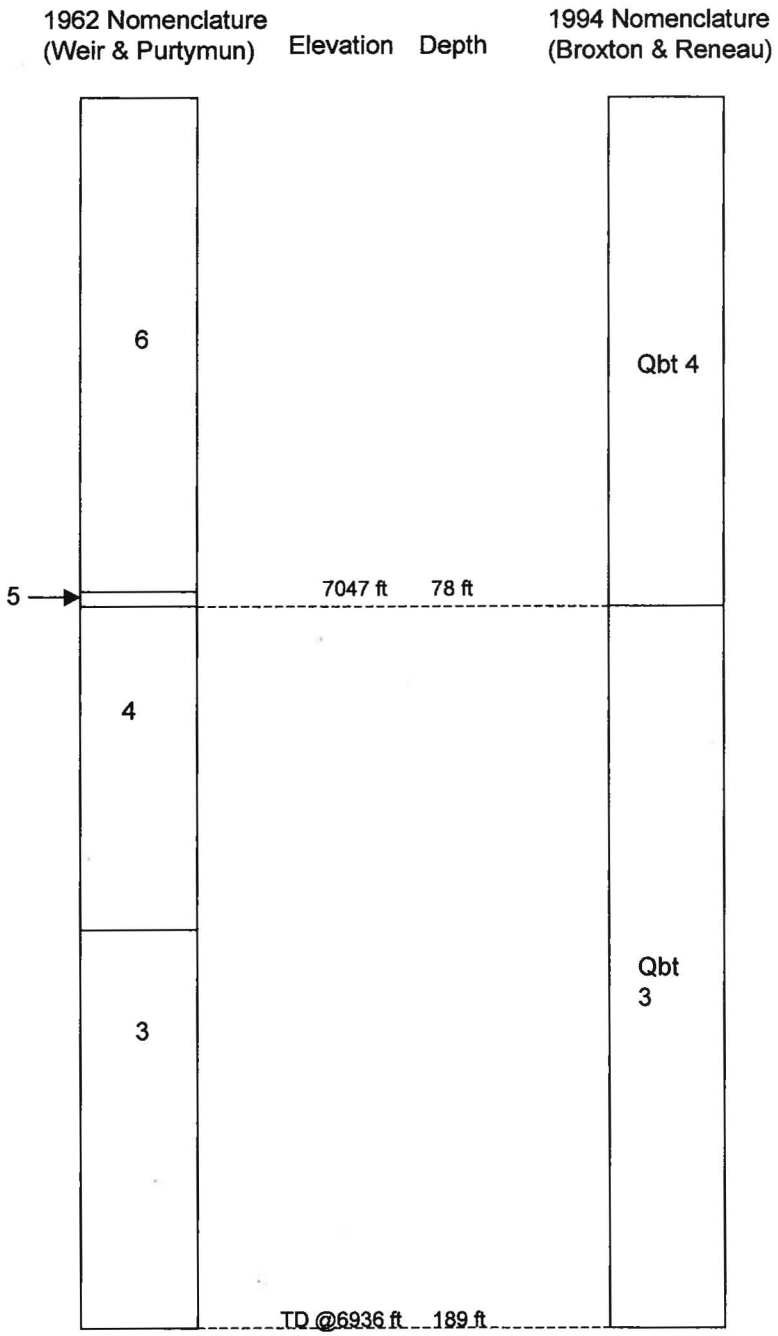
Figure 3.2-8 Stratigraphic units of CH-3



Core hole -4

Adapted from Weir and Purtymun (1962, 011890) and Broxton and Reneau (1995, 049726)

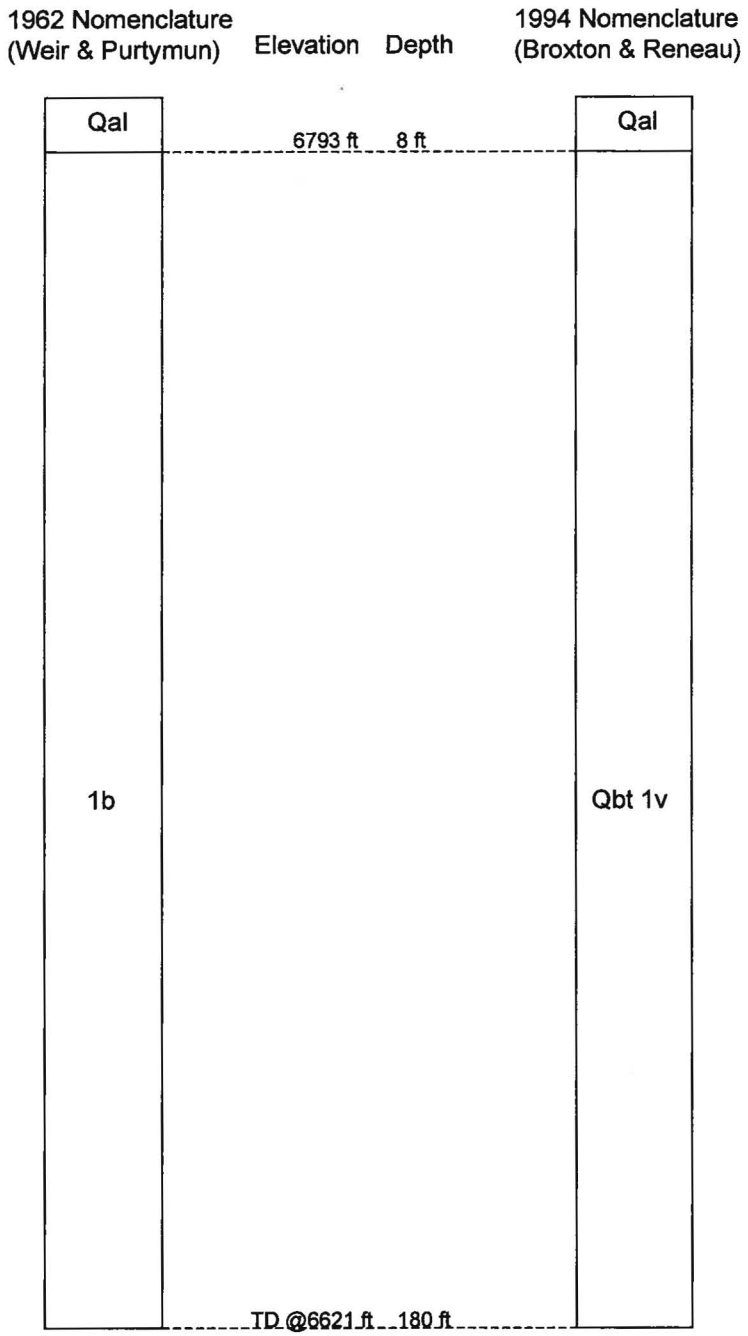
Figure 3.2-9 Stratigraphic units of CH-4



Alpha hole

Adapted from Weir and Purtymun (1962, 011890) and Broxton and Reneau (1995, 049726)

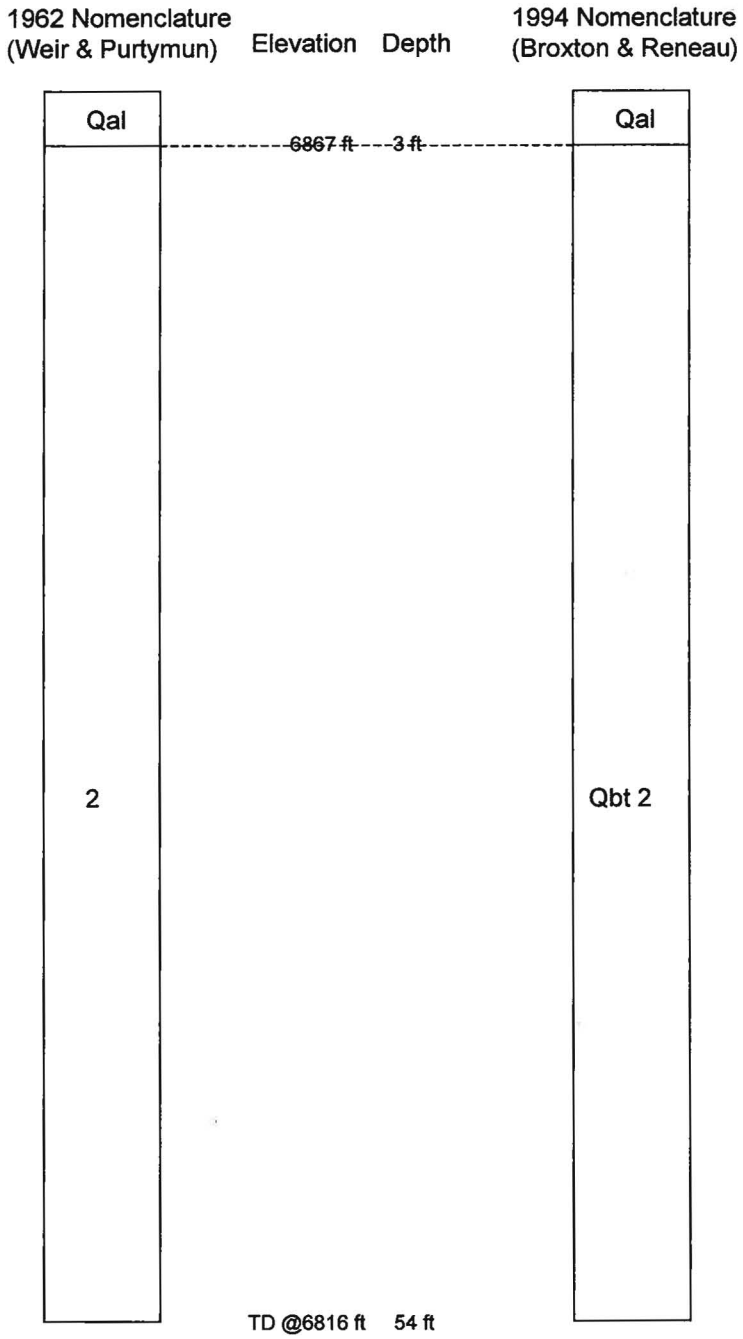
Figure 3.2-10 Stratigraphic units of Alpha hole



Beta hole

Adapted from Weir and Purtymun (1962, 011890) and Broxton and Reneau (1995, 049726)

Figure 3.2-11 Stratigraphic units of Beta hole



Gamma hole

Adapted from Weir and Purtymun (1962, 011890) and Broxton and Reneau (1995, 049726)

Figure 3.2-12 Stratigraphy of Gamma hole

Table 5.1-1
Summary of Analytical Results for Water Sample from Neutron Access Hole 2A-Y

Analyte	Media	Number of Analyses	Number of Detects	Concentration Range (pCi/L)	Frequency of Detects above Background Value
Americium-241	Groundwater, intermediate depth, perched	1	0	[5.813707 to 5.813707]	0/1
Cesium-134	Groundwater, intermediate depth, perched	1	0	[-3.288532 to -3.288532]	0/1
Cesium-137	Groundwater, intermediate depth, perched	1	0	[-3.160709 to -3.160709]	0/1
Cobalt-60	Groundwater, intermediate depth, perched	1	0	[1.48568 to 1.48568]	0/1
Europium-152	Groundwater, intermediate depth, perched	1	0	[-4.195175 to -4.195175]	0/1
Sodium-22	Groundwater, intermediate depth, perched	1	0	[8.693627 to 8.693627]	0/1
Uranium-235	Groundwater, intermediate depth, perched	1	0	[0.7775123 to 0.7775123]	0/1
Gross alpha	Groundwater, intermediate depth, perched	1	0	[5.98 to 5.98]	0/1
Gross beta	Groundwater, intermediate depth, perched	1	1	37.01 to 37.01	1/1

5.2 Biobarrier Repair

On September 28, 2004, it was discovered that a gopher had penetrated the biobarrier adjacent to the concrete pad surrounding neutron access hole 49-10046. An inadequate number of clips between biobarrier sheets had allowed the gopher to slip through and dig into the ET cover. Following this discovery, the gopher's spoil pile was screened by a Health, Safety, and Radiation Protection Group radiation control technician and deemed to be at or below instrument background for the surface of the site. The soil was then spread across the cover and the biobarrier repaired. No further signs of gopher intrusion have been observed since the barrier was repaired.

5.3 Borehole Abandonment

Boreholes Alpha and Gamma A were abandoned during the fourth quarter of FY2005. These boreholes were advanced in 1960 as hydrogeological test holes. Alpha was located west of Areas 2 and 4, with a diameter of 2 ft and a depth of 189 ft. Gamma A was located in Ancho Canyon to the south of Area 4, with a diameter of 4 in. and a depth of 56 ft. The borehole locations are shown in Figure 3.2-1. These boreholes were not used for periodic testing or monitoring; nor were there any foreseeable future uses for these boreholes. The exploratory boreholes were abandoned for the following reasons:

- The exploratory boreholes provided a potential rapid conduit for moisture or other unwanted constituents into the subsurface.
- No construction diagrams or records exist.

- Large diameter boreholes cannot be utilized for vadose zone monitoring.
- Gamma A was located in a canyon-bottom flood plain.
- Neither borehole encountered saturated intervals at time of drilling, nor did any contain water at the time of abandonment.
- These boreholes are not required for future remediation projects.

Borehole abandonment activities began on September 26, 2005, and were completed on October 3, 2005. Boreholes Alpha and Gamma A, drilled for a hydrogeologic investigation in 1960, were abandoned per SOP-5.03, Rev. 3, "Monitor Well and RFI Borehole Abandonment." The constructions are described below.

Alpha

The corrugated steel casing was cut flush at ground surface, with 7.5 ft left in the borehole. This borehole was sealed in three stages.

- *Stage 1:* A cement/sand slurry was placed from total depth to a level of 10.5 ft bgs. The slurry consisted of water, cement, and sand at a ratio of approximately 1:2:8 by weight that had been prepared and delivered by Los Alamos Transit Mix.
- *Stage 2:* A soft bentonite grout was placed on top of the cement/sand slurry over the interval of 10.5 ft bgs to 2 ft bgs. The soft bentonite grout consisted of water, cement, and bentonite at a ratio of 10:3:1 by weight. Type I/II Portland cement and Baroid Aquagel Gold Seal (200 mesh bentonite powder) were used.
- *Stage 3:* A concrete cap constructed of standard 4000 pounds per square inch concrete was placed over the soft bentonite grout and domed over the former borehole. A brass cap was placed in the center of this dome for future identification and geographic reference.

Gamma A

The 4-in.-diameter steel casing was removed, and the borehole was sealed in two stages.

- *Stage 1:* Bentonite pellets (1/4 in.) were placed from total depth to 1 ft bgs and hydrated in 5-ft lifts.
- *Stage 2:* A cement seal consisting of Type I/II Portland cement was placed from 1 ft bgs to the surface.

Appendix C, "2005 Borehole Abandonment Constructions," presents diagrams of the construction described above.

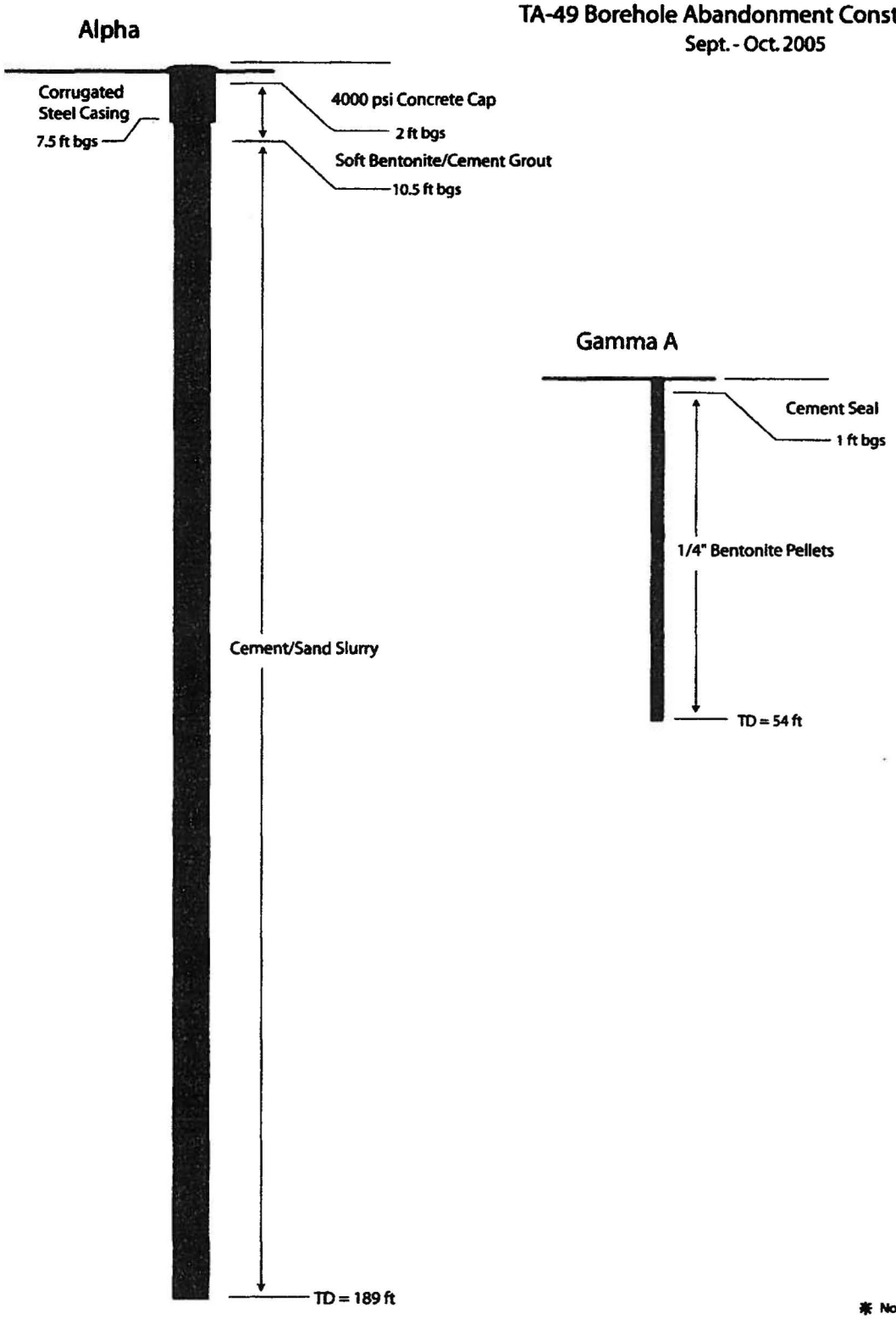
6.0 CONCLUSIONS

Analysis of the moisture monitoring data collected over the past year leads to the following conclusions:

- The neutron log and TDR data indicate that subsurface moisture levels fluctuate in the near surface (<10 ft) and remain constant at greater depth, as expected in a moisture-limited, semiarid climate.

TA-49 Borehole Abandonment Constructions*

Sept. - Oct. 2005



* Not to Scale

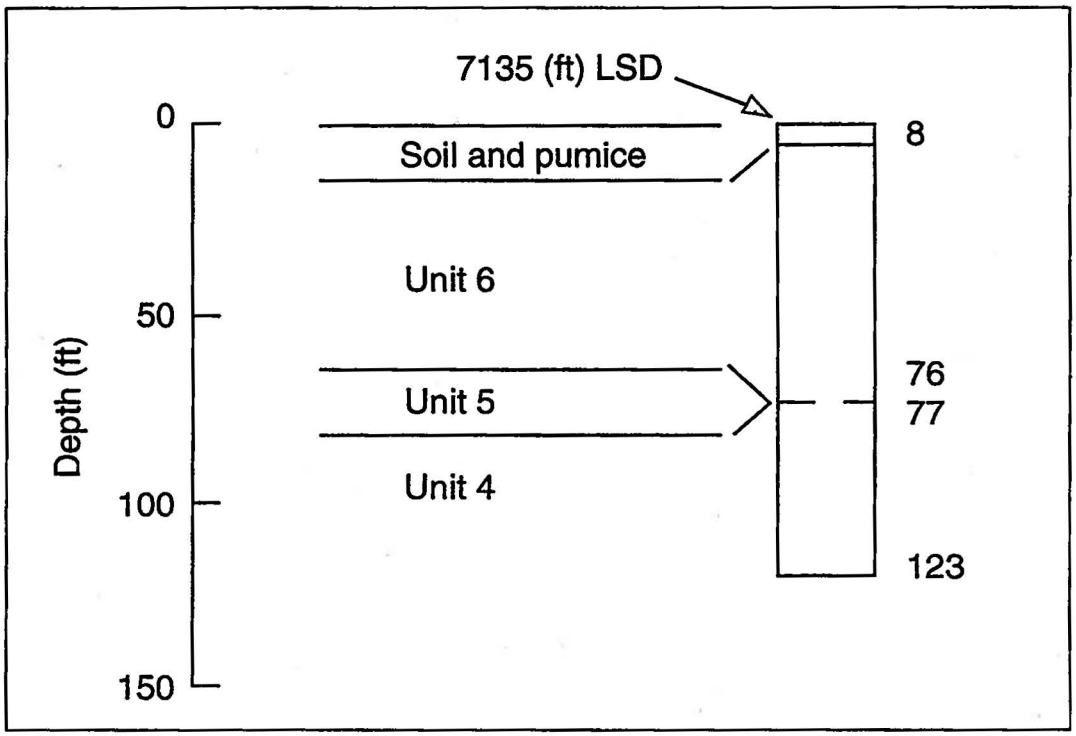


Fig. IX-P. Geologic log of Area 2 Test Hole 1, completed May 1980, dry (Purtymun 1994).

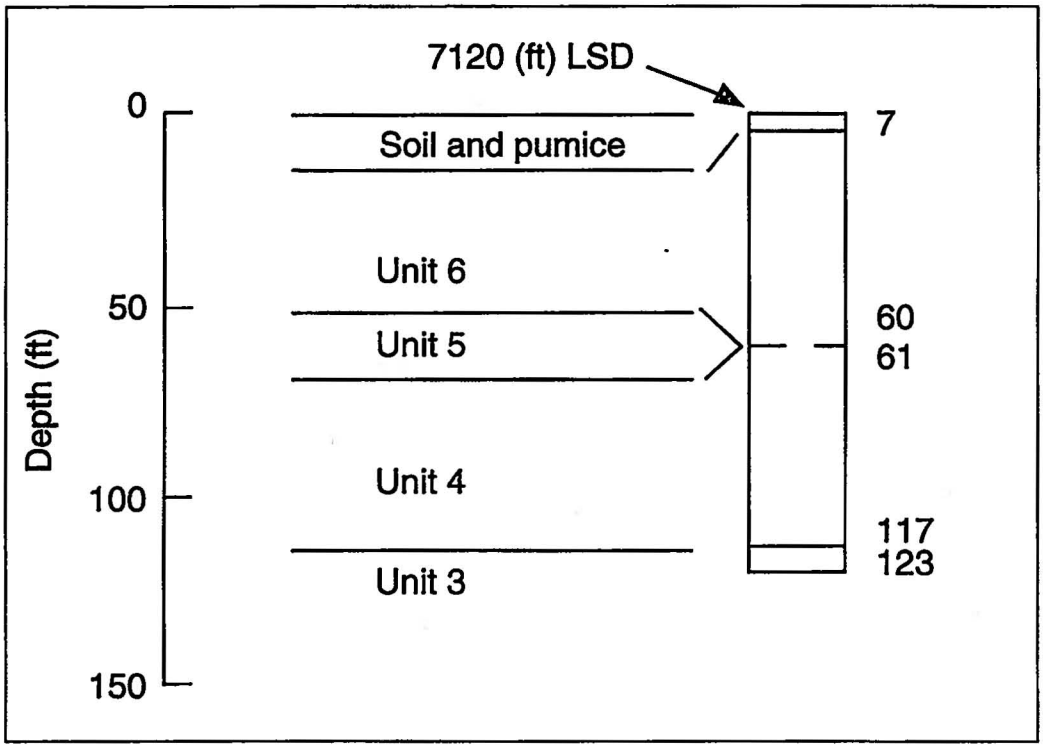


Fig. IX-Q. Geologic log of Area 2 Test Hole 2, completed May 1980, dry (Purtymun 1994).

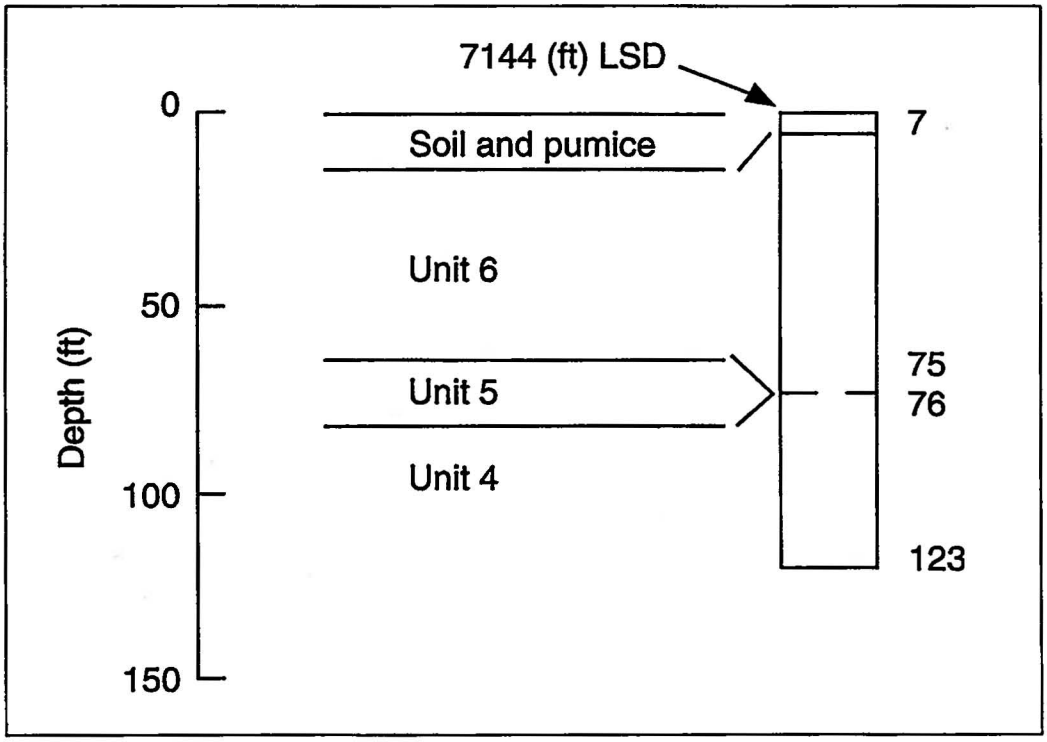


Fig. IX-R. Geologic log of Area 2 Test Hole 3, completed May 1980, dry (Purtymun 1994).

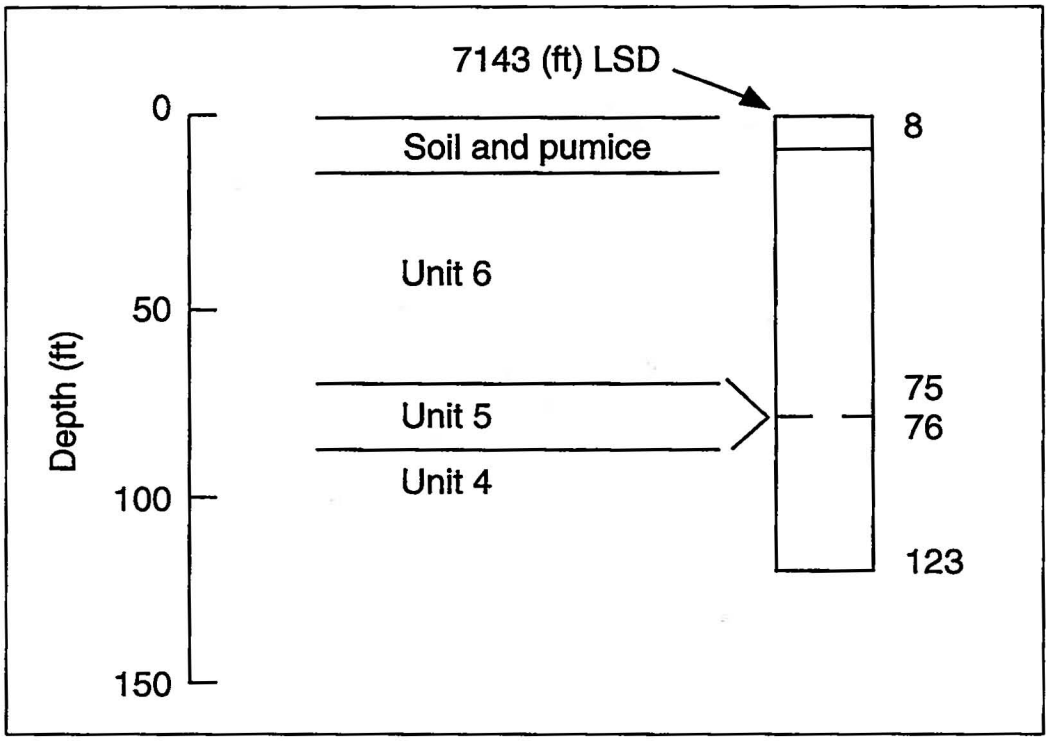


Fig. IX-S. Geologic log of Area 2 Test Hole 4, completed May 1980, dry (Purtymun 1994).

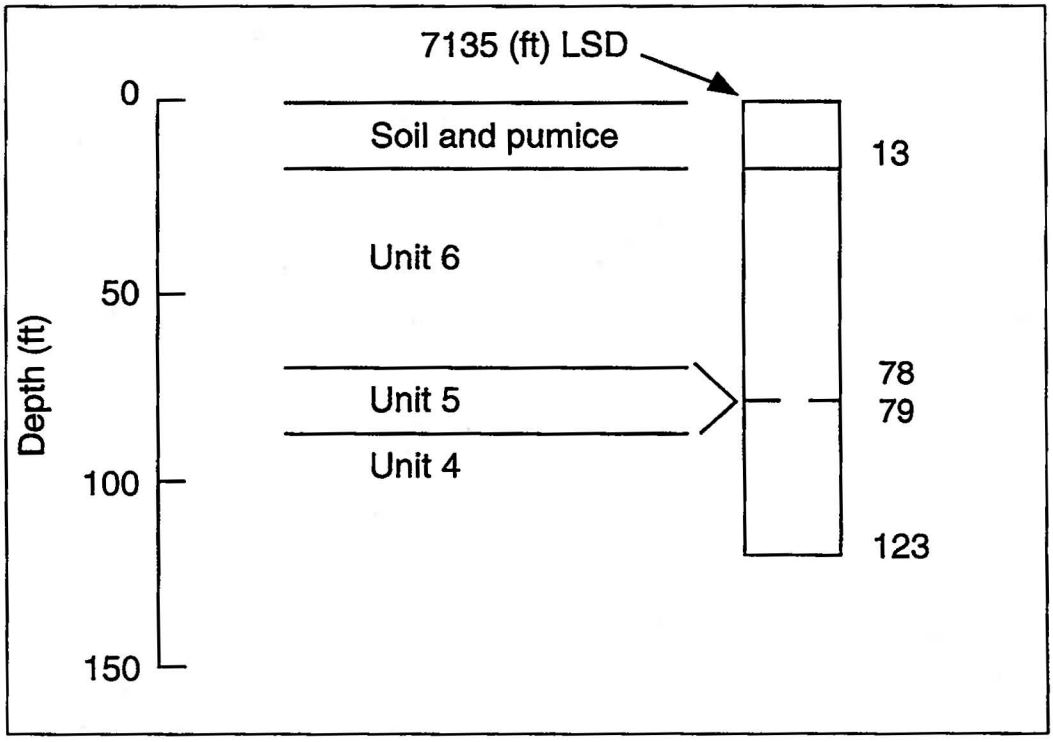


Fig. IX-T. Geologic log of Area 2 Test Hole 5, completed May 1980, dry (Purtymun 1994).

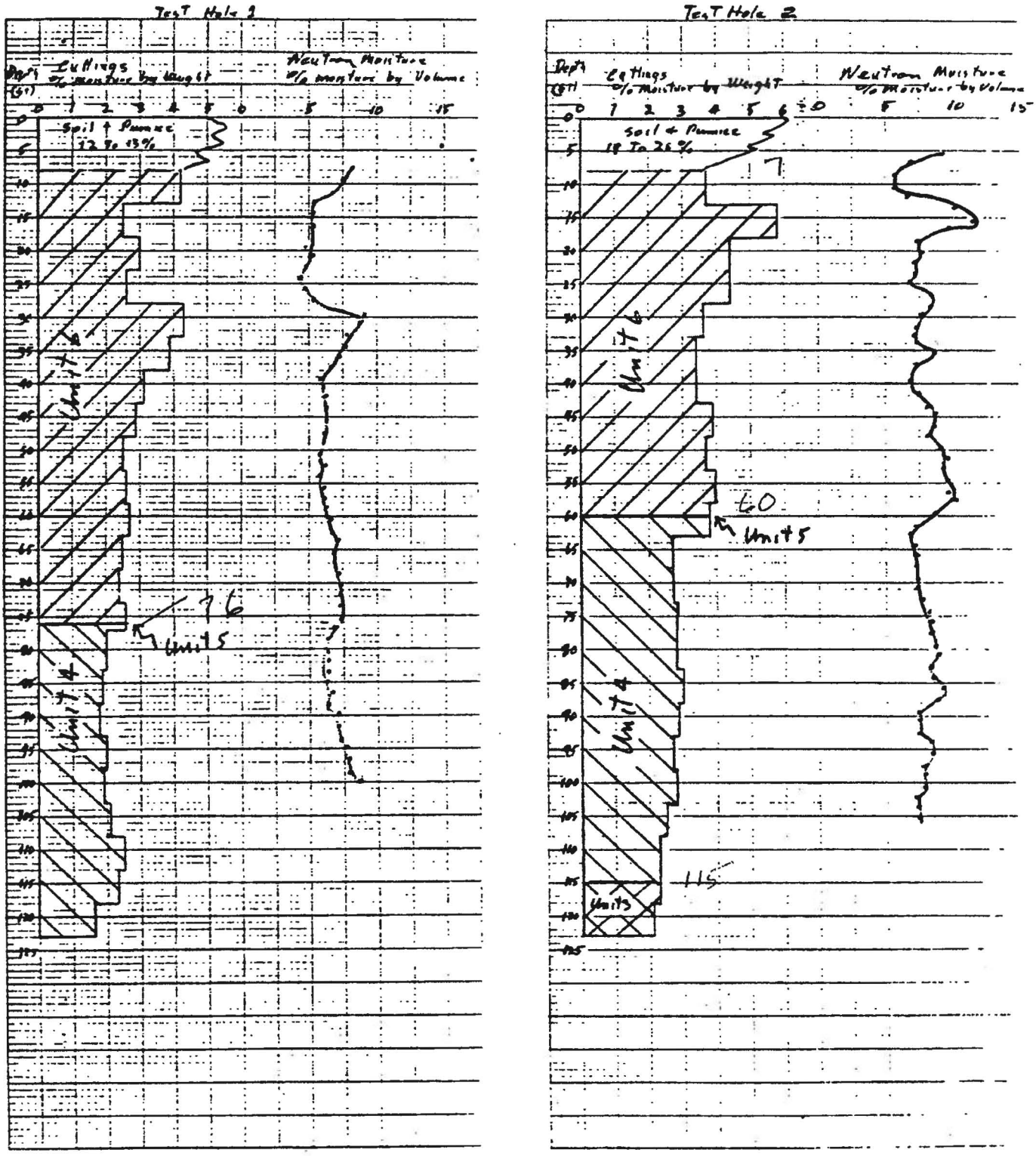


Fig. 2. Geologic and neutron logs of Test Holes TH-1 and TH-2.

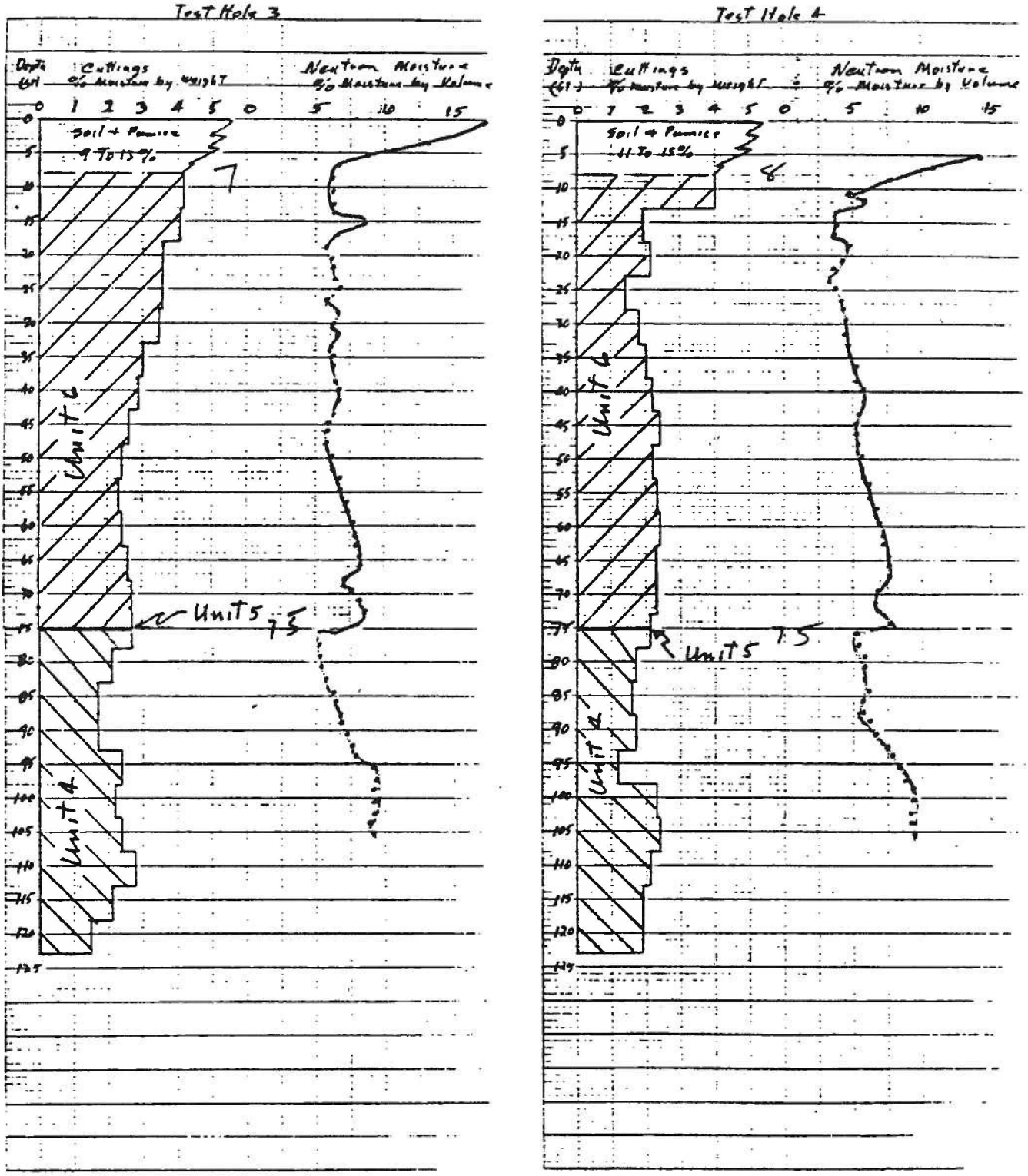


Fig. 3. Geologic and neutron logs of Test Holes TH-3 and TH-4.

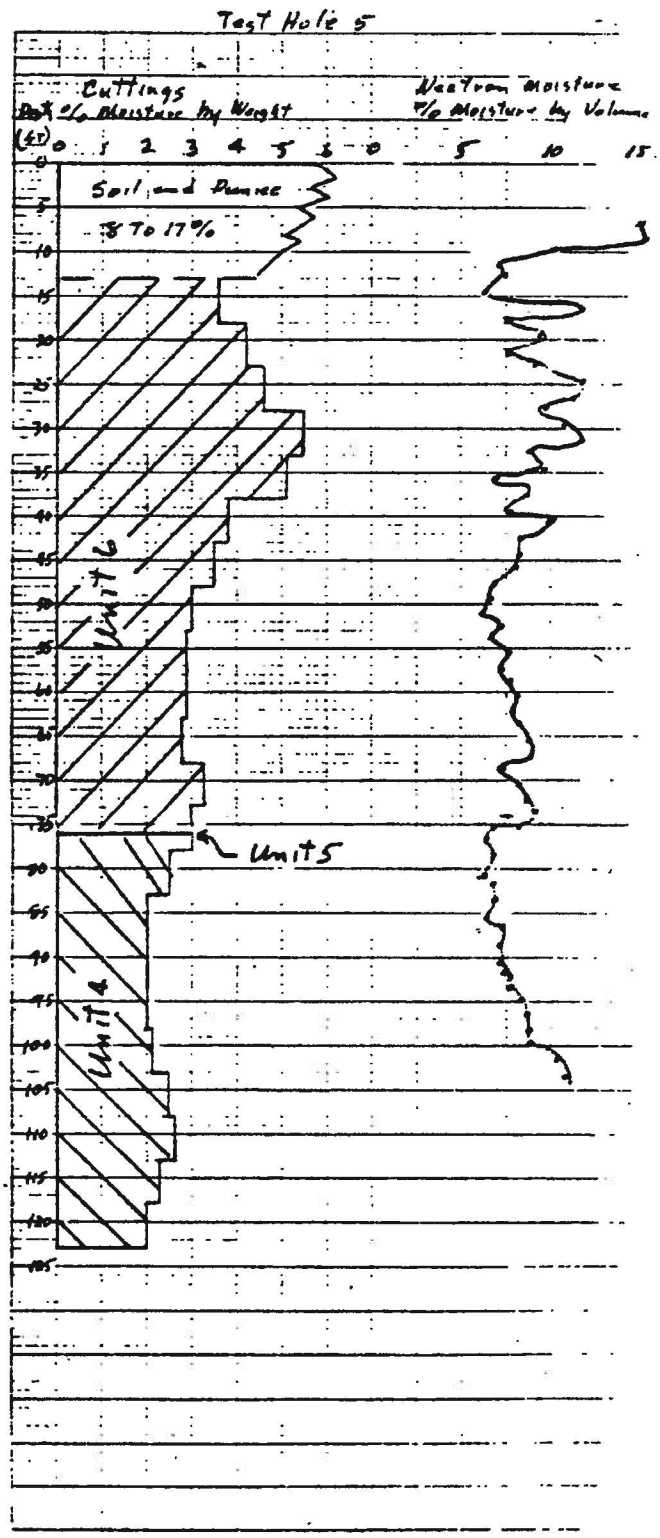


Fig. 4. Geologic and neutron logs of Test Hole TH-5.

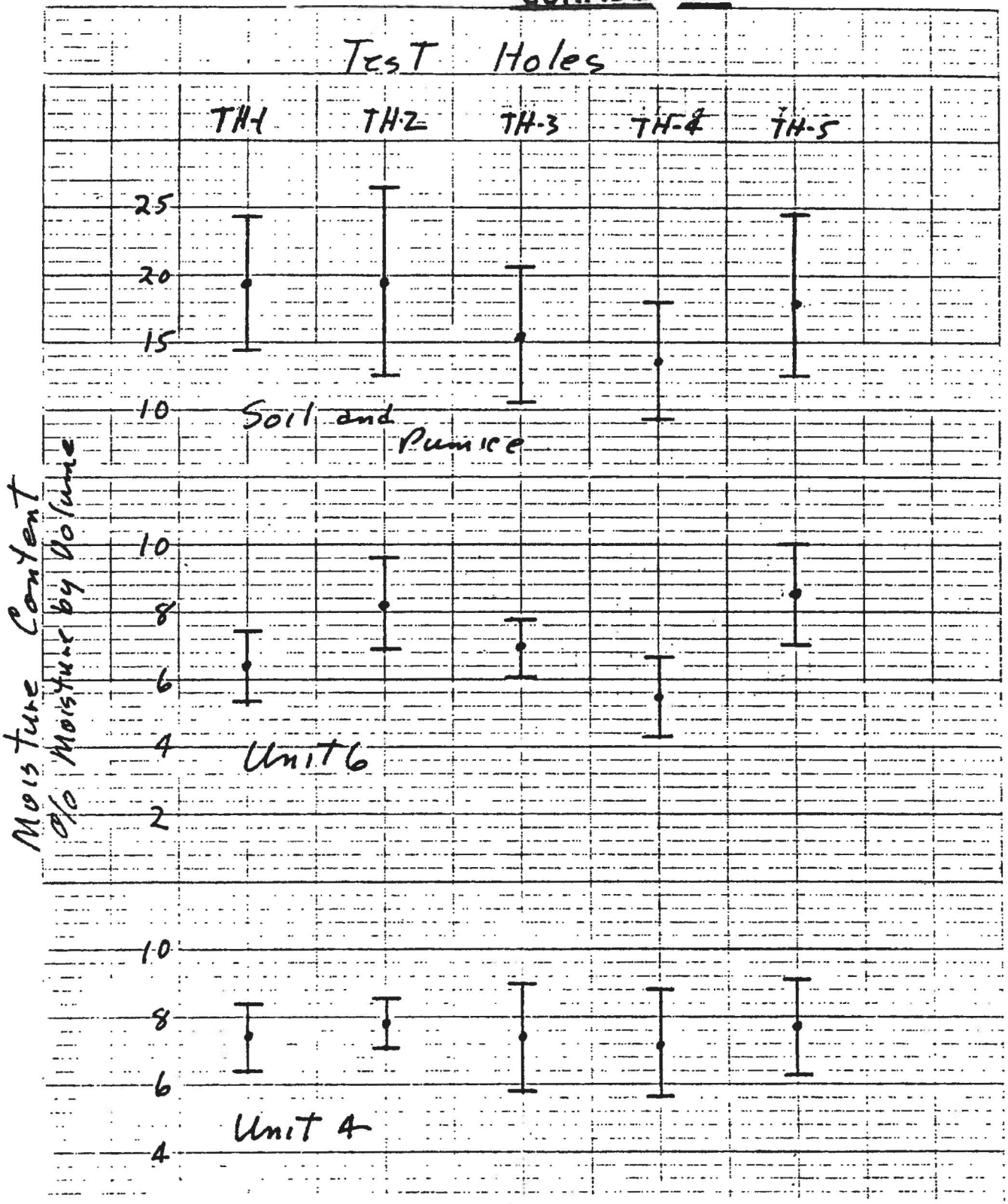


Fig. 5. Average moisture content of pumice and soil and tuff of Unit 4 and 6 in test holes.

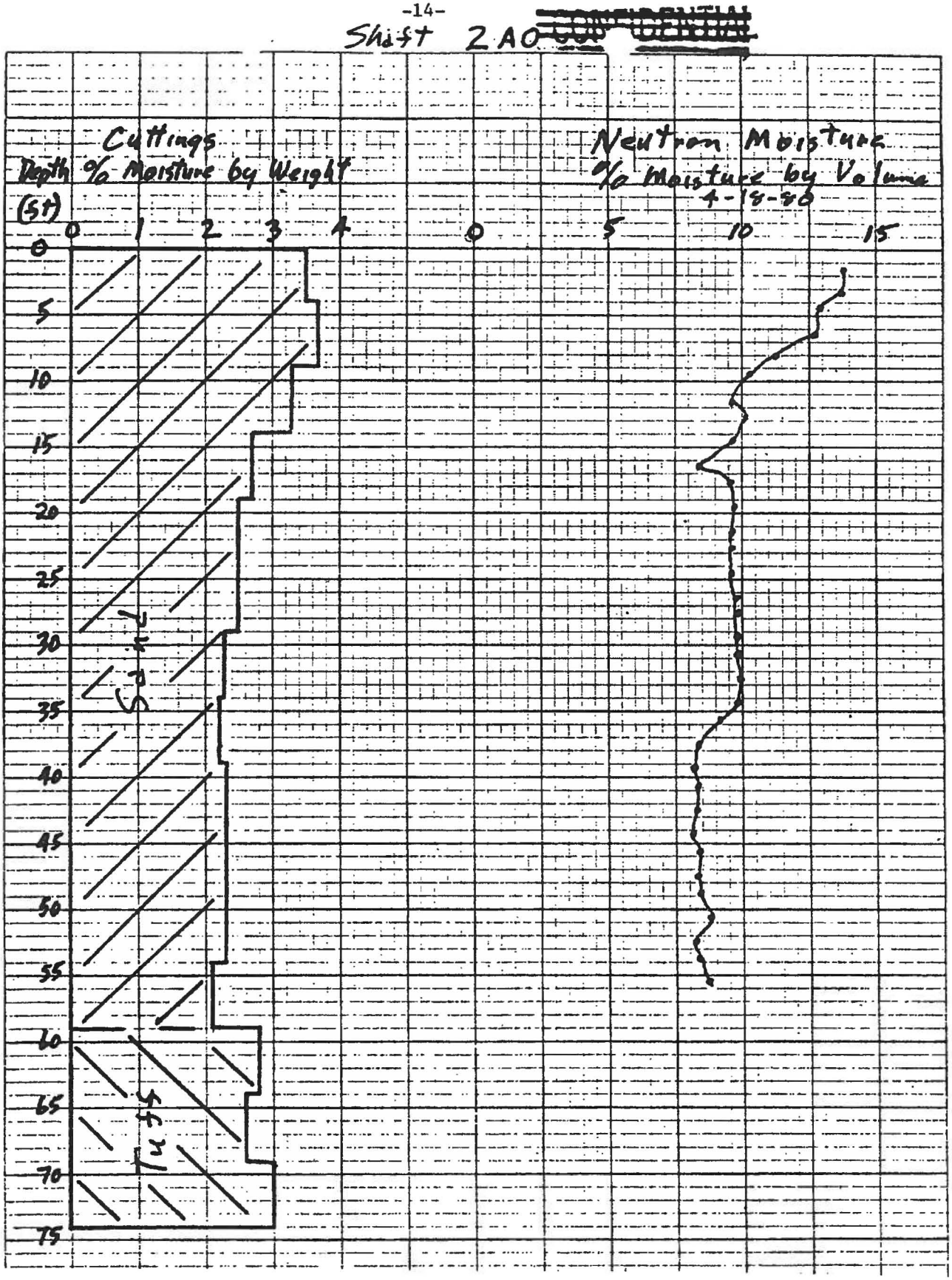


Fig. 6. Geologic and neutron logs of Shaft 2A-0.

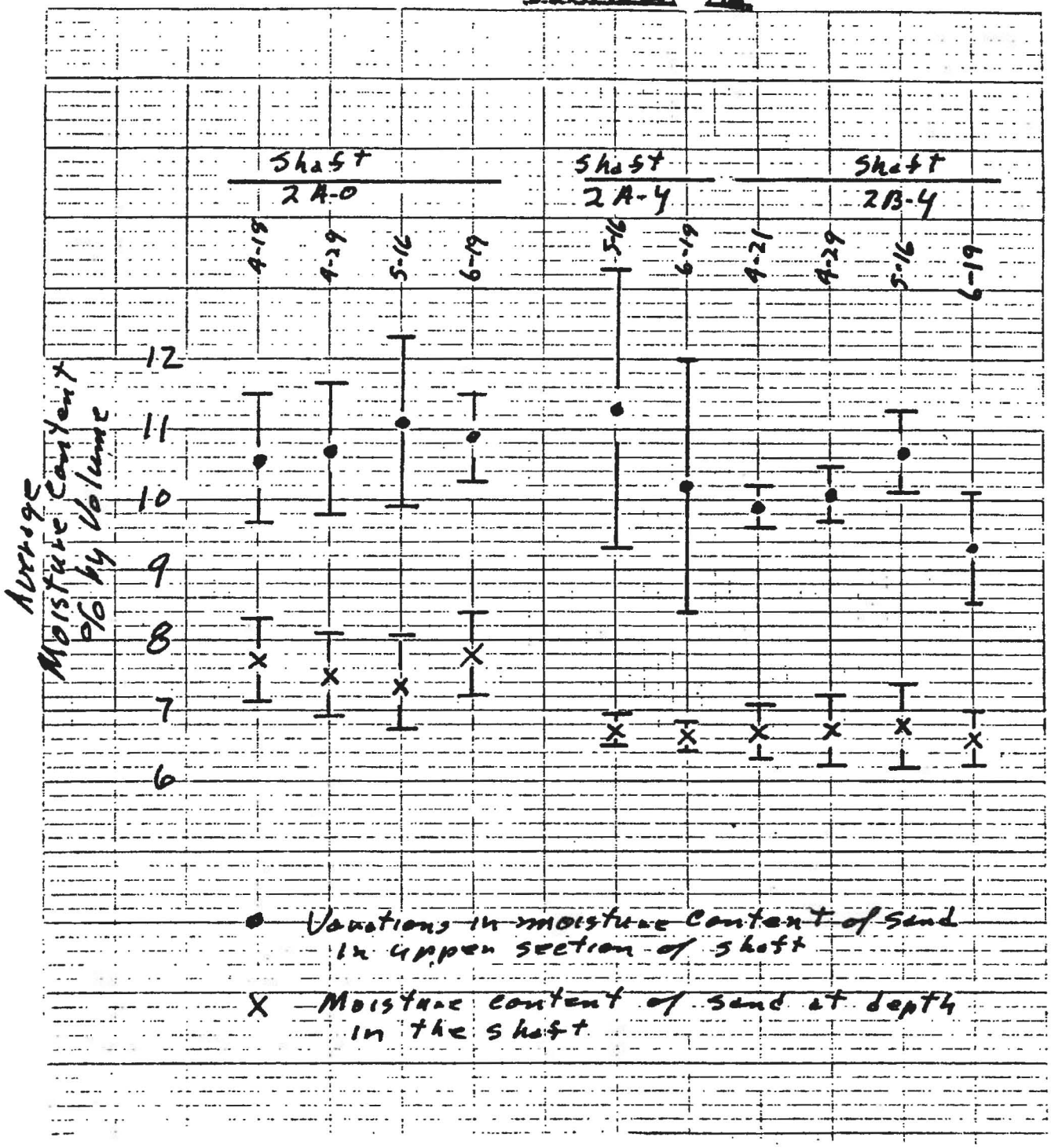


Fig. 7. Average moisture content of sand in Shafts 2A-0, 2A-Y, and 2B-Y.

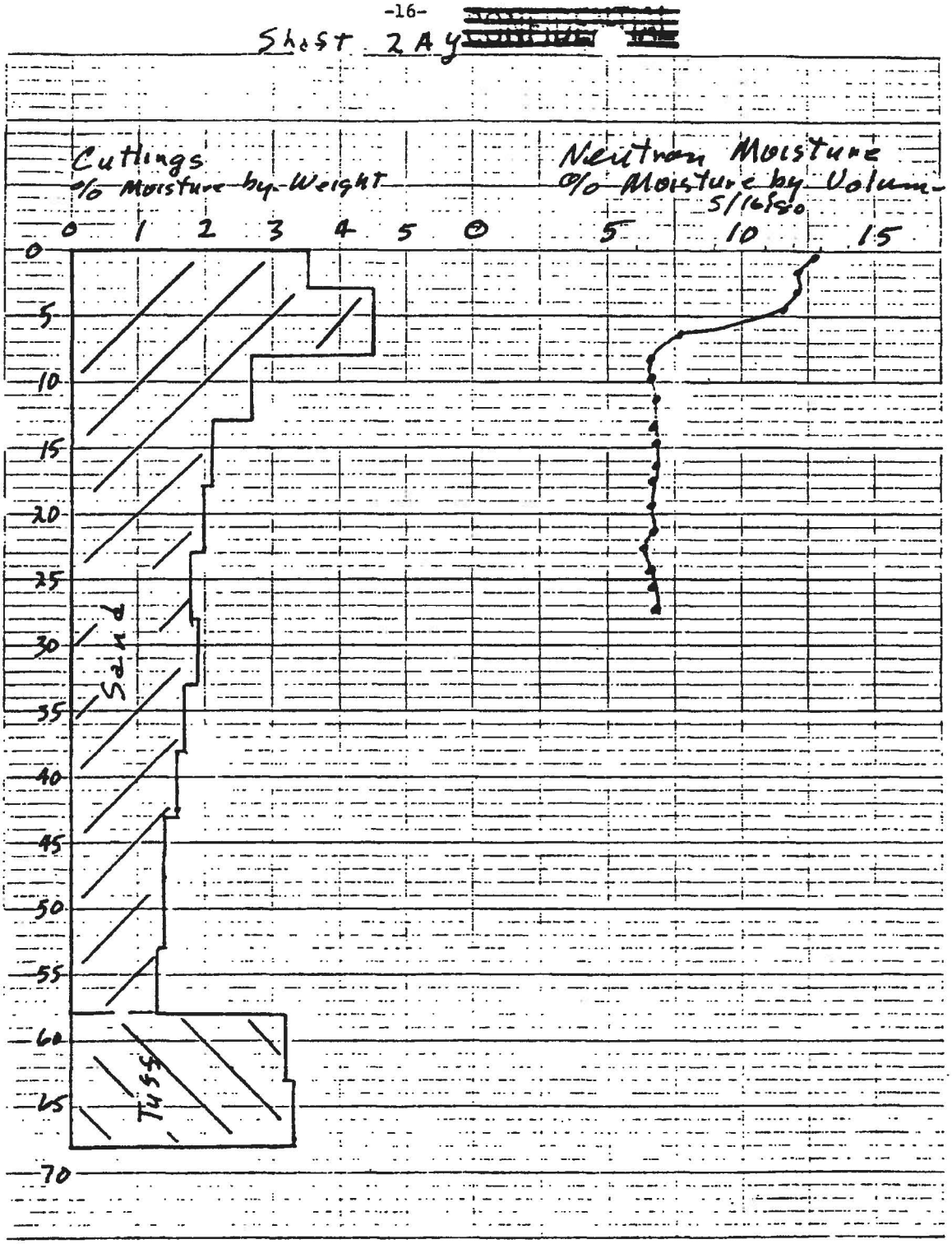


Fig. 8. Geologic and neutron logs of Shaft 2A-Y.

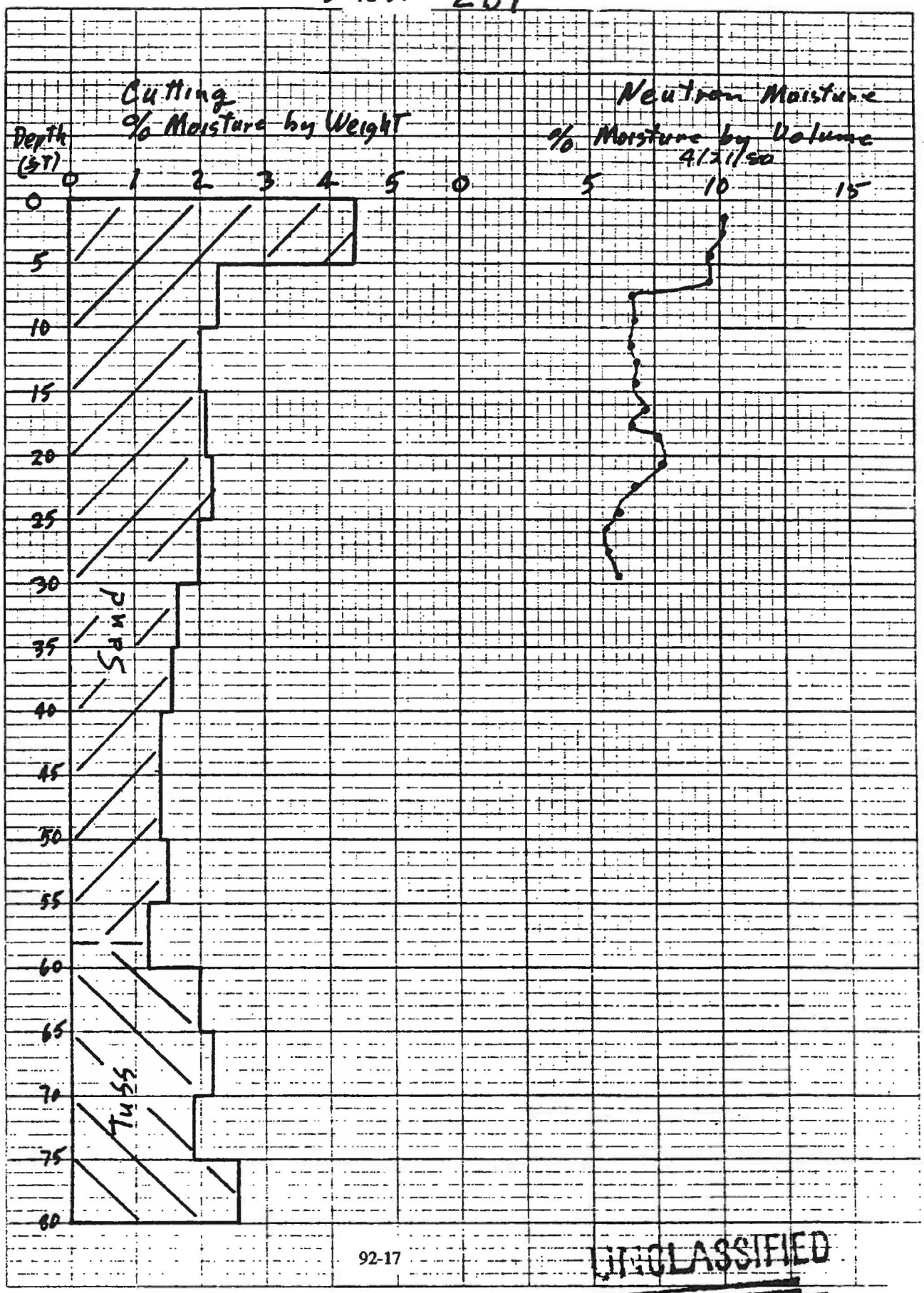


Fig. 9. Geologic and neutron logs of Shaft 2B-Y.

XXXII. SPECIAL TEST HOLES AT TA-49 TO MEASURE BAROMETRIC EFFECTS AND DEFORMATION OF THE TUFF

Two test holes were cored (7 1/4-in. diam) near the eastern edge of TA-49 near well DT-10 (Fig. XXXII-A). The holes were completed in the upper units of the Tshirege Member of the Bandelier Tuff (Fig. XXXII-B). Geologic units are those described by Weir and Purtymun (1962).

Test hole TBM-1 was constructed to measure the barometric effect in the tuff caused by atmospheric pressure changes (Fig. XXXII-C). Test hole TBM-2 was equipped with a Geodetic Biaxial Tiltmeter to determine the deformation of the tuff caused by seismic events. The wellheads for both holes have an 8-ft-sq concrete slab about 6 in. thick. Location is N 1,754,534 E 488,302 (NAD 1927) at an elevation of 7038 ft.

REFERENCES

W. D. Purtymun, Los Alamos National Laboratory, unpublished data (EM-8 field notes), 1993.

J. E. Weir and W. D. Purtymun, "Geology and Hydrology of Technical Area 49, Frijoles Mesa, Los Alamos County, New Mexico," U.S. Geol. Survey Admin. Report (1962).

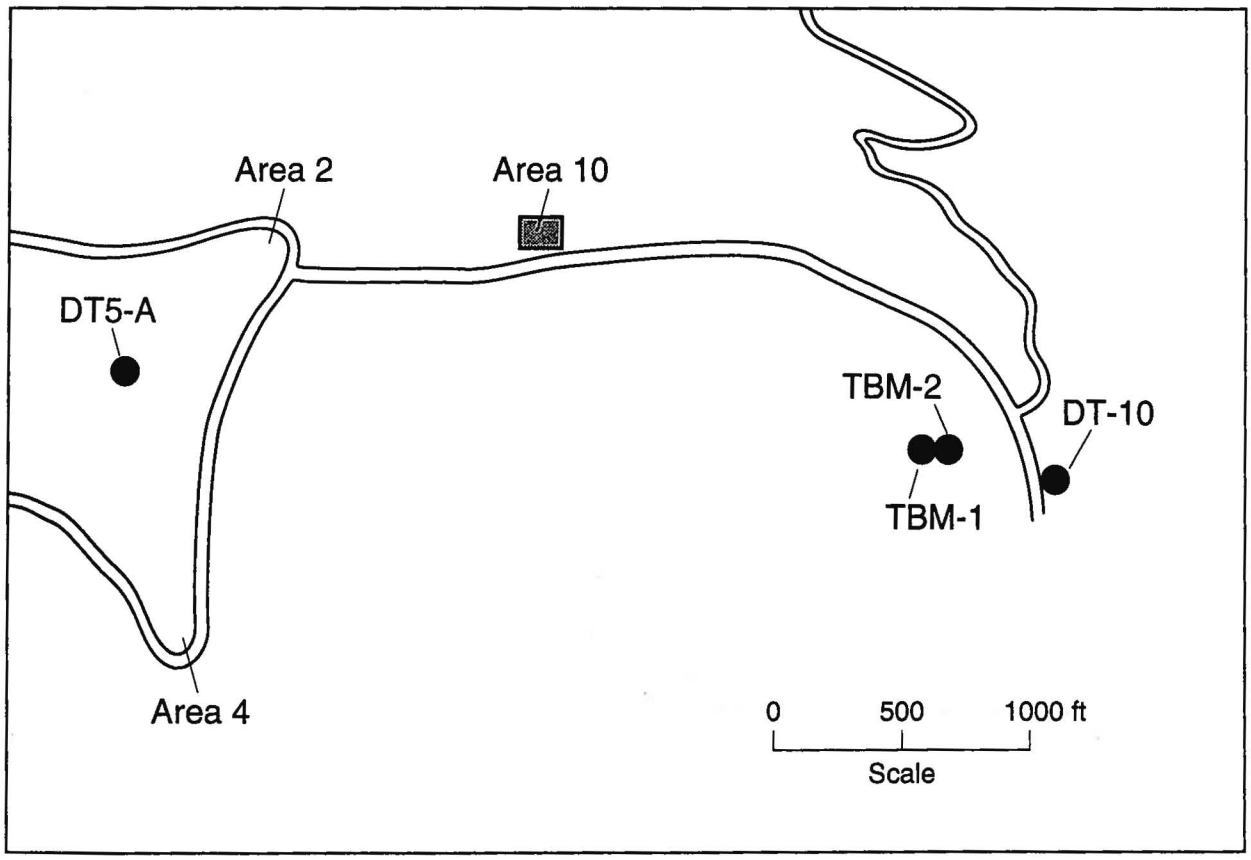


Fig. XXXII-A. Locations of test holes TBM-1 and TBM-2 at TA-49 (Purtymun 1993).

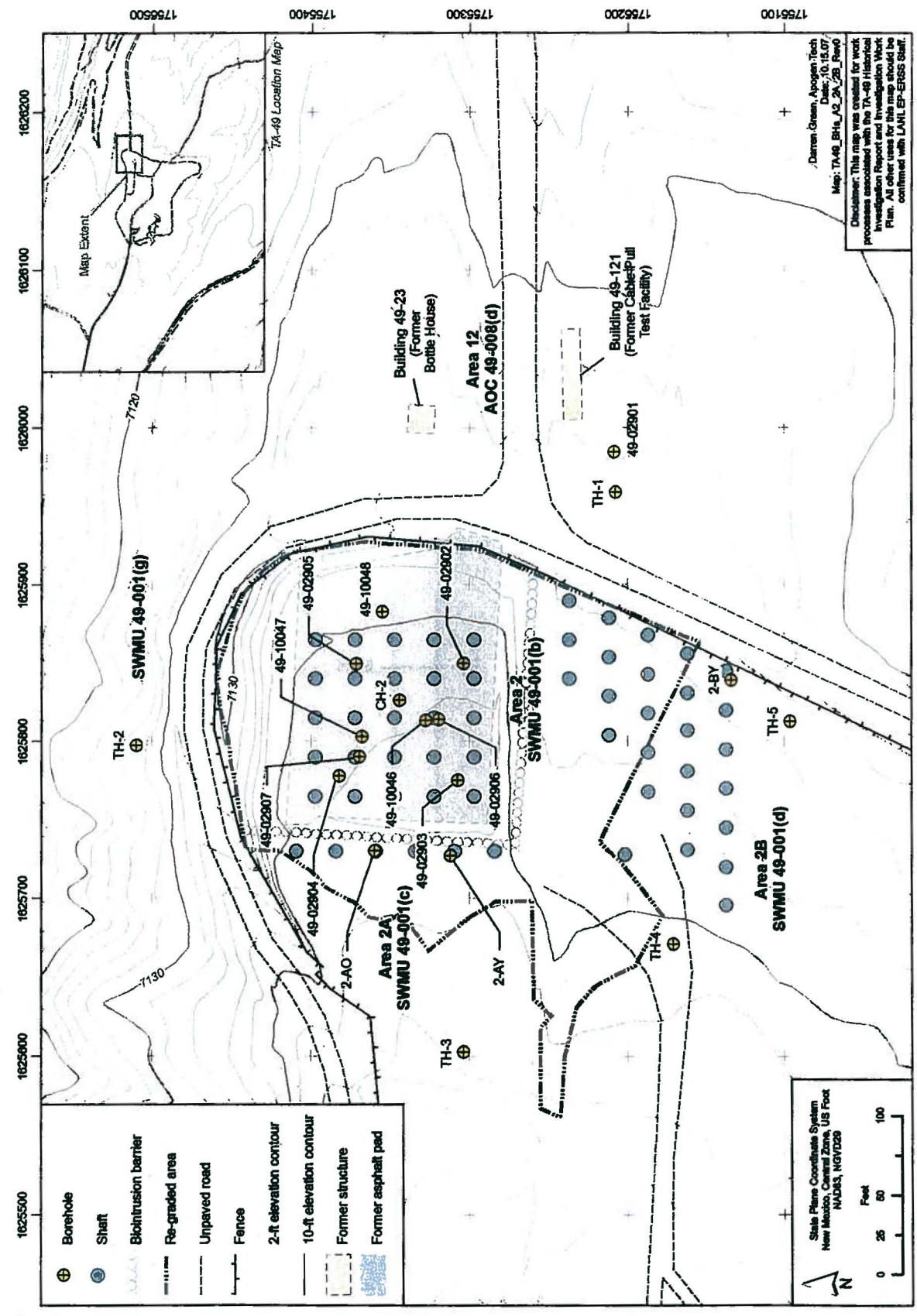


Figure 2.3-3 Areas 2, 2A, 2B, and 12 borehole locations

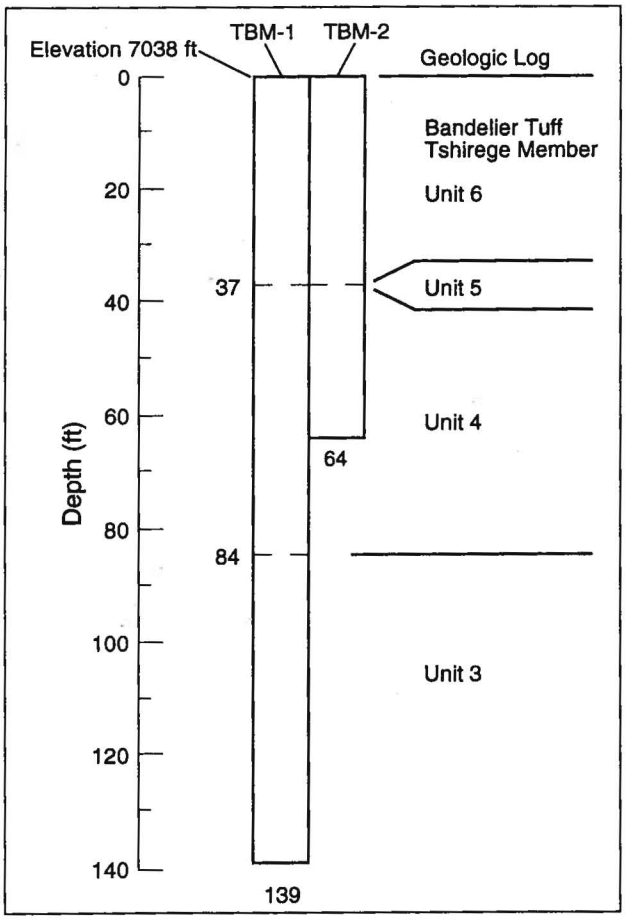


Fig. XXXII-B. Geologic logs of test holes TBM-1 and TBM-2 at TA-49 (Purtymun 1993).

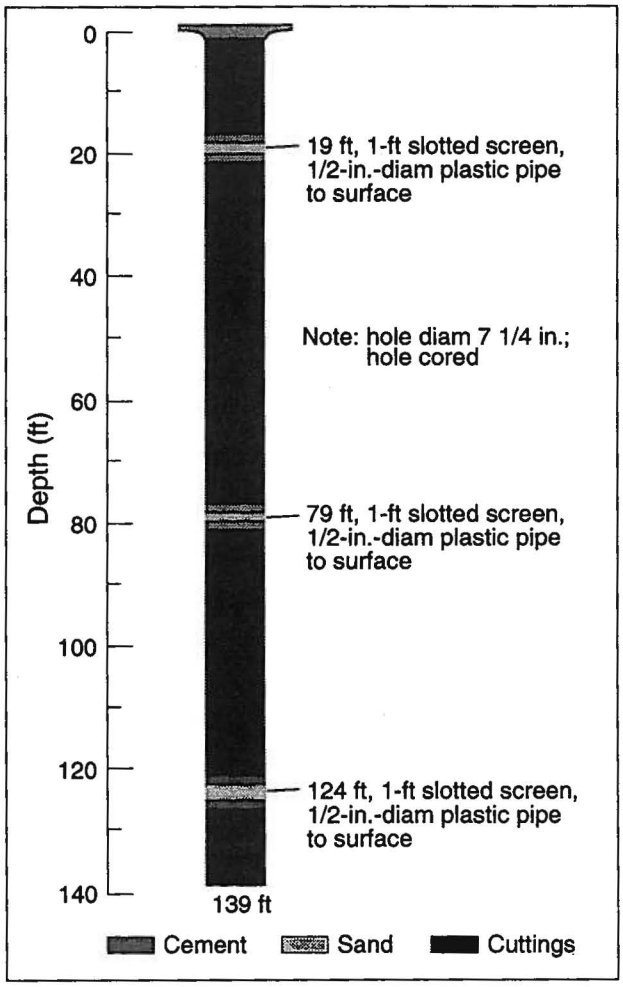


Fig. XXXII-C. Test hole TBM-1 constructed with three zones to measure barometric pressures in the tuff at depths of 19, 79, and 124 ft.

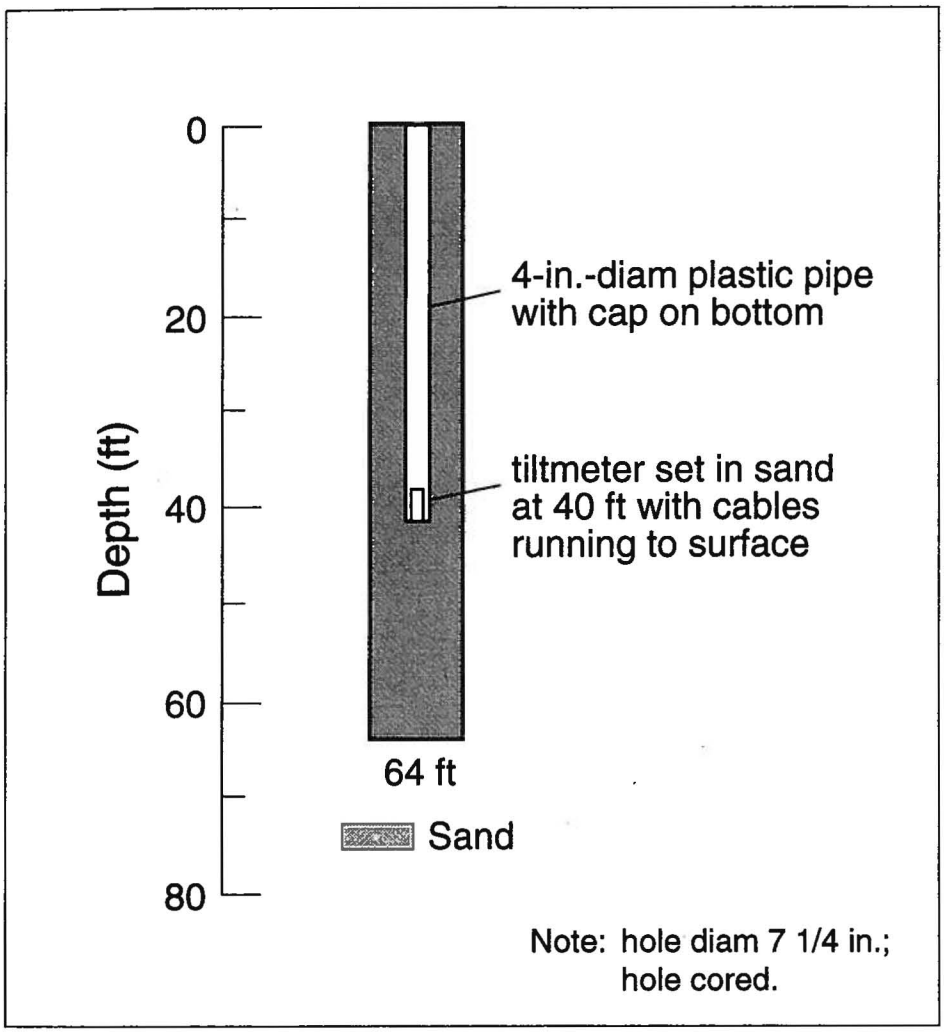


Fig. XXXII-D. Test hole TBM-2 equipped with a biaxial tiltmeter to measure deformation of the tuff at 40 ft.

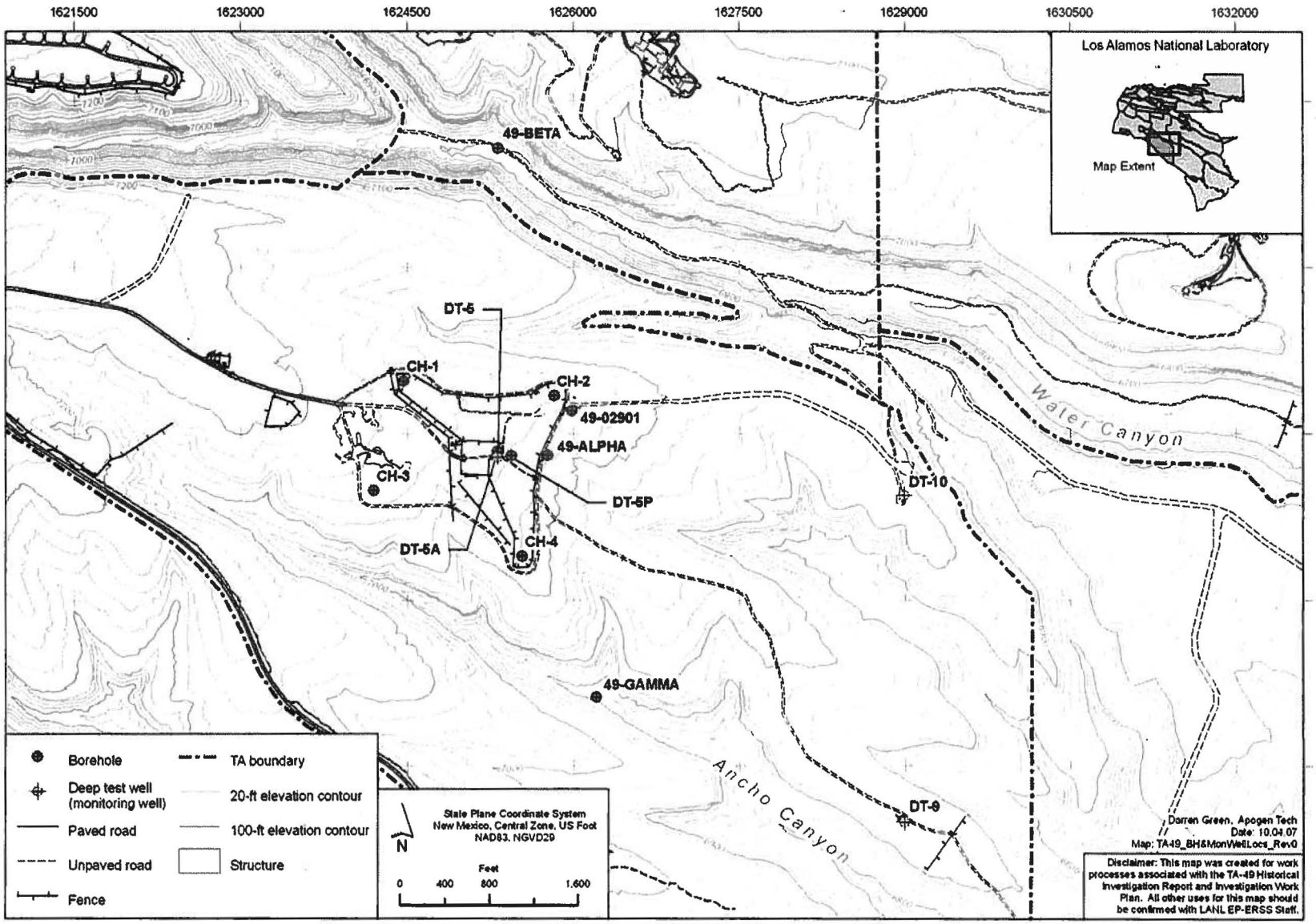
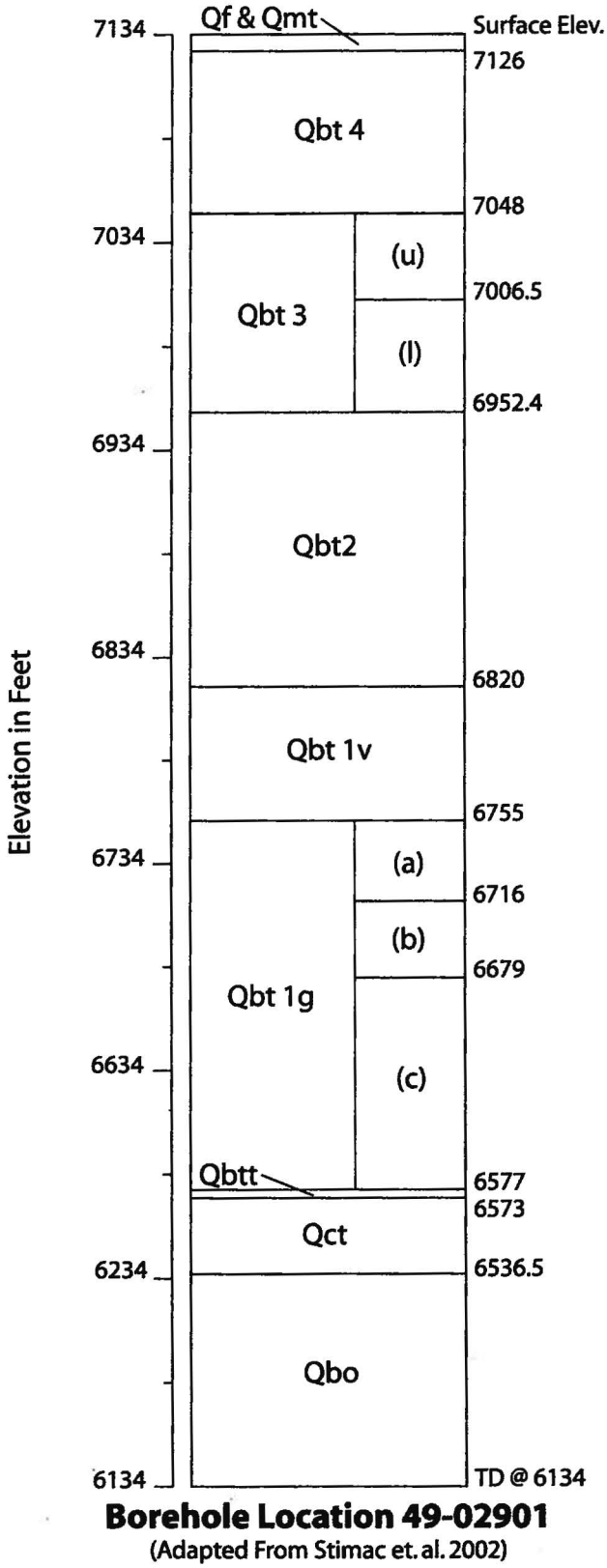


Figure 3.3-1 Locations of deep test wells and select boreholes at TA-49



Source: Adapted from Stimac et al. 2002, 073391.

Figure 2.5-3 Stratigraphy of borehole location 49-02901

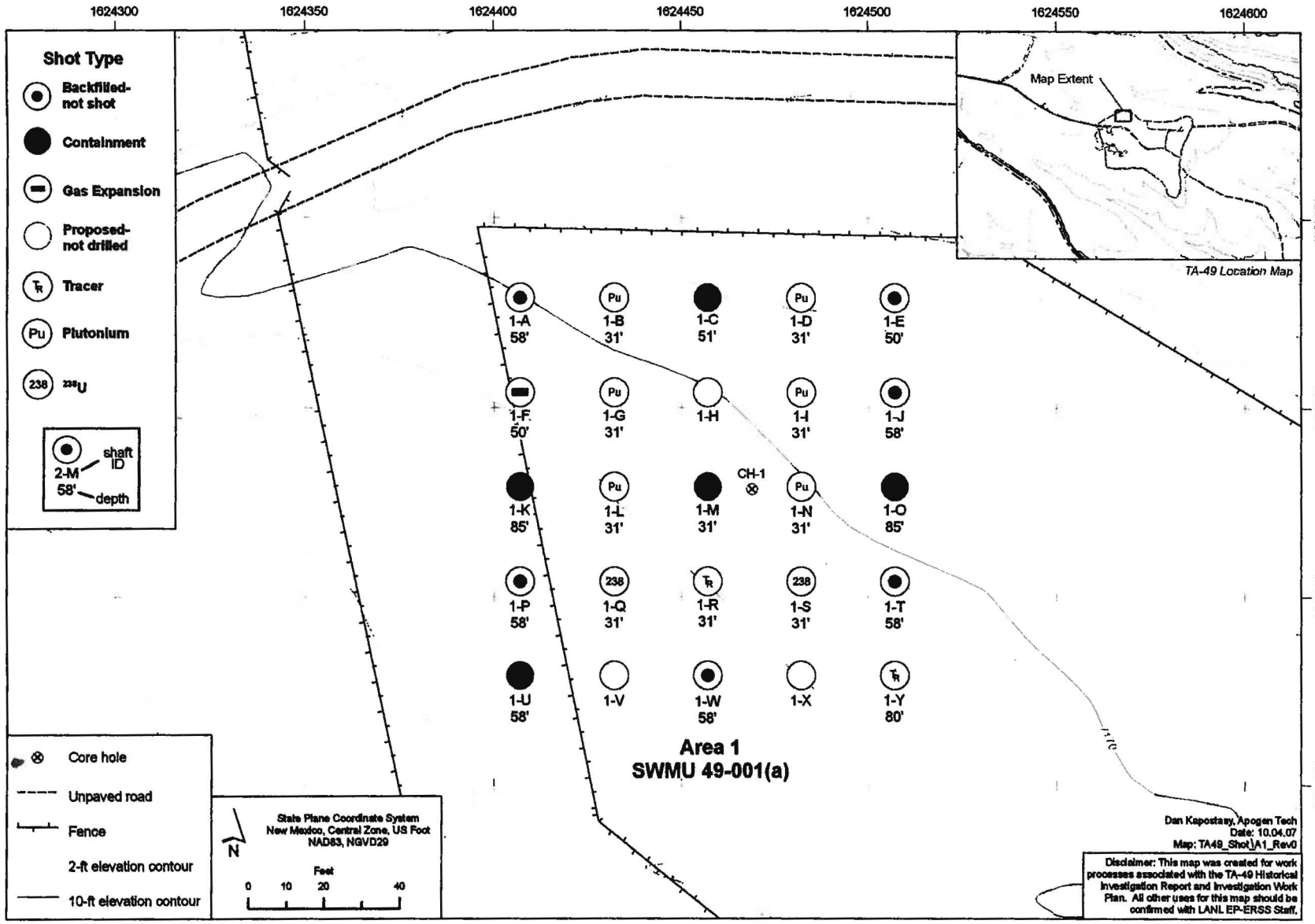


Figure 1.0-3 Area 1 experimental shaft details

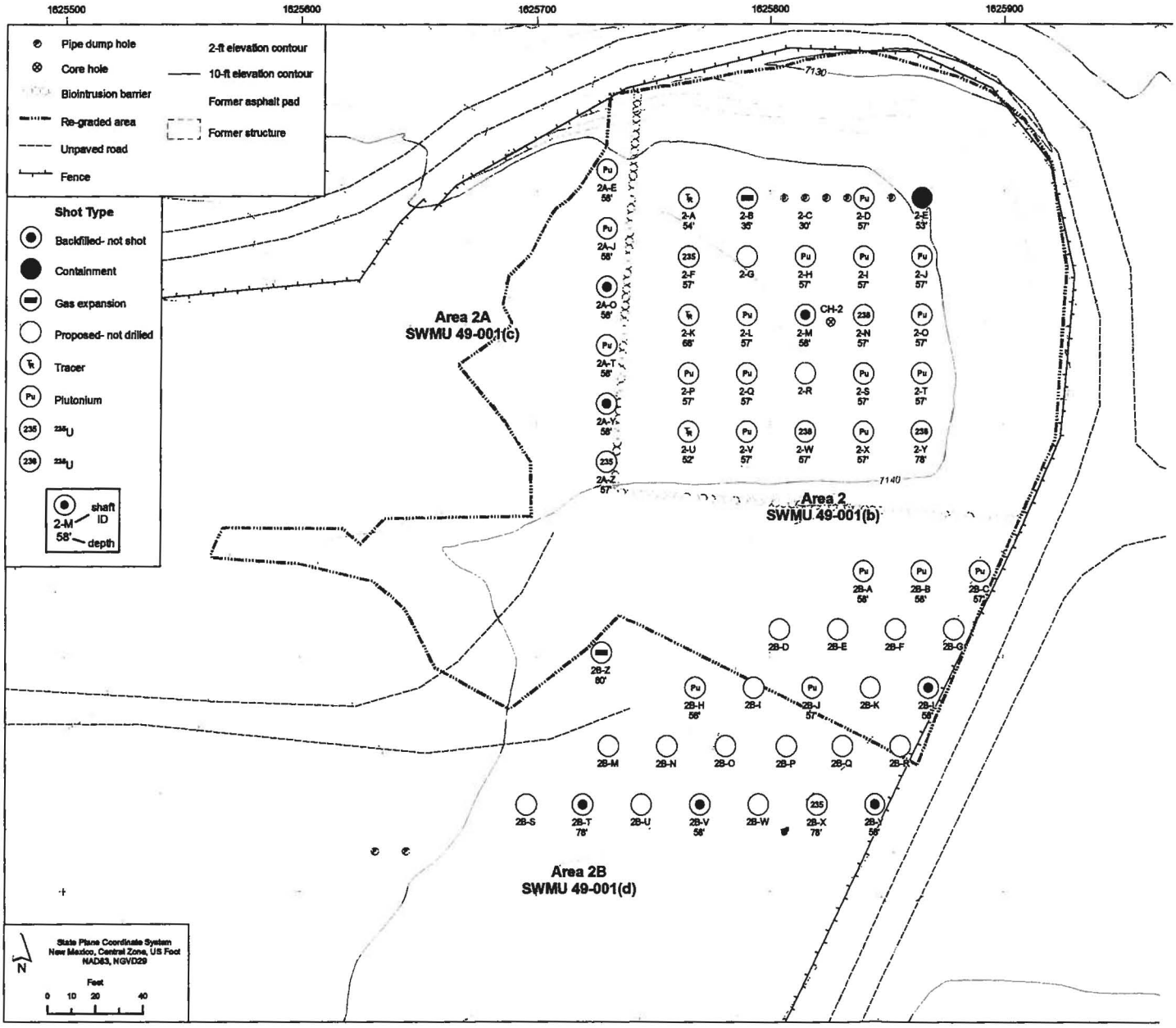


Figure 1.0-4 Area 2, Area 2A, and Area 2B experimental shaft details

EP2007-0552

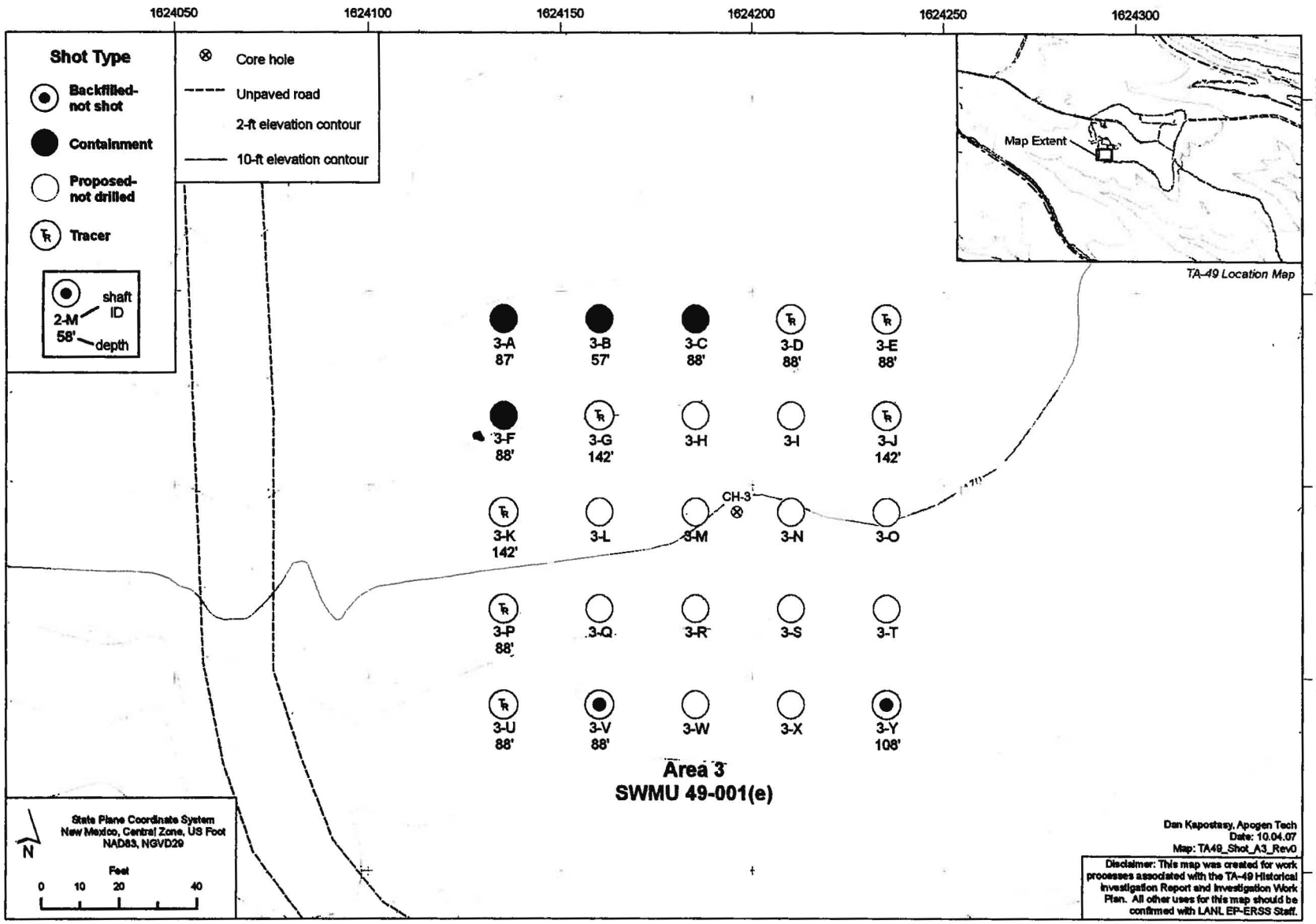


Figure 1.0-5 Area 3 experimental shaft details

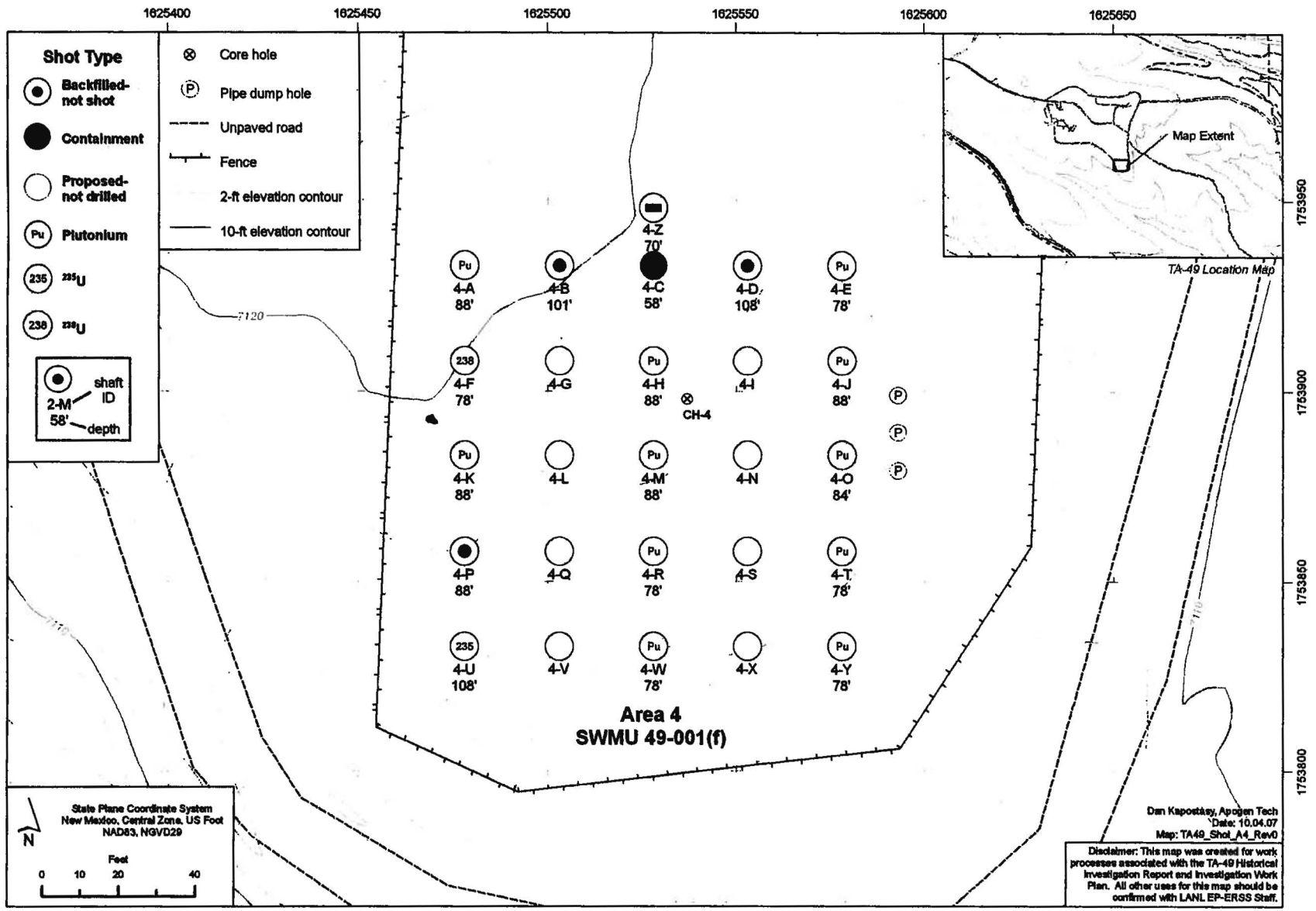


Figure 1.0-6 Area 4 experimental shaft details

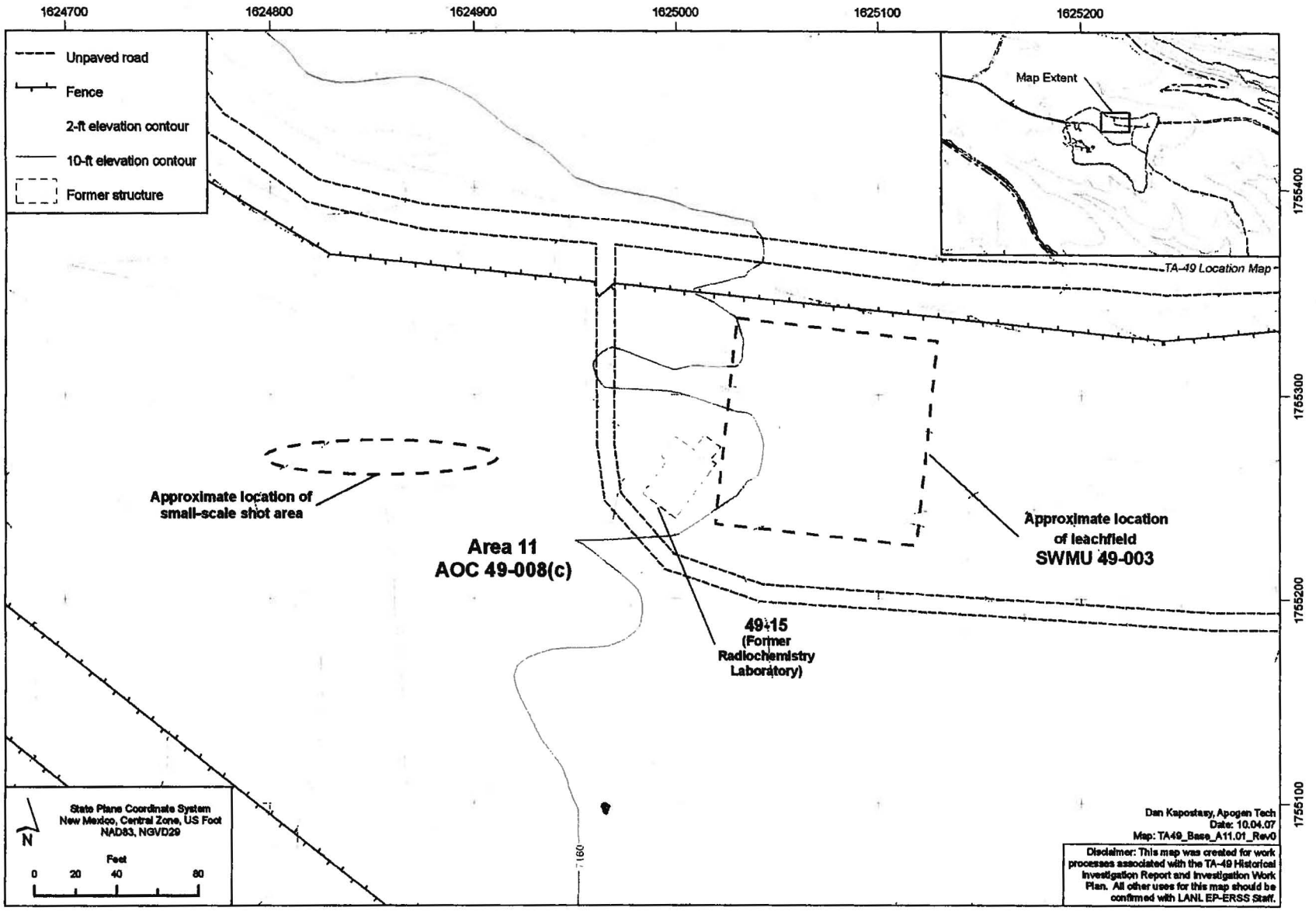


Figure 2.4-2 General site layout of Area 11