TR-7350

IN REPLY REFER TO: ER-750

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

February 20, 1967

Mr. William Kennedy, Group Leader
Group H-6
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Dear Bill,

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

Pit construction and geology

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

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

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

History

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

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

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

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

Retention of plutonium in the tuff

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

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

Movement of plutonium

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

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

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

Observations January 1967

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

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

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

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

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

The January 1967 measurements of hole DPW-1 show the effect of the 3.9 million gallons of effluent from DP-East in which the maximum concentrations of water have moved from a depth of 32 feet (40 percent, August 1961) to 40 feet (41 percent, January 1967). The hole is next to the shaft. The moisture measurements in DPW-2 and DPW-5 show a general decrease in the moisture content of the tuff from August 1961 to January 1967. The indication is that most of the effluents released into pit 1 have moved down in the area of the shaft, a focal point for collection and infiltration of effluents into the tuff.

General statement

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

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

Source of data


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

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

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


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

Please contact us if we can be of further assistance.

Yours truly,

Bill

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For: W. E. Hale, Dist. Chief, WRD

cc: George H. Hilton, Chief
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Table 1.--Plutonium concentrations in tuff from test holes, 1953.

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

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

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

Ion exchange Capacity

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

(Table modified from Hermann, 1954)

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

Horizontal holes in caisson

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

Vertical or near vertical holes around pit

| Hole No. | No. of Samples | Depth (feet) | Gross alpha a/ (Avg.) | (Max.) | (Min.) |
|---|---|---|---|---|---|
| 1 | 10 | 76 | 2 | 3 | 1 |
| 1-A | 10 | 83 | 24 | 24 | 9 |
| 2 | 11 | 93 | 698 | 3,722 | 142 |
| 3 | 11 | 59 | 3 | 7 | 2 |
| 4 | 13 | 93 | 1.5 | 2 | 1 |
| 5 | 7 | 92 | 3 | 6 | 1 |

a/ Counts per minute per gram.

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

(Tables modified from Christenson and Thomas, 1962)

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

**DPW-1**

| Depth (feet) | Percent Moisture (by volume) 3-17-61 | 8-23-61 | 1-30-67 |
|---|---|---|---|
| 1 | 22 | 28 | 34 |
| 5 | 24 | 34 | 37 |
| 8 | 18 | 38 | 39 |
| 12 | 13 | 40 | 22 |
| 16 | 14 | 34 | 22 |
| 20 | 16 | 35 | 40 |
| 24 | 18 | 30 | 34 |
| 28 | 16 | 27 | 36 |
| 32 | 23 | 36 | 39 |
| 36 | 18 | 29 | 41 |
| 40 | 14 | 23 | 41 |
| 44 | 14 | 27 | 36 |
| 48 | 14 | 29 | 30 |
| 52 | 16 | 34 | 30 |
| 56 | 14 | 28 | 19 |
| 60 | 13 | 23 | 16 |
| 64 | 13 | 22 | 26 |

**DPW-2**

| Depth (feet) | Percent Moisture (by volume) 3-18-61 | 8-23-61 | 1-30-67 |
|---|---|---|---|
| 1 | 26 | 34 | 39 |
| 4 | 25 | 38 | 40 |
| 8 | 30 | 24 | 30 |
| 12 | 25 | >50 | 30 |
| 16 | 22 | >50 | 28 |
| 20 | 16 | >50 | 18 |
| 24 | 24 | >50 | 28 |
| 28 | 25 | >50 | >50 |
| 32 | 22 | >50 | >50 |
| 36 | 20 | >50 | 47 |
| 40 | 10 | 44 | 16 |
| 44 | 10 | 46 | 16 |
| 48 | 10 | 42 | 17 |
| 52 | 12 | 44 | 22 |
| 56 | 14 | 40 | 25 |
| 60 | 15 | 28 | 22 |
| 64 | 12 | 24 | 17 |

**DPW-5**

| Depth (feet) | Percent Moisture (by volume) 3-19-61 | 8-25-61 | 1-30-67 |
|---|---|---|---|
| 1 | 20 | 20 | 36 |
| 5 | 16 | 16 | 26 |
| 10 | 19 | 20 | 26 |
| 15 | 20 | 25 | 29 |
| 20 | 17 | 22 | 23 |
| 25 | 13 | 19 | 18 |
| 30 | 12 | 16 | 15 |
| 35 | 13 | 18 | 20 |
| 40 | 13 | 20 | 18 |
| 45 | 11 | 16 | 16 |
| 50 | 13 | 21 | 20 |
| 55 | 12 | 19 | 20 |
| 60 | 12 | 14 | 16 |
| 65 | 12 | 15 | 17 |

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

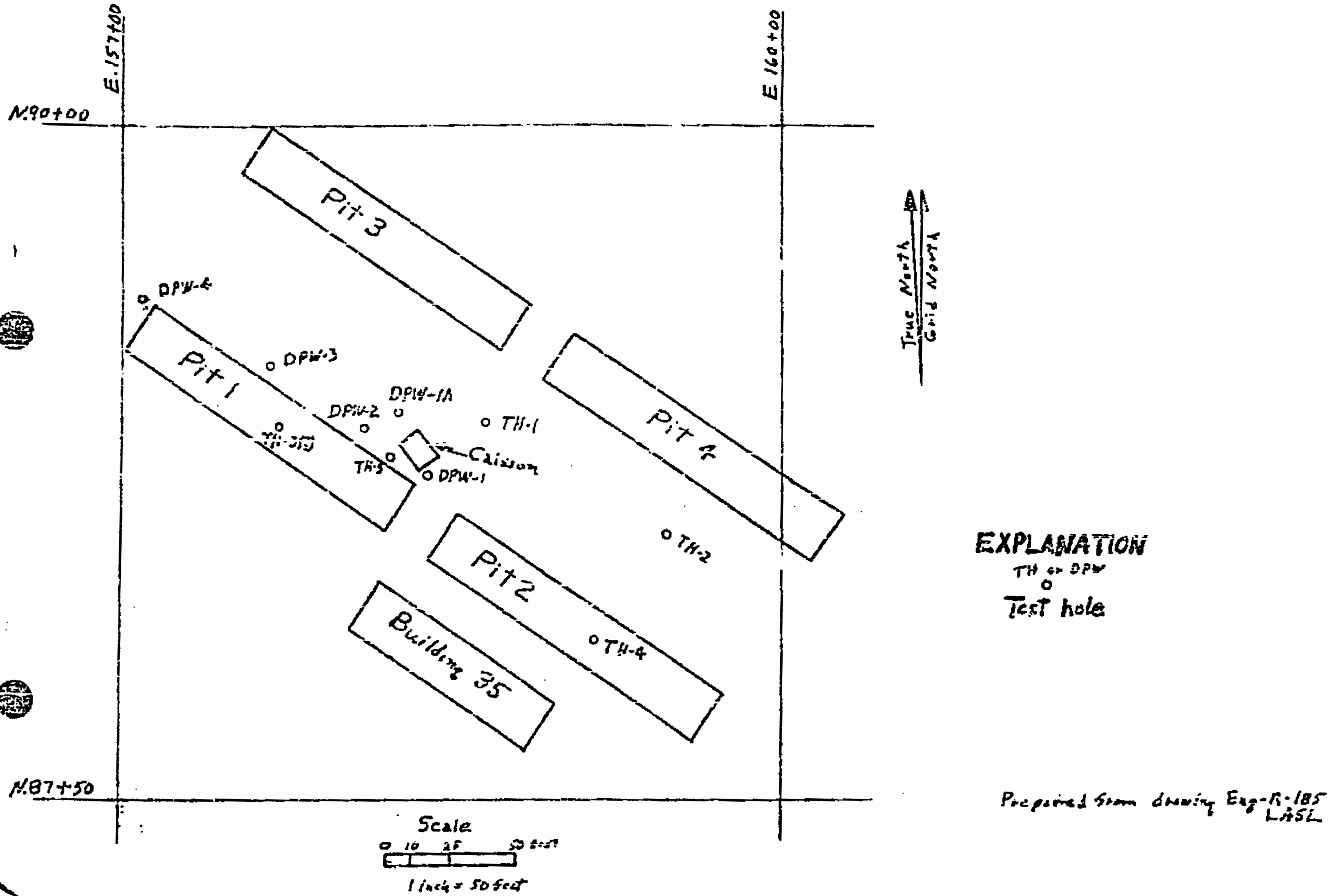


Figure 1.--Sketch map of seepage pits near Building 35 in TA-21, showing location of test holes.