AREA T

General Information

Area T is the DP-West absorption bed area located east of buildings TA-21-286 and TA-21-288, and west of building TA-21-257 (Fig. T-1). It can be reached from the North Perimeter road and is less than a quarter mile from the intersection of the North Perimeter road and DP Road. The axis of the area runs southeast. Most of the area is found within LASL coordinates N.87+50 and N.90+00, and E.157+50 and E.160+00. Area T is an open area with approximate dimensions of 36.6 m x 97.5 m (120 ft x 320 ft) with an approximate acreage of 0.88.[35]

T-1

1830

Engineering Drawing ENG-C 2217, June 13, 1945, shows the absorption bed area enclosed by a fence. Latest engineering drawings show no boundaries for the area, but locate points within the area. The job history given on May 11, 1967, request for survey service[34] states,

> Location of Area T has been established and coordinates computed. Brass caps cannot be set in the area until the DP rehab has been completed, and this work isn't expected to be completed for two years, so this request should be closed. Disposal area caps can be included with the DP site brass caps when the rehab has been completed.[34]

Geology and Hydrology

> The pits [absorption beds] 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 to a moderately welded tuff which underlies the pits. Joints are monre numerous in the upper part of the unit due to the denser welding. Most of the joints are oriented vertical or near vertical. The total thickness of the unit is about 110'. It is underlain by moderate to dense welded tuff.
>
> The total thickness of the Bandelier tuff underlying the mesa at Buidling 35* exceeds 800 ft. The tuff is in the zone of aeration; the top of the main zone of saturation is about 1150' below the surface of the mesa.[36]

**author's note:* Building 35, TA-21-35, has been removed. It was located immediately south of the absorpotion beds. (Ref: Engineering Drawing ENG-C-35571).

With the construction of the disposal shafts which are principally located between Absorption Beds 2 and 4, new geologic data were acquired. Two cross-sections were drawn based on information from Shafts 3, 11, 18, 19, 26 and 27. These shafts range in depth from 4.6- m (15-65 ft). The cross-sections show three units with the following description.

> The lower unit is a light gray moderately welded tuff with an approximate thickness of 100', it is overlain in part by reworked tuff which is deposited in a channel, or low relief cut into the lower light gray tuff unit. The upper unit forming the surface of the mesa of the disposal area is a light, brownish-gray moderately welded tuff.[40] (See Figs. T-2 and T-3.)

T-2
T-3

> [The reworked tuff and pumice contain cobbles and boulders in the lower part and]...was deposited by gaseous forces accompanying the emplacement of the upper ash flow. The cobbles and boulders occur in tabular shapes, or if in mass, show faceted sides as if deposited by sliding rather than rolling as one would expect with water-laid material. The blast caused by the expanding gases accompanying the emplacement of the upper ash flow deposited the larger materials (cobbles and boulders) into areas of low relief in the upper surface of the lower unit. As the upper unit and reworked tuff were emplaced contemporaneously they have cooled as a single unit thus the contact between the two is gradational and not very distinct. A sharp contact is found between the reworked tuff and lower gray unit.[40]

Absorption Bed and Shaft Description

Background

Area T is one of the first disposal areas used at the Laboratory. Construction of four absorption beds for disposal of DP West liquid waste was completed in 1945. Untreated waste from the processing of plutonium at TA-21 was released to the pits from 1945 to 1952.

In April 1947 plans were submitted to the post engineers to connect all the TA-21 and DP-Site contaminated effluent lines into a central line and disposal plant.[37] It is not clear whether the 1947 proposed disposal plant initiated planning for the DP-West disposal treatment plant, Building TA-21-35, however, TA-21-35 was installed in 1952 to remove plutonium and other radionuclides.[36] The reason for this installation was that "the tuff had become clogged with suspended solids."[38] When the amount of wastes discharged to the bsorption beds had reached the order of several thousand gallons per day, the beds had to be abandoned. At infrequent intervals, a few hundred gallons of treated wastes from TA-21-35 were released to the absorption beds from 1952 until 1967.

From 1965 through 1967, Absorption Beds 1 and 2 also received low-level radioactive wastes from DP East (written communication, L. A. Emelity, 1974). A new treatment plant, TA-21 257, was built in 1967. Since mid-1968, treated wastes from TA-21-257 are mixed with cement and pumped down shafts augered between the south absorption beds and the north absorption beds. Effluents from TA-21-257 are discharged to the canyon north of the plant, as were the effluents from TA-21-35.

Type of Waste

The amount of untreated waste released into the absorption beds during the period 1945 to 1952 was on the order of 53 000 m^3 (14 000 000 gal)(written communication, L. Emelity, 1974).

The concentration of plutonium in effluents during this period has been estimated at 60 c/m/ml (counts per minute per milliliter) [120 dis/min/ml] with an average fluoride concentration (associated with the waste) of 160 ppm (parts per million). In addition, 10 450 gallons (39.6 m^3) of effluent, highly concentrated with ammonium citrate,

> was released into the beds from June 1951 to July 1952. The plutonium concentration of this waste averaged about 7000 c/m/ml [14 000 dis/min/ml] and the fluoride concentrations were about 200 ppm.[36]

From 1953 through 1967 16 300 m^3 (4 300 000 gal) of effluent wnt into the absorption beds (written communication, L. Emelity, 1974). Of this amount, 7 500 m^3 (2 000 000 gal) came from DP East (see Table T-1). It was still possible to release treated wastes to Absorption Bed 4 as of July 1974.

T. T-1

As of January 1973,[32] the absorption beds contained 4 Ci of ^{3}H and 10 Ci of ^{239}Pu. These values were decay corrected from the original magnitude to that as of December 31, 1972.

There are 49 disposal shafts in Area T. The wastes going to the shafts are mixed with cement.

> Various wastes such as the neutralized americium 'strip,' alkaline fluoride and plant sludge are being mixed with cement in a pug mill operation and the slurry is being pumped to deep holes [shafts] on the site. This procedure was started on May 1, 1968.[41]

Also, 0.9-m (3-ft) diameter experimental bathyspheres have been placed in shafts--three to a layer and at various depths.[41] Besides ^{239}Pu, ^{238}Pu, ^{241}Am, and ^{235}U, the shafts contain some mixed fission products wich are mostly strontium and cesium.[41] Table T-2 gives the equivalent ^{239}Pu, in grams, in each shaft. As of January 1975,[277] the disposal shafts contained 2 Ci of $^{90}Sr/^{90}Y$, 7 Ci of ^{233}U, 30 Ci of ^{238}Pu, 131 Ci of ^{239}Pu (material generally consisting of approximately 94 wt% ^{239}Pu and 6 wt% ^{240}Pu), and 2345 Ci of ^{241}Am. These values have been decay corrected from the original magnitude to that as of December 31, 1974.

T. T-2

Mode of Disposal

The construction of the absorption beds is shown on Engineering Drawing ENG-C 2217. The four beds are numbered--1, southwest bed; 2, southeast bed; 3, northwest bed; and 4, northeast bed. Each bed is 36.6 m (120 ft) long, 6.1 m (20 ft) wide, and 1.2 m (4 ft) deep. The east and west sides of the beds were sloped so that only the center 30.5 m (100 ft) of each bed has a depth of 1.2 m (4 ft). The north and south sides of the beds appear on ENG-C 2217 as vertical cuts. The bottoms of the beds

were cut level. The distance between the centers of Beds 1 and 3 and Beds 2 and 4 is 24.4 m (80 ft).

The original surface of the site sloped to the north at 12 to 1. Therefore, embankments were placed to the north of the beds and surface water interceptors were cut to the south of the beds. Probably the two embankments were built from material derived from the excavation of the beds. Each embankment had a minimum width of 3.1 m (10 ft) and a minimum height of 0.6 m (2 ft). One embankment extended across the west end of Bed 1, the north sides of Beds 1 and 2, and across the east end of Bed 2. The other extended across the west end of Bed 3, the north side of Beds 3 and 4, and across the east end of Bed 4. The surface water interceptors were cut approximately 0.6 m (2 ft) deep and 0.9 m (3 ft) wide, 3.1 m (10 ft) from the south sides of each pit.

The beds are sometimes referred to as covered pits. This is misleading because the beds were never roofed. They were filled with stone, gravel, sand, and earth. The bottoms of the beds were to be trimmed and cleared of earth and loose material before filling. The bottom 61.0 cm (24 in.) of fill was stone, to be clean and free from dirt, which ranged in size from ± 7.6 to 25.4 cm (± 3 to 10 in.). The stone was to be graded from large at the bottom to small at the top in order to form a deck for the gravel. The next 15.2 cm (6 in.) of fill was gravel followed by 15.2 cm (6 in.) of sand. The top layer of fill was 30.5 cm (12 in.) of earch. The total thickness of graded fill was 1.2 m (4 in.).

Liquid waste moved through 05.2-cm (6-in.) iron pipe from DP West Buildings 2, 3, 4, and 5 to a distribution box between Beds 1 and 2. The distribution box was 1.2 m (4 ft) long, 0.9 m (3 ft) wide, and 1.2 m (4 ft) deep with 15.2-cm (6-in.) walls. It was built of concrete, and the interior was painted with two coats of Inertal Standard Black, or equal. The box had a 5.1-cm (2-in.) creosoted wood cover which was hinged to the concrete and equipped with a hasp and heavy lock. One 15.2-cm (6-in.) round plug 61.0 cm (24 in.) long was provided with the distribution box. The plug was probably used to divert waste into either Bed 1 or Bed 2 instead of allowing waste to flow to both. The floor

drain from Building 12* TA-21-12, emp ied into a 15.2-cm (6-in.) iron pipe leading into Bed 1. Overflow pipes of 15.2-cm (6-in.) iron connected Beds 1 and 3 and Beds 2 and 4. The overflow pipes were positioned in Beds 1 and 2 at the top of the stone layer, i.e., 0.6 m (2 ft), above the bottom and in Beds 3 and 4 at the bottom. All piping was standard weight steel pipe cut in 1.5-m (5-ft) lengths and coated with jennite. All joints were threaded.

More liquid waste moved into beds 1 and 3 than into 2 and 4. At times some of the pits became clogged and overflowed, the overflow moving northward toward a canyon.[8] However, overflow from the pts never reached the canyon (personal communication, C.W. Crhistenson, 1974).

Sixty disposal shafts were located in the site, principally between Beds 2 and 4. Forty-nine of these shafts have been augered using a 1.2-m (4-ft) diam bucket auger and reaming to
F T-4 a 2.4-m (8-ft) diam (Fig. T-4). The shafts are on 3.7-m (12-ft) centers. Shafts 4, 6, 7, 14, 15, 16, 37, 38, 39, 40, and 45 have not been augered. Shafts 14-16 will not be augered because of a power line. Shafts 37-40 are aligned where the overflow pipe is
T.3 between Beds 2 and 4. Table 3 gives the following information on individual shafts: dates shafts were completed and filled, shaft depths, and type of rock encountered during augering. The table is composed of data obtained from the Zia Company and Group H-7.

The waste treatment plant, TA-21-257, is located east of the shaft field. Sludge goes from a holding tank to a pug mill where cement is added on a continuous basis. This mixture is then pumped down the m x ≤ m (8 ft x ≤ 60 ft) asphalt-lined shafts. Irregularities in the substrate prevent all shafts from reaching
F T-5 T-6 a depth of m (60 ft) (Figs. T-5 and T-6).

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*Building 12, DP West, has been dismantled. Filter buidling TA-21-12 was removed in 1973.

Studies and Monitoring

Some of the earliest environmental monitoring surveys at LASL include data on Area T. In "Survey of Los Alamos and Pueblo Canyon for Radioactive Contamination and Radioassay Tests Run on Sewer-Water Samples and Water and Soil Samples Taken from Los Alamos and Pueblo Canyons,"[181] LAMS-516, data on fluid and soil are presented for Absorption Beds 1 and 2.

Absorption Bed 1[181]

Date	Sample Type	Direct Instru. reading "Pee Wee" d/m	Po d/m/L	~~Pw~~ U d/m/L	Pu microg./L
July, 1946	fluid	—*	200	6780	4.8×10^{-2}
Sept. 1946	fluid	—*	65	97	69.2×10^{-5}
Oct.-Nov. 1946	soil	800	~~123~~ 123	~~200~~ 200	

Absorption Bed 2[181]

Date	Sample Type	Po d/m/~~L~~ 50gms	~~Pw~~ U d/m/~~L~~ 50gms	Pu microg./~~L~~ 50gms
July, 1946	soil	80	80	5.7×10^{-4}
Sept. 1946	soil	43	122	87.1×10^{-5}

* Not applicable

Two liter samples were taken for the fluid analysis and 50 g samples were taken for the soil analysis. Analytical procedures are given on pages 5-7 of the report; see Fig. T-7 for location of Oct.-Nov. 1946 soil sample.

T-7

In April 1947, in compliance with a request from L. H. Hempelmann, collection began of effluent samples from the DP-Site chemical sewer outlets, to be performed at 2-month intervals.[37] Samples were assayed for plutonium, polonium, and uranium. The first report was made October 20, 1947.[47]

> These water samples (a to e)*, in addition to being radioassayed, were submitted to the analytical group for a fluorine analysis. (Samples from the same sewer were taken at 3 different times of the day.)[47]

The result of the fluorine analysis for "DP West seepage, main drain," Area T, in mg of fluorine per 100 mc, was 4.2. "As soon as repair work on the hood is finished, all water samples will be prepared for a spectrographic analysis and radioassay will be continued."[47] The monthly report for October 21 to November 20, 1947,[48] gives a radioassay in c/m/L as 29 836 for plutonium and 5.8 for polonium. Samples collected September 26-30, 1947, were reported January 2, 1948.[49] "As expected the highest activity due to Plutonium was found at DP-W Seepage Pit Main Drain ("B") with 65,639 d/m/l."[49] The January 2, 1948, report[49] also included the analytical procedures for (1) polonium in water samples and soil samples, (2) plutonium in water samples and soil samples, and (3) uranium.

Records on studies and monitoring at Area T from 1948 to 1953 are not available at this time. In 1953 the USGS conducted a study[278] at Los Alamos to determine "the fate of plutonium contained in liquid wastes discharged onto or just below the surface of the earth."[278] Area T wasone of the sites chosen. Five test holes were drilled in and around the absorption beds (Fig. T-8). Effort was made to gather samples at -m (1-ft) intervals. All samples were analyzed for plutonium, while three were selected for determination of ion-exchange capacity (Table T-4). Despite the short

T-8

> Despite the shortcomings of the sampling techniques, the patterns of plutonium concentrations from the various borings were reasonably good and each pattern may be considered as representative of the particular sample hole. Furthermore, certain characteristics concerning the travel of plutonium through the earth, sand, gravel and rock media are indicated. These are:
>
> 1. No appreciable horizontal movement of the plutonium occurs in the first 20 feet of depth.

2. The plutonium is readily retained by the various earth media (sand, clay, gravel and rock).

3. Apparently retention of the plutonium is greater in the finer materials.

4. Penetration of the plutonium into the underlying strata is not be be expected.[278]

A joint USGS[51]/LASL[38] study to determine distribution of plutonium previously discharged to the absorption beds was begun in October 1959 with the construction of a caisson m (30 ft) deep, 1.8 m (6 ft) wide, by 3.6 m (12 ft) long, on the northeast corner of Absorption Bed 1.

> Horizontal holes 3 inches in diameter were drilled at 2 foot depth intervals to a depth of 12 feet so as to terminate at about the center of the seepage pit. At each 2 foot interval two holes were drilled 2 feet apart horizontally. In one hole, a 2 1/4 inch diameter plastic pipe was interted with the far end sealed; ground tuff was inserted in the area between the pipe and the solid tuff. This hole was used for measurements of moisture. The companion hole was used for collection of liquid samples. Detail of the collection cup system is shown in Figure T-9. A porous ceramic cup was inserted to the end of the drilled hole; the hole was back filled with ground tuff. Clay was inserted and capped with a molded cement plug at the caisson face around the vacuum and the vacuum release tubes.[38] (See Fig. T-10.)

T-9

F. T-10

A -cm (7-in.) long core sample for each m (2 ft) of horizontal depth was taken when the holes were drilled. Part of each core was assayed for gross alpha (Table T-5).

T. V

In late 1960, after the first infiltration study, six deep holes were drilled at the periphery of Absorption Bed 1 ranging from m to m (76 ft to 99 ft) deep. They were lined with -cm (2.5-in.) plastic pipe. The holes were augered using compressed air to remove cuttings. Samples of cuttings were taken at -m (5-ft) intervals. "This core sampling procedure leaves much to be desired but results did indicate gross variations."[38] (See Fig. T-11 and Table T-6.)

F. F11
T. T VI

The infiltration study for 1960 was done in the summer. DP-West raw waste flowed directly to Absorption Bed 1 for 1 month at an average rate of m^3 (8700 gal) per day. The following month tap water was applied at a rate of m^3 (6600 gal) per day. Moisture data were collected during and after these discharges.

This was a preliminary study.

The 1961 infiltration study was similar to the 1960 one. _____ cubic meters (6400 gal) per day of raw waste went into Absorption Bed 1 from June 30 to August 1. From August 2 through August 26, m^3 (7100 gal) per day of tap water was applied. Sampling continued for an additional week after the application of tap water.

> Samples were collected, at each sampling depth, continuously during each day until 50 mls was obtained or 8 hours had elapsed. Five daily samples were then composited and used as the weekly sample.[38] (See Table T-7.)

no indent ← The objectives of the present study were to determine if and where water moved beneath a disposal pit and to ascertain if waste products moved with the water.[51]

The 1961 study was reported by both the USGS and LASL. The USGS report[51] stated

> [1] that waste water movement may have changed some of the physical properties of the tuff, such as pore and particles sizes. [2] Some of the wastes discharged in the east end of the disposal pit may have moved laterally through the sand material (Bed A on Sketch C and D, Fig. T-10) along the sloping top of the tuff and then vertically into the tuff. [3] The lower moisture values...seem to coincide with areas of tuff in which the greatest amount of staining had occurred. The stained areas may indicate a different stage of weathering than that at the clay layer due to alternate wetting and drying cycles. [4] The tuff is extensively jointed (Fig. T-10) and the tendency for a liquid to move through the joints is indicated by higher gross alpha count of a 1000 per minute per dry gram at the 20' depth.... [5] [There were] several open joints...below a depth of 25 ft. Waste water had penetrated the fineline joints to depths of at least 22 feet and subsequently altered the tuff adjacent to the joint as much as one-quarter to one-half inch. Clays developed locally and impeded drainage so that the joints retained water to the extent that the moisture content of the tuff was locally as much as 35%.... ~~(Fig. 23, profile I).~~" [6] "Water in the low moisture range apparent-

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Indent as above

ly moved to depths greater than 90 feet. Water in unknown quantities moves through open joints or joints enlarged by solvents in the waste." [7] "Below a depth of about 15 - 20 feet the alpha activity was low, except for local areas of high alpha activity where water carried the activity along the joints. Rapid movement of water throug joints was substantiated during infiltration studies.[51]

The LASL report[38] stated (1) a high concentration of potassium salts affects the movement of plutonium. (2) A low concentration of aluminum and silicon in the samples of liquid removed indicates that plutonium was not being transported on colloidal clay of such a size as to escape filtration by the tuff.

> [3] ...total hardness and total solids may be correlated with alpha activity. [4] That both total solids and total hardness tend to increase with depth ...suggests solution or resolution of previously deposited material. [5] There is some indication of an inverse relationship between gross alpha content and pH. [6] "It has been deduced

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from the irregularity of the curves obtained from data for holes 1, A-1, and 2, that "~~because~~ percolating groundwater may be perched,... or may travel rapidly along fissures as seen by a sudden decrease in percent moisture which indicates rapid drainage from the area. These two factors will exert a marked influence on the accumulation and sorption of radionuclides in the areas involved." [7] "Under field conditions, plutonium species have been shown to penetrate to at least 28 feet. That this penetration takes place along fissures is indicated by moisture data, rates of flow of liquid and by physical inspection." [8] "It is apparent that one cannot extrapolate from laboratory studies on intact core sample to conditions which prevail in the field."[38]

Before the excavation of the shaft field at Area T, a Reconnaissance study[36] was made of the absorption beds, in January 1967. Water samples were collected for radiochemical analysis from DPW-1A, DPW-3, the caisson (see Fig. T-8), and a sample of weathered tuff from beneath the gravel fill of Absorption Bed 1 near the caisson. The water samples showed only background amounts of gross alpha and gross beta-gamma and no plutonium or uranium. Tritium analysis of the water samples gave approximations for DPW-1A as 462 DPM, for DPW-3 as background, and for the caisson as 2000 DPM. The sample of weathered tuff had a gross alpha count of 978 c/min/g (1956 dis/min). Observations in January 1967 are as follows:

> Effluents from DP-East have at times partially filled the shaft [caisson] near Pit 1 [Absorption Bed 1] thus creating a more localized point for infiltration for 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.[36]

Moisture contents of the tuff were logged in holes DPW-1, DPW-2, and DPW-5 at selected depths.

> 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 in August 1961 during the study) is shown in Table T-8.
>
> The January 1967 measurements at hole DPW-1 show the effect of the 1.9 million gallons of effluent from DP-East in which the maximum concentrations of water have moved from the depth of 12 feet (40 percent, August 1961) to 40 feet (41 percent, January 1967). The hole is next to the shaft [caisson]. 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 [Absorption Bed 1] have moved down in the area of the shaft, a focal point for collection and infiltration of effluents into the tuff.[36]

On the basis of previous studies and this reconnaissance, it was concluded that

> The movement of the effluents in the tuff underlying the seepage pits [absorption beds] is mostly downward beneath the pits. The plutonium moves with the effluents and the data indicate that most of the plutonium is retained by absorption in the upper 20 feet of the tuff. Some, however, may move to greater depths through open joints.[36]

An average of 10 cuttings samples per shaft have been taken from most of the shafts augered at Area T. These samples are analyzed for tritium and plutonium. Most of these data are unpublished to date.

In March 1974[182] a survey to gather surface and subsurface data for the proposed location of the retrievable waste storage facility was begun. The retrievable waste storage facility is a pit dug between Absorption Beds 1 and 3, west of the shaft field. The pit is dug to within m (5 ft) of Absorption Bed 3 and to within approximately m (20 ft) of Absorption Bed 1, and extends several feet west of both of them.

March 22, 1974, the plutonium-americium surface contamination and external radiation survey[183] was completed. Three monitoring stations were over Absorption Bed 1; six monitoring stations were over the proposed pit; and one monitoring station was over Absorption Bed 2. A LAFPHA/FIDLER system was used to measure the plutonium-americium surface contamination. External radiation levels were measured by a calibrated Reutor Stokes high-pressure ionization chamber dosimetry system, Model RSS-111. The basic conclusions of the survey were:

1. There is no Pu surface contamination (less than approx. 1.2 $\mu Ci/m^2$) within the boundaries of the fenced site.*
2. Americium-241 was detected in Pit # 1 [Absorption Bed 1], but at a level of only 1.1 Ci/m^2 assuming surface contamination.
3. No significant leve s of external radiation could be attributed to the radioactivity with the waste pits 1 and 2 of Area T.** [183]

*The "fenced site" is the part of Area T which does not include the shaft field.

**Typographical error. Should read Absorption Beds 1 and 3.

Seven holes were augered in April 1974, within the boundaries of the proposed pit. The depth of the holes was m (40 ft). Samples were collected at -m (2.5-ft) intervals from to m (1-10 ft) and at -m (5-ft) intervals from to m (10-40 ft). Samples were analyzed for moisture content, gross alpha, gross beta-gamma, tritium, and plutonium-238, 239. Complete analyses are not yet available.

Six holes were augered in the shaft field in May 1974. They were located so as to encounter a "boulder bed" which occurs at a depth of - m (15-25 ft) below the surface. The samples were collected at the same intervals and analyzed for the same things as those from the seven holes augered in April. Complete analyses are not yet available.