LA-UR-07-2379
August 2007
EP2007-0236

Material Disposal Area B: Process Waste Review, 1945 to 1948

Los Alamos
NATIONAL LABORATORY
EST. 1943

Prepared by the Environmental Programs Directorate

EXECUTIVE SUMMARY

Material Disposal Area (MDA) B is an inactive subsurface disposal site, designated Solid Waste Management Unit 21-015, located in Technical Area (TA) 21 at Los Alamos National Laboratory. From 1944 until it closed in 1948, MDA B received contaminated materials from the Laboratory and may contain both hazardous and radiological chemicals. Understanding the context of the historic operations at MDA B in the 1944 to 1948 timeframe is essential to understanding what wastes would and would not have been disposed of at MDA B, and how the chronology of the Laboratory operations and processes may be correlated to the MDA B trench locations. The available evidence, including reports and memoranda archived from the operating groups, log books, aerial photographs, and personal interviews provides the perspective of the processes employed by the Laboratory's various operating groups, the scale of the processes used, and the handling of spent chemicals and solutions, glassware, and contaminated items and debris. Collectively, this body of evidence, focused on land burial of waste, provides the context for knowledge of waste generation and management during the MDA B operational period from 1944 to 1948. Environmental releases such as stack emissions and wastewater effluents are beyond the scope of this report.

Waste generator sites that used MDA B would have been the original technical area (TA-01), DP Site (TA-21), the contaminated laundry (TA-01, then TA-21), the Bayo Canyon RaLa project (TA-10), and the Omega Site (TA-02) which included the water boiler reactor and other experiments. This assessment is confirmed by monthly reports and correspondence of the operating groups, as well as log books kept by the drivers of a truck that picked up contaminated trash and debris from these sites and took them to MDA B. Explosives wastes were not disposed of at MDA B because Anchor Ranch, S Site, and other explosives production and test areas used what is now known as MDA R (located in today's TA-16) for these types of wastes. During the war, the tech area contained virtually all plutonium and uranium research, purification, recovery, and metal fabrication operations. After the war, DP West assumed responsibility for the pilot plant–scale plutonium purification, reduction, metal fabrication, and recovery operations. Polonium operations moved to DP East. The uranium activities remained in the tech area, but D Building converted to plutonium research and analytical support.

By 1947, all laboratories had established waste-disposal procedures that required laboratory and salvage wastes to be boxed and sealed. Large items or equipment were to be wrapped with paper or placed in wooden crates and tagged to indicate waste status. One eyewitness account indicates some wastes may have been placed in large metal boxes and sealed before burial. In general, wastes in boxes were reportedly emplaced simply by piling truckloads into the trench. Using a bulldozer, Zia Company workers subsequently covered the material with fill dirt on a weekly basis. No effort was made to separate waste types, or to compact the wastes beyond the soil cover compaction efforts.

The decontamination efforts employed during the 1940s speak to the fact that the Laboratory tried to conserve and reuse equipment and other supplies. If items could not be decontaminated and could not avoid disposal, personnel had to obtain a release from the property office. No property records of this type have been located to date, however. Items that did not pass decontamination requirements after normal use were reportedly sent to MDA B; these included empty gas cylinders that typically would have been used to store oxygen, neon, helium, argon, and nickel carbonyl; glassware from the polonium operations and the plutonium analytical and research laboratories; and miscellaneous mechanical equipment. The presence of gas cylinders at MDA B is important for present-day excavation safety as the cylinders might still be partially pressurized and may contain residues of toxic chemicals. There is no evidence that fully pressurized gas cylinders or hydrogen fluoride tanks were disposed of at MDA B.

The MDA B pits/trenches are interpreted to be located approximately as shown on the attached map. These pits/trenches were constructed by progressive eastward expansion of a series of semi-contiguous

trenches during the 1944 to 1948 period. The earliest trenches are likely to be on the far western end of MDA B. The far-eastern end of MDA B is thought to consist of small pits and trenches that contain glass bottles with unknown chemicals, as well as radioactive waste. Aerial photographs taken in 1946 and 1947 document which trenches were active in those years. During 1946, 1947, and 1948, three fires took place in the active portions of MDA B; this strongly indicates that uncontained chemicals, such as battery acids or other oxidizers, were placed in MDA B's open pits and mixed with combustible materials, such as clothing, wood, and other organic debris, which created conditions conducive to spontaneous combustion. The locations of the fires are approximated from aerial photographs of the period.

The vast majority of waste disposed of at MDA B waste was contaminated with residual radioactivity, including routine laboratory waste, contaminated glassware, obsolete equipment and wooden laboratory furniture, demolition debris, building materials, clothing, glassware, paper, trash, and small amounts of chemicals from the laboratory areas. All waste and trash from the CMR Division laboratories was considered contaminated trash, and all waste and trash was to be thrown into the "hot" receptacles that were placed in each laboratory. The largest waste contributors may have been the contaminated laundry and building demolition debris as laboratory structures and equipment were upgraded after the war. Non-routine waste would have included materials from spills and accidental releases. Actinium research at DP East would have generated unknown wastes contaminated with actinium-227, while wastes of unknown character from the RaLa implosion experiments at Bayo Canyon were contaminated with strontium-90.

Most liquids, including process waste solutions, decontamination and other mop and wash water, were analyzed for radionuclides, and if below the release tolerance of 0.1 mg/L, were released, untreated down industrial sewer drains through outfalls and absorption beds to the environment. Liquid wastes may have also been dumped down sanitary drains. Treatment plants were not built until after 1948. It is assumed that small volumes of waste chemicals were disposed at MDA B. This is supported by the policy that chemicals could not be returned to the stockroom once they had been in contaminated areas, the observation that chemical bottles were placed in cardboard boxes for disposal, and the minor explosions and some pink smoke observed during the May 3, 1948 fire. No process evidence exists that large volumes of waste chemicals were disposed of by burial at MDA B. Residual chemicals buried at MDA B may include cleaning solutions and other chemicals such as acids, bases and experimental solvents generated at the bench-scale.

Based on an eyewitness account, glass bottles with unknown liquids are buried in at least one pit on the eastern end of MDA B. The authors of this report are unable to definitively identify the source of these bottles. The possibility exists that they may contain aqueous solutions with residual plutonium or other exotic elements. Based on the known Laboratory operations, the concentrations of plutonium would not have been much greater than 1 mg/L of plutonium. Greater concentrations were considered to be recoverable, and concentrations much less would have been released to the environment. The volume of solution present in the glass bottles is considered to be relatively small, possibly a few hundred gallons, in comparison with the thousands of gallons of basic solutions stored in the General's Tanks.

Application of the limited soil concentration and waste surface contamination data available to simple dimensional analyses indicates an estimated maximum MDA B plutonium-239 inventory of 170 g at the 90^{th} percentile. At the 50^{th} percentile, the calculated plutonium inventory of 114 g is similar to the previous 100 g estimate and provides an independent assessment of the inventory and the initial nuclear hazard categorization. The potential plutonium inventory in intact containers indicates an estimated plutonium-239 inventory of approximately 2.3 g. These data indicate that contaminated soils represent the majority of the plutonium inventory at MDA B and suggest that the inventory is homogenously distributed. Individual items may possess locally higher or lower levels of contamination, but they would not represent a significant change in the majority fraction of the plutonium inventory in MDA B.

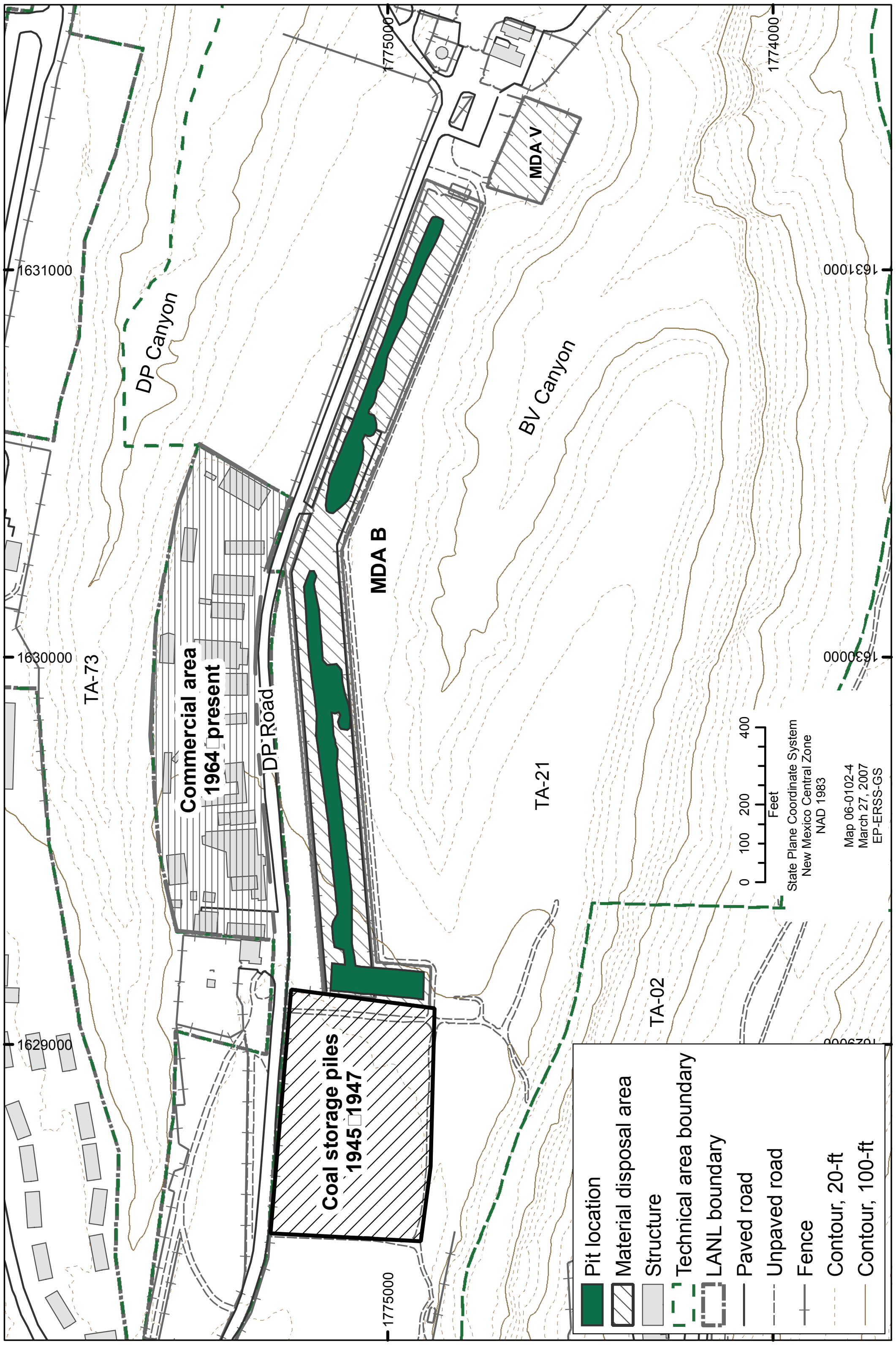

Figure ES-1. General Site Map of MDA B with current and historic adjacent sites identified for reference; the coal storage area was removed in late 1947

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Acronyms and Abbreviations

AEC	Atomic Energy Commission
bbl	barrel (55 gallons)

bgs	below ground surface
CM	Chemistry and Metallurgy (a Laboratory division)
CMR	Chemistry and Metallurgy Research (a Laboratory division)
CMR-11	Chemistry and Metallurgy Research group–DP West plutonium production
CMR-12	Chemistry and Metallurgy Research group–health physics and monitoring
cpm	counts per minute
CWS	Chemical Warfare Service (U.S. Army)
DOE	Department of Energy (U.S.)
DP	delta prime
GAO	Government Accounting Office (U.S.)
GM	Geiger Mueller
HYPO	High Power Water Boiler
LANL	Los Alamos National Laboratory (LASL before January 1, 1981)
LASL	Los Alamos Scientific Laboratory
LOPO	Low Power Water Boiler
MDA	material disposal area
M Division	Experimental and Pit Division (a Laboratory division)
mR/h	milli-Rem/hour
PPE	personal protective equipment
RaLa	radioactive lanthanum
SED	Special Engineer Detachment
SUPO	Super Power Water Boiler
USGS	U.S. Geological Survey
TA	technical area
Tech Area	informal reference to the Laboratory’s original technical area (now TA-01)
WAC	Women’s Army Corps

1.0 INTRODUCTION

Material Disposal Area (MDA) B is an inactive subsurface disposal site, designated Solid Waste Management Unit 21-015, located in Technical Area (TA) 21 at Los Alamos National Laboratory (LANL or the Laboratory) (Figure 1.0-1). From 1944 until it closed in 1948, MDA B received contaminated materials from the Laboratory and may contain both hazardous and radiological chemicals. Known in the 1940s as the "contaminated dump," MDA B currently is scheduled for excavation and the removal of its contents, and planning for the safe implementation of this remediation requires information on the location of the disposal trenches and the nature of the wastes disposed of at the site. Since there are no formal records of the wastes placed at what is now known as MDA B, and since no construction drawings or original site engineering drawings or plans have been found that show the locations of the trenches when they were in use (LANL 1991, 007529), understanding the common research and production elements used at the Laboratory in the 1940s is important for present-day worker safety considerations during the excavation of MDA B. MDA B contents also have never been directly characterized. Thus, understanding the context of the historic operations at MDA B in the 1944 to 1948 timeframe is essential to understanding what wastes would and would not have been disposed of at MDA B, and how the chronology of the Laboratory operations and processes may be correlated to the MDA B trench locations. (Note: LANL was called Los Alamos Laboratory until January 1947, when its name was changed to Los Alamos Scientific Laboratory [LASL]. It remained LASL until January 1981, a generic "LANL" or "Laboratory" is used in this report.)

This report reviews the available documents and information relevant to site operations at MDA B at the time that MDA B is believed to have been in use, including historic records and reports; some previously classified, historic memoranda and other correspondence; and aerial photographs taken in the 1940s. The objectives of this report are to address the following questions in lieu of disposal records (land burial):

- What information is available concerning the physical boundaries, characteristics, and timing of waste burials at MDA B?
- What programs and organizations were active at Los Alamos in the mid- to late 1940s that may or may not have contributed wastes to MDA B?
- What specific process information is available that describes the types and quantities of wastes produced?
- What program, organization, or process information is available to exclude wastes from MDA B?

The operational history of MDA B is tied to the earliest history of the Laboratory, the scope and urgency of World War II, the transition to the Atomic Energy Commission (AEC) in January 1947, and the cold war. Waste management issues largely suffered a lack of attention during the Laboratory's early years because of the need to continue production operations. This document summarizes the development of the process chemistry, metallurgy, and other research and production activities at the Laboratory during the 1944 to 1948 timeframe to provide a perspective of the work conducted at the Laboratory; the scale of those processes; and the handling of spent chemicals, laboratory glassware, and contaminated items. Monthly reports compiled by the operating groups of the period described the application of significant resources and research efforts to the recovery of the then-exotic and priceless new materials plutonium and enriched uranium and addressed the measures to ensure that the materials sent to waste were not recoverable and that recoverable solutions were stored until methods to recover them were developed. These monthly reports documented the development of new and revised processes, the refit and renovation of laboratories, the decontamination and dismantlement of old laboratory areas, and the disposal of items and equipment that did not meet release criteria after decontamination efforts.

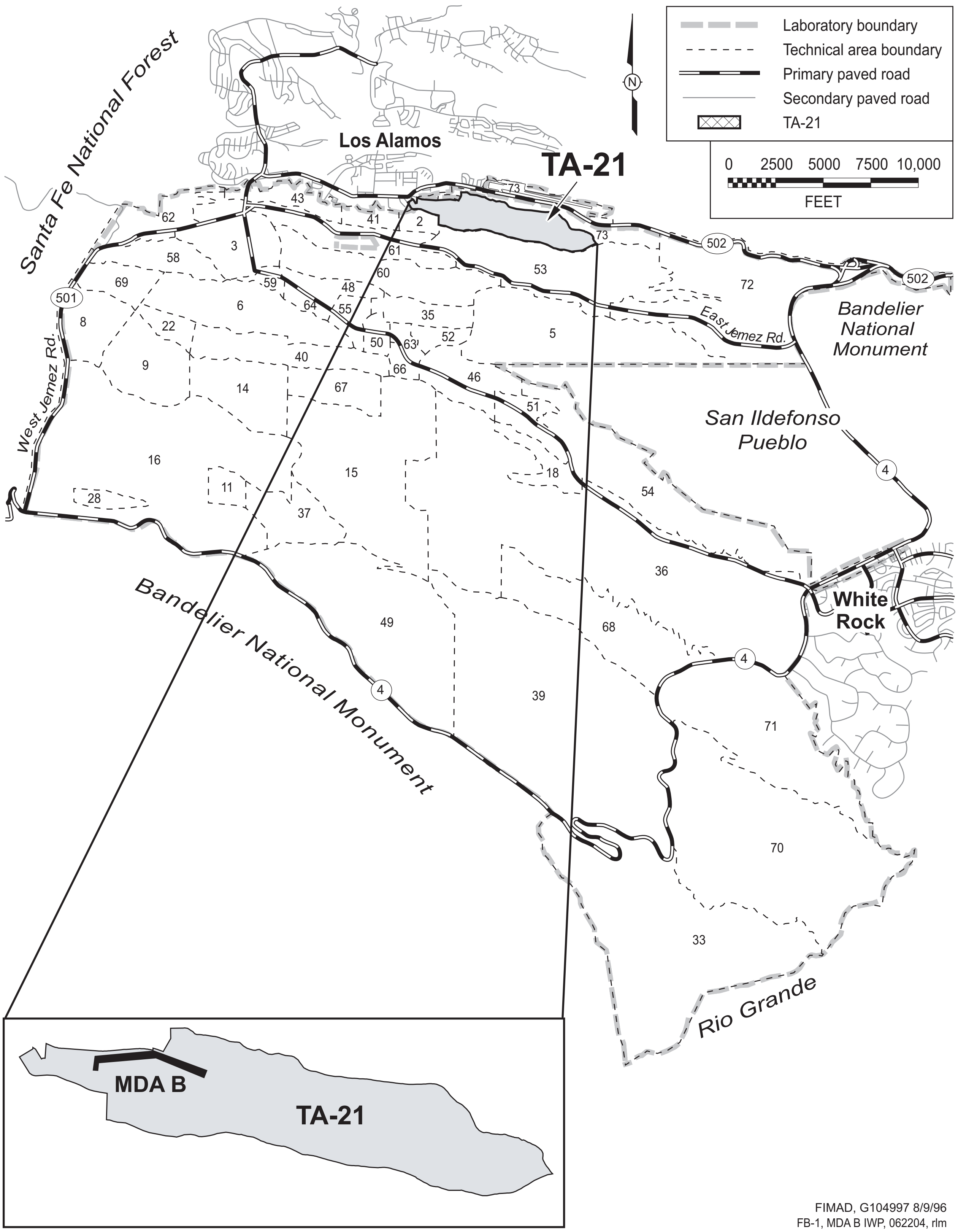

Figure 1.0-1. Present-day MDA B site plan

1.1 Previous Reports

This report builds on a foundation of earlier reports, but none have reviewed all of the available information that pertains to MDA B. A partial foundation for the history of MDA B is provided in the 1977 two-volume report "History and Environmental Setting of LASL Near-Surface Land Disposal Facilities for Radioactive Wastes (Areas A, B, C, D, E, F G, and T)" (LASL 1977, 005707; LASL 1977, 005708). Referred to as the "Rogers report," the document provides a cursory history of MDA B with respect to location, physical design, modes of disposal, general waste types, the results of post-closure studies, and significant events (e.g., fires) through a review of historic memoranda. The Rogers report (LASL 1977, 005707; LASL 1977, 005708) was the first compilation of the operating practices at MDA B. That report indicated that MDA B wastes were emplaced by the truckload in piles filling the entire trench depth and width rather than in vertical layers. Using a bulldozer, workers subsequently covered the material with fill dirt on a weekly basis. No effort was reportedly made to keep routine waste types or loads separate (Meyer 1952, 036622). The MDA B section of Volume I of the Rogers report is excerpted in Appendix A.

Ahead of the addition of cover material over the eastern portion of MDA B in 1982, the Laboratory sampled biota at the site to examine the rooting patterns of long-lived plants into radioactive wastes, the uptake of transuranic materials by plants, and the transport of radionuclides from burial trenches (Wenzel et al. 1987, 058214). This biota sampling project is the only intrusive sampling or excavation known to have taken place at MDA B and included the local excavation of tree roots because of the presence of exposed debris with measurable radioactivity (about 2000 alpha counts per minute [cpm] per 60 cm^2). Beneath the roots, some copper and electrical wires were uncovered but had no measureable radioactivity. At a depth of about 40 cm, a mass of rubber gloves was excavated, which showed surface radioactivity varying from 0 to 6000 alpha cpm. Other gloves in the area had no measurable alpha radioactivity. At a depth of 45 cm, a large lateral root had come into contact with a rubber glove that contained a 6-cm ball of radioactive waste with 10,000 alpha cpm. The excavation was discontinued because of the high radiation levels. Rubber tubing, plaster, painted metal tubing, and brown Duroglass bottles still filled with liquid were also found. Roots and soils were collected, and the hole was backfilled. No cardboard or wooden materials were found in the excavation site. There was also indication that some waste materials had been placed in the trench without packaging. Radiochemical analysis later indicated subsurface plutonium contamination (Wenzel et al. 1987, 058214).

In 1990, E.S. Merrill compiled "A History of Waste Disposal at Technical Area 21" (1990, 011721) that summarized process waste streams, plutonium recovery, waste management practices, and chemicals used at what is now TA-21 in the 1945 to 1948 timeframe and provided general histories for MDA B and other TA-21 disposal areas. Many of the descriptions from the Rogers report (LASL 1977, 005707; LASL 1977, 005708; see Appendix A) were incorporated into the discussions, but Merrill also provided descriptions of early process waste streams. Merrill stated that "the waste generated by a process is a 'fingerprint' unique to the process itself, by knowing something about the initial process, it becomes less difficult to determine the type of contaminant most likely present in a disposal area." The present report builds on the assertion by Merrill and examines many of details of the processes summarized in that paper. Merrill noted that plutonium and weapons-grade uranium were extremely scarce; that the demand for plutonium for chemical testing, metallurgical development, and ultimate core fabrication drove the need to recover and recycle plutonium; that the bulk of plutonium and enriched-uranium chemical waste was stored for recovery and not discarded; and that the contaminated waste in the MDA B trenches is highly heterogenous and may contain a wide variety of spent chemicals that were not targets for recovery, including organic chemicals, perchlorates, ethers, solvents, lecture bottles of mixtures, spent chemicals, old chemicals, and corrosive gases.

As part of its environmental restoration program, LANL compiled the initial categorization of MDA B and other sites (LANL 2003, 090176) in accordance with U.S. Department of Energy (DOE) STD-1027-92, Change Notice No. 1 of September 1997, “Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports.” MDA B was described as an inactive disposal site of approximately 6.03 acres. Based on a 1971 memorandum from D.D. Meyer (1971, 095443), MDA B was categorized as a nuclear hazard category 3 facility containing approximately 100 g plutonium-equivalent. DOE’s Los Alamos Site Office approved the categorization on November 26, 2003 (DOE 2003, 093726).

The “Investigation/Remediation Work Plan for Material Disposal Area B, Solid Waste Management Unit 21-015, at Technical Area 21, Revision 1” (LANL 2006, 091860) provided a historical investigation report of MDA B that summarized what was known about the operational history from the Rogers report (LASL 1977, 005707; LASL 1977, 005708) and that discussed the results of several campaigns of environmental characterization sampling at and around MDA B. The reader is referred to that report for the details and results of the sampling and characterization activities. Figure 1.1-1 depicts the results of a subsurface geophysical investigation conducted in 1998 to delineate the locations and dimensions of the disposal trenches. The results were interpreted to have provided an adequate estimate of the disposal trench locations and dimensions. These results, along with complementary ground-penetrating radar and other methods, indicated that the shallowest objects were from 1.3 to 7.2 ft below ground surface (bgs), and the cover was estimated to be of similar thicknesses. The bottoms of the trenches were estimated to be located 10 to 12 ft bgs. The results of the geophysical investigations are included in their entirety in Appendix B.

1.2 General Operational History of MDA B

The Laboratory was established in 1943 as a military reservation to develop the first atomic bomb. The schedule for the production of enriched uranium and plutonium at Oak Ridge, Tennessee, and Hanford, Washington, respectively, allowed about two years for LANL to research and develop the weapon itself. Theoretical and experimental groups were organized to address specific nuclear and ordnance applications. A radiochemistry program prepared materials for nuclear experiments and developed a neutron initiator for the bomb. A metallurgy program researched the metal reduction of uranium and plutonium and the casting and shaping of these metals and compounds, including uranium hydride and various possible tamper materials. Investigations of the physical properties of uranium and plutonium were performed, and a search for alloys with better physical properties than those of unalloyed metals was conducted. The metallurgy group prepared materials for physical and ordnance experiments, particularly projectile, target, and tamper materials for the gun program (Hawkins et al. 1983, 057519).

Based on available evidence, the site that is now known as MDA B was actively used for the disposal of radioactively contaminated wastes from April 1944 to June 1948 because it offered sufficient space. Only one other disposal area for radioactively contaminated materials—today’s MDA A—was active in the 1945 to 1946 timeframe. Any contaminated material disposed of during this time would have gone to either MDA A or MDA B. MDA A is believed to have closed sometime in 1946, and from then until June 9, 1948, MDA B was the only disposal pit open for radioactive wastes. On June 10, 1948, the first delivery was made to MDA C and MDA B was closed.

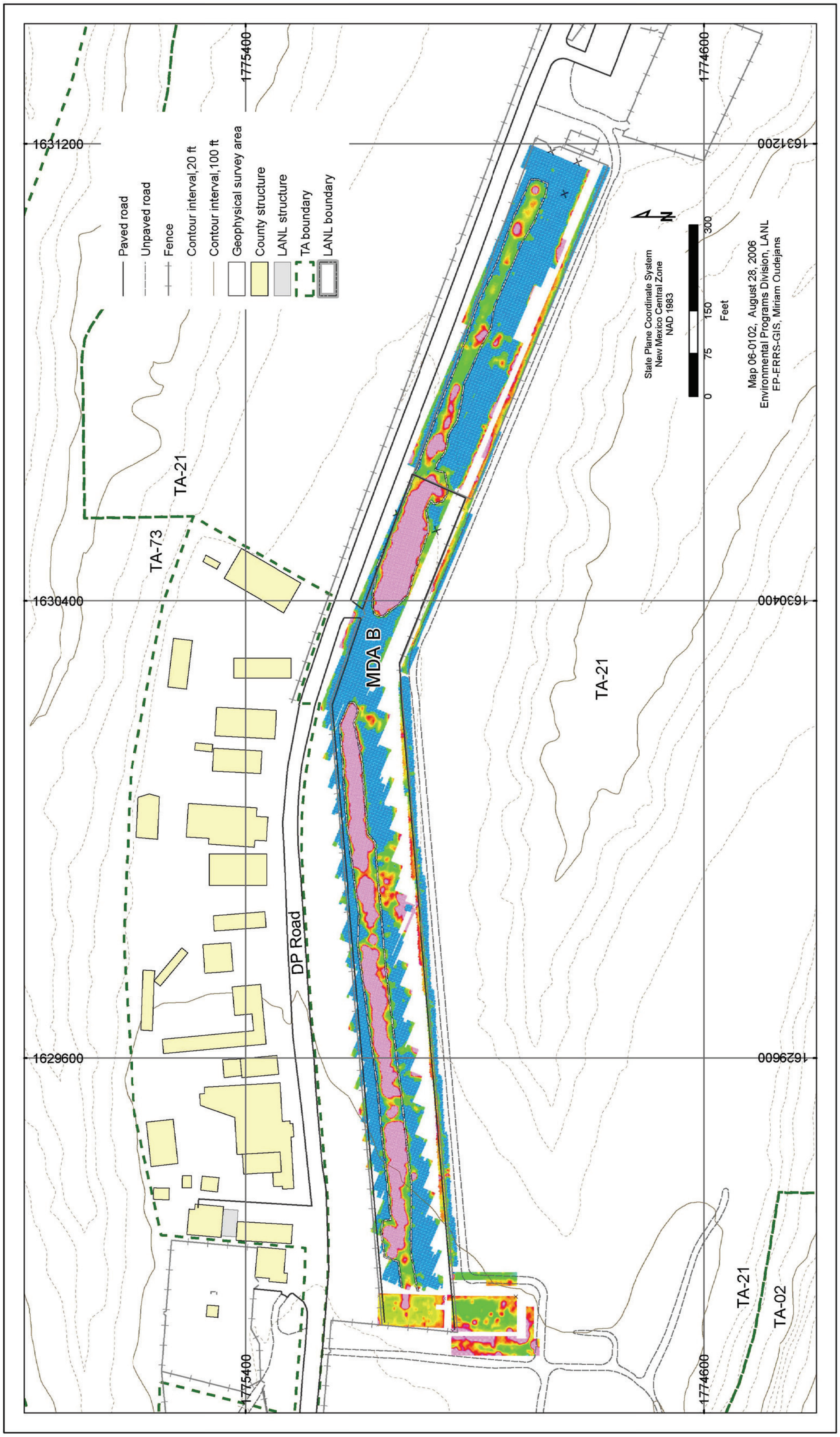

Figure 1.1-1. MDA B trenches delineated using EM-61 geophysical survey data

Most information about the potential inventory of MDA B comes from reports and memoranda generated by historic Laboratory organizations working at these sites. These sources provide evidence that the management of materials disposed of at MDA B was largely the responsibility of the waste-generation sites. The only site-specific documentation consisted of waste pick-up log books that started in 1947. The notebooks were to record all trips each day, including the buildings served, types of materials (e.g., trash, solutions, chemicals) picked up, as well as the drivers' names, their protective clothing, and their radiation exposure data. The log books were issued to the drivers of what was then referred to as the "contaminated truck" (this was the truck that hauled contaminated waste). Los Alamos Scientific Laboratory Notebook No. 1743 (LASL 1948, 095286) was maintained from January 1947 through November 1948, the period that includes the last part of the MDA B operations. The log book supports the premise that the operations of these sites and associated waste streams defined the waste inventory at MDA B.

To appreciate the history of MDA B, it is useful to describe the various groups and sites active at the Laboratory during operational years of MDA B. The U.S. Army Manhattan Engineer District, under the command of General Leslie R. Groves, created and controlled operations at the Laboratory from its inception in 1943 until the formation of the AEC in January 1947. During the war years, the Laboratory consisted of the scientific staff under the University of California, augmented by the 9812th Special Engineer Detachment (SED) and the 4817th Service Command Unit that included the First Provisional Women's Army Corp (WAC) Detachment, the Provisional Engineering Detachment, and the First Provisional Military Police Battalion. The SED recruited chemical, mechanical, and electrical engineers as well as machinists, technicians, and administrative staff. Most of the WACs were assigned to administrative duties, but many were engaged in scientific research. The Provisional Engineering Detachment provided maintenance and construction services for the physical operations of the Laboratory until February 1946 when the Army craft shops were discontinued. The construction and maintenance of MDA B would have been among the tasks of these maintenance groups, but no documentation by any of these groups has been found. The records may have been destroyed.

Through August 1945, the purification of plutonium solutions and the recovery of plutonium from purification residues were carried out in D Building in the original technical area (then informally referred to as "the Tech Area," now known as TA-01; see Figure 1.2-1 for an overview of the Laboratory's early work sites). Other facilities built in the Laboratory's original technical area included

- C Building—machine shop and uranium machine shop (operational October 1943);
- H Building—initial work with polonium-210, barium-140/lanthanum-140, and strontium-90;
- HT Building—heat treatment and machining of natural and enriched uranium;
- HT Barrel House—storage area for enriched uranium and plutonium;
- J-2 Building—radiochemistry research on weapons test debris;
- M Building—processing, metallurgy, and the recovery of enriched uranium;
- O Building—storage of sealed radium and radium/beryllium sources;
- Sigma Building—casting, machining, and powder metallurgy of natural and enriched uranium and later thorium;
- TU Building—machining of natural uranium;
- TU-1 Building—recovery of enriched uranium; and
- V Building—original machine shop; some machining of beryllium and uranium.

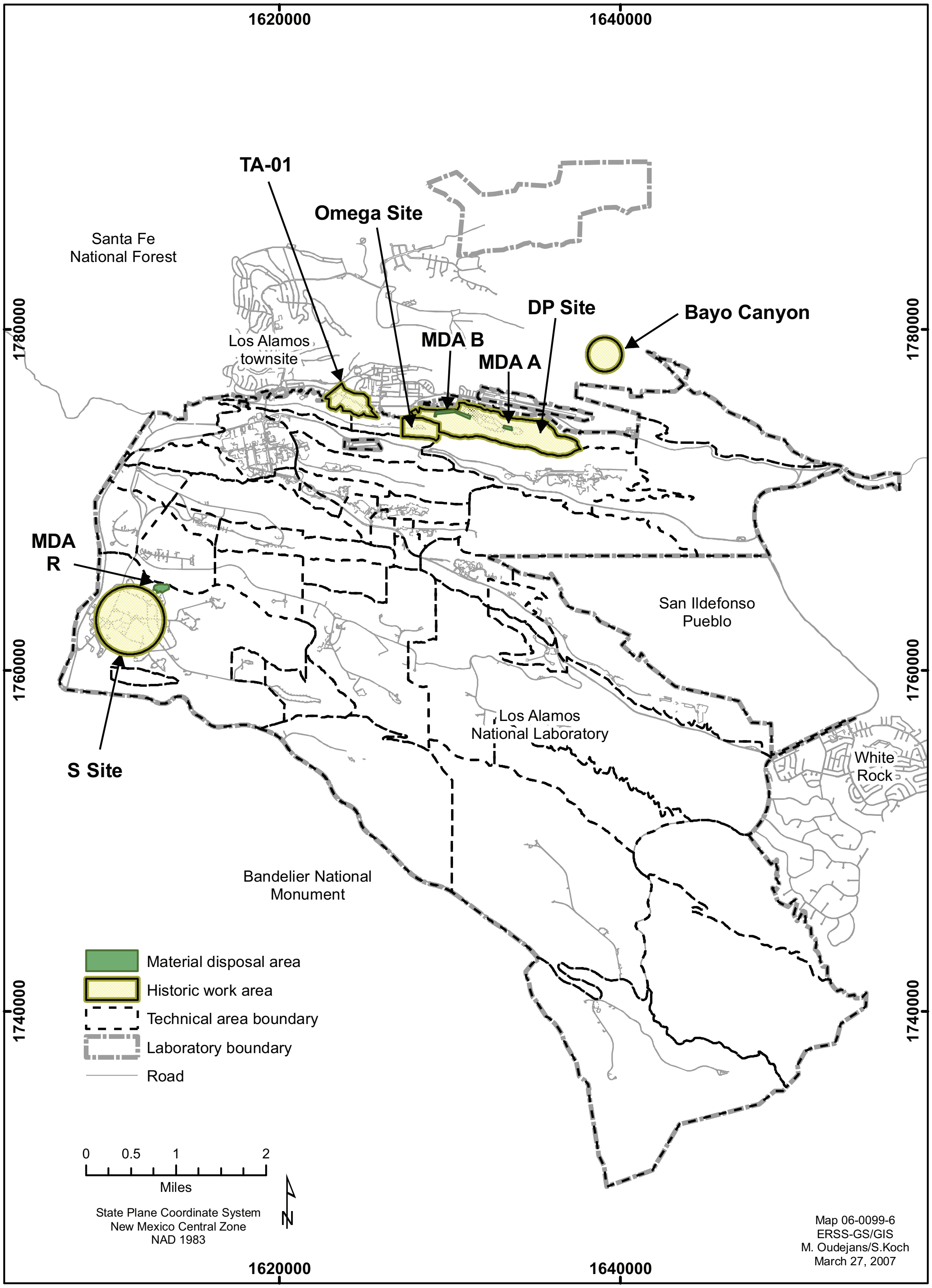

Figure 1.2-1. The Laboratory's work sites during 1944–1948, superimposed on today's boundaries

From 1944 to 1948, the major operational sites at the Laboratory included the following sites:

- The original technical area (now TA-01)
- DP Site (now TA-21)
- The “contaminated laundry” facility (now TA-01 and TA-21)
- Bayo Canyon (radioactive lanthanum [RaLa] program, now TA-10)
- Omega Site (the “water boiler,” now TA-02)
- Other technical areas of the Laboratory (S Site, Anchor Ranch, and other sites sites; see Appendix A).

Members of the SED were assigned to explosives test sites at Anchor ranch and S Site and to chemical and metallurgical tasks, and they served as radiation monitors, decontamination workers, and maintenance personnel in the original technical area and later at DP (Delta Prime) Site after the war. After the war, General Groves recognized that the Laboratory needed to remain active because no other facility combined all of the attributes to continue the research, design, and production of atomic weapons. The discharge of military personnel and the hiring of a civilian workforce were paramount. In February 1946, the Laboratory technical staff was reorganized into the following seven divisions:

- Administrative Division included personnel shops, procurement, technical area maintenance, and safety. In April 1946, procurement was combined with the property office, and tighter property controls were started in late 1946.
- Theoretical Division continued its research into hydrodynamic problems in the interpretation of the Trinity test measurements and other issues.
- Physics Division continued work with particle accelerators such as the cyclotron and the new fast neutron reactor.
- Experimental and Pit (“M”) Division, formed in late 1945, focused on peacetime applications of nuclear energy and the continuation of weapons development, including critical assemblies, weapons maintenance, and military training courses.
- Explosives Division concentrated on explosives research and production after the war; the study of slow explosive compounds, detonators, detonation, and shock effects; and radiographic research.
- Ordnance Engineering Division was established just before the hostilities, and after the war the division was split between the Laboratory and operations at Sandia Base in Albuquerque, with sites as far apart as Wenover Field, Utah, and Salton Sea, California, for the testing and design of weapons components, the stock piling of components, and the assembly of the weapons.
- CMR Division (which before October 1945 had been called the Chemistry and Metallurgy [CM] Division) operated the processes at the Laboratory during the active period of MDA B, and the flow of wastes from these operations are observed in this report as the major contributors to the contents of MDA B. Hawkins et al. (1983, 057519) provided some organizational descriptions of the CMR Division, the names of the group and division leaders, and the descriptions of the scope of operations of the groups. The division had only a loose structure, but after April 1944 the division was extensively reorganized, and plutonium and uranium metallurgy were added. The basic tasks of the CMR Division were metallurgy and physical studies of plutonium and other transuranic elements, research and development of polonium and plutonium chemistry, tritium research, radiochemistry research, and extensive manufacturing functions of essential nuclear

elements for weapons production. The division also included a services organization for the production of nuclear materials for use by other Laboratory divisions (e.g., plutonium fuel rods for the fast reactor). In the fall of 1946, a new research-and-development section was formed that included new methods for plutonium recovery.

The Zia Company began operations in Los Alamos in April 1946 as a prime contractor to the AEC in areas of maintenance, operations, and technical support in relief of the SED. The Zia Company largely supported the Laboratory's research-and-development facilities as well as the operations of the Los Alamos municipal systems, including water, heat, electricity, trash, fuel, and street maintenance. Support to the Laboratory areas also included equipment and materials purchasing, warehousing, salvage and surplus operations, skilled-craft positions such as machinists and operating engineers and firefighters, and non-skilled craft positions such as janitorial services, including decontamination workers, trash pick-up and disposal. Zia Company employees would have conducted waste pick-up and disposal activites, and heavy-equipment operators at MDA B would have maintained the trenches and periodic soil cover and the final cover and installation of fences and other post-closure activities described in this paper. There are no known records of Zia Company's activities at MDA B.

Appendix C contains two papers compiled in 1947 that outlined the general setting of the Laboratory during that year (both papers were attached to Betts 1947, 007007). The first paper ("A Technical Maintenance Group Report on Background Data Concerning the Organization, Space Occupancy, and Building Requirements of the Los Alamos Scientific Laboratory") described the Laboratory organizations (summarized above) and their general missions. Specific references will be made to some of these organizations in the process descriptions that follow in this report. The second of these papers ("A Technical Maintenance Group Report on General Background Data Concerning the Los Alamos Scientific Laboratory Required for Planning Purposes") described the Laboratory's technical areas and their general missions. Specific references will be made to these areas in the process descriptions that follow. By 1947, the operating areas of the Laboratory had been assigned numerical technical area designations. Descriptions of the operations in the technical areas and their wartime designations are provided in the 1947 documents included in Appendix C. D Building was demolished in 1954. Other TA-01 buildings were demolished in the late 1950s and the properties transferred to Los Alamos County in the 1960s.

By 1947, all laboratories had established waste disposal procedures that required all Laboratory and salvage wastes to be boxed, sealed, wrapped with paper or placed in wooden crates, and tagged to indicate waste status (Tribby 1947, 095306). A June 1949 memorandum from Meyer (1949, 036971) yields additional general radioactive waste disposal information about the late 1940s not included in the Rogers' report. The memorandum post-dates the MDA B closure, and although not all details may be applied to MDA B, the information is of general interest to the period.

- The main sources of contaminated wastes were D Building, Sigma, DP West, DP East, and Bayo Canyon. The Chemistry and Metallurgy Research (CMR) Division was serviced daily, with the exception of Bayo Canyon where material was picked up weekly. Other sites were serviced at request. In addition to the materials disposed of daily, there were two other occassional sources: (1) Building material from the destruction of buildings in which radioactive material had been handled, and (2) filter papers from the electrical precipitators at DP West and DP East. The filter papers were disposed of twice a year. The waste from the CMR Division averaged 50 boxes per day.
- The handled waste material consisted of paper, rags, and rubber gloves. The material was placed in cardboard boxes at the sites and the boxes were sealed with masking tape. These boxes also may have contained glassware and small metal apparatus. This type of material made up approximately 90% of the material handled. The rest of the material consisted of metal such as

airducts and large metal apparatus. This latter kind of material was placed in wooden boxes or was wrapped with paper. Two types of cardboard boxes were in use at the time—one measuing 25½ in. x 25½ in. x 30 in. and the other 13 in. x 13 in. x 24½ in. As soon as the supply of the large boxes was to be exhausted, the staff intended to standardize to the smaller box.

- The waste disposal program required three men. Two of them worked on the contaminated truck and were furnished by the Zia Company. The third man was a CMR-12 monitor who supervised the handling of the materials. Before loading, the monitor checked the boxes for external contamination and kept records of any accountable property being buried. The equipment used consisted of a truck and a sedan. The material in the pits was covered once a week and required the use of a bull-dozer and an operator one day a week.
- Two general types of contamination were placed in the burial pits. The main type of contaminated waste consisted of alpha emitters. The other type consisted of small amounts of beta-gamma emitters. The amount of contamination varied, and the staff did not have a quantitative estimate of the amount of active materials buried.
- At the time, solid contaminated wastes were buried. Since the start of the project the staff had filled six pits. Three of the pits were located between a trailer camp and the CMR laundry (MDA B), two pits were in the tank area near DP East (MDA A), and one pit was located at the Alpha Site Dump (MDA C).

A 1946 memorandum (Betts 1946, 036972) that was presented as a brief study concerning the disposal of contaminated wastes at the Laboratory in response to a “District” request (the district in this case is assumed to have been the U.S. Army Manhattan Engineer District) offers intriguing clues, but few details concerning waste sources and disposal methods at the early Laboratory. Three types of wastes were described in the memorandum. First, liquid wastes and their sources and discharges to Pueblo and Los Alamos Canyons were described, as well as a conceptual treatment plant that could have removed radioactive components down to some tolerance levels yet to be determined. Second, an electrostatic filter treatment system was proposed for the air combustion products and other gases that could not be safely handled by the small exhaust blowers in the Laboratory’s original technical area. The main buildings at DP Site were described to have been provided with planned exhaust treatment systems. Third, up to the then-present time the only solutions advanced for contaminated solid materials, such as laboratory clothing, vessels, glassware, laboratory notebooks, wood and other building materials from wrecked laboratories, and similar objects, had been either buried in fenced areas, or sealed in “steel containers,” which from time to time would be sent “by truck to the seaboard, there to be put aboard ship and dumped into the ocean far from shore” (Betts 1946, 036972).

The use of the “sea containers” is poorly documented elsewhere, and it is not known whether any shipments ever departed from Los Alamos for such disposal. An interview with a retired Laboratory employee (section 4.6) who had worked at DP Site after the war recounts the presence of these sea containers at MDA B, but he had no memory of their disposition. He referred to the containers as “sea-cans.” It is probable that some of these containers were built and filled, some may have been shipped off-site, and most or all of them were buried at MDA B. A 1981 report of the Government Accounting Office (GAO) stated that from 1946 to 1970 the United States disposed of low-level radioactive wastes by dumping them into the sea (GAO 1981, 095446). The AEC was the nation’s largest generator of low-level wastes and was thus the biggest contributor to the volume of materials dumped into the ocean between 1946 and 1970. The U.S. Army dumped some of its radioactive wastes into the Atlantic Ocean for three years, but the U.S. Navy conducted most of the ocean dumping and they had no detailed information on their Pacific Ocean dumping activities. The Navy’s information regarding the Atlantic Ocean was nonexistent, with the exception of a few years. The GAO reviewed records from the U.S. Department of Defense and the AEC and concluded that the quality of recordkeeping ranged from poor to nonexistent.

A 1961 memorandum compiled information concerning past burial of radioactive waste at Los Alamos stated that from fiscal years 1947 to 1954 daily routine pickup of solid radioactive waste was not itemized as to the numbers of boxes, etc. that were taken to disposal, but it was assumed to be reasonable that the annual average fell between 1,500 and 2,000 cubic yards per year (Enders 1961, 009685).

Altogether, three fires occurred at MDA B while it was in operation from 1945 to 1948, and accounts of these fires provide useful details about MDA B's content, operation, and the reason for its closure in 1948. All fires occurred in open waste pits and were thought to have resulted from chemically induced spontaneous combustion within the landfill matrix. Documented observations of the fires indicated that conditions were "conducive" to spontaneous combustion and brought into question waste disposal practices. The November 15, 1946, fire was described as more of a chemical reaction fire that remained under control as long as water was played upon it. Whenever the water was taken away, the reaction resumed. At no time were flames visible in the "smoldering debris" (Drager 1946, 000562). According to Drager, bulldozers were used to push "dirt over the affected area of the dump." The early indications were that no person or equipment was contaminated to a degree that was considered serious.

The second recorded fire occurred on October 22, 1947, and was reported about 10:30 am. All fire equipment was out on call to another fire, so a "crash truck" was sent to the dump, and the regular equipment and personnel arrived later. The material on fire was reported to consist of cardboard boxes containing trash (e.g., paper and rubber gloves). The firemen were given respirators and cautioned to stay upwind of the dump. The fire was extinguished about noon and the firemen were taken to DP Site, where they were monitored and given showers. No alpha counts above 400 cpm were found. The fire equipment was monitored and found to be negative. The wind was noted to have been varying in direction during the fire and considerable smoke was blown easterly toward the CMR laundry. The laundry noted higher-than-normal air contamination (0.0868 cpm/L alpha). The burned area was covered with dirt immediately after the fire. The monitoring results indicated that no significant exposures had occurred (Meyer 1947, 095302).

Personnel witnessing the May 3, 1948, fire found 60% of the open portion of the dump ablaze and flames shooting 50 ft into the air. The firemen had little trouble in subduing the blaze, but persistent efforts to put it out were of little avail because of the loaded condition of the dump area. The dense smoke required the evacuation of personnel and the closure of DP Road to traffic (Drager 1948, 001825). The smoke drifted west and remained close to the ground near the intersection of DP Road and Trinity Drive (Buckland 1948, 000562). The investigation failed to produce any obvious cause for the blaze and it was presumed to have started by spontaneous combustion. The area in which the blaze occurred had not had any trash dumped in it for about three days, and much of the trash in the fire had been in the dump for three weeks. The trash included large quantities of wood from temporary storage cabinets, several "live" acid storage batteries, large quantities of miscellaneous scrap metals, discarded contaminated clothing, and boxed laboratory wastes. During the fire, there was some evidence that chemicals had been disposed of in the dump in cardboard containers typically used for the regular disposal of common laboratory wastes. Several minor explosions occurred, and upon one occasion a cloud of pink smoke arose (Drager 1948, 001825). The CMR-12 monthly report indicated that nose counts were given to all personnel involved in the May 3, 1948, fire and no counts above the tolerance were recorded (LASL 1948, 095444). Available information indicates that the location of the 1948 fire corresponds to the active trench visible in the aerial photograph of December 1947 (Figure 2.0-5).

As a result of the May 1948 fire, it was determined that a disposal site so close to living quarters and laboratories was an unacceptable risk and another disposal site, now known as MDA C, was selected on Pajarito Road. Operations ceased at MDA B and started at MDA C on June 10, 1948 (LASL 1977, 005707; LASL 1977, 005708).

1.3 MDA B Post-Closure Activities

After the closure of MDA B in June 1948, a fence was constructed around the entire area. Rogers (LASL 1977, 005707; LASL 1977, 005708) notes that the U.S. Geological Survey (USGS) was asked to assess the filled-in portion of MDA B for commercial use by Los Alamos County. The USGS drilled 12 test borings around MDA B in 1966 from 25- to 50-ft depths and analyzed the samples for moisture, gross alpha and beta radiation, plutonium, and uranium. The distribution of moisture indicated that some lateral movement of water, probably from the contaminated waste pit, had occurred, but radiochemical analyses of the samples showed no indication of radioactive contamination. It was recommended that an asphalt covering on the pit with drainage could prevent any movement of radioactive contamination from the waste pit. The western two-thirds of MDA B were fenced, compacted, and paved in 1966 and leased by DOE to Los Alamos County for trailer and vehicle storage. Rogers notes that other monitoring efforts were conducted in the period during which the County used the area for storage and that none of the readings recorded above background. DOE requested that the County vacate the site by September 30, 1990 (LANL 2006, 091860), and since that time access has been controlled by the Laboratory.

Some post-closure subsidence has been observed at MDA B and is consistent with what is observed at legacy landfill sites with boxed wastes. During a small mammal field investigation in 1980, a member of one of the Laboratory's environmental studies groups reportedly fell through the surface and into a hollow area of MDA B in the eastern portion of the landfill. In preparing this report, it was important to confirm this type of observation. The following is a summary of a 2006 interview with David J. McInroy, conducted on-site, for the purposes of this report. David stated that he was working alone in the unpaved, eastern area of MDA B and fell into what appeared to be a sinkhole that was approximately 5–6 ft deep. He observed at least 2 stacks of large laboratory glass bottles—containing liquids—on pallets, with an open area between the pallets of approximately 2 ft by 5 ft. The sinkhole was located approximately in the south-central portion of the eastern area of MDA B. Mr. McInroy climbed out of the sinkhole and called his supervisor. He was monitored by a radiation technician and no indication of radiation above background was measured. The hole was then backfilled with soil and re-graded (Criswell and Herbert 2006, 096639).

The "Investigation/Remediation Work Plan for Material Disposal Area B, Solid Waste Management Unit 21-015, at Technical Area 21, Revision 1" (LANL 2006, 091860) provided summaries of sampling and environmental characterization activities from the 1960s through the 1990s. These activities included soil and vegetation studies, radiation surveys, and boreholes for moisture, geochemical, and groundwater investigations. In 1982, a surface stabilization of the eastern end of MDA B was completed (October 15, 1982), a new fence was installed 10 ft out from the old one; vegetation was removed; and new soil was added, compacted and reseeded. An experimental cap was installed on the eastern end of MDA B in 1983 to evaluate alternative cover designs and soil samples were collected to evaluate shallow contamination (LANL 2006, 091860). The reader is referred to the aforementioned work plan for the details of these activities and the sampling and analytical results.

2.0 GENERAL LOCATION AND LAYOUT OF MDA B

The approximately 6-acre MDA B site is located on the southern side of DP Road on DP Mesa in today's TA-21 and consists of a series of generally continuous disposal trenches (Figure 1.0-1). The site is long and relatively narrow—about 2200 ft long in total and 120 ft wide—and is bent at an elbow, resulting in two straight legs, with the western leg measuring approximately 1200 ft in length and the eastern leg around 1000 ft. In the 1944 to 1948 timeframe, the area was referred to as South Point or South Mesa. A coal storage area occupied the DP Road frontage west of MDA B (Figure 2.0-1). The coal pile storage area provides a reference point for the photographs and some of the period memoranda. The Rogers report (LASL 1977, 005707; LASL 1977, 005708) provides a review of the number and location of pits and trenches at MDA B. Rogers concluded that the question of how many pits there are and where they are located could not be answered by the available information, but in a memorandum quoted in the Rogers report, Meyer stated, “I am sure that the area contains six pits: two in the west end running north and south making the ‘L’ shape to the fence and four running east and west in the area parallel to DP Road. There was at least one small, shallow trench which was used by CMR Division safety personnel to dispose of hazardous chemicals” (LASL 1977, 005707; LASL 1977, 005708).

Tribby (1945, 033817) indicated that, in April 1945, an 80-ft × 40-ft × 5-ft trench existed at MDA B, a trench which received boxes of contaminated items. Kershaw (1945, 001770) reported that the activated refuse material pit that had been provided on South Point, just southeast of the coal storage piles, had been overfilled, and that cardboard boxes lay outside the trench uncovered. A photograph of comtemporary waste disposal practice at MDA A is shown in Figure 2.0-2. A similar condition appeared to have existed as early as July 1944 when a request was made for a new trench, for dirt to cover the boxes, and for a fence to prevent children from breaking into the boxes and endangering their lives (Popham 1944, 095503). In July 1945, Dow (1945, 006713) requested that “a trench 15 ft wide by 300 ft long be bulldozed as deep as practical before hard rock was encountered, starting just east of the newly covered CM Division disposal pits located southeast of the coal storage yard, and running parallel to, and about 40 to 50 ft north, of the DP Site power line…until a depth of 12 ft was reached or until September 1, 1945, whichever came sooner” (LASL 1977, 005707; LASL 1977, 005708). In agreement with these descriptions, an apparent series of narrow, long trenches can be identified in aerial photographs (described below). The sequence of trenches is inferred from the dates of the photographs. Four large disposal pits 300 ft long, 15 ft wide, and approximately 12 ft deep are interpreted to have been located parallel to the fence line along DP Road, and pits of uncertain length were located in the north-south leg of MDA B at the site’s western end (LASL 1977, 005707; LASL 1977, 005708).

Three aerial photographs (Figures 2.0-3 through 2.0-5) show the physical evolution of MDA B from late 1946 to early 1948. These photographs document the presence of a series of long, narrow trenches parallel to DP Road, with new sections being dug to the east because the previous trench segments were filled. The November 1946 composite photograph (Figure 2.0-3) shows a full photographic view of MDA B from the north and what appears to be the open portion of the active trench with waste in the active pit awaiting cover. A filled trench appears to have extended from the coal piles on the west side of MDA B to the active trench, and the entire eastern portion of MDA B appears undisturbed except for an access road. The December 1946 photograph (Figure 2.0-4) shows a new section of trench either completed or in progress. The new section of trench may have resulted from the reported November 15, 1946, fire in the “contaminated dump” (Drager 1946, 000562). Drager described the active pit being filled to extinguish the smoldering pile. The new section of trench appears to extend the trend of long trenches on the western leg of MDA B, and appears to be about 400 ft long. This is in strong agreement with the modern geophysics data (Figure 1.1-1). The composite photograph again shows that trees have not yet been cleared on the eastern leg of the site, but an access road was probably in use at the time. The photograph taken about December 1947 (Figure 2.0-5) also shows a full photographic view of MDA B from the north. The trees have been cleared on the eastern leg, the active, open portion of the landfill is east of the curve on DP Road, and the entire western portion of the area appears filled. The newly opened trench corresponds to the approximate location of the May 1948 fire. The small *S*-shaped trench scar corresponds to the described location of the small slit trenches in the Rogers report (LASL 1977, 005707; LASL 1977, 005708). The location of the S trench in the photograph is also approximately where the Laboratory employee conducting the 1982 small mammal survey had broken through a rotted plywood cover and had fallen into a cavity (see section 1.3).

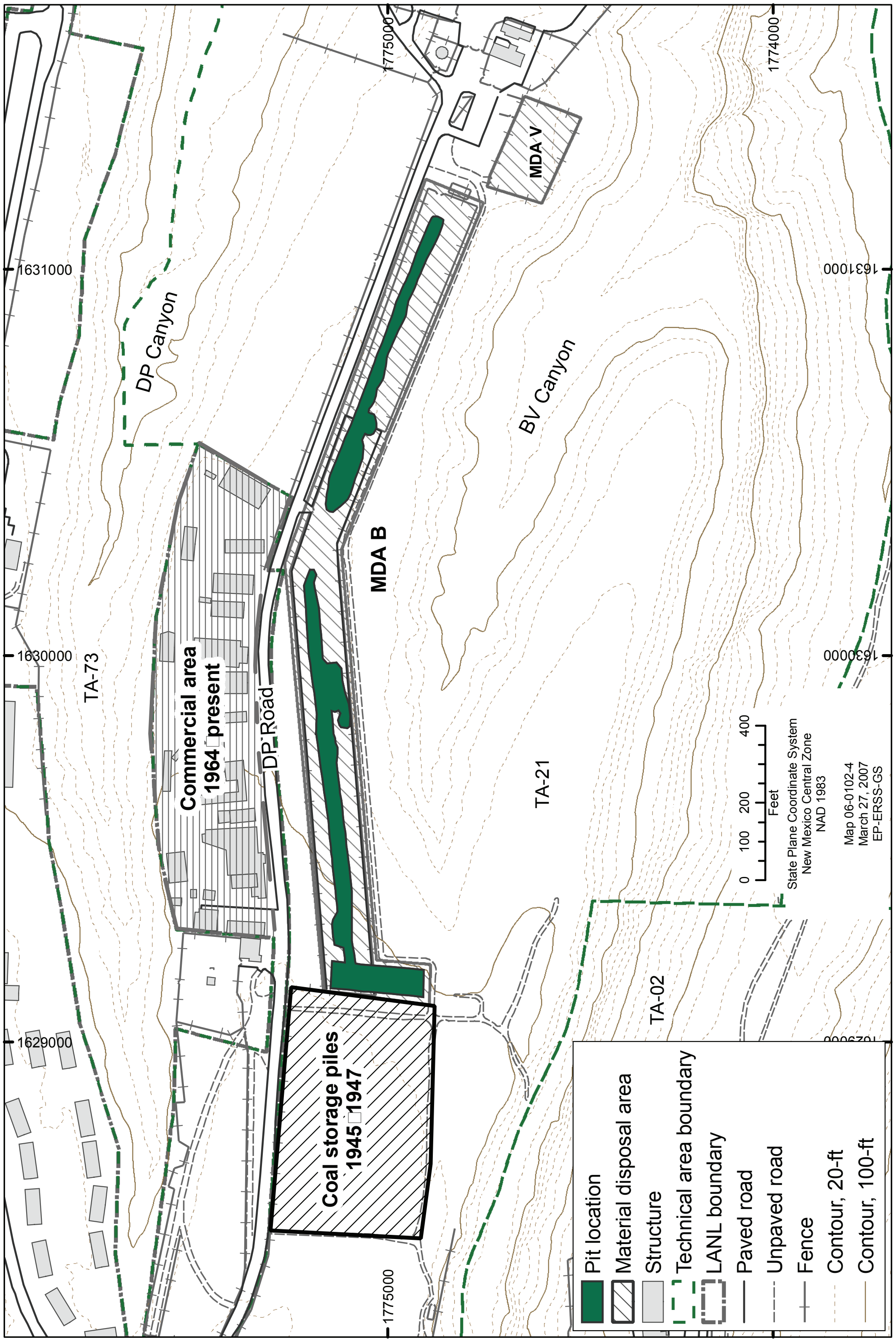

Figure 2.0-1. General Site Map of MDA B with current and historic adjacent sites identified for reference; the commercial area is not present in the historic photographs; the coal storage area is present in historic photographs but was removed in late 1947

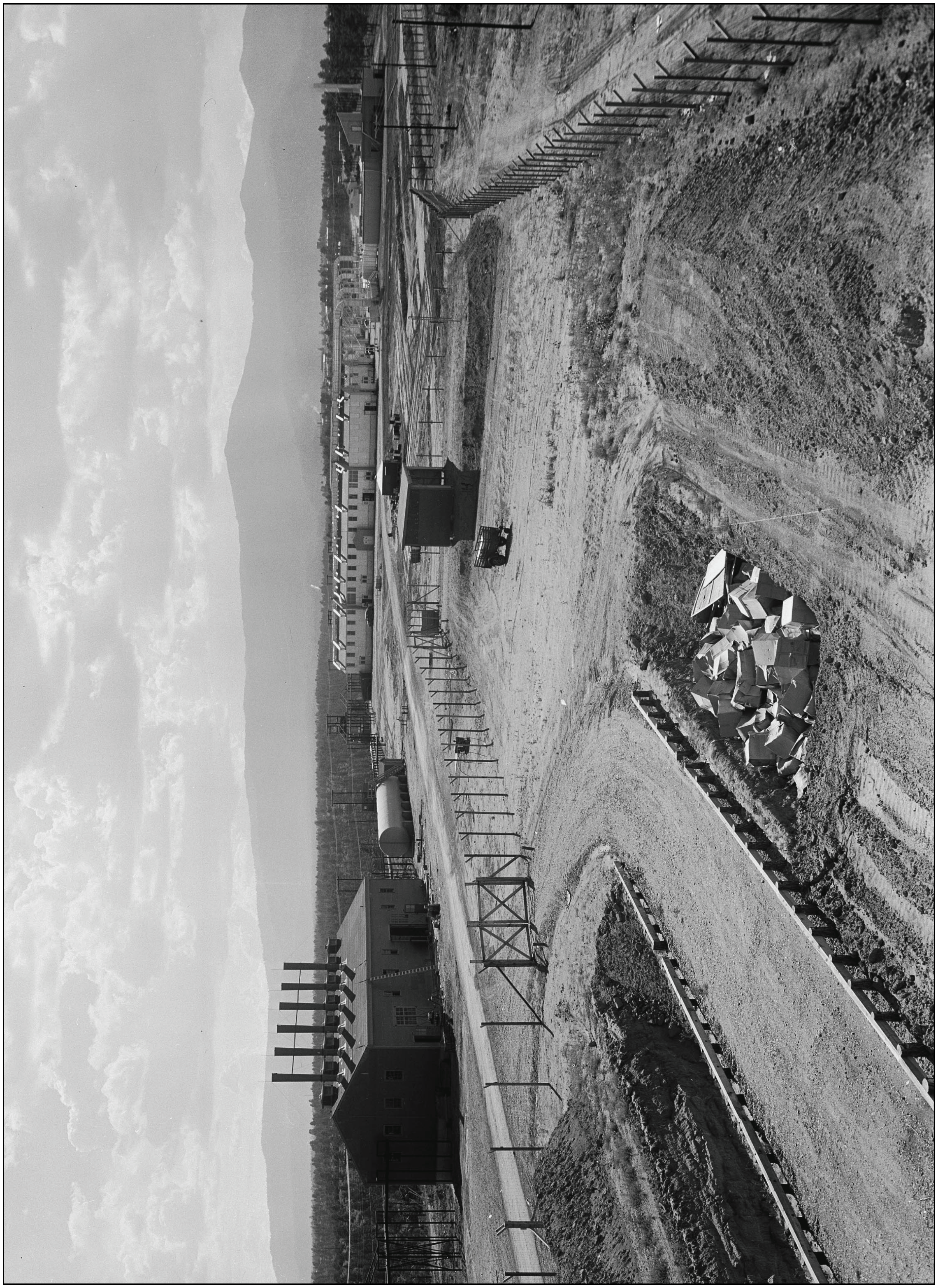

Figure 2.0-2. Waste disposal practices at MDA A circa late 1945; similar trench conditions and waste disposals are assumed to have existed at MDA B during this time period (LANL photograph IM-9: 2284)

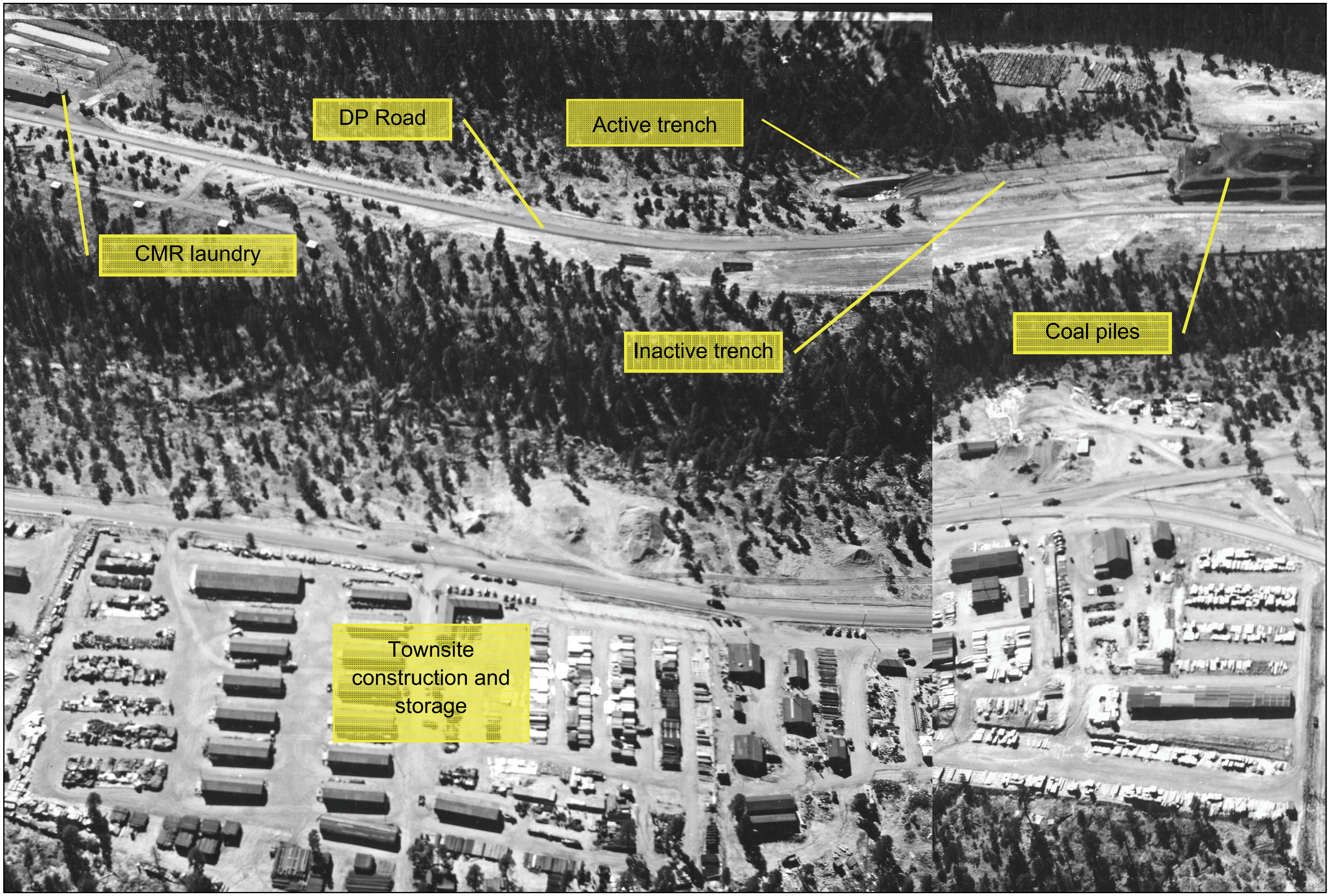

Figure 2.0-3. Composite aerial photograph of MDA B taken in November 1946; view to the south, the entire length of MDA B ,is depicted in this composite; thought to be the oldest photographs of MDA B (notations by authors of present report: photographs by Sandia Labs: scanned images courtesy of Los Alamos Historical Museum Photo Archives)

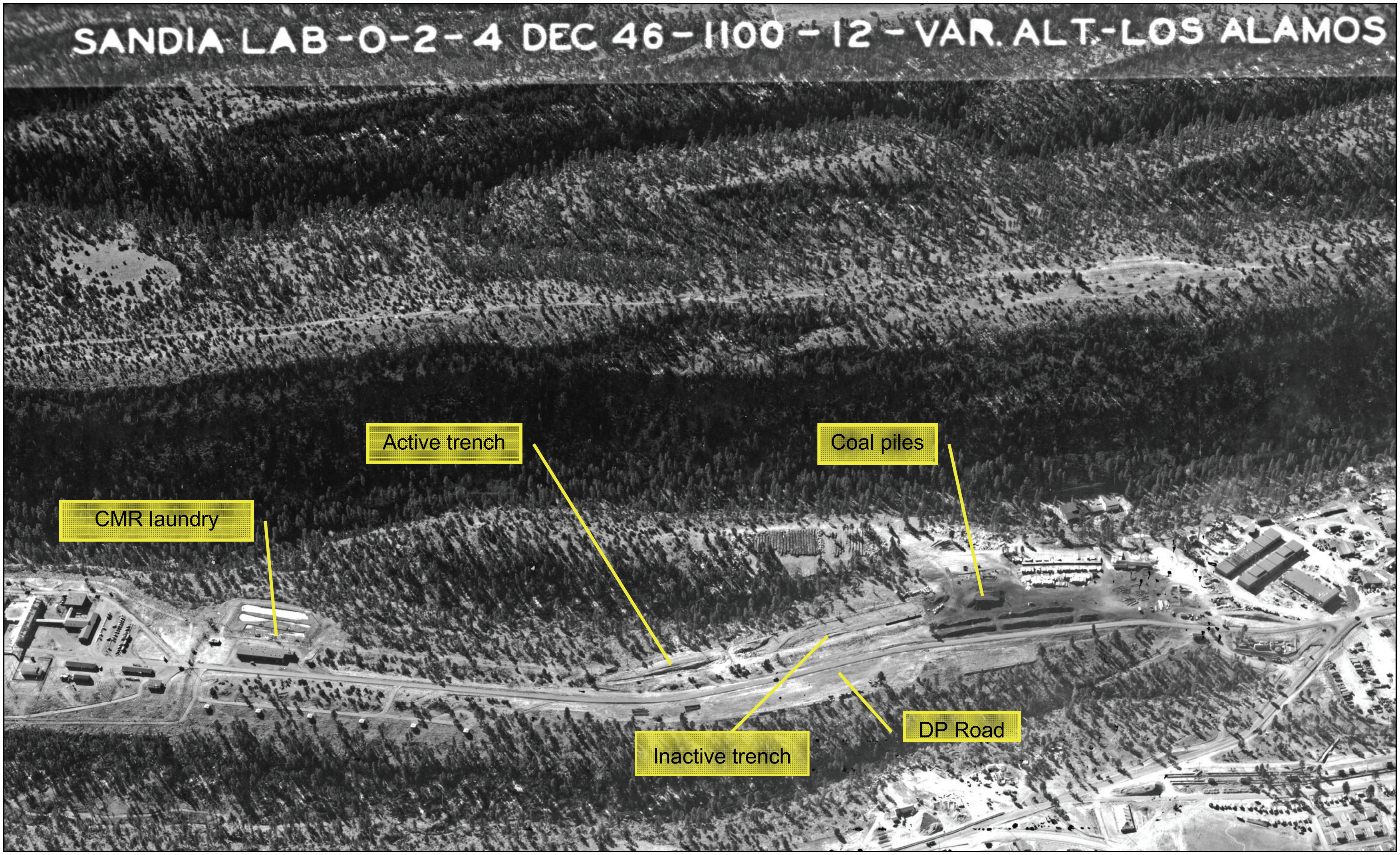

Figure 2.0-4. Aerial photograph of MDA B taken in December 1946; view to the south, the entire length of MDA B is depicted in this enlarged photograph (notations by authors of present report: photographs by Sandia Labs: scanned images courtesy of Los Alamos Historical Museum Photo Archives)

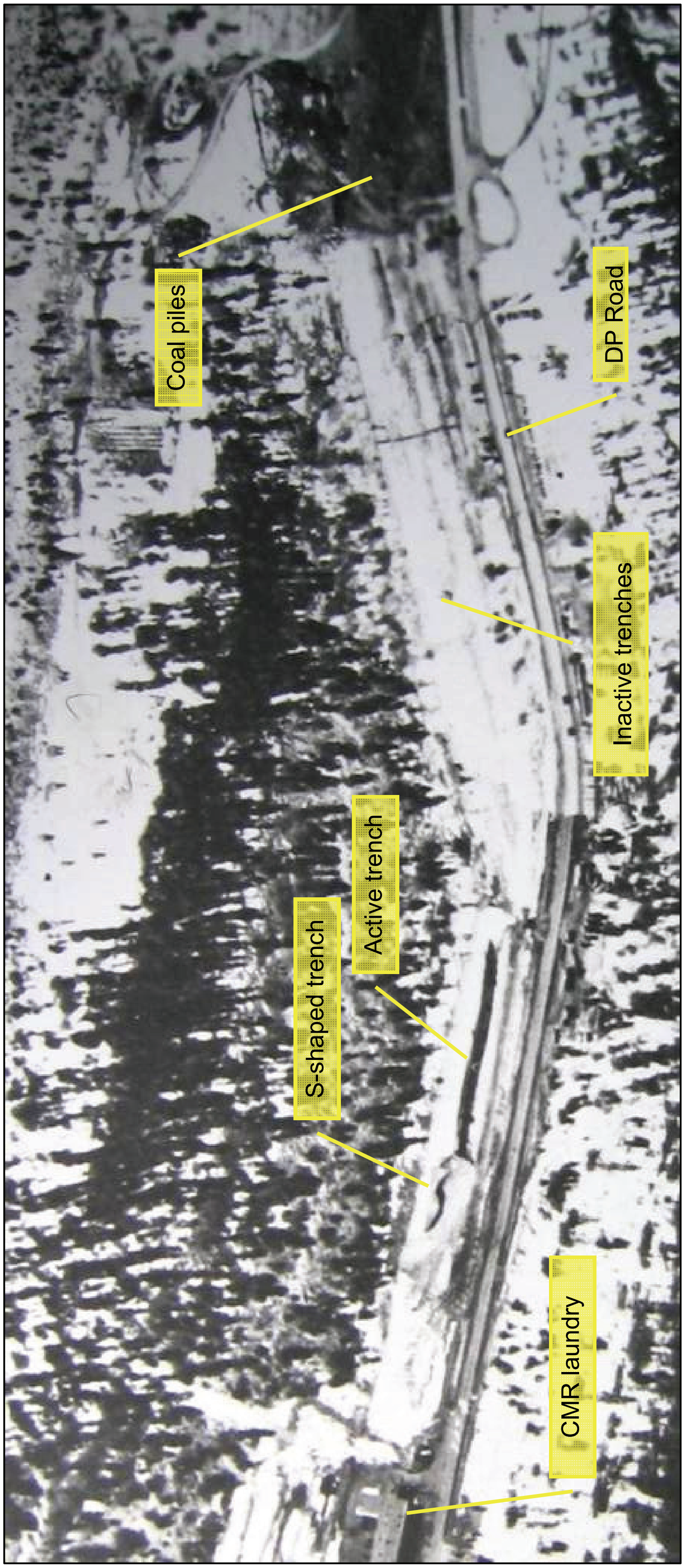

Figure 2.0-5. Aerial photograph of MDA B December 1947; view to south (notations by authors of present report: this is a scanned image of a single, labeled photograph from MDA B project files: source not identified, but thought similar to Figures 2.0-3 and 2.0-4)

3.0 OPERATIONS IN D BUILDING AND THE ORIGINAL TECHNICAL AREA, 1944–1948

Understanding the Laboratory's research and production operations during the lifespan of MDA B from 1944 until its closure in 1948 provide the context of waste generation and the perspective of the types of wastes that would and would not have been disposed of at MDA B. This section describes the Laboratory's earliest uranium and plutonium purification and recovery operations in the original technical area during, and shortly after, World War II. The original technical area constituted the core of the initial Laboratory operations and was located in the areas surrounding the Los Alamos Ranch School that had been obtained by the War Department for the Manhattan Project (Figure 3.0-1). For safety purposes, the explosives research and production operations were conducted at the property known as Anchor Ranch because this area was separated from the original technical area by several miles. The descriptions of Anchor Ranch and the associated S Site areas are beyond the scope of this report because the explosives waste was managed locally in those areas and did not contribute to MDA B. As the scope of the Laboratory research operations progressed during the war, other Laboratory areas were added, such as DP Site. These are described in the following sections, as applicable.

3.1 Uranium Purification and Recovery in D Building

At its inception, the Laboratory had two main problems to examine: (1) processing tetrafluoride for experiments and weapons production, and (2) resolving issues concerning the fuel for the water boiler at Omega Site. The Oak Ridge, Tennessee, operations undertook the purification of enriched uranium before shipment to LANL. LANL specified the chemical form, such as sulfate, nitrate, or tetrafluoride. The primary assignment of the CM Division was to develop and apply the methods for the purification and recovery of uranium to the specifications of composition and purity set by the physics and engineering groups. The processes for uranium purification and recovery are described in "Chemistry of Uranium and Plutonium" (LASL 1947, 095322). The successful accomplishment of the objectives required extraordinary precautions against radioactive toxic hazards and extraordinary precautions against loss of the immeasurably precious isotope uranium-235 (LASL 1947, 095322). Thorium was used as a surrogate during early experiments.

Enriched uranium from the Oak Ridge plant generally was received as a purified fluoride and was reduced directly to metal. It was primarily the role of uranium as a stand-in for plutonium that led to the first work on uranium purification. The first uranium metallurgy at LANL was the preparation of the hydride because use of the hydride in the first bomb was still being considered. Experiments with hot and cold pressing were tried until the use of plastics curtailed the need for the hydride. The essential purification step was the ether-extraction method that concentrated the uranium from gross amounts of impurities (Figure 3.1-1), then the precipitation of uranyl oxalate, and then the ignition to form the oxide that could be converted to tetrafluoride. This process also was used when necessary to decontaminate the water boiler solutions. In September 1946, 13 reductions were made that yielded an average of 99.90% of total uranium (LASL 1946, 095314).

Figure 3.0-1. Original technical area of Los Alamos Scientific Laboratory, December 1946; view to the north; some building identifiers are shown, some buildings discussed in the text (photograph by Sandia Labs, courtesy of Bradbury Science Museum)

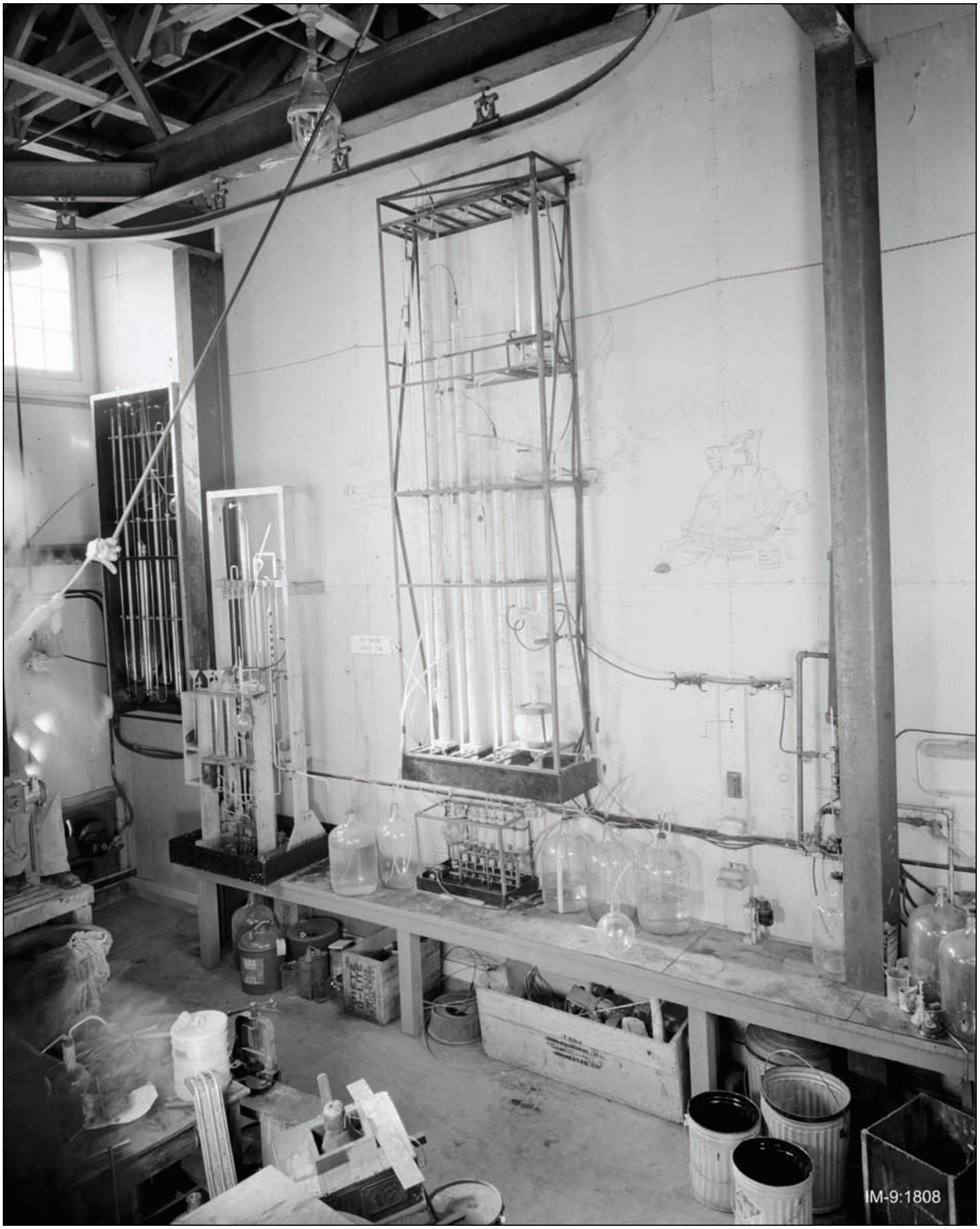

Figure 3.1-1. Uranium process equipment in D Building (LANL photograph IM-9: 1808)

Work on uranium remelting began in June 1944. This process drove off volatile impurities and prepared the metal for shaping. Difficulties were encountered in obtaining crucibles that would not crack when cooled. Magnesium oxide and beryllium were finally used with special heating methods. Techniques for forming uranium were intensively investigated after August 1944. The main techniques used were casting, hot pressing, and rolling. Both magnesium oxide and graphite molds were used successfully for casting. The culminating work of the uranium metallurgy group was casting the final parts for the Hiroshima bomb. Various acid solutions, including nitric, sulfuric, and trichloracetic acids, were used in the course of the fabrication to clean and prepare them for plating (LASL 1947, 095322). The metal physics group established a program of experiments early in 1946, including self-diffusion studies on uranium and many other physical measurements (Hawkins et al. 1983, 057519). The construction and installation of related equipment occupied most of the metal physics group's time for the rest of 1946.

When the hydride or metal experiments were completed, the materials were returned for recovery. Recovery included residues from castings skulls (i.e., the layer of metal left in the magnesium oxide crucibles, lathe turnings, rags, crucibles, molds, pickling solutions, analytical residues, metallic reduction liners, and slag from fabrication). Studies of recovery from liners and slag showed that the complete dissolution of these materials was necessary before recovery. Of the miscellaneous "residues," rags, graphite, cutting oil, and other combustible materials were burned. The ash was extracted with nitric acid, and the residue from this treatment (usually containing only traces of uranium) was extracted with acids (LASL 1947, 095322). The recovery group designed and built a continuous-extraction apparatus capable of giving recovery yields of better than 99.9%. The April 1945 CM Division progress report stated that a total of 1.67 kg of enriched uranium was recovered, chiefly from fabrication residues. The determination of the amount of uranium left in the stripped solutions from the routine ether-extraction recovery of uranium from magnesium liners and slags had finally been solved with sufficient precision to allow decisions about whether such solutions were lean enough to discard. Three runs were made on one stripped solution that gave results of 1–64 µg/L uranium (LASL 1945, 095335). The uranium recovery solutions extracted through the ether-extraction method were tested in batches of about 100 L to determine the residual uranium concentration. This process normally averaged about 50 µg/L of uranium, which was discarded. If the tested solution exceeded 100 µg/L, the solution was stored for further treatment (LASL 1947, 095322).

Enriched uranium was also recovered. By the end of 1945 the methods for the recovery and purification of enriched uranium were still inefficient and unsafe, however. The chemistry and metallurgy groups were reorganized, and intensified research began in late 1945, as follows:

- October 1945: Work continued on the cleanup of various lean uranium residues that remained from earlier operations (LASL 1945, 095341). After that, the CMR Division began to develop a process for the recovery of enriched uranium from all residues originating from the project.
- October 1946: Remelting of the uranium turnings began (approximately 7000 lb were on hand) (Hawkins et al. 1983, 057519).
- December 1946: About 5 g of enriched uranium was recovered and purified from residues of old water boiler samples, and a search had started for a new method of recovering uranium turnings coated with cutting oil (LASL 1947, 095318).
- February 1947: 2.9313 g of enriched uranium were recovered from old water boiler samples and returned to the water boiler (LASL 1947, 095320).
- June 1947: 32.8 kg of enriched uranium were recovered and purified to the oxide, including 25.8 kg of lathe turnings (LASL 1947, 095324).

- August 1947: Work had started on recovery methods for trichloroacetic acid solutions and solutions with large amounts of cutting oil, and 12.5 kg of enriched uranium were recovered and converted into the oxide form, including 11 kg of lathe turnings (LASL 1947, 095327).
- November 1949: Over 25,734 lb of uranium oxide were shipped off-site to a recovery plant (LASL 1948, 095289).

Late in 1946, all the installations CMR Division used in the D and M Buildings were overhauled to reduce the contamination danger. In July 1946, it was reported that M Building was entirely reconstructed for use as a pilot plant for the treatment of reduction crucibles, slags, and metal scrap from the enriched uranium production and fabrication. Several tons of reduction crucibles and slags were to be treated. The number of grams of enriched uranium involved was relatively small, but the monetary value easily warranted the developments planned. A very large portion of the equipment had been ordered, and experimental work on the fundamental operations was well under way (LASL 1946, 095312).

3.2 Plutonium Purification and Recovery in D Building and the Original Technical Area

The purification of plutonium solutions was carried out in the original technical area's D Building until September 1945. The plutonium purification group at LANL was created within the Chemistry Division in May 1943 when the division was assigned the job of purifying the plutonium received from other Manhattan Project laboratories. During most of the period between May 1943 and March 1944 the purification group studied the chemical properties of plutonium on the microgram scale (using the microgram amounts of plutonium made by the 60-in. Berkeley cyclotron). Not until February 1944, when the first material was received from the Clinton reactor at Oak Ridge, Tennessee, was enough plutonium available to enable the group to work on the gram scale. This research led to the adoption in March 1944 of a purification procedure involving two sodium plutonyl acetate precipitations and two ethyl ether extractions; the process did not, however, separate uranium from plutonium. This separation problem became serious when the plutonium had to be recovered from the uranium sulfide crucibles used by the metallurgical group. Plutonium began arriving at LANL from Hanford, Washington, in January 1945, shipped in 80-g "W bombs" (a "bomb" in this sense was a code name for the stainless-steel container used for shipping uranium and plutonium Figure 3.2-1). These were later increased to 160-g containers at the request of LANL. The plutonium purification and reduction processes are described in three documents—"Plutonium Purification in Building D" (LASL 1946, 095344); "Plutonium Processing at the Los Alamos Scientific Laboratory" (LASL 1969, 095300); and "Plutonium Metallurgy at Los Alamos, 1943–1945: Recollections of Edward F. Hammel" (LANL 1998, 095346).

Initially, an 8-g closed apparatus was built and a number of 8-g runs were made to furnish purified plutonium both for dry conversion and metallurgical research. From experience gained on the 8-g apparatus, a 160-g apparatus was designed and constructed. The standard size lot of 160 g was selected because this appeared to be safely below the water boiler critical mass and because it was a multiple of the 80-g lot size planned for Hanford shipments. A lot was never purified until radioassay showed that the lot contained the correct amount of plutonium (LASL 1946, 095344). The January 1945 progress report for the CM Division stated that the first full-scale plutonium purification run was made in the 160-g enclosed apparatus. The yield was 95.4%. It was expected that the yield would gradually be improved to about 98%. Six 8-g runs were also made during January, with an average yield of product of 97.3%, and a total of 187 g of plutonium was purified during January (LASL 1945, 095334). The August 1945 CM Division progress report stated that a total of 6.318 kg plutonium was purified during July. The average yield for all the runs was 97.5%. The new process saved time, increased the yield of the purified material, and reduced the amount of plutonium and the volume of solution sent to the recovery operations (LASL 1945, 095339). The total amount of plutonium purified in D Building through 1945 was 29.16 kg, with an average yield of 89.7% to 98.7%, depending on the specific chemical process. All of the materials from the purification processes were returned to the recovery operations (LASL 1946, 095344).

Figure 3.2-1 Stainless-steel Hanford shipping container known as a "bomb" (right) and the protective case (left) (LANL photograph IM-9: 1831)

The potential loss of plutonium during the purification process led to the establishment of a recovery and concentration section in the CM Division. By September 1944, this section had developed several methods for the recovery and concentration of plutonium from purification residues so that the plutonium could be recycled. The recovery methods included recovery of plutonium from process solids and solutions, including metals, oxides, slags, hydrides, halides, trichlorides, trihalides, and tri- and tetravalent solution returning from chemical, physical, and metallurgical activities. The metallurgy materials included drybox sweepings of tissue paper, rags, wood, and brush hair (LASL 1944, 095350).

The "Plutonium Recovery Methods" report (LASL 1944, 095351) stated that by October 1944 more than 700 L of basic solution had been collected as supernatants from the precipitation of plutonium hydroxide. These solutions contained amounts of plutonium that varied between 1 mg/L and 5 mg/L, amounts that were too great to be discarded. The supernatants from the peroxide treatment were assayed and found to contain plutonium in concentrations between 0.04 mg/L and 0.2 mg/L; the majority of solutions were less than 0.1 mg/L. These solutions were to be discarded because they contained plutonium in unrecoverable quantities (LASL 1944, 095352). In January 1945, it was reported that the recovery of plutonium from the 60 L of supernatants from the 160-g purification run was carried out in 6-L batches. The resulting supernatant contained 0.002–0.1 mg/L plutonium (LASL 1945, 095334). The August 1945 CM Division progress report stated that about 1.44 kg plutonium was recovered and turned over for purification during July, that about 1.39 kg had been submitted for recovery during the month, and that about 0.25 kg plutonium was stored in a form not feasible to recover with the then-current D Building set-up (LASL 1945, 095339).

A second early problem was the recovery of plutonium from the magnesium oxide liners used during the reduction of plutonium. In November 1944, it was concluded that the liners would have to be completely dissolved (LASL 1944, 095352). The amount of plutonium recovered through November 1944 was reported as 232.8 g, with 47.524 g recovered during that month (LASL 1944, 095352).

The February 1945 CM Division progress report noted that the recovery of plutonium from materials such as cutting oils and polishing papers continued to be a problem. The best solution at the time appeared to be the installation of filters in the machines that used cutting oils, with the occasional return of the oils to recovery operations for clarification (LASL 1945, 095334).

During the first years of the recovery section's operation at LANL, much of the plutonium work was done in open-faced hoods (Figure 3.2-2). At the time it was believed that the variety of residues required the use of open hoods for flexibility of operation, and that the operators could be protected by special clothing and various types of respiratory equipment. By August 1945, the D Building recovery laboratory was considered inadequate and dangerous to human health and to production schedules (LASL 1945, 095339). The September 1945 CM Division progress report stated that given the shutdown of plutonium processing in D Building, the recovery section would try to recover as much of the plutonium on hand as would be feasible during the first week of September, and would then shut down after the DP Site began operations. The recovery operation continued about two weeks beyond the shutdown of production processing in D Building. About 260 g of plutonium was reportedly stored in various forms, awaiting the start-up of DP Site operations (LASL 1945, 095341).

As of September 1, 1945, the purification of plutonium in D Building was discontinued, and some of the process hoods dismantled. The laboratory furniture built during the war consisted of cabinets and fumehoods of hardwood (typically maple) and plywood. After the war, parts of the buildings, including walls, floors, linoleum, plaster, framing, and laboratory furniture, were remodeled and metal furniture was installed that was easier to clean (LASL 1945, 095341). The operations in D Buildings changed after the war from the production and recovery operations needed for the combat weapons to plutonium analytical and research support facilities. The enriched uranium operations remained in D Building well into the early 1950s. The metal physics group established a program of experiments early in 1946, including bringing the specific heat of plutonium from room temperature to the melting point, researching the thermal conductivity of plutonium at room temperature, as well as conducting many other physical measurements (Hawkins et al. 1983, 057519). Part of D Building was set aside for these investigations, new laboratory equipment was designed, and the construction and installation of this equipment occupied most of the group's time for the rest of 1946.

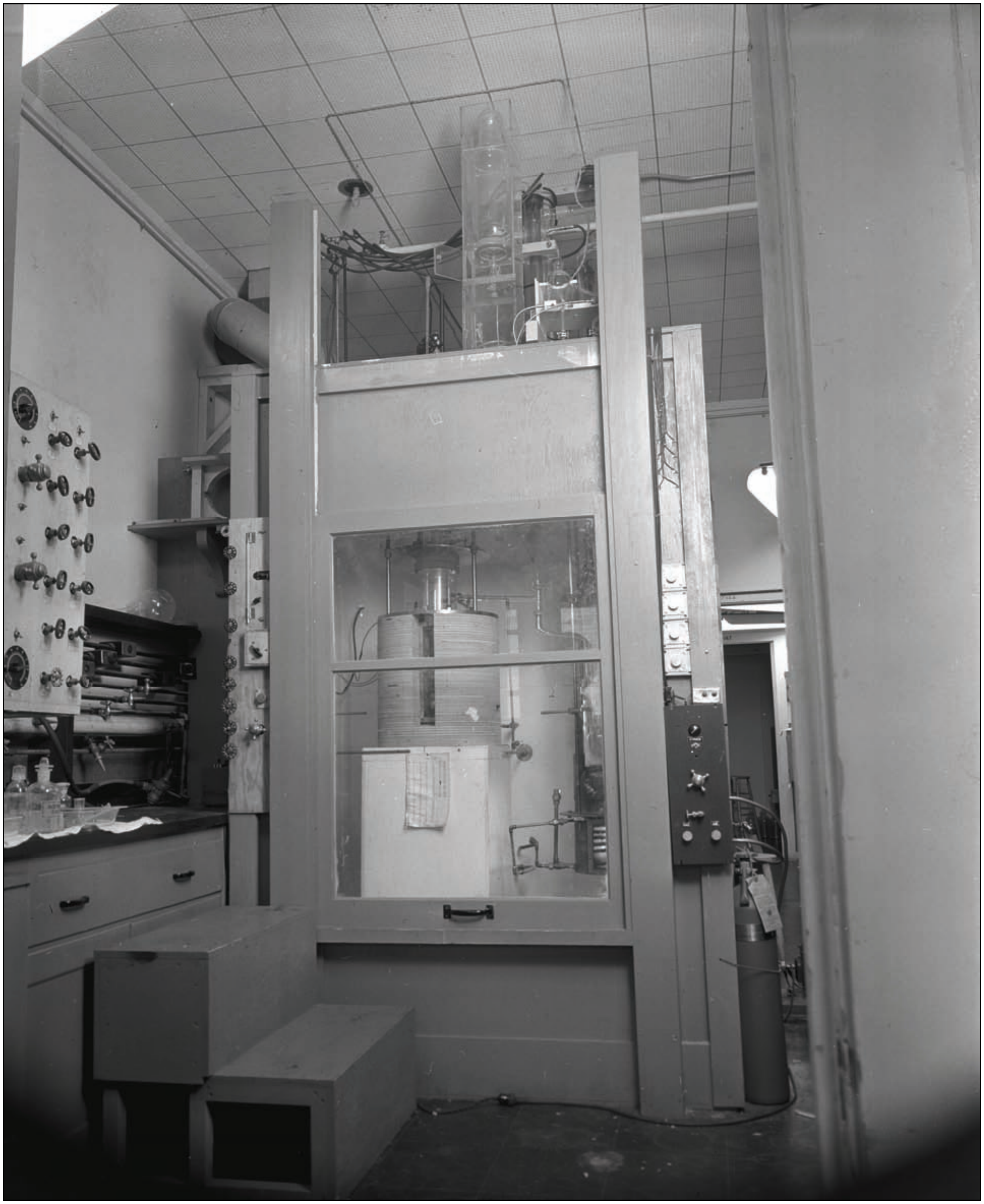

Figure 3.2-2. Chemical operations were conducted in D Building in ventilated, wooden hoods with plywood-mounted accessories and controls; most of these were demolished and replaced with metal and stainless-steel equipment after the war (LANL photograph IM-9: 1830)

3.3 Wastes Sent to MDA B from D Building

MDA B was actively used for the disposal of radioactively contaminated wastes from April 1944 to June 1948. Only one other disposal area for radioactively contaminated materials, today's MDA A, was active between 1945 and 1946; it is believed to have closed sometime in 1946. Between MDA A's closure and the opening of what now is known as MDA C in June 1948, MDA B was the only disposal pit open for radioactive wastes. Los Alamos Scientific Laboratory Notebook No. 1743 (LASL 1948, 095286) recorded the daily pick-ups of contaminated trash from the D, H, M, T, and Sigma Buildings in the Tech Area from January 1947 through June 1948, when MDA B was known to be active. Reports mentioned the disposal of a contaminated truck from the Trinity test (see, for instance, LASL 1977, 005707; LASL 1977, 005708), but no documented evidence of that disposal was found during the review for this report. There were also undocumented rumors of other buried vehicles.

The picked-up material generally was not itemized or characterized, other than noting that it was contaminated material, although there are entries of contaminated cement, lumber, paper, trash, building debris, and a dry-ice box being picked up at U Building. Weekly pick-ups were recorded from the "glass shack" and the salvage warehouse. Solid wastes from the operations at the original technical area between 1943 and 1948 consisted of contaminated clothing; gloves; glassware; equipment; laboratory apparatus; empty gas cylinders (argon, oxygen, neon, and helium were noted); building demolition debris; wooden laboratory furniture; and ordinary trash and paper from the laboratory areas. The operations at D Building changed after the war from research, purification and recovery of plutonium to analytical laboratories in support of DP Site. The enriched uranium operations continued in D Building.

The documented evidence reveals the shortage of plutonium and enriched uranium during and after the war. The process descriptions from the period provide independent evidence that all uranium and plutonium solutions, process equipment, and incidental materials that came into contact with uranium and plutonium were recovered to the extent possible. Purification and recovery processes recorded uranium and plutonium at the milligram level. Every effort was made to conserve uranium, plutonium, polonium, and other radioactive source materials. No process equipment such as uranium and plutonium purification crucibles were disposed of because of the extensive recovery operations. Other process equipment, such as the Hanford plutonium solution shipping containers, were dried, sealed, the exteriors decontaminated, and returned to Hanford. All uranium and plutonium lathe turnings, casting skulls, and other metals and oxide residues generated at D Building and Tech Area buildings were either recovered or stored for future recovery at DP West.

Spills were decontaminated and the materials submitted to recovery. In November 1947, a contamination accident occurred in D Building when a bottle containing approximately 2 g of enriched uranium in 5 gal. of residue solution was broken and the solution spread over a large portion of the room. The solution was recovered and the floors mopped. After the floors had dried, no detectable contamination was found (LASL 1947, 095333). However, in January 1947, two accidents occurred in D Building in which plutonium was lost. The first occurred on January 16 when a worker broke a pipette and approximately 70 mg of plutonium in 300 mg of solution were spilled on the worker's protective clothing and none was recovered (Armstrong 1947, 097492). The second occurred on January 23 in the basement of D Building when a worker broke a 5-gal. bottle containing 6 mg/L plutonium. Approximately 30 mg was spilled on the ground and determined to be unrecoverable (Drager 1947, 097491). In both instances, the contaminated clothing and soil were buried in the contaminated dump (MDA B).

In 1945, procedures were established for handling contaminated objects (including glassware, laboratory equipment, protective clothing, and gloves) to minimize the spread of contamination (Tribby 1945, 095305). The September 1945 CM Division progress report stated that no apparatus that came into D Building or any other contaminated facility was to be returned to stock (LASL 1945, 095340). The

“Health Program for D Building Laboratory Areas” report (LASL 1947, 095328) documented the controls for contaminated property and wastes. No transfer of equipment or materials was to be made, except through the H1 Group, with proper tagging and clearance from the property office. Criteria were formally established for contaminated materials and equipment to be returned to the stockroom (no detectable contamination by swipe or direct reading), for hot storage (no counts over 500 cpm or >0.1 milli-Rem/hour [mR/h]), for other contaminated areas (according to respective area requirements), and for materials to be rejected for reuse and to be sent to MDA B. No transfer was allowed between the plutonium and polonium areas. All equipment and materials that could not be decontaminated to meet requirements was to be condemned and buried, but such items first required clearance through the property office. No property records, however, have been located from this era. Equipment was to be properly boxed or crated, sealed, tagged, and transferred to the disposal site by specially assigned contaminated-truck and transfer personnel. The disposal was monitored and supervised by the H1 Group. All waste and trash from the D Building contaminated area were considered contaminated, and all waste and trash were to be thrown into the “hot” receptacles that were placed in each laboratory (LASL 1947, 095328).

Beginning in April 1945, the CM-12 Group was responsible for monitoring and decontaminating personnel and equipment and for disposing contaminated items. The CM-12 Group shared responsibilities with the H1 Group.

- May 1945: D Building was cleaned, and contaminated material was separated from uncontaminated items; expendable materials were sent to MDA B. Twenty boxes of contaminated materials were sent to storage for later reuse, 30 boxes of contaminated materials were cleaned, and 30 boxes of glassware were sent to the glass-washing shack for cleaning (LASL 1945, 094536).
- August 1945: The report stated that during the week of August 20–25 about 900 pieces of contaminated glassware were washed and that over 50% required more than one washing (LASL 1945, 095340).
- October 1945: The contaminated laundry was completely removed from the original technical area and the equipment was transferred to DP Site. The former laundry building D-2 was remodeled as a dedicated central glass-washing facility (LASL 1945, 095342).
- January 1, 1946: The glass-washing facility (one room) had been remodeled and new equipment installed. Storage for clean and contaminated glassware was possible (LASL 1946, 095343).
- May 1946: The tolerance value for glassware of 50 cpm was lowered to 0 cpm, and few pieces were being lost even at that low value; 2000 pieces of glassware were washed, of which 250 pieces required rewashing before being brought to the new tolerance. Fifty pieces were destroyed by burial because of “inaccessibility of parts to cleaning or monitoring, or because decontamination was impossible” (LASL 1946, 095309).
- July 1946: It was reported that the glass-washing building would be used for the decontamination of valuable equipment, gas cylinders, and liquid air cylinders as well as glass washing. New types of decontamination equipment were to be installed in the hope of salvaging valuable pieces of apparatus by cleaning to tolerance levels. Such equipment was to be returned to the laboratories or stored in the “contaminated warehouse” for future use. Unclaimed glassware found to be contaminated was destroyed by burial. Approximately 500 pieces were returned to laboratories in D Building, but approximately 750 other pieces of glassware were found to run from 250 cpm to infinity and were buried (LASL 1946, 095311).

In September 1945, after the cessation of combat activities overseas and the termination of plutonium purification activities in D Building, several chemical hoods were dismantled and sent to MDA B

(LASL 1945, 095341). These were likely standard chemistry-lab type hardwood cabinets and fume hoods constructed during the war that were being replaced by stainless-steel furniture obtained after the war had ended. Figures 3.3-1 and 3.3-2 show typical laboratory furniture and equipment used in the purification and reduction operations in D Building. All laboratory furniture, such as cabinets and fume hoods, and exposed walls and floor surfaces, were wiped routinely to control airborne contamination and after spills to recover the radioactive materials. The cloths, rags, and cleaning solutions were sent to recovery. A broader cleanup of the original technical area occurred at this time. The start-up of the polonium and plutonium operation in the new DP Site resulted in the dismantling of equipment in D Building used during the war and led to the disposal of that equipment at MDA B. In late 1945, the reorganization of the uranium metal production and chemistry group led to the installation of new equipment for processing purified uranium oxide. It is assumed that older, contaminated equipment was disposed of at MDA B. In December 1946, it was reported that a sharp decrease was detected in the personnel contamination levels as measured by nose swipes; this was attributed to the decreased activity in D Building and the fact that fewer dismantling and reconversion operations were being carried out in the contaminated rooms (LASL 1946, 095316). In May 1948, Room 16 in U Building was dismantled and new wall and floor areas installed, with the dismantled equipment very likely disposed of at MDA B. Room 119 in D Building was also dismantled and rebuilt to include special hoods and dryboxes (LASL 1948, 095284). (Note: dryboxes are now referred to as gloveboxes).

Liquid wastes from the Manhattan Project era (1944–1947) activities in D Building and associated activities in the M, T, U, H, and Sigma Buildings consisted of sanitary and industrial process water and possibly contaminated chemicals, such as trichloethylene used for cleaning turnings. All of the plutonium and uranium purification solutions were retained and the materials recovered. The recovery of plutonium in D Building and other plutonium operations in the original technical area generated recovery solutions, with approximately 0.1 mg/L (10^{-4} g/L) plutonium considered unrecoverable (LASL 1969, 095300). Residual uranium recovery solutions reportedly contained an average of 60 mg/L that was considered unrecoverable. A November 1944 memorandum estimated that 100 L of waste solution that contained roughly 10 mg of enriched uranium would be disposed of (Lipkin 1944, 095301). By comparison, in December 1948 approximately 300 gal. of solution containing 4.2 mg of enriched uranium were discarded (Jette 1948, 094349). Until 1949, liquids with plutonium and uranium below the discharge limits were released untreated to Pueblo Canyon through an industrial waste line, known as the acid waste line, connected to the D, M, T, U, and Sigma Buildings in the original technical area. Los Alamos Canyon to the south received the contaminated mop and wash water from the laboratory buildings and the laundry adjacent to D Building. Some liquid wastes were probably dumped down the sanitary sewer drains.

The “Health Program for D Building Laboratory Areas” report (LASL 1947, 095328) outlined the control for ordinary chemicals, mercury, and precious metals. Chemicals were not to be returned to the stockroom once they had been in contaminated areas; the chemicals were to be reported to the H1 Group and disposed of by destruction methods (e.g., burial). Mercury and precious metals were to be processed by a salvage system by which the materials were to be returned to the D Building shipping-and-receiving room when they became surplus (LASL 1947, 095328). Los Alamos Scientific Laboratory Notebook No. 1743 (LASL 1948, 095286) recorded pick-ups of contaminated cleaning solutions from D Building in January 1947 and chemicals from U Building in September 1947. The CMR monthly reports commonly noted the use of water-soluble cutting oils; diethyl ether; acetone; paints and solvents; hydrogen peroxide; aqua regia; and sulfuric, nitric, citric, hydrochloric, trichloracetic, and oxalic acids. Bottles of chemicals are assumed to have been disposed in MDA B as part of laboratory upgrades.

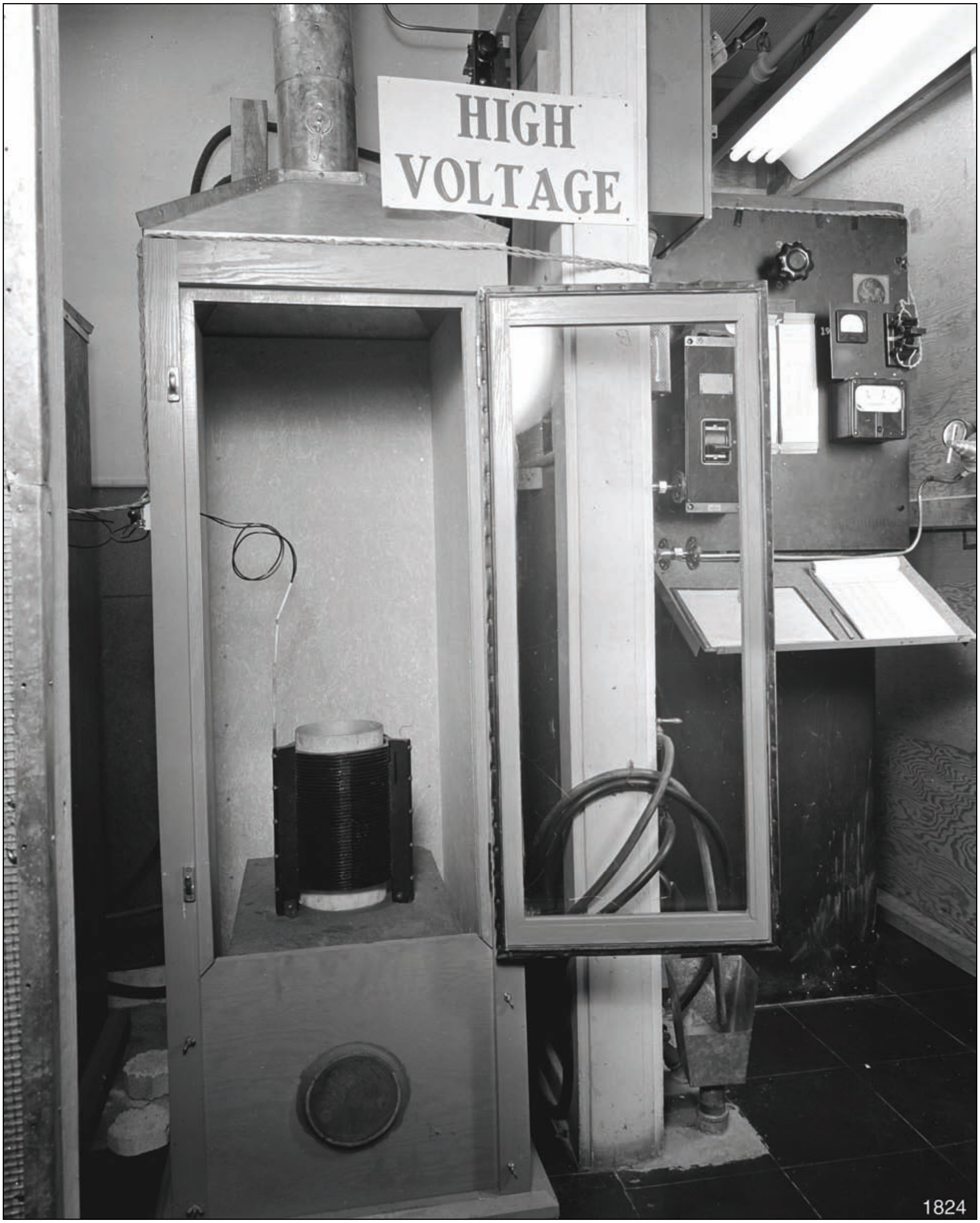

Figure 3.3-1. Induction furnace inside a wooden fume hood and galvanized vent pipe that pre-dated stainless-steel equipment obtained after the war; notice plywood construction in adjacent area (LANL photograph IM-9: 1824)

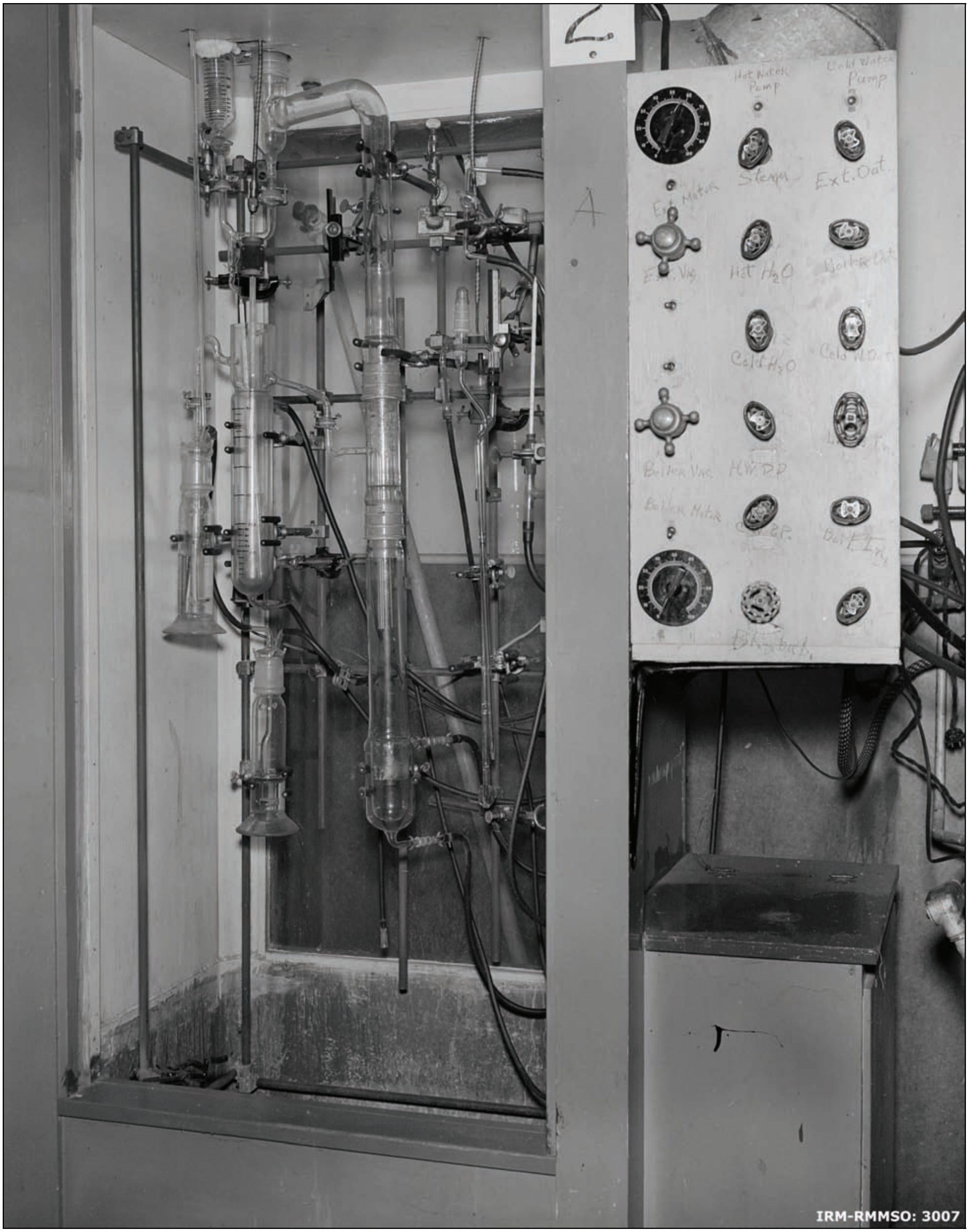

Figure 3.3-2. Typical wet chemistry apparatus in D Building (LANL photograph IM-9: 3007)

4.0 DP SITE OPERATIONS, 1945–1948

Until 1945, all chemical and metallurgical processes of plutonium and polonium were performed in D Building and in attached or adjacent buildings in the original technical area. A fire in the ceiling of the machine shop (C Building) in January 1945 raised awareness of the considerable hazard of working with larger quantities of plutonium. It was decided to construct a new fireproof facility at DP Site, an area removed from the post's living quarters. The construction of DP Site started in April 1945, and polonium and plutonium operations were transferred from the original technical area in the fall of 1945. DP Site was divided into DP East and DP West, for polonium and plutonium operations, respectively. The major facility at DP East was the laboratory in Building 52 and the air filtration plant in Building 53. In DP West, the main processing buildings were the laboratories in Buildings 21-2, 21-3, 21-4, and 21-5; the air filtration plant in Building 12; and many small support structures. The majority of the buildings were of standard design and construction, but the main processing facilities were constructed so that the buildings and equipment would be as fireproof as possible, exposed surfaces could be easily decontaminated, and a high-capacity ventilation system would maintain low air contamination levels (LASL 1947, 095323). This section describes the early Laboratory's polonium and plutonium purification and recovery operations at DP Site and the potential wastes from those operations.

4.1 Polonium Purification and Fabrication at DP East, 1945–1948

The polonium processing was transferred from H Building in October 1945. Polonium-210 was separated from its parent bismuth at the Dayton, Ohio, units, operated by Monsanto Chemical Corporation, after irradiation and activation at one of the Hanford reactors. Monsanto prepared the polonium-210 on thin platinum foils and shipped them to LANL. LANL chemically purified the received materials and fabricated small polonium-210 and beryllium neutron generators for use as weapons initiators. Polonium-210 has high alpha-radiation activity and a half-life of approximately 138 days. The excess polonium was collected and returned to Dayton for recovery. Much of the specific information concerning these devices remains classified. The operations within Building 52 (Figure 4.1-1) largely mirrored those in H Building; the polonium processes remained a small batch process conducted on a benchtop scale in laboratory glassware. A glass-washing room was set up at DP East to decontaminate the materials used and to prepare them for reuse. The Building 52 laboratory was equipped with fume hoods and dryboxes to isolate workers from the active materials. The hoods were exhausted through Building 53, which was equipped with filters and electrostatic particle separators locally termed precipitrons, or electromatic filters. Some DP East research was focused on the chemistry of actinium salts and metal, but this is poorly documented.

4.2 Plutonium Purification and Fabrication at DP West, 1945–1948

The first plutonium was processed at DP West (Figure 4.2-1) on October 19, 1945. By the time plutonium purification and recovery operations were transferred from D Building to DP West, the tolerances for light-element impurities had been relaxed as a result of knowledge gained from plutonium chemistry research. Research on the purification process to eliminate the ether-extraction steps was completed, and the oxalate extraction process was adopted entirely by July 1946. Plutonium was received at LANL as a thick syrup of plutonium nitrate and water from Hanford. The syrup was contained in a stainless-steel container, referred to as a steel bomb due to its shape (Figure 3.2-1). Upon receipt, the bomb was removed from its shipping box, submitted to decontamination on the outside, and either stored or sent to purification. The contents were weighed, an analytical sample was obtained to determine the amount of plutonium in solution, and the contents were removed. The dry, empty bomb and cap assembly were returned to the decontamination room, where they were cleaned on the outside, placed in a carrying case, and returned to the shipping room for shipment back to Hanford. In August 1947, a disposable cap and plug for the Hanford shipping container was designed that eliminated all threads (LASL 1947, 095327). Figure 4.2-2 is a reproduction of the plutonium plant flow sheet (LASL 1947, 095323), graphically depicting the processes sequence at DP West.

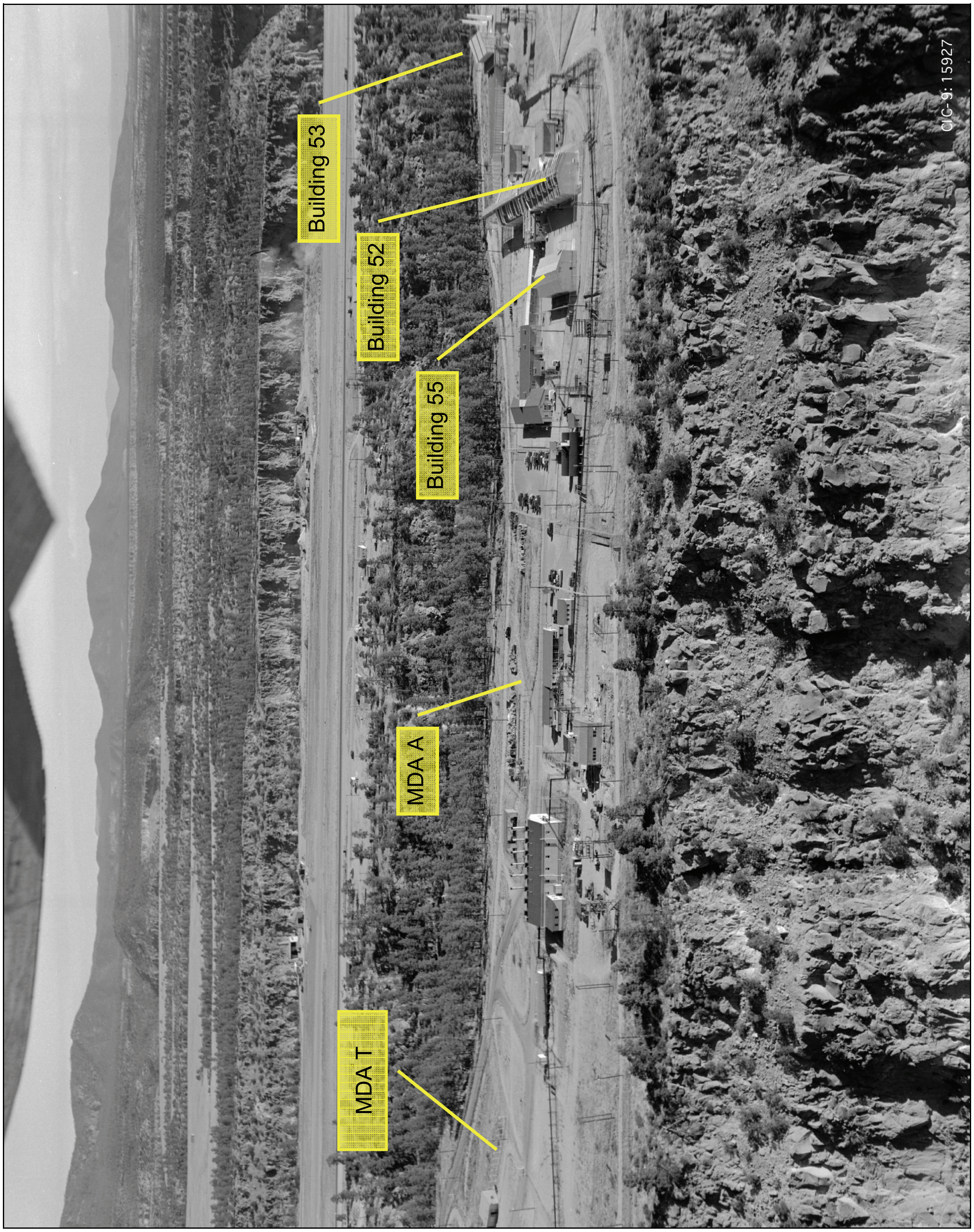

Figure 4.1-1. DP East; September 12, 1950; view to north; notations added (LANL photograph IM-9: 15927)

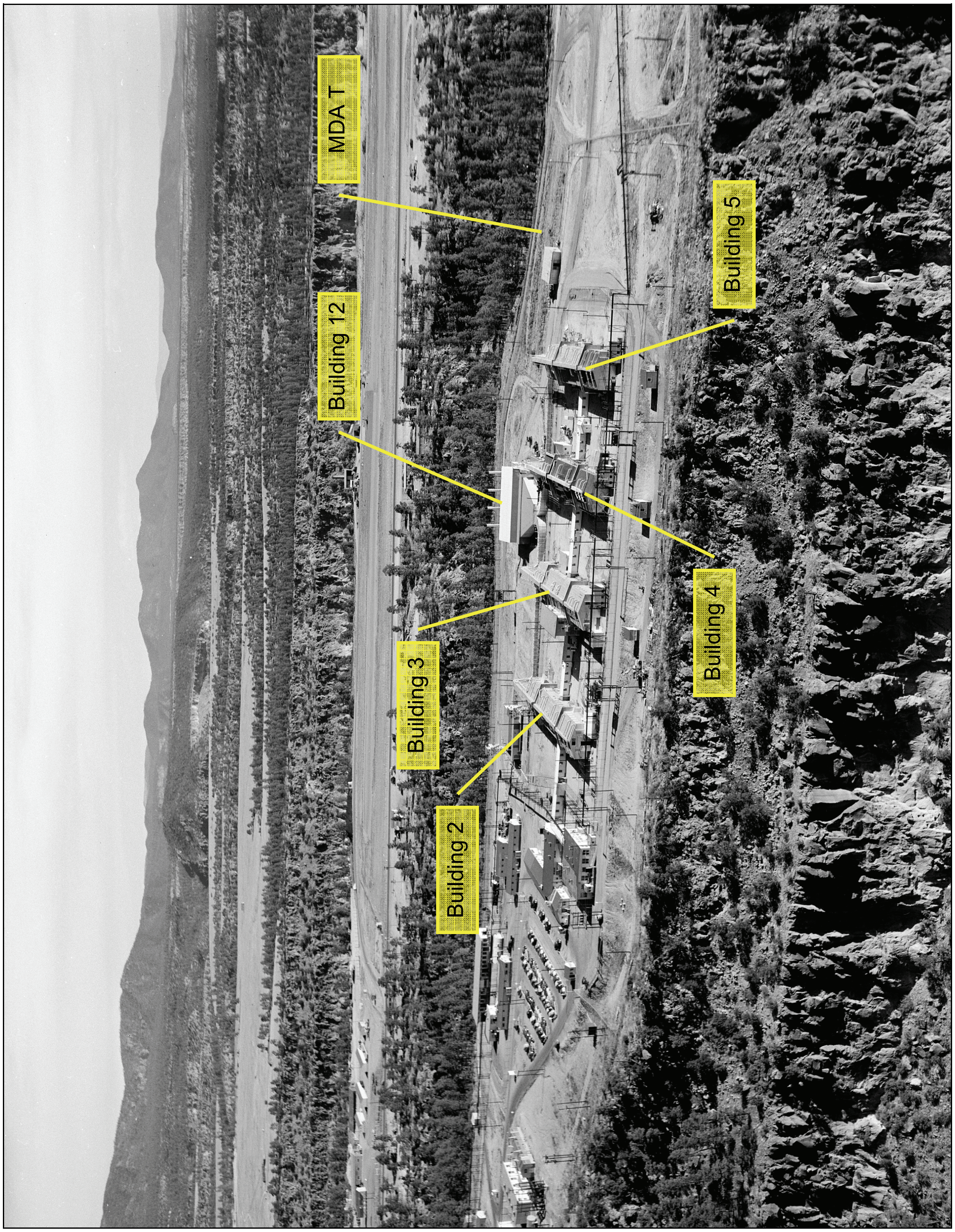

Figure 4.2-1. DP West; September 12, 1950; view to north; notations added (LANL photograph IM-9: 15926)

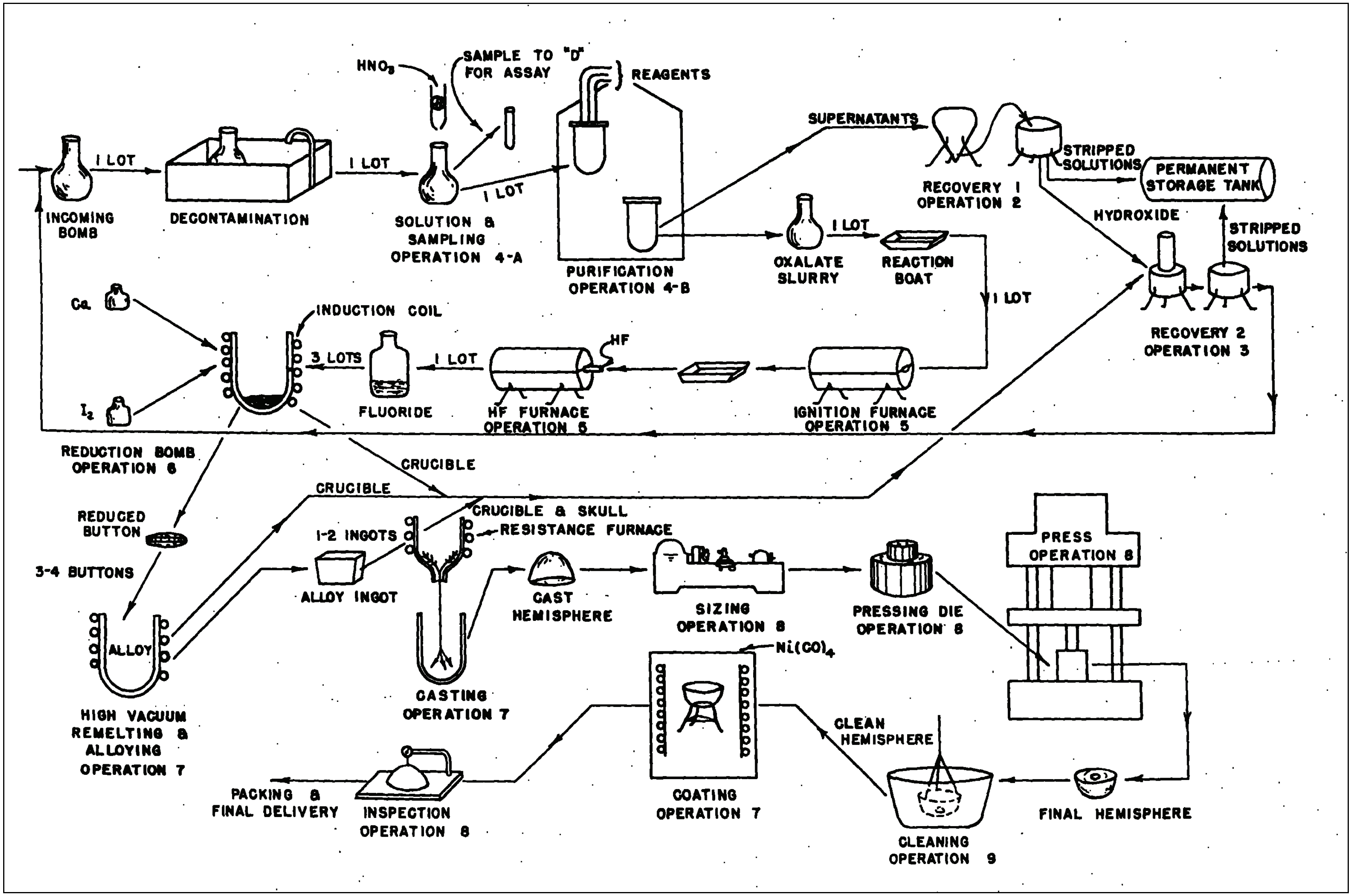

Figure 4.2-2. General plutonium process flow sheet for DP West. The permanent storage tank refers to the General's Tanks (LASL 1947, 095323)

As the purity of the incoming materials from Hanford improved, the purification processes were simplified. The processes are described in "Chemistry of Uranium and Plutonium" (LASL 1947, 095323) and "Plutonium Processing at the Los Alamos Scientific Laboratory" (LASL 1969, 095300). The DP West operations from late 1945 to 1948 represent the pilot scale and production plant start-up of purification and production of metallic plutonium from the Hanford-supplied nitrate solutions. DP West was the result of the lessons learned from the initial operations in D Building during the war. All of the equipment was designed so that an operator never handled the products in open air. Sealed tanks were used in the wet chemistry operations, and material transfers were made by evacuation of the receiving vessels to avoid pumping spills and spray from leaks. The dry chemistry and metallurgy were performed in chemical hoods or dryboxes, now termed gloveboxes. Nevertheless, the procedures and processes continued the practice of extraordinary precautions against loss or severe hold-up of the immeasurably precious isotope plutonium-239 (LASL 1947, 095323).

The plutonium solutions were processed through a series of chemical extraction and purification steps. The standard size lot was 160 g, but several processes were conducted concurrently to increase production. A lot was not purified until radioassay showed the lot to contain the correct amount of plutonium. The supernatants resulting from the purification processes contained plutonium in the range of 1–5 mg/L that was considered too great to store if suitable recovery methods were available (LASL 1947, 095323), hence all supernatant solutions and washes from the purification processes were returned to recovery (Figure 4.2-2). In June 1946, 149 lots of Hanford solution were processed, 82 by the ether-extraction procedure, and 67 by the single-oxalate procedure. The shortened oxalate procedure was then authorized for future purification work (LASL 1946, 095310).

After purification, the plutonium solutions were subjected to a hydrofluorination process and then reduced from the fluoride to metal in dry conversion processes. The hydrofluorination was conducted with anhydrous hydrogen fluoride that was redistilled and tanked in 80-lb (hydrogen fluoride) iron cylinders from the Kinetic Chemical Company of Wilmington, Delaware (LASL 1947, 095323). The plutonium metal was purified through remelting under a vacuum, alloyed as required, formed into shapes, and coated for oxidation protection. All metal castings skulls (excess pour materials) and metal turnings and other excess materials were returned to recovery (Figure 4.2-2). By February 1946, the DP West plant was reportedly operating smoothly. Metal reductions yielded a calculated average of 98.5%, and one reduction to which oxidized turnings were added gave a yield of 96.5% (LASL 1946, 095345). In June 1946, comparisons of plutonium metals reduced by the ether-extraction procedure and the single-oxalate procedure yielded 98.7% and 97.5%, respectively. The results of the new single-oxalate procedure were consistent with impurities in the reduction and doubled the amount of plutonium returned to the recovery process, but they did not change the number of liners submitted (LASL 1946, 095310).

Purification operations did not include the removal of americium-241 until after July 1948. As early as 1945, americium-241 was known as a radiological contaminant in plutonium-239 that resulted from the decay of plutonium-241. Plans to design and build an americium-241 purification facility were discussed as early as January 1947 (LASL 1947, 095319), but the first microgram separations of americium-241 did not occur until July 1948 (LASL 1948, 095283).

4.3 Plutonium Recovery at DP Site, 1945–1948

The plutonium recovery processes were developed for the purpose of concentrating and partially purifying plutonium-containing residues received from all of the plutonium processing and research operations in preparation for final purification. Figures 4.3-1 and 4.3-2 show the plutonium-purification process residues and the plutonium recovery processes used at DP West (LASL 1947, 095323). The primary task was the recovery of small amounts of plutonium from large amounts of other elements. The need to recover plutonium from purification residues drove the expansion of metallurgical and chemical research programs at DP West. The recovery processes of the early DP West operations are described in "Chemistry of Uranium and Plutonium" (LASL 1947, 095323).

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Table 5.6-2

Standard B-2 Purification Process Residues (Per Nominal 160-g Run

P-1(b)

Portion Unextracted by Ether (Total Volume = 7.50 liters)

0.27 M H^+	2.06 moles
2.72 M Ca^{++}	21.00
0.06 M Na^+	0.45
0.003 M Fe^{+++}	0.022
0.0004 M Ni^{++}	0.003
0.003 M La^{+++}	0.022
0.0009 M $H_2PO^{-}_{--}$	0.007
0.0002 M Cr_2O_7	0.0015
5.77 M NO_3^-	43.30
0.03 M BrO_3^-	0.225
0.04 M $CaSO_4$	0.30
0.00009 M PuO_2^{++}	0.0006

$SiO_2 \cdot xH_2O$, $SnO_2 \cdot xH_2O$ (0.3 g)

Total Pu = 160 mg

P-*

Alkaline Bubbler Wash (Total Volume = 1.50)

4.50 M Na^+	6.75 moles
0.92 M SO_3^{--}	1.38
2.34 M OH^-	3.51
0.08 M SO_4^{--}	0.12
0.16 M Br^-	0.24

P-2*

Wash Solution from Ether Extraction Apparatus (Total Volume = 11.50 liters)

Traces of H^+, NO_3^-, Ca^{++}, PuO_2^{++}

P-3(b)

Supernatant from Oxalate Precipitation (Total Volume = 29.40 liters)

2.00 M H^+	58.80 moles
0.0001 M Cr^{+++}	0.0029
0.10 M I^-	2.94
0.003 M I_3^-	0.088
1.87 M NO_3^-	55.00
0.07 M $H_2C_2O_4$	2.06
0.0002 M Pu^{+++}	0.0056

Total Pu = 1340 mg

P-*

Acid Bubbler Wash (Total Volume 1.70 liters)

0.88 M H^+	1.50 moles
0.88 M NO_3^-	1.50

Total Pu = 1 mg

* The acid bubbler wash, alkaline bubbler wash and wash of the extraction apparatus are so low in Pu content that they may be discarded into the water tanks.

Figure 4.3-1. Reproduction of the standard plutonium purification B-process residues per nominal 160-g run. The term "water tanks" in the footnote was a typographical error and should have referred to "waste tanks" (LASL 1947, 095323)

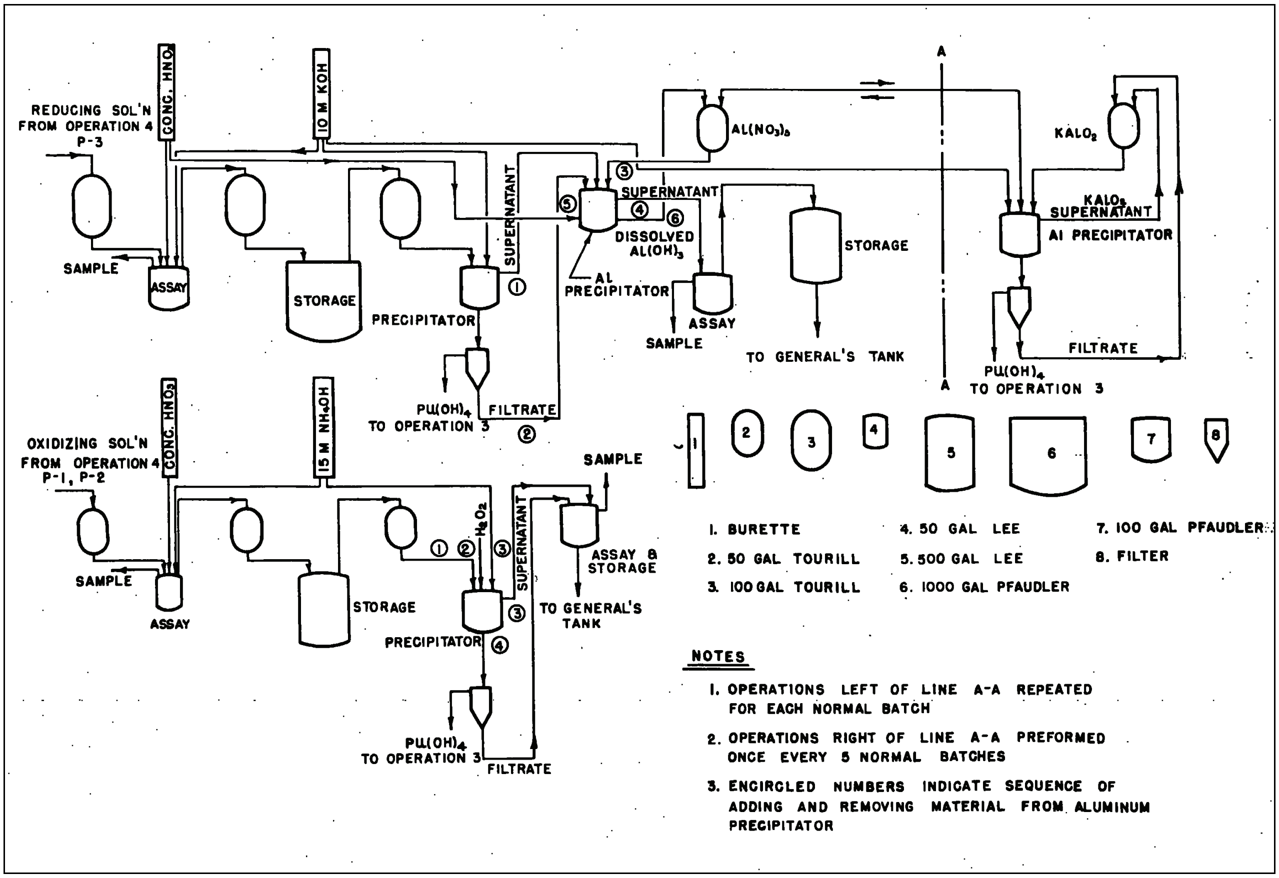

Figure 4.3-2. Reproduction of the plutonium recovery plant flow process (LASL 1947, 095323)

In developing the methods for dissolving the various materials that were sent to recovery, it was necessary to consider the problem of dissolving not only any known compound of plutonium, and some which were unknown, but also various metals, refractory materials, organic compounds, and other miscellaneous items. Materials that were returned for recovery fell into one or more of the following categories:

- solid samples in which the plutonium was in a form capable of being preferentially dissolved, such as plutonium that adhered to platinum foils, glass plates, and glass wool;
- solid samples in which preferential solution was impossible or the inorganic impurity prevented the plutonium from being washed out, such as plutonium metal coating on aluminum foil or in porous magnesium oxide crucibles;
- solid samples in which the plutonium compounds were mixed with organic matter that precluded mechanical separation, such as wood shavings, drybox sweepings, and tissue paper;
- solutions of plutonium salts that contained organic material of low volatility, such as analytical samples or samples containing glycol;
- solutions of plutonium salts that contained organic material of high volatility, such as acetone or ether-and-water mixtures;
- solutions in which plutonium salts were too dilute for recovery, such as assay samples that had been diluted (these were evaporated to increase the concentration);

- solutions of hexavalent or trivalent plutonium, such as hexavalent nitrate for purification or trivalent chloride from analyses; or
- suspensions of plutonium compounds in certain oils, such as cuttings oils and silicone.

The “Chemistry of Uranium and Plutonium” report (LASL 1947, 095323) noted that it was almost impossible to make definite statements concerning the losses of plutonium in the recovery processes. However, no solutions were discarded. From 1946 to 1947, all basic supernatants were radio-assayed and solutions containing approximately 1 mg/L (10^{-3} g/L) were transferred to one of two 50,000-gal. underground storage tanks, known as the General’s Tanks, built at the direction of General Groves, within the boundary of what is now MDA A. The two underground tanks were constructed in late 1945 to store recovery residues from plutonium operations at DP West that contained small concentrations considered too great to discard without further investigation. The two tanks received recovery solutions from which no further recovery was then possible (Hempelmann 1944, 095418). The recovery processes included the supernatant from an ammonia hydroxide treatment that contained $\leq$1 mg/L plutonium, very large quantities of the salts of magnesium and calcium, and the supernatant from the sodium hydroxide precipitation process that had little plutonium and no magnesium or calcium. The high salt concentrations made accurate assay unlikely, and it was stated that because of the inaccuracy somewhat larger amounts of plutonium may have been stored than what was indicated by the assays. Waste solutions sent to the General’s Tanks also included the acid and alkaline rinse solutions of the recovery apparatus and the rinse of the ether-extraction columns (Figure 4.3-1; LASL 1947, 095323). A 1971 memorandum stated that, based on available records, 344 grams of plutonium and americium had been transferred to the 2 tanks during the 1946 – 1947 timeframe (Gibson 1971, 092456).

In the late 1940s it was apparent that the storage of the basic solutions in the General’s Tanks could not continue, due to the large volumes and the capacity of the tanks. Investigations were thus conducted to determine methods of recovery of dilute concentrations of plutonium and the reduction of concentrations to meet the tolerance limits for release to the canyons. Research continued on the recovery of low concentrations of plutonium from solutions for which ordinary recovery methods were impractical, but that were too high in plutonium content to permit discarding. By April 1947, a small evaporator was installed in the recovery operations to increase the concentration of plutonium in dilute, aqueous solutions (LASL 1947, 095329), and by October 1947, three evaporators were reportedly operating (LASL 1947, 095330). In November 1948, 1,568 L of solution were concentrated to 4 L that contained 34 g of plutonium (Jette 1948, 094349). Ultimately, the residual solutions stored in the General’s Tanks were never recovered and remain in the tanks at this writing. (Note – see interview with Wilber McNeese below and Appendix E that confirms these reports)

By February 1946, the recovery group reported that all of the supernatant solutions supplied by the purification operations had been processed as well as 400 gal. of solutions that had been transferred from D Building (LASL 1946, 095345). In March 1946, the recovery group had processed all solutions supplied by the purification operations. Vessels and pipes containing oxalate supernatant from purification were washed with concentrated hydrochloric acid, and about 100 g of plutonium were recovered (LASL 1946, 095308). In July 1946, the recovery group reported the processing of 2,700 gal. of oxalate supernatant from the purification operations. The results indicated that from July 1 to July 15, 1946, 86.6 g of plutonium were received, and 84.7 g had been recovered for a yield of 97.8% (LASL 1946, 095312).

Small volumes of other than the basic recovery solutions were reportedly stored in large glass bottles (LASL 1947, 095323) that ranged from 2-L to 9-L capacities. A complete inventory of the recovery residues was conducted in March and April 1948 (LASL 1948, 095280; LASL 1948, 095281), and separate reports were prepared, but these reports have not been located. The typically aqueous solutions had high iron concentrations and included some solutions from unsuccessful recovery processes that had been saved since the war (LASL 1950, 095293). Many solutions had solids that were reportedly inevitably present in the materials stored for any period of time. Some had grown mold, so phenol was added to inhibit the mold (LASL 1948, 095287). In October 1948, a set of 2-in. glass columns was installed in Room 213, and the preliminary testing on cold solutions was complete. Samples of six bottles of stored solutions indicated iron concentrations of 0.2 to 8.0 g/L and plutonium concentrations of 2.3 to 48.7 g/L. The solutions were similar enough that they could be mixed to create one feed solution for the column-separation process. By May 1949, the recovery solutions from storage had been processed through the ion-exchange columns, with recovery of 90% to 99% of assay. Plutonium was to be precipitated from the effluent by a peroxide treatment. Peroxide precipitation followed by ion exchange was found to remove 99.95% of the plutonium from a sample stored solution (LASL 1950, 095293) and left concentrations of 10^{-5} to 10^{-6} g/L plutonium. In February 1950, laboratory testing was complete and large-scale processing of the stored plutonium solutions was to begin when the equipment in Room 201 had been installed. By May 1950, the peroxide precipitation and ion-exchange methods had yielded a recovery of 99.995% of the plutonium and the wastes could be discarded with 10^{-6} g/L plutonium, considered the discard concentration of plutonium (LASL 1950, 095294). (Note – see interview with W. McNeese Section 4.6)

Contaminated mercury was also assigned to the DP West production group (CMR-11) in January 1948. CMR-11 designed, constructed, and installed a distillation unit for contaminated mercury (LASL 1948, 095277). By February 1948, 700 lb of contaminated mercury received from the stockroom had been combined into 30-lb storage units. To that date, 25 lb of mercury had been distilled and had been cleaned. The plutonium concentration in that batch was lowered from 10^{-5} g/L to 10^{-8} g/L, which indicated that the efficiency of the distillation apparatus was high (LASL 1948, 095279).

4.4 DP Site Exhaust and Filter Buildings, 1946–1948

At DP Site, the polonium and plutonium operating areas in DP East and DP West, respectively, had air engineered exhaust handling systems as part of the site design. At the operating buildings air from the outside was drawn into the buildings by intake fans. This air was filtered and distributed to the operating rooms by ducts which entered the rooms at the ceilings. The exhaust air left the rooms by ducts leading into a large common duct located on the roof of each building. All dryboxes and hoods were vented into these common exhaust ducts. The exhaust fans created a negative pressure in the dryboxes and hoods. At DP West, each of the 4 process buildings had an exhaust duct that converged into a common manifold at Building 21-12, where the exhaust air passed through a set of electromatic air filters supplied by the American Filter Company, then through a set of matted, paper filters before being discharged by exhaust fans and out the 57-foot stack. The electromatic filters were separated into 5 sections of 4 units each that could be isolated for maintenance and cleaning, each section had an exhaust fan and a stack. At DP East, Building 21-52 had a single exhaust duct to Building 21-53 where the exhaust air passed through a similar set of electromatic air filters, through a set of paper filters before being discharged by exhaust fans and out the stacks. The electromatic filters were separated into 3 sections of 3 units each that could also be isolated for maintenance and cleaning, and each section had an exhaust fan and a stack (Meyer 1948, 096494; van Winkle 1946, 0095884). The general stock inventory (section 9.0) from 1946 lists rolls of American air filter paper.

The plates on the electromatic air filters were reportedly self-cleaning through an oil drip system, but a good part of the dust entering the filters was collected on the wire screens in front of the filters, termed ionizer wires. A procedure for cleaning the electromatic filters was compiled in March 1946 that recommended that the filters be cleaned about every 3 months. The cleaning was to be performed with an Electrolux vacuum cleaner. At the end of each cleaning, the dust bag and any rags used were to be placed in a small paper bag, sealed as tightly as possible, and disposed of in the contaminated dump (van Winkle 1946, 0095884).

Troubles were noted with the stack filters as early as 1947. A CMR-12 monthly group report of the fall of 1947 indicates that measurements of plutonium in stack emissions were exceeding the accepted tolerance (e.g., LASL 1947, 095333). A series of tests and measurements were conducted on the DP West exhaust stacks that concluded that the air entering the electrostatic filters was not uniform, so that some of the units were overloaded and some were not working to full capacity. Tests were also being conducted to determine how much contamination was removed in the electrostatic filters and how much was removed by the paper filters (LASL 1948, 095883). The paper filters used in the filter buildings were a low efficiency paper. High efficiency particulate air (HEPA) filters were not used until 1949 after tests were performed on filter papers received from the U.S. Army Chemical Warfare Service (CWS). The results of the preliminary tests indicated that efficiency of removal was much greater than with the electromatic air filters (LASL 1949, 095882). (Note - see former employees interview section 4.6)

4.5 Wastes from DP Site Operations, 1945–1948

The documented evidence reveals that the shortage of plutonium and other critical materials continued during the start-up of the newly constructed DP Site after the war. The plutonium operations at DP West were at the pilot plant scale, whereas the operations at D Buildings had been at the bench scale. Polonium operations at DP East largely remained at the bench scale. All plutonium solutions, process equipment, and all incidental materials that came into contact with plutonium were recovered to the extent possible. Purification and recovery processes recorded plutonium at the milligram level. Every effort was made to conserve uranium, plutonium, polonium, and other radioactive source materials. No process equipment, such as plutonium reduction crucibles, was disposed of because of the extensive recovery operations. Other process equipment, such as the Hanford plutonium solution shipping containers were dried, sealed, the exteriors decontaminated, and returned to Hanford. All plutonium lathe turnings, casting skulls, and other metals and oxide residues were recovered. Excess polonium was collected and returned to Dayton, Ohio for recovery.

Daily pick-ups of contaminated trash were recorded from DP East and DP West in 1947 and 1948 in Los Alamos Scientific Laboratory Notebook No. 1743 (LASL 1948, 095286). Based on process descriptions wastes from the early DP Site operations (1945–1948) consisted of contaminated clothing; gloves; glassware; equipment and laboratory apparatus, such as empty gas cylinders (argon, oxygen, helium, and nickel carbonyl were noted); building demolition debris; ordinary trash and paper from the laboratory areas in Buildings 21-2, 21-3, 21-4, 21-5 in DP West and Building 21-52 in DP East; and oils and filter paper changes from Buildings 21-12 and 21-53, in DP West and DP East, respectively. Since polonium has a half-life of 138 days all contamination from the 1940s has decayed away.

In 1947, the H1 Group published a procedure for the control of contaminated property and wastes (Tribby 1947, 095306). No transfer of equipment or materials was to be made, except through the H1 Group, and everything required proper tagging and clearance by the property office. Criteria were formally established for contaminated materials and equipment to be returned to the stockroom (no detectable contamination by swipe or direct reading), for hot storage (no counts over 500 cpm or 1mR/h), for other contaminated areas (respective area requirements), and for materials rejected for reuse and to be submitted to MDA B. No transfer was allowed between the plutonium and polonium areas. All equipment and materials that could not be decontaminated to meet requirements was to be condemned and buried, but such items required clearance through the property office. No property records, however, have been located from this era.

Equipment was to be properly boxed or crated, sealed, tagged, and transferred to the disposal site by the specially assigned contaminated truck and transfer personnel. The disposal was monitored and supervised by the H1 Group. All waste and trash from the CMR Division laboratories was considered contaminated trash, and all waste and trash was to be thrown into the “hot” receptacles that were placed in each laboratory (Tribby 1947, 095306). Although no specific disposal records were maintained during the operational period of MDA B, the disposal of contaminated equipment and property items were reported monthly in the CM/CMR Division progress reports. Some portions of these reports remain classified, but some portions have been declassified for this report.

- September 1946: It was found impossible to decontaminate six gas cylinders, and they were disposed of by burial at MDA B (LASL 1946, 095314).
- November 1946: Two fisher hot plates were found too contaminated to be cleaned and were disposed of by burial (LASL 1946, 095315).
- December 1946: Recovery equipment in Building 2 was no longer needed and was a source of contamination. The tanks and equipment that were corroded and too hot to be repaired were taken to MDA B (LASL 1947, 095318).
- August 1947: Several unusable dies were placed in double-sealed wooden boxes and turned over to the property section for disposal (LASL 1947, 095327).
- June 1948: All non-disposable-type Hanford shipping container plugs were listed by number, boxed, and buried at MDA B (LASL 1948, 095282).

The decontamination facility at DP West was upgraded in 1948 to facilitate greater recover of equipment, the types of items decontaminated were then reportedly monthly. For example, in March 1946, 89 items were handled by the group, including 27 Hanford containers returned to process, eight empty Hanford containers returned to quantity control, nine hydrogen fluoride tanks returned to stock, six diver suits cleaned, 21 tools cleaned, and 17 glass containers cleaned (LASL 1946, 095308). In September 1948, 76 items were decontaminated so they could be returned to use or released for salvage, including 31 gas cylinders (LASL 1948, 095285). Reports from other months simply listed the total number of items.

The decontamination facility at DP East reported that contaminated glassware and other apparatus were disposed of at MDA B. The report for October 1945 (LASL 1945, 095341) stated that during the month of September 1945, over 2,150 pieces of contaminated glassware were processed and about 60% required rewashing. On September 14, the glassware tolerance from DP East was raised from 500 to 1500 cpm since the percentages of glassware passing the lower limit was so low. In June 1946, however, all of the sinks in the DP East glass-washing room were found to be contaminated. The washing of clean glassware was discontinued, but the washing of contaminated glassware continued. Contaminated glassware requiring disposal remained a contributor of waste to MDA B through 1948, as the following examples indicate:

- June 1946: 634 pieces washed; approximately 30% could not be cleaned to below tolerance (LASL 1946, 095311)
- July 1946: 319 pieces washed; approximately 54% could not be cleaned below tolerance after three washings (LASL 1946, 095312)
- August 1946: 815 pieces washed; 26% disposed of after three washings (LASL 1946, 095313)
- September 1946: 670 pieces washed; 37% disposed of after three washings (LASL 1946, 095314)
- April 1947: 806 pieces washed; 40% disposed of after three washings (LASL 1947, 095321)
- June 1947: 940 pieces washed; 26% disposed of after three washings (LASL 1947, 095326)
- October 1947: 840 pieces washed; 34% disposed of after three washings (LASL 1947, 095331)

In October 1947, it was reported that an agitator and tank assembly for pulping contaminated documents was complete, and that a filter for a vacuum source had been built. After the documents were pulped in water, the pulp was run through the filter so that only a semidried cake was buried (LASL 1947, 095330). By November 1947, the equipment had been put in operation and, with the exception of photostats, all paper could be pulped by use of water alone. Photostats required the use of a caustic solution (LASL 1947, 095332). It is assumed that contaminated documents were buried in MDA B before this date.

Solid media from the DP Site filter buildings may have included filter papers. Low efficiency filter papers were part of the exhaust stack system located after the electromatic air filters in DP East and DP West. An interview with a Wilber McNeese (Section 4.6) indicates that the filter papers were monitored after accidental radioactive material releases and recovered if necessary, but that routine filter changes were not monitored for recovery, because the filters were not very efficient. Some of the filter paper media may have included asbestos materials. The procedure devised to clean electromatic air filters included the use of small vacuum cleaners to clean the screens (van Winkle 1946, 0095884). The dust bags were to be sealed in paper bags and disposed of the contamination dump. D.D. Meyer's June 1949 memorandum indicated that filter papers from the electrostatic precipitators (electromatic air filters) at DP Site were disposed of twice a year at the contaminated dump (Meyer 1949, 036971). It is assumed that routine paper filter changes were disposed at MDA B before it closed June 10, 1948.

The filter house reports by van Winkle (1946) indicate that the oils in the electromatic air filters in DP East and DP West should be replaced every few months. In May 1946, the oil was reportedly drained from the electromatic air filters in the DP East filter building. The oil was taken to MDA B in a trailer and transferred to 50-gal. barrels that were tightly sealed and then were rolled into the trenches (LASL 1946, 095310). Similar oil changes in DP East were reported in August and November 1946 (LASL 1946, 095312; LASL 1947, 095318), so it is assumed this occurred on a regular schedule, but no evidence exists that it did. Los Alamos Scientific Laboratory Notebook No. 1743 (LASL 1948, 095286) records the pick-up of contaminated oil in barrels from DP East on January 28, 1947. There is no record of oil changes from the DP West filter building, but based on practices at the time, it is assumed that oil contaminated with plutonium from DP West was disposed at MDA B every few months. As with the documented oil changes at DP East, the oils from DP West would have been placed in 55- gallon drums.

Liquid wastes from the early DP Site operations (1945–1948) consisted of sanitary wastewater, industrial process solutions, and minor excess chemicals. Most of the plutonium purification and recovery operations were based on aqueous chemistry. Solvent exchanges processes were not in general use until after the close of MDA B in 1948. No central sanitary system was installed at DP Site. Buildings possessed septic systems that drained to tanks and then outfalls along the canyon walls. Some waste solutions were probably dumped down these drains. Other process liquids from plutonium operations, such as the equipment decontamination fluids and waste solutions that met release criteria were released into the absorption beds at today's MDA T through what was termed the chemical or acid waste lines. Overflow from the MDA T absorption beds went to DP Canyon, a tributary to Los Alamos Canyon.

Industrial waste solutions included process wastes from the plutonium purification, recovery and metal finishing operations. The CMR monthly reports noted routine use of acetone; paints and solvents, e.g., trichloroethylene; plastics; hydrogen peroxide; hydrogen iodide; aqua regia; sulfuric, nitric, citric and oxalic acids. Anhydrous hydrogen fluoride was used in the plutonium fluorination process. In 1947 and 1948, bench-scale experiments with thenoyl-trifluoro-acetone dissolved in benzene as a chelating agent for plutonium in dilute solutions were notably unsuccessful (LASL 1948, 095277). Other experiments were performed with mono-butyl ether, hexane, benzene, di-butyl carbital, penta ether, butyl phosphate (LASL 1947, 095319), and hydroxylamine nitrate (LASL 1951, 095298). By 1950, tributylphosphate was used in the recovery process of plutonium. In general, used chemicals and excess process solutions were dumped down the drains destined for the absorption beds. A waste pit for chemicals, not contaminated with radionuclides, located between Buildings 21-2 and 21-3, was used during the 1940s and 1950s. The ether extraction process at DP West was discontinued by June 1946. Wilber McNeese (Section 4.6) stated that in late 1946 excess ether solutions were collected into stainless steel drums and shipped off-site for research purposes.

Contaminated mercury was not simply discarded. The material was assigned to the DP West production group (CMR-11) in January 1948. By February 1948, 700 lb of contaminated mercury received from the stockroom had been combined into 30-lb storage units and to that date, 25 lb of mercury had been cleaned through a distillation unit (LASL 1948, 095277). The plutonium concentration in that batch was lowered from 10^{-5} g/L to 10^{-8} g/L (LASL 1948, 095279). The mercury is assumed to have been re-used.

All solutions and equipment from the plutonium purifications operations were sent back through recovery and were not considered waste. The plutonium recovery processes were reportedly conducted in a manner that made actual material losses unlikely (LASL 1947, 095323). No plutonium recovery solutions were discarded. The recovery of plutonium at Building 21-2 and other plutonium operations in the original technical area resulted in large volumes of basic solutions with approximately 1 mg/L plutonium that were considered unrecoverable given the available technology, so these solutions were stored in the General's Tanks. Once liquid evaporators were successfully placed in operation in 1947, the addition of excess recovery solutions to the General's Tanks was halted and research focused on alternative methods for the recovery of the solutions in storage, as well as methods to meet the tolerance limits for release of waste solutions to the canyons. The evidence indicates that research continued on the dry residues as well, and that methods for the complete recovery of plutonium from the bulk materials were realized in the early 1950s (LASL 1951, 095299) (Note - see interviews with W. McNeese and R. Nance, Section 4.6)

The general standard or tolerance limit for release of plutonium to the environmental was approximately 0.1 mg/L. A 1947 memorandum (Tribby 1947, 001404) provides a detailed account of "fluid waste disposal at D.P. West." The memorandum described three types of fluid waste, the volumes discarded, and the concentration of plutonium in the waste as determined by sample analysis. Wash water from floors, hydrofluorination process aspiration water, and a "bomb" electrolytic decontamination solution were all considered important enough to sample and characterize. The daily waste volume and concentration of plutonium in these waste solutions were 400 L/day and 10^{-8} g/L plutonium for the wash water from floors, 4,000 L/day and 7.2×10^{-4} g/L plutonium for the hydrogen fluoride aspiration water, and 45 L/day and 4.3×10^{-7} g/L plutonium for the bomb electrolytic decontamination solution. These data were used as the basis to determine that plutonium could not be practically recovered from these sources.

The Rogers report (LASL 1977, 005707; LASL 1977, 005708) mentions a small, shallow pit trench used for disposal of hazardous chemicals, but this was poorly documented. An eyewitness account of the early 1980s identified buried glass bottles in a location within the far eastern portion of MDA B (see section 1.3), but the authors of this report are unable to definitively identify the source of these bottles. Clues may be present in the CMR monthly reports, as it was reported that all other solutions that were spent by virtue of accumulated contaminants were stored in large glass containers in Room 213. A complete inventory of the recovery residues stored in Room 213 was reportedly conducted in March and April 1948 (LASL 1948, 095280; LASL 1948, 095281), and separate reports were apparently prepared, but these reports have not been located. In August 1950, Room 213 was cleaned out to make room for a new solvent extraction plant (see interview with W. McNeese, Section 4.6). The recovery materials were reportedly moved to other DP West sites, and "small development units" were transferred to either the "hot dump" or the General's Tanks area (LASL 1950, 095296). It is not known whether the hot dump referred to is MDA B or MDA C on Pajarito Road. Contaminated wastes and trash were sent to MDA C starting in June 1948, but it is possible that the eastern end of MDA B was used for the disposal of these bottles.

There is actually no process evidence that the buried bottles contain plutonium. However, The concentrations of plutonium in residual solutions" may be estimated to be less than 1 mg/L, since the 1-mg/L quantity was still considered too precious to discard or release into the environment. Any solution with concentrations of plutonium much greater than 1 mg/L would have been sent back to recovery. W. Mc Neese and R. Nance (Section 4.6) stated that they worked to recover stored solutions and those with significant amounts of plutonium were recovered. The reference to "small development units" (LASL 1950, 095296) could refer to experiments on the recovery of plutonium from very dilute solutions, the separation of americium-241, or to experiments with rare elements separation such as samarium and neodymium (LASL 1950, 095294). The development of the americium-241 separation process through anion exchange in the late 1940s may have resulted in solutions that had been prepared for americium-241 separation from residual plutonium solutions, but this is poorly documented. The concentrations of americium-241 would have been much less than 1 mg/L, as the americium-241 concentrations were typically 10 to 100 µg/L. The total number and type of buried bottles is unknown, but probably included 2-L and 4-L bottles, some 9-L bottles, and perhaps 20-L bottles, because these were in general use at the time (see interview with Robert Nance below). The total number and types of bottles buried are unknown, but probably included bottles of 4-L, 9-L and 20-L capacity since these were in common use during the 1940s. The smaller bottles would have had ground glass stoppers, some may have been ventilated, and the larger bottles would have had rubber or neoprene stoppers. The volume of solution present in the glass bottles is considered to be relatively small, possibly a few hundred gallons, in comparison with the thousands of gallons of basic solutions stored in the General's Tanks.

4.6 LANL Retiree Interviews Concerning Early DP Site Operations

In preparing this report, it was important to confirm, where possible, the conclusions drawn from the historic record by interviewing former employees who worked at DP Site in the 1945 to 1948 timeframe. The following is a summary of an interview with Wilbur McNeese conducted off-site in 2006 for the purposes of this report (Herbert 2006, 096638). Mr. McNeese one of the first personnel hired by DP West to replace the departing soldiers. He was trained as a chemical engineer and worked in the plutonium recovery operation from 1946 to 1948 (under Frank Pittman) before moving on to support metal fabrication.

Mr. McNeese's comments are summarized as follows:

- The overall operations at DP Site were very "messy", equipment and procedures had not been adequately tested, and personnel worked very hard to compensate and ensure that the work was performed safely. Most all process waste materials were analyzed to determine what could be discarded without significant loss. Many solutions and materials were stored until processes were developed to recovery the materials. Waste liquids were dumped down the drains.
- The plutonium recovery group continued to evaporate spent chemicals for some time and accumulated an inventory of these concentrated plutonium solutions in the plutonium storage vault until the recovery processes could be perfected.
- In the 1948 to 1950 timeframe, the recovery process for spent purification chemicals was rebuilt, the bottles of concentrate were "re-solutioned", and the accumulated solutions were processed to recover the plutonium. The solutions were stored in 5 L glass bottles with vented glass stoppers because they created hydrogen gas. Some of the other extraction solutions were put in stainless-steel drums and were shipped to Berkeley for research purposes.

- Nonliquid "residues," such as rags used to clean plutonium spills and dust, were incinerated and the ash processed to recover plutonium. The general rule of thumb was that "materials that exhibited greater than 50,000 cpm were retained for recovery, as this generally amounted to 1 microgram (ug) of plutonium".
- Mr. McNeese confirmed that basic solutions with low plutonium content were discarded in the General's Tanks. He stated that improvements in the plutonium purification process reduced waste chemicals with plutonium to such an extent that the General's Tanks were no longer needed. He stated that the plutonium in the General's Tanks solutions was low enough that it was not worth recovering when compared with other solutions. "There was a time when plutonium was so much in demand," Mr. McNeese suggested, "that we scrounged for every little bit, that you wouldn't have time to reprocess that stuff. The stuff I told you that we had just concentrated into something we could get into the 5-L bottles—that was the stuff we had to get out and get back into solution and processed with solvent extraction and ion exchange procedures developed in the late 1940s. We just did not have the time to do anything about the material in the General's Tanks."
- Asked about the filters at DP West filter Building 12, Mr. McNeese stated that "standard filter papers were used on the filter building, something like standard laboratory filter paper, some of these contained asbestos.... Personnel monitored the filter papers after accidental radioactive releases, some were taken for recovery, but the low efficiency of the filter paper did not capture much and they were routinely changed and just disposed. In 1949 the U.S. Army CWS provided some HEPA cartridges that were fitted to the glovebox air intakes. Similar filter paper materials was eventually obtained and installed at the filter building as part of the exhaust stacks." He had little knowledge of the electromatic air filters or the oil changes in the filter buildings associated with the electromatic air filters as these were performed by maintenance personnel. The oil was from an oil drip system that wiped the electric wires clean, so the oil would be contaminated (Criswell 2007, 096637).
- Mr. McNeese described seeing 4 ft x 4 ft x 8 ft "black iron boxes" or "sea-cans" being filled at MDA B. Asked about the sea-cans being buried at MDA B, Mr. McNeese replied, "Can't remember them being buried on the western end of the trenches, but I remember them down here" [pointing on the map to the eastern trench segment] "and some were in the trenches and some were up here [pointing on the map to a graded surface area between the northern side of the eastern trench and DP Road] and they were still putting stuff in them. Old beakers, and equipment, and gloves, and trash—anything went in there, and then they put a lid on and welded it shut. I didn't see it, but there was a rumor that there was a dump truck they put in there too that got hot when they started cleaning up old D Building" It was a pretty good-sized pit."
- Asked "how much plutonium should we expect at MDA B?" Mr. McNeese stated, "I think what you'll find there is merely contamination. You have all these old beakers and such and in those days you'd clean it to the extent possible to recover any plutonium you could . . . . You see, a microgram of plutonium gives you 50,000 counts per second. So with a Geiger counter you can scan and know if there's much plutonium there . . . . So if any recoverable amount, especially in those days when it was so valuable, valued at millions of dollars per gram . . . so any quantity at all that was recoverable would have been recovered. It would not have gone down there, so what you're talking is contamination. Not quantities of plutonium."
- To the statement, "Our current upper-bound estimate is not more than 100 g plutonium in the entire trench," Mr. McNeese commented, "I guess there's not near that much in there. If there was a gram . . . they would have . . . broken their backs to recover it at that time"

- To the question, “At what point in time do you think the value of plutonium would have changed and the scarcity would have been less critical?,” Mr. McNeese stated, “I’d say sometime after ’54 or ‘55 there was enough of it around that there was no worry about small quantities of it . . . . What I’m saying is that there were sufficient quantities of it that you weren’t scrapping for every little half a gram.”

The following is a summary of an interview of Robert Nance conducted for the purposes of this report in 2006 (Criswell and Rager 2006, 096640). Mr. Nance was hired in 1951 as a chemical technician, but later became a technical staff member. He worked in the plutonium recovery operation during the 1951 to 1952 timeframe.

- Mr. Nance inherited a 55-gal. drum that contained bottles of residues, analytical solutions, and sludges. He created individual recovery solutions so these could be sent back through the plutonium recovery process.
- Asked if he remembered the storage of recovery residues in Room 213, Mr. Nance stated that it was cleared of stored residues, that by the time he arrived, Room 213 was used for other storage.
- The newly developed ion-exchange and solvent-extraction processes were used by 1951 to recover dilute plutonium solutions.
- Asked what type and size of bottles were used for storing solutions, Mr. Nance stated that “the solution chemistry for these early processes were small in volume,” that he worked with many 2-L, 4-L, some 9-L bottles, and rarely 20-L glass bottles. It was common for 2-L and 4-L bottles to have ground glass stoppers, but the larger bottles had rubber or neoprene stoppers.
- Asked if he knew anything about solutions that may have been stored since the war, Mr. Nance recalled that his friend, Clifford Nordeen, worked in the area with him (Mr. Nordeen has since passed away) and worked through the late 1940s and early 1950s on the recovery of solutions that had been stored since the war. Because the chemistry of plutonium was a new frontier and some of the processes had not worked, the group stored the solutions until they could create the recovery processes.
- Asked about potential chemicals that may have gone to MDA B and may have involved the cloud of pink smoke at the 1948 fire, Mr. Nance did not know how that worked, but that “pink smoke indicated iodine,” the by-product of hydrogen iodide.
- Asked about the types of gas cylinders used in the plutonium recovery area, Mr. Nance recalled gray tanks about 12 in. in diameter for hydrogen fluoride and tall, orange tanks for oxygen. He did not remember the use of hydrogen sulfide in those early years.

5.0 CONTAMINATED LAUNDRY

The contaminated laundry, first located in the original technical area and then DP Site, probably was the single largest volume source of contaminated waste to MDA B. The CMR Division’s monthly report for May 1945 (LASL 1945, 095337)—the month when the CM-12 Group became responsible for the operation of the contaminated laundry and for the disposal of contaminated items—indicated that studies were being performed on improvements in cleaning solutions, laundry solutions, and filters (including filters from hoods). The CM Division’s report for June 1945 (LASL 1945, 095338) states that 17,535 pieces of clothing (e.g., boots, coveralls, caps, socks, towels) were processed in the laundry, and of the 8,943 rubber gloves washed, 912 were discarded, 4,410 required additional washing, and an additional 1,724 were simply disposed of because they had been used four times. Reports for other months reflect similar details. In September 1945, the contaminated laundry was completely removed from the original technical area and the equipment was transferred to DP Site. The report for December 1945 stated that rubber gloves would no longer be washed because it was more economical to supply new gloves rather than to attempt to wash the used ones. Before this time, 8,797 gloves were washed in November and 5,728 in September. In 1946, the number of gloves processed was no longer reported, but 13,260 new gloves were issued in May 1946 (LASL 1946, 095310). In October 1946, it was decided that protective clothing would no longer be monitored before washing to reduce the air and personnel exposures and to leave more instruments available for other uses. Clothing would be carefully monitored after laundry and before reuse (LASL 1946, 095315).

In January 1948, the H1 Group published a report concerning the operation of the contaminated laundry (LASL 1948, 095415). This report established the procedures and materials, health rules, laundry supplies, and equipment for the laundry operation. The report also assigned tolerance levels for the disposal of various contaminated items, such as

- Coverralls from plutonium areas

  >10,000 d/m/150 cm^2

  >500 d/m/150 cm^2 after four washes
- Coveralls from polonium areas

  >1,000 d/m/150 cm^2 after four washes
- Smocks and laboratory gowns from plutonium areas

  >200 d/m/150 cm^2 after four washes
- Underwear, socks, brassieres from plutonium and polonium areas

  >50 d/m/150 cm^2 after four washes
- Booties from all areas

  >500 d/m/150 cm^2 after four washes
- Shoes from all areas

  >500 d/m/150 cm^2

  4 mrem/h surface by Geiger-Mueller (GM) tube
- Towels and washcloths from all areas

  >50 d/m/150 cm^2

  >1.25 mrem/h surface by GM
- Respirators from all areas

  >500 d/m/150 cm^2

  0.3 mrem/h surface by GM

Although the laundry processed a total of 47,312 items in May 1946 (LASL 1946, 095309) and 51,561 items in May 1947 (LASL 1947, 095321), there is no record of how many items, or what percentage of items, were disposed of. Assuming that 1% to 5% of the items were replaced monthly as a result of wear and tear as well as contamination, several hundred to several thousand items may have been disposed of monthly from 1945 through 1948. The Los Alamos Scientific Laboratory Notebook No. 1743 (LASL 1948, 095286) recorded weekly pick-ups of contaminated trash from the DP Site laundry in 1947 and 1948.

6.0 BAYO CANYON (RaLa PROGRAM)

The RaLa (radioactive lanthanum) firing program started in Bayo Canyon (also known as TA-10) on October 14, 1944, and continued until 1962. Permanent explosion-proof facilities were installed after the first shot in November 1944. RaLa became the single most important experiment affecting the implosion bomb design because its data analysis gave an average of the implosion compression as a function of time. Each shot involved the destruction of ionization chambers and electronic equipment that could not be removed from the test area. The first barium/lanthanum separations were conducted in D Building, but the short-lived lanthanum required processing near the site, so a small storage and laboratory facility was constructed in Bayo Canyon (Figure 1.2-1). As the method was developed, requirements grew more stringent for shorter precipitation times, smaller filter sizes, and higher yields. In March 1945, greater controls were placed on the firing area, and the oxalate separation method was modified to produce a crystalline precipitate that improved the test methodology (Hawkins et al. 1983, 057519). Some wastes generated at Bayo Canyon were disposed of on-site. Wastes of unknown type were picked up and sent to MDA B.

The RaLa program was a single-purpose direct application of a known radiographic technique to study implosions that had to be adapted to microsecond time resolutions. This meant developing unprecedented performance with ionization chambers and yet-unheard-of gamma radiation sources. The source of radioactivity was radiobarium from fission products from the Clinton Reactor at Oak Ridge, Tennessee. Isolation of the first batch of radiobarium was conducted at Oak Ridge in April 1944. The material received at LANL was a mixture of barium-140 and lanthanum-140. The half-life of carefully purified lanthanum-140 was measured to be about 40 hours. The short-lived lanthanum had to be separated from its parent barium and used within a few minutes for the test shots.

On August 14, 1947, the H1 Group documented the procedures for personnel who hauled trash from the Bayo Canyon area to MDA B to avoid overexposure to beta and gamma radiation. This procedure defined controls for film badges, truck escort rules, flagging, and criteria for gamma survey readings. The survey meter was to be adjusted daily as required for background and with a shielded radioactive source, presumably lanthanum-140. Maximum times for loading and transport from Bayo Canyon to MDA B were calculated for exposure to gamma radiation, so as not to exceed the one-day tolerance dose (Tribby 1947, 095306). The Los Alamos Scientific Laboratory Notebook No. 1743 (LASL 1948, 095286) recorded weekly pick-ups of contaminated trash from Bayo Canyon in 1947 and 1948. There was no itemization or characterization of the material picked up, other than noting that it was contaminated material.

During the operational life of MDA B from 1944 to 1948, 116 shots involved 75,117 Ci of radioactive lanthanum, conventional explosives, and natural uranium for explosive diagnostics. The radiochemical operations conducted at the site generated solid and liquid radioactive wastes, which were disposed of in subsurface pits and leach fields in Bayo Canyon. During the 18 years of the RaLa experiments in Bayo Canyon, about 226 mCi of strontium-90 were reportedly released; over 80% of this strontium-90 was reportedly released during seven shots in 1945 (Dummer et al. 1996, 055951).

The laboratory facilities in Bayo Canyon were updated in 1947. The original facilities may have been demolished and buried on-site in Bayo canyon or at MDA B. The principal contaminants would have been lanthanum-140, barium-140, and strontium-90, which was an impurity in the product shipped from Oak Ridge. After the initial shipments, Oak Ridge added a step to remove the strontium-90. At LANL, the lanthanum-140 was separated from the barium-140 and appreciable amounts of barium carried over in the lanthanum in the initial separations. Any strontium-90 present would have been carried over as well (Dummer et al. 1996, 055951). The strontium-90 concentrations, therefore would have decreased in the experiments, and would have increased in the waste products.

7.0 OMEGA SITE (THE WATER BOILER AND PAJARITO SITE)

Omega Site was the location of the Laboratory's first nuclear reactor, a homogeneous liquid-fuel reactor, the third nuclear reactor in the United States. For security purposes, the reactor was given the code name "water boiler." Three versions of the water boiler would be built, all based on the same concept and fueled by enriched uranium. The waste from the reactors did not contain any reactor fuel solution or solid element because of the intensive plutonium and uranium recovery programs operational at the time, but since other contaminated waste from Omega Site may have been disposed of at MDA B, a brief discussion of the site is provided below. Omega Site was located southeast of the original technical area in Los Alamos Canyon in what is now TA-02 (Figure 1.2-1).

The first experimental unit—the Low Power Water Boiler (LOPO)—operated between May and August 1944 and was used to determine the critical mass of a simple fuel configuration and to test the new reactor concept. The reactor's fuel, 14% enriched uranium, consumed the nation's total supply of enriched uranium at that time and was prepared by the CM Division in D Building. LOPO had a power output of virtually zero to avoid the need for heavy shielding. Its fuel, a solution of uranyl sulfate, was contained in a 12-in.-diameter stainless-steel sphere surrounded by neutron-reflecting blocks of beryllium oxide on a graphite base. Fifty-three bricks of a beryllium tamper were shaped at the Laboratory to fit around the boiler's sphere. Hundreds of rectangular blocks had been fabricated at a commercial facility. The reactor was housed in a room approximately 12 ft by 12 ft, surrounded by 6-in.-thick walls made of a combination of plaster board, fiberboard, and an insulated wooden floor 4 in. above a concrete floor.

LOPO was dismantled in August 1944 to make way for a second water boiler reactor that could be operated at power levels up to 5.5 kW to provide a strong source of neutrons for various experiments. The High Power Water Boiler (HYPO) began operation in December 1944. Its fuel was converted by the chemistry group from the uranyl sulfate to a uranyl nitrate solution because it was easier to decontaminate fission products. The 12-in. sphere was constructed of 1/16-in.-thick stainless steel instead of the 1/32-in. thickness used in LOPO to compensate for the possibility of greater corrosion when operating at higher temperatures and fluxes. Partly because beryllium was difficult to procure and partly to avoid nuclear reactions in the beryllium (Hawkins et al. 1983, 057519), the fabricated beryllium blocks were reused, but the new tamper used only a core of beryllium bricks surrounded by a layer of graphite. There was also a large graphite block base and removable graphite sections for experimental work. More control rods and cooling coils were installed in the sphere as well as a horizontal 1-in. pipe, which ran through the sphere to permit access to the neutron flux. A massive concrete shield surrounded the core and the large graphite column that radiated from it, and all of it was housed in a 30-ft by 50-ft room. HYPO was replaced by the Super Power Water Boiler (SUPO) in 1951 (Bunker 1983, 044020). The loss of nitrogen in HYPO, which led to the precipitation of nitrate, resulted in the frequent analysis of the fuel solution and the addition of nitric acid. The uranium recovery methods also applied to uranium fuel. In February 1947, 2.9313 g of enriched uranium were recovered from analytical samples and returned to the water boiler (LASL 1947, 095320). Little or no enriched-uranium contamination is anticipated at MDA B.

The "fast reactor" (nicknamed Clementine) was proposed and approved in 1945 as a high-intensity fission neutron source that could also assess the suitability of plutonium as a reactor fuel. The site chosen for the fast reactor was adjacent to the water boiler building at Omega Site. Initial criticality of this reactor was achieved in late 1946, though its design power of 25 kW was not reached until March 1949. Its fuel was small uranium and plutonium rods clad in steel jackets and installed in a steel cage through which liquid mercury flowed as a coolant. The plutonium and uranium fuel rods were fabricated at DP West and the original technical area. The cage was surrounded by a 6-in. natural uranium reflector plated with silver to reduce corrosion. This design in turn was surrounded by an additional 6-in. steel reflector, followed by a

4-in.-thick lead shield. Persistent problems with rupture of the uranium and plutonium fuel rods, poor coolant performance by the liquid mercury, and serious abnormalities in the uranium reflector resulted in Clementine being shut down by the end of 1950.

Until April 1946, critical assembly experiments were conducted at Omega Site. These experiments included routine measurements of the spectral and intensity distributions of neutrons of active materials in a dry environment. Plans were made in the fall of 1945 to transfer the critical assembly work to new Laboratory facilities in Pajarito Canyon (today's TA-18). Experiments included measurements on the critical masses of enriched uranium prepared by the CM Division. An experiment with a critical assembly of a combat-type plutonium core and a beryllium tamper in May 1946 resulted in a tragic, lethal accident. This incident stopped the manual critical assemblies and resulted in the design and construction of a new critical assembly laboratory (Hawkins et al. 1983, 057519).

Contaminated waste from Omega Site disposed of at MDA B may have consisted of debris from the demolition of LOPO, including building debris, steel or wooden framing, piping, and perhaps the LOPO stainless-steel sphere. The latter would have been triple-rinsed in accordance with the enriched-uranium recovery operations of the time. Contaminated trash, such as rags or cheesecloth used for wiping any active materials, would also have been subjected to uranium and plutonium recovery methods. Due to the general materials scarcity, it is assumed that the rectangular beryllium bricks not reused in the assembly of HYPO would have been reused for other criticality experiments (not described here). The scrapings and chips from the shaping of beryllium bricks may have been disposed of, although there is no mention of these items in the records reviewed for this report. An inventory record of beryllium in stock conducted in 1949 indicates that 30 lb of beryllium powders were recorded, as well as metal objects, turnings, and scrap. The record of scrap and turnings indicates that these materials were conserved after machining operations and were not simply disposed of at MDA B.

Los Alamos Scientific Laboratory Notebook No. 1743 (LASL 1948, 095286) shows record of only a few pickups of contaminated trash from Omega Site during 1947 and 1948. One pickup was noted from Pajarito Canyon in August 1947. There was no itemization or characterization of the material picked up, other than the notation that it was contaminated. The spill of a radium solution was documented in November 1947 (Blackwell 1947, 097499). Blackwell noted that clothing, wooden furniture, plumbing fixtures, and floor tile were too contaminated to leave in place and were to be thrown out. Contaminated items ranged from a few hundred to >20,000 cpm (Blackwell 1947, 097499).

8.0 OTHER EXPERIMENTAL AREAS OF THE LABORATORY DURING 1944–1948

The Laboratory operations in the mid- to late 1940s included several experimental areas at S Site (Figure 1.2-1) and the areas south of the original technical area. Early implosion experiments with polonium-210 and beryllium were conducted in Sandia Canyon for the development of the neutron initiator. Experiments to simulate actual conditions were set up to study various design options, but performance could only be measured by the operation of the bomb itself. A large part of the problem was the procurement of polonium, which was to come from Dayton, Ohio. Experimental corroboration of theoretical designs was produced by x-ray, flash photography, and electric methods. By February 1945, an alpha-neutron design was selected, and experiments addressed the mixing of materials. The recovery of experimental units was an important part of early work (Hawkins et al. 1983, 057519). Experiments in Sandia Canyon included large, turbine ball bearings in which holes were drilled and tapped and experimental devices inserted. After imploding these "screwballs," they were recovered and the remains examined. In April 1948, contaminated articles and temporary facilities were removed from Sandia Canyon. At least three small buildings, including the "cut-off shack" and the "hot house," were demolished and the contents removed. All property with property numbers was cleared and disposed of with the trash. Three Sandia Canyon burial grounds were excavated, and all contaminated items were picked up, including rubber gloves, clothing, and a deteriorated radioactive lanthanum source. All items were sent to MDA B (Buckland 1948, 006001). The Los Alamos Scientific Laboratory Notebook No. 1743 (LASL 1948, 095286) recorded a few pick-ups of contaminated trash from Sandia Canyon in late March and early April 1948. There was no itemization or characterization of the material picked up, other than the note that it was contaminated. The primary contaminants from the initiator experiments were polonium-210 and strontium-90 from the radioactive lanthanum source.

The Anchor Ranch and S Site areas were the principal locations of experiments for the development of the high explosives required for both the gun-type and implosion bombs during the Manhattan Project and the explosives firing and test sites described in Appendix C. These areas were selected precisely because they offered isolation from the main technical area. Anchor Ranch served as the central facility for the gun emplacement, sand butts, bombproof magazines, control room, and shop. Most of the standard proving-ground techniques were adapted for this work, but some new ones were developed. Although Anchor Ranch had been designed to accommodate both the gun and implosion programs, an expansion of the implosion program soon crowded the facilities. Casting and detonation of large charges required a large casting plant and several widely separated test areas. The casting plant, begun in the winter of 1943, included an office building, steam plant, casting house, facilities for trimming and shaping high-explosive castings, and magazines for the storage of high explosives and finished castings. S Site was staffed almost entirely by military personnel (Hawkins et al. 1983, 057519). An open-burn, open-detonation area was established near Cañon de Valle to destroy excess high-explosive materials, excess equipment contaminated with high-explosive residues, and other wastes generated in the Anchor Ranch and S Site areas. This disposal area was operated and maintained in accordance with military protocol and is now known as MDA R (LANL 2006, 092386). No evidence exists that high explosives or high-explosive residues were ever transported through the townsite or the original technical area to be disposed of at MDA B. The Los Alamos Scientific Laboratory Notebook No. 1743 (LASL 1948, 095286) did not record any contaminated trash pick-ups in the Anchor Ranch or S Site areas from 1947–1948.

9.0 CHEMICAL AND INVENTORY LISTS FROM 1946 TO 1949

Two independent lists of chemical inventory records compiled during the 1944 to 1948 timeframe were found during the records review for this report. Although these lists do not provide an account of chemical wastes sent to MDA B, they do provide insights into the types of chemicals in use at the Laboratory during the active time period of MDA B, as well as approximate container sizes. The first list from LASL Notebook 1612 (excerpted here as Table 9.0-1) appears to be a chemical and supply inventory conducted in August 1946 (LASL 1946, 095317). The inventory includes quantity information for chemicals, listed as a 6-months supply of chemicals, as well as an inventory of general stock items such as batteries, thermometers, lubricating oils and greases, paints, beakers, hardware, electrical items, and rolls of American air filter paper. The locations of many of the items were recorded but not the quantities. The inventory list is generally in a military format (LASL 1946, 095317) and is copied in its entirety in Appendix D. No container size was listed for hydrogen fluoride. The process information in section 4 indicates that DP Site typically received this highly corrosive chemical as ultra-purified anhydrous hydrogen fluoride in 80-lb iron cylinders. The carboys listed in Table 9.0-1 may have been 3 to 6-gal. glass bottles. Typically the term carboy refers to a 5-gal. heavy-walled bottle. No 55-gal. drums were listed on the general stock inventory, acetone and ethylene glycol were listed in the chemical inventory as gallons in barrels (bbl). The full August 1946 inventory (Appendix D) lists other containers, such as

- Bottles—small neck 20 litter [sic]
- Jars—Pyrex 1 gal. with tops

- Bottles—glass 50 litter [sic]
- Bottles—50-litter [sic] Pyrex
- Containers—1 gallon tin
- Containers—5 gallon tin
- Flask – American Thermos 5 gal. #8625

Table 9.0-1
Chemical Inventory of August 1946

Items	Max.
Okite Stripper M-3	300 lb
Hydroxidic Acid	350 lb (7-lb bottles)
Ammonium Nitrate	In shacks (explosives) 150 lb
Calcium Nitrate	250 lb (25-lb containers)
Caustic Soda	250 lb (100-lb drums)
Sodium Citrate	1175 lb (25-lb and 100-lb containers)
Sulfite	100 lb
Oxalic Acid	120 lb
Nitric Acid	189 lb (7-lb bottles)
Potassium Hydroxide	300 lb
Ammonium Sulphate	100 lb
Tartaric Acid	100 lb
Bicarbonate of Soda	1 lb
Lead Oxide (Yellow)	20 lb
Glycerine	1 gal.
Hydrogen Peroxide	1 carboy
Nitric Acid	30 carboys
Ammonium Hydroxide	42 carboys
Hydrochloric Acid	4 carboys
Sulfuric Acid	300 lb, 1 carboy and 4 cases
Sodium Silicate	1 qt.
Barium Sulfate	2 lb
Ethylene Glycol	220 gal.
Benzene	5 gal.
Sodium Hydroxide as pellets	50 lb
Aluminum Nitrate	125 lb
Ambilite 1R-100	100 lb
Magnesia Oxide	500 lb
Iodine	1-lb jar
Asbestos, powdered bulk	No value recorded

Source: LASL 1946, 095317.

Note: A copy of the complete, handwritten inventory is provided in Appendix D. The table shown here has been modified for informational purposes.

A few chemicals were specifically listed as needed for the next 6 months (Table 9.0-2). It is not known whether this list represented the actual inventory or recorded the needs for the next 6 months.

Table 9.0-2
Chemicals Needed for Next 6 Months (1946)

Items	Max.
Hydrochloric Acid Conc.	300 lb – 5 cases
Nitric Acid Conc.	1,000 lb – 15 cases
Iodine	1-lb bottles 52 lb
Acetone	605 gal. 11 bbl
Phosphoric Acid 85%	8,000 lb
Ethylene Glycol	800 gal. 15 bbl
Benzene	25 gal.
Ammonium Tetrate	8 lb

Source: LASL 1946, 095317.
Note: For clarity, the abbreviation used for pound is *lb,* but *pds* was used in the original table.

Mercury and beryllium are common hazardous metals that contaminate landfills. Items that contain mercury and beryllium are included on the lists, indicating that they were common research and production elements used at the Laboratory in the 1940s. How much of these items may have been disposed of at MDA B is important for present-day worker safety considerations during the excavation of MDA B. Both household and laboratory thermometers are listed, but no bulk mercury. It is known that mercury distillation was a common practice, and in February 1947 700-lb had been stored and 25 lb of mercury had been cleaned through a distillation unit (LASL 1948, 095277).

Although outside the timeframe for MDA B, a 1949 memorandum recorded that a beryllium inventory was conducted at Los Alamos in August 1949 which yielded values for materials on hand (LASL 1949, 095292). The memorandum stated that it was difficult to obtain an accurate figure of the actual beryllium because of irregularities in the jacket construction of materials. Thirty pounds of beryllium powders were recorded in the inventory, as well as metal objects and 190 pounds of turnings, and scrap. The scrap and turning entry suggests that these materials were conserved after machining operations and were not simply disposed of at MDA B. The largest inventory item was recorded as beryllium oxide, which is consistent with statements concerning the scarcity of metallic beryllium during this period (Hawkins et al. 1983, 057519). There is no evidence that any of these materials were considered waste. The beryllium inventory memorandum (LASL 1949, 095292) is included in Appendix D for reference purposes.

A second list of chemicals was provided in a 1947 memorandum (also copied here in Appendix D) that requests that the stockroom inform the Health Division and the Director's Office when chemicals specified on the list were checked in excess of the quantities listed. The stockroom was asked to send out a list of excess withdrawals once a week so that the Health Division could contact individuals to ensure that toxic substances were being handled under safe conditions (Hempelmann 1947, 095348). An excerpt of the list indicates the following items:

- Benzene 1 gal.
- Toluene 1 gal.

- Nickel carbonyl 1 lb
- Nitrobenzene 1 kg
- Hydrazine compounds 1 lb
- Hydroxylamine 1 lb
- All metallic fluorides 5 lb
- All cyanides 1 lb
- Beryllium metal 1 lb

10.0 CALCULATION OF THE PLUTONIUM INVENTORY AT MDA B

A recent study—discussed in more detail in Appendix F—uses the limited analytical data, measurements, and observations recorded in "Cesium-137, Plutonium-239/240, Total Uranium, and Scandium in Trees and Shrubs Growing in Transuranic Waste at Area B" (Wenzel et al. 1987, 058214) to estimate the plutonium-239/240 inventory in disposal trenches at MDA B. Primary inventory components include the interstitial soils and fill added during waste-disposal operations, gloves and other protective equipment, discarded laboratory glassware and debris, and intact liquid containers.

Based on one eyewitness account, glass bottles are buried in at least one pit on the eastern end of MDA B. Although this report is unable to definitively identify the source of these bottles, the fact remains that they may contain residual plutonium or other exotic elements. Based on the known Laboratory operations, the concentrations of plutonium would be approximately 1 mg/L of plutonium, a concentration considered at the time to be potentially recoverable, but too concentrated to release into the environment.

Application of the soil concentration and surface contamination data ranges in Wenzel et al. (1987, 058214) and the range of possible liquids in intact containers at MDA B to the calculation method indicates an estimated MDA B plutonium-239 inventory of approximately 114 g at the 50th percentile. This method provides an independent confirmation of the plutonium inventory. The total value is similar in magnitude to the 100-g plutonium-239 estimate of Meyer (1971, 095443). The total possible MDA B plutonium inventory ranges from 24 to 246 g of plutonium. The plutonium inventories at the 50th and 90th percentiles indicate the following distributions:

- 50th percentile of total inventory – 114 g (7.08 Ci)

interstitial soil and fill	72.9 g (4.53 Ci)
gloves and personal protective equipment (PPE)	25.7 g (1.60 Ci)
glassware and lab debris	13.5 g (0.84 Ci)
intact liquid containers	2.3 g (0.14 Ci)

- 90th percentile of total inventory – 170 g (10.6 Ci)

interstitial soil and fill	94.6 g (5.87 Ci)
gloves and PPE	38.7 g (2.40 Ci)
glassware and lab debris	35.8 g (2.22 Ci)
intact liquid containers	0.96 g (0.06 Ci)

- The plutonium inventory in intact containers, based on the analogy of recoverable solutions of the period, indicates an estimated MDA B plutonium-239 inventory of approximately 2.3 g. Perhaps more surprising is the relatively small potential inventory of intact liquid containers at the discard limit. Even if the number of containers were to increase, it would not seriously affect the entire inventory. Based on the waste process history of the period, individual items may possess higher or lower levels of contamination, but they would not represent a significant change in the majority fraction of the inventory in MDA B. At higher total inventory probabilities, the soil component is quite sensitive and dominates the overall inventory.

11.0 SUMMARY AND CONCLUSIONS

The existing reports, records, archived memoranda, additional correspondence, and other documents reviewed for this report substantiate the assumption that no formal disposal records for MDA B are known to exist. The available evidence, including reports and memoranda archived from the operating groups, log books, aerial photographs, and personal interviews provides the perspective of the processes employed by the Laboratory's various operating groups, the scale of the processes used, and the handling of spent chemicals and solutions, glassware, and contaminated items and debris. Collectively, this body of evidence, focused on land burial of waste, provides the context for knowledge of waste generation and management during the MDA B operational period from 1944 to 1948. Environmental releases such as stack emissions and wastewater effluents are beyond the scope of this report.

Waste generator sites that used MDA B would have been the original technical area (TA-01), DP Site (TA-21), the contaminated laundry (TA-01, then TA-21), the Bayo Canyon RaLa project (TA-10), and the Omega Site (TA-02) which included the water boiler reactor and other experiments. This assessment is confirmed by monthly reports and correspondence of the operating groups, as well as log books kept by the drivers of a truck that picked up contaminated trash and debris from these sites and took them to MDA B. Explosives wastes were not disposed of at MDA B because Anchor Ranch, S Site, and other explosives production and test areas used what is now known as MDA R (located in today's TA-16) for these types of wastes. Limited information suggests that some radioactive waste during the 1946 timeframe may have been shipped off-site for ocean dumping, but that information cannot be verified because records were poor or nonexistent. During the war, the tech area contained virtually all plutonium and enriched-uranium research, purification, recovery, and metal fabrication operations. After the war, DP West assumed responsibility for the pilot plant–scale plutonium purification, reduction, metal fabrication, and recovery operations. Polonium operations moved to DP East. The uranium activities remained in the tech area, but D Building converted to plutonium research and analytical support.

The Laboratory's historical record and retiree interviews document the scarcity of the then-exotic new materials of plutonium and enriched uranium, and they provide the context of the imperative to recover these materials from process chemicals, crucible molds, lathe turnings, or other process residuals. Reports compiled by the operating groups of the period described the application of significant resources and research efforts to the recovery of these precious radionuclides, as well as measures to store residual solutions until methods to recover them could be developed. All uranium- and plutonium-purification solutions and materials were required to be returned to the recovery processes, and similar recovery methods were applied to any medium offering precious radionuclide residue. Solutions that contained more than 1 mg/L of plutonium or enriched uranium were stored for later recovery. It was calculated that 344 g of plutonium and americium were stored in the General's Tanks for later recovery. Liquids, including process waste solutions, decontamination and other mop and wash water, were analyzed for radionuclides, and if below the release tolerance of 0.1 mg/L, were released, untreated down industrial sewer drains through outfalls and absorption beds to the environment. Liquid wastes may have also been dumped down sanitary drains. Treatment plants were not built until after 1948.

By 1947, all laboratories had established waste-disposal procedures that required laboratory and salvage wastes to be boxed and sealed. Large items or equipment were to be wrapped with paper or placed in wooden crates and tagged to indicate waste status. One eyewitness account indicates some wastes may have been placed in large metal boxes and sealed before burial. In general, wastes in boxes were reportedly emplaced simply by piling truckloads into the trench. Using a bulldozer, Zia Company workers subsequently covered the material with fill dirt on a weekly basis. No effort was made to separate waste types, or to compact the wastes beyond the soil cover compaction efforts.

The decontamination efforts employed during the 1940s speak to the fact that the Laboratory tried to conserve and reuse equipment and other supplies. If items could not be decontaminated and could not avoid disposal, personnel had to obtain a release from the property office. No property records of this type have been located to date, however. Items that did not pass decontamination requirements after normal use were reportedly sent to MDA B; these included empty gas cylinders that typically would have been used to store oxygen, neon, helium, argon, and nickel carbonyl; glassware from the polonium operations and the plutonium analytical and research laboratories; and miscellaneous mechanical equipment. The presence of gas cylinders at MDA B is important for present-day excavation safety as the cylinders might still be partially pressurized and may contain residues of toxic chemicals. There is no evidence that fully pressurized gas cylinders or hydrogen fluoride tanks were disposed of at MDA B.

The MDA B pits/trenches are interpreted to be located approximately as shown on the geophysical map (Figure 1.1-1). These pits/trenches were constructed by progressive eastward expansion of a series of semi-contiguous trenches during the 1944 to 1948 period. The earliest trenches are likely to be on the far western end of MDA B. The far-eastern end of MDA B is thought to consist of small pits and trenches that contain glass bottles with unknown chemicals, as well as radioactive waste. Aerial photographs taken in 1946 and 1947 document which trenches were active in those years. During 1946, 1947, and 1948, three fires took place in the active portions of MDA B; this strongly indicates that uncontained chemicals, such as battery acids or other oxidizers, were placed in MDA B’s open pits and mixed with combustible materials, such as clothing, wood, and other organic debris, which created conditions conducive to spontaneous combustion. The locations of the fires are approximated from photographs of the period.

The vast majority of waste disposed of at MDA B waste was contaminated with residual radioactivity, including routine laboratory waste, contaminated glassware, obsolete equipment and wooden laboratory furniture, demolition debris, building materials, clothing, glassware, paper, trash, and small amounts of chemicals from the laboratory areas. All waste and trash from the CMR Division laboratories was considered contaminated trash, and all waste and trash was to be thrown into the “hot” receptacles that were placed in each laboratory. The largest waste contributors may have been the contaminated laundry and building demolition debris as laboratory structures and equipment were upgraded after the war. Non-routine waste would have included materials from spills and accidental releases. Documented accidents in D Building released 30 to 70 mg of plutonium to clothing, soils and building materials that were determined to be unrecoverable and were sent to MDA B. A spill of a radium solution at Omega Site resulted in contaminated clothing, furniture, floor tiles and plumbing fixtures that were also sent to MDA B. Actinium research at DP East would have generated unknown wastes contaminated with actinium-227, while wastes of unknown character from the RaLa implosion experiments at Bayo Canyon would have been contaminated with strontium-90.

The chemical inventory lists of 1946 to 1949, as well as the process and research descriptions do not indicate the volumes of chemical wastes, but do provide a comprehensive view of chemicals in use from 1945 to 1948. It is assumed that small volumes of waste chemicals were disposed at MDA B. This is supported by the policy that chemicals could not be returned to the stockroom once they had been in contaminated areas, the observation that chemical bottles were placed in cardboard boxes for disposal, and the minor explosions and puff of pink smoke observed during the May 3, 1948 fire at MDA B. No process evidence exists that large volumes of waste chemicals were disposed of by burial at MDA B. Residual chemicals buried at MDA B may include cleaning solutions, such as trichlorethylene and other chemicals such as acids, bases and experimental solvents generated at the bench-scale.

Based on an eyewitness account, glass bottles with unknown liquids are buried in at least one pit on the eastern end of MDA B. The authors of this report are unable to definitively identify the source of these bottles. The possibility exists that they may contain aqueous solutions with residual plutonium or other exotic elements. Based on the known Laboratory operations, the concentrations of plutonium would not have been much greater than 1 mg/L of plutonium. Greater concentrations were considered to be recoverable, and concentrations much less would have been released to the environment. The possible concentration of americium in these solutions would have been much less than 1 mg/L because the plutonium delivered from Hanford contained trace amounts of plutonium-241 and americium-241, and the processes for separation and purification of americium-241 were in the early stages. The total number and types of bottles buried are unknown, but probably included bottles of 4-L, 9-L and 20-L capacity since these were in common use in the 1940s. The smaller bottles would have had ground glass stoppers, some may have been ventilated, and the larger bottles would have had rubber or neoprene stoppers. The volume of solution present in the glass bottles is considered to be relatively small, possibly a few hundred gallons, in comparison with the thousands of gallons of basic solutions stored in the General's Tanks.

Other evidence exists that chemicals were not simply dumped in the landfill. Contaminated mercury was not simply discarded; by February 1948, 700 lb of contaminated mercury received from the stockroom had been combined into 30-lb storage units, and 25 lb of mercury had been cleaned through a distillation unit. Scraps and turnings of beryllium were recycled or saved for reuse, but grindings or other dusts may have been disposed of at MDA B with sweepings or vacuum bags. Dust bags from the small vacuum cleaners which were used for cleaning parts of the electromatic exhaust air filters at DP West would have been disposed of at MDA B. Paper filters from the DP East and DP West filter buildings may have been changed every few months and disposed of as routine radioactive materials. Some of these may have contained asbestos materials. HEPA filters were not used prior to 1949, and are not expected at MDA B.

The disposal of waste in 55 gallon drums was rare in the 1940s. The only drums of waste documented to MDA B by the Laboratory from 1946 to 1948 were from DP East that resulted from routine oil changes of the electromatic exhaust filters which were polonium contaminated. Since polonium has a half-life of 138 days all contamination from the 1940s has decayed away. Process knowledge, but not documentation, indicates that oil changes were suggested for the exhaust filters at DP West as well, so MDA B may contain a few 55-gallon drums of plutonium-contaminated oils.

Application of the limited soil concentration and waste surface contamination data available to simple dimensional analyses indicates an estimated maximum MDA B plutonium-239 inventory of 170 g at the 90^{th} percentile. At the 50^{th} percentile, the calculated plutonium inventory of 114 g is similar to the 100 g estimate of Meyer (Meyer 1971, 095443). This analysis provides an independent assessment of the inventory and the initial nuclear hazard categorization. The potential plutonium inventory in intact containers, based on the analogy of recoverable solutions of the period, indicates an estimated MDA B plutonium-239 inventory of approximately 2.3 g. These data indicate that contaminated soils represent the majority of the plutonium inventory at MDA B and suggest that the inventory is homogenously distributed throughout the entire volume of MDA B. Based on the waste process history of the 1945 to 1948, individual items may possess locally higher or lower levels of contamination, but they would not represent a significant change in the majority fraction of the plutonium inventory in MDA B. These data also indicate that the waste at MDA B would be characterized as low-level radioactive waste. The presence of hazardous materials would augment this characterization.

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Appendix A

MDA B–Related Excerpts from
"History and Environmental Setting of LASL Near-Surface Land Disposal Facilities for Radioactive Wastes" of 1977

LA-6848-MS, Vol. I

Informal Report

Special Distribution

Issued: June 1977

History and Environmental Setting of LASL Near-Surface Land Disposal Facilities for Radioactive Wastes (Areas A, B, C, D, E, F, G, and T)

A Source Document

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AREA B

I. GENERAL INFORMATION

Area B is located on the south side of DP Road approximately 488 m (1600 ft) east of the intersection of DP Road and Trinity. It is east of the old trailer court area and west of TA-21 (see Fig. B-1). It is between LASL coordinates E.145+00, E.120+00, N.90+00, and N.95+00. Surveyed corners, clockwise from the northeast corner are N.91+92, E.143+35; N.90+72, E.142+96, N.93+90, E.134+08; N.92+45, E.123+06; N.91+00, E.123+14; N.91+08, E.122+35; N.93+64, E.122+38; and N.95+09, E.133+28. It can also be located by township and range — SE 1/4 sec. 15, T. 19 N., R. 6 E., and SW 1/4 sec. 14, T. 19 N., R. 6 E. Approximate acreage is 6.03.[196] The western two-thirds of Area B is presently covered by a layer of asphalt and is leased by Los Alamos County for storage of privately-owned boats and trailers.

Area B probably was the first common solid waste burial ground for LASL. It appears on Engineering Drawing ENG-R 4458 as one large pit; no individual pits are shown within the area. However, from old memos dated July 5, 1945 through January 31, 1952, it would appear that Area B is actually a series of pits. The July 5, 1945 memo[184] is a request for the provision of a new pit for disposal of contaminated trash from CM-Division laboratories.

> *"...suggest that a trench 15 ft wide and 300 ft long be bulldozed out as deep as practical before hard rock is encountered, starting just east of the now covered CM*[R] *disposal pits located SE of the coal storage yard, and running parallel to and about 40 or 50 ft north of the DP power lines. This trench should have a parking bumper along its north edge with a gravelled 20-ft clearing for truck access, and of course a fence surrounding the whole area.*
>
> *Such a trench in the suggested location would,...be a realistic solution to the contaminated trash disposal problem and would have the further advantage that it could be progressively filled and covered from the west end toward the east, and if necessary be extended for several hundred yards should the need arise."*[184]

By July 12, 1945,[197] the pit had been located, staked out, and a work order issued for completion by August 1, 1945. On July 30, 1945,[198] there was a request to extend the completion date for the new pit. The request asked, *"...that work on the new pit be continued until a 12' depth is reached, or until September first whichever is sooner."*[198] A pencilled note on this memo notes completion August 8th.

A January 10, 1947[199] memo states:

> *"The present contaminated materials disposal ditch is judged by the CMR Division maintenance engineer to be adequate for approximately three months from date. Past experience also indicates the necessity of starting the preparation of a new ditch of that size not less than a month before actual usage. It is therefore felt necessary to start digging about March 1.*
>
> *The present site is probably too small for expansion unless the south fence is moved closer to the canyon edge, or the east fence moved farther in that direction. Either of these moves would be a somewhat temporary expedient, and we suggest the assignment of a larger area permitting reasonable expansion. Perhaps east of the DP-East Site."*[199]

There are several notes on this memo. A typed note from H. R. Hoyt, Assistant Associate Director, sent this memo to the Maintenance Group on January 13, 1947, with the statement *"for necessary action."* A pencilled note dated February 5, 1947, says *"...will issue job order to enlarge ditch until some decision has been reached by the Director."* At the top of the January 10, 1947 memo is another pencilled notation indicating that someone could not decide whether the memo was discussing what is now called Area A or

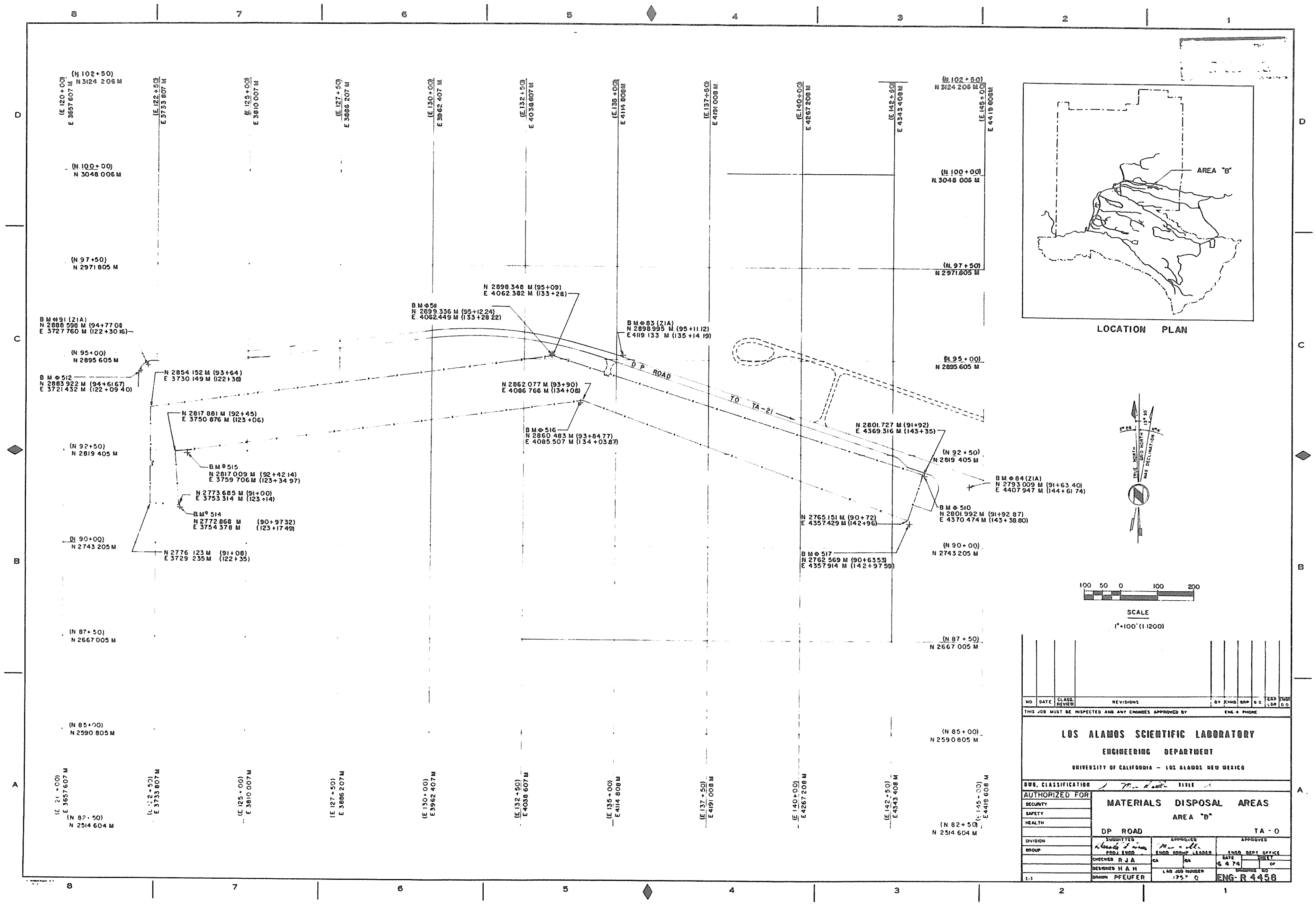

Fig. B-1.
Materials Disposal Area B, DP Road, TA-0.

Area B. (Area B is the pertinent area because the south fence of Area A would not have been near the canyon edge.) This memo is the first record of discussion to find a new location for the common burial ground; however, it was the May 3, 1948 fire in Area B which initiated construction of Area C.

II. GEOLOGY AND HYDROLOGY

Area B is located on the same narrow eastward trending mesa as Area A and T. The south side of Area B is approximately 30 m (100 ft) from a canyon tributary to Los Alamos Canyon. The Area B pits are probably cut in Unit 3a of the Tshirege Member of the Bandelier Tuff.

The thickness of the Bandelier Tuff beneath the disposal pits is estimated to exceed 243.8 m (800 ft).[200] The tuff is in the zone of aeration with the zone of saturation (water table) at a depth of approximately 365.8 m (1200 ft) below the surface of the mesa.[200]

III. PIT DESCRIPTIONS

A. Background

The question of how many pits and where they are located in Area B cannot be answered by available information. Area B may be the first Materials Waste Disposal Area at LASL.

> *"Letters in the CMR-12 files indicate that sometime in 1944 a pit located in the fenced area* [Area B] *between the Trailer Court and the CMR laundry* [Area V] *was in use. When this pit was filled two more were dug in the area now known as the General's Tank Area* [Area A]. *When these were filled (1945) three more pits were dug in the area between the Trailer Court and the CMR laundry. Space in this area was exhausted in 1948 and new pits were started at the present location* [Area C] *on Pajarito Road."*[201]

The 1944 *"pit located in the fenced area"*[201] could well be *"the now covered* [as of July 5, 1945] *CM Disposal pits located southeast of the coal storage yard."*[184] Three pits, constructed and filled after July 5, 1945, are referred to in memos dated June 14, 1949,[188] and January 31, 1952.[201] In a June 12, 1964 memo[202] Review of Preliminary Drawings: "Materials Disposal Areas" comment 6 states that

> *"There is a covered shallow trench in Area B (ENG-R 3641) which was used for disposal of hazardous materials. The trench was three feet in depth, two feet wide and about 40 feet long. It lies parallel to the south fence line E.140+00 and below line N.92+50. It extends about half the distance to E.142+50.*[202]

This *"shallow trench"*[202] lies in the extreme eastern end of Area B and therefore cannot be *the now covered CM disposal pits located southeast of the coal storage yard"*[184] which would have had to have been located in the extreme western end of Area B in order to have had 91.4 m (300 ft) long pits located to the east of them. It would thus seem that there are a minimum of five pits located in Area B.

> *"I am sure that the area contains six pits: two in the west end running north and south making the 'L' shape to the fence and four running east and west in the area parallel to DP Road. There was at least one small, shallow trench which was used by CMR-DO safety personnel to dispose of hazardous chemicals.* (Written communication, D. D. Meyer, Fall 1974).

B. Type of Waste

Solid waste placed in Area B was logged in LA Notebooks 1743 (January 6, 1947 through November 23, 1948) and 2587 (November 24, 1948 through April 28, 1950).[104] Opinions on the waste vary. January 30, 1952,[189] the waste was said to be predominately long-life alpha accompanied by slight amounts of beta and gamma. January 31, 1952,[201] the following was stated:

> *"The contamination on materials in these pits consists of all types of radioactive materials used at Los Alamos. Some of the known types of activity are: plutonium, polonium, uranium, americium, curium, RaLa* [radioactive lanthanum]*, actinium, and waste products from the Water Boiler. No attempt has been made to keep the various materials separated."*[201]

January 4, 1971,[185] information was given that

> *"The total volume of the pits, after deducting the three foot of cover material, is 28,000 cubic yards. These pits actually contain very little Plutonium. At the time they were in use, Pu was scarce and only that which was present as contamination was buried.* [It is estimated] *that the entire pit area contains no more than 100 grams of* ^{239}*Pu."*[185]

Approximately 90% of the contaminated waste consisted of paper, rags, rubber gloves, glassware, and small metal apparatus placed in cardboard boxes by the waste originator and sealed with masking tape.[188] *"The rest of the material consists of metal such as airducts and large metal apparatus. This type of material is placed in wood boxes or is wrapped with paper."*[188] There is also reference to large quantities of wood from temporary storage cabinets used by the Quantity (sic) Control Department, several live storage batteries,[203] and contamined or toxic chemicals.[201]

C. Mode of Disposal

In the literature[200] and in conversation Area B is frequently referred to as a single pit with an approximate depth of 6.1 m (20 ft). Area B does not appear to be a single pit. Whether some of the pits in the area have a depth of 6.1 m (20 ft) is open to speculation. It could well be the 6.1 m (20 ft) is an estimate based on the average depth of most pits excavated in Areas C and G.

For reasons already stated, the depiction on Engineering Drawing ENG-R 4458 of Area B as one continuous pit is wrong. Consistent reference has been made through the years[188,201,185] to a series of pits in Area B. One might assume their construction to be similar to the 1945 Pit [4.6 m (15 ft) wide, 91.4 m (300 ft) long, and 3.7 m (12 ft) deep], with the exception of the hazardous materials pit which was described as a trench 0.6 m (2 ft) wide, 12.2 m (40 ft) long, and 0.9 m (3 ft) deep.

When Area B was in use, waste was handled in the following manner.

> *"The waste disposal program requires three men. Two of these work on the contaminated truck and are furnished by the Zia Company. The third man is a CMR-12 monitor. This monitor supervises the handling of material. Before loading he checks the boxes for external contamination and keeps records of any accountable property that is buried.*
>
> *The equipment used consists of a truck and a sedan. The material in the pits is covered once a week. This requires the use of a bulldozer and operator one day a week."*[188]

Unlike the current LASL practice of layering waste in pits, waste filled the depth and width of the pits in Area B before it was covered by fill dirt. As a result, subsidence occurred. Shortly after Area B was closed, subsidence over the pits was remedied by using the area for disposal of noncontaminated concrete and dirt from construction sites. (Written communication, D. D. Meyer, Fall 1974.)

IV. STUDIES AND MONITORING

A fire broke out in Area B at approximately 10:20 a.m., May 3, 1948.[203] When the fire department arrived,

"[they] *found sixty percent of the open portion of the dump ablaze and flames shooting approximately fifty feet into the air. The firemen had little trouble in subduing the blaze, but persistent efforts to put it out were of little avail because of the loaded condition of the dump area in which the blaze was confined. Dense, low-hanging smoke prevailed in large volume.*

At approximately 10:35 am, James Tribby was notified of the fire, in the absence of other Health Group personnel, and with representatives of the Safety Department went immediately to the scene of the blaze and took charge with Herbert Drager. Because of the dense smoke which scattered throughout the area, due to the condition of shifting winds, all areas east and west of the dump, from the food warehouses to the DP laundry, were evacuated of personnel. Respiratory protection was provided for all persons at the scene, and it was necessary to close the DP road to traffic."[203]

"At 11:15 am, May 3, 1948, our monitoring section [H-2] *drove to the DP contaminated dump section to assist the CMR group in surveying the extent of contamination, if any.*

General air count proved negative with a Pee Wee alpha survey meter ...

We later helped check personnel in and around the area including firemen and security guards. The grounds and vehicles in the area were also checked. All proved negative excepting one security car windshield which had about 50 c/m and one spot on the west fence had 200 c/m. The security car is believed contaminated from former contamination trouble or from accompanying a 'hot' run. The fence is believed contaminated from dust blown from the dump because it was localized in one spot only.

The smoke drifted west and close to the ground near the food storage plant corner of Trinity and DP road. The east wall was checked. No activity found.

It is believed there could not have been an air count present due to the absence of any deposit on local objects."[204]

"By 12:15 pm, the fire had been extinguished except for two very small, isolated points and there was no longer any hazard from smoke. Fire department personnel were dismissed at 1:15 pm, but a stand-by crew of two men and one piece of apparatus were left until 5:30 pm to watch for rekindling of the fire.

Investigation has failed to disclose any obvious cause for the blaze, and it is presumed that it started by spontaneous combustion. The area in which the blaze occurred had not had any trash dumped into it for about three days, and much of the trash in the fire area had been in the dump for three weeks. The trash included large quantities of wood from temporary storage cabinets used by the Quantity (sic) *Control Department, several 'live' storage batteries, large quantities of miscellaneous scrap metals, discarded contaminated clothing and boxes laundry waste. The conditions were ideally suited for spontaneous combustion.*

During the fire, there was some evidence that chemicals had been disposed of in the dump in an unauthorized manner in cardboard containers used for the regular disposal of common laboratory waste. Several cartons of waste gave off minor explosions, and upon one occasion a cloud of pink smoke arose from the debris in the dump. Whether this was due to the heat of the fire, the action of the water or chemical reaction is not known. The condition certainly did not help in keeping the fire under control.

This most recent dump fire should serve as an object lesson in many respects. It should point to the hazards of having the dump located in areas near or in line with living and working areas where toxic smokes and vapors can create an emergency condition. Even though we are presently short of dump space, it is poor policy to leave the dump uncovered for extended periods of time. If it is not practical to cover the trash with a light layer of dirt as a temporary measure before covering over any portion completely, it is suggested that the dump be wet down with large quantities of water at least twice a week until such a time as more adequate precautions can be taken."[203]

As a result of the fire, there were, no doubt, many other changes besides the relocation of the common burial ground.

The following is from a February 1963 USGS report. *"The highest concentration of gross alpha in soil samples collected in June 1955 a short distance downgradient in the canyon south of the pit* [Area B] *was 48 disintegrations per minute per dry gram."*[30] There is no map showing the precise location of the sampling point (which may have been closer to Area V than it was to Area B).

The USGS was asked to do a study of Area B in 1966.

"Expansion of laboratory facilities and increased growth of the community of Los Alamos has caused a re-evaluation of present land use to determine if the land is being utilized in the best possible way. It was proposed by the Los Alamos Scientific Laboratory and the U. S. Atomic Energy Commission that a portion of the filled-in contaminated waste pit, outside the radius of 1050 ft from TA-21 (an area approved for commercial property), be leveled, filled where necessary, and sealed with asphalt, and used for a storage area for trailers and boats. It is thought that a seal of asphalt will prevent any contamination from reaching the surface of the storage area."[200]

The USGS drilled test holes, 7.6 - 25.2 m (25-50 ft) deep, around the perimeter of Area B (see Fig. B-2). Moisture content of the soil and tuff penetrated by the test holes was determined by neutron scattering moisture probe. Samples of the drill cuttings were analyzed for gross alpha and gross beta-gamma, plutonium, and uranium. The results of the study were reported[200,77] in 1966 (see Table B-I). The study concluded

"Distribution of moisture in five test holes indicated some lateral movement of water, probably from the contaminated waste pit. The amount of water moving through the tuff was well below the estimated effective porosity of the tuff. Radiochemical analyses of the soil and tuff from the test holes showed no indication of radioactive contamination. A much larger amount of water than occurs from precipitation would be required to move radioactive contaminants from the waste pit into the adjacent soil and tuff. An asphalt covering on the pit with adequate drainage could prevent any movement of radioactive contaminants from the waste pit.*[200]

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*The USGS considered Area B to be one large pit.

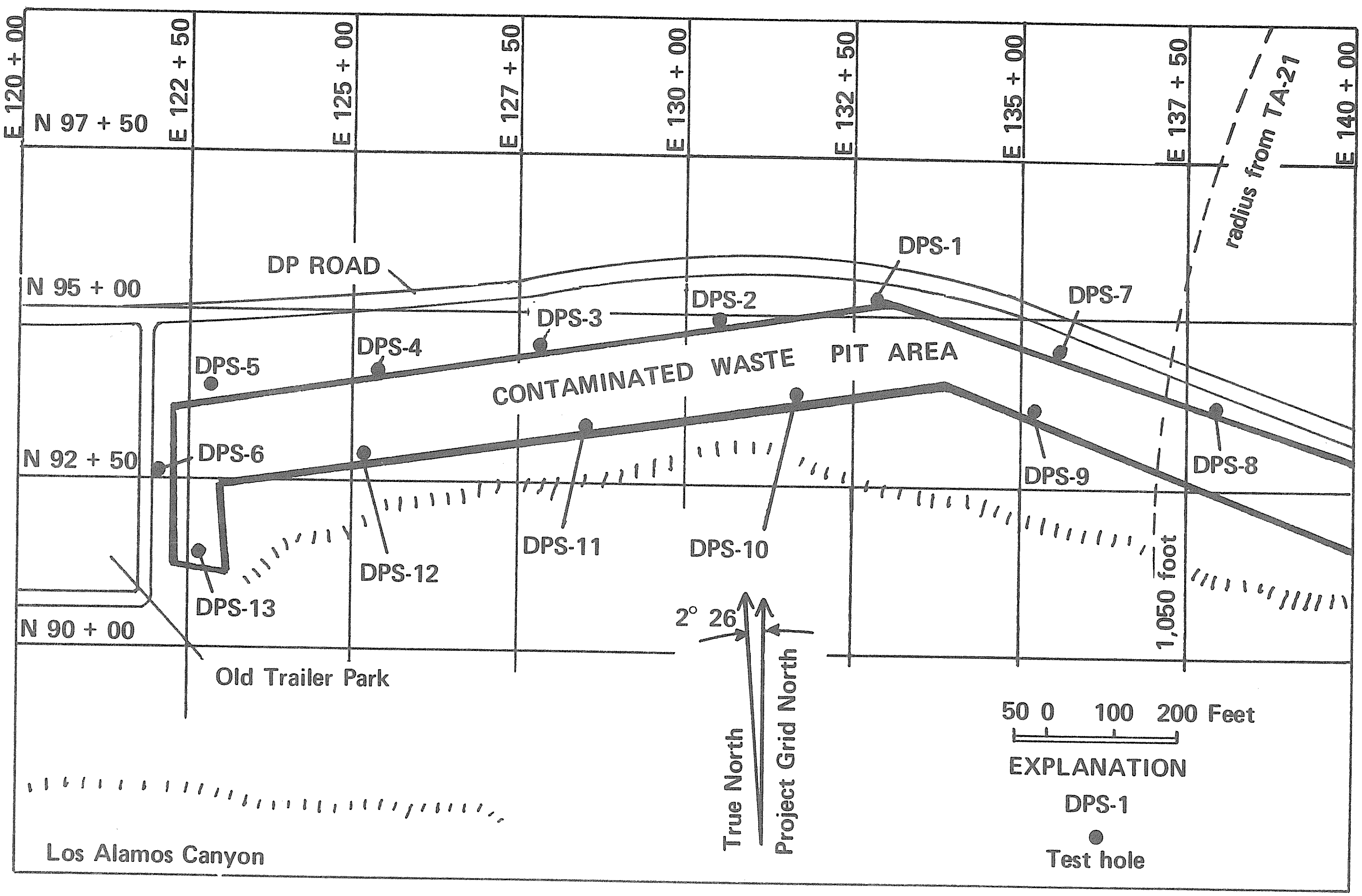

Fig. B-2.
Location of test holes drilled near the contaminated waste pit [Area B] west of TA-21.

TABLE B-I

DATA FROM 1966 USGS TEST HOLES DRILLED ON THE PERIMETER OF AREA B

USGS Designation	Date	ERDA & LASL Coordinates	Diameter (in.)	Depth (ft.)	Altitude (ft. above mean sea level)	Log: Soil (ft.)	Log: Bandelier Tuff (ft.)	Moisture Content Percent by Volume	Gross Alpha (dmg)	Gross Beta-gamma (dmg)	Plutonium (dmg)	Uranium (μgg)
DPS 1	2/7/66	N 95 + 13 E132 + 97	4	50	7,190	3	47	4-12.5	0.2-0.7	.0- 6.0	<.4	<.5
DPS 2	2/7/66	N 94 + 78 E130 + 56	4	25	7,191	3	22	6-23	0.3-0.9	0.3- 9.1	<.4	<.5
DPS 3	2/7/66	N 94 + 43 E127 + 87	4	50	7,194	3	47	4-22	0.0-1.2	0.0-12.6	<.4	<.5
DPS 4	2/7/66	N 94 + 16 E125 + 89	4	25	7,202	3	22	7-29	0.0-1.1	0.0- 4.9	<.4	<.5
DPS 5	2/7/66	N 93 + 80 E122 + 85	4	50	7,214	3	47	6-23	0.1-1.0	0.9- 7.6	<.4	<.5
DPS 6	2/8/66	N 92 + 58 E122 + 10	4	50	7,216	6	44	11-30	0.2-1.2	2.7- 6.1	<.4	<.5
DPS 7	2/8/66	N 94 + 41 E135 + 69	4	25	7,185	3	22	5-25	0.2-1.2	1.3- 5.5	<.4	<.5
DPS 8	2/8/66	N 93 + 66 E138 + 06	4	50	7,181	6	44	4-24	0.1-0.6	1.0- 5.8	<.4	<.5
DPS 9	2/9/66	N 93 + 66 E135 + 19	4	25	7,180	4	21	4-12	0.3-0.7	1.0- 3.7	<.4	<.5
DPS 10	2/9/66	N 93 + 66 E131 + 55	4	35	7,182	4	31	4-16	0.2-1.0	0.7- 4.3	<.4	<.5
DPS 11	2/9/66	N 93 + 21 E128 + 50	4	50	7,192	4	46	4- 9.5	0.3-0.9	1.2- 4.0	<.4	<.5
DPS 12	2/9/66	N 92 + 79 E125 + 21	4	36	7,192	3	33	8-35	0.3-0.8	0.0- 3.0	<.4	<.5
DPS 13	2/9/66	N 91 + 39 E122 + 72	4	35	7,210	2	33	4-11	0.4-1.0	0.0- 4.3	<.4	<.5

Compiled from data in Purtymun and Kennedy, 1966,[200] and John, Enyart, and Purtymun, 1966,[77] *A beta gamma survey of the material waste pit at TA-21* [Area B] *was conducted on September 16, 1966. Dose rate measurements were taken at a distance of twenty inches from the surface of the black topping with an Eberline Mod. E-112-B Geiger counter. No appreciable reading above the normal background of 0.07 mr/hr was detected."*[205]

The accompanying map showed the survey was down the center of the storage area portion of Area B. November 10, 1971, the asphalt was surveyed with an alpha counter, Ludlem Model 139, and beta-gamma counter Model E-112-B. *"No alpha contamination was detected, and the beta count was background."*[206]

"On 8/26/76, M. A. Rogers and Merle Wheeler, H-8, and I [John Warren] *inspected the Los Alamos County operated storage area located near TA-21 over the LASL radioactive waste disposal Area B. In general the condition of the area paving and fencing may be described as very good; some preventive maintenance and minor repair work are suggested.*

There is no major growth of vegetation through the pavement, nor was there any indication of any new area settling as had been seen a few years ago [Fall 1973]. *All of the repair work done then is in very good condition. The area fencing, with one possible exception, is quite secure. We see absolutely no reason why the area cannot continue to be used at this time by the Los Alamos County for its present purpose.*

Specific preventive maintenance and repair measures that should be considered at this time are:

(1) All cracks in the pavement area should be resealed with hot tar to prevent any future damage and plant growth.

(2) All plant growth through the asphalt (seen especially around the edges at the west end of the area) should be removed and hot tar applied as a sealant.

(3) The area fencing in the one location on the DP-road side (approximately across from Morgans and the Los Alamos Monitor) should be repaired.

(4) Several of the fence grounding cables appeared to be either detached or broken. If this is of any importance the appropriate repairs should be made.

Several pictures [Polaroid SX-70 prints] *of the area were taken; these are enclosed..."*[280]

175. Los Alamos Scientific Laboratory internal memo from Bill Purtymun and Linda Trocki, H-8 to Margaret Anne Rogers, H-8. Subject: Percent Moisture by Weight from Auger Holes in Pit #7, Area G. Date: December 12, 1973, 1 p. Symbol: H8-73-M296.

176. Los Alamos Scientific Laboratory internal memo from John Enders, Leader, CMR Building Monitoring Section, H-1 to Dean Meyer, Group Leader, H-1. Subject: Report of Spilled Sludge at Pit #8, TA-54. Date: 1-7-72, 1 p.

177. Los Alamos Scientific Laboratory internal memo from M. Wheeler, K. Schiager, W. Purtymun, H-8 to J. A. Mohrbacher, H-8. Subject: Request for Monitoring in Pit No. 8, Area G. Date: 1-7-74, 2 p. Symbol: H-8-WM-90., 1 map.

178. Los Alamos Scientific Laboratory internal memo from J. Warren, H-8 to LaMar Johnson, H-8. Subject: Plan for Disposal by Burial of ^{238}Pu Contaminated Sludge in the Leaky Drums in Pit #8. Date: 1-14-74, 2 p. Symbol: H-8-WM-97.

179. Los Alamos Scientific Laboratory internal memo from M. Wheeler, H-8 to Distribution. Subject: Monitoring in ^{238}Pu Retrievable Storage Complex. Date: December 6, 1974, 2 p., 2 figs., 2 tables. Symbol: H8-WM-352.

180. Los Alamos Scientific Laboratory internal memo from John Enders, H-8 through LaMar Johnson, Group Leader, H-8 to Roy Reider, Group Leader, H-3. Subject: Fires Involving Solid Radioactive Waste. Date: 8-30-73, 2 p.

181. Los Alamos Scientific Laboratory internal memo from John Enders, H-1 to Dean Meyer, Group Leader, H-1. Subject: Report on Fire at Pit #3, Area G. (Mesita del Buey). Date: 11-24-64, 2 p., 3 maps.

182. Los Alamos Scientific Laboratory internal memo from John Enders, H-1 to Dean Meyer, Group Leader, H-1. Subject: 1964 Annual Report on Disposal of Solid Radioactive Waste. Date: 1-14-65.

183. W. D. Purtymun, "Materials Waste Pit, Area A, TA-21 — Excavated April 1969," U.S. Geol. Survey letter report (1969).

184. Los Alamos Scientific Laboratory internal memo from David Dow to Colonel G. R. Tyler. Subject: New Disposal Pit for CM Division. Date: July 5, 1945, 1 p.

185. Los Alamos Scientific Laboratory internal memo from Dean D. Meyer, Group Leader, H-1 to C. W. Christenson, Group Leader, H-7. Subject: Volume of Transuranium Wastes Buried at Los Alamos. Date: 1-4-71, 2 p.

186. Los Alamos Scientific Laboratory internal memo from Geo. L. Voelz, M.D., Health Division Leader to E. E. Wingfield, Chief, Operations Br., AEC-LAAO. Subject: Waste Storage Tanks. Date: 10-30-73, 1 p.

187. Los Alamos Scientific Laboratory internal memo from J. R. Buchholz, H-7, T. K. Keenan, H-7 Group Leader, P. E. McGinnis, H-7 to Margaret Anne Rogers, H-8. Subject: Activities at Area T, TA-21 During 1975. Date: February 3, 1976, 2 p. Symbol: H7-76-PEM-86.

188. Los Alamos Scientific Laboratory internal memo from Dean Meyer, CMR-12 to Jack Cully, ENG-4. Subject: Disposal of Solid Contaminated Materials at Los Alamos. Date: June 14, 1949, 2 p.

189. Los Alamos Scientific Laboratory internal memo signed by John Bolton, Assistant Director for Engineering to Carroll L. Tyler, Manager, SFO, USAEC. Subject: Location of Classified and Contaminated Dumps in Los Alamos Area. Date: January 30, 1952, 1 p.

190. Los Alamos Scientific Laboratory internal memo from W. B. Gibson, CMB-11 to W. J. Maraman, CMB-11. Subject: General's Tanks — Memo from Dean D. Meyer, December 3, 1971. Date: 12-6-71, 1 p.

191. Los Alamos Scientific Laboratory internal memo from P. E. McGinnis, H-7 through L. A. Emelity, H-7 Alt. Group Leader and J. R. Buchholz, H-7 to Margaret Anne Rogers, H-8. Subject: General's Tanks Waste. Date: March 12, 1976, 2 p. Symbol: H7-76-PEM-162.

192. Los Alamos Scientific Laboratory internal memo from J. L. Desilets, ENG-2 to C. A. Reynolds, ENG-4 Group Leader. Subject: Materials Disposal Area "A", DP West. Date: November 9, 1972, 1 p.

193. Letter from Thomas K. Keenan, H-7 Group Leader, Waste Mgmt., Los Alamos Scientific Laboratory to Delacroix Davis, Jr., Director, Nuclear Matls. & Waste Mgmt. Div., Albuquerque Operations Office. Date: January 9, 1976, 4 p.

194. Los Alamos Scientific Laboratory internal memo from Wilbur Workman, H-1 Section Leader, DP Site to Dean D. Meyer, Group Leader, H-1. Subject: Use of Radioactive Waste Pit at TA-21. Date: 6-30-72, 1 p.

195. Los Alamos Scientific Laboratory internal memo from M. Wheeler to file. Subject: Test Borings at Area A, TA-21. Date: June 21, 1976. Symbol: H8-WS-610, 3p.

196. Los Alamos Scientific Laboratory internal memo from Engineering Department to L.J. File 1757; Materials Disposal Areas, Q. Date: April 9, 1965, 1 p.

197. Los Alamos Scientific Laboratory internal memo from Asst. Operations Officer (signed by C.V. Forrest) to David Dow. Subject: New Disposal Pit for CM Division. Date: July 12, 1945, 1 p.

198. Los Alamos Scientific Laboratory internal memo from David Dow to Major Stevens. Subject: Contaminated Pit. Date: July 30, 1945, 1 p.

199. Los Alamos Scientific Laboratory internal memo from John Bolton to Henry R. Hoyt. Subject: Contaminated Materials Disposal Ditch. Date: January 10, 1947, 1 p.

200. W. D. Purtymun and W. R. Kennedy, "Distribution of Moisture and Radioactivity in the Soil and Tuff at the Contaminated Waste Pit near Technical Area 21, Los Alamos, New Mexico," U.S. Geol. Survey open-file report (1966).

201. Los Alamos Scientific Laboratory internal memo from Dean D. Meyer, Group Leader, H-1 to Salvatore E. Russo, ENG-4. Subject: Location of Contaminated Waste Burial Pits. Date: January 31, 1952, 1 p.

202. Los Alamos Scientific Laboratory internal memo from Safety Office (signed by James G. Stearns, Safety Engineer) to ENG-3. Subject: Review of Preliminary Drawings: "Materials Disposal Areas." Date: June 12, 1964, 1 p.

203. Los Alamos Scientific Laboratory internal memo from CMR Division Safety Department (signed by Herbert W. Drager) to E. R. Jette. Subject: Contaminated Dump Fire, May 3, 1948. Date: May 5, 1948, 2 p.

204. Los Alamos Scientific Laboratory internal memo from Carl Buckland, Monitoring Section, H-2 to Harriet L. Hardy, M.D., Occupational Health. Subject: Contaminated Dump Fire. Date: 5-5-48, 1 p.

205. Los Alamos Scientific Laboratory internal memo from William F. Romero, H-1, DP West to Dean D. Meyer, Group Leader, H-1. Subject: Beta Gamma Survey of Material Waste Pit, Area B, TA-21. Date: September 19, 1966, 1 p.

206. Los Alamos Scientific Laboratory internal memo from Wilbur Workman to Dean Meyer. Subject: Cave In of Asphalt at County Trailer Parking Lot, DP Road. Date: November 10, 1971, 1 p.

207. Los Alamos Scientific Laboratory internal memo from Engineering Department (signed by S. E. Russo) to Distribution. Subject: Approximate Acreages of Materials Disposal Areas A through X. Date: May 29, 1968, 2 p.

208. Los Alamos Scientific Laboratory internal memo from Construction and Maintenance Group (signed by Geo. L. Williams, Acting Group Leader) to AEC Operations Division, Attention: W. A. Curtis. Subject: New Contaminated Dump at TA-4 (Alpha Site). Date: May 10, 1948, 1 p. Reference LAB-A-5.

209. Letter from John H. Abrahams, Soil Scientist, GWB, U.S.G.S. to Dean Meyer, H-1. Information compiled by W. D. Purtymun. Subject: Burial of radioactive wastes in Area C at a maximum depth of 60 ft. Date: February 13, 1962, 2 p.

210. Los Alamos Scientific Laboratory internal memo from John Enders, H-1 to Dean Meyer, Group Leader, H-1. Subject: Disposal of solid radioactive trash, 3rd quarter, 1959. Date: 11-2-59, 2 p.

211. Los Alamos Scientific Laboratory internal memo from Ellis L. Stout, CMB-AS to C. A. Reynolds, ENG-4. Subject: LASL Chemical Disposal Area. Date: November 12, 1959, 1 p.

212. Los Alamos Scientific Laboratory internal memo from James G. Stearns, Safety Engineer to Distribution. Subject: Closing out of the Hazardous Chemical Pit, Area C. Pajarito and Pecos Road Intersection. Date: May 22, 1964, 2 p.

213. Los Alamos Scientific Laboratory internal memo from John Enders, H-1 to Dean Meyer, Group Leader, H-1. Subject: Solid Radioactive Waste Disposal Report for the First Quarter of 1965. Date: 4-23-65, 3 p.

214. Los Alamos Scientific Laboratory internal memo from Merlin Wheeler, H-8 to Distribution. Subject: Tritium Content of Disposal Areas. Date: October 7, 1974. Symbol: H8-WM-290.

215. Los Alamos Scientific Laboratory internal memo from Philip F. Belcher, Assistant Director for Classification and Security to Donald P. Dickason, Chief, Security Branch, LAAO. Subject: Disposition of Classified Waste Material. Date: 3-31-59. 2 p. Symbol: ADCS-10832.

216. Los Alamos Scientific Laboratory internal memo from Carl Buckland, H-1 Monitoring Section to Chas. H. Perry, Glenn Vogt, Dean Meyer, Jack Aeby, Robert Barker, Chas. Blackwell, Ralph Gosline, and Reynold Hoover. Subject: Contaminated Dump. Date: 12-30-50, 1 p.

217. Los Alamos Scientific Laboratory internal memo from John Enders, H-1 to Dean Meyer, Group Leader, H-1. Subject: Covering Contaminated Trash at Contaminated Dump. Date: 2-5-57, 1 p.

218. Los Alamos Scientific Laboratory internal memo from John Enders, H-1 to Dean Meyer, Group Leader, H-1. Subject: Disposal of Contaminated Trash for 1956. Date: February 4, 1957, 5 p.

219. Los Alamos Scientific Laboratory internal memo from John Enders, Section Leader H-1, CMR-Bldg. to Dean Meyer, Group Leader, H-1. Subject: Quarterly Report on Disposal of Solid Radioactive Trash, 2nd Quarter, 1958. Date: July 15, 1958, 2 p.

220. Los Alamos Scientific Laboratory internal memo from John Enders, H-1 to Dean Meyer Group Leader, H-1. Subject: Quarterly Report on Disposal of Contaminated Trash from July 1, 1957 to September 30, 1957. Date: 12-9-57, 5 p.

221. Los Alamos Scientific Laboratory internal memo from John Enders, H-1 to Dean Meyer, Group Leader, H-1. Subject: Annual Report on Solid Radioactive Waste Disposal for 1961. Date: 1-11-62, 6 p.

222. Los Alamos Scientific Laboratory internal memo from John Enders, H-1 to Dean Meyer, Group Leader, H-1. Subject: Proposal for Sealing Disposal Shafts by H-1. Date: 5-15-67, 2 p.

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282. Los Alamos Scientific Laboratory internal memo from L. Trocki, H-8 to File. Subject: September, 1976 Report. Date: October 16, 1976, 1 p., 2 figs., 1 table, Symbol: H8-WS-663.

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Appendix B

Results of the Integrated Geophysical Investigation of 1998

Bay Geophysical Associates, Inc.

206 Cambridge Way, Coatesville, PA 19320

24 July 1998 Project No.:98-176P

Mr. John Hopkins
Morrison Knudsen Corporation
2237 Trinity, Bldg. 2, 1st Floor
Los Alamos, New Mexico 87544

RE: **Results of Integrated Geophysical Investigation**
Los Alamos National Laboratory TA-21, MDA-B

Dear Mr. Hopkins:

Bay Geophysical Associates, Inc. appreciates the opportunity to present this letter report summarizing the results of a geophysical investigation completed at the above-referenced site on 15 through 20 July 1998. The purpose of the investigation is to delineate the lateral and vertical boundaries of former disposal pits. To achieve this objective, an integrated geophysical investigation was completed using high-sensitivity metal detector (EM61), terrain conductivity (EM31), and ground-penetrating radar (GPR) techniques.

The survey area encompasses approximately 6 acres and consists of both paved and unpaved areas. Figure 1 illustrates the survey area locations. The site was divided into three separate survey areas that are bounded by chain-link fences. Area 1 is the main survey area encompassing approximately 5.5 acres. This area includes the large paved area and unpaved area at the western end of the site. Area 2 is the small (approximately 0.2 acres) paved area on the eastern end of the site. Area 3 is the small (approximately 0.2 acres) unpaved area south of Area 2.

METHODOLOGY

The geophysical investigation was completed using an integrated approach. Integrating two or more geophysical techniques provides a complementary or synergistic effect by reducing the inherent ambiguities in interpretation that may exist if only one method was used. This approach often provides higher confidence levels and more complete subsurface information.

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The EM61 survey was completed to help delineate the lateral extent of the former trenches by mapping the locations of metallic objects contained within the trench. A minimum depth of the trenches can be estimated by calculating the depth of the objects based on the EM response. The EM31 survey was used in conjunction with the EM61 to delineate the lateral extent of the trenches by mapping the anomalous conditions created by disturbed zones and buried metal objects. The GPR technique was chosen to provide a cross-sectional image of the subsurface from which depth estimates could be made. These data could be used to corroborate and refine the lateral boundaries of the trenches determined by the other techniques.

HIGH-SENSITIVITY METAL DETECTOR (EM61)

The metal detector survey was completed using a Geonics EM61 High-Sensitivity Metal Detector. The EM61 is a time domain electromagnetic (EM) system that can discriminate between conductive soils and metal objects. The EM61 generates rapid electromagnetic pulses and measures the response of the subsurface between pulses. Secondary EM fields are generated in the ground after each pulse. These fields dissipate rapidly in earth materials but remain for a longer time in buried metal objects. The EM61 measures the prolonged metal response only after the earth response has dissipated. This response is measured and displayed in millivolts (mV).

For this investigation, data were acquired along parallel grid lines spaced 5 ft apart. Measurements were recorded at less than 1-ft intervals along each grid line. Data were collected at approximately 60,000 points to provide very high lateral resolution.

TERRAIN CONDUCTIVITY (EM31)

The terrain conductivity method uses the principle of electromagnetic induction to measure the electrical conductivity of earth/fill materials. Commonly, significant contrasts in the electrical properties between non-indigenous materials and surrounding soil enable accurate delineation of former disposal sites.

A Geonics EM31-D was used to conduct the survey. The EM31-D operates in accordance with the theory of operation at low induction numbers. An alternating current is passed through transmitter coil to induce eddy currents into the ground below the instrument. These eddy currents generate a secondary magnetic field. The quadrature-phase component of the induced secondary magnetic field is detected by a receiver coil and measured by the instrument. The measured response is linearly related to the terrain conductivity. The instrument converts the measured signal and displays it as terrain conductivity in milliSeimens per meter (mS/m).

Data were acquired at 2.5-ft intervals along parallel grid lines spaced 5-ft apart. The data were digitally recorded to improve precision and eliminate the possibility of transcription error. The EM31-D was calibrated prior to operation at an off-site background reference station believed to free from cultural interference. The reference station was re-occupied at the end of each day of operation for system functional checks.

GROUND PENETRATING RADAR (GPR)

The GPR technique uses the transmission and reflection of radio waves to image objects beneath the ground surface. The technique responds to changes in the electrical properties of the earth or buried materials. A GPR target must possess electrical characteristics that are different from the surrounding media. When the transmitted wave encounters an anomalous object or layer, the wave is reflected back to the surface where it is recorded and analyzed. The waves are transmitted rapidly such that a continuous subsurface image is generated as the transmitter is pulled along the ground surface.

The GPR survey was performed using a digital SIR System-2 Subsurface Interface Radar System, manufactured by Geophysical Survey Systems, Inc. A 400 MHz transducer was chosen after initial field tests to provide maximum penetration with sufficient resolution. Data were digitally recorded, displayed, and analyzed during acquisition to allow real-time interpretation. Further detailed processing was completed on a portable computer.

The location of GPR survey lines were chosen after the EM61 and EM31 data were processed and interpreted to allow strategic placement. Data were collected continuously along traverses established over EM anomalies.

SUMMARY OF RESULTS

AREA 1: MAIN SURVEY AREA

Plate 1 presents a plan map of the EM61 data collected at the main survey area. All values above background (0 mV) are considered anomalous and are attributed to occurrence of metal objects. The data are characterized by high-amplitude, linear patterns of anomalies that extend throughout the majority of the site. Very few significant metallic anomalies were identified outside the boundaries of these anomalies. Based on anomaly amplitude as well as the depth and linear arrangement of buried metal objects, these linear anomalies are interpreted as former disposal trenches.

The linear anomaly along the western portion of Area 1 is approximately 40-ft wide and over 1,000 ft long. The western end of this anomaly extends into Area 2 and is described in the following section. Two anomalous areas containing buried metal were detected south of the interpreted trench near stations 450N/700E and 600N/975E.

The linear anomalies on the eastern end of Area 1 are also well defined. The western end of this anomaly has a higher amplitude and greater width (approximately 60 ft) than the eastern end. The lower amplitudes measured at the eastern end indicate fewer metal objects are present. Additional anomalies, which are attributed to buried metal, are identified south of the interpreted trench location near station 650N/1650E. Finally, a small continuous metal object was detected near the southern fence and is interpreted as a buried pipeline. The remaining anomalies observed near the perimeter of the Area 1 are attributed to the chain link fence that surrounds the site.

Depths to the top of buried metal objects were estimated using the EM61 data. If numerous metal objects are buried close, these estimates would represent the depths to the most shallow objects. The estimated depths of selected metal object within the interpreted trenches ranges from 1.3 to 7.2 (mean = 4.1). feet? There does not appear to be any significant difference between the range of depths calculated for objects in the western and eastern trenches.

Plate 2 presents the in-phase EM31 data collected in Area 1. The locations of detected anomalies are consistent with those detected during the EM61 survey and corroborate the interpreted trench boundaries. However, these boundaries are less well defined due to interference from the chain link fence and the lower resolution of the EM31. An decrease in overall conductivity is observed in the unpaved area and is attributed to the surficial materials.

Figure 2 presents the EM31 conductivity data in the unpaved portion of Area 1. These data show a low conductivity anomaly that is consistent with the documented location of the former chemical disposal pits. This anomaly may be caused either by the presence of organic constituents associated with the former chemical trench or by lateral changes in fill materials.

GPR data were collected over the interpreted location of the former trenches to confirm the interpreted boundaries and determine depths. The locations of the profile lines are presented in Figure 3. The GPR profiles are shown in Figures 4 through 10. The X/Y coordinates presented along the tope of the profile correspond to survey grid coordinates. The processed data indicate the depth of the trenches range from approximately 11 to 15 ft below ground surface (bgs).

The GPR data collected in the unpaved area did not reveal any anomalies attributable to disposal trenches due to insufficient electrical contrasts between the buried and native materials. However, horizontal interfaces were encountered and are attributed to the cover materials. An example of these interfaces is presented in Figure 10.

AREA 2: SMALL PAVED AREA

Area 2 is located at the western end of the survey site and is adjacent to Area 1 (Figure 1). Figure 11 shows a linear anomaly located along grid line 375N. This anomaly corresponds to the interpreted trench identified in Area 1 and defines the western boundary of the trench. The remaining anomalies around the perimeter of the site are attributed to interference from the surrounding chain-link fence. The EM31 (Figure 12) data show no evidence of trench boundaries due to excessive interference from the fence. The depth of the interpreted trench could not be determined from the GPR data due to poor data quality.

AREA3: SMALL UNPAVED AREA

Figure 13 is a plan map of the EM61 data collected at Area 3. These data show numerous anomalies that are scattered randomly throughout the area. No linea: patterns of anomalies — similar to those seen in Area 1 and 2 — were observed, suggesting a more heterogeneous distribution of buried materials. Based on the location of metal objects, the boundary of the disposal area extends at least to the survey area boundary. The calculated depths of detected buried metal object ranges from 0.1 to 6.8 ft.

The terrain conductivity data presented in Figure 14 show no evidence of lateral changes in conductivity attributable to disposal area boundaries. If this boundary were located near the fence, it would be masked by the observed interference. Finally, the GPR data did not reveal any continuous anomalies attributable to the boundary of the disposal area.

In conclusion, the results of the investigation successfully achieved the project objectives by delineating the extent of major disposal trenches. Please contact me at 610-384-6772 if you have question regarding the results presented in this summary report.

Kind regards,

Bay Geophysical Associates, Inc.

M. Scott Mc Quown, P.G.
Principal Geophysicist

Attachments: Plate 1 EM61 Anomaly Map of Area 1
Plate 2: EM31 In-phase Map of Area 1

Fi re 1
Survey Area Location Map
Los Alamos National Laboratory
TA-21, MDA B

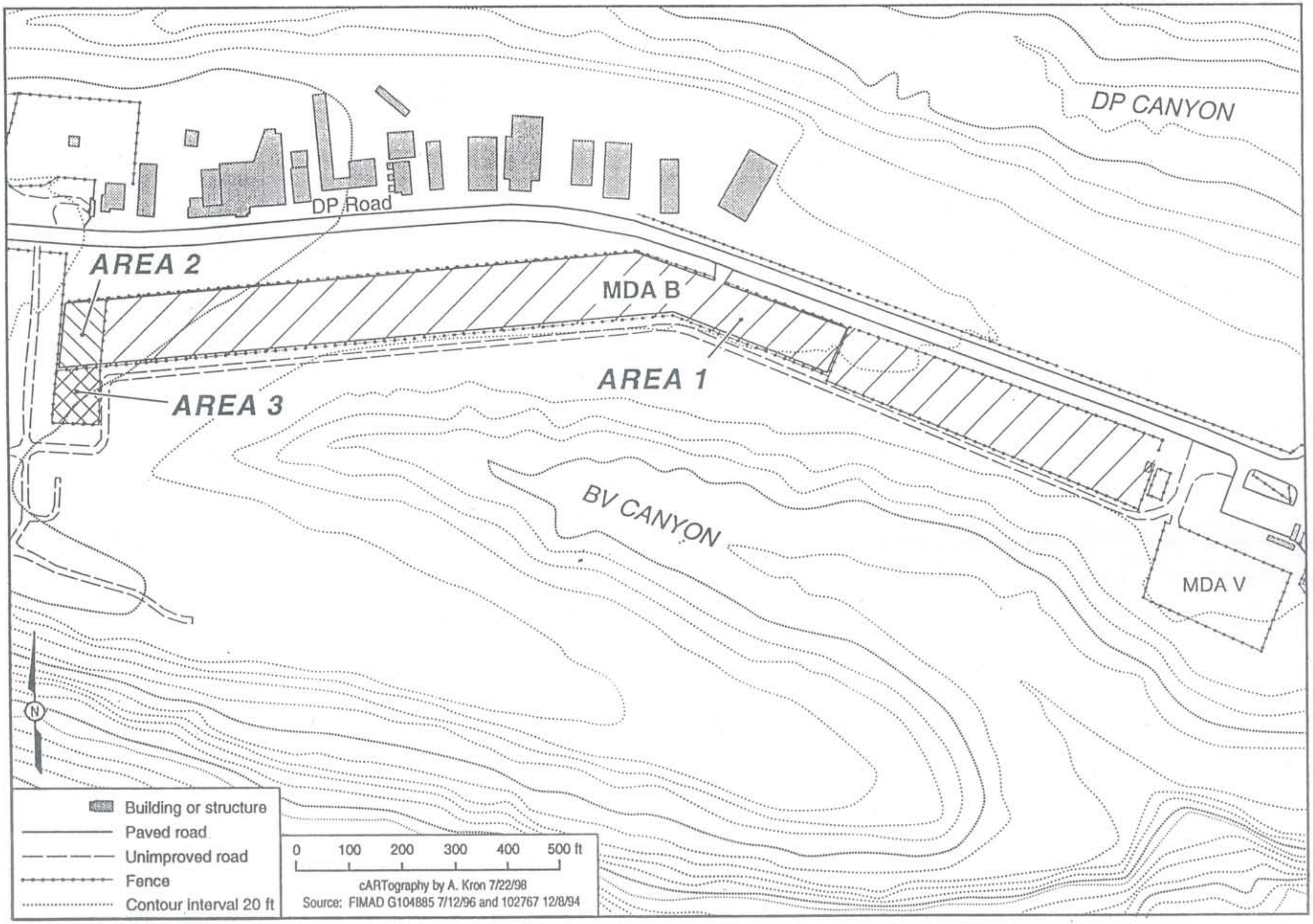


Figure 2
Terrain Conductivity Map
Former Chemical Disposal Pit Area
TA-21, MDA-B

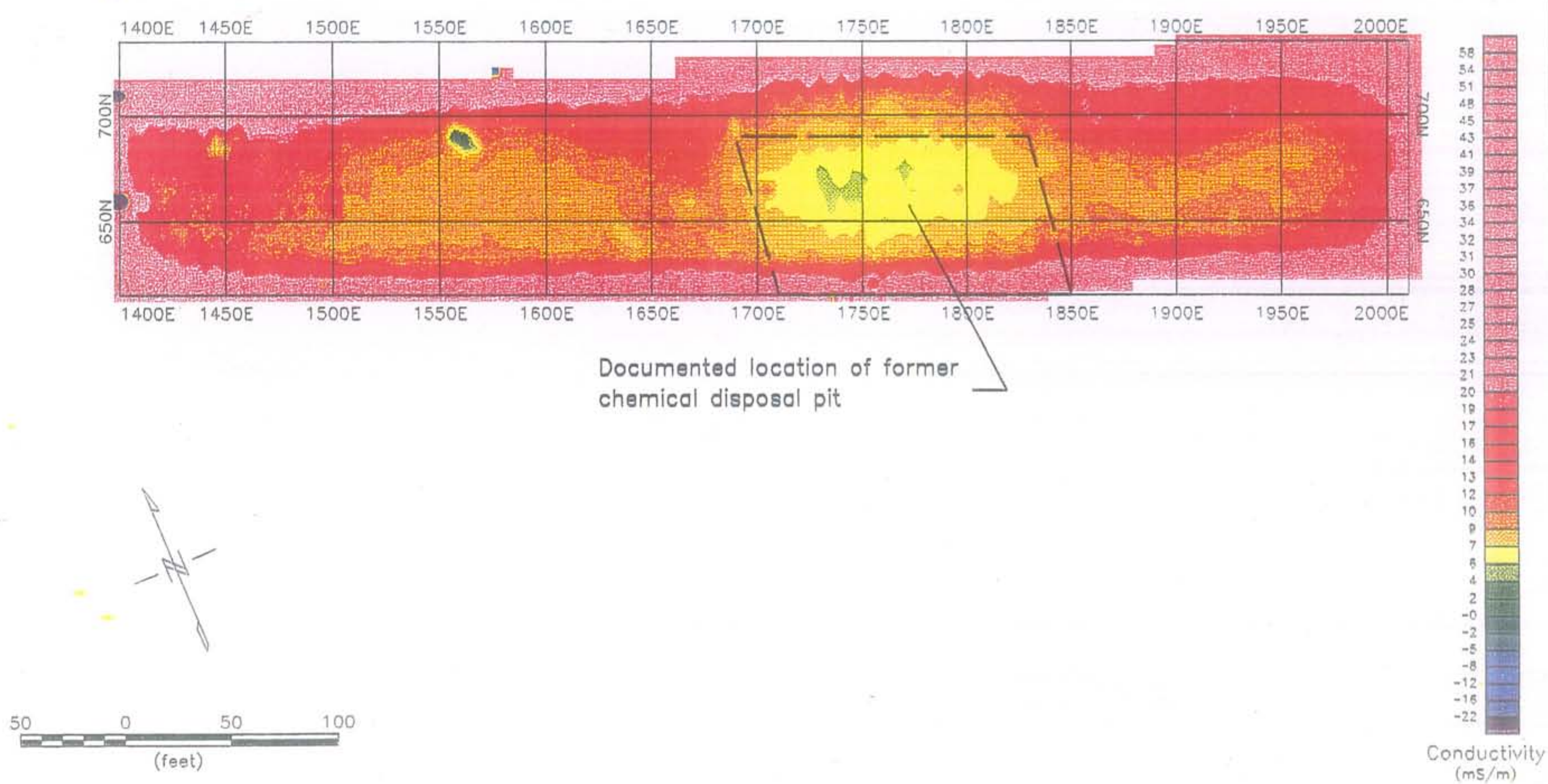


Figure 3
GPR Line Location Map
Los Alamos National Laboratory
TA-21, MDA-B

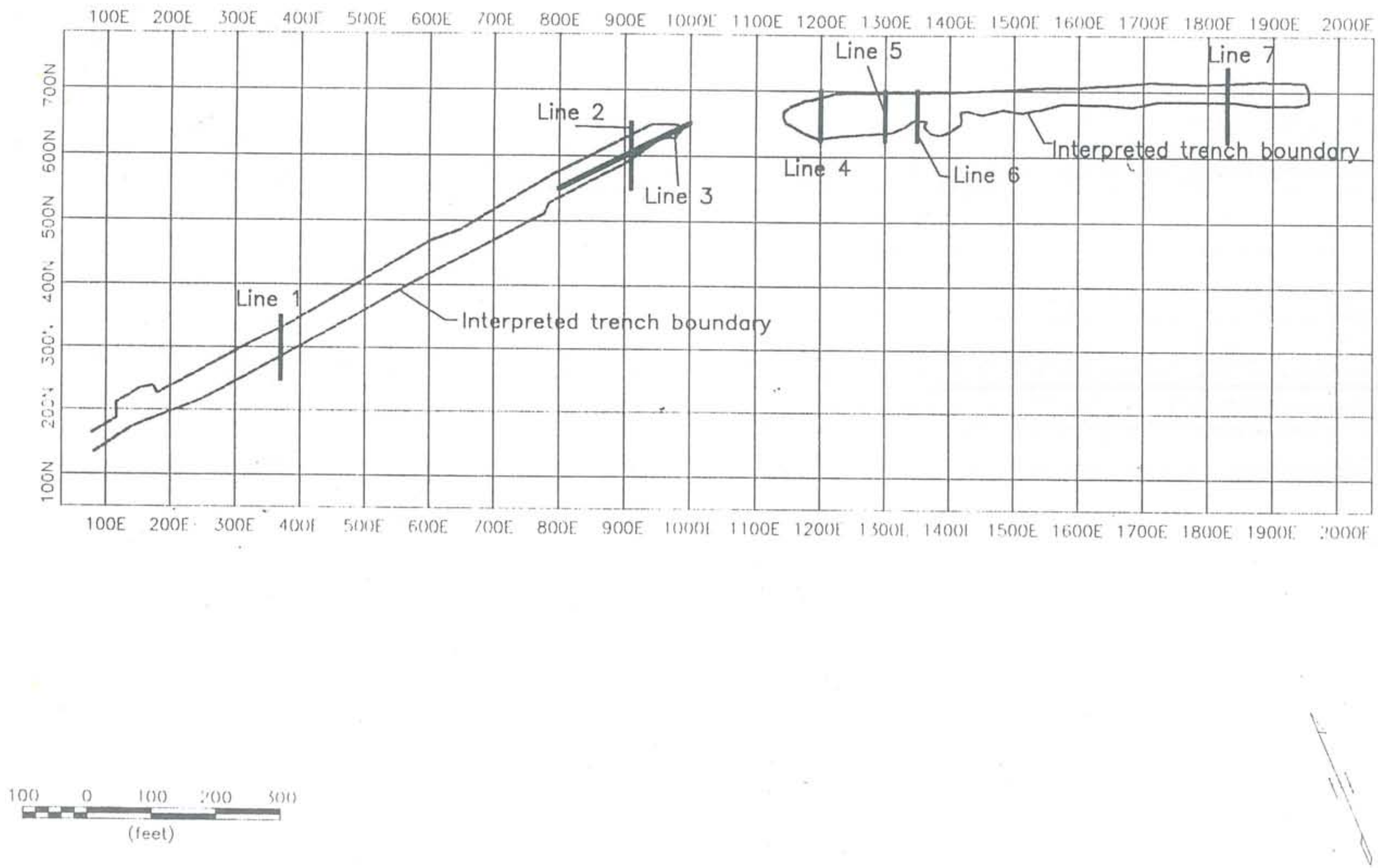


Figure 4
GPR Profile – Line 1
Los Alamos National Laboratory
TA-21, MDA B

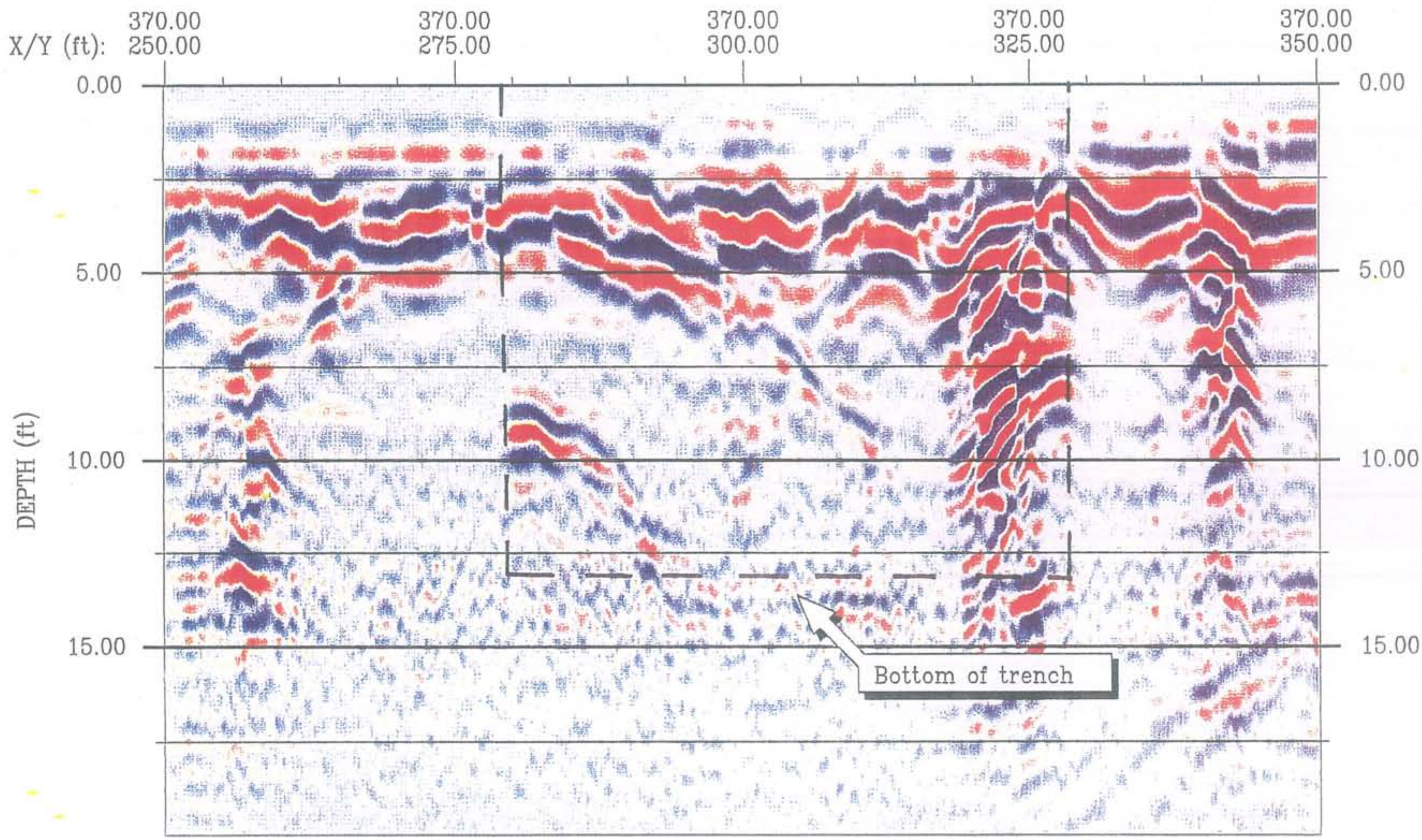


Figure 5
GPR Profile – Line 2
Los Alamos National Laboratory
TA-21, MDA-B

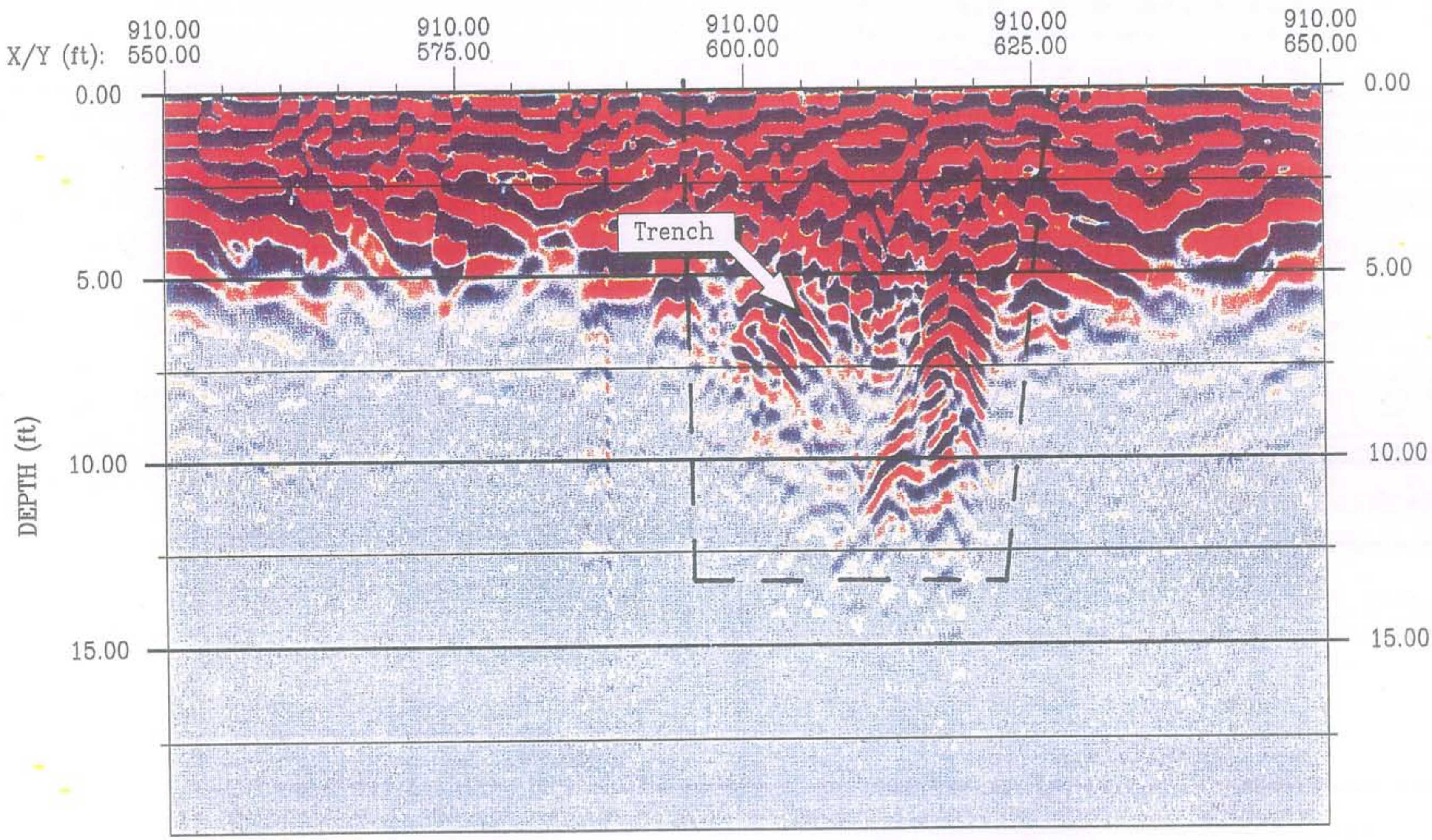


Figure 6
GPR Profile – Line 3
Los Alamos National Laboratory
TA-21, MDA-B

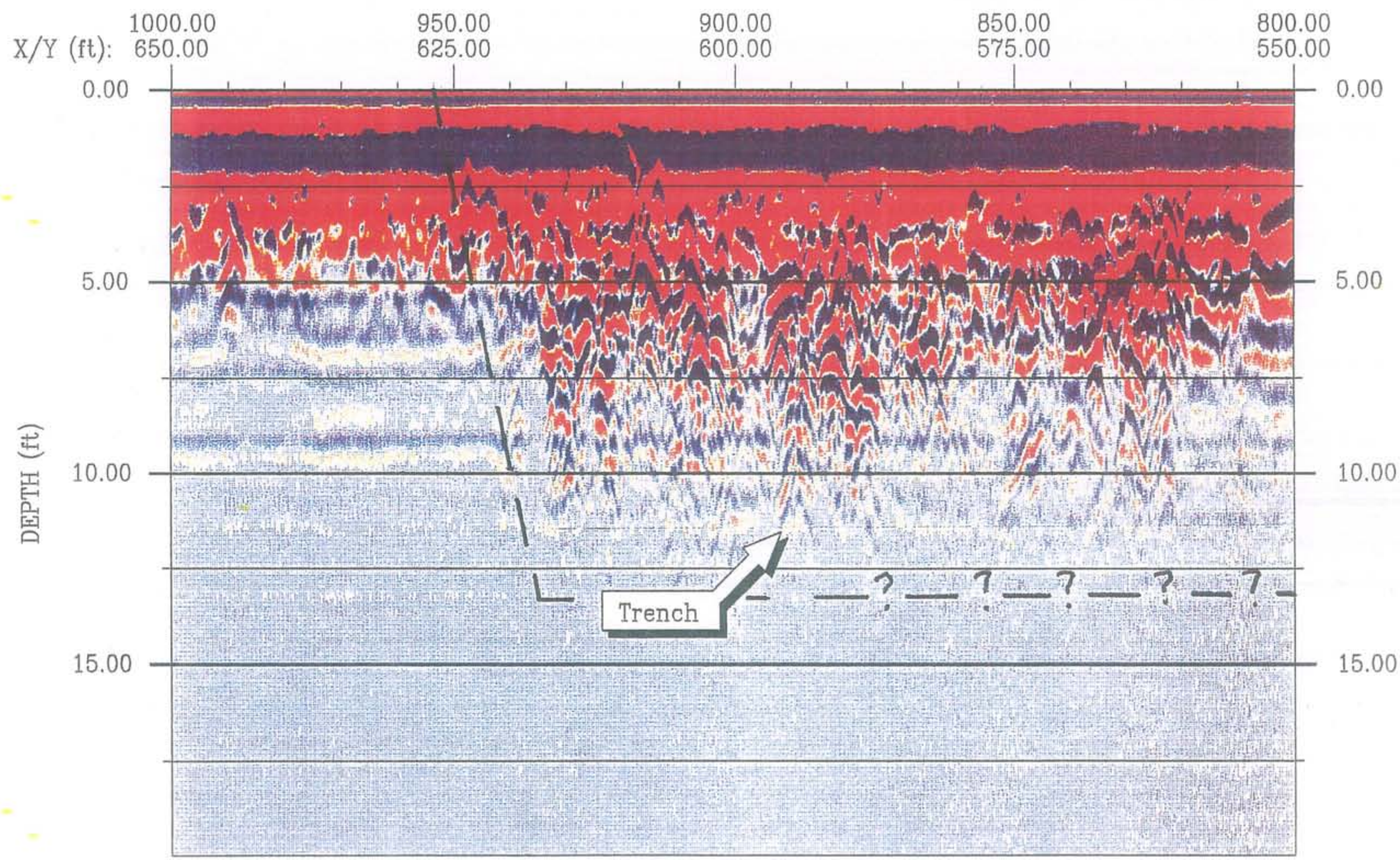


Figure 7
GPR Profile – Line 4
Los Alamos National Laboratory
TA-21, MDA-B

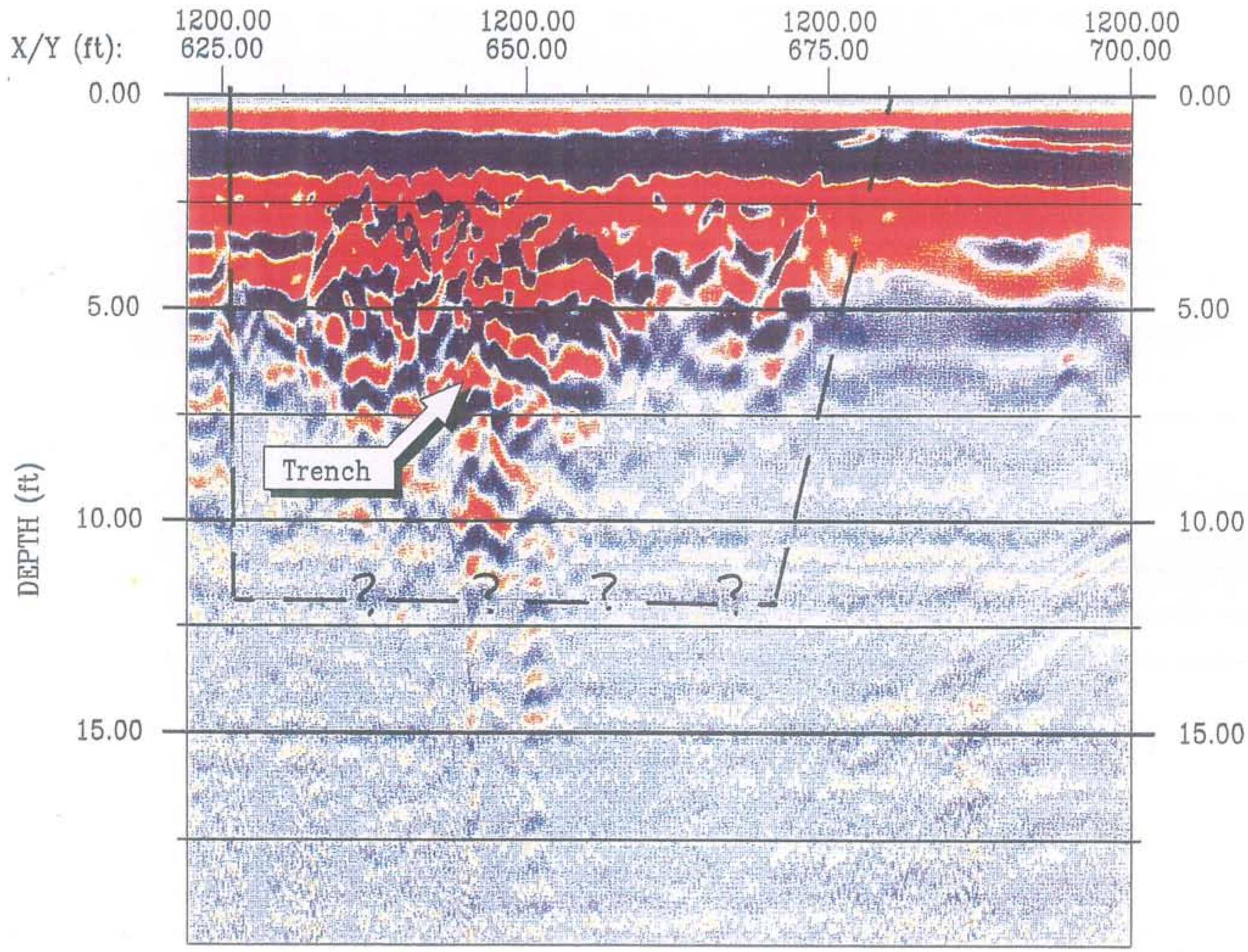


Figure 8
GPR Profile – Line 5
Los Alamos National Laboratory
TA-21, MDA-B

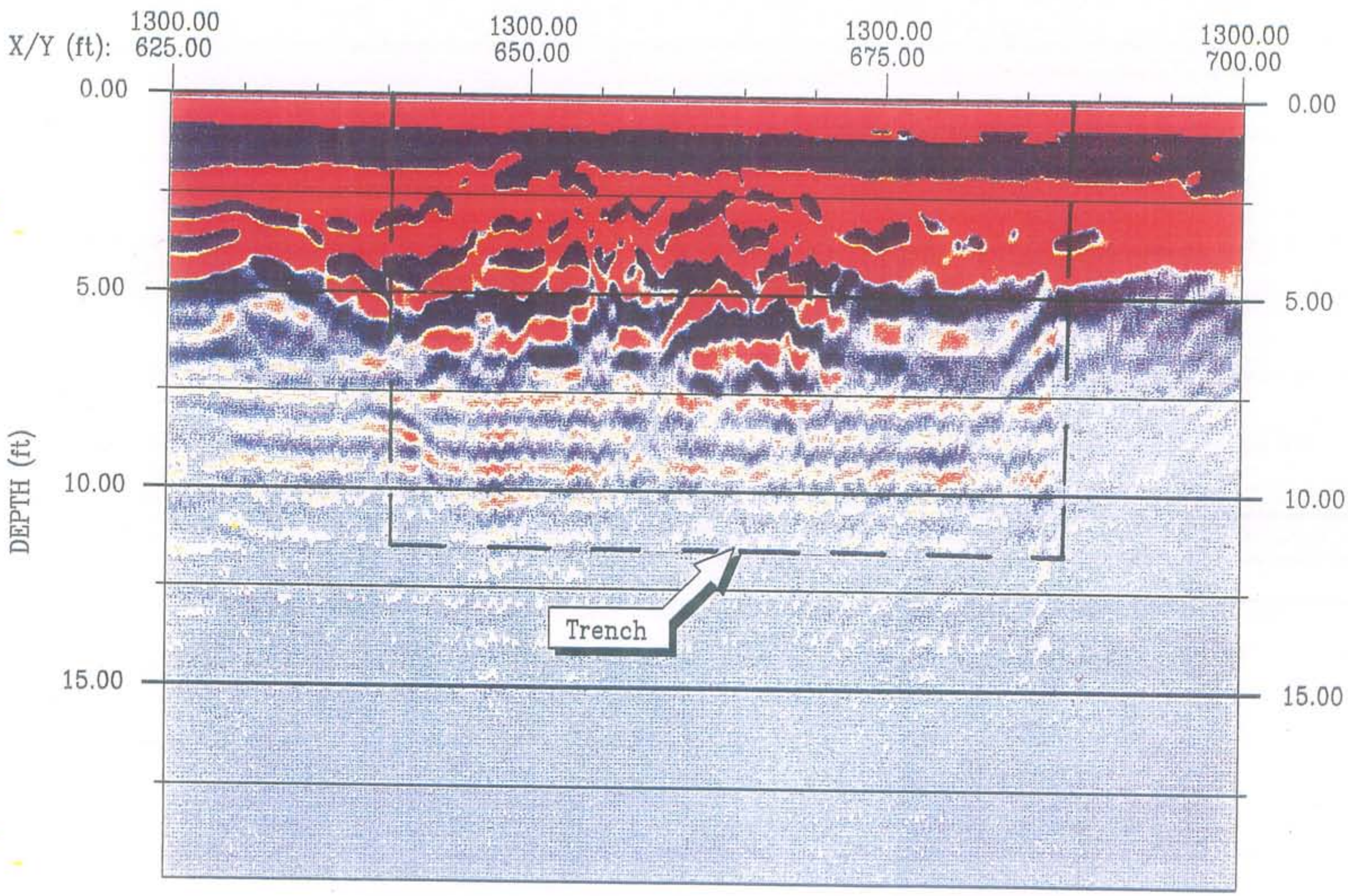


Figure 9
GPR Profile – Line 6
Los Alamos National Laboratory
TA-21, MDA-B

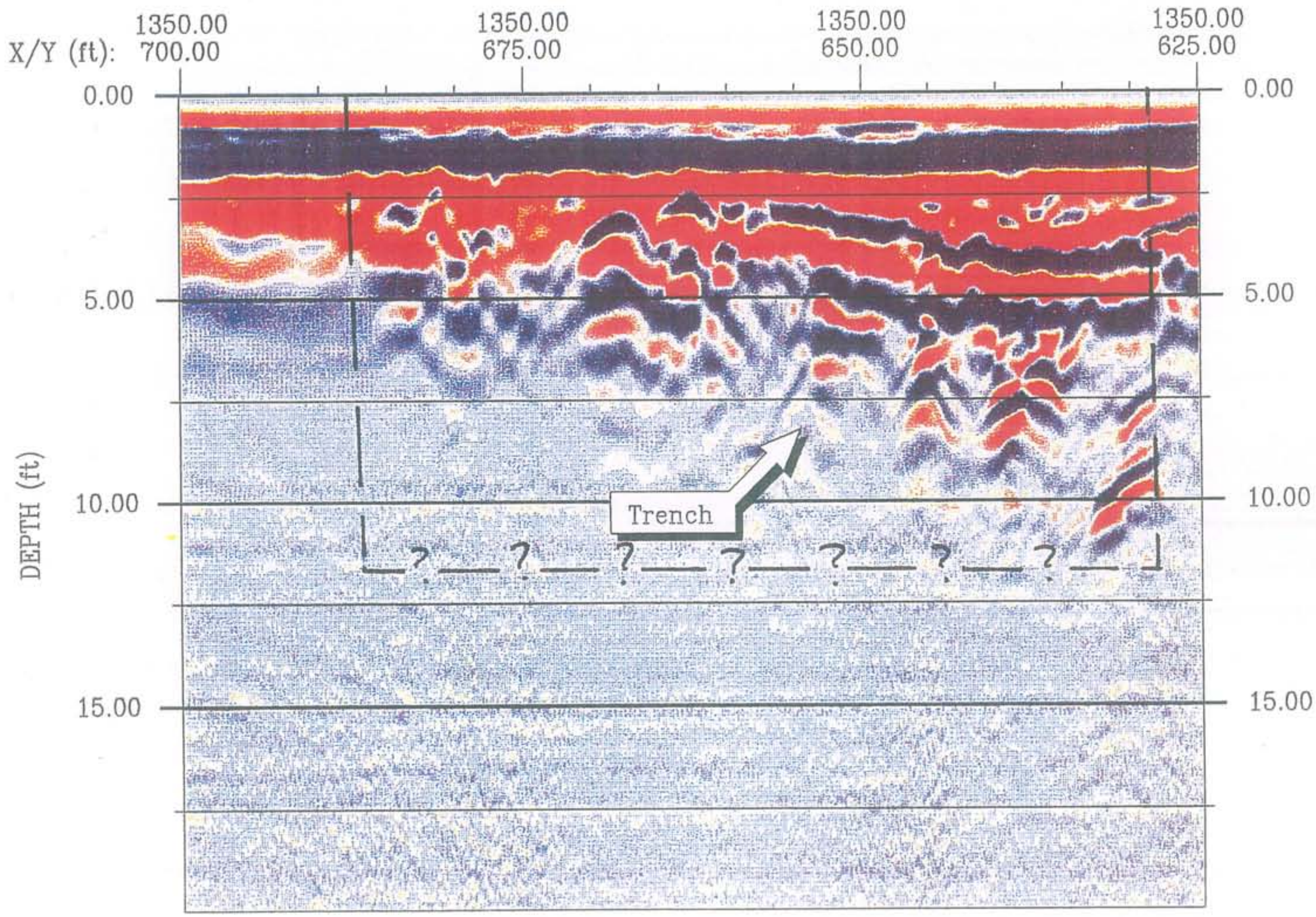


Figure 10
GPR Profile – Line 7
Los Alamos National Laboratory
TA-21, MDA-B

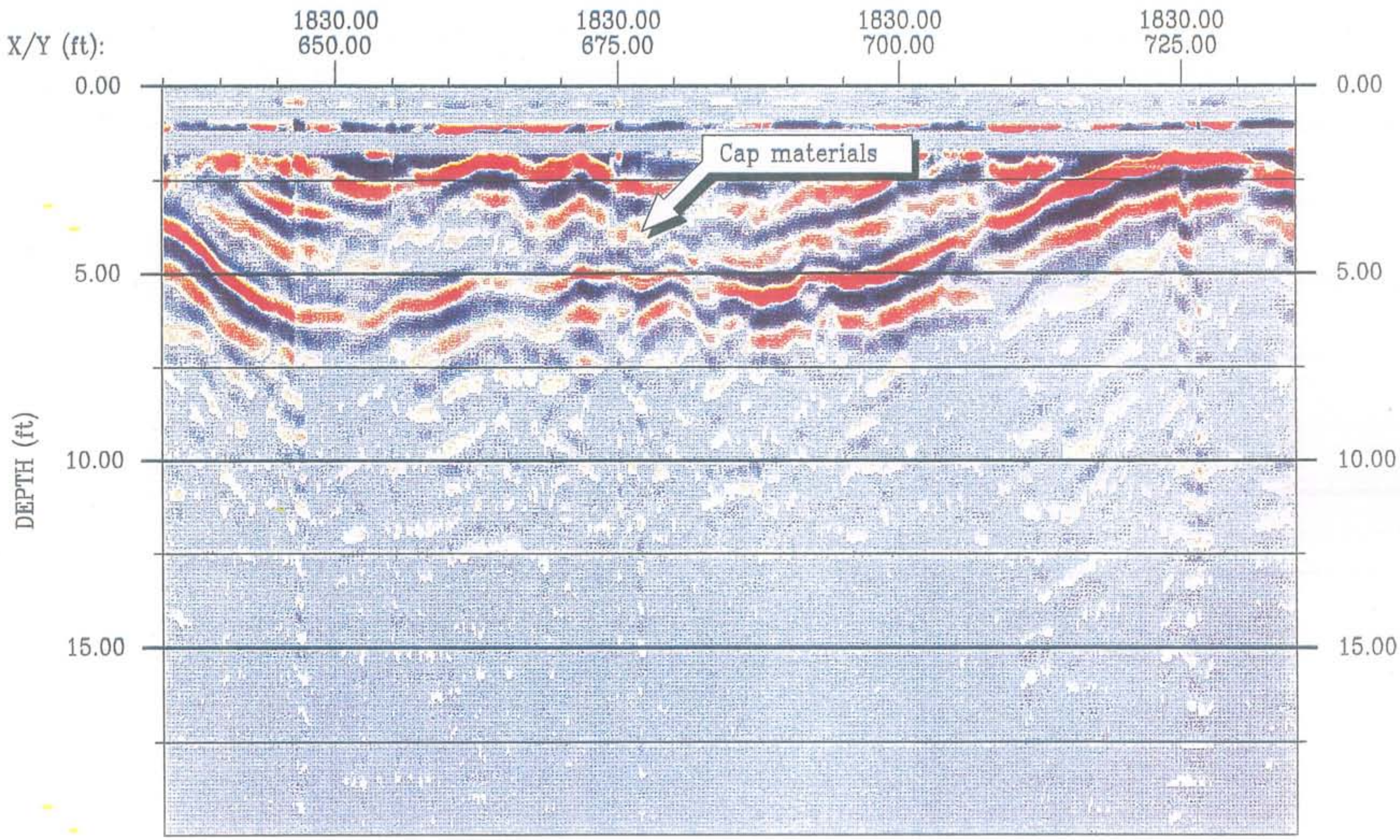


Figure 11
Buried Metal Anomaly (EM61) Map - Area 2
Los Alamos National Laboratory
TA-21, MDA-B

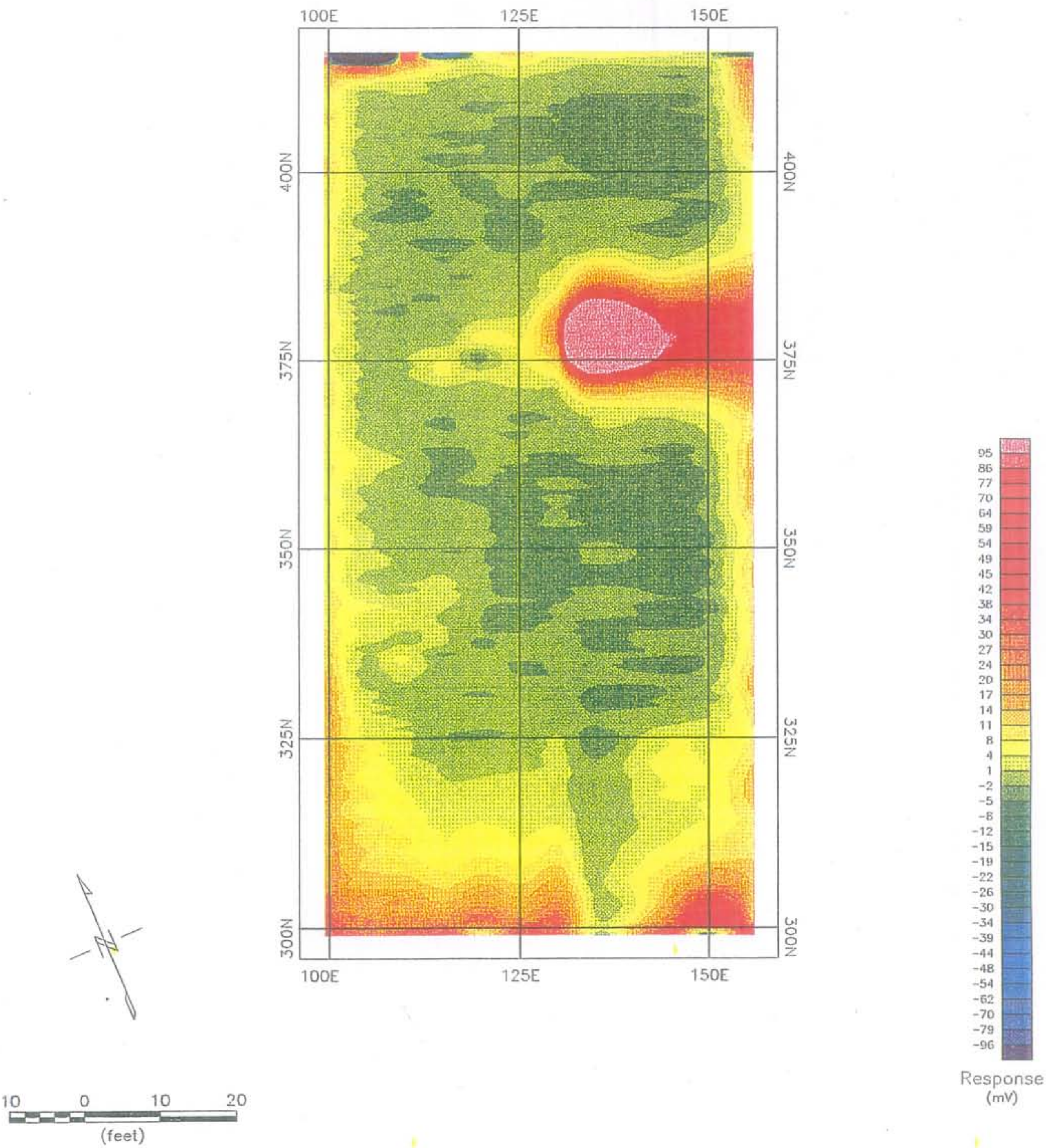


Figure 12
Terrain Conductivity Map - Area 2
Los Alamos National Laboratory
TA-21, MDA-B

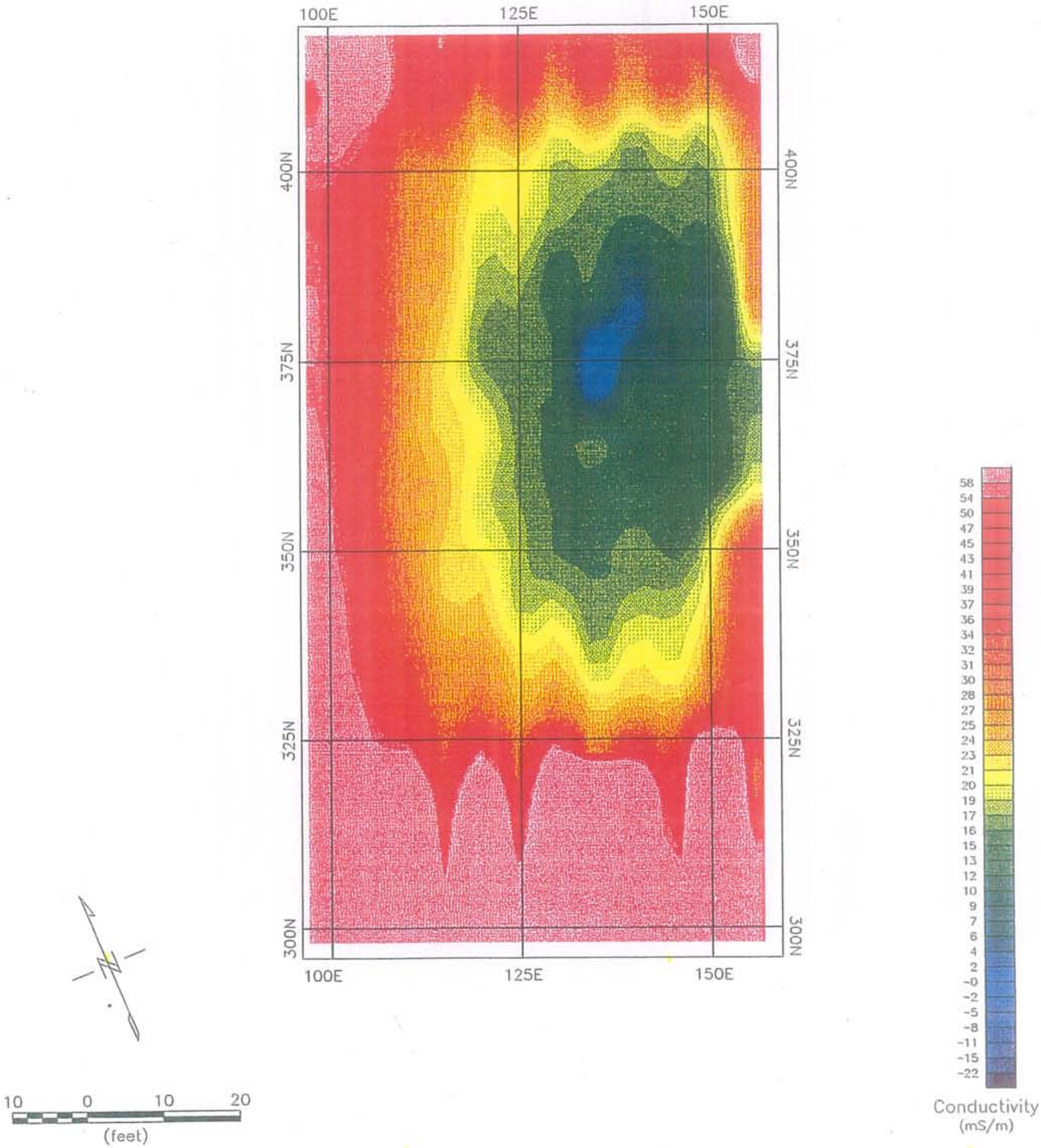


Figure 13
Buried Metal Anomaly (EM61) Map - Area 3
Los Alamos National Laboratory
TA-21, MDA-B

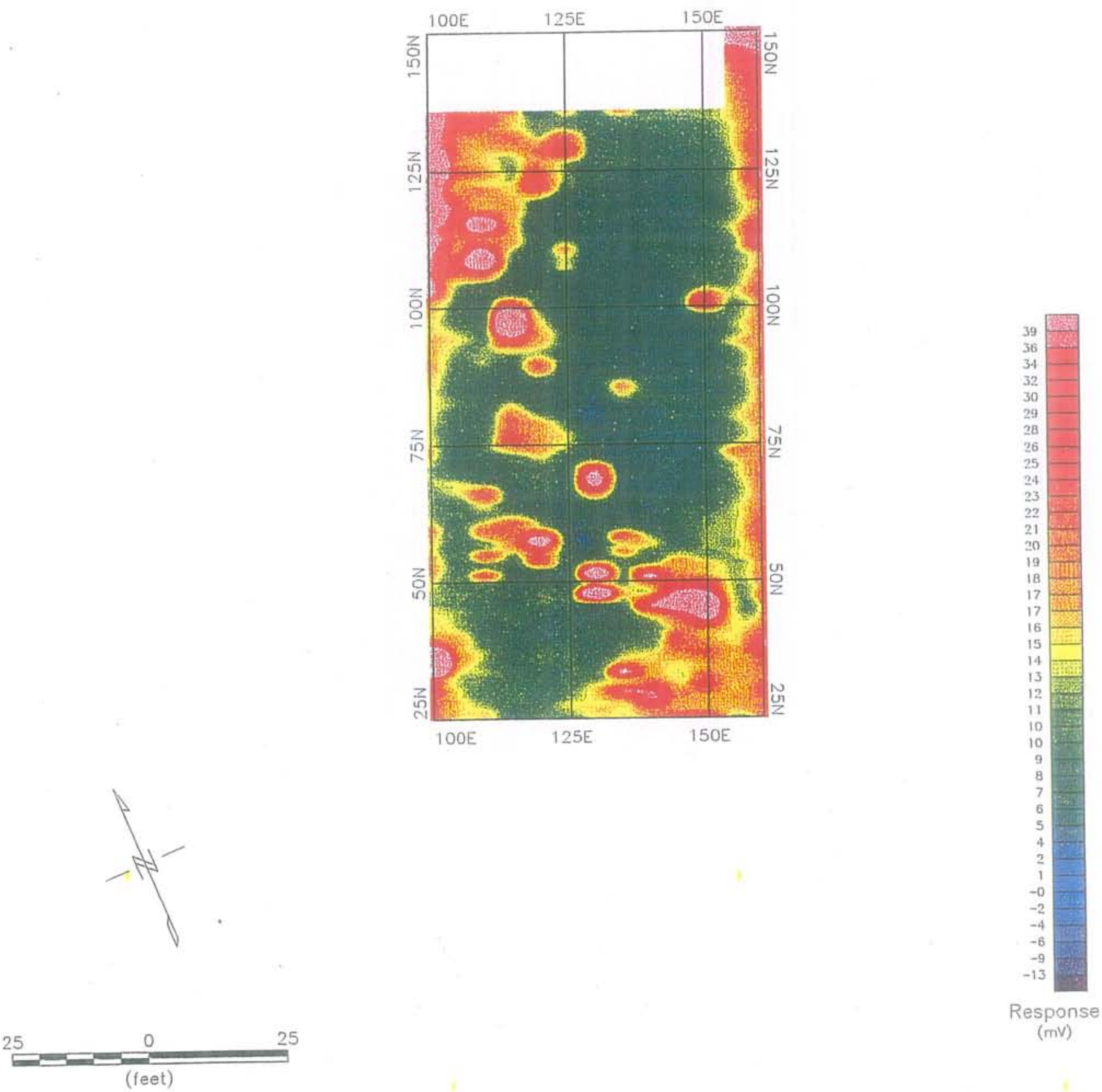
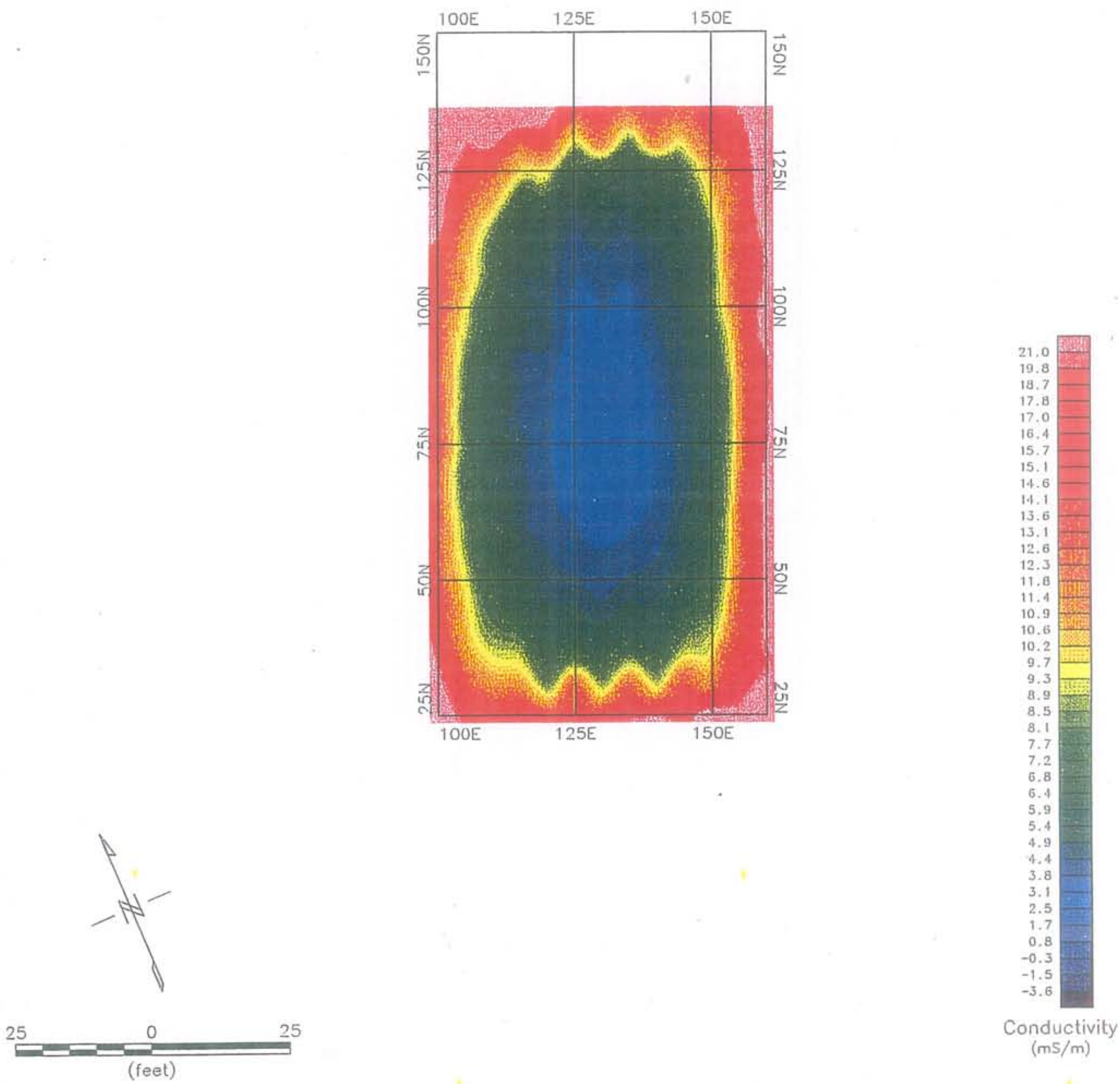


Figure 14
Terrain Conductivity Map - Area 3
Los Alamos National Laboratory
TA-21, MDA-B



Bay Geophysical Associates, Inc.

206 Cambridge Way, Coatesville, PA 19320

31 August 1998 Project No.: 98-176P

Mr. John Hopkins
Morrison Knudsen Corporation
2237 Trinity, Bldg. 2, 1st Floor
Los Alamos, New Mexico 87544

RE: **Results of additional geophysical surveying**
TA-21, MDA B, Los Alamos, New Mexico

Dear Mr. Hopkins:

This letter summarizes the result of the additional geophysical survey that was completed at the above reference site on 12 and 13 August 1998. The survey was completed to further delineate anomalies detected at Areas 1 and 3 during our initial survey. The results of our initial survey are described in our previous report dated 24 July 1998. Time domain EM metal detector (EM61) and ground penetrating radar (GPR) surveys were performed to achieve the survey objectives.

METHODOLOGY

The EM31 and GPR methods used for this survey are described in our previous report dated 24 July 1998. EM61 data were recorded at less than 1-ft intervals along lines spaced 5-ft apart. GPR data were recorded continuously along lines spaced 5-ft apart.

RESULTS AND DISCUSSION

AREA 1

Data were collected along the access road located south of the original survey area. Data collection was confined to the road because dense vegetation on either side of the road prevented access with the geophysical instruments. The primary focus of this survey was to define the southern extent of the anomalies located near 460N/725E and 600N/975E and to verify that the anomaly located along the southern boundary near the eastern end of Area 1 is due to the wastewater pipeline.

A plan map of all the EM61 data collected at Area 1 is presented in Plate 1. The data collected during this survey is represented by the narrow band located along the southern boundary of the site. The areas of elevated EM61 readings located along the northern edge of the access road are attributed to interference from the fence and the wastewater pipeline. No buried metal objects were detected along the southern edge of the access road with the exception of two small objects near 170N/290E. These data confirm that the anomalies of concern do not extend south of the access road. The GPR data collected along the road also do not indicate the presence of buried metallic waste. The GPR data do indicate several bedrock depressions that may have been backfilled during the construction of the access road.

Detailed GPR surveying was completed to further define the EM61 anomaly located near 460N/725E. Figure 1 presents a north-south GPR profile collected along grid line 710E. A strong reflection event was observed and is interpreted as the bedrock interface. This interface dips to the south (toward the adjacent valley) from approximately 15 ft to 22 ft. Similarly, sloping events were observed at the western (Figure 2) and eastern (Figure 3) edges of the EM61 anomaly. The three-dimensional configuration indicated by the GPR data suggests that one or more north-south trending bedrock depressions exist in this area. The presence of a bedrock depression is also supported by surface topography. Evidence of construction debris was visually observed at the surface in this vicinity.

AREA 3

Figure 4 presents the EM61 data collected at Area 3. Additional data were collected outside of the fenced area in an attempt to define the extent of buried metal objects detected during the previous survey. The blank areas shown on the figure indicate areas that could not be surveyed due to surface obstructions. The results indicate the presence of additional buried metal objects located outside the fence. Partially buried objects were visually observed in the western portion of the survey area. In addition, several utilities are known to exist in this area as well.

The GPR data did not detect any features that could be interpreted as former waste burial trenches. However, chaotic reflection events were observed in the western portion that suggest the presence of fill materials.

CONCLUSIONS

The results of the additional surveying at Area 1 indicate the anomalies detected during the previous survey do not extent past the southern edge of the access road. The occurrence of exposed bedrock along the majority of the access road corroborates this interpretation. EM61 anomalies located along the northern edge of this survey are attributed to the fence and the wastewater pipeline. Several buried bedrock depressions were interpreted from the GPR data. One of these depressions was observed south of the EM61 anomaly near 460N/725E. The occurrence of construction debris exposed near the surface in this area suggests that this area had been backfilled with construction debris. This interpretation suggests that the anomalies of concern may be caused by construction debris that was used to fill a former topographic depression. The shallow depth and low amplitude of the EM61 anomalies detected in this area are consistent with this interpretation.

The additional data collected at Area 3 was unsuccessful at delineating the extent of the suspected waste burial site. The data does indicate the presence of buried metal objects at the western edge of the site. However, the presence of known pipelines and surface observations suggest that this area has been disturbed and possibly backfilled for reasons unrelated to the alleged disposal of materials within the fence boundary.

Please contact me at 610-384-6772 if you have any questions regarding the results of this investigation. We appreciate the opportunity to provide our services and we look forward to the possibility of working with you again.

Kind regards,
Bay Geophysical Associates, Inc.

M. Scott McQuown, P.G.
Principal Geophysicist

Figure 1
GPR Profile - 420N/710E to 460N/710E
TA-21, MDA B
Los Alamos National Laboratory

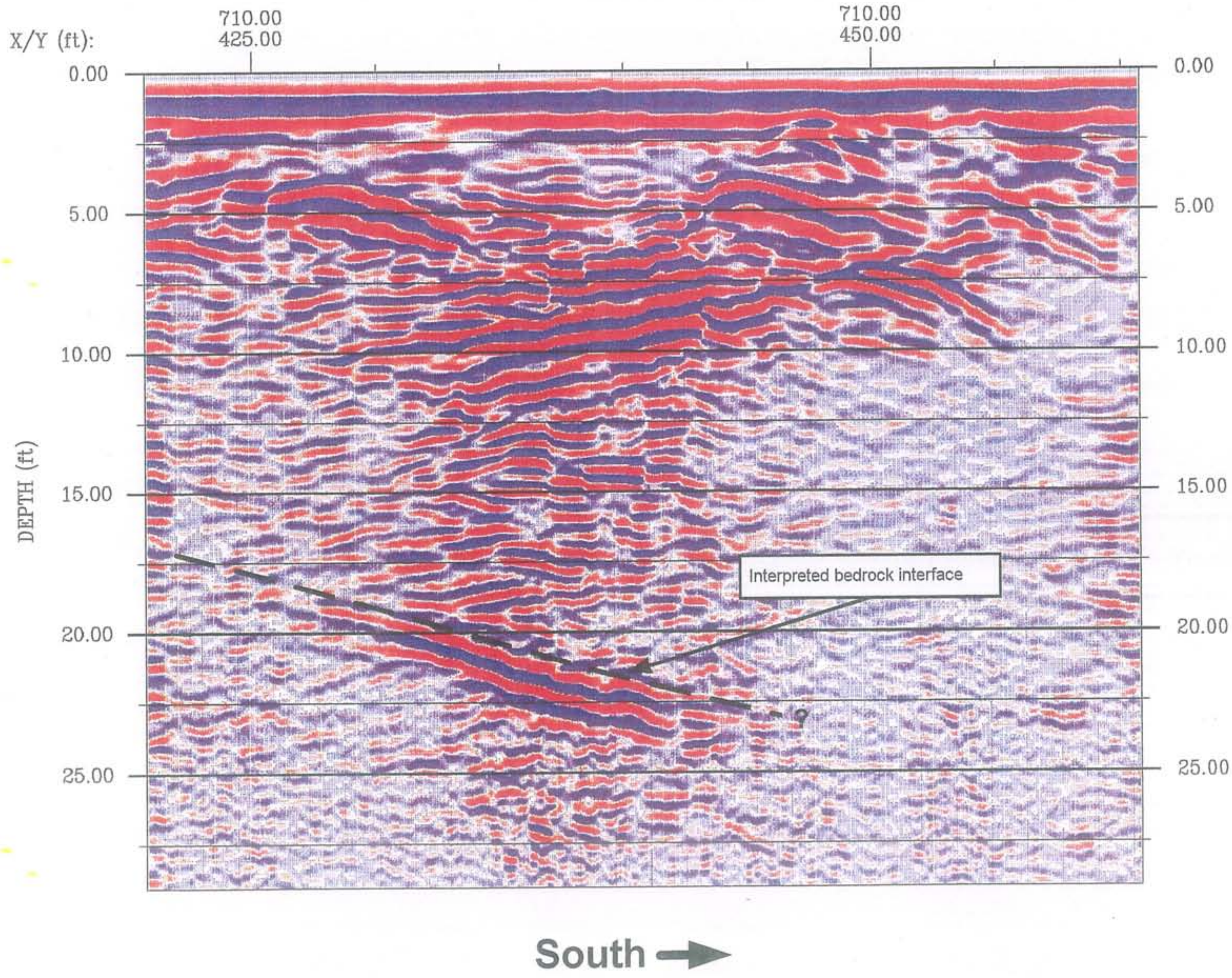


Figure 2
GPR Profile - 405N/723E to 415N/744E
TA-21, MDA B
Los Alamos National Laboratory

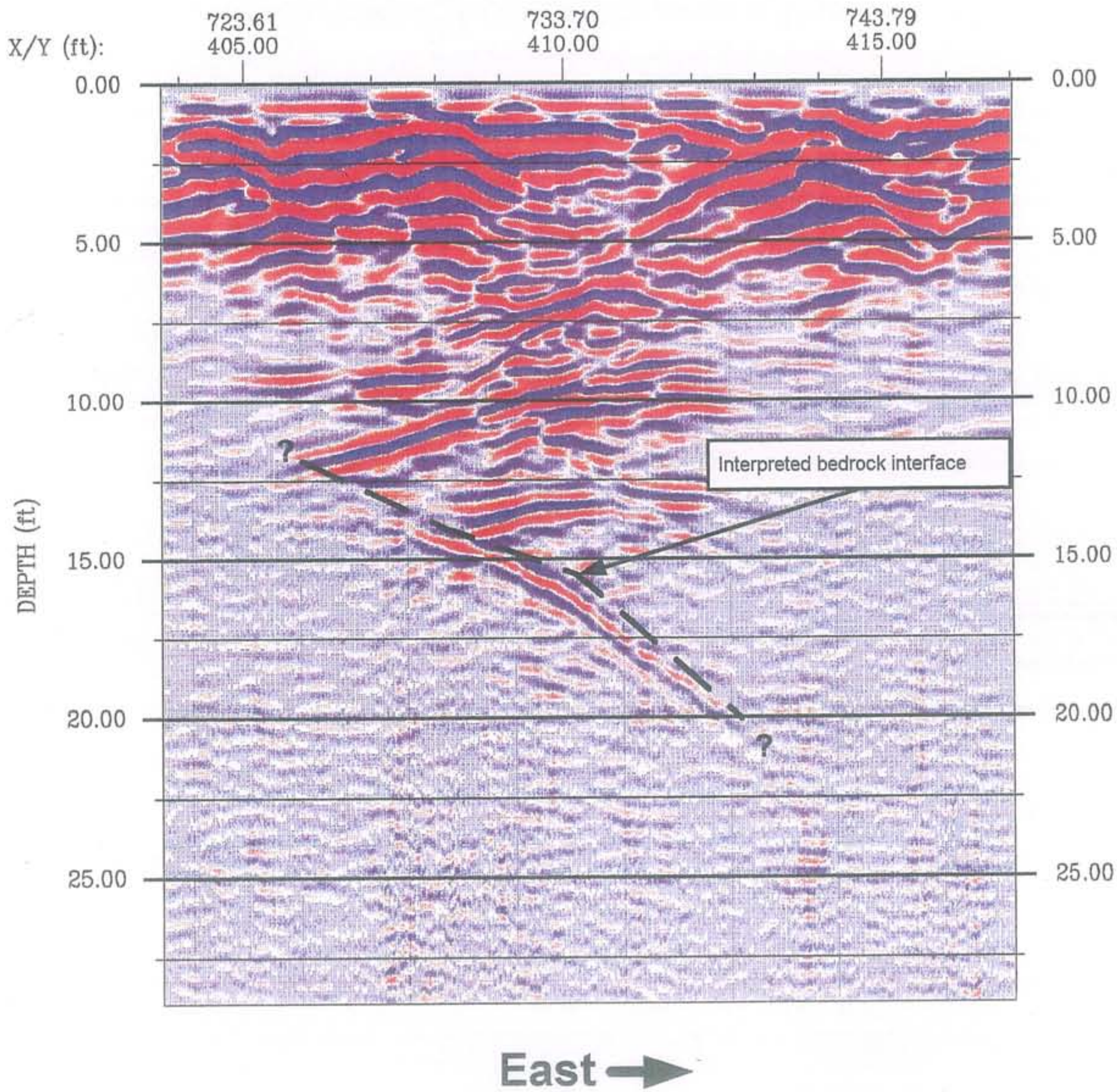


Figure 3
GPR Profile - 420N/750E to 450N/810E
TA-21, MDA B
Los Alamos National Laboratory

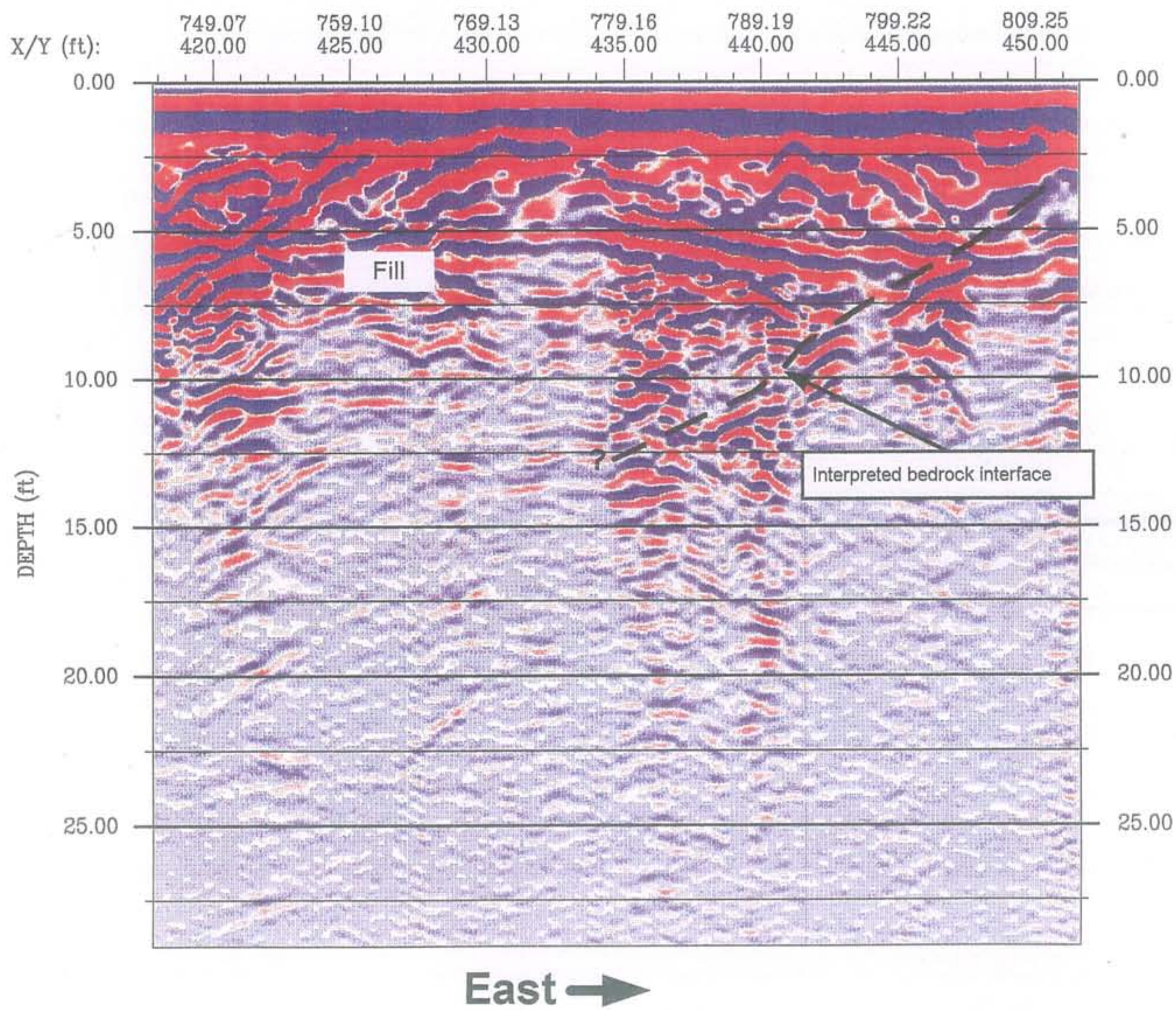
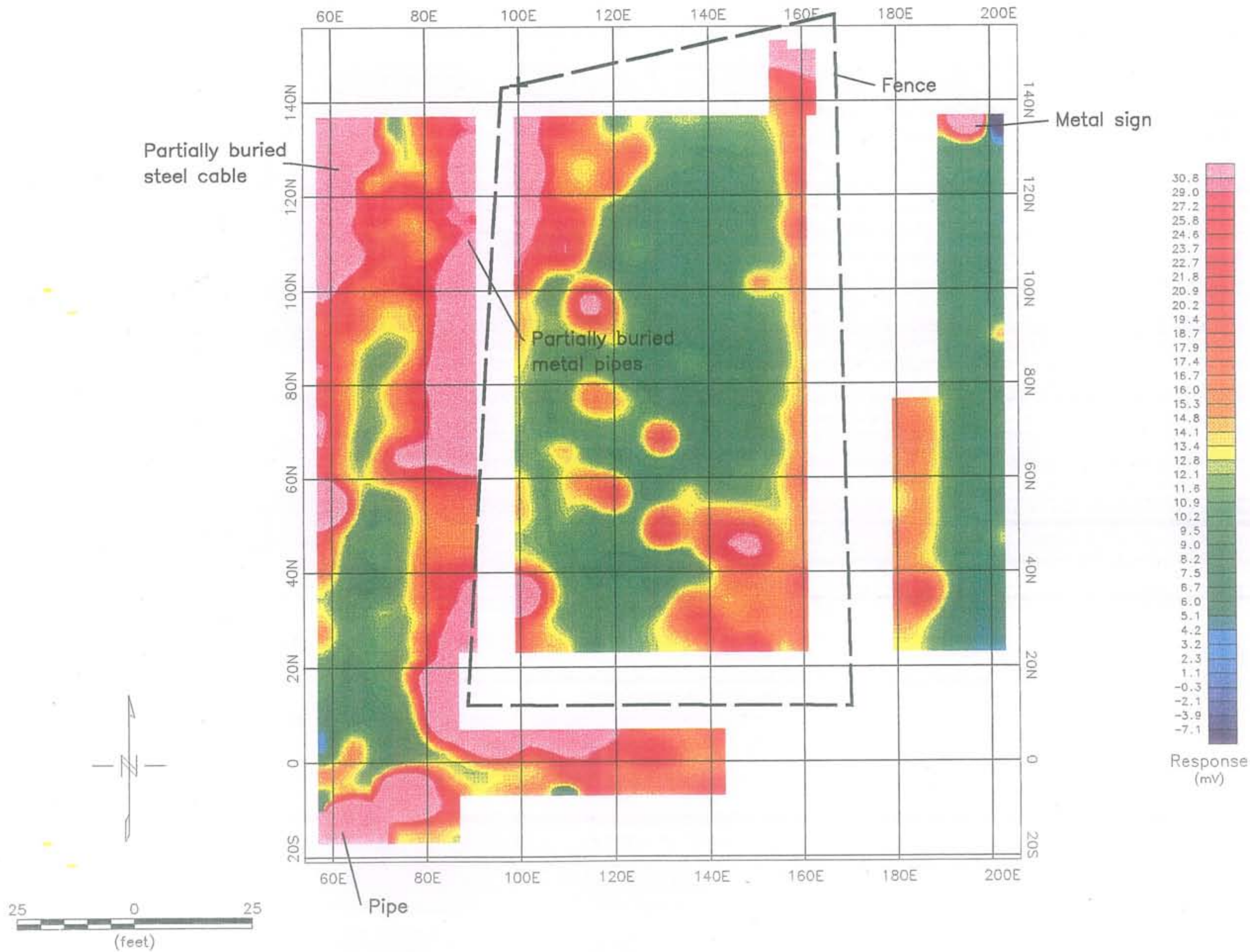


Figure 4
Buried Metal Response – Area 3
TA-21, MDA B
Los Alamos National Laboratory



Appendix C

Historical Background Concerning the Los Alamos Scientific Laboratory Technical Areas and Organizations, 1947

This document contains restricted data within the meaning of the Atomic Energy Act of 1946 and/or information affecting the national defense of the United States within the meaning of the Espionage Act, 50 U.S.C. 31 and 32 as amended. Its transmission or the revelation of its contents in any manner to an unauthorized person is prohibited and may result in severe criminal penalty.

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UNCLASSIFIED

September 11, 1947

To: The Manager, U.S.A.E.C. Office of Santa Fe Directed Operations

From: The Director, Los Alamos Scientific Laboratory

Subject: General Background Data Concerning the Los Alamos Scientific Laboratory

Symbol: LAB-A-5

1. Attached for your use are three copies of a compendium of background data concerning the setting, history, and mode of operation of the Laboratory, plus three other copies for Mr. J. F. Brown of Associated Architects Engineers Inc.

2. No attempt has been made here to go into any detail on design considerations for the various types of installations which will be required by the Laboratory, but such data will be forwarded at a later date.

FOR THE DIRECTOR

A. W. Betts
Associate Director

GLM:lu

Encl. 6 copies (Background Data)

cc: N. E. Bradbury
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2-12-

A Technical Maintenance Group Report
on
General Background Data Concerning
The Los Alamos Scientific Laboratory
Required for Planning Purposes

LAB-A-5 September 11, 1947

SPECIAL RE-REVIEW
FINAL DETERMINATION
UNCLASSIFIED, DATE:

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INDEX

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I. Preliminary Statement

In accordance with a directive of the General Manager, U.S.A.E.C., the Manager, U.S.A.E.C., Office of Santa Fe Directed Operations, has the responsibility of undertaking a complete study of the functioning of the Los Alamos Laboratory in all its ramifications, and of deriving from this study a comprehensive master plan for the housing of the Laboratory's activities in permanent fireproof structures, these structures to be erected at sites so disposed that they will: a. permit successful security protection; b. in general cause no danger to persons or property outside the Project boundaries as a result of their activities; c. will similarly cause no interference one to the other because of these same activities; and d. will be conveniently located with respect to one another. The background against which the study must take place is that at present the major part of the community activities plus the central technical establishment are crowded together almost at the geographic center of the project land area on Los Alamos Mesa, with some thirty other technical areas located to the east, southeast and southwest, some within a half mile or less of the southern Project boundary which runs along State Route #4. The entire northern half of the project area plus the mountainous regions in the Jemez Mountains to the west has been left unused except for the five water sources in the Jemez Range, the military firing ranges along the Gauje water line in the upper regions of Barrancas Canyon about two miles north of the main technical area, and the golf course and other recreational facilities situated about a mile and a half north of the main technical area along the upper reaches of Pueblo and Bayo Canyons. This means, then, that approximately two-thirds of the project area, about forty-five or fifty square miles, has been relatively untouched and should be seriously considered for possible use as the planning work moves ahead.

II. Delineation of the Problem.

A. Technical Area Locations

Spacially, the activities of the Laboratory must be so situated that reasonably convenient access is to be had among all the parts, and preferably that the major areas of activity can be quickly reached from the community areas. No hard and fast rule can be set on this, but it would certainly seem advantageous to have all of the technical areas within easy driving distance, say fifteen minutes at the most, of the most remote residential areas, so that in the event of an emergency at an isolated laboratory or firing site responsible technical personnel could be summoned to the scene in short order. Also, if at all possible, connecting roadways should be so arranged that it will not be necessary - as it is at present - to transport explosives, active material and classified objects through the residential and business areas or closely adjacent thereto.

B. Organizational Relations

Organizationally, the master plan will have to be adjusted to best accomodate Laboratory procurement and warehousing problems, maintenance facilities, utility supply and distribution, special shop services, adequate communications, and both normal and contaminated waste disposal. At the present time the arrangements in almost all of these fields are somewhat of a hodge podge, and necessarily so because of the way in which the Project was organized and constructed during the War years when it was assumed that all installations were temporary and would be removed at the end of the War. Another phase of the organizational planning must necessarily come from higher authority and involves decisions as to methods of community organization and management, including the question of dual or single contract operation of all physical facilities including the Laboratory, with its resultant effect on the manner in which actual work is done, by whom and under what authority; and with further consequent result in the desirability of location for such items as power plants, maintenance shops, sewage disposal units, and even central administration buildings. In this field the Consultant Planning Group must clearly set up the overall results which will follow from varying organizational arrangements so that higher authority can make such decisions with a full understanding of the consequences which will follow.

C. Decision on TA-1 Location

A decision on the future use of the TA-1 location was forced upon us by the time scale which future planning and reconstruction activities must necessarily follow. The A. A. E., Consultant Planning Group, because of difficulties in the recruiting and clearing of adequately experienced personnel, will not begin to function on any large scale before October or November of this year. If they are to do a thorough job, it is difficult to believe that anything resembling a master plan or several alternative master plans can be produced in less than six to eight months, so it will be perhaps March, 1948 before these plans are ready for discussion and consequent decision by higher authority. Another year will elapse before the first section of buildings for a new area can be completed and occupied, so that it will be around March, 1949 before we can expect any use from the first structures resulting from the planning work. The decision having been made that the central functions of the Laboratory are to be transferred to South Mesa, we can now decide more clearly what should and should not be done to the structures and facilities in TA-1. Any large structures which have to be built here should be as light and temporary as possible, but since all of the present structures will be in use for a period of two years and many of them up to six years, depending on how fast reconstruction progresses, proper maintenance and the provision of certain amenities at least will surely be necessary and will have to be considered as part of the price to be paid for the relocation of the central Laboratory functions.

III. Status of the Project as a Whole

A. Boundary Conditions

The original land acquisitions in Sandoval County which resulted in the Project as it is today were made by the real estate section of the Albuquerque U. S. Engineers Office and the resulting boundaries, roughly, are the Santa Fe County line on the east, State Route #4, and the Bandelier National Monument on the south, Baca location #1 on the west, and the Santa Clara Indian Reservation on the north, the whole comprising a little more than seventy-five square miles.

B. Possibilities for Expansion

It is conceivably possible to acquire some land east of Sandoval County to State Route #4. One half is San Ildefonso Pueblo territory, one quarter is held by the Park Service as part of the Bandelier National Monument but there are no widely publicized Indian ruins in the area and if national policy so dictated, this stretch of territory could probably be ceded to the A.E.C. by Congress, and the remaining quarter is privately owned. For reasons of security patrol, the existence of the boundary along Route #4, rather than one to two miles back up into the canyons and mesas where patrol is almost impossible, would certainly be to our advantage. On the south the land between the Project boundary and Route #4 is privately owned, and could no doubt be procured. On the west, Baca location #1 is privately owned and it is conceivable that the A.E.C. could acquire by outright purchase a considerable percentage of this property. At the moment such acquisition has no great value, but in the future if the Project continues its work in the development of atomic power plants, the Valle Grande would make an excellent location for one and could be connected to the main body of the Project at no too great expense with a tunnel through the Jemez Range, thereby insuring all-weather communication. Conceivably also, should future necessity arise for more stringent security measures regarding the Project as a whole, a fenced line in the lowland of the Valle Grande would certainly make a more easily watched and protected boundary to the west than does the present western boundary, running as it does through the highest part of the Jemez Range. To the north there is little likelihood that Congress could be induced to deprive the Santa Clara Indian Reservation of any of the land now assigned to it, or that it could legally do so should it so desire.

C. General Considerations

All of the above discussion is, of course, subject to the eventual disposition which the A.E.C. may care to make of the Laboratory as a whole, but inasmuch as a recent directive calls for the planning and reconstruction which is about to be undertaken, it seems reasonable to expect that the Laboratory will become a permanent institution unless the exigencies of possible future guided missile warfare should render it completely impossible of defense and hence cause its abandonment and/or destruction. This latter grim note should also remind us that in the overall planning scheme it may be wise to completely bury certain key installations such as storage vaults for active material and other important bomb components, so that in the event of destruction of all or most of the community by guided missile attack, we would at least have the essential parts remaining here of the weapons themselves, in such location and in such condition as to be salvaged for retaliation.

IV. Status of the Community

A. Population

Early in 1943 when construction for this project got under way, the total population was only several hundred. During the War years the civilian population grew to approximately 2500 and another 3000 military personnel were stationed here. Since the end of the War military personnel has declined to about 1,000 men, but the civilian population growth has more than exceeded the loss of military personnel and the total population of the Project is now in the neighborhood of 7,000. An additional 2,000 persons or more commute daily to and from the Hill, the majority of them being construction contractors' employees, janitors, manual laborers, household servants and the like, although a sizable number of more responsible personnel also commute. From the viewpoint of convenience of operations and the growth of community pride and integration, it is of course desirable that as many as possible of these commuters eventually be housed here at Los Alamos. Preliminary studies prepared for the Manager have indicated that a minimum of 1200 new family housing units above and beyond those presently contracted for will be required in the next two or three years for this purpose. This obviously will only take care of housing units which are not available in any form and will not take care of replacement of the many hundred temporary units in the Morgan, Hanford, McKee and possibly the Leonard Wood areas. As an estimate, perhaps 1000 more units will be required for this purpose some time in the next five to seven years.

B. Primary Community Areas

The size of the primary areas required for housing and basic community functions will probably turn out to be between two and three square miles. Approximately two-thirds of this can be taken care of, if it be desired, here on Los Alamos Mesa, including the western housing development and adjacent Denver metal housing development. The remaining one-third could be conveniently situated on North Mesa or in the hilly country north and west of the golf course, this again requiring consideration of possible locations for new technical areas.

C. Secondary Community Areas

The size of secondary community areas is a little difficult to define because such recreations as hiking and horseback riding, as well as hunting and fishing, will take people to all but the most inaccessible spots which have not been restricted for Laboratory use. Because of the nature of the terrain, it is often very difficult even to keep them out of such restricted areas unless they know their way around very well and know where they are at all times. For more organized recreation, baseball, golf, tennis and the like, the areas already allocated are probably sufficient with perhaps some slight enlargement, and the whole question of allocating new secondary areas to the community becomes principally one of negative assignment, in that all areas not restricted for Laboratory use, nor directly adjacent to the water sources, are essentially made available for hikers, etc. This would certainly amount to a minimum of thirty or forty square miles and, of course, to all intents and purposes the Bandelier National Monument property to the south and east should come under this same heading because it is likewise open to the public.

D. Security Considerations

Basic to all considerations affecting the status of the community and its land allocations is the question of whether or not Los Alamos is to be an open community. Originally an Army post on a Government reservation, it still retains the closed characteristics of an Army establishment, although it is now under civilian control. All persons, whether inhabitants, commuters, or visitors, must have permission to enter the Project and must carry proper passes and identification at all times. There has been some talk that this situation would be eased and that all persons having transportation could enter the Project at will, leaving only the various technical areas, public utility services, etc., restricted to personnel permitted to enter them. This would put the Project on essentially the same status as Boulder Dam and Boulder City, and there is much in parallel. Boulder Dam is a large and valuable Government property which, during the War, was carefully guarded as an essential sector of the War effort, yet Boulder City, where the people responsible for the Dam reside and where the administrative offices are located, is an open town on a public highway where any tourist may stop and shop around to suit himself. Only when he visits the Dam are his movements restricted. Applying this principle to Los Alamos, it would seem feasible to have the main Laboratory and the community definitely separated physically, by several miles if possible, and in this regard it is unfortunate that the Main Technical Area and most of the community have become located so closely adjacent to one another on Los Alamos Mesa. The ideal arrangement would probably be to place the community two mesas to the north or even in Barrancas Canyon, at least a mile or two from the nearest technical installation, with a new access road built to the community location from the Rio Grande Valley. Even yet it may not be too late to accomplish this because the only large amount of permanent housing thus far constructed in the Western Area is sufficiently off the main Los Alamos Mesa road to serve our purposes, although the early completion of the community center will make this transition a difficult one to decide upon and it may be that sufficient segregation can be obtained simply by creating a belt of park land - say, 100 yards minimum width - around the Main Technical Area on this mesa, and thereby achieve physical separation by this protective belt and by adequate fencing, rather than by a separation of a mile or two. A third method of achieving the desired result is, of course, to move the entire Main Technical Area from Los Alamos Mesa to some other location or locations. This possibility will be taken up in the next section.

V. Status of the Laboratory

A. Personnel

The personnel presently employed by the Laboratory number about 1,500 and as a conservative estimate, were housing freely available, this would probably be increased to 2,000 or possibly 2,200. Essentially working for the Laboratory, although not its employees, are the numerous janitors, laborers and workmen of the various maintenance and construction crafts, who are required to keep it in running order. These people number perhaps five or six hundred and require provisions in the way of working quarters, offices, shops, warehouse facilities, etc. in or closely adjacent to several of the technical areas. The future working force required by the Laboratory, then, may be set at something like 2,500 to 3,000, barring contingencies such as a major change by the A.E.C. of the basic directives by the Laboratory, in which case this figure might be either halved or doubled as the case might be. Allowing perhaps 300 sq. ft. of overall working space per employee, this means that the Laboratory will require around 900,000 sq. ft. of floor space and with the addition of warehousing and storage facilities, this figure would probably reach a million square feet of floor space. The total ground area set aside for technical purposes will, of course, be far greater than this, because of the necessity for isolation of many operations made hazardous by the use or production of high explosives, radioactive wastes, etc. As we have seen previously, something like twenty or twenty-five square miles is presently set aside for this purpose and some enlargement of the figure may be necessary either due to rearrangement of existing facilities in relation to one another, or because of the construction of a number of new technical areas.

B. Details Concerning Existing Areas

1. TA-1 (Main Technical Area)

a. This 25 acre area is the seat of all the central functions of the Laboratory. Here are the Director's offics, the various administrative and service groups, the central warehousing, the technical shops, the principal chemical and metallurgical laboratories, most of the experimental physics machines and equipment, the headquarters, shops, and preparation laboratories of the groups which operate the firing sites and other outlying technical areas, as well as the offices of the A.E.C., Security, Safety, Fire Protection, Accountable Property, and Communications personnel.

b. As noted above, all its buildings will still be in use for the next two to six years, while new facilities are being constructed at South Mesa, and considerable money will have to be extended for reasonable maintenance and minor construction, as well as for certain larger construction jobs admittedly temporary in nature. The Sigma Building Addition will be the first of these.

2. TA-2 (Omega Site)

a. There is much to be said both for and against the present location of Omega Site. A year ago the necessity of providing an immediate shelter for the installation of a fast reactor by the Physics Division made necessary a decision as to whether or not it should be located at TA-2, already used for three years by the Division. Considerations regarding trained personnel, shop equipment and the like made the decision in the affirmative, in spite of the fact that the site was located in Los Alamos Canyon directly below the occupied Los Alamos Mesa and that a serious accident would probably cause earth and air shock with consequent probable danger to structures on the Mesa, and would also produce a cloud of radioactive smoke and dust which might endanger the inhabitants on the Mesa. The physicists' calculations showed that the probability of such accidents on both counts was remote enough that Dr. Bradbury decided to go ahead with the reactor shelter at TA-2. This in turn involved construction of two other small permanent buildings for guard quarters and standby electric power, so that approximately half of the site is now of permanent construction and the remainder could be made so without too great an expenditure. Basically, the question of whether the site should remain where it is, once the money spent and decisions already made have been discounted, is that of whether or not the installations there are still regarded as having a sufficient degree of safety by the physicists to warrant their retention in a spot so close to the main community functions.

b. One basic problem which will have to be solved if Omega Site is to continue as a permanent location is the problem of the stream which runs through the site from west to east. Apparently the soil on which the main building is situated is of an extremely porous nature and the result has been that the whole underside of the eastern half of the building is under more or less continuous pressure from water which has seeped through from the stream. Some attempt to meet this problem has already been made by deepening the stream slightly and by taking steps to waterproof the main basement of the structure. It is basically a bad condition, however, and the only solution may well be to provide either a large culvert all the way through the site or to line the sides and bottom of the stream with concrete so that no seepage is possible. The former solution is preferable in that it would probably run to little more expense and that it would also make possible a considerable extension of the driveway area which is now somewhat cramped by the location of the stream.

3. TA-3 (South Mesa Site)

a. South Mesa Site is a grouping of temporary frame structures of extremely light construction together with some prefabricated hutments, several small magazines, a few lightly fabricated test chambers and one concrete explosives burning pit. The site was originally built for G Division and upon dissolution of this organization in 1945 was transferred to Group X-7 in the Explosives Division. It has always been used for the manufacture and testing of detonators, this latter usually in such numbers as to amount to less than half a pound of high explosive in any one firing. The entire site is scheduled for abandonment whenever the proposed permanent detonator laboratory is completed on Two Mile Mesa. The existing facilities are essentially useless for any further purpose other than perhaps temporary warehousing or something of that nature. The land on and adjacent to the site, however, is cleared and relatively level, and could be used as a location for some large technical installation should planning studies show that the area was desirable for such. A road through the area will have to be retained in any event to provide access to a. the 44 KV power line coming in from Albuquerque and b. the mast for exhaust gases for Omega Site which is scheduled to be built in the near future on lower South Mesa.

4. TA-4 (Alpha Site)

a. Alpha Site was constructed as a test firing site for small charges by members of G Division in 1944. Upon the dissolution of G Division in 1945 it was transferred to M Division and has continued to be used for its original purpose. The maximum charges fired there amount to 200 lbs. The buildings are all of reasonably light temporary construction, consisting of an underground control building with periscope, a small work shed directly adjacent to the control building, a hutment used as a trimming building, three small magazines and a dark room. Dr. Froman has recently asked that the site be considered permanent, but this should be studied in the light of the overall plan.

5. TA-5 (Beta Site)

a. Beta Site was constructed as an adjunct to Alpha Site in 1944. It was originally used for slightly larger charges than Alpha Site, ranging up to 600 pounds per shot. In the spring of 1945 the site was improved and a firing point was built some 700 feet to the east just off the toe of the mesa, to be used for charges up to one ton. Situated at the end of the mesa as it is, the only visible structures at the site are the control building, together with a trimming building further back along the road and a medium-sized magazine. The firing site is still in use and has three basic disadvantages: a. the types of experiments performed in the course of the firing have caused numerous forest fires in the valley land on both sides of the mesa, which is very narrow at that point, and in spite of numerous fire roads which have been cut through the forest to meet this contingency, recurrent fires still present a very awkward problem; b. being situated on high ground, the air shock from the shots travels directly across the intervening 3/4 mile and causes appreciable tremors at the DP Site buildings; c. again, because of its being situated on high ground, it is within fragment range of the Sandia Canyon installation and persons working there must be notified to seek shelter whenever a shot is fired at Beta Site. From this it can be seen that some advantages would certainly accrue were the firing activities now carried on at the site to be relocated either to some wide expanse of mesa land which could be cleared of brush and trees or else to a narrow canyon which could likewise be cleared and whose high walls would prevent the escape of flying fragments. If this were done, the activities presently carried on at Alpha Site could conceivably be removed to the present location of Beta Site and be more happily accomodated there. If the road is used to gain access to Mortandad Canyon, both sites will have to be eliminated. In any event, the Beta

Site location will require a complete rebuilding somewhere before it may be considered usable as a permanent facility.

6. TA-6 (Two Mile Mesa)

a. The Two Mile Mesa Laboratory area has served several purposes during the past several years. It originally consisted of some rough field installations such as bunkers, together with a control building and shop. Ordnance Division personnel used it for miscellaneous test purposes, principally in connection with handling and testing of high explosive. In October of 1944 a test saucer some 200' in diameter was constructed to be the scale model of a lake for the purpose of trying recovery shots. So far as I know, the project was dropped about the time the saucer was completed and it was never used. In the spring of 1945 the area was used for the construction of a detonator testing laboratory consisting of one main building and several test structures, the latter of concrete construction. A number of small magazines have been since added. The lab building and test structure may certainly be considered permanent if activities with detonators are to continue at Two Mile Mesa. At the present time a complete set of plans has been prepared by Black and Veatch for the construction of a permanent detonator laboratory and, so far as I know, these plans are ready for bids. In case a permanent detonator laboratory is not built on Two Mile Mesa, the area would furnish as good a building site for some other large technical installation as would South Mesa, again being clear of trees and relatively level.

7. TA-7 (Gomez Ranch Site)

a. Gomez Ranch Site was constructed in 1944 for some type of small explosives experiments involving radioactive material. It consisted of a frame structure of about 600 sq. ft. floor area and two firing pits or stadia about 40' in diameter with earthen banks about 5' high surrounding them. So far as I know, it has not been used since the spring of 1945. It is a small installation and of no great importance.

8. TA-8 (Anchor Site West)

a. This site was established in the fall of 1943 for the Ordnance Division. It is built near what was formerly the residence area of Anchor Ranch which was vacated only a short time before construction work began on the new site. The control building with its periscope tower, machine shop, control rooms and attendant magazines are of concrete construction and are located in an embankment. Being set as they were in a natural drainage area there have, of course, been recurrent troubles after storms with the catch basin and culverts filling or becoming clogged, with the result that large quantities of water and mud were washed down into the site. This was finally eliminated in 1946 by the construction of an earth dam and diversion ditch just west of the site. This site is of permanent construction and now that the drainage troubles have been eliminated, should be seriously considered as a permanent location for some technical activity, possibly for a relocated TA-16 (S Site). In the fall of 1945, it was turned over to the Explosives Division and has since been used for various experimental work in connection with the manufacture of certain types of high explosives.

9. TA-9 (Anchor Site East)

a. Anchor Site East is a motley collection of temporary and semipermanent structures and was originally a sort of catchall for miscellaneous experiments in explosives manufacture, explosives test firing, and experimental X-ray work. The main manufacturing and X-ray facilities are directly adjacent to the Anchor Ranch road and the test firing facilities are several hundred yards to the east in the open meadow. One firing site which consisted of an underground hexagonal steel-lined pit with a heavy roof was originally used for recovery shots but was abandoned in the spring of 1945 in favor of a similar but larger chamber at TA-12 (L Site). The other firing location, commonly known as "far point," is still in service, but the concrete structure constituting the control room is now in danger of failing from repeated shock and will shortly be abandoned. There is nothing at this site worthy of being considered permanent construction and the area should be considered as available for some other purpose. If it is determined that it shall continue as an explosives handling area, the new buildings should certainly be located considerably further from the main road than is now the case.

10. TA-10 (Bayo Canyon Site)

a. Bayo Canyon Site work was begun in Bayo Canyon in September, 1944 using two M4 tanks as mobile control rooms and personnel shelters during the firing. In the early spring of 1945 there were constructed: a. special buildings for the radioactive chemistry work necessary for the experiments and b. a heavily bunkered control building, battery house, magazine, and trimming building to two firing points. In the late spring of 1945 a second firing area was constructed, again having a control building, a battery building and two firing points. Since that time several other minor structures have been completed. The site was originally constructed for G Division and was turned over, upon dissolution of the latter in the fall of 1945, to M Division in conjunction with a group of radio-chemists from CMR Division. The indications are that the type of experiment which has been done here will be continued indefinitely as a standard part of the Laboratory work, and a permanent experimental area of roughly the present dimensions and with the present facilities or improved equivalents will be necessary as far into the future as we can now see. Because of the location of the present site near the eastern sections of North Mesa and Medio Mesa, both of which will almost undoubtedly be seriously considered for either community or Laboratory installations, it would seem quite possible that Bayo Canyon might not remain a suitable location for the present type of experimentation, involving as it does the firing of explosive charges up to 600 pounds in size and the utilization of extremely radioactive sources which produce highly penetrating gamma rays. The general design of the firing points, control buildings and explosives handling facilities has proven generally satisfactory and with some improvement can undoubtedly be used wherever the site may be reconstructed. The chemistry building and attendent facilities have proven very unsatisfactory and at the present time are undergoing a complete redesign study by CMR Division personnel with some help expected on the matter shortly from Black and Veatch. It is exceedingly unlikely that any final design will result from this study in less than eighteen months to two years because of the complex considerations involved.

11. TA-11 (K Site)

a. K Site was constructed in the winter of 1944-1945. It consists of two heavy concrete battleship-type structures, between the armored noses of which charges of high explosive up to 200 lbs. have been fired, a combination control and laboratory building heavily bunkered, and a shop and general purpose building also heavily bunkered. Back along the road leading to the site a trimming building and a magazine were constructed. Since then a small magazine has been added at the site and several other small modifications have been effected. The site was originally constructed for G Division and upon its dissolution in 1945 was assigned to P Division which has since used it for betatron work. The site is sufficiently isolated to be used again for explosives work if necessary and is of such heavy construction that with minor modifications it may definitely be considered permanent. At the present time its use as what is essentially a pure physics laboratory makes it sort of an odd stepchild in the firing site area in which it is located, and possibly some consideration should be given to the housing of the betatron in some other location more convenient to the general operations of the Physics Division.

12. TA-12 (L Site)

a. L Site was constructed in the early spring of 1945 for the Explosives Division and consisted of a steel-lined hexagonal pit with a heavy earth filled cover of bridge-like construction which was used for certain recovery experiments. An open section of the mesa just east of the pit was used for several months as a more or less unimproved firing site for charges up to 200 pounds, and in connection with this work a hutment was set up as a work shop and two small magazines were installed, together with a small AC diesel generator set. The site was abandoned by X Division in April, 1946 and has not been used since that time. It is our understanding that X Division has plans to reactivate the site and to construct there permanent laboratory buildings of a size and nature yet to be determined, but presumably in connection with some sort of explosives testing or experiment. The location of the site is all right for a permanent installation for this sort of operation, provided the charges fired are relatively small - say, up to 100 pounds - and provided that the area is cleared of trees for a reasonable radius around the site. Because it is just across the canyon from TA-15 (R Site), it has no possibility of being used for the firing of large charges.

13. TA-13 (P Site)

a. This site was constructed in the early fall of 1944, and consists of a frame control building protected by a timber barricade from the firing area some 600' to the east. At the firing area are two concrete battleship-type structures, one of which has been altered to provide a heavy steel blister on one side. These buildings were used for X-ray work in connection with explosives experiments. The site was originally constructed for G Division and, upon dissolution of the latter in the fall of 1945, was turned over to M Division. It has since been used for a variety of miscellaneous experiments for which no other site was quickly available, and as the result of which a fair amount of radioactive contamination has been scattered on the shelf area leading down into the canyon on the northeast side of the firing area. The intention now is to establish a working area for trailers and a hutment for certain mockup arrangements of the experimental equipment required for experiments with highly radioactive sources which are actually to be performed at some other location. The site is located on a broad but heavily forested mesa and the area should be more thoroughly cleared of trees and undergrowth if the site is to be used permanently for any purpose. It is also fairly close to S Site and if the latter becomes a permanent explosives manufacturing area and expands further to the east, P Site may well become too close for comfort and have to be abandoned.

14. TA-14 (Q Site)

a. Q Site was constructed for X Division work in the fall of 1944. It has a number of small specialized buildings for close observation work on small explosive charges including a closed chamber, an open chamber, a small stadium with a central firing point, and control buildings and rooms for the above, together with several small magazines, trimming buildings and the like. Because of a deviation from specifications, the closed chamber failed structurally after several charges had been fired in it. It was buttressed with steel beams, but has seen little further use. The open chamber and the remainder of the site are still in use. Located on the far side of a ridge parallel to the R Site road, the site location still seems adequate for explosives experiments of the magnitude now employed. All the buildings are either temporary or unsuitable and will have to be completely replaced for permanent occupancy. Probably the simplest thing to do in this regard would be to rebuild the site a short distance east of the present location and then eliminate the original site when the new one is occupied. On the other hand, it is conceivable that the work done at Q Site could readily be combined with work now done elsewhere and a larger firing site with better central facilities established for several types of experimentation, each of which involves the firing of small charges. There are several places on the land leading to R Site where this could be done, provided again that the heavy forest was cleared away sufficiently to make a good sized operating area free from the danger of forest fires.

15. TA-15 (R Site)

a. The first installations at R Site were completed in October, 1944 and consisted of a central control building and laboratory with several firing points, a trimming building, and a couple of hutments and small magazines. Since that time numerous additions have been made, mostly various types of barricade at new firing sites. The site was originally assigned to X Division for the use of Walter Koski and was later transferred to M Division, together with Mr. Koski's group. Late in 1946 general conversations between this office, the Director's office and the M Division people resulted in a general agreement that R Site be considered the permanent location for firing explosives experiments involving charges up to as much as two tons. Since that time a series of small permanent firing control chambers and a completely new large scale firing site with an underground timber control building have been completed. A new cutting building is under construction at the moment and a new permanent magazine is in the hands of W. C. Kruger Co. for the making of contract drawings. Generally speaking, the R Site area still seems to be an ideal location for the purposes to which it is now being put, and the Planning Group should seriously consider keeping it so. With proper layout of facilities it is conceivable that as many as four or five separate firing points could be established and used at the same time, working from a central service and magazine area. Two bad features of the present installation, which should be removed, are the two firing sites directly adjacent to the road leading to the large scale firing point recently completed at the eastern end of the mesa. With as much space as is available at R Site, there is little excuse for the permanent installation of firing sites directly alongside the main road.

16. TA-16 (S Site)

a. S Site was constructed early in 1944 and consisted of six buildings including a steam plant. Since then the site has been under practically continuous expansion, more or less dignified and delineated under the titles S2 Expansion, S3 Expansion and S4 Expansion. In the course of these progressive additions, the total plant has come to include some eighty buildings of various sizes and uses for all types of explosives manufacture, storage, treatment, and testing. Regrettably, some 85% of the site is of temporary frame construction and is completely unsuitable for use as a permanent explosives manufacturing plant. The area may be viewed both favorably and unfavorably. The cleared expanse originally present has proven sufficiently large for the plant to grow to its present size without additional forest clearing. Should it remain in this location and be expanded in the future, a large amount of such clearing would be necessary. On the unfavorable side is the fact that the site is within easy walking distance of State Route #4 and represents a tempting target for possible saboteurs, especially since Magazine Areas A and B are between the site and Route #4 and the prospective saboteur by breaking into one of these locations could secure ready ammunition for destructive purposes. Also enmeshed in the problem is the question of whether such a major explosives manufacturing installation should be kept here at Los Alamos at all. This is a matter which must be settled at higher levels and possibly by the Commission itself.

17. TA-17 (X Site)

a. X Site construction was requested early in the fall of 1944 and was to be used for expansion of X-ray work on explosives experiments then being carried on at Anchor Site East. The work was cancelled shortly after construction began and the site has not been used for any purpose since that time. It is dubious if it can be used for anything, inasmuch as the water line from the Pajarito water source west of the Anchor Ranch area now passes close by.

18. TA-18 (Pajarito Canyon Laboratory)

a. This area was developed during 1944 for G Division, three firing points being established, one for small charges of a few pounds each in the west wing of the canyon, a second for charges of several hundred pounds each in the south wing, and a third for testing charges up to two tons in the east wing. A heavily bunkered laboratory was built at the junction of the two canyons, and a trimming building and magazine constructed back along the road toward Anchor Ranch. During 1945 several storage hutments, two magazines, a carpenter shop, and an underground battery building were constructed in the central area, and considerable alterations were made in the second firing point, making it suitable for the firing of charges up to two tons in size. Use of the site passed to M Division in the fall of 1945. Early in 1946 a 26' x 40' addition to the central laboratory building was constructed for integral assembly work involving radioactive material. In the spring of 1947 the permanent Integral Assembly Building was completed in the north wing of the canyon and the area was abandoned as a location for explosives experiment. Because of the isolation of the site it is ideal for integral assembly work and I feel it should continue to be used for that purpose. A permanent laboratory building should replace the present one and the other temporary structures be removed. The concrete "battleships" and the underground structures might as well be left - some use might be found for them.

19. TA-19 (East Gate Laboratory)

a. This small site, consisting of one frame laboratory building and a storage hutment, was constructed in the summer of 1944 for the use of Dr. Segre, who needed an isolated spot for exacting experimental work on small sources. Because of the rush in which the construction was carried out, the site was located just east of the Project boundary, as indeed was Post One, the east gate to the Project. The past two years the site has been used only upon occasion by the Physics Division. The disposition of it requires no great rush, and it may well be that upon its demolition no replacement will be required.

20. TA-20 (Sandia Canyon Site)

a. This explosives field test site was built for G Division in the spring of 1945. Installations consisted of a laboratory and control building adjacent to a firing point for charges up to 50 pounds, two "Dumbo" metal vessels for small recovery shots, a small magazine, a trimming hutment, and an underground pit with a metal mesh cover (which failed after the first few shots) for larger recovery shots. In April a 22 mm gun setup, together with a second magazine and a small workshop, was constructed in a side canyon to replace a similar setup previously installed in an armored room on the south side of Building B in the Main Technical Area. The site was assigned to M Division in the fall of 1945 and since then has been used for a miscellany of experiments without much change in the original installations. The canyon could be reached by a properly constructed road from the mesa land to the west, and the necessity for using the Route #4 approach thereby be obviated. All the construction is temporary in nature and will have to be replaced if the site becomes permanent.

21. TA-21 (DP Site)

a. This important site was conceived and built during the spring and summer of 1945 for major chemical and metallurgical work. At that time it consisted of ten major structures together with twenty-odd smaller ones. Later a concrete vault and several other maintenance and storage buildings were constructed. This site is the nearest thing to a permanent working area now used by the Laboratory, and with replacement of several frame structures by fireproof ones can be made completely so. Most of the planning work required will be in this category.

22. TA-22 (TD Site)

a. This site was constructed in the summer of 1945 for O Division as a center for the handling of special assemblies, replacing V Site. It consisted of two prefabricated stran steel buildings, two large frame magazines (unbarricaded) and one improved ranch building. The assembly work was transferred from Los Alamos in 1946, and the site has since been used by X Division as an additional storage area for high explosives.

23. TA-23 (Nu Site)

a. This firing site was constructed in the spring of 1945 for X Division, to relieve the crowded firing schedule at "far point," Anchor Site

East. Up to a short time ago it was used for camera work but is now being re-equipped for X-ray work, still in connection with high explosives experiments. The battleship-type concrete structure at the firing point may be considered permanent, but the control building, magazine, and small laboratory are not. This site could well take on greater importance, and is not badly located. Decisions made regarding it will have to be in conjunction with those regarding the other firing sites in the same vicinity.

24. TA-24 (T Site)

a. This site, directly adjacent on the north to S Site, was constructed in the fall of 1944 as a service area for the X-ray examination of high explosive charges. A year later a large storage magazine was constructed and general alterations and additions made to the main laboratory building and the several hutments. On November 19, 1946, a fire allegedly resulting from improper wiring destroyed the center portion of the laboratory building. The latter was subsequently repaired with considerable improvements during the spring of 1947. All buildings at the site are temporary and will eventually have to be replaced. Any decisions as to the rebuilding of the area will have to be tied in with the plans for S Site.

25. TA-25 (V Site)

a. This area, having two main buildings, and now essentially an integral part of S Site, was constructed in 1944 for experimental work in connection with special assemblies. When this work was transferred to TD Site in 1945, the site underwent extensive alterations (delayed several weeks by a fire in a newly constructed section) to fit it for S Site process work on explosive charges. As is the case with TA-24, its fate must be settled along with that of S Site.

26. TA-26 (D Site)

a. D Site, constructed in the summer of 1946, consists only of a concrete storage vault built for CMR Division, plus a small sentry building and guard tower. Located about 300 yards from Post I, it has recently been subjected to criticism from the Security People, and will probably be replaced by a vault elsewhere, after which we should be able to turn it to some new purpose, as it is certainly permanent in nature.

27. TA-27 (Gamma Site)

a. This area was originally used for field testing of H. E. assemblies and was the third area noted in the Pajarito Canyon construction. In the fall of 1945 it was considerably improved for the use of G Division in test firing of two ton charges, and renamed Gamma Site. After being in use for several months, a faulty explosion scattered unburned H. E. for a considerable distance up and down the canyon, subsequent to which the area was isolated with protective fences and abandoned. A thorough spraying with oil followed by burning would seem to be the only feasible method of rendering the area safe for use again.

28. TA-28 (Magazine Area A)

a. This site consists of five permanent magazines constructed as part of the S3 expansion on the isolated mesa directly south of S Site. If properly fenced and guarded, it could be a good permanent installation, but it is too close to Route #4 for comfort.

29. TA-29 (Magazine Area B)

a. This area is an abandoned CCC Camp directly adjacent to the west gate of the Project at Route #4, in which two permanent magazines were constructed in 1944. Both are still used by S Site. The area can be reached by anyone who cares to cross or crawl through a cattle fence along Route #4. It should be abandoned as soon as possible regardless of the fate of S Site.

30. TA-30 (Electronics Test Area)

a. This small site consists of a single hutment erected in the spring of 1945 on the Anchor Ranch Road at the intersection with the Pajarito Canyon Road. It is shortly to be removed.

31. TA-31 (East Receiving Yard)

a. This area was set up for use of the Navajo Van Lines in the summer of 1945 with the construction of a roofed receiving dock. Since then four other buildings have been added for general warehouse and salvage work. All are temporary. Any planning regarding this area will of necessity have to tie in with the overall plans developed for the Tech Procurement Group operations.

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A Technical Maintenance Group Report
on
Background Data Concerning the Organization,
Space Occupancy, and Building Requirements of
The Los Alamos Scientific Laboratory

LAB-A5-2 November 4, 1947

SPECIAL RE-REVIEW
FINAL DETERMINATION
UNCLASSIFIED, DATE: FEB 12 1990

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I. Laboratory Organization

A. The Laboratory Director, N. E. Bradbury, is held personally responsible for the operation of the Laboratory by the Regents of the University of California, which institution is the Technical Contractor at this Site. The only two facets of Laboratory operation which are not under his control are: first, the handling of patent matters by the Patent Advisor, who reports directly to Washington, and second, the handling of the business matters of the Project by the Business Manager, who is directly responsible to the Regents of California for affairs relating to salaries, wages, travel expenses, and the like. All other matters are the direct responsibility of the Director, but are sometimes qualified by directives from the A. E. C. Security Division as to specific methods of handling, classification, etc. The Director's office has a personnel of 4 and occupies 1430 sq. ft. of office space in Building A, TA-1, plus assembly rooms totaling 4720 sq. ft., a total of 6150 sq. ft. in all. The design figure for future conference and assembly rooms should be about 10,000 sq. ft.

B. The Associate Director for Administration and Services, Lt. Col. A. W. Betts, reports to the Director and acts for him in administrative matters. His office has a personnel of 7 and occupies 1400 sq. ft. of office space in Building A, and in the future will require perhaps 2400 sq. ft. The Administration and Services Division has the following groups:

1. Group A-1 under Loris Gardner provides all necessary services required by the rest of the Laboratory in photography, blueprinting, photostating, mimeographing, and other forms of multiple reproduction for drawings or documents. At the present time the Group has a personnel of 16 and is occupying, under very crowded conditions, 3680 sq. ft. of space on the first floor of Building T, TA-1. Since the Group is purely a service organization, and the majority of its work is done for the Document Room, the Central Mail and Records Group, and the various drafting rooms, it should preferably be located in the Engineering Division offices of which it will be made a part. In any event the Group will need about double its present space allotment, or 7400 sq. ft.

2. Group A-2 under J. V. Young is responsible for the handling of all personnel matters for the Laboratory. In this it works closely with the Business Office. The Group has a personnel of 51 and occupies 4300 sq. ft. of space in Building P', plus 1280 sq. ft. in P' Annex. It will shortly acquire an additional 2000 sq. ft. of floor space in a proposed addition to the north end of Building P', making a total of 7580 sq. ft. In considering plans for permanent occupancy for this Group, some consideration will have to be given to the desirability of maintaining an office for it on Los Alamos Mesa after the Main Technical Area has been moved to South Mesa. This may or may not prove to be necessary, but a parallel can be found in Mrs. McKibben's office in Santa Fe, where personnel make their first contact with the Laboratory. Also to be considered is the possibility that its operations may be merged with those of the Zia and A. E. C. personnel offices, but for the time being, 8000 sq. ft. may be used as a design figure.

3. Group A-3 under G. H. Schultz is responsible for providing all the necessary technical shop services required by the Laboratory: machine shop, toolmaking, sheetmetal, heat treatment, foundry, pattern making and glassblowing, as well as the supervision of contract work on machines, equipment and supplies of a technical nature which are either purchased or manufactured to order outside the Laboratory. This latter function has resulted in the building up of an Engineering Section under R. I. Howes, which also does miscellaneous jobs of design work and drafting both for general use and for work which is going into the shops. In the future organization of the Laboratory, Group A-3 will be transferred to the Engineering Division. The Group has a personnel of 149 and occupies 62,000 sq. ft. of space in Buildings B, C, V, FP, HT, R and Y in the Main Technical Area, while also providing personnel for the Graphite Shop in Sigma Building and for several small gadget shops maintained elsewhere for various technical groups. Space for the Group's permanent occupancy should preferably be under one roof for ease of administration, again with the possible exception of the gadget shops noted above which can more conveniently be placed near the operating laboratories of the groups which they serve. Unless circumstances change radically, a building of 100,000 sq. ft. should prove adequate.

4. Group A-4 under H. S. Allen is responsible for the procurement of all items required by the Laboratory, from office stationery and supplies through to the most expensive and complicated of technical apparatus, together with the maintenance of stockrooms and warehouses, and the keeping of property records. At the present time the Group has a personnel of 196 and occupies 9000 sq. ft. of office space in Buildings P and P', together with some 19 warehouses totaling 91,500 sq. ft. located in TA-1 and TA-31, plus 5 hutments for chemical storage at TA-21 totaling 1300 sq. ft., for a grand total of 101,800 sq. ft. In planning permanent quarters for this Group some consideration will have to be given to the receiving and shipping problem. If a permanent access road is built from South Mesa down through Sandia Canyon or Mortandad Canyon to State Route #4 or to the possible rail heading which may be constructed near Route #4, it will probably be advisable to have receiving and shipping facilities built as far to the east as possible on South Mesa and possibly the warehousing as well, whereas the Group offices and stock rooms should be placed at or near the entrance or administrative center of the Technical Area construction on South Mesa for convenience to the rest of the Laboratory personnel. Several special problems will enter into this, such as provision for metal stock used by the fabricating shops, glassware and chemical stock used by the various laboratories, and electronics stock used mostly by the Electronics Group in P Division. Also, because of the unpredictable vagaries of month to month procurement resulting from the institution of special research or development programs without much prior notice, considerable space should be left in all of this Group's installations for possible expansion or alteration. As an estimate, however, total space requirements should be about 120,000 sq. ft.

5. Group A-5 under R. C. Hill is charged with the handling of maintenance and construction problems for all of the Laboratory except TA-16 (S Site). It furnishes engineering advice; makes working drawings for minor construction jobs; forwards and follows through on maintenance and construction jobs; keeps records of space occupied by the other Laboratory groups; and in general furnishes engineering liaison between the Laboratory, the maintenance and construction contractors, and the A. E. C. Operations Office. Formerly the Group was responsible for the operation of the Technical Maintenance Shops in Building R, and since the Manager has indicated his belief that these maintenance activities should eventually be restored to the control of the Laboratory, it is highly probable that Group A-5 will again resume responsibility for them. Here again, as in the case of Groups A-1 and A-3, the Tech Maintenance Group will find itself part of a Laboratory Engineering Division by the time this comes to pass. At the present time its personnel numbers 17 and occupies 3100 sq. ft. of office and drafting room space in Building B, TA-1, but the possibilities as noted above may well mean an eventual personnel of several hundred and much enlarged space requirements. As in the case of the Procurement people, a splitting of space occupancy will probably be necessary, in that the main shop area should be situated near the machine shops and the warehousing area, whereas the offices and drafting rooms should be in the administrative center of the Main Technical Area for convenience to Laboratory personnel. Also involved in the office location will be convenience of relationship with the A. E. C. Operations Office and possibly with Architects-Engineers and contractors' offices. These latter will probably be situated wholly or in part outside of but immediately adjacent to the entrance to the Main Technical Area on South Mesa. For design purposes, a fair estimate of the Group's requirements would be 6000 sq. ft., not counting possible shop needs.

6. Group A-11, the Business Office, under A. E. Dyhre has the responsibilities noted above. At the present time it has a personnel of 28 and occupies 3400 sq. ft. of office space in Building P'. If its present functions are retained unimpaired with possible slight additions, it will require approximately double its present floor space or 6800 sq. ft. for efficient operation. However, should the Project ever change to single contractor operation, the Business Office would expand enormously, as indeed would all other administrative functions, since most of the work now handled by Zia Company would be lumped together with that now handled by the various Laboratory administrative groups. The location of this Group's permanent quarters should be in the administrative center of the Technical Area on South Mesa.

7. Group A-13, Central Mail and Records, under G. S. Challis is responsible for the handling of all incoming and outgoing Laboratory correspondence, telegrams and teletypes - with the exception of those for the Patent Advisor and the Business Manager - as well as the managing of the Director's files and other central records. At the present time the Group has a personnel of 27 and occupies 2680 sq. ft. of office space in Building A. Its permanent quarters should be closely adjacent to those of the Director's office in the Technical Area on South Mesa, and it may well be feasible to establish a large vault for the Director's

files and other documents in the basement of the central administration building, with elevator or dumb waiter service to the offices above. Certainly this would lend a greater security, though perhaps not as much convenience as is the case now. The personal mail handling facilities, which now take up 1000 sq. ft. of space, will be eliminated by the end of 1947, but will probably be equaled by the increase in vault requirements, so the overall Group requirements will remain at about the present figure or a little higher, say 3000 sq. ft.

8. It is quite possible that all the administration and office activities of A Division, together with the Director's office, and possibly the Manager's office, can be housed in a single building of two or three stories near the entrance to the Main Tech Area on South Mesa. The building, as previously noted, should have adequate storage vaults and other handling facilities for mail and documents and probably for teletype and telegraph communication. Considering future developments, radio and television requirements should also be considered. As will be the case with other office buildings in permanent construction, the mass of the building should be of steel, concrete and masonry, with all general office sections divided up by standardized metal partitions which can be altered at will, and with typical color schemes imposed that will permit frequent alterations without the necessity of painting and repainting. In or close to this central structure there should be a cafeteria or restaurant of sufficient size to handle those persons who prefer to eat one or more meals at the Laboratory. Also in or near to this central administrative building there should perhaps be located the offices and other functions later to be discussed under D Division, such as the library and document room.

C. CMR Division under Eric Jette is responsible to the Director for all necessary research, development and production work required by the Laboratory in the fields of general chemistry, radio-chemistry, metallurgy and refractories. (The Division is not responsible, however, for the chemistry of high explosives, which is under X Division.) The Division office, plus its associated service sections, has a personnel of 88, will have 105, and occupies 50,170 sq. ft. of space.

1. Group CMR-1 under C. F. Metz is primarily a service group responsible for the running of whatever analyses are needed by other Laboratory groups. Methodologies employed range from ordinary qualitative analysis to spectro-chemical analysis. The Group has a personnel of 24, will eventually have 34-39, and occupies 6490 sq. ft. of space in D Building and its smaller satellite structures.

2. Group CMR-2 under J. F. Lemons is responsible for research and development in general chemical methodology. The Group has a personnel of six, will eventually have 13 to 15, and occupies 2170 sq. ft. of space in Building D.

3. Group CMR-3 under D. T. Vier and M. G. Bowman is responsible for the necessary chemistry work in connection with the development and manufacture of "urchins." The Group has a personnel of 25, will have 32, and

occupies 14,400 sq. ft. of space at TA-21 (DP Site). This includes essentially the whole of the East DP Area including the exhaust filter building.

4. Group CMR-4 under R. W. Spence is responsible for the radio-chemistry work required by the Laboratory, not so much in uranium and plutonium chemistry as in the chemistry of highly radioactive isotopes of other elements. The Group has a personnel of 36, will have 56, and occupies 13,350 sq. ft. of space in Buildings D, D-7, H and U in TA-1, and the Chemistry Building at TA-10, (Bayo Canyon), together with about an acre of land at TA-10. A portion of CMR-4 personnel will be separated sometime in December to form a new group, CMR-10. This group is to take over responsibility for the TA-10 chemistry processes. The separation from CMR-4 will not affect the total personnel and space requirements given.

5. Group CMR-5 under A. S. Coffinberry is responsible for physics-metallurgy studies in connection with the basic properties of the rare metals handled at this Laboratory. The Group has a personnel of 9, will have 17, and occupies 1400 sq. ft. of space in Building D.

6. Group CMR-6 under J. M. Taub is responsible for the fabricating of U-235 into various shapes which may be required by other Laboratory groups, together with the service functions required for the supply of refractories, plastic, sintered carbides, and other special fabricated items required by the Laboratory groups. The Group has a personnel of 31, will have 42, and occupies 13,400 sq. ft. of space in Building Sigma and its four small satellite structures in TA-1.

7. Group CMR-8 under R. D. Baker is responsible for purification processes involving the handling of U-235. The Group has a personnel of 20, will have 31, and occupies 3300 sq. ft. of space in Buildings D and M, TA-1.

8. Group CMR-9 under E. F. Hammel, Jr. is responsible for metal physics studies involving the behavior of various metals under extreme conditions of temperature and pressure. The Group has a personnel of 3, will have 10, and occupies 3250 sq. ft. of space in Buildings D and Y, this latter occupancy including the use of the high pressure gas equipment and gas liquification equipment which is installed there.

9. Group CMR-11 under F. K. Pittman is responsible for the processing of plutonium in all its stages. The Group has a personnel of 50, will have 53, and occupies 23,600 sq. ft. of space in TA-21, (DP Site), utilizing essentially the entire west area of the site, with the exception of the five storage hutments assigned to Group A-4, the space assigned to Zia maintenance people, the warehouse and maintenance offices assigned to the CMR Division office, and a small area reserved for the CMR-12 Group.

10. Group CMR-12 under James Tribby is responsible for the health safety aspects of the Division work (essentially the same responsibility that the Health Division under Dr. Hempelmann has for the Laboratory as a whole). The Group has a personnel of 34, will have 43, and occupies

4550 sq. ft. of space in Building D and its satellite structures, together with small space allotments in the various other CMR Division properties.

11. The work of the Division takes place in four main areas. The first one is D Building and its eight associated smaller structures, D1 through D8, in TA-1. Replacement of this building group comes high on the priority list, but it will require such specialized design treatment that no discussion is in order here.

12. The second main area is Sigma Building with its four small additional structures, Sigma 1 through Sigma 4, together with the adjacent graphite warehouse, which acts as a source of supply for the graphite shop in Sigma Building proper. In this area is carried out the fabrication of U-235 into various shapes, together with the research and development work required as background for this work. Here also is done the foundry and fabrication work on normal uranium - usually termed "tuballoy" in Laboratory parlance. In other sections of the building are the graphite shop which is operated by Group A-3, and which produces all the graphite molds and other special pieces required by the Division as well as some of the machined graphite pieces required by the Physics Division, plus several shops and laboratories devoted to development methods and manufacture of refractory items, crucibles, and the like. Some small service work is also done in metallography physical testing and in the manufacture of many items of special plastic compositions. In the near future we contemplate the erection of a large addition to the west end of Sigma Building, which will be devoted almost entirely to development and production work on U-235. The cost of this addition will probably be of the order of a half million dollars, but it is needed immediately and the Director does not believe it feasible that construction of this particular building should await the main reconstruction work for the central technical area on South Mesa. Plans for this will be submitted shortly through the usual channels. Once it is complete we can afford to make Sigma Building operations the last to move to South Mesa.

13. The third main operating area is DP Site. The site is a complete technical layout of some 35 buildings including a laundry, steam plant, vault and several service shops, in addition to the office and laboratory buildings. The plant as originally designed utilized a relatively cumbersome method of processing the work which had to be accomplished in the West Area, and many improvements since effected have been and are continuing to reduce the working space necessary for the basic plutonium fabricating processes. As a result, certain portions of the plant have gradually become available for assignment to other groups. For example, a portion of Building 3 in the West Area is now being remodeled for the use of Group CMR-4 and a smaller addition, already requested, will be built at one side to be used as a special counting vault. We can expect this process to continue as the basic work originally assigned to the site gradually requires less and less space for its fulfillment, although development work will continue to expand into some of this space. In the East Area the situation is not quite the

same. Here the work, a highly specialized "urchin" process, is basic- ally a small batch process, and no way has yet been found to simplify it that less space will be required. The nature of the work also pro- duces a much higher degree of contamination on floors, walls, equipment and clothing than is the case in the West Area, and greater working space must be allowed for each person employed in the technical process- ing. It is extremely dubious that any reduction in the space required can be effected in the foreseeable future. In general, the whole site, including both the East and West Areas, is of excellent construction of a permanent nature. Interiors are heavily plastered and painted and can be frequently decontaminated to a reasonably satisfactory degree. Equipment which becomes too highly contaminated must be removed and buried or otherwise disposed of. The same holds true for exhaust venti- lation ducts which will probably have to be replaced from time to time, but since these are mounted on the building roofs or on trestle work outside the buildings entirely, this need cause no great complication. In fact, some work of this nature has already been accomplished at DP East, where the original exhaust risers from individual lab hoods have been replaced with stainless steel risers. The only basic drawback to considering the site permanent, once the Main Technical Area has been moved to South Mesa, is the fact that the only possible road connection to it will of necessity lead through the center of the community. Pos- sibly this one objection can be avoided by extending the TA-2 road in Los Alamos Canyon on eastward past TA-2 to some point opposite the DP installation and there constructing some type of cable car incline or elevator up to the site itself, so that all handling of active material of any kind could be done by means of this mechanism, rather than hav- ing the material brought directly into the site through the community by truck or automobile. The consideration is certainly worth some thought, inasmuch as something of the order of eight million dollars has already been spent on the site.

14. The fourth area of operation for the Division is at Bayo Canyon where a small section (soon to become Group CMR-10 as noted above) handles the radio-chemistry connected with the extremely active sources which are required there. This section also utilizes some laboratory and office space in Building H in the Main Technical Area. It is quite probable that all or most of this type of radio-chemistry work will be centered at the technical area which must be built to replace the Bayo Canyon Site, probably about two years from now.

15. Considering the Division operations as a whole, the highest priority work at the moment is the Sigma Building Addition. Second is the pre- liminary design work on a replacement for the present D Building and its smaller satellite structures. In all probability this new chemistry building should be the first to be completely designed and erected as part of the permanent South Mesa installation. Third in priority is the re-design of the Bayo Canyon chemistry process building and equip- ment now under way as a responsibility of CMR Division itself, and which will probably be given to A. A. E. for eventual contract drawings. Fourth and much further down the list in priority are the general im- provements and additions which will be required to make DP Site an

adequate and satisfactory permanent operating location, these latter including, as noted above, some kind of elevator or other means of transportation from the proposed road in Los Alamos Canyon up to the site itself.

D. D Division under R. C. Smith is responsible to the Director for the provision and maintenance of all technical documents including the "Technical Series" and the dead files, together with the provision of a history service, a legal service, a review and declassification service, a technical illustration and art service, the maintenance of a technical library, and the control of dissemination of classified information. It is also responsible to Washington for the handling of all patent matters affecting the Laboratory, and to this end in addition to the office force maintains a drafting room to make up the necessary patent drawings, a highly specialized art. At the present time the Division's activities are confined to Building T in the Main Technical Area and its personnel of 43 occupies some 10,270 sq. ft. of office and vault space. As indicated above in the details concerning the Administration and Service Division, many of the functions of D Division could advantageously be placed near the Director's office in the permanent Technical Area on South Mesa. The Division also has certain responsibilities at Sandia Base but these will not concern us in the rebuilding of the Laboratory here. Two of the foremost design problems required for the Division will be the provision of a dignified and serviceable library - by which, incidentally, a technical institution is often judged by visitors - and the provision of adequate and usable document vaults, which latter should conform pretty much to the remarks made under Administration and Services Division above.

E. H Division under Dr. L. H. Hempelmann is both a service and research organization. In its service aspect it is responsible for safety measures affecting the health and well-being of every employee of the Laboratory, so far as general health is concerned and secondly, and more pointedly, for the safety of many of the technical personnel who are exposed in one way or another to radiological or other special chemical hazards in the course of their work. This involves the setting up of standards for making periodic inspection of equipment and processes and the carrying out of physical examinations, blood counts, etc., for personnel who have had any chance whatever of being exposed to the above-mentioned hazards, (including at times Zia Company and construction contractor personnel, as well as Laboratory personnel), and in general making sure through these health safety activities and the keeping of records concerning them that the Laboratory or the Atomic Energy Commission will have as little chance as possible of being periodically exposed to damage suits for amounts running up into the millions, as the result of what people - formerly employees here - may fancy has happened to them during their period of employment. In the research field the Division's responsibilities are to carry forward investigations on the many biological effects of radiation exposure and of radioactive dust ingested into animal bodies or tissues and other similar phenomena which bear very directly on the standards set up under the various safety services. Also involved in the research program is the cooperation with and the training of Army and Navy medical personnel who will be connected in any way with the handling, testing, or use of atomic weapons or fissionable material in any form. At the present time the Division offices are on the second floor of Building B in the Main Technical Area. The basic service labs are in Buildings A, Q, and ML in TA-1, and the research and training functions are being carried out in the

Medical Research Laboratory recently made available by the elaborate reconstruction of two former barracks on 9th St. To this lab there will be added later this winter two other converted barracks with more lab facilities installed therein. The Division also maintains a nurse and first aid room at TA-16 (S Site) and another at TA-21 (DP Site). A special wing has been constructed on the hospital for the use of the Division in required "rest" hospitalization of Laboratory employees who are under examination at periodic intervals to determine whether or not they have absorbed any radioactive material into their bodies. The Division has a personnel of 72 at the present time and occupies 15,720 sq. ft. of office and laboratory space, plus the hospital ward assigned to it. Current plans for the Division call for the establishment in the new permanent hospital of an elaborate clinical and research installation totalling 26,000 sq. ft., where the main bulk of the Division's work will be done. Only reasonably small installations will be required for them in the permanent Technical Area to be built on South Mesa. Unless some drastic change is made in these present plans, the A. A. E. will have very little work to do in basic design for this Division.

F. M Division, formerly under Darol Froman but recently put under the acting leadership of Marshall Holloway, is charged with responsibility to the Director for the designing, testing, and certifying of accuracy of manufacture of certain components of the atomic bomb, and with doing the necessary research required to successfully carry out these responsibilities. This research extends into the fields of electronics, high precision optics, high-speed motion picture photography, hydrodynamics, critical assemblies, and some pure nuclear physics, with all of the above implemented from time to time by experiments using relatively large amounts of high explosives. In general the operations of the Division are centered in Building Gamma and its satellite Gamma 1 (formerly known as the icehouse) in TA-1, with experimental activities carried out at a number of outlying sites, as will be indicated in the sections below covering activities of the several groups in the Division. The Division office has a personnel of 5 and occupies 5850 sq. ft. of space in Building Gamma. This should be sufficient for the future also.

1. Group M-1 under W. C. Bright is responsible for the physical design, procurement, measurement, and processing of certain metal components used both in and in connection with the bomb; and the training of AFSWP personnel. The Group has a personnel of 12 and occupies 4380 sq. ft. of space in Building Gamma and Building Gamma 1, and also has the use of part of the TA-26 (D Site) storage vault. The prospects are that the Group will be expanded by about 30% and will require a little more than twice the office, lab and shop space it now occupies. A possible additional responsibility will be the maintaining of a museum devoted to the parts, special assemblies, etc., of various models of the atomic bomb for which at present there is no provision. Such a museum was projected for the first floor of the proposed new Building L, action on which has since been withdrawn, with the preliminary working drawings now located in the A. A. E. files. All told, the Group's requirements should be about 10,000 sq. ft.

2. Group M-2 under R. E. Schreiber is responsible for the testing of critical assemblies of radioactive material, both bomb components and

experimental assemblies. For these purposes the Group has a permanent assembly building at TA-18, (Pajarito Canyon Laboratory), together with lab, shop and storage space there and in Gamma Building. The Group has a personnel of 23 and occupies 14,650 sq. ft. of space. At TA-18 only the assembly building is of permanent construction, but the construction of a sentry building and a vault has been requested and presumably these structures should be complete by next summer. In addition to them the Group will require a warehouse for machinery and other experimental equipment and in due course will require a replacement of the present laboratory building with a permanent structure. About 17,000 sq. ft. of new construction should be sufficient.

3. Group M-3 under D. P. MacMillan is responsible for the development and testing work on the "urchin," together with the research necessary to carry out these responsibilities. The Group has a personnel of 11 and occupies 7180 sq. ft. of office and laboratory space in Building Gamma, and at the mockup and electronics equipment testing area at TA-13, (P Site), which latter site, as noted in the previous planning report, was formerly used for explosives test firing. The Group has also carried on very important testing work at Trinity Site utilizing underground chambers and, if present plans go through, will require the construction of perhaps twenty more expendable underground chambers, each capable of completely containing an experimental high explosive charge of 25 lbs. At the present time we are thinking of locating these chambers in some of the land to be acquired by the A. E. C. between the east boundary of the Project and the Rio Grande, but no definite locations have yet been selected for consideration. In connection with the design problem inherent in the construction of these chambers, it should be pointed out that sooner or later the A. A. E. will have to undertake a basic study of design procedures for structures of various sizes subjected either to internal or external shock, depending on the experimental circumstances under which they are to operate. About 12,000 sq. ft. of space will be required by the Group, including the underground chambers.

4. Group M-4 under S. W. Burriss is responsible for explosives experiments utilizing the so-called "electric method" of detonation wave determination. The Group has a personnel of 23 and has shop, office and laboratory space in Gamma Building, together with the whole of TA-4 (Alpha Site) and TA-5 (Beta Site), plus the recently completed firing points E and F at TA-15 (R Site), totaling 10,570 sq. ft. The Group has also done some miscellaneous experiments in Sandia Canyon, but these will probably be discontinued before the end of the year. Firing points E and F at TA-15, together with their control building and accessory installations are essentially permanent and should not require much study, except from the viewpoint of design usability. TA-4, TA-5, and TA-20 (Alpha, Beta, and Sandia Canyon Sites) lie directly along one of the routes proposed for a construction road and may have to be relocated in their entirety, should this proposal go through. In any event, as mentioned in our former report, they will need to be completely rebuilt, and prior to their rebuilding there must be developed good design

criteria for firing sites utilizing small to medium-sized charges, say from a few pounds up to as much as a ton. The development of these design criteria and their resulting standards will tie in directly with the studies noted above for the underground chambers which will be required by Group M-3. Other studies concerning Laboratory operational procedures should also be initiated in this connection with regard to the design and location of magazines, cutting and trimming buildings, assembly buildings, and control buildings. From these studies we may be able to develop standard designs applicable to certain general types of experimental explosive work, perhaps going so far as to work up standard design drawings for conduit installations, pull boxes, manholes, firing saucers, charge platforms and a number of other items such as siren installations, all of which are now treated as individual problems at each firing site. About 9000 sq. ft. of new construction should be required.

5. <u>Group M-5</u> under Donald Mueller is responsible for the "RaLa" experiments at TA-10 (Bayo Canyon). This Group has a personnel of 11 and occupies 9400 sq. ft. of space in Gamma Bldg., TA-1, and the TA-10 firing sites and working buildings, not counting the chemistry building and its attendent facilities which are used by the radio-chemists who prepare the sources for the experiments. These experiments, designed to reveal certain facts about the hydrodynamic behavior of metals, are conducted with the aid of extremely radioactive sources and some 600 lbs. of high explosive at each experiment. The radioactive material used with these experiments is scattered somewhat with each one, with the result that the area immediately surrounding the firing point is rendered unusable for further work for a period up to a month. This makes it necessary that the Group have at least four firing points, if anything resembling a regular work schedule is to be carried on. As noted in our previous report, the area alloted for firing and the control and equipment buildings situated at the firing points have proven reasonably satisfactory. However, it is proposed that sometime in the next two years the work of the Group be extended to experiments involving as much as two tons of high explosive at each shot with even more highly radioactive sources than are now utilized. This will mean that each firing point will be contaminated more thoroughly and will contaminate a wider area about it after each shot than is now the case, so that the firing points for the new site which will be required by that time will have to be more widely separated and will probably have to be more numerous. Mr. Mueller's present estimate is that at least eight firing points separated by perhaps 600' intervals will be required for continuous operation of the proposed new site. Some re-design of the control and instrumentation facilities will also be required. Some consideration has been given to possible locations for the new site, and only three major areas seem to be available. About 16,000 sq. ft. of new construction will be needed.

a. One of the canyon areas in the northern part of the Project towards Santa Clara Canyon. This would presumably have to be reached by a new road extending westward from the present Espanola Road and would necessitate about a 15 mile haul for all equipment and materials used in the experiments, unless several mesas were tunneled through to provide a direct route.

b. A location might be selected somewhere in the general area between Route #4 and the Rio Grande in the tract shortly to be acquired by the A. E. C. This location is excellent if it does not prove to conflict with the proposed location of the contractor's construction camp. Even so, the area is large enough that if the firing site could be placed reasonably close to the Rio Grande and fragments from the shots allowed to fall therein, the location could still possibly be used.

c. The rough triangle of land between Route #4 and the present southeast boundary line of the Project, also shortly to be acquired by the A. E. C., presents an excellent location in Water Canyon with access by road both to the lowland to the east and to the higher mesa land to the south for subsidiary facilities.

6. Group M-6 under Frank Willig is responsible for the prosecution of certain experiments designed to reveal pertinent data regarding shock wave phenomena produced by various sizes of high explosive charge fired under special conditions. The methodology used is primarily that of flash photography in which an armored camera is used to secure a picture of an explosion which takes place behind or to some extent around the side of a bunker or other barrier, the explosion itself being photographed by reflection in a mirror in the line of sight of both the camera and the explosion. Ordinarily the time scale involved is more than sufficient for the camera to record the picture of the exploding mass by reflection from the mirror shortly before the latter is destroyed by the expanding shock wave. At the present time the Group has a personnel of 11 and occupies 6200 sq. ft. of office, laboratory and shop space in Gamma Building, TA-1, and at firing points A, B, C and D at TA-15 (R Site) with their accompanying buildings. The laboratory and control buildings at R Site are temporary structures but should be serviceable for several more years before replacement is necessary. Possibly some re-planning of the site to fit it for the use of the two groups (as noted above, M-4 also uses the area) in a more effective fashion may be necessary. Altogether about 8000 sq. ft. of new construction will be required for the Group.

7. Group M-8 under Berlyn Brixner is responsible for special work in the field of high-speed photography involving the construction and operation of various types of high-speed cameras and the developing and analyzing of some of the photographs resulting from this photographic work. The Group has a personnel of 4 and occupies 3600 sq. ft. of office and laboratory space in Gamma Building. Some slight expansion of the space occupied during the next several years might conceivably be entailed by possible enlargements in the scope of the work carried on by the Group, but no further commitments at any of the outlying technical areas are likely.

G. P Division under J. M. B. Kellogg is responsible to the Director for the experimental physics work of the Laboratory. The Division offices are used by personnel numbering 6 and occupying 900 sq. ft. of space in Buildings T and U; no great increase in this space requirement should be necessary. Unlike the applied physics work characteristic of the M Division groups, most of the P Division work is concerned with more or less pure research in the field of nuclear physics, and for this work, as will be noted below under the various groups, various types of physics machines are used for the production of beams of nuclear particles which in turn are used for the study of various nuclear reactions and other phenomena. Naturally, all of this work bears some relation to the design characteristics of the atomic bomb, but it is still the closest thing to pure research in nuclear physics which is carried on at this Laboratory.

1. Group P-1 under J. K. Lamb is responsible for the design and construction of all the special electronic equipment required, not only by the Division itself, but by the rest of the Laboratory. At the present time the Group has a personnel of 44 and occupies 11,260 sq. ft. of office and shop space in Building U. When the Group is provided with permanent quarters no unusual problems will be involved because most of the work simply requires rooms of normal construction with adequate work bench space and with a multiplicity of electric power supply circuits for the testing of various assemblies being developed or under construction. One measurements lab will require special air conditioning. Probably 13,000 sq. ft. of permanent construction will suffice.

2. Group P-2 under L. D. P. King is responsible for the operation of the water boiler at TA-2 (Omega Site). The Group has a personnel of 11 and occupies 12,500 sq. ft. of office space in Building T and in lab, office and shop space at TA-2. The water boiler was the earliest of the experimental atomic reactors and has been used as a good source for neutron beam experiments, as well as for studies concerning the nature of liquid critical assemblies utilizing enriched uranium salt solutions. The water boiler is housed in a temporary but capacious structure at TA-2 to which the permanent fast reactor addition was constructed last year. Since the Director is convinced that the whole TA-2 installation should be considered permanent, we are currently undertaking an engineering and architectural study of the whole TA-2 installation with a mind toward improving and revamping the original temporary structure to match more closely in appearance and function the permanent fast reactor addition. A few years hence, some of it may have to be replaced altogether. It is not likely that the A. A. E. will be required to do much in the way of basic design study at this site for Group P-2, though conceivably if other experimental apparatus is ever developed for installation at the site, new housing will have to be provided for it.

3. Group P-3 under Richard Taschek is responsible for a miscellany of experiments designed to aid nuclear study which, for the most part, utilize high-speed particle beams from the Van de Graaff machine in Bldg. W or the Cockroft-Walton machine in Building Z. The Group has a personnel

of 15 and occupies 3550 sq. ft. of office space in Building U, in addition to 7350 sq. ft. in Buildings G, H, W and Z. There is some question as to whether or not experiments which are currently beginning may force the removal of the Van de Graaff and the Cockroft-Walton machines from their present TA-1 locations well ahead of their normal place in the rebuilding schedule, because of extremely penetrating neutrons which are being produced by these experiments. Necessity or lack of necessity for this should become clear in the next six months. At least 12,000 sq. ft. of permanent construction will be required for the Group.

4. Group P-5 under D. B. Hall is responsible for the construction and experimental operation of the fast reactor just recently completed at TA-2. The Group has a personnel of 11 and occupies 3900 sq. ft. of office and laboratory space in Buildings T and U, TA-1, plus 5000 sq. ft. of laboratory space in Building 1 at TA-2 (Omega Site). Most of this latter space is in the reactor room addition and its adjoining control room. It is extremely unlikely that Dr. Hall will require much further operating space for some time to come and since his present installation is permanent, his operations will require little attention from the A. A. E.

5. Group P-9 under J. L. McKibben has been assigned the responsibility for the development, design, and construction of a new and quite large Van de Graaff machine. The original plans for this installation have been pretty well completed and the location for its installation selected, but the former now seems to be caught in mid-air by lack of a definite decision on the part of the Commission to proceed with construction of the Van de Graaff; and the location, of course, is probably now subject to change by virtue of the decision that the Main Technical Area is to move to South Mesa. Such being the case, Mr. McKibben's Group is in somewhat of a quandary, from which it can only be released by a decision from the Commission. The Group has a personnel of 9 and occupies 3000 sq. ft. of space in Building U.

6. Group P-11 under William Ogle is responsible for the experimental work involving the use of the betatron. As noted in the previous report, all of this work is concentrated at K Site in heavily bunkered concrete structures and is in a very real sense a sort of stepchild installation among surrounding firing sites and explosives manufacture and storage areas. As a matter of policy the work of the Group should eventually be transferred elsewhere, unless some contingency should arise in which the use of the betatron was again required in connection with explosives experiments. The Group has a personnel of 4 and occupies 2100 sq. ft. of operating space at K Site, plus a land area of approximately one acre. It would be difficult to define at this time exactly what type of operating space would be required for the new permanent installation, but it would probably be of somewhat the same general magnitude as noted above.

7. Group P-12 under J. L. Fowler is responsible for the experimental studies which utilize the cyclotron. The Group has a personnel of 7

and occupies 10,400 sq. ft. of space in Buildings J and X, TA-1. At the present time other laboratories in TA-1 believe that their instruments are being disturbed by stray radiation, particularly fast neutrons from the cyclotron operations. This has been especially annoying to Health Division personnel in Building Q, only 100 yards or so away from the cyclotron. If the stray radiation produced by the cyclotron continues to increase in intensity, it may be necessary to put the permanent cyclotron installation well up on the priority list. Space requirements for the permanent installation should be only a small amount more than are now used by the Group, say 12,000 sq. ft., but the mode of construction should be vastly different. In connection with this we will attempt to obtain copies of installation drawings for other permanent cyclotron installations which have been made in recent years, to serve as a guide for our new installation here.

H. T Division under Robert Richtmeyer has approximately twelve groups of theoretical physicists and mathematicians who are responsible for working out the various theoretical problems which come up in connection with both bomb design and pure research work. The groups which make up the Division change in size and in problem assignment every so often and there seems little point in discussing them individually. The Division as a whole has a personnel of 38 and occupies 11,340 sq. ft. of office space in Building E, TA-1. In designing their permanent quarters three main considerations will govern. First is a location in a quiet area with no industrial-type operations in the neighborhood. Second is a more or less standard office building construction capable of division and re-division into reasonably small offices suitable for use by one or two people at the most. The present offices in Building E average about 12 sq. ft. and, generally speaking, have proven satisfactory as far as size is concerned. Third will be one or more large calculating machine rooms. The precise requirements have not yet been determined for this, but there will probably be one or two rooms devoted to I. B. M. calculators such as are now installed in Building E, together with one or more large installations of calculators at present in a developmental stage. The precise requirements for one of these modern computers are not yet available, but we have procured a set of plans of the installations for the ENIAC and EDVAC at Aberdeen and they will be forwarded to the A. A. E. in due course, after we have had an opportunity to study them. Although the newer computers will differ from these in some respects, their basic requirements may be rather similar, so that the installations at Aberdeen should furnish us with relevant information on such matters as power supply, heat elimination (there are several thousand vacuum tubes in each machine) and noise isolation.

I. X Division under Max Roy is responsible to the Director for the research, development, and manufacture of such explosives as are necessary for the work of the other technical divisions. The X Division office consists of three people and occupies 1600 sq. ft. of space in Building B.

1. Group X-1 under G. H. Tenney is responsible for the radiographing of explosive charges to make sure that they are homogeneous and contain no cracks, blowholes, or other imperfections. The Group has a personnel of 8 and occupies 5410 sq. ft. of office, laboratory and magazine

space at TA-24 (T Site). With the exception of a large concrete and timber magazine, the entire site is of temporary frame construction and will have to be replaced in its entirety. Since most of the site operations are in conjunction with those at TA-16, (S Site), the new X-1 building facilities should probably be in the same general area, but not as near the operations of TA-16 as they now are.

2. Group X-2 under M. L. Brooks is responsible for the research work carried on by the Division in the development of new explosives and in fabricating methods for such explosives. In practice its work ties in very closely with the manufacturing work of Group X-3 discussed in the next section. The Group has a personnel of 27 and occupies 27,100 sq. ft. of office, laboratory, shop, and magazine space at TA-16, (S Site), and TA-8 and TA-9 (Anchor Ranch West and Anchor Ranch East). Except for a few permanent structures which are actually unsuited for their present use, buildings occupied by the Group are of temporary frame construction and will have to be replaced. It is difficult to predict the exact space requirements as of a few years hence, but if anything, these requirements should be somewhat larger than is now the case.

3. Group X-3 under L. E. Hightower is responsible for all the manufactured high explosive charges required by the Laboratory. The Group has a personnel of 54 and occupies 125,400 sq. ft. of temporary office, shop, warehouse and manufacturing building space at TA-16 (S Site) and TA-25 (V Site), TA-28 (Magazine Area A) and TA-29 (Magazine Area B), for all of which about 200 acres of operating field area is used. As pointed out in our previous report, the exact size and future activities of Group X-3 are matters which await policy decisions by higher authority, and no comments made in this report have much point, although tentative figures have been given in the tabular summary.

4. Group X-6 under J. C. Clark is responsible for studies in detonation physics required by the Division or by other Laboratory groups. This Group has a personnel of 5 and occupies 3500 sq. ft. of office and laboratory space in Building B, TA-1, TA-9 (Anchor Ranch East) and TA-23 (KU Site). This is a small group and its future is indeterminate at this time.

5. Group X-7 under L. B. Seely is responsible for research and development work on the various types of detonators required for explosive experiments by other Laboratory groups, together with the manufacture of these detonators. The Group has a personnel of 51 and occupies 19,180 sq. ft. of office, manufacturing and laboratory space in Building B and Building Y, TA-1, TA-3 (South Mesa) and TA-6 (Two-Mile Mesa). Almost all of the presently occupied space is of temporary frame construction and is already scheduled for demolition as soon as the new permanent detonator laboratory construction on Two-Mile Mesa has been completed, presumably 12 to 15 months from the present time. The requirements of this Group are therefore well in hand and little or no design time will be required for its requirements.

6. Group X-8 under A. W. Campbell is responsible for the field testing of explosive charges, partly in routine check of standard manufactured charges and partly in critical examination of the behavior characteristics of experimental charges. The Group has a personnel of 10 and occupies 5050 sq. ft. of office and laboratory space in Building B, TA-1, TA-9 (Anchor Ranch East) and TA-14 (Q Site). The activities of this Group should remain at about their present level of magnitude but, as indicated in our previous report, their firing areas at TA-9 and TA-14 will both need rebuilding at new locations for permanent usage.

J. Z Division has all of its operations at Sandia Base and its requirements need not concern us in planning for permanent construction here at Los Alamos.

K. The recently formed J Division under D. K. Froman is to be responsible for the Laboratory's part in the coming Pacific Proving Ground Test. So far as is known now, the Division will have no permanent requirements for space here at Los Alamos, and need not be considered in computing future space requirements.

L. Several A. E. C. offices are also housed in TA-1: the Security Office, Safety Office, and Manager's Project Office. These offices have a personnel of 65 and occupy 10,000 sq. ft. of space.

M. Zia Company maintenance shops have a personnel of 550 and occupy 40,800 sq. ft. of space in TA-1, TA-16 (S Site) and the Anchor Utility Yard.

N. Tabular Summation:

NOTE: Building Space - sq. ft.

Office or Organization	Personnel Now on Hand	Bldg. Space Per Person	Bldg. Space Occupied	Future Bldg. Space Req'd.	New Bldg. Const. Req'd.
Director	4	358	1430	1500	1500
Assembly Rooms	-	-	4720	10000	10000
Assoc. Director	7	200	1400	2400	2400
Group A-1	16	230	3680	7400	7400
A-2	51	110	5580	8000	8000
A-3	149	127	62000	100000	100000
A-4	196	520	101800	120000	120000
A-5	17	183	3100	6000	6000
A-11	28	121	3400	6800	6800
A-13	27	100	2680	3000	3000
A Div. Totals	495	384	189790	265100	265100

Office or Organization	Personnel Now on Hand	Bldg. Space Per Person	Bldg. Space Occupied	Future Bldg. Space Req'd.	New Bldg. Const. Req'd.
CMR Div. Office	9	113	1020	1500	1500
CMR-A Depts.	79	622	49150	61000	50000
Group CMR-1	24	270	6490	10000	10000
CMR-2	6	362	2170	5000	5000
CMR-3	25	577	14400	16400	2000
CMR-4	36	371	13350	20800	18000
CMR-5	9	156	1400	2600	2600
CMR-6	31	432	13400	17700	17700
CMR-8	20	165	3300	5100	5100
CMR-9	5	650	3250	6500	6500
CMR-11	50	472	23600	20000	-
CMR-12	34	134	4550	5700	4500
CMR Div. Totals	328	415	136080	172300	122900
D Division	43	239	10270	14000	14000
E Division	72	218	15720	26000	26000
M Div. Office	5	1170	5850	6000	6000
Group M-1	12	365	4380	10000	10000
M-2	23	638	14650	20000	17000
M-3	11	652	7180	12000	12000
M-4	23	460	10570	12000	9000
M-5	11	852	9400	16000	16000
M-6	11	564	6200	8000	8000
M-8	5	720	3600	3600	3600
M Div. Totals	101	612	61830	87600	81600
P Div. Office	6	150	900	1000	1000
Group P-1	44	256	11300	13000	13000
P-2	11	1130	12500	12500	-
P-3	15	800	12000	12000	12000
P-5	11	809	8900	9000	4000
P-9	9	534	4800	10000	10000
P-11	4	850	3400	3000	3000
P-12	7	1485	10400	12000	12000
P Div. Totals	107	600	64200	72500	55000
T Division	38	300	11340	12000	12000

Office or Organization	Personnel Now on Hand	Bldg. Space Per Person	Bldg. Space Occupied	Future Bldg. Space Req'd.	New Bldg. Const. Req'd
X Div. Office	3	533	1600	1600	1600
Group X-1	8	675	5400	6000	6000
X-2	27	1000	27100	28000	28000
X-3	54	2320	125400	150000	100000
X-6	5	700	3500	3500	2000
X-7	51	376	19200	22300	-
X-8	10	505	5100	5000	5000
X Div. Totals	158	1186	187300	216400	142600
A. E. C.	65	154	10000	10000	10000
Zia Company	550	74	40800	60000	60000

DIVISION TOTALS

Office or Organization	Personnel Now on Hand	Bldg. Space Per Person	Bldg. Space Occupied	Future Bldg. Space Req'd.	New Bldg. Const. Req'd
A Division	495	384	189790	265100	265000
CMR Division	328	415	136080	172300	122900
D Division	43	239	10270	14000	14000
H Division	72	218	15720	26000	26000
[illegible] Division	101	612	61830	87600	81600
P Division	107	584	62500	72500	55000
T Division	38	300	11340	12000	12000
X Division	158	1186	187300	216400	142600
A. E. C.	65	154	10000	10000	10000
Zia Company	550	74	40800	60000	60000
Totals	1957	370	725630	935900	789100

O. The above figures are not intended to cover utility service buildings or technical building requirements resulting from large scale programs which may be assigned to the Laboratory in the future. Rather, the figures represent the best guesses possible on the part of Laboratory management at the present time; they will be useful for planning and budget estimating purposes, but should in no case be construed as final commitments.

II. General Building Design Considerations

A. At the present time most of the Laboratory's occupied buildings, as contrasted to non-occupied structures such as magazines, personnel shelters, equipment rooms and the like, are of temporary frame construction based on interior construction normally of 2 x 4 studding faced with sheet rock or other wallboard on both sides. Floors for the most part are hardwood or pine flooring covered with mastic tile or linoleum. The same is true of the A. E. C. and Zia Company Administration Buildings. In all the structures, therefore, it has been a relatively simple matter to effect interior alterations by removing and demolishing existing partitions, stripping or relocating the utility conduits and piping which were set in those partitions, and rebuilding other partitions of a similar nature to suit the requirements of the office or organization to which the area in the building had been allocated. Because of the shifting lines of authority and the ever continuing development of new services or technical assignments, such changes have been almost continuous in all of the Project's office and laboratory buildings. Then, too, the relative ease of construction with frame walls has made possible a variety of additions from tiny bulges to complete wings for most of these structures. All of the above practices have become thoroughly engrained in the habit pattern of the Laboratory and its occupants, and will probably be difficult if not impossible to discourage to any great extent after the permanent construction on South Mesa has been occupied. It therefore seems imperative that we break down the various types of structures required by the Laboratory into several basic classes or types and make the buildings in any particular type, no matter for how many Laboratory groups or divisions they may be required, in the same basic structural pattern, so that we may change partitions, hallways, entrances, windows and similar items to suit the changing needs of the future even as is done now with frame buildings, although, let us hope, with less frequency.

1. Office Buildings - The most pertinent feature of office buildings, whether one story or more, should be the use of demountable metal partitions which will permit varying office arrangements within a greater or less limited scope, depending on the purpose of the building. In some cases it will be impossible to carry this to a complete extreme as, for example, if a single laboratory or vault has to be included as part of a third floor office arrangement, but the principle should be applied wherever possible. To make the system workable a module system will have to be adopted, so that partition changes can be made only in certain unit sizes. With such design, floors and ceilings will never need to be touched and only the exterior and corridor walls will reflect any change in partition arrangements. The ceiling arrangement would consist in all probability of perforated metal pan sections with built-in recessed light troffers. Sprinkler heads and HADs would be run above this ceiling and be projected down through it in a pre-determined pattern compatible with the module scheme agreed upon. Floors would probably be of light concrete surfaced with linoleum or asphalt tile and contain in their structure channels for telephone, inter-com, and electric service wiring, so that they could be tapped wherever necessary to suit any possible office arrangement. Heating and ventilating could

be similarly adapted to this scheme with the perforated metal ceiling acting as an evenly distributed source of ventilating air without regard to the partition arrangement. For such an overall scheme to work satisfactorily, so far as maintenance and replacement problems are concerned, one or at most a very few basic color schemes would have to be agreed upon so that replacement panels could be maintained in stock and the matter of changing office layouts would be only a task of a few hours duration. Where practical, storage vaults and other repositories of heavy construction should be placed in the basement of the office building, with service arranged to the upper floor or floors by dumb waiter or elevator. If this is not possible, the vaults should at least be stacked one above the other, so that a certain section only will be of concrete construction through all floor levels.

2. General Laboratory Buildings - This type laboratory is considered as encompassing the sort of operation to be found in rooms devoted to electronics, general physics, instrument and meter manufacture and repair, non-radioactive chemistry, some medical or biological research, and the small service shops necessary as accompaniments to these laboratories. Here again the main building structures should be of steel or reinforced concrete framing with light concrete floors and metal ceilings and partitions, as in the case of the office buildings. However, there will be considerable additional complication in the necessity for running a complete variety of piping, ventilating and electrical services to every possible configuration of laboratory rooms and equipment setups which can be visualized in advance. A number of such designs have been developed for industrial laboratories, two of the most recent examples being the Murray Hill Unit of the Bell Telephone Laboratories, Inc. at Summit, N. J., and the Firestone Research Laboratory at Akron, Ohio, which might well be studied for possible solutions to our permanent installations here. Because of the frequent interchanging of laboratory space units, simple and interchangeable color schemes will be just as necessary as in the office structures.

3. Radio-chemical Laboratories and Process Buildings - At the present time there have been evolved two basic types of structures at Los Alamos to take care of the requirements of radio-chemical and radio-metallurgical operations. In these operations the dangers are not so much those of direct radiation, (although this may sometimes be the case under special conditions, in which case heavy shielding is required), but is rather from radioactive dust, fumes, or liquid spillage which may be produced during laboratory operations. For this reason the basic construction design problem is not unlike that required for a bacteriological laboratory where surgical cleanliness must be maintained at all times, and where there can be no cracks or crannies where the virus or bacteria of some virulent disease can escape detection. For these buildings, then, we have not only the problems enumerated above for Type 2, but also the problem of establishing and maintaining floors, walls, ceilings and equipment

installations characterized either by continuous surfaces or by extremely tight flush joints. The seriousness of this problem is such that, as has already been indicated, it is felt that at least one good architectural design man should be put on this problem as soon as he can be obtained, to work on preliminary studies of it for at least six months or more in close conjunction with CMR Division engineers and chemists. Dr. Jette, the CMR Division Leader, has already pretty well decided on one design consideration; namely, that such laboratory buildings should be of only one story with neither basement nor attic spaces, in order to simplify as far as possible the decontamination problems which will exist.

a. The first present basic type of structure, exemplified by D Building, is the temporary frame structure with double wallboard surfaced partitions (utilizing staggered joints so that no penetration through the wall surfacing is possible); the second, the operating buildings at TA-21 (DP Site). The first type depends on exceedingly thorough paint jobs at all joints to reduce to a minimum the escape into partitions, floors and ceilings of radioactive dusts or liquids, but at best this sort of construction is merely stop-gap and, although it permits frequent alteration, fairly well protected joints, and relatively easy cleaning and decontamination procedures including where necessary the entire removal of a wall, floor or ceiling, there has been a loss during the four years of Building D's existence of several grams of plutonium. This is a relatively enormous loss, considering the fact that persons handling plutonium or plutonium salts are normally held responsible down to one-thousandth of a gram. The current assumption is that this lost material has infiltrated through tiny cracks into the structure of the building itself and will therefore present a considerable hazard when the time for demolition of the building arises.

b. The second present type of structure has utilized a prefabricated steel frame and exterior wall surfaces with a concrete floor and interior metal lath and plaster walls and ceilings, again heavily painted. This mode of construction has proven reasonably satisfactory, except upon those occasions when interior alterations must be made, and at such times the demolition of the metal lath and plaster sections produces considerable dust and is generally messy. Another flaw in this type is the utilization of under floor tunnels and pipe conduits, some with steel plate covers. Naturally, all wash-down decontamination procedures on walls and floors have resulted in some of the washed down liquid seeping into these tunnels and conduits, rendering them radioactive to some degree. Because of this, Dr. Jette is quite positive that he wants no utility connections placed in the floor, with the exception of the necessary drains.

4. <u>Standard Industrial Shops</u> - These may be utilized for metal working equipment: welding, heat treating, machining, forging, foundry work and the like. These structures, so far as can now be seen, may be of

standard industrial construction with an exterior design harmonized to agree with the rest of the surrounding buildings. Preferably a "tree form" sawtooth roof design should be adopted, and interior wall and ceiling surfaces made as clean and clear as possible.

5. Specialized Shop, Laboratory and Fabricating Structures of Large Dimensions - These extremely individualized buildings will be used for such diverse purposes as uranium metallurgy and the installation of large physics machines such as the cyclotron or Van de Graaff generator. In a uranium metallurgy or processing installation, heavy concrete floors, special machine foundations and high shop-type ceilings will be required to house satisfactorily typical pressing, rolling and similar metal-working equipment, yet the interiors of such work spaces must be capable of being kept as immaculately clean as is the case with the radio-chemical laboratories. In the case of the large physics machines, the first requisite is a large single room, again with a high ceiling purely and simply to provide space in which the machine may function and receive the necessary maintenance and servicing. In both of these buildings, however, the accessory offices, laboratories and small shops should follow the general pattern set forth under Types 1 and 2 above. Thus there is no reason why a set of offices adjoining the permanent cyclotron installation could not utilize the same metal partitions and ceilings as the office buildings which will be utilized by administrative personnel.

6. Explosives Manufacturing and Handling Buildings - Here the sort of construction which has been found suitable for permanent-type ordnance plants should be applied to meet the peculiar types of explosive development and fabrication work now done at TA-8, TA-9, TA-16 and TA-25 (Anchor Ranch West, Anchor Ranch East, S Site and V Site). A start in this direction has been made in the recently accepted Black and Veatch design for the permanent detonator laboratory building at Two Mile Mesa. In this structure the explosives handling areas are of heavy reinforced concrete sized in accordance with the weights of explosives handled in this particular location, usually only of small amounts. The non-HE portions of the building have utilized a more or less standard floor and plastered ceiling arrangement, but have also utilized metal partitions supplied by the E. F. Hauserman Co. of the type noted above as desirable for office and laboratory buildings.

7. Storage Magazines - On the subject of storage magazines it may be well to cover the several philosophies which may be applied to their design.

   a. The policy of pure isolation; of using an ordinary frame or masonry structure devoid of bunkers or earth cover and relying purely on the distance between it and any neighboring road or building for protection of personnel using the latter. The only two such major structures of this type now used by the Laboratory are at the extreme east end of TA-22 (TD Site).

b. The second policy is to use a medium-weight timber or concrete structure surrounded on three sides by an earth barricade but with none on top. In one variant of this design the barricade may be piled directly against the building and in the second variant it may be separated from the building by some arbitrary distance, say 4' or 5', this latter design making possible a still lighter primary structure in the magazine itself. The fourth side of the building is of course used as an entryway and loading dock, and is faced away from the access road toward a densely forested canyon or other unoccupied area.

c. A third policy is the construction of extremely heavy concrete magazines completely covered on three sides and the roof with a heavy earth barricade, again with the fourth side left open as an entryway. Such structures depend for their safety effectiveness on sheer mass, and in our opinion must be of excessively heavy and expensive construction to approach the usefulness of the second type noted above.

d. An analysis of the three types soon rules out the first for our purposes. We do not have enough available space on the Los Alamos reservation to afford the luxury of single buildings for explosives storage, each separated by many hundreds of yards from the next. Under certain local conditions as, for example, if a narrow side canyon off the main canyon floor is available, it might be used for a small magazine of the unbarricaded type, because the narrow canyon walls effectively act as barriers. The second type seems a much more reasonable and effective design on which to base magazine construction, and most of the ones constructed here in the last two years have been of this nature. Normally the three side walls are barricaded to a height of six to eight feet above the magazine floor and heavy concrete or timber walls are used to retain this barricade. The roof is of light frame construction, so that if an explosion should occur in the magazine, its force will be directed skyward and little damage should result to the immediate surrounding countryside as the result of the shock wave or of flying projectiles consisting of portions of the magazine. The third type we may disregard as a possibility except under special conditions where relatively small amounts of high explosive must for operating reasons be stored immediately adjacent to inhabited structures. In such cases the magazine loading should be kept well under 100 lbs. and each magazine should be of the general type developed for construction in conjunction with the Two Mile Mesa detonator laboratory; namely, a hollow concrete shell, approximately a 6' cube, completely covered with an earth barricade. Yet a further type has been developed by the Laboratory and will shortly undergo construction at TA-15 (R Site) as an experimental structure. The basic theory behind this new type of magazine is as follows:

(1) The building as such should be as light in construction as feasible and hence as cheap as possible.

(2) The smallest possible amount of earth fill should be employed, again with the idea of reducing expense.

(3) Should an accident occur, the main force of the explosion should be directed skyward and the residual portion which goes sideward should carry with it no projectile-like fragments as a result of the building's shattering.

(4) The building must be fireproof, since it will be situated in a forested area and hence be exposed to the possible danger of forest fires.

To satisfy these four conditions we have specified that the floor foundation and apron of the building be of standard concrete construction, inasmuch as the force of any possible explosion would merely drive them into the ground. The walls of the building have been specified as of 8" tufa-concrete. The tufa aggregate is light and porous and upon being subjected to a violent explosion should be pulverized into a fine powder, rather than into chunky fragments such as would be the case with standard concrete or other masonry. The roof of the building has been specified as corrugated asbestos cement sheeting clipped with wire connectors to light steel ceiling beams. In the event of an explosion this corrugated asbestos cement sheeting will shatter into tiny fragments because of its extreme brittleness, fly skyward and drop in small fragments in the immediate area of the magazine. The earth barricade is set back several feet from the building itself, so that, as noted above, the building may be light in structure and will not have to act as a retaining wall. The only features of the building which will result in flying fragments in the event of an explosion are the windows, doors, window and door frames, and the lintel of the entry side of the magazine, and these have been faced toward an inaccessible canyon. In the ceiling structure the light steel beam supports for the roof will similarly become flying fragments, but should be directed skyward. Sometime in the not too distant future we hope to build scale models of this type magazine and blow them up intentionally to see if they are as effective as our theory has pre-supposed. If this proves not to be the case, the one magazine we are constructing at R Site will still be as good from an overall design standpoint as the other and more standard types now in use elsewhere on the Project.

B. In general, then, it would seem feasible to work up standard details for each of the main types of buildings which will be required in the permanent construction, and develop standard color schemes which will be applicable throughout all of the new technical areas and will permit easy replacement or alteration of office or laboratory arrangements to suit changing needs. Together with this, utility arrangements should be standardized and coded so far as possible for ease of maintenance.

Appendix D

General Stock and Chemical Inventory Lists, 1946–1949

Notebook 1612

UNCLASSIFIED

1

Chemicals 6 months supply

RESTRICTED

Retyped 8/12/46

Items	Max.
Okite Stripper M-3	300 lbs.
Hydriodic Acid	350 lbs 7# bottle
Ammonium Nitrate - on shelf (explosive)	150#
Calcium Nitrate	250# (25# containers)
Caustic Soda	250# (100# drums)
Sodium Citrate	1175# (75 & 100# containers)
Sulfite	100#
Oxalic Acid	120#
Nitric Acid	189# (7# bottle)
Potassium Hydroxide	300#
Ammonium Sulphate	100#
Tartaric Acid	100#
Bicarbonate of Soda	1#
Lead Oxide (yellow)	20#
Litharge	5#
Glycerine	1 gal.
Hydrogen Peroxide	1 Carboy
Nitric Acid	30 Carboys
Ammonium Hydroxide	42 Carboys
Hydrochloric Acid	4 Carboys
Sulfuric Acid	300#, 1 Carboy & 4 Cases.
Sodium Silicate	1 qt.
Barium Sulfate	2 pound
Ethylene Glycol	220 gal.
Benzene	5 gal
Sodium Hydroxide Ar pellets	50 pounds.
Aluminum Nitrate	125 pounds
Amberlite IR-100	100 lbs.
Magnesia Oxide	500 lbs.
Iodine	
Acetone	
Igepal	
Butyl Carbitol	
Oxygen	
Hydrogen Flouride	
Helium	

~~RESTRICTED~~

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Chemicals

Argon
Acetylene
Butane
Nitrogen
Hydrogen
CO_2
Magnesium Oxide
Xylene
Carbon Tetrachloride
Calcium
Bromobenzene
Magnesium powder
Nitric Acid Fuming

Chemicals needed for next six months

Hydrolonic Acid Conc. 350 lbs 5 cases
Nitric Acid ~~(tech)~~ Conc. 1000 lbs - 15 cases
Iodine (Mallinckrodt) 1# bottles 52 lbs.
Acetone 605 gal. 11 bbls.
Phosphoric acid 85% 8000 lbs.
Ethylene Glycol 800 gal. 15 bbls.
Benzene 75 gal.
Ammonium Nitrate ? pounds
Bromobenzene White label

[redacted]

UNCLASSIFIED

RESTRICTED 5

General Stock

Date	Item	Sec.	Bin
8/30/46	Doors - Dry box - Complete w/latch & hinges	1	2
	Clamps - glove - dry box 5" I.D.	1	2
	Bolts - jar - for dry box windows size 10-32 - oval h.	1	2
	Screws - Drybox hinge size 10-32 flat head	1	2
	Plates drybox	1	2
	Hinges - Drybox	1	2
	Latch - drybox	1	2
	Tape - drybox sealing (rolls)	1	3
	Bulbs - 33" flourescent - 20w	1	4
	Bulbs ½ w. 125 V double contact	1	4
	Switch - tumbler (single pole) 20A - 125V	1	4
	Containers - 1 gallon tin	1	7
	Plastic - Clear spraying	1	8
	Containers - 5 gallon tin	1	10
	Flask - American Thermos 5 gal. #8625	1	11
	Gauze - Brunswick - 100 yds - 36" width type 7 not sterilized	2	1
	Thermometers - Household - 40° to 120° F	2	4
	Respirator - Dust for aluminum (McDonald)	2	4
	Cleaner hand (Great stuff) 37 oz Cans	2	4
	Tape - friction - 3/4" width	2	5
	Tape - Masking - ½" width	2	5
	Tape - Asbestos 1½" width	2	5
	Vials - Glass - 1 dram	2	5
	Parafin - Blocks (1" thick)	2	5
	Bearing - Roller type w/keeps 3½" length	2	5
	Thermocouple - Brown - Chart Range 0-2000 F #552	2	6
	Paper - Chart #2132 - Range 0-1800 F (40 yds)	2	6
	Gargoyle - 1/4 gal D.T.E Extra heavy	2	7
	Lubricant - Valve - Special Can	2	7
	Grease - Chassis Phillip 66, 5 lb can	2	7
	Oildag - Colloidal Graphite in oil (1 lb jar)	2	8
	Ink quick drying - 4 oz. for brown recorders part #3 17792		
	Ink recorder pen - 8 oz. Grade 49 #18R-23-N-30-542	2	

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Cont.

General Stock

Date	Items	Sec.	Bin	Dec
7/20/46	Drying Agent, 2oz - National Tech. Laboratories	2	9	8/22
	Tank-o-Meter, - 2oz Red Indicating fluid No1.	2	9	
	Liquid King Gage, 2oz Green #7642	2	9	
	Glycerine - Clear, 4oz.	2	9	
	Litharge 2 lb. for making glycerine cement.	2	9	
	Oxide Lead yellow, 5 lb.	2	9	
	Iodine - 1 lb jar	2	10-11	
	Traps - for mine Refrigeration	2	12	
	Clayfaucet 3/4"	2	12	
	Pump - centrifical - Parts 3/4" connection	2	12	
			13	
			14	
			15	
	Tube Westinghouse Electric, W.L. 5793.	3	1	
	Glass Wool	3	1	
	Truck parts, 3/4 ton Manual	3	2	
	Coils, Copper, 5" dia. 1/4 mil tubing	3	3	
	Paint, Waterspar white enamel 1 gal can	3	4	
	Glyptal - Gloss semi Black 1 pt can #7209	3	4	
	Paint - Ilex Finish Jade Green 1/2 pt can #2651	3	4	
	Oil - Acetone - Gal. Cans.	3	7	
	Oil - Lacquer - gal cans	3	7	
	Salts - Soldering	3	8	
	Flux Handy	3	8	
	Gloves, Drybox 15 G. Left hand size 9	4	1	
	Gloves, Drybox 15 G. Right hand size 9	4	2	
	Gloves, Drybox 15 G. Left hand size 10	4	3	
	Gloves Dry Box 15 G. Right hand size 10	4	4	
	Electrode, Calomel Beckman P.H. Meter #1170	4	5	
	Electrode, Glass, Beckman P.H. Meter #1190 #8990, #	4	4	
	Electrode Calomel Beckman P.H. Meter #8970T, #4970	4		
	Gloves, Surgical size 9	4	6	
	Gloves, Drybox 30 G. size 9 Left.	4	7	
	Gloves Drybox 30 G. Size 9 Right	4	8	
	Glove Dry box 30 G. Size 10 Left	4	9	
	Gloves Drybox 30 G. Right size 10	4	10	

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General Stock

Cont. 7-

Lower Lakes

Date	Items	Sec.	Bin
8/20/46	Gloves V.M.C. 1/42L Right size 9	4	11
	Gloves, Synthetic S.R. No. 166 Right size 10	4	
	Gloves, Style 8, marked size 15 # RT1319	4	
	Glove-stem - 10 in for drybox gloves.	4	
	Gloves, Surgeons Miller #5592 size 8 1/2	4	12
	Gloves special Drybox Sureseal size 9	4	13
"	Gloves, special Drybox, sureseal size 9	4	14
	Gloves, Surgeons Brown Latex #835 12 pr. to box	4	15
	Vises, Bench, 8 inch	4	16
	Kleenex Tissue	5	1
	Pyrometer, alnor Range 0-100 app #51034, #51033	5	2
	Jacks, Lift, with handles.	5	3
	Pumps - Air	5	—
	Cans, oil, pint size	5	4
	Gauges, 12" 160 # Air Pressure	5	—
	Rheostat #3-19	5	5
	Glass 3" x 3"	5	5
	Guns, Grease, with extensions	5	8
	Tanks, fuel, 5 gal. size	5	8
	Funnels, Lead - 6"x6"x1 spout	6	1
	Funnels tin.	6	1
	Racks - wooden paper towel 9"x7"x1 1/2	6	2
	— — — — —		3
	Cables, Insulated 1" dia 6' long	—	6
	Couplets, flexible #58872C 3" dia. 20" long	6	7
	Couplets, flexible #58872B 2" dia 20" long	6	7
	Couplets flexible #58872 A 1/2 dia. 20" long	6	7
	Tubing, Pennaflex 1/2 dia	6	7
	Tubing, Pennaflex 1" dia	6	7
	Refiner - Air filter	6	7
	Grease - ball bearing 8 oz tube	7	1
	Cement - transparent Dupont 1 3/4 fl. oz.	7	1
	Paint Brush	7	1
	Linen thread spool 3 1/2 x 4	7	1
	Permatex #2. 8oz can	7	1
	1/2 pt. Oilers with 6" L spouts	7	1
	1 pt. oil cans	7	1

(Continued) General Stock

Date	Items	Sec.		Da
8/29/46.	Cork gaskets 1"x7"	7	Bins 1	8/2
..	Cork gaskets. 1"x4½"	7	1	..
..	Stainless steel strip	7	1	..
..	Wire wheel brush 1"x4"	7	1	..
..	Wire wheel brush 1"x6"	7	1	..
..	Bulb 125 W 120 volts.	7	1	..
..	Bulb, base candle 10 W 230 V S6	7	1	..
..	Bulb clear S6 6 W 120 V	7	1	..
..	Bulb S6 clear	7	1	..
..	Bulb 6S6 6 W 120 V	7	1	..
..	Mazda Lamps #35C 24 V G 5½	7	1	..
..	Glass bulb #233, 23 V 3½ amps.	7	1	..
..	Soldering paste nokorode. 2 oz cans	7	1	..
..	Solder 1 lb rolls.	7	1	..
..	Bar solder 50/50	7	1	..
..	Radio wire 1# spool	7	1	..
..	Welding plate shade #10	7	1	..
..	Double sockets	7	1	..
..	Solder wire 1/2" 200 silver	7	1	..
..	Wire stainless steel size .013 #13701	7	1	..
..	Union twist ladder drill sets fraction 1/16-1/2	7	1	..
..	Stencils - steel	7	1	..
..	Batteries - eveready dry cell. 1½ volts.	7	1	..
..	Controller - Leeds & Northrup (clock size) #7-82	7	1	..
..	Tool bag 18"x6"x6" #48304	7	1	..
..	Oxygen regulator - Victor app. #51990, #H-51973 - VTS43	7	1	..
..	Reflectors - Green and red.	7	1	..
..	Padlock - steel	7	1	..
..	Horseshoe scraps	7	1	..
..	Cylinders - steel 6"x8"	7	1	..
..	Bottles - small neck 20 liter	7	1	..
..	Chain hoist 3" app. #29327	7	1	..
..	Fiber gasket material 3'x6' 1/32 thick	7	1	..
..	Pressure regulator air app. #5214	7	1	..
		8	1	..
			2	.
			3	

[redacted]

(Continued) General Stock

Date	Item	Sec.	Bin
8/20/46	Caps bottle 2"	8	4
"	Caps bottle 2½"	8	5
"	Bottle caps 1"	8	6
"	Brown paper bag size 8	8	7
"	Talc Merck #6460 1 lb cans.	8	8
"	Tin pails, galvanized #10	8	1
"	Bottles - #B qt.	9	2
"	Jars - #3 qt	9	3
"	Jars - #A-pint size	9	3
"	Rubber tubing	11	1
"	Identification clamps for pipes	11	2
"	Koroseal tubing 5/8 x 1/8	11	4
"	Rubber tubing 3/4"	"	5
"	Gas & Oxygen hose 3/8"	"	5
"	Rubber tubing 1/4	"	5
"	Rubber tubing 3/8	"	5
"	Ohmite Potentiometer	"	7
"	Coil transformer #15	"	7
"	Electrical controls	"	7
"	Rubber air hose 1/4" with insulation	11	8
"	Air hose 1/8"	11	11
"	Rubber hose 1/4	"	11
"	Barrel faucets 1/4" I.P.T.	"	13
"	Pans steel 32x22x5	"	15
"	Caps for centrifical pumps 2"		1
"	Drybox w/gaskets (door, plate, glove).	11	2
"	Stainless steel containers 3'3x1/2	11	34
"	Electric wire insulated 1/2"	11	5
"	Rubber cords Belden 2"		—
"	Weatherproof outside wire 1/4"		—
"	Inside wire 1/8"		—
"	Rubber hose 5/8		7
"	Rubber scrap strip (bundles).		8
"	Transformer - General Electric		10
"	Welding rod fuse weight 50		1
"	Jars - 1 gal. pyrex with tabs		4
"	Tantalum rods 1/2 in. 36" long		2

(Continued) General Stock

Date	Items	Sec.	Bin	Da
8/30/46	Jars paper 1 qt		4	8/29
"	Jars: paper 1 gal with tape		5	"
"	Magnesium Cans 3½ x 12			"
"	Magnesium Cans - 3½ x 3			"
"	Cardboard containers 3½ x 9			"
"	Smaller cardboard cans 4 x 4½			"
"	Boxes cardboard 36" x 18 x 24"			"
"	Record storage boxes size 12			"
"	Liberty record storage boxes size 22			"
"	Automatic Electric precipitator type L.F.			"
"	Electric transformer #44792			"
"	Laboratory safe cabinets 24" x 15 x 28			"
"	Four leg steel tables 15 x 12 x 31 tall.			"
"	Rpg #3 KW Converters S. #629453-B			"
"	Stainless steel box 11" x 11" x 18			"
"	Cardboard containers or Cans 4½ x 9½			"
"	1 pt. Ice cream containers 3⅜ dia			"
"	Cable - 200 ft spool 3/8"			"
"	Wire - 1/8" Rubber insulation			"
"	Wire - Insulation			"
"	Tin Cans with lids - 6" dia 19			"
"	Cardboard Cans 6" dia 20			"
"	Tanks - stainless steel 21			"
"	" " " " 22			"
"	" " " " 23			"
"	" "			"
"	Mess hall food containers - 5 gal.			"
"	Wire Carriers.			"
"	Cork 3" x 36"			"
"	Cork 2" x 36			"
"	Glass ¼". 36" x 60".			"
"	Alundum Crucibles 3 x 13¾			"
"	Alundum pipes 3" x 24			"
"	Alundum Crucibles 3¾ x 11½			"
"	Office Chairs			"
"	Drafting table 60" x 36			"

[redacted]

(Continued) General Stock UNCLASSIFIED

RESTRICTED

Date	Items	Sec.	Bin
9/20/46	Bookcase 32" x 14 x 12		
"	Truck chairs		
"	Truck drills - 27" x 24"		
"	Truck access.		
"	American air filter paper - rolls		
"	Stainless steel. Cans 16 x 8		
"	Wastecan #200 approved.		
"	Welders carts (airco)		
"	Wraping paper.		
"	Bottles - wide mouth 8 oz.		
"	Bottles pint wide mouth		
"	Jar - 1 gal. (ball).		
"	Jars - with tops V.T. 499		
"	Jars - 1 qt with blue tops		
"	Jar - 10 1/2 gal. V.T 76		
"	Bottle 2 qt. bleach. RT. 4632		
"	Air pump with motor #45970, #45964 #45959 #45963, 45969, 45962, 45966, 45968, 45961, 45960, #44893 #44891, #45965, #45967, #44898, #44004, #44974.		
"	Mop wringer		
"	Photostat acid 12 1/2 oz		
"	Lens Brass #43747, #43741, #43748 #43742,		
"	Fire brick boxes - insulating.		
"	Charger - for air filter - V.M 2338		
"	Stationery Sec. V.M. 2338		
"	Transfer Sets V.M. 2338		
"	Gear, speed reducing. Wood fell and Smith.		
"	Bottles - gas glass 50 liter		
"	Air pumps with G.E. motors #45972, #45959		
"	Pump - Vacuum, Nelson - #49592, #49593, #49594		
"	Heater #45956		
"	Pump. #48925		
"	Motor - double duty delta #44845 #44846		
"	Motor - 3/4 H.P.		
"	Motor - Elec. 2 H.P. #34528		
"	Pump. Glass centrifugal #51161, #51131		
"	Pump. Cenco Megavac #32014, #51430, #51433 #32008, #32009, #32016		

RESTRICTED

UNCLASSIFIED

Laura LaRue

12 Continued General Stock -

Date	Items	Sec.	Bin	Date
8/20/46.	Pumps Worthington #C26275			8/2.
"	Glass apparatus #52642			"
"	Step ladders 6 ft.			"
"	Tank, semi type P. 3 gal.			
"	Stenographers stool			
"	Photostat Developer 4 oz jar			
"	Photostat Developer 10½ oz jar			
"	Photostat paper. 30 ft reel.			
	Fixer, photostat acid - 12½ oz bottles			8/
	Holders - Glass portholders - 5" dia.			8/
	Cans - tin 6½" dia x 13" high (light weight transfer.			
	Pipes - Alundum - 6" dia. x 24" long			
	Bottles - 50 - liter pyrex			
	Tubing copper - ¼"			
	Hose, Vacuum 3" dia 71-44			
	Tubing - saran ½" x .062			
	Tubing saran ½ x .059			
	Tubing saran ¾ x .062			
	Tubing copper - Refrigeration ⅜"			
	Tubing - Rubber - 1" dia			
	Wire Copper - ⅜"			
	Belts - fan - Super service - size 47 - #D-240			
	Belts - Fan - Vulcan Rope - Size 47 - #3			
8/21/46	Stainless steel ⅛" x 7½" x 7½" finished size			
"	Dural ⅛" x 1" x 48"			
"	⅛ x ⅞ x 48"			
"	⅛ x 2" x 48			
"	Shim stock .002 .005 .010 .022			
"	Machine Screws - ¼-20 x ⅝"			
"	Drills H.S.S. ⅛"			
"	Copper tubing cutter			
"	Cold rolled steel ¼" x 6" x 6"			
"	Brass Disk			
"	Masking tape 2"			
"	39/32 H.S. Drill w/ ½ shank			
	31/32			
	1"			

Continued General Stock. 13

Date Items Sec. Bin

8/21/46 Belt Lacing #4
" Jars, pyrex battery 13" x 12"
" Gage, pressure 0-100# scale
Dural 4" dia x 2 3/4 lengths
2 1/4 " x 3 1/4 "
Dural tubing 3 1/4" O.D. x 1/4 x 3 1/4"
Dural 3/8" x 4" x 3 1/2" plate
Cold rolled steel 1" dia x 15
8/22/46 Dies 1/4-28
8/22/46 Hose clamps 1 1/2" to 2"
" " 1 3/4 to 2 3/4
Carriage bolts 2 1/2" x 1/4"
Machine screws 1 1/2 fillister head w/nuts 10-24 thread
Bulb nipple to screw to wall
Rubber V. belt x 2" inside dia.
Hydrometers Sp. G. R. Range 1.200 to 1.42
Beakers 100 ml.
Beakers 150 ml
Beakers 250 ml
Beakers 500 ml.
Drills numbered 1 to 60 high speed with rack.
Drills fractional 1/16" to 1/2" high speed with rack.
Mason pressure reducing valve -150 0-15# control
on 60# line 1/4" pipe thread
Dural 2 1/2" dia x 6" long
Brass 1" dia 18" long
Supports - tube
Plates - perforated
Hex Brass stock 5' x 1 1/4"
C. R. S. 30" long x 5/8" wide x 1/16 thick
Dural Plate 18" x 8" x 3/16
Pipe 5' x 1/2" O.D. Cu.
Morse taper chuck arbor
Sand. cord
Lucite 4 1/2 x 1 1/2 x 1/4"
Lucite 11" x 14" x 1/4
Lucite 20 x 28" x 1/4

Continued General Stock

Date	Items	Sec.	Bin	Da
8/27/46	Hex Head Bolts & nuts 3/8"-16 x 2 1/2" steel			9/3,
	Boat Inverter			"
8/30/46	Chain light weight			"
	Screws Machine 1/4-20 x 5/8			"
	Screws Machine 1/2 filister head w/nuts 10-24 thread			
	Screws Machine 3/8 x 2 1/4 Steel with nuts			
	Screws Machine 1/4-20 x 1"			
	Screws Machine 4-40 x 1/4			
	Screw Caps. 10-32			
	Screw Cap. 8-32			
	Screws Machines 4-40 x 3/8			
	Screws Machine 6-32 x 1/2			
	Screws Machine 6-32 x 1/4 Steel			
	Screws Machine 6-40 x 5/8 Brass			
	Screws Machine 6-40 x 1/2 Brass filled			
	Screws Machine 8-32 x 1/8			
	Screws Machine 8-32 x 1/2			
	Screws Machine 8-32 x 5/8			
	Screw Machine 8-32 x 3/4			
	Screws Machine 10-24 x 5/8 Steel filled			
	Screws Machine 10-32 x 7/8			
	Screws Machine 10-32 x 1/2			
	Screw Machine 12-24 x 3/4			
	Tubes Copper 3/8 90° Elbow soldered			
	Tubes Copper 3/4 90° Elbow soldered			
	Washers 1/4			
	Washers #10			
	Washer #6			
	Washers steel #4			
	Washers flat brass 1/2"			
	Washers flat brass 3/8			
	Washers flat brass 5/16			
	Washer flat brass 1/4			
	Washer flat #10			
	Washers lock 1/4			
	Washers lock #8			
	Washers lock #6			

SE.

[redacted]

Continued General Stock

Date	
9/3/46	Turnbuckle 4" long
"	90° angle Bracket 4"
"	Hose Clamps 1/4"
"	Angle Irons 2x2x1/4
	Flat Irons 2"x1/8"
	Flat Iron - 2x1/4
	Poly T.F.E 1/4 x12x12
	Electrical sockets with switch
	Male Plugs
	Wire
	Fittings, Photoswitch probe type 31 w/ SS nipple
SEP 5 1946	
	Plugs 3 way
	Drills center H.S.S. A1, C2, D7, E2 F2
	Green Ink
	Ells 1/2 - 90°
	Cap copper 5/8
	Resistor 35 OHM 50 WATT
	Dural tubing 4 1/2 x 3/4 O.D x 1/16
	Screws flat head
	Dural tubing 1/4" x 1D x 1/8" SW
	Coupling male 3/8" SAE, flare to 1/4" pipe
	Screw door spring
	Flare Nuts SAE 1/4
	Drawing boards 30" x 24"
	Squares T 24"
	Triangles 60° - 10
	Triangles 60° - 6"
	Triangles 45° - 10"
	Architects Scales
	Pencil pointers
	Curves 2152-18
	Curves 2152-14
	Nuts, steel wing 3/8" x 1 1/2
	Notebook, leather bound small
	Notebook, spiral, small
	Hinge strip 2"

Continued General Stock
9/5/46 Item

Hasps with 1/2" Screws
Socket Screws.
Rubber Bands
Ratchet spiral screw driver
Wire Desk trays
Cover Clock
Amphibious Suits Nylon
Yankee screw driver
Paint brush 1"
Paint brush 2"
White Shellac
Stove bolts 3/16 x 1"
Buffing wheels
Cable Clamps
Steel drawer sections
10' long by 1/2" hot rolled rod.
Switches, S.P.D.T
Dental Mirrors
Scissors 10"
Cards index 3 x 5"
Cards index 5 x 8
Filing box
Neoprene tubing 3/4 x 1/4
Red Paint
2" Pulley
Cylinder Graduate
Neoprene hose for over 1/2" pipe or 3/4 I.D.
Linoleum knife
Brass tubing 4" OD x 1/8"
Steel cold rolled 1" x 1" long
Pump oil Duo. Seal.
Circles sawed from 3/16" S.S. plate
3 ring looseleaf notebook 9 x 11
Fillers for above - plain & ruled.
Wooden desk tray
Hose Clamps 5/8" I.D
Plastic desk tray

General Stock
Items

Eveready batteries #455-1543"
Hacksaw frame.
Chloroform
Brass Rod 24" long 3/10" dia
Scissors 8"
Accopress Binders
18" Flourescent Bulbs, (daylight)
Welding Rods
Gage Vac. pressure 30" Vac. 30# pressure
Pipette Volumeter 1 Ml
Liquid glue
Black paint
Nickel Carbonyl.
Kraft paper
Thumb tacks
Battery hydrometer
Screen - Stainless steel 23"x23"
Neoprene - 24"x24"

General Stock.
New Inventory.

Item	Se.	Bin.
Grease - Litecal - Medium weight	3	23
Tape - Drybox Sealing - 1/8"	3	29
Tape - Drybox Sealing 1/8"	Warehouse	
Toweling - absorbent - 18" x 25 yds.	3. Top	
Valves - Solenoid - type M-635 - E-115V - 60 Cycle 250 Press.	2	29
Gauge - Ashcroft - 2½" dial - type 100K 15" pressure - 30" Vacuum	3	30
Transformers - Model 393-11-12 amps - 115V 60 cycle Spencer Lens Co. Buffalo, N. Y.	3	31
Variacs - type 200C - 115V - 5 amps	3	30
Switch - Magnetic - #CR7006-D50B Cat. 5369679-G19	3	31
Cones - Heater - for Glo-Electric Ray Heater	3	30
Thermometers - Laboratory - Liquid - Mod. 2264.010, 10° to +110°C	3	30
Transformers current - 600V Circuit - 5 amp.	3	32
Gauge - Carrier - 2½" dial - 30" Vac. 30" Press.	3	30
Valves - General Control - Pilot Piston Operated	2 -	29.
type K-15-2 Size ½" Fullport - 115V. 60 cycle	3	33 32
Valves, General Control Magnetic - type K-10-2 size 3/8" - 115 V. 60 cycle	3	30
Valves - General Control Magnetic - type K-10-5 Size ¼" - 115V. 60/50 cycle	2	29
Beakers - 2000 ML - Pyrex	3	14
Beakers - 1500 ML - Pyrex	3	15
Beakers - 1000 ML - "	3	16
Beakers - 800 ML "	3	17
Beakers - 600 ML	3	18
Asbestos, powdered bulk	3	19
Thermoregulator - De Khotinsky 99:05A-3-C	3	20
Cups - #1328 Timken Roller Bearing Co.	3	20
Cone - #1380 Timken Roller Bearing Co	3	20
Cylinders - graduate - 2000 ML - Hex base pyrex	3. Top.	
Cylinders - graduate 4000 ML - Hex base pyrex	3 Top	
Flasks - 1,000 cc - for Lucite transfer case	3	21-27-28
Jars - battery small	3	21-27-28
Cylinder - graduate 1000 hex base pyrex	3	top

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~~General Stock~~

RESTRICTED

	Item	Sec.	Bin
3			
9	Thermocouple, Vacuum tube device - Xactline Claude S. Gordon Co.	3	20
	Beakers - 250 ML Pyrex	3	18
9	Liquid - Direct Process	2	26
	Brushes, paint 4", 3", 2", 1½" 1" Lacquer & Lettering	2	25
0	Shock absorber L&M #10011-A	3	24
	Tubes, Pyrex test #9800 - 13 x 100 mm	3	24
1	Koroseal - Sheet 12" x 24" x 1/16	3	24
0	Bearings, w/lock screw 1" OD x ½" I.D. Norma Hoffman Precision	3	24
0	Glyptal - Semi-gloss Black enamel 1092 G.E.	3	23
	Glyptal - Semi-gloss Red enamel #1201 G.E.	3	23
0	Paint - flex finish - White #2601	3	22
2	Grease - Texaco Starfak - H - Special for Nordberg	3	23
0	Transformer - filament #T-19F79	3	24
9	Tubes - Pyrex #98 w/rim 15 x 125 MM.	3	24
3	Grease Nordco Lubricant - for Nordstrom Valves #D	3	23
	Grease A.C.F Lubricant #17 Bulk Am. Car & Fndry Co.	3	23
5	Grease ACF Lubricant #16 " " " "	3	23
	Grease ACF Lubricant #58 " " " "	3	23
9	Paste - Garlock Lubricating - compound #2	3	22
4	Grease - Nordco Lubricating - for D		
5	Nordstrom Valves #D	3	23
6	Grease - Lubriseal for sealing stopcocks		
7	Arthur H. Thomas Co	3	22
8	Grease ACF Lubricant - Temp. Range 10° - 150°F		
5	#23	3	23
0	Grease - Fafnir type RBG for ball bearings.	3	23
20	Permatex #2 - 8 oz	3	22
20	Gauge - Vacuum thermocouple #E-5208 National Research Corp.	3	10
	Capacitor - #5-4776-1 8-8-10 MFD for teletalk		
7-28	Model #2245 Cornell - Dubilier	3	11
1-28	Fuses - Monarch Renewable - 60 amp. 250 Volts	3	12
	Links - Monarch Renewable - 60 amps. 25 Volts	3	12

 General Stock

	Sec.	Bin
Relay, Temperature - 125 Amp. G.E.	3	11
Controller - Refrigeration Pressure - M.H. type L413A3X3 185# - 220#	3	13
Housing - M.H. thermostatic temp controller Horizontal	3	9
Relay - Trane #CR2820-1099 A.C. PR.41583 G.E.	3	11
Condensers - type TJH-6040 4MFD 600 V.D.C.	4	13
Controls - Push button motor - #CR2940-284 600V G.E.	4	11
Transformers #3456-2	4	12
Transformers - #3471-3	4	12
Transformers - #3465-63	4	12
Transformers - #UX681913	4	12
Valves - Solenoid #CR9507-C1B 150# pressure	4	13
Controller - Refrigeration pressure TYPE L404H1X1	4	12
Heating Unit #8-dg Size 2160 watts - Fisher Scientific for Barnstead stills - Single phase	4	9
Fields - electric - Small #208-220 V. 60 cycle	3	12
Variac - type 60-A-115V - 400 cw 5A Calibrated - General Radio co.	3	10
Gear - Reduction - for Bodine motor	4	13
Cores - Small Electric furnace 115-230V furnace - type 86	4	10
Gear Reduction - Miscellaneous	3	13
Motor - air Small	3	13
Lamps - G.E. 6-watt - 120 volts code 6S6 screw base	3	8
Lamps G.E. - 10 watt - 230 volt - S6.		
Lamps 2.3 Volts - flashlite Lamps for 2 cell	4	8
Lamps 2.4 Volts - Hand lantern No 35-C	4	8
Lamps NE30 - 125V - 1 watt	4	8
Lamps 150 watt Mazda	4	5
Lamps 100 w G.E.	4	6-7
Lamps - 40 w - Mazda	4	2-3
Lamps - 60 w. - Mazda	4	1-2

[redacted]

General Stock New Inventory.

	Location
Paint - Flux - Jade Green #2631	S-12-B6
" " Black #2602	" "
" " White #2601	" "
" " Indian Yellow #2613	" "
" " Oriental Red #2612	" "
Glyptal - Semi Gloss Black enamel #1209	S-4 B-23 S-12-B-6
Lubricant - Special Value - for Aqua Regia	S-12-B7
Slyptal - Clear Varnish #1202	S-12-B6
Plastic Wood - Natural	
Plastic	
Glue - Lepages	S-12-B7
Tape - friction - Black 3/4 x 82 1/2'	S-12-B7
Sponge - Dupont Plastic	S-12-B5
Gaskets - Cork - 1/4" thick x 4 5/16" OD x 2 1/4" I.D.	S-12-B5
Lamps - G.E. #233 2.3V. .27A.	S-4-B8
Lamps	
Shellac - Orange	S-12-B2
Shellac - Pure white	S-12-B-2
Brushes - Paint - lettering	S-12-B25
Lubricant - A.C.F. #53	S-4-B-23
Tape - adding machine	S-12-B10
Springs - Coil 3/4" Dia x 6"	S-12-B13
Tape adhesive - White - 3"	S-12-B12
Cement Duco - Dupont	S-12-B-7
Screws Allen Set 1/4-20 x 1/2"	S-12-B14
Soldering sets - Allen	S-12-B14
Flux [illegible] - Brazing	S-12-B-2
Holder - Fisher Burette #5-779	S-12-B73
Tape - masking - 1"	S-12-B8
Tape - masking 1/2"	S-12-B8
Tape - masking 2"	S-12-B19
Tape paper adhesive 3"	S-12-B-9
Tape Industrial adhesive - 1"	S-12-B11
Packing [illegible] asbestos 1 1/2" x 1/16"	S-12-B-11
Gaskets Cork 5 1/2" x 3 1/2" x 1 1/4	S-12-B-3

General Stock
New Inventory

Pipette - #963 - 1 ML - Grad in 1/100	S-12-B-13
Gaskets - Leas 11 5/8" x 9" I.D. punches w/12 only - 1/16" holes	S-12-B-13
Beakers - Pyrex - 4000 ML	S-4 top
Screen Wire 7" x 11" fine mesh	
Hose - Binks Air w/chuck	
Tubing - Rubber 9/32 OD x 1/16" wall - 152	

2-1-47 General Stock

Asbestos 1½" wide - 1/32" thick	S-12-B-11
Asbestos, ¾ wide 1/16" thick	S-12-B-11
Asbestos 1½" wide - 1/16" thick	S-12-B-11
Asbestos -	S-12-B-12
Asbestos -	S-12-B-21
Blue Layout Dope	S-12-B-15
Batteries - Flashlite	S-11-B-6
Battery - BA - Navy Type - A.	S-10-B-4
Battery - BA - Navy Type - A.	S-10-B-5
Batteries Flashlite #950 Size D.	
Bulbs - Light - 6-5 Volt & 120 Volt.	S-10-B-28
Beakers - 250 ML	S-9-B-18
Beakers - 400 ML	S-9-B-18
Beakers - 600 ML	S-9-B-18
Beakers - 800 ML	S-9-B-18
Beakers - 1000 ML	S-9-B-25
Beakers - 2000 ML	S-9-B-24
Brushes ½"	S-9-B-25
Brushes 1"	S-9-B-25
Brushes 1½"	S-9-B-25
Brushes 2"	S-9-B-25
Brushes 2½"	S-9-B-25
Brushes 3"	S-9-B-25
Brushes 3½"	S-9-B-25
Brushes 4"	S-9-B-25
Brushes Wire	S-9-B-25
Bearings - Precision	S-9-B-25
Bearings - Roller -	S-9-B-20
Burette Holder	S-12-B-13

Cans 5 gal.	S.
Capacitor for teletalk model #2245	S-9-B-11
Cheese cloth	S-9-B-34
Chisels	S-11-B-33
Clamps - for drybox parts	S-12-B-23
Compound Sealing Epoxy	S-12-B-21
Cones Glosses	S-9-B-13
Controller Refrigeration fan	S-7-B-13
Cone Airline 450-1645	S-15-B-2
Condenser type TJH-6040	S-9-B-13
Control Push Button Motor G.E.	S-7-B-11
Control Temp. Captive	S-7-B-20
Coupling - 3 jaw 1/2" Bore -	S-10-B-3
Coupling pennaflex.	S-10-B-14
Coupling pennaflex 1/4" pipe male 1/4"	S-10-B-14
Cork 1" Hose -	S-12-B-29
Cores - 115V 230V - Small Electric Furnace	S-2-B-10
Cup Grease -	S-10-B-1
Cup Tulip	

S-7 WHR 4/27/05 3 pp.

441.2

1 October 1947

: A. W. Betts Attention: Harry Allen

: Louis H. Hempelmann, Health Division

: Toxic Chemicals from Z Stock

REFERENCE : LAB: HEALTH

Reviewed/Lab Counsel
Publicly Releasable
5-23-05

In order to keep a record of the work being done throughout the Laboratory with hazardous chemicals, it is requested that the Health Division office and the Director's office be informed by Z Stock whenever the chemicals specified on the attached list are checked out in excess of the quantities listed.

The purpose of this is to inform the Health Division of the use of toxic chemicals in large amounts. It will be necessary, therefore, that you send out a list of excess withdrawals once each week. The Health Division will then check with these individuals to see that the toxic substances are being handled under safe conditions.

Louis H. Hempelmann, M. D.

cc:

N. E. Bradbury
File

LIST OF TOXIC CHEMICALS

Organic

CHEMICAL	AMOUNT
Benzene	1 Gallon
Toluene	1 Gallon
Carbon tetrachloride	"
Methyl alcohol	"
Ethylene glycol	"
Chloroform	"
Carbon disulfide	"
Nickel carbonyl	1 Pound
Pyridine	1 Kg.
Aniline	1 Kg.
Bromobenzene	"
Nitrobenzene	"
Phenol	1 Pound
O-Phenylenediamine	500 G.
All Nitrotoluenes	1 Pound
Methylsulfate	500 G.
All organic nitriles (cyanides)	"
All oxalates (and oxalic acid)	1 Pound
Hydrazine compounds	"
Hydroxylamine	

Inorganic

CHEMICAL	AMOUNT
All metallic fluorides	5 Pounds
Hydrofluoric acid	
Arsenic metal and arsenic compounds	1 Pound
Ammonium sulfide	"
Ammonium persulfate	"
Ammonium bisulfate	"
All thiocyanates	"
Antimony metal and all compounds	
All bisulfites	"
Barium metal and all barium compounds	"
Beryllium metal	"
Bromine	"
Cadmium metal	"
All cyanides	"
Calcium peroxide	"
Calcium phosphide	"
Chromium acetate	"
Chromium chloride	"
Chromium nitrate	"
Chromic acid	"
Chromium potassium sulfate	"
Cobalt acetate	"
Cobalt nitrate	1 Pound
Cupric acetate	"
Cupric aceto arsenite	"
Copper arsenite	"
Cupric borate	"
Cupric chloride	
Cuprous cyanide	
Cupric nitrate	
Cupric oxide	5 Pounds
Cupric sulfate	"
Cupric silicate	1 Pound
Cuprous sulfide	"
Ferric ammonium oxalate	"
Ferric oxalate	"
Iodine	"
Iodic acid	"
Lead acetate	"
Lead bromide	"
Lead carbonate	"
Lead fluoborate	"
Lead chloride	
Lead chromate	
Lead fluoride	
Lead iodide	
Lead nitrate	
Lead nitrite	1 Pound
Lead oxalate	"
Lead oxide	"
Lead peroxide	"
Lead phosphate	"
Lead sulfide	"
Lead sulfocyanate	"
Manganese oxalate	"
Yellow phosphorus	"
Phosphorus oxychloride	"
Phosphorus pentachloride	"
Phosphorus trichloride	"
Phosphoric anhydride	5 Pounds
Phosphoric acid	5 Pounds
Phosphorus pentasulfide	1 Pound
Phosphorus sesquisulfide	
Potassium dichromate	5 Pounds
Potassium chlorate	"
Potassium chromate	"
Potassium thiocyanate	
Potassium hydroxide	5 Pounds
Potassium ferricyanide	"
Potassium bisulfate	"
Potassium oxalate	1 Pound
Silicon tetrachloride	"

Inorganic, con't

CHEMICAL	AMOUNT
Sodium amalgam	1 Pound
Sodium hydroxide	10 Pounds
Sodium hypochlorite	1 Pound
Sodium dichromate	5 Pounds
Sodium chromate	"
Sodium cobalt nitrite	1 Pound
Sodium thiocyanate	1 Pound
Sodium hydride	1 Pound
Sodium nitrite	5 Pounds
Sodium nitro ferricyanide	1 Pound
Sodium oxalate	5 Pounds
Sodium peroxide	1 Pound
Sodium bisulfite	
Stannous chloride	1 Pound
Stannous oxalate	"
Strontium oxalate	"
Thallium oxide	"
Thallium iodide	"
Thionyl chloride	500 G.
All selenium compounds	1 Pound
Zinc acetate	"
Zinc carbonate	"
Zinc chloride	"
Zinc chromate	"
Zinc nitrate	"
Zinc oxalate	"
Zinc phosphate	"
Zinc sulfate	"
Zinc sulfite	"
All Silver salts	"

August 11, 1949

AEC Supply Division, Attn: George Udell, Director
For: A. C. Hull, Jr.
Department of Supply and Property, Los Alamos Scientific Laboratory
Beryllium Inventory

Reference: sp

Reference is made to our telephone conversation of yesterday in which I informed you that it would be rather difficult to obtain an accurate figure on the actual beryllium at this installation. The reason for this is simply because of the irregularity in the jackets of the rod which constitutes a fair portion of all of the material on hand.

The attached listing indicates net weight in pounds wherever weight is given in the report. We are highly desirous of having the interested Operations Office accept this manner of reporting inasmuch as we will control the material in the units as indicated in the report.

RJV:nk

Robert J. Van Gemert
Associate Department Head

Reviewed/Lab Counsel
Publicly Releasable
4-29-05

DECLASSIFIED BY DECLASSIFICATION
1ST REVIEW DATE: 4/22/05
NAME: W.H. Roberts/PM Tech
TITLE: Sr. Classification Analyst
2ND REVIEW DATE: 4/22/05
NAME: RC Adams PA Tech
TITLE: Sr. Class Analyst
SOURCE: LA-4000 Ver 1 Sep 2002
3 pp.

[redacted]

BERYLLIUM INVENTORY

STOCK NO.	NOMENCLATURE		INV. BALANCE
C 1492	BERYLLIUM OXIDE		1927½#
C 1493	Beryllium metal, Powder		20#
C 1494	Beryllium Metal, Fine Powder		10#
C 1495	Beryllium Metal, Small Lump		12 oz.
C 1496	Berylliµm Metal Flake		2½#
C 1497	Beryllium Metal, Turnings, Fin~~e~~ Tech		27# 5 oz.
C 1498	Beryllium Metal, Turnings, Tech		159#
C 1499	Beryllium Metal, SCRAP		4#
C 1500	Beryllium Metal, Block, Size: ½"x½"x½"		65 ea.
C 1501	Beryllium Metal, Block. Size: ½"x½"x1"		75 ea.
C 1502	Beryllium Metal, Block, Size: 1"x1"x½"		40 ea.
C 1503	Beryllium Metal, Block, Size: 1"x1"x1"		69 ea.
C 1504	Beryllium Metal, Block, Size: 3/4"x3/4"x2"		7 ea.
C 1505	Beryllium Metal, Block, Size: 1"x½"x2"		50 ea.
C 1506	Beryllium Metal, Block, Size: 1¼"x½"x4"		4 ea.
C 1507	Beryllium Metal, Block, Size: 2"x2"x4"		50 ea.
C 1508	Beryllium Metal, Block, Size: 2"x2"x8"		100 ea.
C 1509	Beryllium Metal, Block, Size: 3 5/16" x3 5/16" x7/8"		11 ea.
C 1510	Beryllium Metal, Block, Size: 4"x4"x8"		50 ea.
C 1511	Beryllium Metal, Block, Size: 5"x4½"x10½"		1 ea.
C 1512	Beryllium Metal, Disc.	" 3/4" diam. x 3/8" thick	17 ea.
C-1534	Beryllium Metal, Disc.	" 1" diam. x 1/8" thick	13 ea.
C 1513	Beryllium Metal, Rod	" ½" diam. w/1/64" jacket	1423½"
C 1514	Beryllium Metal, Rod	" 5/8" diam.w/1/64" jacket	670½"
C 1515	Beryllium Metal, Rod	" 1" diam WO/ jacket	87"
C1516	Beryllium Metal, Rod	" 1" diam. W/1/64" jacket	127 7/8"

[redacted]

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Beryllium inventory - continued

STOCK NO.	NOMENCLATURE	INV. BALANCE
C1517	Beryllium Metal, Rod, Size: 11/8" diam. w/1/64" jacket	2213½"
C 1518	Beryllium Metal, Rod, Size:1 1/8" diam w/ 1/32" "	29 3/8"
C 1519	Beryllium Metal, Rod, Size:1 3/16" diam. w/1/32" "	70 1/8"
C 1520	Beryllium Metal, Rod, Size: 1½" diam. w/O jacket	36¼"
C 1521	Beryllium Metal, Rod, Size: 1 5/8" diam. w/ 1/64" jacket	1061¼"
C 1522	Beryllium Metal, Rod, Size: 2 1/8" diam. w/1/16" "	749½"
C 1523	Beryllium Metal, Rod, Size: 2½" diam. w/o jacket	9"
C 1524	Beryllium Metal, Rod, Size: 2 9/16 diam. w/o jacket	5 3/4"
C 1525	Beryllium Metal, Rod, Size: 2 9/16" diam.W/1/16" "	684"
C 1526	Beryllium Metal, Rod, Size: 2 13/16"diam.w/o jacket	9½"
C 1527	Beryllium Metal, Rod, Size; 2 13/16" diam. w/1/32" "	114"
C 1528	Beryllium Metal, Rod, Size: 2 15/16" diam. w/o jacket	10 3/4"
C 1529	Beryllium Metal, Rod, Size: 3" diam. w/o jacket	56 1/2"
C 1530	Beryllium Metal, Rod, Size: 3 1/8" diam.W/1/32" jacket	27 3/4"
C 1531	Beryllium Metal, Rod, Size: 3 3/16" diam. w/o jacket	140"
C 1532	Beryllium Metal, Rod, Size: 3 3/16" diam. w/1/16" "	116½"
C 1533	Beryllium Metal, Tube, Size: 1" OD x 1/2" ID	6"

~~RESTRICTED~~

Appendix E

Notes from Interviews with Current and Former Laboratory Employees

Interview of Wilbur McNeese

RE: Early Plutonium Recovery operations at DP West
Date: November 6, 2006
Place: off-site in Santa Fe, NM
Interviewer: Ercle Herbert

Wilber is former chemical engineer in support of Chemical and Metallurgy Research (CMR) Division at DP Site, and worked in the plutonium recovery operations starting in 1946.Wilbur was the 1st person hired on with DP West to replace soldiers that were leaving. He was 26 in January 1946 when he started. He was hired as a chemical engineer, but did not quite have a degree (which he received later). His responsibilities included plutonium recovery in 1946 and 1947. He periodically checked health of plumbing and disposal systems – he would crawl the perimeter pipe tunnels to check things and once found that the bldg 3 HF system waste drain pipe had been eaten through and the liquid HF had eaten a hole in the concrete floor and continued down in to tuff so far that he could not hear a stone dropped hit the bottom. Location was center of east side of south wing of bldg 3.

How much plutonium should we expect in MDA B?
"I think what you'll find there is merely contamination. You have all these old beakers and such and in those days you'd clean it to the extent possible to recover any plutonium you could possible recover. Now, there were high counts. You see a microgram of plutonium gives you 50,000 counts per second. So with a Geiger counter you can scan and know if there's much plutonium there. You can throw away a microgram and it still pretty hot, but a microgram you'll never find except for the counter. So if any recoverable amount, especially in those day when it was so valuable, valued at millions of dollars per gram, … how else can you evaluate it, and so any quantity at all that was recoverable would have been recovered, it would not have gone down there, so what you're talking is contamination. Not quantities of plutonium."

Our current upper bound estimate is not more than 100 grams Pu in the entire trench.
"I would guess that that was an awful liberal estimate. I guess there's not near that much in there. If there was a gram, … they would have done … broken their backs to recover it at that time. Do you see, now remember on the bombs that they made, the inventory went to virtually zero. And so any quantity that was recoverable at all was recovered. Nowadays, it might be a different story."

What can you tell us about the General's Tanks?
"We dumped chemicals in tank trailer outside, when it was full, they would haul trailer around to tanks and dump contents. Not likely that much in the way of acid was disposed because acid would damage tanks."

The contents were left be because they were not that high in Plutonium?
"No real reason the contents were never recovered – "it was something that came up every once in a while and we discussed it, talked about it, but nothing ever got done. We had other problems. There may not be all that much in it." Always had other fish to fry on higher priority basis. The tanks were salted out and weren't hurtin anything. It was sampled and was not a worry at the time."
There was a time when Plutonium was so much in demand that we scrounged for every little bit, that you wouldn't have time to reprocess that stuff. The stuff I told you that we had just concentrated into

something we could get into the 5l bottles, that was the stuff we had to get out and get back into solution and processed. With solvent extraction and ion exchange. We lost a man on that job. Kelly. Got killed on a criticality accident at our place and a .. but that was in that facility were he was working. But we wouldn't have had time to do anything about the General's Tanks."

Was there a point in time when everyone was told to stop using the General's Tanks?
"I imagine so. … You can see after a while things became more organized, we had chemists working on it right there and before they had taken just little bits of knowledge and expanded into the whole plant and after a lot of this stuff didn't work. Then we had chemists like Larry Mullen and Gus Hendrickson working out processes that eliminated the need for the General's Tanks."

At what point in time do you think the valve of plutonium, the scarcity would have been less critical?
"Oh it would have been clear into the … oh let's see, what would I say, … I told you about the, getting the orders to recover all the plutonium we could, turning it into metal as quickly as we could,"

Now, that was after the war.
"Oh yes, that was several years after the war, but we were cranking bombs out pretty fast, and there the plutonium went, and they were wanting to build up an inventory. And I would say that it would have been when Rocky Flats was going good. Rocky Flats started in about 53. and by the time they got rolling, they got pretty casual about They took the attitude that if it wasn't economical to recover it went down the drain. I'd say sometime after about 54, 55 there was enough of it around that there was no worry about small quantities of it. I think it was long about there that, … I can't … I was trying to think of when we put in the plutonium weapons plant at Hanford. I think that was probably in the mid 50's. We had already … we had rebuilt our plutonium facility and put it on a semi-remote control purification of metal and parts of that were copied at Hanford, although they thought that they could go to a continuous hydroflourination process and they ended up with so much dust in the bottom of the box that they had a pulsing reactor "…

So Hanford wasn't producing plutonium is large quantities until the 50's?
"I didn't say that. What I'm saying is that there were sufficient quantities of it that you weren't scrapping for every little half a gram. I know Rocky Flats was … a lot more liberal in their thinking about what was put down the drain. Of course, they got in all kinds of trouble since then. And I guess that was along about the mid 50's. And Venable and I were real good friends. And I would go to Rocky Flats regularly and we argued over that principle for a long time. He had been working for DuPont where dollars were dollars and he took that same attitude towards plutonium. If it wasn't economical to recover, then don't bother with it. And that would have been along about the mid '50's.

What can you tell me about plutonium?
"It was a long time before they got enough to really make anything out of it. And they did that in old D building. And they essentially worked on table top and with open faced hoods. And so a lot of those fellows got a snoot-full right then."

[After showing Wilbur aerial photos and graphics of MDA B]
"Well let me tell you what I know … about this. We they started out they were only interested in one thing and that was turning metal into a weapon and that was all that mattered, but they did realize that they had to do something with their waste. The thinking was short term and they didn't think Los Alamos would be there too long. So they built a whole bunch of iron, black iron cans. As I remember they were something like 4x4x8. And they started putting the waste in there, and by waste I mean that's anything you didn't know what else to do with. Old beakers, and equipment, and gloves and

trash – anything went in there, and then they put a lid on and welded it shut. I believe the intent was to take those out in the deep Pacific and drop them in a trench."

The C-Cans?! I've seen a memo talking about C-Cans.
"OK, well that was the intent, but it kinda got vetoed somewhere along the line, and so that's what they started putting in this trench was those cans. Now when I came to work, there was still a bunch of those there and there was still a bunch of those open, but you find in there a good many of those were actually buried. And, I didn't see it, but there was a rumor that there was a dump truck they put in there too that got hot when they started cleaning up old D-Building, it was pretty from everything and the dump truck hauling things out of there got contaminated and they had to put the dump truck in there. It was a pretty good size pit. Now I don't remember it being quite that long.

"It seems to me there was an old disposal pit over here for chemicals [pointing just northwest of the branch off road to DP East]. And we used these buildings for various things, one was a training place for new employees that couldn't get in the gate and they were just plain old wooden standard army buildings. They was supposedly no contaminated work done here. Later on this became a plumbing shop. And I worried quite a bit about plumbers carelessly bringing pipe back out. But I had it monitored pretty closely. They were training buildings and places you could talk to people outside the fence. This road cut around and went to DP East. … and they were across form the laundry.

We understand that folks would bring small amounts of chemicals to room 213 in bldg 2 and store them there until they could figure out what to do with them.
"I was in charge of that. Now here's what we did. When I hired in I said I don't know anything about plutonium processing. They said you don't have to know anything, we have the best people in the country working on this. Everything they've worked out in detail. All you've got to know is if they say open that valve, you open that valve. Nothing could have less true than that. Nothing worked in that place. You couldn't get a solution from one pipe to another. It would run out. They have used a very low quality stainless steel, 204, very low quality. It couldn't stand nitric acid. We'd have to cut line in two with a hacksaw and catch the plutonium nitrate in a bucket. And then take and pour it into another tank. And that tank we put it in was a tank that we had scrounged from Hershey's Chocolate. And it turned out to be monel. It wasn't stainless steel. So they ate right through it. And see I was in charge of it at that time. The process for recovery at that time was, … you we had two streams – an oxalate and a nitrate process coming from purification. And they came to separate tanks. And then we were supposed to precipitate that out with a peroxide precipitation on it … and get the plutonium. But there was so much iron in it that it didn't work.

Let me play catch up here, you had two streams from purification – oxalate and ???
"Oxalate and the other was ether extraction.   Now years later when I removed those tanks I had a 1000 gallon glass lined, jacketed, augured tank interlaced with thin-walled ??? tube because they were worried about plutonium inhalation. When I took the lid off that to see what was in it, a lot of those thin-walled tubes were half full of plutonium oxalate that had never gotten past that point.

And this was when?
"This was several years later. Anyway, nothing worked and what happened, we ended up with just a red sludge that looked like dissolved brick.

Was this in the oxalate, the ether, or both?
"Both, we blended them together after we got' em. And anyway, I had a fella come to work for me named Pierre Hortzhorn, a graduate of MIT and the first thing I did was have him build an evaporator.

So we started evaporating this down as far as we could go and put it in 5l glass bottles. And put it in storage until we could get a process worked out, but this was an expediency. We had to keep emptying these tanks because purification was running and it was working. We kept getting the residue and couldn't handle all that because the processes didn't work at all. We had to replace all the piping with a higher grade of stainless, all the pumps and everything else had to go. We had to rebuild it as an expediency. We had to do something with the discarded solutions. So we evaporated it down til it because, as I said, a solutions of red brick. And we put this in 5 liter bottles while it was still warm, and we closed those up and put them in the vault."

What vault did you put them in?
"Over at the north side we had a big vault for plutonium, and we put them in there.

What building was that in?
That would have been in '46, that we built that evaporator. You know we used to be able to do things. If I needed something, we did it. A little while later, a few years after that, Bill Marriman was in charge of recovery operations, I was in charge of metal fabrication, but we got an order from the Secretary of Defense. We were to start recovering plutonium by February, this was in August that we got the order. There was just a dire shortage and they knew a lot of it was in the recovery stuff. So, Bill Maraman and I worked out a schematic of what we might need. Bill went on the road with the authority to go into anyplace and say I want that and get it. And I started tearing out all the old processes.

And what date was this?

This would have been, … oh, … I'm just giving you an example of how you could get things done. They assigned me a full crew of plumbers, and I made a deal with them that they didn't have to work for ??? cuz all he did was upset the plumbers. I had a full crew of plumbers, a full crew of electricians and I had to rip out all of the original stuff, clean the room out, and we had worked out a plan where we had certain piping that we could depend on no-matter what the process. And by February we were processing plutonium.

February of what year?
"I can't remember the year, but it would have probably been about '48, '49. Some where in there. I know we got that order from the Secretary of Defense. We were to be recovering plutonium by February. We didn't even have a process I started gutting the building and getting it ready. That when I pulled out that big 1000 gallon tank. We had to drag it out because we had nothing that we could lift it with. We drug it across the floor to the doors where we could pick it up. In the mean time I had to pull all those tubes out and clean them out. But anyway, in that six month period, we tore the old stuff out and put in all new tanks and whole new processes, and started recovery with that, because we didn't have to go through all the ri-ga-ma-role you do know. They said you do it and we did it. And we had the authority.

How long after you started work there did this happen?
"It would have been at least a couple or three years So it would have been around '48 or around there. But, the idea is, then you could get things done. Now, you can't do anything. Just like the plutonium production. I was in charge of the planning and construction of TA-55.

Do you remember anybody pouring chemicals into the trench over here (pointing to the middle of the east area of MDA B?

"No I don't remember anyone ever doing that."

How about filling glass bottles with chemicals and putting the glass bottles down in the trench?
"I don't remember – that's why I told you about the glass bottles that I was in charge of recovery and we were putting all of the concentrated solutions into 5 liter bottles and we had to design a special plug to go in the top with a sintered glass filter in it because you're constantly giving off hydrogen due to the constant reactions in the jars. All those went into storage because they had large quantities maybe up to 50 grams plutonium."

But the glass bottles that you are talking about all got processed.
"All got processed. After we rebuilt the place, we brought the bottles back in, re-solutioned them, and we separated them with solvent extraction and ion-exchange. Not with the final peroxide treatment, which didn't work with all the iron in them. But we had real college quality men that designed it, they had it right down, they could show you a full flow diagram, right to the cc how you were using and they you realized nothing worked. Nothing worked. The lines filled in. With the much higher iron that would precipitate out, we'd have to saw the line in two and catch it in buckets. Can you imagine doing that now?"

What we're trying to do is figure out …
"OK, I can help you to there (pointing to the eastern portion of MDA B on the late 1947 satellite photo), but I can't help you with that (pointing to the western, graded over portion of MDA B on the same photo). And that's what I remember being an open pit, with a big pile of stuff on the end – dirt and all, I don't know what they did with all that dirt. Seem like they had more than they needed to fill up. They may have hauled some off. You were, talking, … 65 years ago."

Yes, but in terms of presence or absence of things, you don't remember them stashing bottles in here (pointing to the center eastern area of MDA B)?
"No, No. Now, like I told you, I remember talk of a chemical waste place over on this side of the road (pointing to the north side of DP Road). Just up the road a little bit from those two buildings we were talking about."

So we don't know what these are (pointing again to the six small square structures on the North side of the road)?

"No, I have no idea what those are. They had nothing to do with us. I knew pretty well what went on with our place."

So someplace over here people would dump chemicals?
"Now, within the site we had an acid waste disposal … and it was nothing but a, … almost like a cement septic tank, in which we could dump acid waste. Now not plutonium contaminated, but just common waste. "

What we found in the literature is discussion of "unworkable solutions" and they when to room 213 bldg 2.
"That's our recovery operation."

And that was you?
"Now when was that literature?"

"I don't know"
"You see, that was me until 47 or so, when I when down, … well maybe a little later."

"recovery was you until 47?"
"Yeah, I was in charge of that for about a year and a half or so and then I went down to metal fabrication where Doug Ballard, who was in charge of metal fabrication was going away, going back to school, leaving. He went down there and got his doctors degree and went to work for Sandia. He was an awful nice fellow and a very well known artist. And he died about a year and a half ago. I went down there and essentially took over weapon production until we could get someone in who was more of a metallurgist. But I was in charge of metal production then and we worked two shifts we were trying to knock out weapons as fast as we could. And then we started to develop the thin walled later on and I still worked there but by then we had a fella working full time in charge of metal production and I went back to being a plumber. Doing my own research work and stuff like that. Any time a problem came up, that was mine

You know, In summary, when you were working at DP West, when you got done with recovery solutions, and you had recovered all the Pu from them that you could, what did you do with them?
"They went to waste treatment.

"They went to waste treatment?"
"Sure. What else would you do with them?"

"Well, what waste treatment did you have?"
"You'd pour it in the sink, and open the valve, and let it run out. That's what they did. But later on they developed processes for reprocessing it specifically trying to take out any contamination.

So in the 1946 to 1948 timeframe, the first two years that you were there, everything went to the general's tanks?
No, no, I told you, when we couldn't process it, we evaporated it, precipitated it out, put it in 5 liter bottles, then we put it in the vault."

"So it went in the vault and stayed in the vault until you could do something with it?"
Yeah. And then we brought it back out, re-solutioned it, and treated it with ion exchange and, and reprocessed it."

"When did you start treating the red concentrates?"
"That was what I told you around the early fifties. We got this letter from the commanding general that we had to have the plutonium. I remember very well, they showed up the telegram, … we had to have, … the process running by February without regard to neatness or cheatness… in other words, no bullshit, we've got the money, we've got the priority. Bill Maraman could go into any manufacturing place and say, 'I want that thing' and they'd say 'oh, that's so and so's' and we said "not now, that's ours. You ship it to this address. At the time I got the building done, we had a process, we know we need tanks, we settled on 250 gallon stainless steel tanks, and besides, by the time we got the tanks we had a process. Now, we knew how to hook the pipes up. And that was in 213."

"And you set up those tanks in 213?"
"Pulled out all the old equipment, cleaned the room down, … by then see, we were working on a remote control, remote processing, purification and metal production. And we were moving out of 313, where we had the reconstruction and upgrades to extraction, now that used to come to us in a

trench in the floor, trench, a covered over trench filled with pipe and years ago we pulled that piping out, processed it, got rid of it. I came directly from bldg 3, from 313 to 213 by pipe. And now there was another one, ether extraction stuff, often came over in bottles, and we poured them into the tank, now we had an order one time to start putting that in special stainless steel drums, and ship that to Berkeley and Seaborg and his crowd were looking for new elements and that's where they found them – in the solutions that I sent them."

So the solutions left over from ether extraction and purification where what you sent them?"
"They were darned clean. Not a bunch of 'em we shipped out there, just one or two batches, we shipped out there in special stainless steel drums."

And when did you do that?
"In 46, late 46, early 47."

So nothing, came out of 213 and went to MDA B?
"No siree, that stuff came out of old D building."

So that tells me that 213 did not produce waste that went to MDA B, or not that you're aware of?
"No."

Now when you threw trash out, these was a dump truck that went around and picked up contaminated trash. You contributed trash to that, yes?
"Yeah. … Now we had a trench down there between the General's Tanks, that where our trash went."

Even in '46?"
"Yeah. When you get to thinking about it, what would you have done with your trash in '46?"

Well, I would have put it in whatever the open trench was.
"Now how would you contain it, your trash in the room? We didn't have plastics, that's the point, it went in a cardboard box. Now we needed a method of taking something out of a box and moving it to some other location without spreading contamination, so we reasoned that if we put a 24" extension on the bottom of the box, put a plastic bag around that and a thing to hold it and that in a box, then you cold transfer into that, seal off the box so you could carry it over, now the outside … flips over, you put that in the box. We had to make our own plastic bags. We'd get sheet stock, rolls of sheet and make out own plastic bags. And I got hell once, it was the only time I got a call from the director's office, and I wanted an electric iron with an automatic control on it to seal the plastic. So I ordered one from stock at the hardware store. And he call's up and say's "Neese, what in the hell do want an electric iron for? Is your wife going to iron your shirts?" So I told him what it was for. So we got it. So we had to make our own plastic bags for quite a while until we could get an outside vendor to make them. Think how hard these were to manage – 15 mils, and now they're one and a half, half a mil. These were thick."

And you put those inside a cardboard box?
"Well those didn't go to the dump. I'm talking about stuff like weapons parts you're moving to another box. At first we would wash it with alcohol, place it on filter paper and carry it on our hand to another box, open the airlock and set it in there. Well, we had to get past that and that when we went to the plastic bag transferred between boxes."

And now laboratory things like lab coats and all the things that got contaminated, those went in the cardboard boxes?
"And that went to our own little dump, down there, that trench back of the general's tanks."

So that trench behind the Generals Tanks was used until when?
"I don't know. I'd say it was the early sixties, probably. Maybe a little later. I think all that's been dug up and taken care of."

Interesting, so it (MDA A) was in use in 1946 and continued to be in use until, 1960's did you say?
"Oh yeah, I'd say yeah, you see you couldn't put it in the city dump. Let's see, it seems like we had our own incinerator that burned a lot of our, … rags and stuff that we used insides of our boxes. We could incinerate that and then recover the oxide. I built two or three of those. No we're taking, … I'm trying to picture it, … something like a foot by a couple of feet. And another thing, up until I started rebuilding things, our gloveboxes were just vented into the room. They had a piece of adhesive filter paper on the outlet of the box and it was just vented into the room. And in metal fabrication, where we had lots of heat and stuff, it went into the wall duct that ventilated the room. It wasn't until about 55 that they started rebuilding the metal fabrication operation and I put in special filtering elements to clean up the air. You couldn't get any filters until they started to make chemical filters, high efficiency filters for the army. They developed real efficient high efficiency filters. At first we just used the cartridges off the gas masks that the army developed, we used that just as an in-line filter. And then we got to manufacturers making them for us; 12 x 12 x 6 and then 24 x 24 x 16, they called them HEPA, high efficiency particulate filters."

Now you tore out a lab and started over because of all the rotted piping? When did you do that?
"Well, in the early fifties, that's when we took metal purification and fabrication, making the plutonium button, we built a remote control line for that. In room 501 in the early fifties. And Dupont was coming on-line and Hanford was re-built and they kept men in our plant all the time to test stuff that we were rebuilding."

So the process piping and things that were waste that you were throwing out, the debris, where did that go?
"That trench. That trench back of the General's Tanks."

So it didn't go over to MDA C, over by TA-55…
"Oh no, no, we didn't send anything over there."

And you must have a done a quick lab clean out when you got that order to reprocess all plutonium, that's really what drove it all, right?
"Oh, right. That gave us the authority to do something and man we did it quick."

And all of that stuff you threw out to make room and get ready went into that …"
"It went into that trench."

Behind the General's Tanks?

"Yes, and remember even one of the thousand gallon steam jacketed tanks, these are things that we picked up on the open market that they had before I got there. All they could get to handle those solutions was a glass lined tank. You see they didn't have stainless steel tanks."

And so they just dropped them in the hole and …
"You clean them up as best you can, put people in there in pressure suits and wipe them down and clean them, and do the best job decontaminating them that you can. Period. What else can you do? And at some point, that's it, they're as clean as you can get. We had people, now really they were janitors, and we trained them for decontamination and they got pretty good at it. You know, they worked carefully and had good monitors. By today's standards, maybe we didn't have, … well, we did the best we could at the time. What would you do with a 1,000 gallon tank today?"

"We even sandblasted to get a little more off. We got a vacuum blaster. It was a machine that blasted grit and sucked it up into filters so that you could cut the concrete just a little pit."

So you used the sandblasting on what?
"Floors. …We had one job, … the original gloveboxes had five inch glove ports. The orginal gloveboxes were taken from Notre Dame's biological research lab. We built these gloveboxes for biological research on dangerous bacteria and stuff, and they made them so that at the end of the experiment, they could steam clean them. They were made smooth on the inside and they were made by a dairy equipment supply company in Iowa. And we adopted that same box to start with. But they had five inch glove ports. We had machinists that would come out that couldn't put their arm through a five inch hole. So I decided to build a new line of gloves, eight inch, so we got all organized on it. i had all new molds made for gloves, by the rubber companies, and they made us a whole new line of eight inch rubber gloves. In metal fabrication, which is our most dangerous worst place, we lined the whole room, walls and everything, with masking paper, and then we had the Zia company come in with all the old paints they had and spray that so its tacky. Floors, walls, everything. And then we went in and used hydraulic lift table and mounted a milling machine on it, and put that up to a box. We cleaned the box first. And we put a fly cutter on it and we'd bore an eight inch hole out. We worked in pressure suits, two of us working."

So you're retrofitting an existing glovebox?
"Oh yeah. Then we bolted on an eight inch flange that was adaptable to an eight inch glove.'

And when did you do that?
"Oh shoot, … I'd say, the early fifties. I know it was when we were trying to get filters on stuff. I know I went down to Espanola in the morning and gave blood for … someone. Got back, went to work, and then … I didn't realize a thing could hit you so, but working in that pressure suit with a lack of oxygen, … I just didn't hardly make it through the day. And then when we got through with all those, we cleaned up the best we could, then we came in again and sprayed all that paper with gummy paint, then took it down and the room was relatively clean."

And that paper all went in MDA A?
"Yeah."

So you worked in DP West until what year?
"In 68 we said we've got to do something to make these places safer, mainly form a fire standpoint. So I was asked to write up requirements for a plutonium facility, so I put down everything I thought, my boss and I looked it over and that then became the bible for the new plutonium facility. In 68 they gave us money to retrofit the old plant. At that time we did a lot of stuff like putting in sprinklers, which we didn't have before. And we did a lot to make the place more fire safe. Because they had had that fire at Rocky Flats. They said we can't let that happen again. So that was, … long about '68. By the time we got the job about done, they said we need a head to build a new plant, so starting in '69,

early '70 we again started meeting with Washington, deciding what we needed, and setting up and using those old requirements and reworking it, of course Washington, they can do wonders to something, they can tear it up to where its totally unusable. So we had to battle all the time on the practical things, as well as the desirable. So then started looking for contractors for building new plutonium facilities at Rocky Flats and at our place. That was my job from then on."

We still have stories of people carrying bottles of chemicals down here, filling up carboys beside a hole and then burying the carboys right in this area (pointing to map of east MDA B).
"I'm not saying they didn't, but it wasn't us. Understand, I'm saying we didn't do it. Now think of D Building, right in the Tech area, uptown – what would you do with all your cleaning solutions? Take them down there in bottles and bury them. But not us."

So that must be it then, they didn't have anything else and got license to use that area?
"They built a waste treatment facility for them over across the road from the united church where the swimming pool is now. And they, ah, … before that they didn't have any waste treatment."

When was that built?
"I don't remember."

Was it built in the 40's?
"Latter part of the 40's."

So in the early 1940's, everything is coming here? Early forties until whenever that plant was built?
"I imagine that trench was there before they built DP site. They built DP site from, as I understand it, the spring of '45 and finished it in the fall. That's why they these buildings that they could get. They had these brick layers from New York building fire walls and worked them around the clock. And the same with pipefitters and all. And welders, he'd stay on duty, they would sleep on the job until they needed them. It was a phenomenal thing, they built DP site in something like 16 weeks. Wartime urgency. See it was started before Hiroshima. And ended up after."
"I would have gotten out of school in '41. I was working my way completely taking chemical engineering, which is the hardest of the courses and ROTC and everything, and they told us in the spring of '41, don't worry about a job after graduating, you're going to be on active duty in 30 days. And boy I went on active duty in June of '41. I got out, of course, of finals."

And you were in the Air Force?
"Army Air Corps. There was no Air Force. I went on active duty in the Coast Guard service with an anti-aircraft unit. places like Galvaston and those places with the big guns, which was all obsolete, so they made us anti-aircraft. Anyway an opportunity came up. The adjutant at Eligren Field was a real good friend, and he called me one day and said would you like to go through pilot training? I said I sure would, cuz they made 50% extra, that boosted me up to $225 a month. Anyway, I went through pilot training at Renaughten??? There was one class of us that did that. And then I was army air corps, and it was Army Air corps until '48, … as a separate unit."

And you stayed in as a reserve officer?
"Yeah."

And you got Lt.Col. as a reserve officer?
"Right"

Interview with Wilber McNeese, former chemical engineer at DP West

RE: Filter papers at DP West
Date: May 9, 2007
Place: Wilber's home, San Jose, NM
Interviewer: C. William Criswell

Wilbur was interviewed by Ercle Herbert in November 2006, but I wanted to clarify some information about filters and oil changes at the DP West filter building.

1. What can you tell me about the filter papers used in Building 21-12?
They used standard filter paper, like a laboratory filter paper, micropore or something like that, some of those contained asbestos. Nothing very efficient, in fact they were very inefficient. I don't remember if they used pleated filters.

2. Did you try to recover plutonium from the filter papers?
No, not routinely. We monitored the contamination when we had an accident or a non-routine release, some of the filters were taken for recovery after those incidents, but routinely the filters were probably sent to the dump.

3. What do you know about the electrostatic filters?
They had charged wires that were supposed to attract the plutonium, and oil dripped down the wires to wash the plutonium into the oil.

4. Did you recover plutonium from the oil?
No, the oil was changed by the maintenance group, we really did not have anything to do with it.

5. Did you know if the screens on the electrostatic filters were ever cleaned?
No, I do not know how that was done or if it was ever done.

6. What do you know about CWS filters?
The CWS filters were from the U.S. Army Chemical Warfare Service. They had these high-efficiency filters, we call them HEPA filters now. We first got them as cartridges and experimented with them on our gloveboxes, we called those dryboxes back then. Eventually, about 1949 or 1950, we got larger HEPA filters from the same supplier as the U.S. Army and we put them on the filter building because the electrostatic filters were not that great either.

Interview with Robert Nance, former chemist at DP West

RE: Recovery of Stored Solutions at DP West
Date: May 24, 2006
Place: Rm 112 at Pueblo Complex, LANL
Interviewers: C. William Criswell and Ron E. Rager

Robert was a chemist hired at DP West in 1951. He called himself a "slop bucket chemist" as he was given the task to help recover plutonium from solutions stored in Building 21-2. Often times these solutions consisted of thick sludge from processes that had failed in the past. We were particularly interested in solutions that were stored in Building 21-2, how they may have been related to solutions sent to the General's Tanks and if they may have been sent to MDA B as waste.

1. Can you tell us about your job and what you did at DP Site.

I was hired as a chemical technician for CMR Division and later converted to a technical staff member. I first worked in Building 21-2 at DP West. There were bottles stored in Room 213, but that was cleaned before I got there. I was given the task of clearing out the bottles stored in a 55-gallon drum. These were typically a couple of liters each. I would take one of them at a time and develop a method to create a solution that was acceptable to the plutonium recovery group, such as acidifying the solution and placing the materials in the proper oxidation state. The plutonium recovery group would perform the actual recovery operations through their processes.

2. Did you know where the stored solutions came from or were you aware of solutions from D Building?

In most cases back then, no I did'nt exactly where they came from. I did'nt work on D Building solutions. I had a friend named Clifford Nordeen (he has since passed away) that had worked there after the war, and he worked on solutions that had been stored since the war. These came from D building, but they were gone by the time I started. The chemistry of plutonium was just in its infancy, and during the war I heard that some attempts to oxidize or reduce plutonium failed. These were saved until the methods could be developed.

3. Do you know of any bottles of solutions that may have been buried or that were sent to the dump for any reason?

When I started work there wasn't much going on on DP road (MDA B). No, I have no knowledge of any type of bottles or solutions sent to the dump.

4. What were the typical types of bottles used at the time?

Most were 2 liter or 4 liter glass with ground glass stoppers.

5. What about 20 liter or 5 gallon bottles?

We rarely had any 20 liter, but they would have rubber or neoprene stoppers. The same with 9 liter bottles, they rarely had ground glass stoppers.

6. There was a fire in MDA B in 1948, it was before your time, but there was some pink smoke seen, any in sights into that?

The pink smoke would have been iodine, we used hydrogen iodide as a reducing agent, some of this might have gone to the dump.

7. The aqueous recovery solutions were sent to the General's Tanks for future recovery, but that did'nt happen. Do you know why not?

No, I really did not have much to do with those tanks.

8. Do you know how the dilute solutions were managed?

When I got there we used an ion-exchange process for dilute solutions, then the more concentrated solutions could be sent back to the recovery operations. We experimented with solvent-extraction for some things as well, and that took a couple of years to develop, as I remember.

9. Do you know what hydrogen sulfide gas would have been for?

I don't remember much hydrogen sulfide during those early years.

10. Do you remember what types of gas cylinders were in use in the area?

There were dark gray 80 pound tanks, about 18-inch diameter and 4-foot high for the hydrogen fluoride, and tall orange tanks for oxygen. The process using hydrogen fluoride ultimately resulted in metal casting/machining which used nickel carbonyl. Empty nickel carbonyl cylinders may have ended up in MDA B. We used rifles to puncture contaminated tanks before disposal. Nitric acid and lots of other acids were common liquids used. I don't remember what the container types were for these liquids.

Interview with David J. McInroy, former environmental technician

RE: Employee Observation of bottles buried east end of MDA B
Date: May 31, 2006
Place: David's office at Pueblo Complex, LANL
Interviewers: C. William Criswell and Ercle Herbert

Dave is currently the Program Director for Environmental Restoration at LANL. He started working at the Laboratory in 1980 as an environmental technician as a summer student. One of his early projects was a small mammal survey on MDA B. He was working alone inside the fence and was walking across the area when he fell into a hole and had to climb out.

1. Where did this happen?

This was just about in the center part of the eastern area, the dirt area east of the asphalt. The hole was in the southern half of MDA B, closer to the south fence than the north.

2. How big was the hole?

The hole was a couple of feet across and about 5 or 6 feet deep. There had been some sort of cover and there was some sort of space between the pallets where I fell.

3. What did you observe in the hole?

There were pallets on 2 sides of me, at least 2 pallets high with large glass bottles stacked on the pallets, perhaps dozens to a hundred of them.

4. How large were the bottles?

I could not say exactly. They were large chemical bottles, like you'd see in a laboratory.

5. What happened next?

I had to climb up between the pallets to get out, kind of like a ladder. I was not paying much attention to the details in the hole at the time. The dirt was sloped into the hole so it was slippery. I radioed my supervisor who sent out a radiation technician. I was scanned, told no problem. The next day or very soon after, the hole was backfilled with dirt.

6. Did you observe any other holes in the area?

Not that I saw at the time.

Appendix F

Calculation of the Plutonium Inventory at MDA B, Based on Historical Data

F-1.0 INTRODUCTION

Material Disposal Area (MDA) B is an inactive subsurface disposal site, designated Solid Waste Management Unit 21-015, located in Technical Area (TA) 21 at Los Alamos National Laboratory (LANL or the Laboratory). From 1944 until it closed in 1948, MDA B received contaminated materials from the Laboratory and may contain both hazardous chemicals and radiological materials. There are no formal records of the wastes placed, and the contents have never been directly characterized. As part of its environmental restoration program, LANL compiled the initial categorization of MDA B in accordance with U.S. Department of Energy (DOE) STD-1027-92, Change Notice No. 1 of September 1997, “Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports,” and, based on a 1971 memorandum from Meyer (1971, 095443), MDA B was categorized as a nuclear hazard category 3 facility, containing approximately 100 g plutonium-equivalent (LANL 2003, 090176). MDA B is scheduled for excavation and the removal of its contents. Planning for the safe implementation of this remediation requires information about the nature of the wastes disposed of at the site.

The authors of this report utilized the limited analytical data, measurements and observations recorded in “Cesium-137, Plutonium-239/240, Total Uranium, and Scandium in Trees and Shrubs Growing in Transuranic Waste at Area B” (Wenzel et al. 1987, 058214) to estimate the plutonium 239/240 (Pu-239/240) inventory in disposal trenches at MDA B. Primary inventory components include the interstitial soils and fill added during waste disposal operations, gloves and other protective equipment, discarded laboratory glassware and debris, and intact liquid containers.

Based on an eyewitness account, glass bottles are buried in at least one pit on the eastern end of MDA B. The authors of this report are unable to definitively identify the source of these bottles. They likely contain residual plutonium or other exotic elements. Based on the known Laboratory operations, the concentrations of plutonium would be approximately 1 mg/L of plutonium, a concentration considered at the time to be potentially recoverable in the future and too concentrated to release into the environment. Any solution with a concentration of plutonium greater than 1 mg/L would have been sent back to recovery.

F-2.0 PRELIMINARY REVIEW AND PREPARATION OF DATA

Wenzel et al. (1987, 058214) presented a small set of analytical results from the sampling of a variety of vegetation growing within the MDA B boundary fence (Table IV in that report). Some of the vegetation was growing directly into the disposal cells, while other growth was in the periphery between the cells and the boundary fence. Common vegetation included ponderosa pine, peach and elm (deciduous trees), and oak and chamisa (shrubs). Key information collected in the report, and used in this analysis, are the Pu-239/240 concentrations associated with soil and fill samples near the root systems of the vegetation. Scandium and uranium were sampled for, but they were determined to have low sample variation and likely representative of background. Cesium-137 (Cs-137) was sampled for and found at relatively low concentrations in comparison to Pu-239/240, thus excluding it from further use in this analysis. Table F-2.0-1 presents a summary of the sample results from soil and fill collected near root systems in the disposal cells of MDA B. Wenzel et al. (1987, 058214) reported all analytical data in femtocuries per gram fCi/g (10–15 Ci/g) on a dry weight basis. Using these data, the average Pu-239/240 concentration associated with disposal cell soil/fill is 473 pCi/g. Both Tables F-2.0-1 and F-2.0-2 present Cs-137 results for information and comparison; these values are not carried further into this analysis.

Table F-2.0-1
Average MDA B Disposal Cell Soil/Fill Concentrations Derived from Wenzel et al.

Description	Class	N	Cs-137 (fCi/g)	Cs-137 (pCi/g)	Pu-239/240 (fCi/g)	Pu-239/240 (pCi/g)
Pondersosa pine growing in waste around debris (>100 cm)	waste cell soil	6	168	0.168	578000	578
Oak, chamisa, ribes, fallugia around waste debris (>100 cm)	waste cell soil	2	75.5	0.0755	159000	159
	summary ave.	***8***	***144.9***	***0.1***	***473250.0***	***473.3***

Table F-2.0-2 presents a summary of the sample results from soil collected in association with root systems outside of the disposal cells. Using these data, the average Pu-239/240 concentration of “non-fill” soil is 6.2 pCi/g. This average concentration is not carried forward in this analysis but may be used for other calculations associated with soils at MDA B.

Table F-2.0-2
Average MDA B Periphery Soil Concentration as Derived from Wenzel et al.

Description	Class	N	Cs-137 (fCi/g)[1]	Cs-137 (pCi/g)[1]	Pu-239/240 (fCi/g)[1]	Pu-239/240 (pCi/g)[1]
All remaining ponderosa pine soil (2 cm)	peripheral soil	3	1075	1.075	5650	5.65
All remaining ponderosa pine soil (10 cm)	peripheral soil	3	289	0.289	4720	4.72
All remaining ponderosa pine soil (25,30 cm)	peripheral soil	4	110	0.11	1230	1.23
All remaining ponderosa pine soil (45-55, 80 cm)	peripheral soil	2	186	0.186	884	0.884
All remaining ponderosa pine soil (150-160 cm)	peripheral soil	1	-46.9	-0.0469	1020	1.02
Peach and elm soil (2 cm)	peripheral soil	1	476	0.476	18100	18.1
Peach and elm soil (10 cm)	peripheral soil	1	383	0.383	29500	29.5
Peach and elm soil (25, 30 cm)	peripheral soil	1	189	0.189	7850	7.85
Peach and elm soil (80 cm)	peripheral soil	1	72.7	0.0727	12100	12.1
Oak, chamisa, ribes, fallugia (2 cm)	peripheral soil	3	1200	1.2	14600	14.6
Oak, chamisa, ribes, fallugia (10 cm)	peripheral soil	3	664	0.664	5320	5.32
Oak, chamisa, ribes, fallugia (25, 30 cm)	peripheral soil	3	163	0.163	1670	1.67
Oak, chamisa, ribes, fallugia (45-55, 80 cm)	peripheral soil	2	-13.3	-0.0133	4140	4.14
Oak, chamisa, ribes, fallugia (45-55, 80 cm)	peripheral soil	1	-35.8	-0.0358	729	0.729
	average	***29***	***413.7***	***0.4***	***6212.0***	***6.2***

Source: Wenzel et al. 1987,058214.

The average concentrations by vegetation type and depth shown in Tables F-2.0-1 and F-2.0-2 do not include associated uncertainties as presented in Wenzel et al. (1987, 058214). These uncertainties are used in development of the random variable ranging described in the "Input Parameters and Calculation Methods" described below.

Wenzel et al. identified a "mass of rubber gloves" in the vicinity of "ponderosa pine 5" at a depth of approximately 40 cm. These gloves exhibited total alpha surface activity ranging from 0 to 6000 counts per minute (cpm). At a depth of 45 cm, a lateral root had exposed a glove exhibiting 10,000 cpm. Conservatively selecting 10,000 cpm as the total alpha surface contamination level to be used in this analysis, it is necessary to apply estimated probe efficiency and surface area factors to derive the total alpha surface contamination level in disintegrations per minute (dpm)/100 cm^2. Common Ludlum and Eberline alpha monitors of the period could be expected to have alpha detection efficiency that ranged from 25% to 40% and active detection areas of 60–125 cm^2. An effective efficiency factor encompassing these factors is estimated as 33% and applied to 10,000 cpm to yield 30,000 dpm/100 cm^2 total alpha contamination for use in this analysis.

F-3.0 REVIEW AND POTENTIAL FOR LIQUIDS BURIED IN GLASS BOTTLES

In the early 1980s a member of the Laboratory's environmental studies groups reportedly fell through the surface and into a hollow area of MDA B in the eastern portion of the landfill. He observed multiple stacks of 4- to 8-liter glass bottles, containing liquids stacked 2 to 3 ft high on one or more pallets. The source of those bottles was part of the focus of this report, and the authors of this report are unable to definitively identify the source of these bottles. The bottles likely contain residual plutonium or other exotic elements. This authors of this report reviewed period documentation and personnel interviews to create a process history that summarized waste production during the 1944 to 1945 timeframe of MDA B. During the 1940s, all of the plutonium and uranium purification solutions were retained and the materials recovered. No plutonium recovery solutions were discarded. The recovery of plutonium at Building 21-2 and at other plutonium operations resulted in large volumes of basic solutions with <1 mg/L plutonium that were considered unrecoverable given the available technology, so these solutions were stored in the General's Tanks at MDA A. All other solutions were reportedly stored in large glass containers in Room 213. In August 1950, Room 213 was cleaned out to make room for a new solvent extraction plant. The recovery materials were moved to other DP West sites, and other solutions were reportedly transferred to either the "hot dump" or the General's Tanks area.

The concentrations of plutonium in the other-than-basic solutions were estimated to be approximately 0.1 to 1 mg/L since the 1 mg/L quantity was still considered too precious or too concentrated to discard or release into the environment. Solutions with concentrations of plutonium greater than 1 mg/L were sent back to recovery. The total number and type of buried bottles are unknown but probably included 2-L, 4-L, 9-L, and perhaps, although unlikely, 20-L capacity bottles, because these were common at the time. Based on the aqueous chemistry, a few hundred gallons stored in glass bottles was considered a reasonable and likely volume of these materials.

F-4.0 INPUT PARAMETERS AND CALCULATION METHODS

This analysis uses engineering judgement and the data from Wenzel et al. (1987, 058214), basic physical characteristics, and simple algorithms to calculate the MDA B Pu-239 inventory in four likely components of the disposal cells: (1) interstitial soil and fill, (2) disposal cell gloves and personal protective equipment (PPE), (3) disposal cell glassware and lab debris, and (4) intact liquid containers. To simplify the approach, Pu-239/240 data values are exclusively attributed to Pu-239.

The key input variables supporting the analysis are shown in Table F-4.0-1. Variables are defined as random (R), dependent (D), constant (C), or output. Random variables are assumed to have an equal probability of occurrence over the selected range. Random variable ranges were developed based on review of Wenzel et al. (1987, 058214) and professional judgment and are presented in Table F-4.0-1. Dependent variables are calculated based on random variables and/or constant variables.

Table F-4.0-1
Monte Carlo Analysis Input Variables

Input Parameter Description	Variable	Type	Low	High	Units	Notes
Total volume disposal cells	TVDC	R	21600	26400	CY	Estimated volume based on geophysical survey data disturbance boundaries and reported trench depths -24,000 CY. Variable ranged from -10% to +10%
Percentage soil and interstitial fill	%S	R	15	40	%	Range estimated from standard disposal processes at time
Average soil and interstitial fill concentration–Pu-239	SCONC	R	255	901	pCi/g	range set at +/- one sigma of ponderosa pine 5 soil data set in Wenzel et al. (1987, 058214)
Assumed compaction gloves and PPE fill	CPPE	R	1.83E+06	3.58E+06	cm^2/CY	Range developed based on estimated compaction levels for PPE and laboratory glassware.
Assumed compaction glassware and lab debris	CG	R	2.34E+05	2.44E+06	cm^2/CY	Range developed based on estimated compaction levels for PPE and laboratory glassware.
Total 4-liter liquid containers	LC4	R	50	300	#	Professional judgment based on review of historical data and interview with D. McInroy
Total 9-liter liquid containers	LC9	R	10	100	#	Professional judgment based on review of historical data and interview with D. McInroy
Liquid container Pu-239 max. concentration	LCONC	R	1.00E-05	5.00E-03	g/l	"Plutonium Recovery Methods" (LA-175, 1944)
Assumed unit surface radioactivity	SCL	R	1	30000	dpm/100 cm^2	Default derived from maximum value Wenzel, et al. (1987, 058214); all activity attributed to Pu-239

Table F-4.0-1 (continued)

Input Parameter Description	Variable	Type	Low	High	Units	Notes
Percentage gloves and PPE fill	%PPE	D	varies	[redacted]	%	Dependent variable calculated as 0.5 x (100 - %S)
Percentage glassware and lab debris	%G	D	varies	[redacted]	%	Dependent variable calculated as 0.5 x (100 - %S)
Soil and interstitial fill density	SD	C	1.22E+06	[redacted]	g/CY	physical properties
Specific activity Pu-239	PUSA	C	0.0621	[redacted]	Ci/g	specific activity Pu-239

The Pu-239 inventory in grams (g) associated with the interstitial soil and fill is defined as SINV and calculated from equation (1):

Equation (1): SINV (g) = TVDC x %FILL x SDENS x SCONC x 10-12 ÷ PUSA

Pu-239 inventory in g associated with the glove and PPE component of MDA B is defined as PPEINV and calculated from equation (2):

Equation (2): PPEINV (g) = ((TVDC x %PPE x CPPE x 0.01 x SCL) ÷ 2.22) x 10-12 ÷ PUSA

Pu-239 inventory in g associated with the glassware and laboratory debris component of the disposal cells is defined as GLABINV and calculated from equation (3):

Equation (3): GLABINV (g) = ((TVDC x %G x CG x 0.01 x SCL) ÷ 2.22) x 10-12 ÷ PUSA

Intact liquid containers Pu-239 inventory is defined as LIQINV and calculated based on the number of 4 liter and 9 liter containers by equation (4):

Equation (4): LIQINV (g) = ((LC4 x 4) + (LC9 x 9)) x LCONC

The CPPE and CG variables defined in Table F-4.0-1 above (compacted surface area per unit volume) were derived through application of surface areas to compaction volumes for common PPE and glassware objects as estimated by the MDA B project team. The CPPE value was determined through use of a 300 cm^2 contaminated surface area on a mid-arm isobutyl, poly, or vinyl glove. The estimated range of compacted volume for a glove (low to high) is 125 to 64 cm^3. The CG value was determined based on an approximately 4-liter glass beaker with an internally contaminated surface area of 1355 cm^2 and subject to compaction ranging from 0% to 90% over the entire volume of 4425 cm^3. Both CPPE and CG were normalized to cm^2/CY.

The total MDA B inventory is defined as TOTINV (Pu-239 g) and calculated from equation (5):

Equation (5): TOTINV = SINV + PPEINV + GLABINV + LIQINV.

After assigning ranges to the random variables as shown in Table F-4.0-1, a random number generator was set up for 10,000 iterations within the range of each *R*. Each of the random variables are assumed to have equal probability within the range. These values were incorporated into a separate processing worksheet in which dependent variables were calculated from random variables and constants as appropriate. Equations (1) through (5) as shown above were linked to the array of variables for each iteration such that a discrete output value was calculated. Using the TOTINV results, the total data array was sorted from lowest to highest and assigned a corresponding percentile within the population of 10,000 values. Individual data points associated with equations (1) through (5) were plotted in Microsoft Excel v7.0 for each of the 10,000 iterations.

F-5.0 RESULTS

Using the limited analytical data, measurements, and observations recorded in “Cesium-137, Plutonium-239/240, Total Uranium, and Scandium in Trees and Shrubs Growing in Transuranic Waste at Area B” (Wenzel et al. 1987, 058214), and engineering judgement concerning potential liquids in intact bottles buried at MDA B, the Pu-239/240 inventory in disposal trenches at MDA B was estimated. Inventory components included the interstitial soils and fill added during waste disposal operations, gloves and other protective equipment, discarded laboratory glassware and debris, and intact liquid containers. The results of the calculations are illustrated in Figure F-5.0-1.

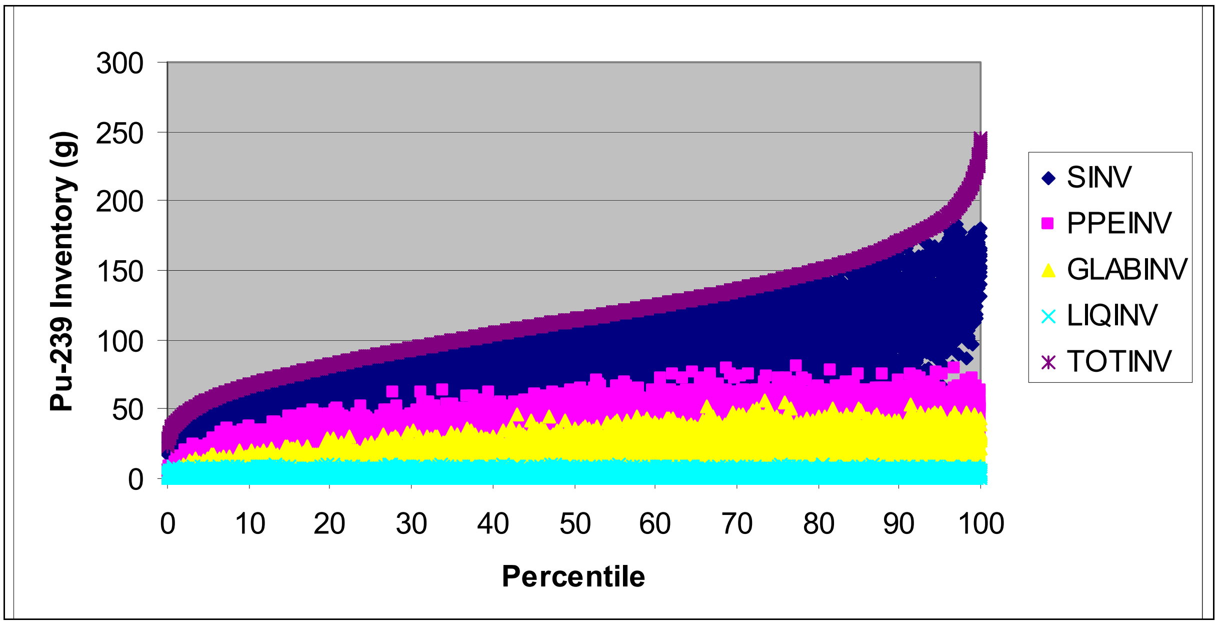

Figure F-5.0-1. MDA B plutonium inventory distribution

The plutonium inventory at the 50th and 90th percentiles indicate the following distributiuons:

- 50th percentile of total Inventory – 114 g (7.08 Ci)
  - interstitial soil and fill at 50th percentile of total inventory – 72.9 g (4.53 Ci)
  - gloves and PPE at 50th percentile of total inventory – 25.7 g (1.60 Ci)
  - glassware and lab debris at 50th percentile of total inventory – 13.5 g (0.84 Ci)
  - intact liquid containers at 50th percentile of total inventory – 2.3 g (0.14 Ci)
- 90th percentile of total Inventory – 170 g (10.6 Ci)
  - interstitial soil and fill at 90th percentile of total inventory – 94.6 g (5.87 Ci)

- gloves and PPE at 90th percentile of total inventory – 38.7 g (2.40 Ci)
- glassware and lab debris at 90th percentile of total inventory – 35.8 g (2.22 Ci)
- intact liquid containers at 90th percentile of total inventory – 0.96 g (0.06 Ci)

Based on the best available information and the calculation method in this paper, the total possible MDA B plutonium inventory ranges from 24 to 246 g of plutonium.

Assuming an average soil density of 1.6 g/cm and the mostly likely waste volume of MDA B of 24,000 CY we calculate an average plutonium inventory of a representative cubic yard (CY) across the total inventory depicted in Figure F-5.0-1. Figure F-5.0-2 presents the average plutonium concentration in g/CY associated with the total inventory shown in Figure F-5.0-1. This method indicates that the average plutonium concentration is 0.0048 g/CY at the 50th percentile of total inventory and is 0.0071 g/CY at the 90th percentile.

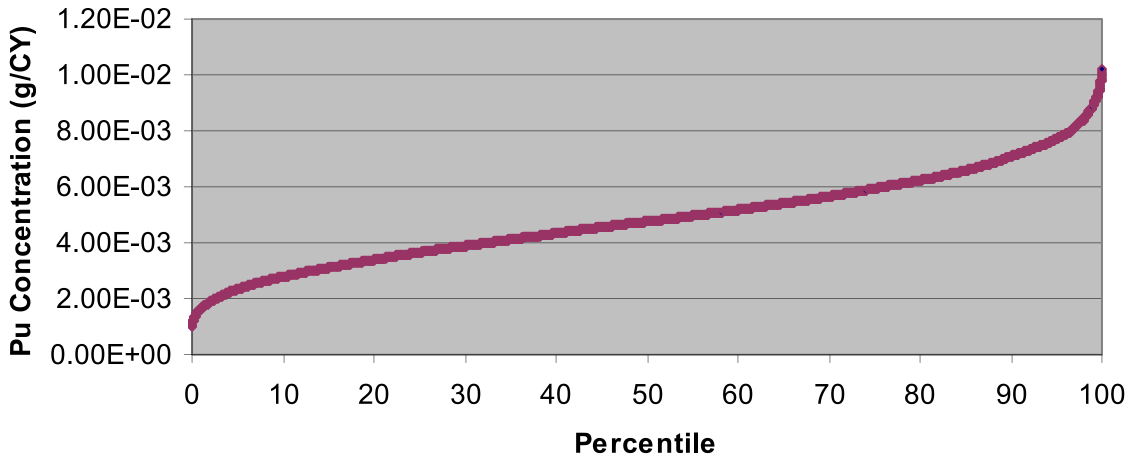

Figure F-5.0-2. Average plutonium concentration (per CY) corresponding to inventory distribution

F-6.0 CONCLUSIONS

Applying the soil concentration and surface contamination data ranges in Wenzel et al. (1987, 058214) and the range of possible liquids in intact containers at MDA B to the calculation method indicates an estimated MDA B Pu-239 inventory of approximately 114 g at the 50th percentile. This method provides an independent confirmation of the plutonium inventory. The total value is similar in magnitude to the 100-g Pu-239 estimate present of Meyer (1971, 095443).

The plutonium inventory in intact containers, based on the analogy of recoverable solutions of the period, indicates an estimated MDA B Pu-239 inventory of approximately 2.3 g. Perhaps more surprising is the relatively small potential inventory of intact liquid containers at the discard limit. Even if the number of containers were to increase, it would not seriously affect the entire inventory. Based on the waste process history of the period, individual items may possess higher levels of contamination, but they would not represent a significant change in the majority fraction of the inventory in MDA B.

The calculated quantity of 170 g at the 90th percentile is considered conservative for the following reasons:

1. It applies a high compaction coefficient to gloves, PPE, laboratory glassware, and debris that may not be representative of the waste disposal practices of the late 1940s, as wastes were typically placed in cardboard boxes and dumped into the disposal trenches. No significant volume compaction at either the point of site collection or the disposal trenches has been described.

2. The total alpha surface contamination value of 30,000 dpm/100 cm^2 as applied to the surface area of gloves and glassware in MDA B was developed from the maximum surface contamination measurement of 10,000 cpm described in Wenzel et al. (1987, 058214), and the input to the calculation approaches this maximum. Other objects were removed from the disposal cell that yielded no surface contamination above background. Common laboratory and site disposal practices in the 1940s probably included significant quantities of uncontaminated or slightly contaminated trash to the waste containers bound for MDA B. The practice of discarding consumables that are potentially—but likely not—contaminated continues today.

3. The soil contamination factor is applied to the entire estimated waste trench volume of MDA B. The documented practice at the time was to place clean soils over the waste materials, and not all of these soils would have been affected by dry materials such as building demolition debris.

4. The total alpha surface contamination value is solely attributed to Pu-239.

5. Approximately 1,300 liters of solution in intact bottles are assumed to be present. The upper concentration is assumed to be near the 1940s Pu-239 discard limit of 1 E-3 g/l. Some of the solutions may not have contained plutonium at all. Given past handling and disposal practices, it is likely that many of the solutions have leaked from broken or damaged containers and have integrated the associated plutonium inventory into the soil and interstitial fill matrix, contributing to the levels presented in Wenzel et al. (1987, 058214).

Figure F-5.0-1 illustrates that, at higher total inventory probabilities, the soil component is quite sensitive and dominates the overall inventory. This relationship is noteworthy in that it supports the assumption that most of the inventory at MDA B is diffuse and reasonably homogeneous through the site. Other observations: the laboratory glassware and debris become a significant component of inventory only if there is extremely high compaction of disposal containers and breakage of related glassware. Inventory contributions from gloves and PPE are relatively insensitive to the variation of input parameters, as is the case with the calculated total liquid inventory. The relative limitations on the total potential quantity of liquid present result in a somewhat small and constant contribution to the total inventory.

F-6.0 REFERENCES

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