53B

DOE/CD-ETEC-654

RD99-158

DRAFT DOCKET

FOR THE RELEASE OF BUILDING 4654 AT THE ENERGY TECHNOLOGY ENGINEERING CENTER

May 1999

U.S. DEPARTMENT OF ENERGY
OAKLAND OPERATIONS OFFICE
ENVIRONMENTAL RESTORATION

FORWARD

The purpose of this Certification Docket is to document the successful decontamination & decommissioning of Building T654 at the Energy Technology Engineering Center (ETEC) at the Santa Susana Field Laboratory, Area IV, for unrestricted use. The material in this docket consists of documents supporting the DOE draft docket that conditions at ETEC, Building T654, are in compliance with applicable DOE and proposed Environmental Protection Agency and Nuclear Regulatory Commission standards and criteria established to protect human health, safety, and the environment.

EXHIBIT I

DOCUMENTS SUPPORTING THE CERTIFICATION FOR THE UNRESTRICTED USE OF BUILDING T654 AT THE ENERGY TECHNOLOGY ENGINEERING CENTER

United States Government **Department of Energy**

memorandum

DATE: October 1, 1998

REPLY TO
ATTN OF: DOE Oakland Operations Office/ER

SUBJECT: Release of Decontaminated Building 654 without Radiological Restrictions at the Energy Technology Engineering Center.

TO: Andy Gupta, EM-44

The Oakland Operations Office (OAK) has implemented environmental restoration projects at the Energy Technology Engineering Center (ETEC) as part of the Environmental Restoration Program (ERP) per Headquarters Northwestern Area Program Office direction. The objective of the program is to identify and cleanup or otherwise control facilities where residual radioactive contamination remains from activities carried out under contract to the Atomic Energy Commission and the Energy Research and Development Administration during the early years of the Nation's atomic energy program.

The Energy Technology Engineering Center performed testing of equipment, materials, and components for nuclear and energy related programs. These nuclear energy research and development programs began in 1946 and ended in 1995. Numerous buildings and land areas became radiologically contaminated as a result of facility operations and site activities. One such area that has been designated for cleanup under the ERP is Building 654.

Building 654, the Interim Storage Facility was constructed in 1958 to support the Sodium Reactor Experiment (SRE). It was originally used to store dummy and spent fuel elements, shipping storage casks, and the waste generated at the SRE. Since the SRE ceased operating the facility has been used to store material from two other programs, the Organic Moderated Reactor Experiment and the Systems for Nuclear Auxiliary Power. Some asphalt and soil was contaminated (low level) as a result of the deterioration of casks and equipment. The facility decontamination began in 1984 and was completed in 1985.

The Environmental Survey and Site Assessment Program of the Oak Ridge Institute for Science and Education (ORISE) has completed independent verification of the Building decontamination project.

Post remedial action surveys have demonstrated, and the DOE Oakland Operations Office hereby certifies, that the subject property is in compliance with DOE decontamination criteria and standards established to protect members of the general public and occupants of the property.

Final project closeout documents have been submitted to your office under separate cover.

DOE/OAK requests approval for release of this property without radiological restrictions to Rockwell International, in accordance with the closeout provisions of the contract, and authorization to remove this facility from the DOE/OAK real property records.

Michael Lopez
ETEC PM
Environmental
Restoration Division

STATEMENT OF CERTIFICATION: Energy Technology Engineering Center, Building 654

The U.S. Department of Energy, Oakland Operations Office, Environmental Restoration Division, has reviewed and analyzed the radiological data obtained following decontamination of the Energy Technology Engineering Center Building 654. Based on this analysis of all data collected, the Department of Energy (DOE) certifies that the following property is in compliance with DOE decontamination criteria and standards. This certification of compliance provides assurance that future use of the property will result in no radiological exposure above applicable guidelines established to protect members of the general public or site occupants. Accordingly, the property specified below is released from DOE's Environmental Restoration Program.

Property is owned by Rocketdyne Propulsion and Power, part of the Boeing Company.

Building 654, at the Energy Technology Engineering Center, located in a portion of Tract "A" of Rancho Simi, in the County of Ventura, State of California, as per map recorded in Book 3, Page 7 of Miscellaneous Records of Ventura County.

CERTIFICATION:

[signature]
Hannibal Joma, ETEC Site Manager

10/1/98
Date

EXHIBIT II

SITEWIDE RELEASE CRITERIA FOR REMEDIATION OF FACILITIES AT THE SANTA SUSANA FIELD LABORATORY (INCLUDES ENERGY TECHNOLOGY ENGINEERING CENTER) AND ASSOCIATED DOCUMENTATION

memorandum

DATE: 0 5 SEP 1996

REPLY TO
ATTN OF: DOE Oakland Operations Office(ERD)

SUBJECT: Radiological Site Release Criteria for ETEC

TO: Sally Robison, EM-44

I am requesting the approval of the radiation site release criteria for the Energy Technology Engineering Center. The release criteria are a critical component in the DOE process for releasing facilities for unrestricted use. The California Department of Health Services has approved the site release criteria in a letter dated August 9 (see attachment 1).

The proposed limits were developed in the following way:

1) Annual exposure dose. Rocketdyne proposes to use a dose limit of 15 mrem/yr to comply with the 100 mrem plus ALARA as required by DOE 5400.5). This limit is also consistent with the anticipated rules of the NRC and EPA.

2) Ambient exposure rate. The proposed limit of 5μR/hr above natural background complies with the limit of 20μR/hr, plus ALARA, as stated in DOE Order 5400.5. This proposed limit is consistent with NRC limits for Rocketdyne facilities at the Santa Susana Field Laboratory. This limit would be imposed for accessible, or potentially accessible, structures and land.

3) Surface contamination. Surface contamination limits comply with DOE Order 5400.5 and specify the potential contaminants present in the Rocketdyne facilities.

4) Generic Limits for Soil and Water. The generic limits for soil and water were established using the DOE pathway analysis code RESRAD.

09/16/96

The proposed site release criteria are included in "Proposed Sitewide Release Criteria for Remediation of Facilities at the SSFL", Revision A, N001SRR140127.

Your approval is requested by September 16,1996.

Laurence McEwen
Acting Director
Environmental
Restoration Division

Attachments

cc: R. Liddle, ESO
M. Lopez, ERD
D. Williams, EM-443

96-ER-095/

United States Government **Department of Energy**

memorandum

SEP 1996
RECEIVED

DATE: SEP 17 1996

REPLY TO ATTN OF: EM-44 (D. Williams, 903-8173)

SUBJECT: Sitewide Limits for Release of Facilities Without Radiological Restriction

TO: R. Liddle, Oakland Operations Office

We have reviewed Rocketdyne's proposed sitewide limits for release of facilities at the Santa Susana Field Laboratory (SSFL) without radiological restriction and are satisfied that our previous concerns and comments have been addressed.

The proposed limits are consistent with the Department of Energy (DOE) Order 5400.5 requirement for a Total Effective Dose Equivalent limit of 100 mrem/yr plus As low As Reasonably Achievable (ALARA) for future occupants, the Nuclear Regulatory Commission proposed a radiological guideline of 15 mrem/yr ALARA, and the Environmental Protection Agency proposed a guideline of 15 mrem/yr for release of properties.

Corrective actions taken by Rocketdyne for the sampling and statistical approach to final survey data validation for DOE projects are now comparable to methodologies or standard practices used at other DOE sites and the requirements of Nuclear Regulatory Commission Nuclear Regulation (NUREG)/CR-5489 (Manual for Conducting Radiological Surveys in Support of License Termination).

We also received a copy of the letter from the California Department of Health Services stating concurrence with the proposed release guidelines and the intent to incorporate these guidelines into Rocketdyne's California Radioactive Material License.

Based upon the above information, the proposed sitewide release criteria for remediation of facilities at the SSFL are hereby approved for use.

If you have any questions, please call Mr. Don Williams of my staff at 301-903-8173.

Sally A. Robison, Ph.D.
Director
Office of Northwestern Area Programs
Environmental Restoration

007857 RC

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RD99-158

STATE OF CALIFORNIA—HEALTH AND WELFARE AGENCY PETE WILSON, Gover

DEPARTMENT OF HEALTH SERVICES
714/744 P STREET
P.O. BOX 942732
SACRAMENTO, CA 94234-7320

(916) 323-2759

96ETEC-DRF-0455

August 9, 1996

Ms. Majelle Lee, Program Manager
Environmental Management
Rocketdyne Division
Rockwell International Corporation
P. O. Box 7930
Canoga Park, CA 91309-7930

Subject: Authorized Sitewide Radiological Guidelines for Release of Unrestricted Use

Dear Ms. Lee:

This letter is to acknowledge the receipt of your letter dated June 28, 1996 requesting concurrence of the above subject. The above mentioned letter and its attachments have been reviewed by the staff of this office. The Radiologic Health Branch (RHB) concurs that the proposed release guidelines provide adequate assurance for the release of the facilities and properties at Rocketdyne's Santa Susana Field Laboratory (SSFL) and DeSoto sites without further radiological restrictions. Your letter dated June 28, 1996 with attachments will be incorporated into Rocketdyne's California Radioactive Material License # 0015-70 upon receipt of a commitment letter signed by Mr. Phil Rutherford.

If you have any questions concerning this matter, please feel free to call Mr. Stephen Hsu of this office at (916) 322-4797.

Sincerely,

Gerard Wong, Ph.D., Chief
Radioactive Material Licensing Section
Radiologic Health Branch

BOEING

Supporting Document

GO NO.	S/A NO.	PAGE 1 OF	TOTAL PAGES	REV. LTR/CHG. NO.	NUMBER
90127		28	28	New	N001SRR140131

PROGRAM TITLE
Radiation Safety

DOCUMENT TITLE
Approved Sitewide Release Criteria for Remediation of Radiological Facilities at the SSFL

DOCUMENT TYPE
Safety Review Report

RELATED DOCUMENTS

ORIGINAL ISSUE DATE
12/18/98

RELEASE DATE 2-18-99 RELEASE E.M.

PREPARED BY/DATE: P. D. Rutherford 12/16/98 — DEPT. 641 — MAIL ADDR T487

APPROVALS	DATE
P. D. Rutherford	12/16/98
M. E. Lee	12/16/98
J. Willenberg	12/18/98

IR&D PROGRAM? YES NO X
IF YES, ENTER AUTHORIZATION NO.

DISTRIBUTION

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ABSTRACT

This document supersedes revision A of N001SRR140127, "Proposed Sitewide Release Criteria for Remediation of Facilities at the SSFL" issued August 22, 1996. N001SRR140127 was submitted to the Department of Energy (DOE) and the California Department of Health Services (DHS) who subsequently approved the use of these criteria for release of radiological facilities at Rocketdyne for unrestricted use.

A complete set of release criteria for facilities at the SSFL has been developed, and are presented in this report. The various categories of release guidelines include; 1) annual expected dose, 2) soil and water concentration guidelines, 3) surface contamination guidelines, and 4) ambient gamma exposure rate. The guidelines were obtained from regulatory values where available. Where not available, for example for soil, guidelines were calculated by use of the DOE computer code, RESRAD. For these calculations, the annual dose limit is 15 mrem/year, which is consistent with proposed EPA and NRC guidelines and ALARA principles.

RESERVED FOR PROPRIETARY/LEGAL NOTICES

FORM 734-C REV. 7-97

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1. INTRODUCTION

This document supersedes revision A of N001SRR140127, "Proposed Sitewide Release Criteria for Remediation of Facilities at the SSFL" issued August 22, 1996. N001SRR140127 was submitted to the Department of Energy (DOE) and the California Department of Health Services (DHS) who subsequently approved the use of these criteria for release of radiological facilities at Rocketdyne for unrestricted use. Copies of approval letters from DOE and DHS are included in Appendix B.

At several locations at the Santa Susana Field Laboratory (SSFL), low levels of radiological contamination in buildings and in soil have occurred and have been or will be cleaned up for eventual release for use without radiological restrictions. The DOE requirements for allowable residual radioactivity in sites suitable for release without radiological restrictions ("unrestricted release") are established in DOE Order 5400.5 (Ref. 1). Specific guidelines are given in 5400.5 for surface contamination and for direct gamma exposure. However, except for radium and thorium in soil, no specific guidelines are provided for residual contamination in soil or water. It became clear that a set of DOE-authorized limits for the SSFL would greatly facilitate the process of determining that a facility is acceptably clean, and verifying this with a confirmatory survey. Approval of such a set of authorized limits is provided for in DOE Order 5400.5, Chapter IV, Section 5, and in draft 10 CFR 834.301(c).

The purpose of this report is to document the set of approved guideline values for the release without radiological restriction of DOE facilities at the SSFL. The various categories of release guidelines include; 1) annual expected dose, 2) soil and water concentration guidelines, 3) surface contamination guidelines, and 4) ambient gamma exposure rate. The guidelines presented in this report are for residual radioactivity above background. When feasible, the local background activity of the suspect radionuclides should be determined and these background values subtracted from the measured release survey data.

The goal for these limits is to provide assurance that reasonable future uses of the property will not result in individual doses exceeding 15 millirem per year. This is consistent with current EPA and NRC guidance, and is supported by a generic cost-benefit analysis presented in Reference 2.

2. ANNUAL DOSE LIMITATION

DOE Order 5400.5 specifies a base Total Effective Dose Equivalent (TEDE) limit of 100 millirem per year for any potential future occupant of a remediated site. The Order also requires the use of the As Low As Reasonably Achievable (ALARA) principle to establish Authorized Limits at a level that is below the base limit. Rocketdyne will apply a value of 15 millirem per year for the calculation of derived limits for the cleanup of DOE sites at the SSFL, consistent with EPA and NRC guidance. A limit of 15 millirem per year (mrem/year) is adopted to assure that future uses will contribute small doses compared to natural background doses, which are in the range of 250-400 mrem/year (Ref. 3). This limit is considered to be as low as reasonably achievable below the basic DOE dose limit of 100 mrem/year. The 15 mrem/year value corresponds to a calculated increased lifetime cancer risk to a potential future user of the site of 3×10^{-4}.

For any reasonable assigned cost per person-rem, further reduction of anticipated dose due to exposure to residual radioactivity at the site is difficult to justify. For example, the EPA proposed TEDE of 15 mrem/year was arrived at after extensive ALARA analysis of cleanup costs and benefits at sixteen "Reference Sites" representing a wide range of conditions found at contaminated sites throughout the United States. Their analyses assumed a residential use of the decontaminated sites, and their conclusions were that the 15 mrem/year limit represented the most effective value considering all the technical and socio-political issues involved.

Furthermore, at the SSFL, conservative choices in the development, measurement, and interpretation of limits and final surveys provide a firm bias towards overestimation of the remaining risk. These include, 1) a conservative residential scenario for the pathway analyses, 2) use of calibration sources that tend to underestimate the detector efficiency for the likely contaminants, and 3) both qualitative and quantitative tests that provide assurance that the decommissioned facility is suitable for release without radiological restrictions.

3. SOIL AND WATER GUIDELINES

Since there are no federal or state regulatory limits for soil contamination for many of the potential or actual radionuclides of concern at SSFL, site-specific guidelines must be developed. This development is done, as required by the DOE Order, by use of a "pathways" analysis program, which estimates the radiological dose (total effective dose equivalent) that a future user of the property might receive, considering the residual radioactivity and various conditions of use. An effort is made to make these use conditions as reasonable for the use and the local area as can be achieved, without greatly over-estimating or under-estimating potential doses.

To establish these guidelines for cleanup operations at SSFL, the pathways analysis program RESRAD (Ref. 4), developed at Argonne National Laboratory (ANL) for use by DOE, has been used to calculate single radionuclide guidelines for the radionuclides of potential concern at SSFL.

For soil, a dose limit of 15 millirem per year is used. For consideration of radiological contamination in water, which may be collected from wells, sumps, below-grade seepage, or surface water, concentration guidelines were calculated from the Dose Conversion Factors (DCFs) in RESRAD, using the EPA limit of 4 millirem per year for ingested drinking water (Ref. 5), and the EPA assumed intake of water, 2 liters per day. These limits are more restrictive than those imposed on releases from operating facilities, as provided by DOE Order 5400.5 (Ref. 1), NRC (Ref. 6), the State of California (Ref. 7), and EPA for uranium mines and mills (Ref. 8).

3.1 Pathway Analysis

Pathways analysis involves calculating the doses received by a person through several pathways: direct radiation exposure; inhalation of airborne radioactivity; drinking water containing radioactivity; eating foods that have accumulated radioactivity, through uptake of water with radioactivity from the soil, or with airborne radioactivity deposited on the foliage; and ingestion of small amounts of contaminated soil.

The pathways analysis program RESRAD, was developed in the late 1980's for DOE by Argonne National Laboratory for the purpose of performing pathways analysis for a broad range of applications. Considerable flexibility is provided in the program for representing the site-specific conditions of exposure, to permit making the calculation as reasonable for the application as is possible.

Four general types of use may be considered for land for the purpose of calculating dose, other than the obvious zero-dose case of non-use. These may be identified as the industrial scenario, the wilderness scenario (or recreational, such as a park or golf course), the residential scenario, and the family farm scenario. Within these general use scenarios, choices are made for occupancy time (indoors and outdoors), water use, and food sources. Further choices are made to represent the contamination situation, geology, and hydrology. The program comes with a complete set of generally conservative default values, and these may be changed as appropriate to reflect local reality in terms of usage practices and physical conditions, to produce a realistic pathways analysis for the specific site. The default values and the values actually used by the program in the analysis are listed in the output for each calculation, so departures from the default set are well recorded. The printed results from the calculations described in this report are stored in the Radiation Safety library file.

The family farm, on which family members spend 100% of their time, drinking water from the surface or from wells, eating vegetables and fruit grown on the land and irrigated with the same water, raising their meat, milk, and fish on that land, is not a reasonable scenario for the site. Although commercial farming is practiced in low-lying valley and coastal areas west of the facility, the rugged nature and topography of the SSFL, combined with poor soil quality, would reasonably preclude a family farm activity on the site. Further, recent land use trends in the area have been to conversion of previous farming property to other non-farming uses. Thus, the industrial, wilderness, and residential scenarios are all perhaps equally probable for the future of the site, and should be the scenarios considered.

3.2 Property Usage Scenarios

The basic usage conditions (per year) modeled in these calculations, for each of the three realistic scenarios, are summarized in Table 1. A complete listing of all RESRAD input data, for the three scenarios, is given in Appendix A. Discussion on specific RESRAD input parameters is given below in Section 3.3

Table 1. Property Usage Conditions for Three Realistic Scenarios

	Industrial	Wilderness	Residential
Occupancy, indoors (hours/year)	1752	0	4380
Occupancy, outdoors (hours/year)	350	876	2190
Occupancy, off site (hours/year)	6664	7890	2190
Drinking water (liters/year)	0	0	510
Fruit, vegetables, grain (kg/year)	1.6	1.6	16
Leafy vegetables (kg/year)	0	0	1.4
Cover thickness (meters)	0	0	0
Contamination area (m^2)	10000	10000	10000
Contamination thickness (meters)	1	1	1
Depth to water table (meters)	5	5	5

3.3 RESRAD Input Parameters

Default values provided in RESRAD are considered to be conservative estimates intended for use when no site-specific information is available. Users of the program are encouraged, however, to use input data that most closely reflects actual conditions existing on their site. As part of several earlier efforts at the SSFL, a number of screening evaluations were performed using the RESRAD code to determine which of the approximately 80 input parameters required by RESRAD were of significance to the general SSFL area. These screening evaluations also were useful in determining conservative site-specific values for input to the code, when the default values were not used. In general, changes to most of the parameters were found to have a negligible effect on the final results because certain dose pathways were either not applicable or negligible for the given scenarios.

Contaminated Zone Parameters: Default values for the area of contamination (10,000 m^2) and the length parallel to aquifer flow (100 m) were assumed. For the depth of contamination, a conservative value of 1 meter is assumed. Measurements conducted at the site have indicated historical maximum values ranging from about 0.4 to 0.6 m for this parameter.

Occupancy Parameters: The default RESRAD values for occupancy of a residence on an affected site are 50% of the time spent indoors and 25% of the time spent outdoors, on the site. Thus, 25% of the time the occupancy is assumed to be off site. For the residential scenario, assuming 8,760 hours in a year, this translates into 4,380 hours spent indoors, 2,190 hours spent outdoors on the site, and 2,190 hours spent off site. For the industrial scenario, the corresponding percentages are assumed to be 20%, 4%, and 76% respectively. For the wilderness scenario, the corresponding percentages are 0%, 10%, and 90%.

Shielding Factors: The annual dose estimates calculated by RESRAD from either direct exposure or by inhalation (dust) are functions of two "structural" shielding parameters and the fraction of time an individual is assumed to spend inside a structure built on the site. Both shielding factors range from 0 to 1, and may be changed by the user to more appropriately match actual site conditions. For inhalation, the RESRAD default is 0.4, and this value is assumed for the present evaluations. For direct gamma exposure, the RESRAD default is 0.7, which is a rather conservative estimate of gamma shielding by a structure. For the present calculations, this latter value was adjusted from the default, for both the industrial and residential scenarios, to account for local construction practice which dictate a minimum 4-inch (0.1 m) concrete slab under the structure.

The gamma shielding factor used as input to RESRAD was calculated by modeling a typical two-story residential structure, and a single story industrial structure using the computer code MicroShield[1]. MicroShield is a point-kernel gamma shielding code developed for IBM-compatible personal computers, based on the mainframe code ISOSHLD. For the residential structure, a conservative lower bound footprint (area) value of 93 m^2 (1,000 ft^2) was assumed. For the industrial structure, a 186 m^2 (2,000 ft^2) area was assumed. A circular area was used with MicroShield to obtain maximum code accuracy with minimum computational time. Screening

[1] MicroShield, Version 4.0, Grove Engineering, Inc., 15215 Shady Grove Road, Suite 200, Rockville, MD 20850.

calculations indicated no significant differences between the results for circular and square areas of the same volume.

In all cases the contaminated soil was assumed to have a density of 1.5 g/cm^3, and a thickness of 1 meter. Dose calculations were performed for two vertical distances (1m for the ground floor and 3.6 m for the second story) and for three radial distances (center, midpoint, and edge of structure). The isotopic mix input to MicroShield was the same as that used for the present RESRAD calculations, with a concentration of 1 pCi/g for each isotope. Resulting gamma energy groups for this isotope mix ranged from 0.1 to 1.5 MeV. A factor of 0.89 was used to account for gamma shielding from a typical structural wall composed of approximately 1 inch of stucco and 5/8 inch of drywall, and a window area of approximately 10% of the wall area.

Effective gamma shielding factors obtained from the MicroShield calculations are given in Appendix A. For the residential scenario (the most credible), it is assumed that 12 hours are spent inside the structure per day. If it is further assumed that 8 of these hours are spent upstairs in a bedroom, 4 hours are spent downstairs in a family room, and that a person (on average) is located at the midpoint between the center and the edge of the structure, then the effective gamma shielding factor would be: (0.67)(0.61) + (0.33)(0.31) = 0.51. For the industrial scenario, the value is 0.25, which is the shielding value at the midpoint location for the single story structure.

Table 2. Gamma Shielding Factor Calculations for Typical SSFL Structure

	Gamma Shielding Factor	
Radial Location	**1st Floor**	**2nd Floor**
Residential Structure (93 m^2 footprint, two story)		
Center	0.27	0.57
Midpoint[a]	0.31	0.61
Perimeter[b]	0.57	0.71
Industrial Structure (186 m^2 footprint, single story)		
Center	0.22	-
Midpoint[a]	0.25	-
Perimeter[b]	0.58	-

[a]Midpoint between the center and the perimeter of the structure
[b]Edge of the structure.

It should be noted, that these values do not take into account any out-structures such as garages and patios, both of which would result in additional gamma shielding, and both of which would almost certainly be part of any residences built on the site.

Dietary Parameters: Default RESRAD input values for food and water consumption are based on the family farm scenario, where a significant portion of the diet is grown or raised on the site. For the three credible scenarios considered here, these parameters were adjusted as follows: for the residential scenario, it is conservatively assumed that a small fraction (10% of that grown on a family farm) of the fruit and leafy vegetables consumption would be from material grown on site. The values used are 16 kg/year per person and 1.4 kg/year per person, respectively. It was further assumed that water for the residence would be obtained from a well on the site (510 liters/year per person).

For the industrial and wilderness scenarios, it was assumed that no water would be used that was taken from the site; thus, all water pathways were suppressed with the exception of a secondary pathway via plant ingestion. In the industrial case, bottled drinking water is supplied. Since essentially all surface water at present is a result of the current industrial operations, no surface water would be available in the wilderness scenario. It is also assumed that perhaps 1% of the family farm fruit consumption value might be collected from wild sources, thus, 0.14 kg/year is used for these scenarios.

Contaminated Zone Hydrology Data: The SSFL facility is located in the Simi Hills in eastern Ventura County, California. The Simi Hills are in the northern part of the Transverse Range geomorphic province, and are composed primarily of exposures of the Upper Cretaceous Chatsworth Formation. This formation is a marine turbidite sequence of sandstone with interbedded siltstone/mudstone and minor conglomeratic lenses. The Chatsworth Formation is at least 1,800 m thick in locations east and north of the Facility.

The principal geologic units at the SSFL are the Chatsworth Formation and the shallow alluvium which overlies the Chatsworth Formation in some parts of the Facility, notably in Area IV of the SSFL where the decommissioning and decontamination of nuclear sites is taking place. This layer is Quaternary alluvium consisting of mixtures of unconsolidated sand, silt, and clay, and would include the contaminated zone. Drill holes indicate that the layer may be as thick as 6 meters in some locations.

The density of this alluvium layer is approximately 1.5 g/cm^3. The total and effective porosity of the contaminated zone are assumed to be 0.43 and 0.20 based on the average of data for sand, silt, and clay as given in the RESRAD manual. Precipitation at the facility is measured annually by a rain gauge located in the northeastern portion of the SSFL (Ventura County Rain Gauge Number 249). Based on measured data since 1959, the mean annual precipitation at the SSFL is approximately 18.6 inch, or 0.47 meters. In general, the majority of the precipitation occurs during the months of January through March.

Saturated Zone Hydrology Data: There are two groundwater systems at the SSFL: 1) a shallow system in the surficial alluvium and the underlying zones of weathered sandstone and siltstone/claystone, and isolated shallow fracture systems; and 2) a deeper regional system in the fractured Chatsworth Formation. The shallow zone is discontinuous, with depths to groundwater ranging from land surface to over 9 m. For the present study, we assume that this shallow region most conservatively represents the saturated zone, with an average depth to the water table of about 5 m. Hydraulic conductivity in the saturated zone generally ranges from about 30 to 3,000 m/year. Here, the higher value has been assumed.

Typical pumping rates for deep wells in the Chatsworth Formation (rock) range from 60 to 70 m^3/year up to a maximum of about 300 m^3/year. For the shallow (alluvium) region, however, pumping rates are significantly lower, typically about 35 m^3/year. Further, in the shallow region, many wells would be dry for a good fraction of the year as the replenishment rate is generally low. Water table drop rates, therefore, would range up to 10 m as a result of on-site pumping. Without pumping, however, no data is available on any inherent lowering of the water table. For conservatism, therefore, the default value of 0.001 m/year has been assumed.

Radon Pathway: Two default values were modified for the radon pathway. The thickness of the foundation was set at 0.1 m (4 inches) to correspond to the gamma shielding calculations discussed above. Also, the depth below ground surface was also set at 0.1 m, as basement structures are not typical for the local area.

3.4 Calculated Soil and Water Guidelines from RESRAD

The guidelines calculated from the RESRAD code for various single radionuclides are listed in Table 3 for comparison of the three scenarios. Values for each of the scenarios were determined from separate RESRAD calculation runs using the input parameters given in Appendix A. Water guideline values in Table 3 were calculated from the dose conversion factors used in RESRAD for ingestion, using an EPA value of 2 liters/day total water consumption (per person) from the site, and an EPA dose limit of 4 mrem/year (Ref. 5).

For radionuclides specifically regulated by the EPA (and the State of California), the Safe Drinking Water Act (and CCR Title 22) limits were used. These are (in pCi/l):

H-3	20,000
Combined Ra-226 and Ra-228	5
Sr-90	8
Gross alpha (not including radon and uranium)	15
Gross beta	50
Uranium (U-234 + U-235 + U-238)	20

For U-234, U-235, and U-238, DOE imposes the EPA regulations in 40 CFR 192 (and parts 190 and 440). Similarly, for Ra-226, Th-228 and Th-232, DOE imposes the limits in DOE Order 5400.5.

3.5 Soil and Water Guidelines

Based on the data in Table 3, conservative guidelines, consistent with the several applicable regulations governing residual radioactivity discussed above, are listed in Table 4. With the exception of uranium, radium, and thorium, the soil guidelines are those calculated from RESRAD for the residential use scenario. For uranium, the guidelines are those adopted by the NRC (30, 30, and 35 pCi/g for U-234, U-235, and U-238, respectively, see Ref. 9). For

Table 3. RESRAD-Calculated Single Isotope Guideline Values

	Soil Guidelines (pCi/g)			
Radionuclide	**Industrial**	**Wilderness**	**Residential**	**Water (pCi/l)[a]**
Am-241	120	162	5.44	1.50
Co-60	10.9	9.83	1.94	204
Cs-134	18.7	16.9	3.33	74.7
Cs-137	51.9	46.7	9.20	110
Eu-152	25.3	22.8	4.51	845
Eu-154	23.0	20.7	4.11	573
Fe-55	2,370,000	4,780,000	629,000	9,020
H-3	129,000	129,000	31,900	85,600[b]
K-40	162	147	27.6	294
Mn-54	34.4	30.9	6.11	1,980
Na-22	13.0	11.7	2.31	476
Ni-59	1,390,000	1,560,000	151,000	26,100
Ni-63	511,000	572,000	55,300	9,490
Pu-238	140	192	37.2	1.71
Pu-239	127	175	33.9	1.55
Pu-240	127	175	33.9	1.55
Pu-241	4,740	6,430	230	79.9
Pu-242	133	183	35.5	1.63
Ra-226	0.520	13.6	0.199	4.12[b]
Sr-90	370	376	36.0	35.8[b]
Th-228	14.8	14.7	2.81	6.78
Th-232	7.94	7.98	1.53	2.01
U-234	519	647	106	19.3[b]
U-235	163	160	32.1	20.5[b]
U-238	399	445	90.9	20.4[b]

[a]Water guidelines calculated from RESRAD ingestion dose conversion factors, assuming the EPA dose limit of 4 mrem/year (see text).

[b]For these radionuclides, the EPA Safe Drinking Water Act or the State of California CCR Title 22 limits should be used (see Table 4).

Table 4. Soil and Water Guidelines for SSFL Facilities

Radionuclide	Soil Guidelines (pCi/g)	Water (pCi/l)
Am-241	5.44	1.5
Co-60	1.94	200
Cs-134	3.33	75
Cs-137	9.20	110
Eu-152	4.51	840
Eu-154	4.11	570
Fe-55	629,000	9,000
H-3	31,900	20,000[a]
K-40	27.6	290
Mn-54	6.11	2,000
Na-22	2.31	480
Ni-59	151,000	26,000
Ni-63	55,300	9,500
Pu-238	37.2	1.7
Pu-239	33.9	1.6
Pu-240	33.9	1.6
Pu-241	230	80
Pu-242	35.5	1.6
Ra-226	5[c] and 15[c]	4.1
Sr-90	36.0	8[a]
Th-228	5[c] and 15[c]	6.8
Th-232	5[c] and 15[c]	2.0
U-234	30[b]	
U-235	30[b]	total uranium 20[a]
U-238	35[b]	
Gross alpha (not including radon and uranium)		15[a]
Gross beta		50[a]

[a]State of California Maximum Contaminant Levels, CCR Title 22
[b]Generally more conservative NRC limits for uranium isotopes are used.
[c]DOE Order 5400.5 limits are used (5 pCi/g averaged over first 15 cm of soil depth and 15 pCi/g averaged over 15 cm layers below the top 15 cm).

radium and thorium, DOE Order 5400.5 limits are used (5 pCi/g averaged over first 15 cm of soil depth and 15 pCi/g averaged over 15 cm layers below the top 15 cm, see Ref. 1). Guidelines established from the residential use scenario are the most restrictive of the three scenarios considered.

The choice of a basic dose limit of 15 mrem/year for all pathways combined leads to lower limits than would result from the use of the dose limits established by the EPA for the uranium fuel cycle (Ref. 10) and by DOE for unrestricted release of contaminated property (Ref. 1). The water guidelines are those calculated from the RESRAD dose conversion factors, using the EPA values for the basic dose limit and daily water intake, with the Maximum Contaminant Levels (MCL) specified for certain radionuclides by the State of California (Ref. 11).

4. SURFACE CONTAMINATION GUIDELINES

Surface contamination limits are specified in Figure IV-1 of Chapter IV in DOE Order 5400.5. For SSFL facilities, these limits have been modified by specifying the potential contaminants present in the Rocketdyne facilities, and eliminating those that are not pertinent. The proposed guidelines are given in Table 5. As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute measured by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

Table 5. Surface Contamination Guidelines for SSFL Facilities

Radionuclide	Average over 1 m^2 (dpm/100 cm^2)	Maximum in 100 cm^2 (dpm/100 cm^2)	Removable (dpm/100 cm^2)
Plutonium, Radium	100	300	20
Thorium	1,000	3,000	200
Uranium	5,000	15,000	1,000
Mixed fission products	5,000	15,000	1,000
Activation products	5,000	15,000	1,000
Tritium	-	-	10,000

As included in Table 5, Pu, Ra, U, Th, mixed fission products, and activation products, refer to those forms of radioactive material that comprise the residual activity at the SSFL. Plutonium is predominately Pu-239; Radium is Ra-226. It is assumed that thorium is sufficiently aged that all daughters are in equilibrium, Th-natural. Uranium will occur in depleted, normal, or enriched forms; U-233 is not present. Mixed fission products include Sr-90 and Cs-137 as components of the mixture. Possible activation products include Co-60, Fe-55, Mn-54, Eu-152, Eu-154, Al-26, and similar radionuclides.

Tritium contamination limits are based on interim guidelines for removable surface contamination (Ref. 12). This level of removable contamination insures that any non-removable or volumetric contamination will not cause unacceptable exposures.

These guidelines will be imposed for accessible (or potentially accessible) surfaces and structures.

5. AMBIENT GAMMA EXPOSURE RATE

A guideline of 5 μR/hr above natural background, measured at 1 meter above the surface, is used. This value has been imposed by the NRC for decommissioning research reactors (Ref. 13). It is as low as reasonably measurable, due to variations in background, and is significantly lower than the guideline of 20 μR/hr stated in DOE Order 5400.5, Chapter IV, Section 4.c. This guideline is imposed for accessible (or potentially accessible) structures and land. Our experience has been that this level can be achieved and verified in facilities that would be suitable for continued use.

6. APPLICATION OF GUIDELINES

Note: The survey protocols described below were those employed at the time of issue of N001SRR140127 and have been in use up until the end of 1998. As of the beginning of 1999, MARSSIM protocols will be employed (Reference 19) utilizing the guidelines developed in this report as the DCGL$_W$s (derived concentration guideline limits).

The guidelines presented above should be used in planning any decontamination effort at the SSFL. Analytical capability for detection of each radionuclide should be, if possible, less than one-tenth of the guideline values. That is, the Minimum Detectable Activity (MDA, our LLD) should be less than 0.1 x guideline. Field measurements used to direct removal of contaminated soil should be capable of practical measurements below the guideline value. Survey measurements and sample analyses should be corrected for the local background activity of each radionuclide.

6.1 Soil Guidelines

Sample analysis is necessary to demonstrate the successful decontamination of soil areas. A qualitative scan will be performed using gamma-sensitive and/or beta-sensitive detectors to identify any significant areas of residual contamination. Soil samples will be taken from locations based on a 3x3 meter master grid. One sample will be taken from within a 1x1 meter grid location in each 3x3-meter section, based either on the qualitative scan survey indications at the area of maximum readings or, if no noticeable readings were found, at the location most likely to have residual contamination, by the surveyor's judgment. This selection assures a reasonably uniform sampling of the ground areas, at a sample density of approximately 11 samples per 100 m^2.

Results from individual samples will be compared with the limit for hotspots of 9-m^2 area, that is, 3.3 x the adopted concentration limit. Averages of adjacent samples, covering 100 m^2, will be compared with the average limit. The overall average, assuming that the individual and 100-m^2 area averages satisfy the applicable limits, will be used for a RESRAD confirmatory calculation. This calculation will be performed to demonstrate that the maximum expected annual dose for the indicated reasonable use scenario for the facility *does not exceed* the proposed 15 mrem/year guideline value.

For mixtures of radionuclides in soil, the "Sum of Fractions" rule is used. The sum of the ratios of concentration of each radionuclide to the corresponding guideline must not exceed 1. This value must be satisfied when samples are averaged over each 100-m^2 region. For cases in which the relative concentrations are known or assumed, this method is used to generate combined radionuclide guidelines for each radionuclide in the mixture.

The guidelines are not intended to be spot limits, and should not be applied to individual measurements. If the specific sampling provides only (or fewer than) one measurement per 100-

m^2 area, each measurement becomes, by default, the "average" for that 100-m^2 area, and the guidelines have the effect of acting as spot limits. In cases where an individual sample exceeds the guideline value, additional samples should be taken from within the same 100-m^2 area, and used to define the average contamination in this area.

The maximum concentrations remaining as "hot spots" must have contamination less than that calculated by the hot-spot rule presented in DOE Order 5400.5, Chapter IV, page 4. The average contamination within any area not exceeding 25 m^2 shall not be greater than $\sqrt{100 / A}$ guideline, where A is the area in m^2. Reasonable efforts shall be made to remove any soil with contamination that exceeds 30 x guideline (Ref. 4).

6.2 Surface Contamination Guidelines

The proposed surface contamination guidelines would be applied to all accessible surfaces and structures. This would include ceilings, floors, and walls, and other potentially accessible locations such as attics. Where surface contamination by both alpha- and beta-gamma-emitting radionuclides exists, the guidelines established for alpha- and beta-gamma-emitting radionuclides should apply independently. Measurements of average contamination are averaged over an area of 1 m^2. For objects of less surface area, the average should be derived for each such object. The maximum contamination level applies to an area of not more than 100 cm^2. Surfaces of facilities which are likely to be contaminated, but are inaccessible for purposes of measurement, shall be presumed to be contaminated in excess of the applicable limits.

Following a complete qualitative scan of the facility, quantitative surface contamination measurements will be made over a fraction of the structural surfaces, as determined by the designation of the area as affected or unaffected. Affected areas will be surveyed at a nominal fraction of 11%. Unaffected areas will be surveyed at lesser fractions. Locations for the quantitative survey measurements will be based on a 3x3 meter master grid. One sample will be taken from within a 1x1 meter grid location in each 3x3-meter section, based either on the qualitative scan survey indications at the area of maximum readings or, if no noticeable readings were found, at the location most likely to have residual contamination, by the surveyor's judgment. Results from individual locations will be compared with the applicable limits.

Total surface contamination is measured by use of detectors primarily or exclusively sensitive to alpha or beta-gamma radiation. After a qualitative survey of the surfaces of the entire subject area, quantitative measurements are made on 1-m^2 areas selected uniformly throughout the area. These measurements are made with the detectors connected to a scaler set to accumulate counts for a 5-minute period. The detector is slowly scanned over the 1-m^2 grid location and the numerical result, after correction for background, count time, and detector efficiency, yields the 1-m^2 average surface activity. These detectors are calibrated against Th-230 for alpha activity and Tc-99 for beta activity. The emission energies of these radionuclides is generally less than those radionuclides found as contamination at SSFL. This results in an underestimate of the efficiency of the detectors for the actual contaminant radioactivity and hence an overestimate of the actual measurement.

The amount of removable activity per 100 cm^2 of surface area is determined by wiping an area of that size with dry filter or soft absorbent paper, applying moderate pressure, and measuring the amount of radioactive material on the wiping with an appropriate instrument of known efficiency. Typically at Rocketdyne, a low background gas flow proportional counter is used. When removable contamination on objects of surface area less than 100 cm^2 is determined, the activity per unit area should be based on the actual area and the entire surface should be wiped. It is not necessary to use wiping techniques to measure removable contamination levels if direct scan surveys indicate that the total residual surface contamination levels are within the guidelines for removable contamination.

Smear methods for tritium detection are similar to that described above, with the exception that a wet swipe or piece of Styrofoam should be used. If the property has been recently decontaminated, a follow-up measurement (smears) should be conducted to ensure that there is no build-up of contamination with time.

6.3 Ambient Gamma Exposure

Measurements of the ambient gamma exposure rate provides a useful determination of residual volumetric radioactivity that may not be as easily detected by surface measurements or sampling and analysis. For the purpose of demonstrating suitability for release, this measurement provides an additional test.

The DOE established a limit of 20 μR/hr above natural background for screening radium-contaminated property. The NRC has imposed a 10μR/hr limit on the decommissioning of radioactive materials licensees, and a 5μR/hr limit on the decommissioning of research reactors. The 5 μR/hr limit above natural background is proposed for use at Rocketdyne. Because of the variability and differences in natural background, the limit of 5 μR/hr is about as low as can be reasonably implemented.

Quantitative measurements of the ambient gamma exposure rate will be made over a fraction of the structural surfaces, as determined by the designation of the area as affected or unaffected. Affected areas will be surveyed at a nominal fraction of 11%. Unaffected areas will be surveyed at lesser fractions. Locations for the quantitative survey measurements will be based on a 3x3-meter master grid. One measurement, covering one 1-m^2 grid location, will be made at each grid location chosen for the surface contamination measurements. Results from individual locations will be compared with the applicable limits.

At Rocketdyne, gamma exposure rate is generally measured by use of a 1x1 inch NaI(Tl) detector/photomultiplier probe, connected to a scaler to provide objective numerical values. The detector is placed 1 meter above the local (ground or floor) surface. This instrument is calibrated by reference to a High Pressure Ion Chamber (HPIC) in a background area.

6.4 Statistical Validation of Survey Data

The statistical approach employed at Rocketdyne/ETEC for establishing that survey data meets guideline values is a method referred to as Sampling Inspection by Variables (Ref. 14). This method has been widely applied in industry and the military and is essential where the lot size is impractically large. Application of this method to the remediation of contaminated sites has been discussed in detail elsewhere (see for example, Ref. 15).

In sampling inspection by variables, the number of data points on which measurements are obtained is first chosen to be large so that the parameters of the distribution are likely to have a normal distribution (i.e., Gaussian). The mean of the distribution, $\bar{x}$, and its standard deviation, s, are then related to a "test statistic", TS, as follows:

$$TS = \bar{x} + ks$$

where $\bar{x}$ = average (arithmetic mean of measured values)
s = observed sample standard deviation
k = tolerance factor calculated from the number of samples to achieve the desired sensitivity for the test

TS and $\bar{x}$ are then compared with an authorized acceptance limit, U, to determine acceptance or other plans of action, including rejection of the area as contaminated and requiring further remediation.

The sample mean and standard deviation are easily calculable quantities; the value of k, the tolerance factor, bears further discussion. Of the various criteria for selecting plans for acceptance sampling by variables, the most appropriate is the method of Lot Tolerance Percent Defective (LTPD), also referred to as the Rejectable Quality Level (RQL). The LTPD is defined as the poorest quality that should be accepted in an individual lot. Associated with the LTPD is a parameter referred to as consumer's risk (β), the risk of accepting a lot of quality equal to or poorer than the LTPD (or 10%). NRC Regulatory Guide 6.6 (Ref. 16) states that the value for the consumer's risk should be 0.10. Conventionally, the value assigned to the LTPD has been 10%.

The State of California, Department of Radiological Health Branch, has stated that the consumer's risk of acceptance (β) at 10% defective (LTPD) must be 0.1 (Ref. 17). For those choices of β and LTPD, $K_\beta = K_2 = 1.282$. The number of samples is n. Values of k for each sample size are calculated in accordance with the following equations:

$$k = \frac{K_2 + \sqrt{K_2^2 - ab}}{a}; \quad a = 1 - \frac{K_\beta}{2(n-1)}; \quad b = K_2^2 - \frac{K_\beta^2}{n}$$

where k = tolerance factor,
K_β = the normal deviate exceeded with probability of β, 0.10 (from tables, $K_2 = 1.282$, see Ref. 18),
K_2 = the normal deviate exceeded with probability equal to the LTPD, 10% (from tables, $K_\beta = 1.282$, see Ref. 18)[2], and
n = number of samples.

The statistical criteria for acceptance of a remediated area are presented below.

a) Acceptance: If the test statistic ($\bar{x}$ + ks) is less than or equal to the guideline (U), accept the area as clean. If any single measured value exceeds 80% of the limit, decontaminate that location to as near background as is possible, but do not change the value in the analysis.

b) Collect additional measurements: If the test statistic ($\bar{x}$ + ks) is greater that the limit (U), but $\bar{x}$ itself is less than U, independently resample and combine all measured values to determine if $\bar{x} + ks \leq = U$ for the combined set; if so, accept the area as clean. If not, the area is contaminated and must be remediated.

c) Rejection: If the test statistic ($\bar{x}$ + ks) is greater than the limit (U) and $\bar{x} > = U$, the region is contaminated and must be remediated.

Thus, based on sampling inspection, we are willing to accept the hypothesis that the probability of accepting an area as not being contaminated which is, in fact, 10% or more contaminated is 0.10. Or in other words, the final survey acceptance criteria corresponds to assuring with 90% confidence that 90% of an area has residual contamination below 100% (a 90/90/100 test) of the authorized limit.

7. REFERENCES

1. "RADIATION PROTECTION OF THE PUBLIC AND ENVIRONMENT," DOE Order 5400.5, U. S. Department of Energy, February 8, 1989.

2. "Regulatory Impact Analysis for Radiation Site Cleanup Proposed Rule - Draft", U. S. Environmental Protection Agency, January 17, 1996.

3. "Health Effects of Exposure to Low Levels of Ionizing Radiation -- BEIR V," Committee on the Biological Effects of Ionizing Radiations, Board on Radiation Effects Research, Commission on Life Sciences, National Research Council. National Academy Press, Washington, 1990.

4. "A Manual for Implementing Residual Radioactive Material Guidelines," DOE/CH/8901, U. S. Department of Energy, June 1989.

5. "National Primary Drinking Water Regulations; Radionuclides," 40 CFR 141.15 and .16, U. S. Environmental Protection Agency, July 18, 1991.

6. "STANDARDS FOR PROTECTION AGAINST RADIATION," 10 CFR 20, U. S. Nuclear Regulatory Commission.

7. "CALIFORNIA RADIATION CONTROL REGULATIONS," CCR 17, State of California Department of Health Services.

8. "ORE MINING AND DRESSING POINT SOURCE CATEGORY," Subpart C--Uranium, Radium and Vanadium Ores Subcategory, 40 CFR 440, U. S. Environmental Protection Agency.

9. "Disposal or Onsite Storage of Thorium or Uranium Wastes from Past Operations," Federal Register . Vol. 46, No. 205, pp. 52061-52063, Friday, October 23, 1981. U. S. Nuclear Regulatory Commission.

10. "ENVIRONMENTAL PROTECTION STANDARDS FOR NUCLEAR POWER OPERATIONS," 40 CFR 190, U. S. Environmental Protection Agency.

11. "Environmental Health, Radioactivity," CCR 22, Article 5. State of California Department of Health Services.

12. "Application of DOE 5400.5 Requirements for Release and Control of Property Containing Residual Radioactive Material", DOE Memorandum, DOE-OAK, January 5, 1996.

13. "Order Authorizing Dismantling of Facility and Disposition of Component Parts", Docket No. 50-375, Enclosure to NRC Letter dated February 22, 1983, D. Eisenhut to M. Remley.

14. DOE/CH/8901, A Manual for Implementing Residual Radioactive Material Guidelines, T. L. Gilbert, et al., June 1989.

15. "Statistical Treatment of Radiological Survey Data for Cleanup Decisions and Regulatory Compliance", Proc. Spectrum '92 Conference, Boise, Idaho, August 23 - 27, 1992.

16. "Acceptance Sampling Procedures for Exempted and Generally Licensed Items Containing By-Product Material", U. S. Nuclear Regulatory Commission Guide 6.6, dated June 1974.

17. DECON-1, State of California for Decontaminating Facilities and Equipment Prior to Release for Unrestricted Use, dated June 1977.

18. MIL-STD-414, Sampling Procedures and Tables for Inspection by Variables for Percent Defective, June 11, 1957.

19. NUREG-1575 (EPA 402-R-97-016), "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)", December 1997.

Appendix A

Input Parameters for RESRAD Calculations (Sheet 1 of 3)

Parameter	Value Used for Scenario			RESRAD Default
	Industrial	Wilderness	Residential	
Area of contaminated zone (m^2)	1.000E+04	1.000E+04	1.000E+04	1.000E+04
Thickness of contaminated zone (m)	1.000E+00	2.000E+00	1.000E+00	2.000E+00
Length parallel to aquifer flow (m)	1.000E+02	1.000E+02	1.000E+02	1.000E+02
Basic radiation dose limit (mrem/yr)	1.500E+01	1.500E+01	1.500E+01	3.000E+01
Time since placement of material (yr)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Times for calculations (yr)	1.000E+00	1.000E+00	1.000E+00	1.000E+00
Times for calculations (yr)	3.000E+00	3.000E+00	3.000E+00	3.000E+00
Times for calculations (yr)	1.000E+01	1.000E+01	1.000E+01	1.000E+01
Times for calculations (yr)	3.000E+01	3.000E+01	3.000E+01	3.000E+01
Times for calculations (yr)	1.000E+02	1.000E+02	1.000E+02	1.000E+02
Times for calculations (yr)	3.000E+02	3.000E+02	3.000E+02	3.000E+02
Times for calculations (yr)	1.000E+03	1.000E+03	1.000E+03	1.000E+03
Times for calculations (yr)	3.000E+03	0.000E+00	3.000E+03	0.000E+00
Times for calculations (yr)	1.000E+04	0.000E+00	1.000E+04	0.000E+00
Cover depth (m)	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Density of cover material (g/cm^3)	not used	not used	not used	1.500E+00
Cover depth erosion rate (m/yr)	not used	not used	not used	1.000E-03
Density of contaminated zone (g/cm^3)	1.500E+00	1.500E+00	1.500E+00	1.500E+00
Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	1.000E-03	1.000E-03
Contaminated zone total porosity	4.300E-01	4.300E-01	4.300E-01	4.000E-01
Contaminated zone effective porosity	2.000E-01	2.000E-01	2.000E-01	2.000E-01
Contaminated zone hydraulic conductivity (m/yr)	3.000E+03	3.000E+03	3.000E+03	1.000E+01
Contaminated zone b parameter	5.300E+00	5.300E+00	5.300E+00	5.300E+00
Humidity in air (g/cm^3)	8.000E+00	8.000E+00	8.000E+00	8.000E+00
Evapotranspiration coefficient	5.000E-01	5.000E-01	5.000E-01	5.000E-01
Precipitation (m/yr)	4.700E-01	4.700E-01	4.700E-01	1.000E+00
Irrigation (m/yr)	2.000E-01	2.000E-01	2.000E-01	2.000E-01
Irrigation mode	overhead	overhead	overhead	overhead
Runoff coefficient	2.000E-01	2.000E-01	2.000E-01	2.000E-01
Watershed area for nearby stream or pond (m^2)	1.000E+06	1.000E+06	1.000E+06	1.000E+06
Accuracy for water/soil computations	1.000E-03	1.000E-03	1.000E-03	1.000E-03
Density of saturated zone (g/cm^3)	1.500E+00	1.500E+00	1.500E+00	1.500E+00
Saturated zone total porosity	4.300E-01	4.300E-01	4.300E-01	4.000E-01
Saturated zone effective porosity	2.000E-01	2.000E-01	2.000E-01	2.000E-01
Saturated zone hydraulic conductivity (m/yr)	3.000E+03	3.000E+03	3.000E+03	1.000E+02
Saturated zone hydraulic gradient	2.000E-02	2.000E-02	2.000E-02	2.000E-02
Saturated zone b parameter	5.300E+00	5.300E+00	5.300E+00	5.300E+00
Water table drop rate (m/yr)	1.000E-03	1.000E-03	1.000E-03	1.000E-03
Well pump intake depth (m below water table)	1.000E+01	1.000E+01	1.000E+01	1.000E+01

Input Parameters for RESRAD Calculations (Sheet 2 of 3)

Parameter	Value Used for Scenario			RESRAD
	Industrial	Wilderness	Residential	Default
Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	ND	ND
Well pumping rate (m^3/yr)	not used	not used	7.000E+01	2.500E+02
Number of unsaturated zone strata	1	1	1	1
Unsat. zone 1, thickness (m)	4.000E+00	4.000E+00	4.000E+00	4.000E+00
Unsat. zone 1, soil density (g/cm^3)	1.500E+00	1.500E+00	1.500E+00	1.500E+00
Unsat. zone 1, total porosity	4.300E-01	4.300E-01	4.300E-01	4.000E-01
Unsat. zone 1, effective porosity	2.000E-01	2.000E-01	2.000E-01	2.000E-01
Unsat. zone 1, soil-specific b parameter	5.300E+00	5.300E+00	5.300E+00	5.300E+00
Unsat. zone 1, hydraulic conductivity (m/yr)	3.000E+03	3.000E+03	3.000E+03	1.000E+01
Inhalation rate (m^3/yr)	8.400E+03	8.400E+03	8.400E+03	8.400E+03
Mass loading for inhalation (g/m^3)	2.000E-04	2.000E-04	2.000E-04	2.000E-04
Dilution length for airborne dust, inhalation (m)	3.000E+00	3.000E+00	3.000E+00	3.000E+00
Exposure duration	3.000E+01	3.000E+01	3.000E+01	3.000E+01
Shielding factor, inhalation	4.000E-01	4.000E-01	4.000E-01	4.000E-01
Shielding factor, external gamma	2.500E-01	7.000E-01	5.100E-01	7.000E-01
Fraction of time spent indoors	2.000E-01	0.000E+00	5.000E-01	5.000E-01
Fraction of time spent outdoors (on site)	4.000E-02	1.000E-01	2.500E-01	2.500E-01
Shape factor flag, external gamma	1.000E+00	1.000E+00	1.000E+00	1.000E+00
Fruits, vegetables and grain consumption (kg/yr)	1.600E+00	1.600E+00	1.600E+01	1.600E+02
Leafy vegetable consumption (kg/yr)	0.000E+00	0.000E+00	1.400E+00	1.400E+01
Milk consumption (L/yr)	not used	not used	not used	9.200E+01
Meat and poultry consumption (kg/yr)	not used	not used	not used	6.300E+01
Fish consumption (kg/yr)	not used	not used	not used	5.400E+00
Other seafood consumption (kg/yr)	not used	not used	not used	9.000E-01
Soil ingestion rate (g/yr)	3.650E+01	3.650E+01	3.650E+01	3.650E+01
Drinking water intake (L/yr)	not used	not used	5.100E+02	5.100E+02
Contamination fraction of drinking water	not used	not used	1.000E+00	1.000E+00
Contamination fraction of household water	1.000E+00	0.000E+00	1.000E+00	1.000E+00
Contamination fraction of livestock water	not used	0.000E+00	not used	1.000E+00
Contamination fraction of irrigation water	1.000E+00	1.000E+00	1.000E+00	1.000E+00
Contamination fraction of aquatic food	not used	not used	not used	5.000E-01
Contamination fraction of plant food	-1	-1	-1	-1
Contamination fraction of meat	not used	not used	not used	-1
Contamination fraction of milk	not used	not used	not used	-1
Livestock fodder intake for meat (kg/day)	not used	not used	not used	6.800E+01
Livestock fodder intake for milk (kg/day)	not used	not used	not used	5.500E+01
Livestock water intake for meat (L/day)	not used	not used	not used	5.000E+01
Livestock water intake for milk (L/day)	not used	not used	not used	1.600E+02
Livestock soil intake (kg/day)	not used	not used	not used	5.000E-01
Mass loading for foliar deposition (g/m^3)	1.000E-04	1.000E-04	1.000E-04	1.000E-04
Depth of soil mixing layer (m)	1.500E-01	1.500E-01	1.500E-01	1.500E-01
Depth of roots (m)	9.000E-01	9.000E-01	9.000E-01	9.000E-01

Input Parameters for RESRAD Calculations (Sheet 3 of 3)

Parameter	Value Used for Scenario			RESRAD
	Industrial	Wilderness	Residential	Default
Drinking water fraction from ground water	1.000E+00	1.000E+00	1.000E+00	1.000E+00
Household water fraction from ground water	not used	not used	1.000E+00	1.000E+00
Livestock water fraction from ground water	1.000E+00	1.000E+00	1.000E+00	1.000E+00
Irrigation fraction from ground water	not used	not used	not used	1.000E+00
C-12 concentration in water (g/cm^3)	not used	not used	not used	2.000E-05
C-12 concentration in contaminated soil (g/g)	not used	not used	not used	3.000E-02
Fraction of vegetation carbon from soil	not used	not used	not used	2.000E-02
Fraction of vegetation carbon from air	not used	not used	not used	9.800E-01
C-14 evasion layer thickness in soil (m)	not used	not used	not used	3.000E-01
C-14 evasion flux rate from soil (1/sec)	not used	not used	not used	7.000E-07
C-12 evasion flux rate from soil (1/sec)	not used	not used	not used	1.000E-10
Fraction of grain in beef cattle feed	not used	not used	not used	8.000E-01
Fraction of grain in milk cow feed	not used	not used	not used	2.000E-01
Storage times of contaminated foodstuffs (days):				
Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	1.400E+01	1.400E+01
Leafy vegetables	1.000E+00	1.000E+00	1.000E+00	1.000E+00
Milk	not used	not used	not used	1.000E+00
Meat and poultry	not used	not used	not used	2.000E+01
Fish	not used	not used	not used	7.000E+00
Crustacea and mollusks	not used	not used	not used	7.000E+00
Well water	1.000E+00	1.000E+00	1.000E+00	1.000E+00
Surface water	1.000E+00	1.000E+00	1.000E+00	1.000E+00
Livestock fodder	not used	not used	not used	4.500E+01
Thickness of building foundation (m)	1.000E-01	not used	1.000E-01	1.500E-01
Bulk density of building foundation (g/cm)	2.400E+00	not used	2.400E+00	2.400E+00
Total porosity of the cover material	not used	not used	not used	4.000E-01
Total porosity of the building foundation	1.000E-01	not used	1.000E-01	1.000E-01
Volumetric water content of the cover material	not used	not used	not used	5.000E-02
Volumetric water content of the foundation	3.000E-02	not used	3.000E-02	3.000E-02
Diffusion coefficient for radon gas (m/sec):				
in cover material	not used	not used	not used	2.000E-06
in foundation material	3.000E-07	not used	3.000E-07	3.000E-07
in contaminated zone soil	2.000E-06	not used	2.000E-06	2.000E-06
Radon vertical dimension of mixing (m)	2.000E+00	not used	2.000E+00	2.000E+00
Average annual wind speed (m/sec)	2.000E+00	not used	2.000E+00	2.000E+00
Average building air exchange rate (1/hr)	5.000E-01	not used	5.000E-01	5.000E-01
Height of the building (room) (m)	2.500E+00	not used	2.500E+00	2.500E+00
Building interior area factor	0.000E+00	not used	0.000E+00	0.000E+00
Building depth below ground surface (m)	1.000E-01	not used	1.000E-01	-1.000E+00
Emanating power of Rn-222 gas	2.500E-01	not used	2.500E-01	2.500E-01
Emanating power of Rn-220 gas	not used	not used	not used	1.500E-01

Appendix B
Agency Approvals

1. Letter from Gerard Wong (DHS) to Majelle Lee (Rocketdyne), "Authorized Sitewide Radiological Guidelines for Release for Unrestricted Use", 96ETEC-DRF-0455, August 9, 1996.
2. Memorandum from Sally A. Robison (DOE-ER) to Roger Liddle (DOE-OAK), Sitewide Limits for Release of Facilities Without Radiological Restriction", 007857RC, September 17, 1996.

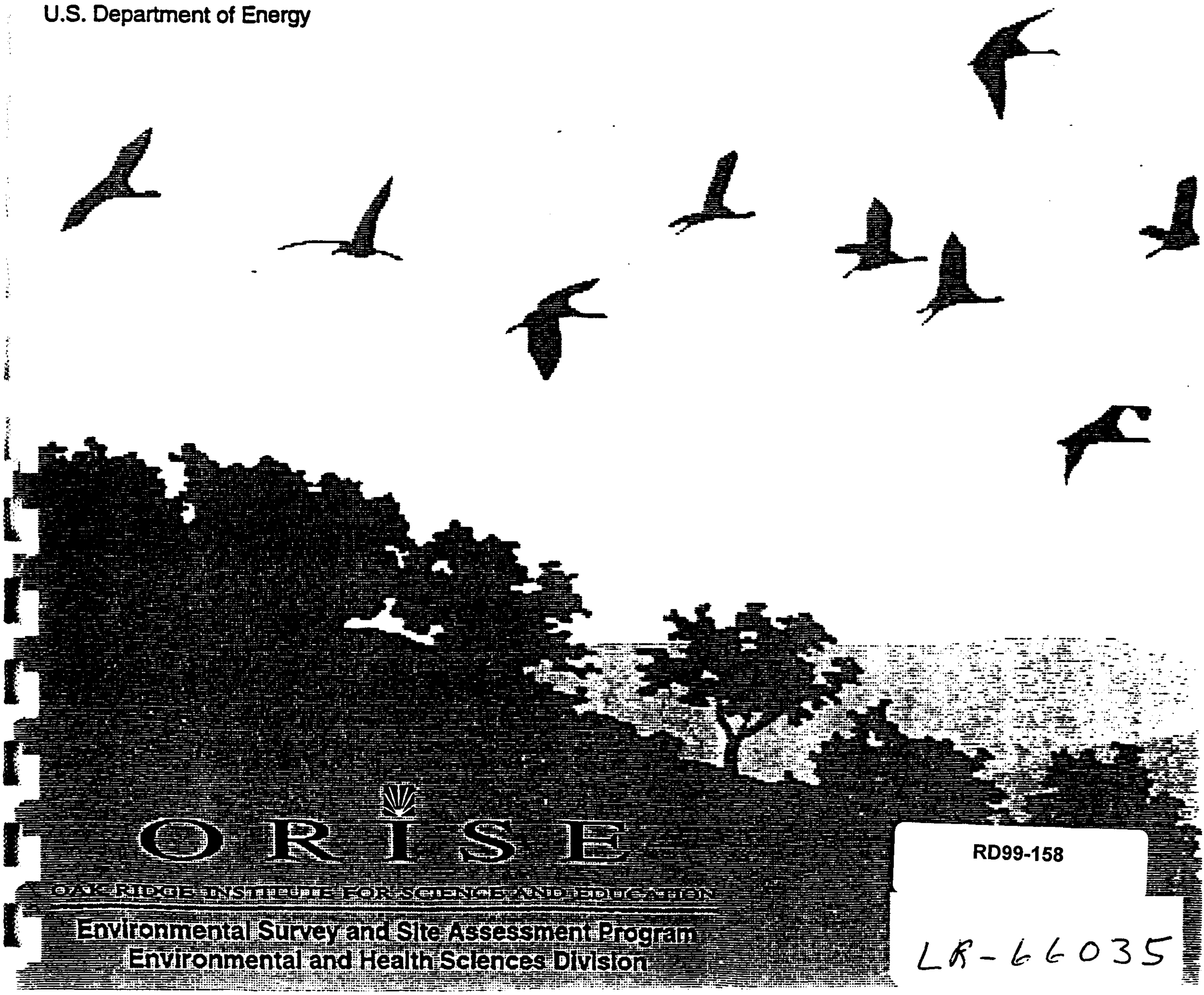
EXHIBIT III

INDEPENDENT VERIFICATION DOCUMENTATION OF THE RADIOLOGICAL CONDITION OF BUILDING T654 AT THE ENERGY TECHNOLOGY ENGINEERING CENTER AFTER DECONTAMINATION AND DECOMMISSIONING

VERIFICATION SURVEY OF THE INTERIM STORAGE FACILITY (T654) SANTA SUSANA FIELD LABORATORY ROCKWELL INTERNATIONAL VENTURA COUNTY, CALIFORNIA

T. J. VITKUS

Prepared for the
Office of Environmental Restoration
U.S. Department of Energy



RD99-158

LR-66035

ORISE 97-1900

VERIFICATION SURVEY OF THE INTERIM STORAGE FACILITY (T654) SANTA SUSANA FIELD LABORATORY ROCKWELL INTERNATIONAL VENTURA COUNTY, CALIFORNIA

Prepared by

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Prepared for the

Office of Environmental Restoration
U.S. Department of Energy

FINAL REPORT

NOVEMBER 1997

This report is based on work performed under contract number DE-AC05-76OR00033 with the U.S. Department of Energy.

VERIFICATION SURVEY
OF THE
INTERIM STORAGE FACILITY (T654)
SANTA SUSANA FIELD LABORATORY
ROCKWELL INTERNATIONAL
VENTURA COUNTY, CALIFORNIA

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ACKNOWLEDGMENTS

The author would like to acknowledge the significant contributions of the following staff members:

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ABBREVIATIONS AND ACRONYMS

μR/h	microroentgens per hour
AEC	Atomic Energy Commission
ASME	American Society of Mechanical Engineers
cm	centimeter
DOE	U.S. Department of Energy
EML	Environmental Measurements Laboratory
EPA	Environmental Protection Agency
ERDA	Energy Research and Development Administration
ESSAP	Environmental Survey and Site Assessment Program
ETEC	Energy Technology Engineering Center
GM	Geiger Mueller
ha	hectare
ISF	Interim Storage Facility
kg	kilograms
km	kilometer
M&O	Management and Operating
MDC	minimum detectable concentration
NaI	sodium iodide
NIST	National Institute of Standards and Technology
NRC	U.S. Nuclear Regulatory Commission
ORISE	Oak Ridge Institute for Science and Education
pCi/g	picocuries per gram
PIC	pressurized ionization chamber
SSFL	Santa Susana Field Laboratory
SNAP	Systems for Nuclear and Auxiliary Power
SRE	Sodium Reactor Experiment

VERIFICATION SURVEY
OF THE
INTERIM STORAGE FACILITY (T654)
SANTA SUSANA FIELD LABORATORY
ROCKWELL INTERNATIONAL
VENTURA COUNTY, CALIFORNIA

INTRODUCTION AND SITE HISTORY

Rockwell International's Rocketdyne Division, now known as Rocketdyne/Boeing, operates the Santa Susana Field Laboratory (SSFL). The Energy Technology Engineering Center (ETEC) is that portion of the SSFL, operated for the Department of Energy (DOE), where nuclear energy research and development programs were performed. Contract work for the Atomic Energy Commission (AEC) and the Energy Research and Development Administration (ERDA), predecessor agencies to the DOE, began in the early 1950's. Specific programs conducted for AEC/ERDA/DOE involved engineering, developing, testing, and manufacturing operations for nuclear reactor systems and components. Other SSFL activities have also been conducted for the National Aeronautics and Space Administration, the Department of Defense, and other government related or affiliated organizations and agencies. Some activities have been licensed by the Nuclear Regulatory Commission and by the State of California Radiological Health Branch of the Department of Health Services.

Numerous buildings and land areas became radiologically contaminated as a result of the various activities which included operation of ten reactors and seven criticality test facilities, fuel fabrication, reactor and fuel disassembly, laboratory work, and on-site storage of nuclear material. Potential radioactive contaminants identified at the site are uranium (in natural and enriched isotopic abundances), plutonium, Am-241, fission products (primarily Cs-137 and Sr-90), activation products (H-3, Co-60, Eu-152, Eu-154, Ni-63, Pm-147, and Ta-182). Chemical contaminants, mainly chlorinated organic solvents, have also been identified in groundwater, primarily as a result of rocket engine testing.

Decontamination and decommissioning of contaminated facilities began in the late 1960's and continues as the remaining DOE program operations at ETEC have been terminated effective September 30, 1995. As part of this program, Rocketdyne/Boeing performed decommissioning and final status surveys of a number of facilities that supported the various nuclear related ETEC operations during the latter part of the 1950's and continuing through the 1980's. Environmental management of DOE contaminated properties continues under the termination clause of the existing Management and Operating (M&O) contract. Surplus sodium facilities have been included in the current DOE Environmental Restoration and Waste Management Program for stabilization and eventual cleanup.

The Interim Storage Facility (ISF), also referred to as DOE Facility 654, was constructed in 1958 to support the Sodium Reactor Experiment (SRE). The ISF was used to store dummy and irradiated fuel elements, shipping and storage casks, hot waste generated at the SRE, and items from the Organic Moderated Reactor Experiment and Systems for Nuclear Auxiliary Power (SNAP). The ISF consisted of a concrete pad with a trench containing eight 51-centimeter diameter galvanized steel cells extending 7.6 meters into the rock strata. While the ISF was in use, a number of the items stored there deteriorated and released low-level contamination to adjacent asphalt and concrete surfaces and soil areas. Decommissioning of the ISF began in 1984 and involved removal of contaminated surfaces, soil, and the storage cells. A radiological survey was performed; the area was backfilled and then returned to a natural state (Rockwell 1985). Due to limited subsurface soil data, Rocketdyne/Boeing performed further subsurface soil sampling on September 30, 1997 in order to supplement the original final status survey.

DOE's Office of Environmental Restoration, Northwestern Area Programs is responsible for oversight of a number of remedial actions that have been or will be conducted at the SSFL. It is the policy of DOE to perform independent (third party) verification of remedial action activities conducted within Office of Environmental Restoration programs. The purpose of these independent verifications is to confirm that remedial actions have been effective in meeting established and supplemental guidelines and that the documentation accurately and adequately describes the radiological conditions at the site. The Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education (ORISE) was designated as the organization responsible for this task at SSFL and was requested by the DOE to perform verification surveys of the ISF. This report describes the results of the verification surveys.

SITE DESCRIPTION

The SSFL is located in the Simi Hills of southeastern Ventura County, California, approximately 47 kilometers (29 miles) northwest of downtown Los Angeles (Figure 1). The site is comprised of approximately 1,090 hectares (ha [2,700 acres]) and is divided into four administrative areas (Areas I through IV) and a Buffer Zone. DOE operations were conducted in Rockwell International-owned and DOE-owned facilities located within the 117 ha Area IV (Figure 2). The ETEC portion of Area IV consists of government-owned buildings that occupy 36 ha.

The ISF was located in the north-central portion of Area IV. The ISF was paved with a concrete berm containing the eight storage cells. The pavement, berms, and storage cells were removed during the decommissioning and the area was backfilled and graded. Total area of the ISF is approximately 1000 m^2. Figures 2 and 3 show the location and plot plan of the ISF.

OBJECTIVE

The objective of the verification surveys was to validate that cleanup procedures and survey methods used by Rocketdyne/Boeing were adequate. Perfomance of independent document reviews and evaluation of measurement and sampling data provide assurance that the post-remediation data were sufficient, accurate, and demonstrate that remedial actions were accomplished in accordance with appropriate standards and guidelines, and that authorized limits were met.

DOCUMENT REVIEW

ESSAP previously reviewed Rocketdyne/Boeing's supporting documentation concerning final status survey procedures and results for the ISF (Rockwell 1985). This documentation was judged to be inadequate under current practice to justify release of the facility for use without radiological restrictions. A supplemental survey plan was developed by Rocketdyne (Boeing 1997) for a cooperative soil sampling effort with ESSAP.

PROCEDURES

ESSAP personnel initially conducted independent measurement and sampling activities of the ISF during the period September 11 through 14, 1995, the results of which were initially provided in a 1996 report (ORISE 1996a). To address the lack of detailed analyses of subsurface soil, Rocketdyne/Boeing provided a drilling contractor to perform subsurface sampling at three locations within the ISF on September 30, 1997. At each borehole location, the contractor used mechanical augers to advance the borehole in 2.4-meter increments, at which point a split-spoon sampler was driven into the soil in order to obtain the sample for ESSAP. ESSAP's survey activities were performed in accordance with two site-specific survey plans (ORISE 1995a and 1997a), using procedures and instruments described in the ESSAP Survey Procedures and Quality Assurance Manuals which are summarized in Appendices A and B (ORISE 1995b and 1995c).

REFERENCE SYSTEM

Measurement and sampling locations were referenced to prominent site features during the initial survey and to Rocketdyne/Boeing's grid system during the subsurface investigations. Field data was recorded on representative area drawings.

SURFACE SCANS

Surface scans for gamma activity were performed over 100 percent of the ISF during the 1995 survey. The ISF was excavated to a depth of 7.5 to 9 meters when the storage cells were removed and then backfilled to grade. As a result of backfilling, the original soil was inaccessible except by drilling; therefore, scans of the ISF were concentrated in the peripheral areas where contamination may have migrated. Surface scans were performed using NaI scintillation detectors coupled to ratemeters with audible indicators.

Each subsurface sample core was scanned with a GM detector for beta-gamma activity. After the completion of each borehole and the removal of the auger, the borehole was gamma logged at one meter intervals using a NaI scintillation detector enclosed within a lead collimator that had four slots at the detector midpoint.

EXPOSURE RATE MEASUREMENTS

Exposure rate measurements were performed at four locations in the ISF area. Figure 3 shows the measurement locations. Exterior background exposure rate measurements were made at six locations within 0.5 to 10 km of the site (Figure 4). Exposure rate measurements were performed at one meter above the surface using a pressurized ionization chamber (PIC).

SOIL SAMPLING

Individual surface soil samples were collected from four locations in the ISF area. Four samples were collected from each of the three boreholes at depth intervals of 2.4 meters. Sampling locations are shown on Figure 3. Soil samples were collected from the six background exposure rate measurement locations (Figure 4).

SAMPLE ANALYSIS AND DATA INTERPRETATION

Samples and data were returned to ORISE's ESSAP laboratory in Oak Ridge, Tennessee for analysis and interpretation. Sample analysis was in accordance with the ORISE/ESSAP Laboratory Procedures Manuals (ORISE 1995d and 1997b). Soil samples were analyzed by solid-state gamma spectrometry. Spectra were reviewed for U-238, U-235, Th-232, Cs-137, Co-60 and any other identifiable photopeaks, particularly longer-lived activation and fission products. Four composite samples were analysed for Sr-90 by wet chemistry methods. The composite samples were prepared from equal aliquots of the samples collected from each borehole at the respective depth interval. Soil analytical results were reported in picocuries per gram (pCi/g). Exposure rates were reported in microroentgens per hour (μR/h).

FINDINGS AND RESULTS

DOCUMENT REVIEW

Based on the review of the initial 1985 project document, it was ESSAP's opinion that the documentation was inadequate to satisfactorily demonstrate that the ISF met the DOE guidelines for release for unrestricted use. Overall, the documentation did not provide a clear description of the sequence of events necessary for demonstrating compliance with the DOE guidelines. That is, the specification of contaminants present, selection of the appropriate guidelines, development of a sampling and analysis plan that provided adequate data for guideline interpretation, and presentation of the data in a manner that could be directly compared with the guidelines were not adequately identified. The types of deficiencies noted included the following: all potential contaminants were not identified, final surveys were not designed to identify residual contamination of all suspected radionuclides, radionuclide-specific sample analyses were not performed (i.e., gross beta analysis of soil samples was performed and the data used for demonstrating compliance), and appropriate guidelines were not always cited or unapproved site-specific guidelines were used. Comments on the documentation were provided to the DOE (ORISE 1996b). Rocketdyne/Boeing responded to these comments for the ISF by developing and implementing additional survey activities for the ISF that would address each of the deficiencies (Boeing 1997).

Surface Scans

Gamma surface scans and borehole logging did not identify any locations of elevated direct radiation indicative of residual contamination. Beta-gamma scans of the extracted sample cores also did not identify any elevated direct radiation.

Exposure Rates

Exposure rates are summarized in Table 1. Exposure rates for the ISF were 15 μR/h. Exterior background exposure rates ranged from 12 to 16 μR/h, and averaged 14 μR/h.

Radionuclide Concentrations in Soil

Radionuclide concentrations in soil samples are summarized in Table 2. Background concentration ranges for the naturally occurring radionuclides were less than 0.20 to 1.19 pCi/g for Ra-226, 0.56 to 1.72 pCi/g for Th-232, less than 0.13 pCi/g for U-235, and less than 2.15 to 2.54 pCi/g for U-238. Background concentrations of activation and fission products and Am-241 were all less than the respective minimum detectable concentration (MDC)—the maximum MDC was 1.09 pCi/g for Cr-51—with the exception of Cs-137 which ranged from less than 0.07 to 0.24 pCi/g. Radionuclide concentrations in the samples collected from the ISF ranged from less than 0.61 to 1.25 pCi/g for Ra-226, 0.67 to 1.94 pCi/g for Th-232, less than 0.84 pCi/g for U-235, and less than 2.35 pCi/g for U-238. All activation and fission products were less than the maximum MDC of 1.50 pCi/g for Cr-51. Only Cs-137 was detected above the MDC, as found with the background samples, with a concentration range of less than 0.22 to 0.43 pCi/g. The four borehole composite samples that were analyzed for Sr-90 were less than the MDCs, which ranged from 0.39 to 0.55 pCi/g. All MDCs were well below the associated authorized release limits.

COMPARISON OF RESULTS WITH GUIDELINES

The primary contaminants of concern for this site are uranium and mixed fission and activation products. The applicable site-specific guidelines are provided in Table 3 and have been approved by both the DOE (DOE 1996), in accordance with DOE Order 5400.5 which is summarized in Appendix C (DOE 1990), and the State of California (State of California 1996). All quantified radionuclide concentrations were less than the respective guideline.

The DOE's exposure rate guideline is 20 μR/h above background (DOE 1990), although Rocketdyne/Boeing has elected to use a more restrictive guideline of 5 μR/h above background. Exposure rates at one meter above the surface were within this guideline.

SUMMARY

The Environmental Survey and Site Assessment Program of the Oak Ridge Institute for Science and Education conducted verification activities for the ISF at the Santa Susana Field Laboratory in Ventura County, California. Verification activities included document reviews and during the period September 9 through 12, 1995 and September 30, 1997, ESSAP personnel visited the site and performed independent surface scans, surface activity measurements, exposure rate measurements, and soil sampling.

ESSAP's review identified a number of deficiencies in the ISF's final status documentation for the survey performed by Rocketdyne in 1984-1985. The deficiencies were addressed by Rocketdyne/Boeing through additional site investigations and by providing subsurface soil sampling for this verification survey. ESSAP's verification survey results for the area showed that exposure rates and radionuclide concentration levels in soil were comparable to background concentrations and correspondingly less than the guidelines for release for unrestricted use.

FIGURES

402–006 (2)

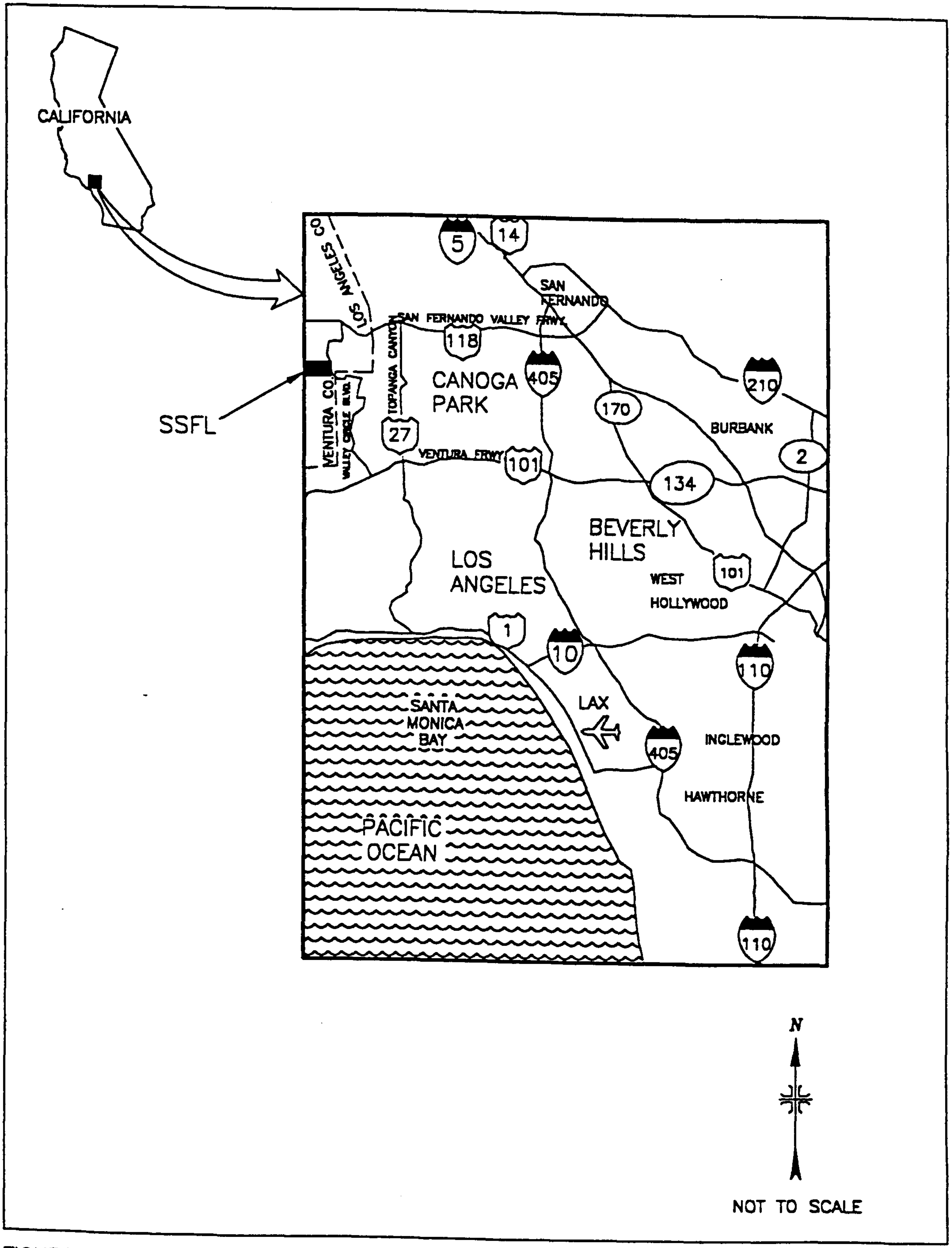

FIGURE 1: Los Angeles, California Area – Location of the Santa Susana Field Laboratory Site

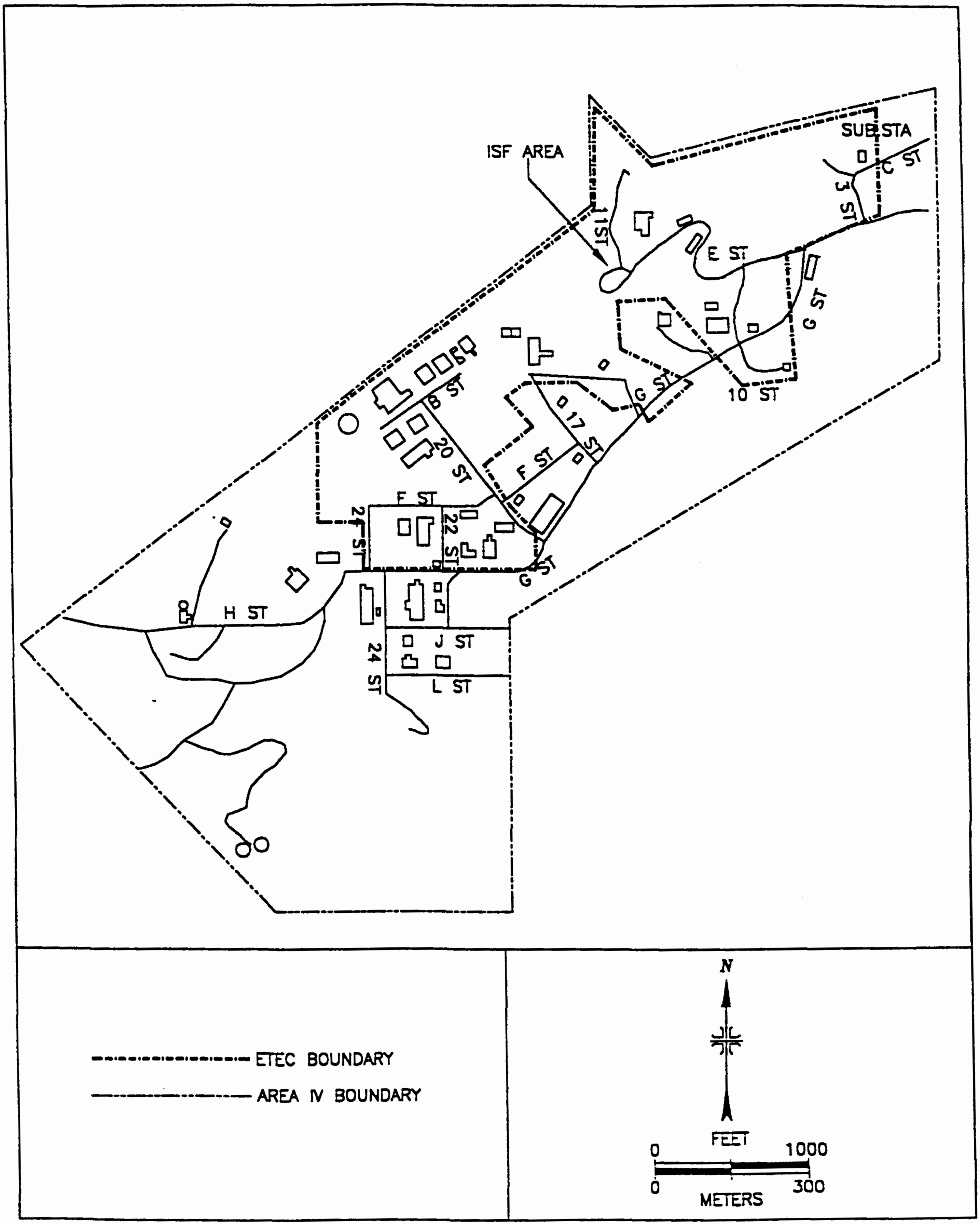

FIGURE 2: Santa Susana Field Laboratory Area IV, Plot Plan – Location of the Interim Storage Facility (T654)

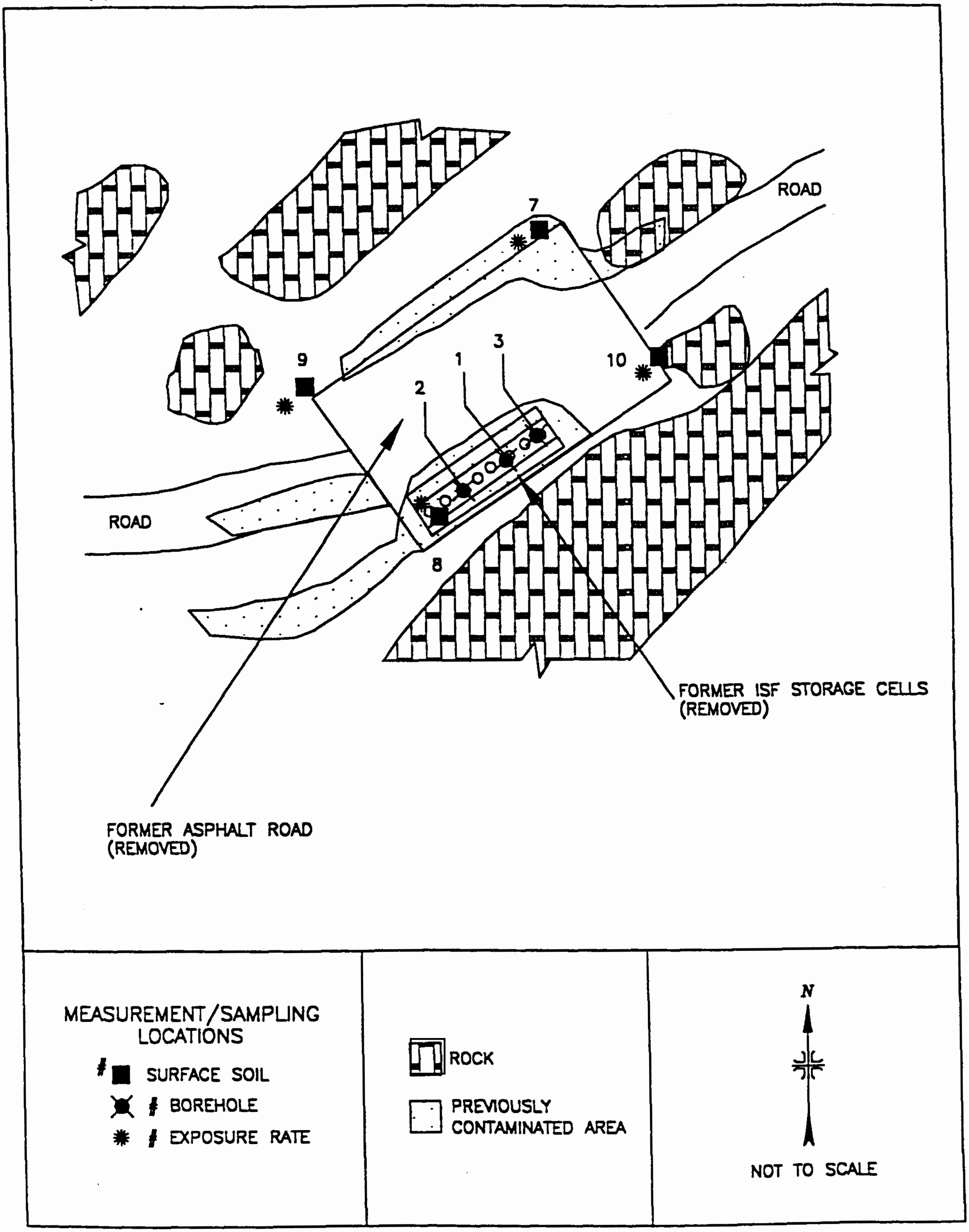

FIGURE 3: Interim Storage Facility – Plot Plan and Measurement and Sampling Locations

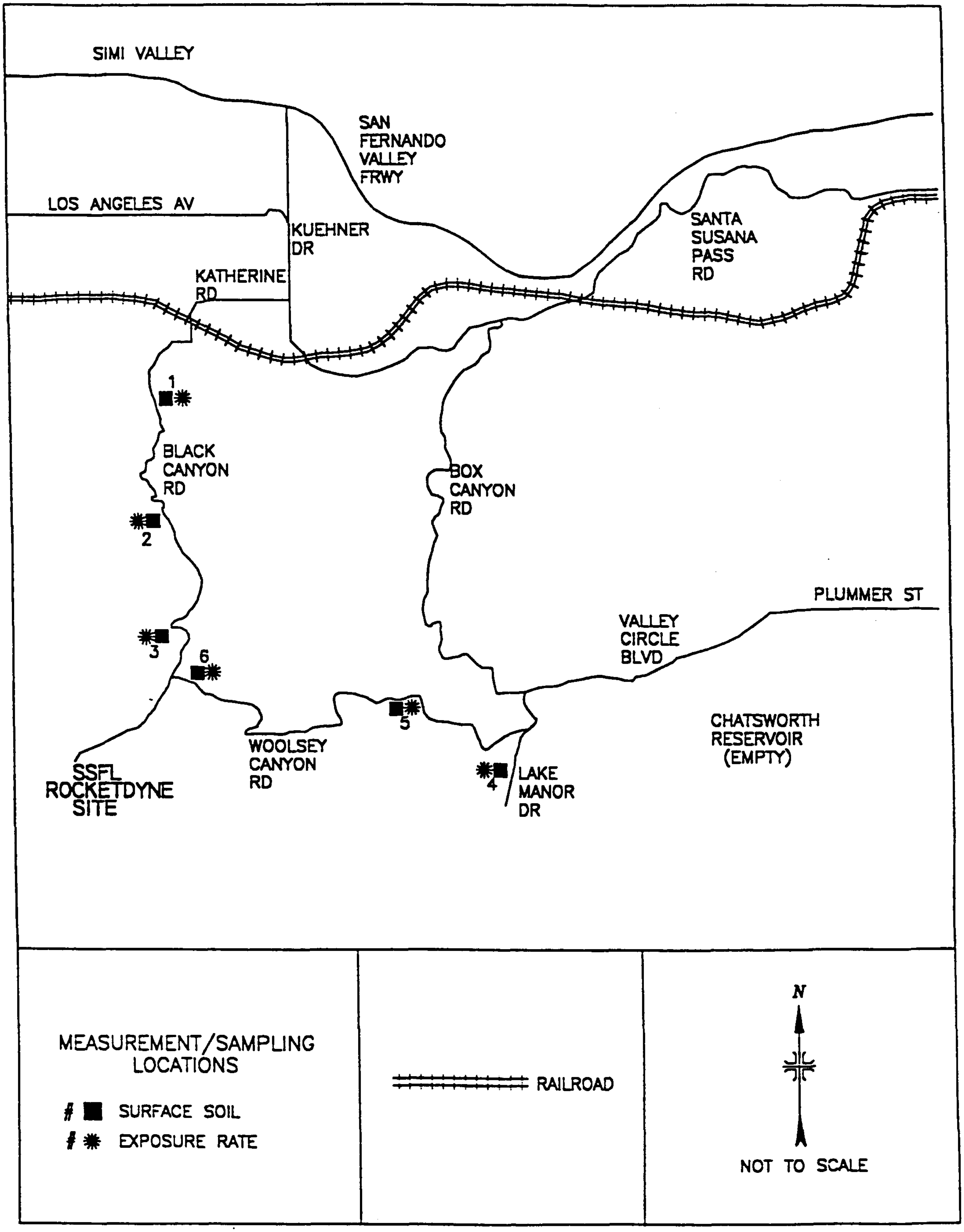

FIGURE 4: Santa Susana Field Laboratory, Ventura County, California – Background Measurement and Sampling Locations

TABLES

TABLE 1

BACKGROUND AND INTERIM STORAGE FACILITY EXPOSURE RATES SANTA SUSANA FIELD LABORATORY ROCKWELL INTERNATIONAL VENTURA COUNTY, CALIFORNIA

Location[a]	Exposure Rate at 1 m above Surface (μR/h)
Backgrounds	
#1 Gaston Road	13
#2 Black Canyon Road	16
#3 Black Canyon Road	14
#4 Valley Circle Road	15
#5 Woolsey Canyon Road	12
#6 Woolsey Canyon Road	14
Interim Storage Facility	
#7	15
#8	15
#9	15
#10	15

[a]Refer to Figures 3 and 4.

TABLE 2

RADIONUCLIDE CONCENTRATIONS IN SOIL
FORMER INTERIM STORAGE FACILITY (T654)
SANTA SUSANA FIELD LABORATORY
ROCKWELL INTERNATIONAL
VENTURA COUNTY, CALIFORNIA

Location[a]	Radionuclide Concentration (pCi/g)														
	Am-241	Co-57	Co-58	Co-60	Cr-51	Cs-137	Eu-152	Fe-59	Mn-54	Ra-226	Sb-124	Th-232	U-235	U-238	Zn-65
Borehole #1															
2.4m	<0.13	<0.04	<0.07	<0.09	<0.54	0.11 ± 0.09	<0.17	<0.15	<0.07	0.80 ± 0.18	<0.08	1.37 ± 0.39	<0.35	<1.44	<0.23
4.9m	<0.12	<0.04	<0.06	<0.09	<0.42	<0.08	<0.14	<0.14	<0.06	0.58 ± 0.13	<0.06	1.13 ± 0.31	<0.28	1.92 ± 1.20	<0.16
7.3m	<0.11	<0.03	<0.05	<0.09	<0.40	<0.05	<0.12	<0.14	<0.06	0.65 ± 0.13	<0.05	1.31 ± 0.30	<0.28	<1.17	<0.14
9.8m	<0.22	<0.06	<0.11	<0.15	<0.94	<0.11	<0.25	<0.32	<0.12	0.73 ± 0.22	<0.04	1.15 ± 0.43	<0.62	1.13 ± 1.49	<0.29
Borehole #2															
2.4m	<0.10	<0.04	<0.08	<0.12	<0.59	<0.08	<0.19	<0.21	<0.08	0.51 ± 0.15	<0.10	0.67 ± 0.39	<0.30	1.40 ± 1.05	<0.21
4.9m	<0.10	<0.04	<0.08	<0.12	<0.59	<0.08	<0.19	<0.21	<0.08	0.51 ± 0.15	<0.06	0.79 ± 0.37	<0.33	0.67 ± 0.78	<0.20
7.3m	<0.12	<0.04	<0.09	<0.12	<0.64	<0.10	<0.20	<0.20	<0.09	0.52 ± 0.15	<0.07	1.25 ± 0.36	<0.37	1.95 ± 1.07	<0.17
9.8m	<0.21	<0.06	<0.10	<0.13	<0.73	<0.08	<0.26	<0.25	<0.11	0.59 ± 0.18	<0.08	1.15 ± 0.41	<0.52	<2.35	<0.23
Borehole #3															
2.4m	<0.11	<0.03	<0.06	<0.09	<0.45	<0.06	<0.15	<0.14	<0.06	0.64 ± 0.14	<0.09	1.39 ± 0.35	<0.29	1.23 ± 1.39	<0.16
4.9m	<0.11	<0.04	<0.07	<0.09	<0.48	0.24 ± 0.10	<0.17	<0.15	<0.06	0.75 ± 0.17	<0.05	1.18 ± 0.37	<0.33	0.89 ± 0.95	<0.15
7.3m	<0.13	<0.04	<0.05	<0.10	<0.42	0.36 ± 0.06	<0.14	<0.12	<0.06	0.86 ± 0.14	<0.05	1.23 ± 0.30	<0.28	<1.21	<0.16
9.8m	<0.27	<0.09	<0.20	<0.22	<1.50	<0.22	<0.48	<0.50	<0.23	<0.61	<0.04	1.94 ± 0.78	<0.84	0.60 ± 1.61	<0.42

TABLE 2 (Continued)

RADIONUCLIDE CONCENTRATIONS IN SOIL
FORMER INTERIM STORAGE FACILITY (T654)
SANTA SUSANA FIELD LABORATORY
ROCKWELL INTERNATIONAL
VENTURA COUNTY, CALIFORNIA

Location[a]	Radionuclide Concentration (pCi/g)														
	Am-241	Co-57	Co-58	Co-60	Cr-51	Cs-137	Eu-152	Fe-59	Mn-54	Ra-226	Sb-124	Th-232	U-235	U-238	Zn-65
ISF Perimeter															
#7	<0.15	<0.04	<0.06	<0.11	<0.89	0.15 ± 0.10	<0.18	<0.19	<0.07	0.95 ± 0.16	<0.07	1.56 ± 0.31	<0.10	<1.48	<0.18
#8	<0.19	<0.06	<0.10	<0.13	<1.04	0.08 ± 0.10	<0.24	<0.27	<0.12	0.71 ± 0.20	<0.10	1.74 ± 0.39	<0.12	<2.04	<0.21
#9	<0.15	<0.05	<0.08	<0.09	<0.80	<0.08	<0.18	<0.22	<0.08	1.25 ± 0.18	<0.06	1.55 ± 0.35	<0.10	1.05 ± 1.50	<0.21
#10	<0.20	<0.06	<0.10	<0.14	<1.13	0.43 ± 0.08	<0.24	<0.25	<0.08	0.76 ± 0.19	<0.10	1.69 ± 0.36	<0.13	1.18 ± 1.28	<0.18
Backgrounds															
#1 Gaston Rd	<0.16	<0.05	<0.10	<0.10	<0.96	<0.07	<0.17	<0.21	<0.10	1.19 ± 0.21	<0.09	1.56 ± 0.37	<0.11	2.54 ± 1.59	<0.23
#2 Black Canyon Rd	<0.17	<0.06	<0.15	<0.15	<1.03	0.15 ± 0.10	<0.27	<0.24	<0.12	1.02 ± 0.22	<0.08	1.72 ± 0.32	<0.13	1.37 ± 1.49	<0.25
#3 Black Canyon Rd	<0.13	<0.04	<0.08	<0.11	<0.69	0.24 ± 0.10	<0.18	<0.28	<0.08	1.02 ± 0.16	<0.07	1.31 ± 0.30	<0.09	1.61 ± 1.15	<0.17
#4 Valley Circle Rd	<0.20	<0.06	<0.09	<0.13	<1.09	0.15 ± 0.06	<0.22	<0.27	<0.11	1.02 ± 0.22	<0.11	1.15 ± 0.40	<0.13	<2.15	<0.31
#5 Woolsey Canyon Rd	<0.13	<0.05	<0.09	<0.08	<0.71	<0.06	<0.15	<0.19	<0.07	0.88 ± 0.18	<0.05	1.24 ± 0.33	<0.09	2.08 ± 1.24	<0.19
#6 Woolsey Canyon Rd	<0.10	<0.03	<0.07	<0.07	<0.58	<0.06	<0.12	<0.15	<0.06	<0.20	<0.04	0.56 ± 0.29	<0.06	<1.02	<0.16

[a]Refer to Figures 3 and 4.
[b]Uncertainties represent the 95% confidence level, based only on counting statistics.

TABLE 3

SITE-WIDE LIMITS FOR SOIL AND WATER (REFERENCE N001SRR140127)[a] SANTA SUSANA FIELD LABORATORY ROCKWELL INTERNATIONAL VENTURA COUNTY, CALIFORNIA

Radionuclide	Soil Guidelines (pCi/g)	Water (pCi/l)
Am-241	5.44	1.5
Co-60	1.94	200
Cs-134	3.33	75
Cs-137	9.20	110
Eu-152	4.51	840
Eu-154	4.11	570
Fe-55	629,000	9,000
H-3	31,900	20,000[b]
K-40	27.6	290
Mn-54	6.11	2,000
Na-22	2.31	480
Ni-59	151,000	26,000
Ni-63	55,300	9,500
Pu-238	37.2	1.7
Pu-239	33.9	1.6
Pu-240	33.9	1.6
Pu-241	230	80
Pu-242	35.5	1.6
Ra-226	5[d] and 15[d]	4.1
Sr-90	36.0	8[b]
Th-228	5[d] and 15[d]	6.8

TABLE 3 (Continued)

SITE-WIDE LIMITS FOR SOIL AND WATER
(REFERENCE N001SRR140127)
SANTA SUSANA FIELD LABORATORY
ROCKWELL INTERNATIONAL
VENTURA COUNTY, CALIFORNIA

Radionuclide	Soil Guidelines (pCi/g)	Water (pCi/l)
Th-232	5[d] and 15[d]	2.0
U-234	30[c]	
U-235	30[c]	total uranium 20[b]
U-238	35[c]	
Gross alpha (not including radon and uranium	---	15[b]
Gross beta	---	50[b]

[a]Reference taken from Rocketdyne/Boeing 96ETEC-DRF-0374, Enclosure A, June 28, 1996
[b]State of California Maximum Contaminant Levels, CCR Title 22
[c]Generally more conservative NRC limits for uranium isotopes are proposed.
[d]DOE Order 5400.5 limits are proposed (5 pCi/g averaged over first 15 cm of soil depth and 15 pCi/g averaged over 15 cm layers below the top 15 cm).

REFERENCES

Energy Technology Engineering Center, Boeing North America, Inc. (Boeing). Building T654 Supplemental Final Radiological Survey Plan SSWA-0009. Canoga Park, CA; April 9, 1997.

Oak Ridge Institute for Science and Education (ORISE). Verification Survey Plan for the Interim Storage Facility; Buildings T030, T024, T019, T013; An Area Northwest of Buildings T019, T013, T012, and T059; and a Storage Yard West of Buildings T626 and T038; Santa Susana Field Laboratory, Rockwell International, Ventura County, California. Oak Ridge, TN; September 6, 1995a.

Oak Ridge Institute for Science and Education (ORISE). Survey Procedures Manual for the Energy/Environment Systems Division, Environmental Survey and Site Assessment Program, Revision 9. Oak Ridge, Tennessee; April 30, 1995b.

Oak Ridge Institute for Science and Education. Quality Assurance Manual for the Energy/Environment Systems Division, Environmental Survey and Site Assessment Program, Revision 9 and 10. Oak Ridge, Tennessee; January 31, 1995c and April 30, 1995c.

Oak Ridge Institute for Science and Education. Verification Survey of the Interim Storage Facility; Buildings T030, T641, and T013; An Area Northwest of Buildings T019, T013, T012, and T059; and a Storage yard West of Buildings T626 and T038, Santa Susana Field Laboratory, Rockwell International, Ventura County, California. Oak Ridge, TN; February 1996a.

Oak Ridge Institute for Science and Education. Comments on the Final Status Survey Documentation for the Interim Storage Facility; Building T013, T019, T024, T030, and T641; the Storage Yard West of Building T626 and T038; and the NW Area; Santa Susana Field Laboratory, Ventura County, California. Oak Ridge, TN; January 11, 1996b.

Oak Ridge Institute for Science and Education. Verification Survey Plan for Land Areas Formerly Supporting the Hot Laboratory (T020) and Interim Storage Facility (T654), Santa Susana Field Laboratory, Boeing North America, Inc., Ventura County, California. Oak Ridge, TN; September 25, 1997a.

Oak Ridge Institute for Science and Education. Laboratory Procedures Manual for the Energy/Environment Systems Division, Environmental Survey and Site Assessment Program, Revision 9. Oak Ridge, Tennessee: January 31, 1995d and April 30, 1997b.

Rockwell International. Interim Storage Facility Decommissioning Final Report. Ventura County, CA; March 15, 1985.

State of California, Department of Health Services. Authorized Sitewide Radiological Guidelines for Release of Unrestricted Use. August 9, 1996.

REFERENCES (Continued)

U.S. Department of Energy (DOE). Radiation Protection of the Public and the Environment. Washington, DC: Doe Order 5400.5; February 1990.

U.S. Department of Energy. Memorandum from S. Robinson to R. Liddle, "Sitewide Limits for Release of Facilities Without Radiological Restrictions", September 17, 1996.

APPENDIX A

MAJOR INSTRUMENTATION

APPENDIX A

MAJOR INSTRUMENTATION

The display of a specific product is not to be construed as an endorsement of the product or its manufacturer by the author or his employer.

DIRECT RADIATION MEASUREMENT

Instruments

Eberline Pulse Ratemeter
Model PRM-6
(Eberline, Santa Fe, NM)

Ludlum Ratemeter-Scaler
Model 2200
(Ludlum Measurements, Inc.,
Sweetwater, TX)

Ludlum Ratemeter-Scaler
Model 2221
(Ludlum Measurements, Inc.,
Sweetwater, TX)

Detectors

Eberline GM Detector
Model HP-210
Effective Area, 20 cm^2
(Eberline, Santa Fe, NM)

Reuter-Stokes Pressurized Ionization Chamber
Model RSS-112
(Reuter-Stokes, Cleveland, OH)

Victoreen NaI Scintillation Detector
Model 489-55
3.2 cm x 3.8 cm Crystal
(Victoreen, Cleveland, OH)

LABORATORY ANALYTICAL INSTRUMENTATION

High Purity Extended Range Intrinsic Detectors
Model No: ERVDS30-25195
(Tennelec, Oak Ridge, TN)
Used in conjunction with:
Lead Shield Model G-11
(Nuclear Lead, Oak Ridge, TN) and
Multichannel Analyzer
3100 Vax Workstation
(Canberra, Meriden, CT)

High-Purity Germanium Detector
Model GMX-23195-S, 23% Eff.
(EG&G ORTEC, Oak Ridge, TN)
Used in conjunction with:
Lead Shield Model G-16
(Gamma Products, Palos Hills, IL) and
Multichannel Analyzer
3100 Vax Workstation
(Canberra, Meriden, CT)

Low Background Gas Proportional Counter
Model LB-5100-W
(Oxford, Oak Ridge, TN)

APPENDIX B

SURVEY AND ANALYTICAL PROCEDURES

APPENDIX B

SURVEY AND ANALYTICAL PROCEDURES

SURVEY PROCEDURES

Surface Scans

Surface scans were performed by passing the detectors slowly over the surface; the distance between the detector and the surface was maintained at a minimum—nominally about 1 cm. Identification of elevated levels was based on increases in the audible signal from the recording and/or indicating instrument. Combinations of detectors and instruments used for the scans were:

Gamma	-	NaI scintillation detector with ratemeter
Beta	-	GM detector with ratemeter-scaler

Exposure Rate Measurements

Measurements of gamma exposure rates were performed using a pressurized ionization chamber (PIC). The instrument was adjusted to one meter above the surface and allowed to stabilize. The measurement was read directly in μR/h.

Soil Sampling

Approximately 1 kg of soil was collected at each sample location. Collected samples were placed in a plastic bag, sealed, and labeled in accordance with ESSAP survey procedures.

ANALYTICAL PROCEDURES

Gamma Spectrometry

Soil samples were dried, mixed, crushed, and/or homogenized as necessary, and a portion sealed in 0.5-liter Marinelli beaker or other appropriate container. The quantity placed in the beaker was chosen to reproduce the calibrated counting geometry. Net material weights were determined and the samples counted using intrinsic germanium detectors coupled to a pulse height analyzer system. Background and Compton stripping, peak search, peak identification, and concentration calculations were performed using the computer capabilities inherent in the analyzer system. All photopeaks associated with the radionuclides of concern were reviewed for consistency of activity. Energy peaks used for determining the activities of radionuclides of concern were:

Co-57	0.122 MeV
Co-58	0.811 MeV
Co-60	1.173 MeV
Cr-51	0.320 MeV
Cs-137	0.662 MeV
Eu-152	0.344 MeV
Eu-154*	0.723 MeV
Fe-59	1.099 MeV
Mn-54	0.835 MeV
Ra-226	0.351 MeV from Pb-214**
Sb-124	0.603 MeV
Th-228*	0.239 MeV from Pb-212**
Th-232	0.911 MeV from Ac-228**
U-235	0.143 MeV (or 0.186 MeV)
U-238	0.063 MeV from Th-234** (or 1.001 MeV from Pa-234 m)*
Zn-65	1.115 MeV

*Spectra reviewed for these radionuclides; however, unless anomalous concentrations identified, they were not included in the data table.

**Secular equilibrium assumed.

Spectra were also reviewed for other identifiable photopeaks.

Strontium-90

Soil samples were dried, mixed, crushed and then aliquots of the soil were dissolved using a potassium fluoride and pyrosulfate fusion. Strontium was dissolved in dilute hydrochloric acid and precipitated as lead sulfate. Lead and calcium were removed in EDTA. Barium was removed as barium chromate. Strontium carbonate was collected on a filter and counted using a low-background Tennelec gas proportional counter. Count rates were corrected for yttrium-90 ingrowth. Chemical yield was determined gravimetrically.

Uncertainties and Detection Limits

The uncertainties associated with the analytical data presented in the tables of this report represent the 95% confidence level for that data. These uncertainties were calculated based on both the gross sample count levels and the associated background count levels. Additional uncertainties, associated with sampling and measurement procedures, have not been propagated into the data presented in this report.

Detection limits, referred to as minimum detectable concentration (MDC), were based on 2.71 plus 4.65 times the standard deviation of the background count [$2.71 + 4.65\sqrt{BKG}$]. When the activity was determined to be less than the MDC of the measurement procedure, the result was reported as less than MDC. Because of variations in background levels, measurement efficiencies, and contributions from other radionuclides in samples, the detection limits differ from sample to sample and instrument to instrument.

CALIBRATION AND QUALITY ASSURANCE

Calibration of all field and laboratory instrumentation was based on standards/sources, traceable to NIST, when such standard/sources were available. In cases where they were not available, standards of an industry recognized organization were used. Calibration of pressurized ionization chambers was performed by the manufacturer.

Analytical and field survey activities were conducted in accordance with procedures from the following documents of the Environmental Survey and Site Assessment Program:

- Survey Procedures Manual, Revision 9 (April 1995)
- Laboratory Procedures Manual, Revisions 9 and 10 (January 1995 and April 1997)
- Quality Assurance Manual, Revision 7 (January 1995)

The procedures contained in these manuals were developed to meet the requirements of DOE Order 5700.6C and American Society of Mechanical Engineers (ASME) NQA-1 for Quality Assurance and contain measures to assess processes during their performance.

Quality control procedures include:

- Daily instrument background and check-source measurements to confirm that equipment operation is within acceptable statistical fluctuations.
- Participation in EPA and EML laboratory Quality Assurance Programs.
- Training and certification of all individuals performing procedures.
- Periodic internal and external audits.

APPENDIX C

RESIDUAL RADIOACTIVE MATERIAL GUIDELINES SUMMARIZED FROM DOE ORDER 5400.5

APPENDIX C

RESIDUAL RADIOACTIVE MATERIAL GUIDELINES SUMMARIZED FROM DOE ORDER 5400.5

BASIC DOSE LIMITS

The basic limit for the annual radiation dose (excluding radon) received by an individual member of the general public is 100 mrem/yr. In implementing this limit, DOE applies as low as reasonably achievable principles to set site-specific guidelines.

STRUCTURE GUIDELINES

<u>Indoor/Outdoor Structure Surface Contamination</u>

	Allowable Total Residual Surface Contamination ($dpm/100\ cm^2$)[b]		
Radionuclides[a]	**Average**[c,d]	**Maximum**[d,e]	**Removable**[f]
Transuranics, Ra-226, Ra-228, Th-230 Th-228, Pa-231, Ac-227, I-125, I-129 [g]	100	300	20
Th-Natural, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1,000	3,000	200
U-Natural, U-235, U-238, and associated decay products	5,000α	15,000α	1,000α
Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above [h]	5,000β-γ	15,000β-γ	1,000β-γ

External Gamma Radiation

The average level of gamma radiation inside a building or habitable structure on a site that has no radiological restriction on its use shall not exceed the background level by more than 20 μR/h and will comply with the basic dose limits when an appropriate-use scenario is considered.

SOIL GUIDELINES

Radionuclides	Soil Concentration (pCi/g) Above Background[i,j,k]
Uranium and mixed fission and activation products	Soil guidelines are calculated on a site-specific basis, using the DOE manual developed for this use.

[a] Where surface contamination by both alpha- and beta-gamma-emitting radionuclides exists, the limits established for alpha- and beta-gamma-emitting radionuclides should apply independently.

[b] As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute measured by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

[c] Measurements of average contamination should not be averaged over an area of more than 1 m^2. For objects of less surface area, the average should be derived for each such object.

[d] The average and maximum dose rates associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/h and 1.0 mrad/h, respectively, at a depth of 1 cm.

[e] The maximum contamination level applies to an area of not more than 100 cm^2.

[f] The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping an area of that size with dry filter or soft absorbent paper, applying moderate pressure, and measuring the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of surface area less than 100 cm^2 is determined, the activity per unit area should be based on the actual area and the entire surface should be wiped. It is not necessary to use wiping techniques to measure removable contamination levels, if direct scan surveys indicate that total residual surface contamination levels are within the limits for removable contamination.

[g] Guidelines for these radionuclides are not given in DOE Order 5400.5; however, these guidelines are considered applicable until guidance is provided.

[h] This category of radionuclides includes mixed fission products, including the Sr-90 which is present in them. It does not apply to Sr-90, which has been separated from the other fission products, or mixtures where the Sr-90 has been enriched.

[i] These guidelines take into account ingrowth of radium-226 from thorium-230 or thorium-232 and radium-228 and assume secular equilibrium. If either Th-230 and Ra-226 or Th-232 and Ra-228 are both present, not in secular equilibrium, the guidelines apply to the higher concentration. If other mixtures of radionuclides occur, the concentrations of individual radionuclides shall be reduced so that (1) the dose for the mixtures will not exceed the basic dose limit, or (2) the sum of ratios of the soil concentration of each radionuclide to the allowable limit for that radionuclide will not exceed 1 ("unity").

[j] These guidelines represent allowable residual concentrations above background averaged across any 15-cm-thick layer to any depth and over any contiguous 100 m^2 surface area.

[k] If the average concentration in any surface or below-surface area, less than or equal to 25 m^2, exceeds the authorized limit of guideline by a factor of $(100/A)^{½}$, where A is the area of the elevated region in square meters, limits for "hot spots" shall also be applicable. Procedures for calculating these hot spot limits, which depend on the extent of the elevated local concentrations, are given in the DOE Manual for Implementing Residual Radioactive Materials Guidelines, DOE/CH/8901. In addition, every reasonable effort shall be made to remove any source of radionuclide that exceeds 30 times the appropriate limit for soil, irrespective of the average concentration in the soil.

REFERENCES

"U.S. Department of Energy Guidelines for Residual Radioactive Material at Formerly Utilized Sites Remedial Action Program and Remote Surplus Facilities Management Program Sites," Revision 2, March 1987.

"DOE Order 5400.5, Radiation Protection of the Public and the Environment," February 1990.

EXHIBIT IV

BUILDING T654 FACILITY FINAL REPORT

BOEING

Engineering Product Document

GO Number	S/A Number	Page 1 of	Total Pages	Rev. Ltr/Chg. No. See Summary of Chg.	Number
97055	37154		24	N/C	EID-04364

Program Title CLOSURE OF ETEC (R21-RF)

Document Title FINAL REPORT DECONTAMINATION & DECOMMISSIONING OF INTERIM STORAGE FACILITY 4654

Document Type	Related Documents
D&D Report	

Original Issue Date | Release Date

Prepared By/Date	Dept.	Mail/Addr
Satish N. Shah / May 20, 1999	117	T038

IR&D Program? Yes ☐ No ☒
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R. D. Meyer	RDMeyer	5-25-99
P. H. Horton	PH Horton	5/25/99
S. E. Reeder	Norm Reeder	5-25-99
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Abstract

This document updates the information in ESG-DOE-13507, "Interim Storage Facility Decommissioning Final Report" (1985).

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Rocketdyne Form 651-F REV. 2-97

CONTENTS

FIGURES

1.0 INTRODUCTION

Boeing North American's Rocketdyne Propulsion & Power Division operates the Santa Susana Field Laboratory (SSFL). The Energy Technology Engineering Center (ETEC) was a portion of Rocketdyne which, along with the sister organization, Atomics International (Division of the Energy Systems Group), performed testing of equipment, materials, and components for nuclear and energy related programs at portions of the SSFL on behalf of the Department of Energy (DOE). Contract work for the Atomic Energy Commission (AEC) and the Energy Research and Development Administration (ERDA), predecessor agencies to the DOE, began in the early 1950's. Specific programs conducted for AEC/ERDA/DOE involved the engineering, development, testing, and manufacturing operations of nuclear reactor systems and components. Other SSFL activities have also been conducted for the National Aeronautics and Space Administration, the Department of Defense, and other government related or affiliated organizations and agencies. Some activities were under license by the Nuclear Regulatory Commission (NRC) and the State of California Radiological Health Branch of the Department of Health Services.

Some buildings and land areas became radiologically contaminated as a result of the various operations which included ten reactors, seven criticality test facilities, fuel fabrication, reactor and fuel disassembly, laboratory work, and on-site storage of nuclear material. Potential radioactive contaminants identified at the SSFL are uranium (in normal, depleted, and enriched form), plutonium, Am-241, fission products (primarily Cs-137 and Sr-90), and activation products (tritium [H-3], Co-60, Eu-152, Eu-154, Ni-63, Pm-147, and Ta-182).

Decontamination and decommissioning (D&D) of contaminated facilities began in the late 1960's and continue as the remaining DOE nuclear program operations have been terminated. As part of this D&D program, Rocketdyne performed decommissioning and final status surveys of a number of facilities that supported the various nuclear-related operations. The Interim Storage Facility (4654) is one of the facilities that was previously decontaminated and decommissioned under DOE's Surplus Facilities Management Program (SFMP). Environmental management of DOE contaminated properties continues under the new contract (DE-AC03-99SF21530) entered into between DOE and Boeing North American on 1 January 1999 to complete remediation of all liabilities associated with former DOE activities at the site.

The Decommissioning work of 4654 was documented in ESG- DOE- 13507 "Interim Storage Facility Decommissioning Final Report" in 1985 (Ref. 1). This report updates the information provided in the Decommissioning Final Report.

2.0 BACKGROUND

2.1 LOCATION

The Interim Storage Facility (ISF) 4654 was located within the Boeing North American's (formerly Rockwell International's) Rocketdyne Propulsion & Power's Santa Susana Field Laboratory (SSFL) in the Simi Hills and approximately 29 miles northwest of downtown Los Angeles, directly south of the city of Simi Valley. Location of the SSFL relative to Los Angeles and vicinities is shown in Figure 2-1. An enlarged map of neighboring SSFL communities is shown in Figure 2-2. Figure 2-3 is a plot plan of the western portion of SSFL known as Area IV, where 4654 was located. A drawing (plan view) of 4654 and its adjoining areas is shown in Figure 2-4.

2.2 FACILITY CHARACTERISTICS

The Interim Storage Facility (4654) (Figure 2-5) included eight 20-inch diameter galvanized steel tubes, extending 25 feet into 32-inch diameter bore holes drilled into rock strata. The top portions of the storage tubes were encased in a common concrete trench and berm structure, and the bottom ends were seal-welded closed. See Figure 4-1 on page 15. The remainder of the ISF fenced-in area measured 65 feet by 40 feet and was paved with approximately 2-inch thick asphalt.

2.3 OPERATING HISTORY

The ISF (DOE Facility 4654) was constructed in 1958 at the Santa Susana Field Laboratory (SSFL) to support the Sodium Reactor Experiment (SRE). It was originally used to store dummy and spent fuel elements, shipping and storage casks, and radiological waste generated at the SRE. In addition to the SRE waste storage, the ISF was also used to store a variety of items from two other DOE programs: the Organic Moderated Reactor Experiment (OMRE) and Systems for Nuclear Auxiliary Power (SNAP).

Seals and packing on some of the casks and equipment stored at ISF over the years had deteriorated from exposure to the elements. Some low-level contamination had been released into the asphalt surface near the casks and onto soil just outside the ISF fence. The casks and other sources of potential contamination were subsequently removed and sent to the DOE-Hanford (Washington) disposal site for burial. Radioactive core components and material placed in the eight storage tubes during ISF usage had also contaminated the internal storage baskets and interior surfaces of the storage tubes. Funding for the site decommissioning activity became available in 1984.

Figure 2-1. Map of Los Angeles Area

Figure 2-2. Map of Neighboring SSFL Communities

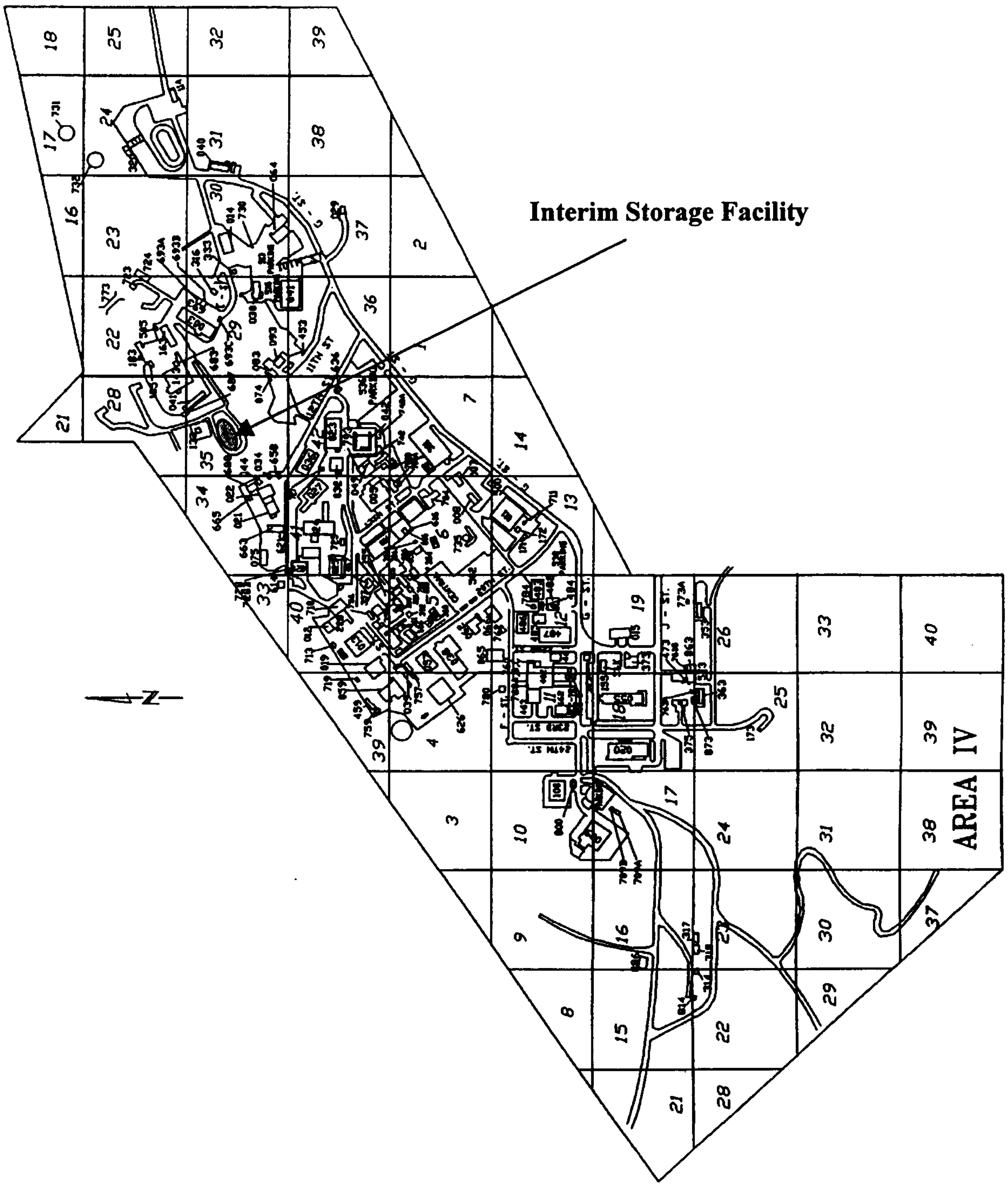


Figure 2-3. Area IV, SSFL

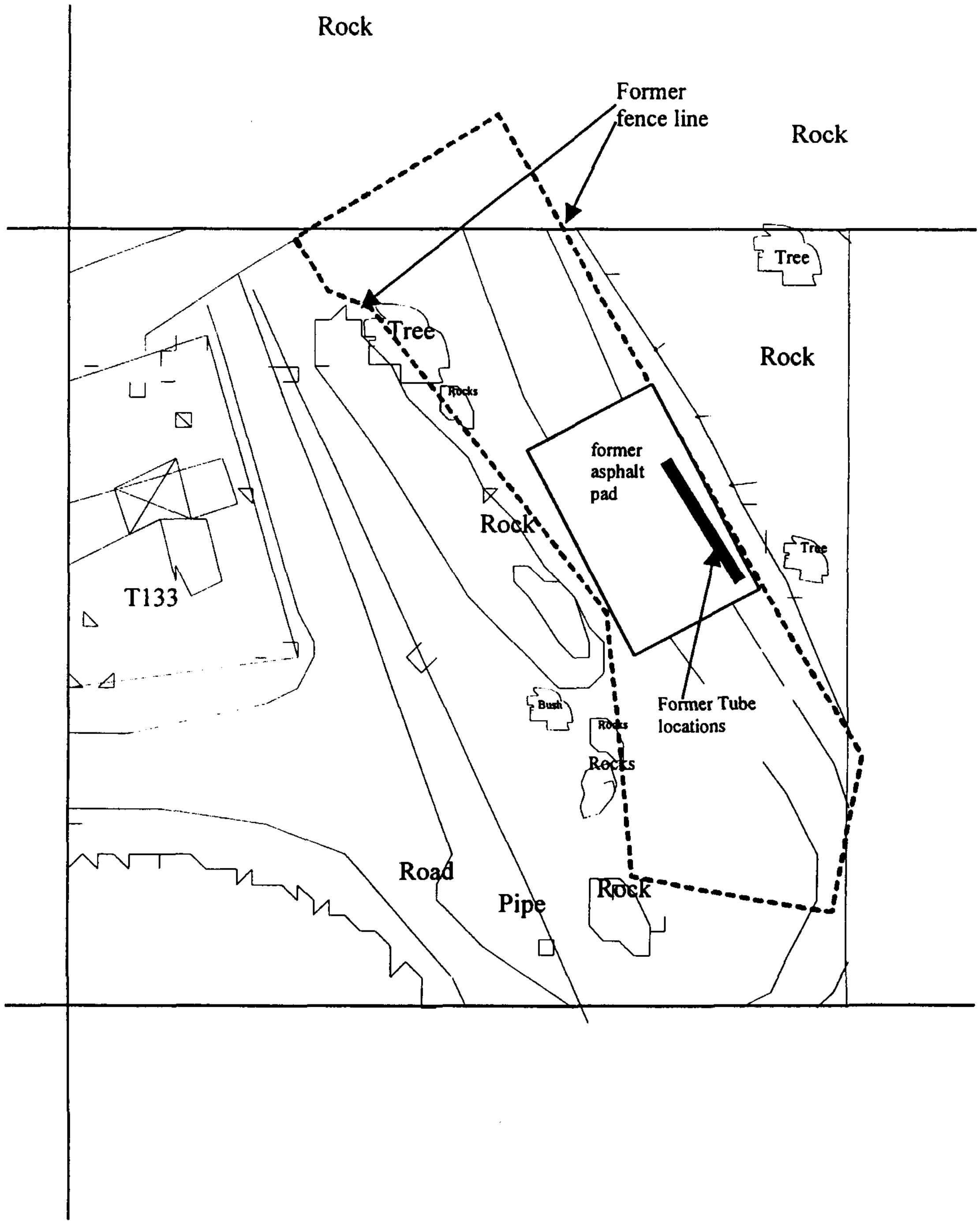


Figure 2-4. Interim Storage Facility Location

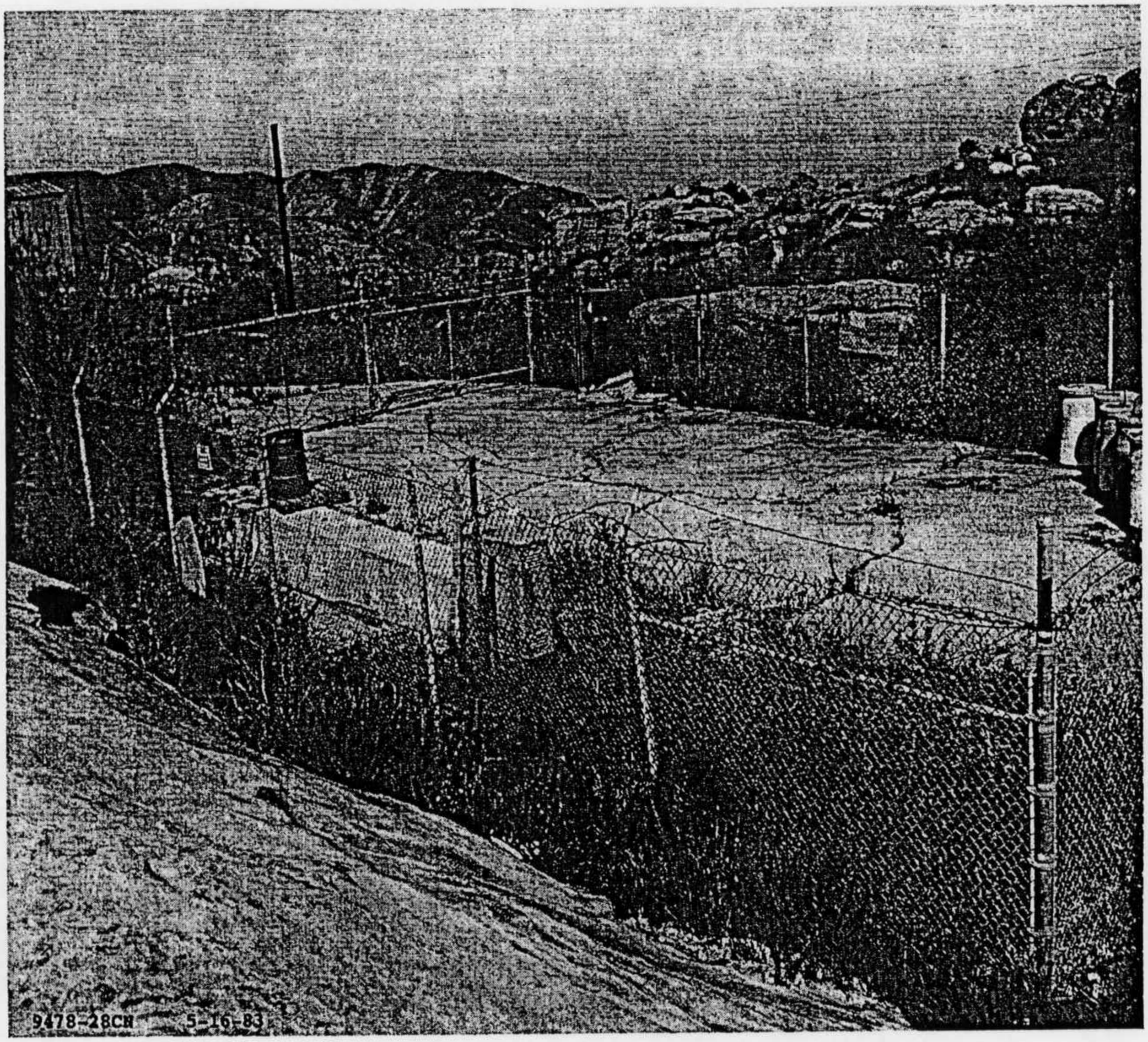


Figure 2-5. Interim Storage Facility (4654)

3.0 SUMMARY

The initial Decontamination and Decommissioning (D&D) of the Interim Storage Facility (ISF), was started in 1984 and completed in 1985. Activities included performing a detailed radiation survey of the facility, removing surface and imbedded contamination, excavating and removing the fuel storage tubes, restoring the site to natural grade, and packaging & shipping waste to the DOE-Hanford (Washington) disposal site for burial. The project was completed on schedule and under budget with no measurable radiation exposure to personnel.

ETEC's radiological survey of the ISF (Ref. 1) determined it to be suitable for release without radiological restrictions.

DOE routinely contracted with the Oak Ridge Institute for Science and Education (ORISE) to perform independent third party verification release surveys of sites throughout the nationwide DOE complex. In 1995, at the request of DOE, ORISE reviewed the 1984 survey documentation and suggested that additional sampling was required to adequately demonstrate that the facility could be released (Ref. 2 and 3). Accordingly, in 1997 Rocketdyne arranged for subsurface core samples of the area be taken at ORISE's direction and then provided the samples to ORISE for analysis. At the same time, Rocketdyne took an additional 93 surface soil samples. ORISE documented their verification survey in 1997 (Ref. 4) and Rocketdyne completed the final documentation of their final survey in 1999 (Ref. 5). Both surveys confirmed that the exposure rates and radionuclide concentration levels in soil at the ISF are less than the guideline criteria levels for release for unrestricted use.

4.0 PROJECT ACTIVITIES/RESULTS

4.1 PHASE I D&D (1984) – External Site Clean-up

The Interim Storage Facility (ISF) had not been used to support an active program from 1964 through 1984. During that period, stored material and equipment had been removed from the facility.

Phase I D&D commenced with a thorough scoping or characterization radiation survey of the ISF. The concrete trench and berm (top, sides, and ends), all soil, rock, concrete, storage-tubes/baskets were surveyed with portable radiation survey instruments, and any material with an indicated surface radiation in excess of 50 cpm of beta activity or with any detectable alpha activity was deemed to be contaminated. Soil samples which indicated Co-60 or Cs-137 levels above 1 pCi/g activity measured on a multi-channel analyzer were also considered contaminated (Ref. 1).

The contaminated concrete trench and berm were decontaminated using pneumatic scabblers with HEPA-filtered vacuum systems attached to capture concrete dust. The concrete surfaces were resurveyed and rescabbled until all surface contamination was removed. Contaminated soil removed to expose below-grade concrete surfaces was transferred to waste containers for shipment to the DOE-Hanford disposal site.

Sections of the asphalt within the exclusion area and a portion of the east and west entry roads were found to be contaminated. The asphalt was removed, broken into small pieces and loaded into approved radioactive waste packages for off-site shipment and disposal. A survey of the soil (exposed by the asphalt removal) indicated localized areas of contamination. The contaminated soil was removed and packaged for shipment to the DOE-Hanford disposal site.

Contaminated internal storage baskets were found in five of the eight storage tubes (Ref. 1). These were removed using a Grove mobile crane. Each basket was drawn into a plastic bag as it was removed from its respective storage tube to ensure containment of any contaminants. These baskets were transferred to the Radioactive Materials Handling Facility (RMHF), then known as the Radioactive Materials Disposal Facility (RMDF), for size reduction and packaging for shipment to the DOE-Hanford disposal site.

Four of the eight storage tubes were found to contain water contaminated with Cs-137. The storage tubes were filled with Redimix concrete to absorb the contaminated water and fix the contaminant in place. Figure 4-1 shows the depth of the water found in tubes 2, 3, 4, and 6 and the quantity of Redimix used.

After completion of the above Phase I activities, the ISF controlled area and the surrounding area were resurveyed. Figure 4-2 shows the ISF area that was surveyed. During this survey, additional soil was found to be contaminated. Less than 6 inches of soil in approximately 10 % of the total area and up to 18 inches of soil in approximately 1 % of the total area were removed and packaged into radioactive waste containers for off-site shipment and disposal. The Phase I radiation survey (Ref. 1) was performed and confirmed that all surface contamination had been removed and all radiation levels were within acceptable limits.

4.2 PHASE II D&D (1984, 1985) – Removal of the Storage Tubes and Surrounding Structure

Concrete Cutting International Inc. was awarded a fixed-price contract to remove the storage tube trench and berm concrete, excavate and remove the storage tubes, and perform backfill operations.

The first excavation operation required removing the concrete that contained the upper portion of the storage tubes. This clean material was temporarily stored (after survey) in a retention area (Figure 4-3), then later used for backfill material.

The excavation of soil and rock from the north side of the storage tubes exposed the tubes for removal (Figures 4-4 and 4-5) to a depth of 23 feet. During the excavation operation, at approximately 15 feet, the hydraulic hammer mounted on the end of a backhoe being used to excavate the area punctured storage tube 7 (see Figure 4-6). The storage tube and the surrounding area were surveyed and verified to be free of contamination. All the dirt and rock removed during this operation were found to be free of contamination and were stored and later used as backfill material. Samples were analyzed for Co-60, Cs-137, and other gamma emitters (Ref. 1).

A mobile crane was used to transfer each storage tube to a flatbed truck for transport to the RMHF (Figures 4-7 and 4-8). As each storage tube was removed, it was surveyed, and verified to be externally free of contamination. As an extra precaution, a plastic bag was placed around the lower section to prevent the potential spread of contamination during transit. A soil sample was taken from each of the emptied boreholes as the tube was removed. These samples were analyzed for Co-60, Cs-137, and other gamma emitters. Results were found to be less than the then release criterion of 100 pCi/g gross detectable activity (Ref. 1, section 4.7).

Throughout this project, Rocketdyne Radiation Safety monitored all operations. Much of this effort was directed toward detecting and eliminating residual radioactive contamination. The final D&D radiological survey can be broken into three phases:

- Phase IIA: Constant monitoring of soil and structure surfaces during final phases of structure removal
- Phase IIB: Radiometric screening and analysis of soil samples taken from excavation by gamma spectroscopy

- Phase IIC: Final statistical survey of ISF area, including surrounding fringe areas for gross gamma activity.

Since all structural surfaces were removed, the criteria for release relate only to site soil activity and ambient radiation. Each phase and its findings are discussed below.

Phase IIA. Constant surveillance of removed and onsite materials was conducted by Radiation Safety personnel to monitor for possible alpha, beta, and gamma emitting radionuclides. No measurable contamination was found in the soil or surrounding native rock. Logical paths of possible contaminant migration (e.g., runoff channels) were followed by soil sampling and radioactive analysis as well as in situ gamma radiation surveys. No measurable contamination was found.

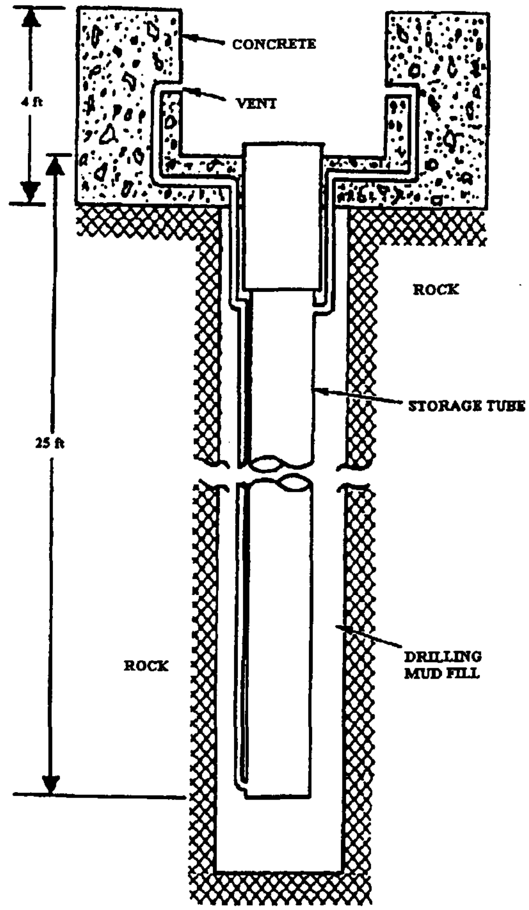
Phase IIB. Soil samples were taken both during the soil removal process and also at the maximum depth of the excavations. Soil samples were screened for detectable activity using a germanium detector. Samples indicating a measurable level of cesium (Cs-137 was the only nonnaturally occurring isotope encountered during this activity) contamination were subjected to quantitative analysis. None of the samples contained activity in excess of 2.0 pCi/g, which was calculated to be equivalent to a maximum beta activity of 36 pCi/g. This value was less than the release criterion of 100 pCi/g gross detectable beta activity.

Phase IIC. After completion of the final backfilling, a statistical survey was made at the surface in both the areas previously occupied by the ISF facility and its environs (Ref. 1). Since the instrument used for radiation measurement was sensitive to the scattered "skyshine radiation" from the nearby RMHF, a correction was applied to the data set. The corrected mean value of the survey data, 12 μR/h, met the guideline criterion of less than 5 μR/h above background (10 μR/h).

4.3 ADDITIONAL RADIOLOGICAL SURVEYS OF ISF (1997)

In 1995, the Oak Ridge Institute of Science and Education (ORISE) reviewed the 1984 survey documentation and suggested that additional sampling was required to adequately demonstrate that the facility could be released (Ref. 2 and 3). Accordingly, in 1997, Rocketdyne arranged for subsurface core samples of the area be taken at ORISE's direction and then provided the samples to ORISE for analysis. At the same time, Rocketdyne took an additional 93 surface soil samples. ORISE documented their verification survey in 1997 (Ref. 4), and Rocketdyne completed the documentation of their final survey in 1999 (Ref. 5).

Both surveys confirmed that the exposure rates and radionuclide concentration levels in soils at the ISF are less than the guidelines for release for unrestricted use.



Cross Section of ISF Storage Tube

STORAGE TUBE NUMBER

	1	2	3	4	5	6	7	8
Water Level	**Dry**	**31 inch**	**24 inch**	**13.5 inch**	**Dry**	**6 inch**	**Dry**	**Dry**
Sacks Redimix reqd for solidification		**25.2**	**19.5**	**11.1**		**4.8**		

Figure 4-1. ISF Tube Cross Section and Tube Water Levels

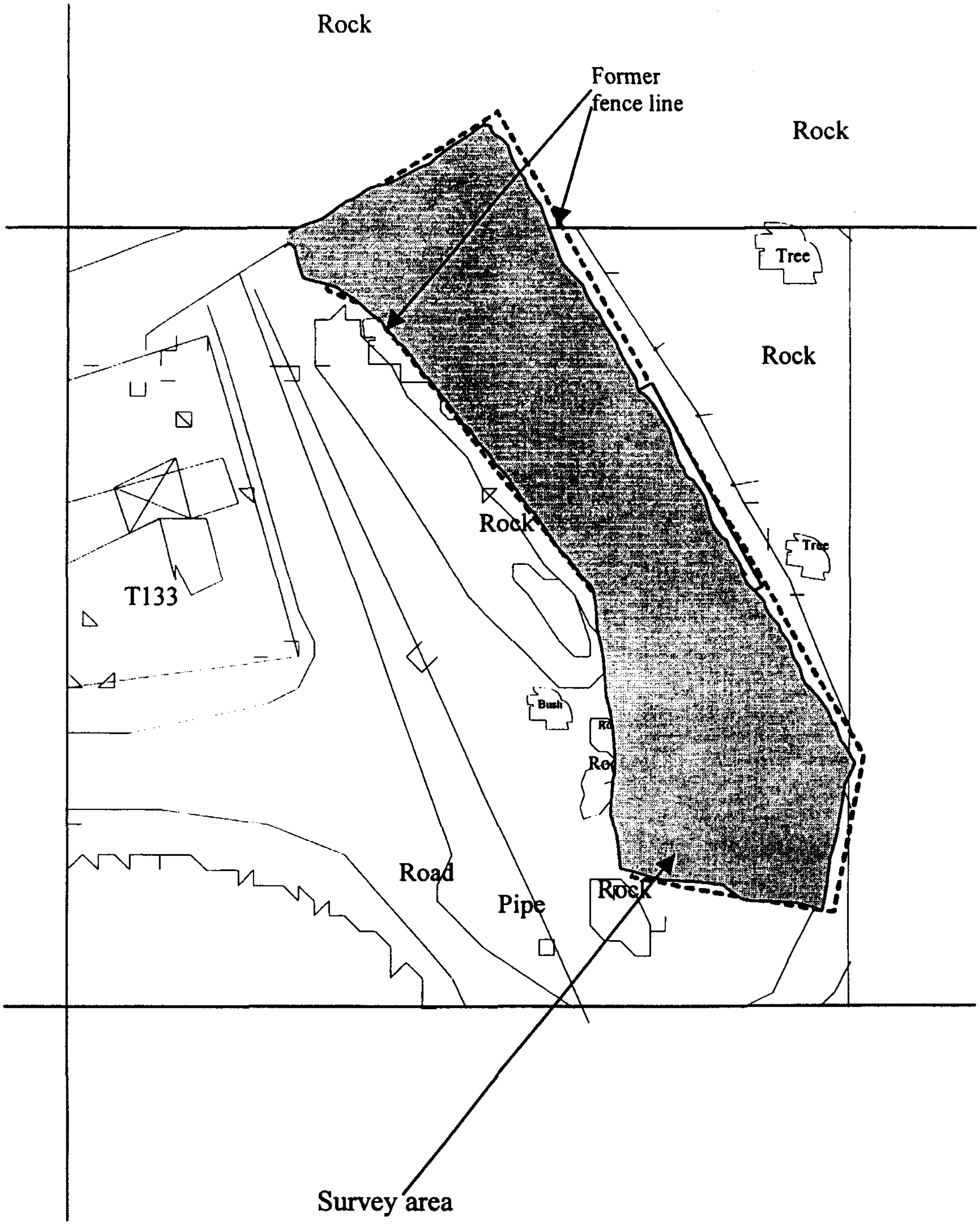


Figure 4-2. ISF Survey Area

Figure 4-3. Broken Concrete Retention Area

Figure 4-4. Soil and Rock Retention Area

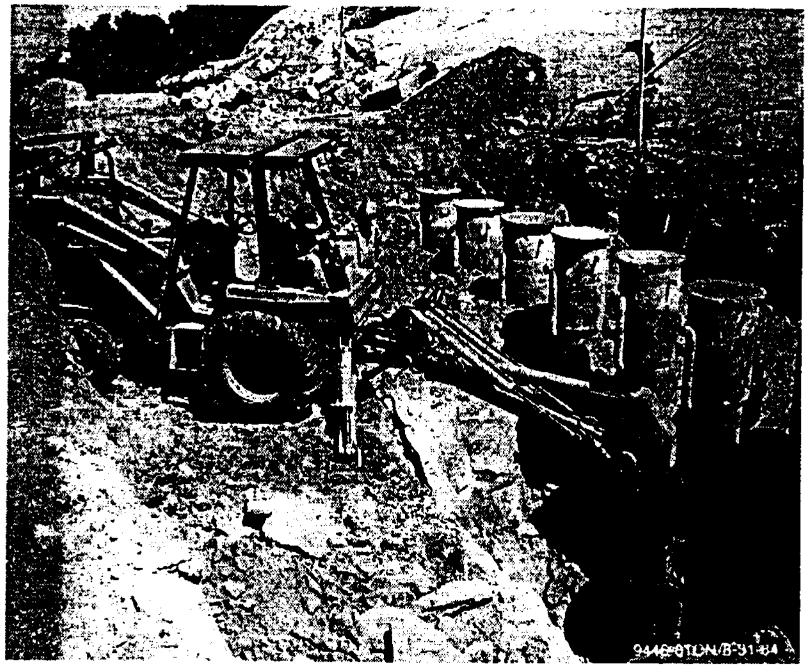


Figure 4-5. ISF Excavation Staging Trench

Figure 4-6. Damage to Tube # 7 During Excavation

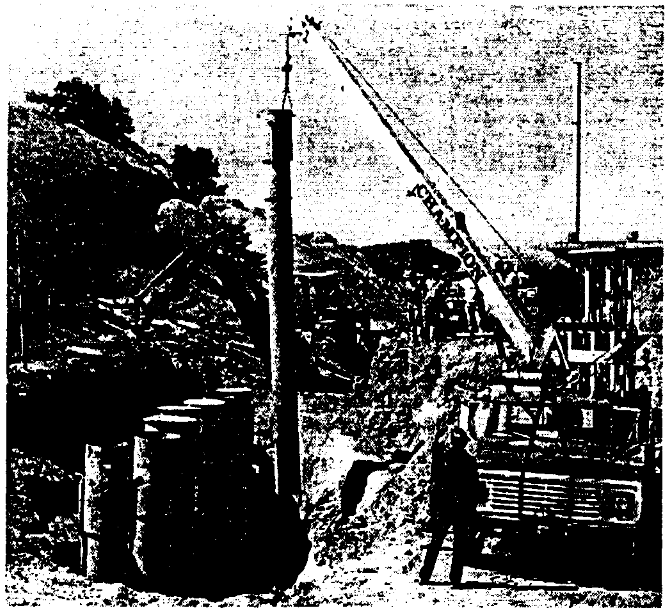


Figure 4-7. ISF Storage Tube Removal

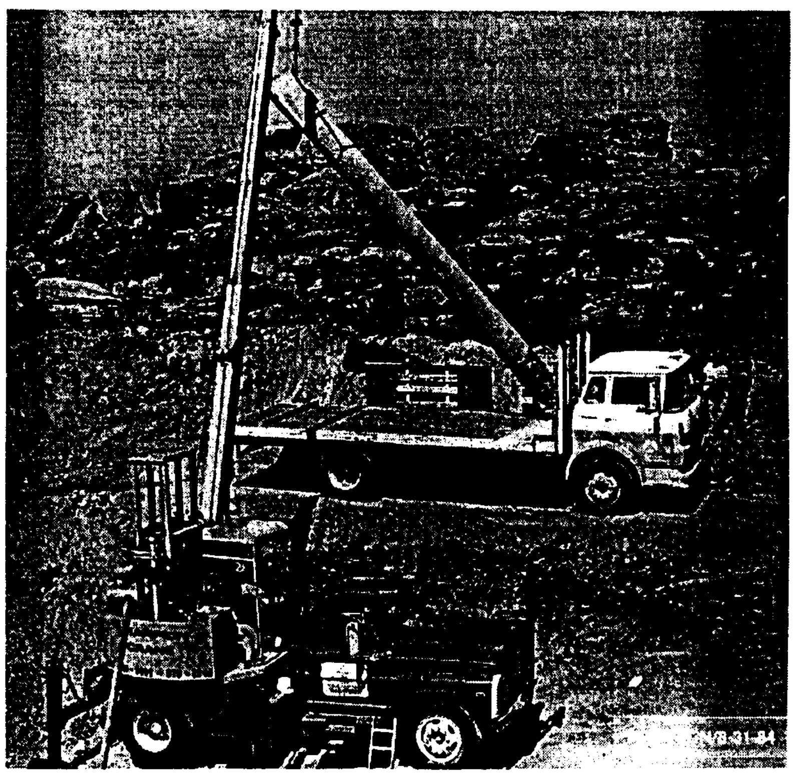


Figure 4-8. ISF Storage Tube Transfer

5.0 WASTE GENERATED AND DISPOSAL

A total of 168.5 cubic meters of low specific activity (LSA) waste consisting of 126 King-Pac containers (1 cubic meter each) containing soil, asphalt, and concrete and 12 wood box containers (3.54 cubic meters each) containing storage tube and basket sections were generated during the decommissioning of the ISF.

The King-Pac containers were transferred to the RMHF for final disposition before shipment. Container integrity was verified, and plastic liners were sealed. The containers were labeled and banded to transport and loading pallets. Six truckloads of the King-Pacs (126) were shipped to the DOE site at Hanford, Washington.

The 25-feet-long fuel element baskets and storage tubes were transferred to the RMHF for size reduction and packaging. Both the storage tubes and baskets were sectioned into approximately 4-feet lengths using an oxygen acetylene cutting torch in Building 021. Figures 5-1 and 5-2 show the cutting operation. A special prefilter smoke retention housing was fabricated to prevent the facility's absolute filters from plugging with the large amount of particulate matter generated during the cutting activity. The tube and basket sections were packaged in 12 wooden containers and also shipped as LSA waste to the DOE-Hanford site for disposal.

Figure 5-1. ISF Storage Tube Cutting

Figure 5-2. ISF Storage Tube Cutting

6.0 PERSONNEL RADIATION EXPOSURE

None of the Rocketdyne Operations and Radiation Safety or contractor personnel assigned to the ISF decommissioning project received any measurable exposure to ionizing radiation during the decommissioning (Ref. 1).

7.0 COST

Decommissioning labor included mechanics, health physicist; and direct supervisors performing the decommissioning activity. Support labor included program offices, photographic, word processing, and program administration.

The original budget for the ISF decommissioning was $430,000. The total cost of the ISF decommissioning, prior to the Final Verification surveys, was $267,000. The cost of the final verification surveys is estimated to be $50,000. A breakdown of the final cost is as follows:

ISF decommissioning labor (including Health Physics support)	$170,000
Demolition contract	48,000
Waste transportation burial	40,000
Program management and support	9,000
ISF DECOMMISSIONING	$267,000
Final Radiological Surveys	50,000
TOTAL COST	$317,000

8.0 REFERENCES

1. ESG- DOE- 13507 "Interim Storage Facility Decommissioning Final Report", March 15, 1985.

2. Letter from T. J. Vitkus (ORISE) to D. Williams (DOE-EM), "Comments on the Final Status Survey Documentation for the Interim Storage Facility; Building T013, T019, T024, T030, and T641; The Storage Yard west of Buildings T626 and T038; and the NW Area; Santa Susana Field Laboratory, Rockwell International Ventura County, California", January 11, 1996.

3. ORISE 96/C-4, "Verification Survey for the Interim Storage Facility; Buildings T030, T641, and T013; An area Northwest of Buildings T019, T013, T012, T059; and a storage yard West of Buildings T626 and T038; Santa Susana Field Laboratory, Rockwell International Ventura County, California", Oak Ridge Institute for Science and Education (ORISE), Oak Ridge, TN, February, 1996.

4. "Verification Survey of the Interim Storage Facility (4654) Santa Susana Field Laboratory Rockwell International Ventura County, California", Oak Ridge Institute for Science and Education (ORISE), Oak Ridge, TN, November, 1997.

5. RS-00004 "Building 4654 Supplemental Final Status Survey Report", March 15, 1999.

ESG-DOE-13507
REMEDIAL ACTION AND
DECOMMISSIONING PROGRAM
UC-70A

INTERIM STORAGE FACILITY DECOMMISSIONING FINAL REPORT

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ABSTRACT

Decontamination and decommissioning of the Interim Storage Facility were completed. Activities included performing a detailed radiation survey of the facility, removing surface and imbedded contamination, excavating and removing the fuel storage cells, restoring the site to natural conditions, and shipping waste to Hanford, Washington, for burial. The project was accomplished on schedule and 30% under budget with no measurable exposure to decommissioning personnel.

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1.0 BACKGROUND

1.1 FACILITY HISTORY

The Interim Storage Facility (ISF) (DOE Facility 654) was constructed in 1958 at the Santa Susana Field Laboratory (SSFL) to support the Sodium Reactor Experiment (SRE). It was originally used to store dummy and spent fuel elements, shipping and storage casks, and hot waste generated at the SRE. Since SRE ceased operating, it has also been used to store a variety of items from two other DOE waste generating programs: Organic Moderated Reactor Experiment (OMRE) and Systems for Nuclear Auxiliary Power (SNAP). The seals and packing on some of the casks and equipment stored at ISF had deteriorated from exposure to the elements to such an extent that low-level contamination had been released. This release contaminated the asphalt surface near the casks and soil just outside the ISF fence. The casks and other sources of potential contamination were subsequently removed and sent to burial. Radioactive core components and material placed in the eight storage tubes contaminated the internal storage baskets and surfaces of the storage cells. The facility was kept in a surveillance and maintenance mode until decommissioning began in 1984.

1.2 PROJECT PURPOSE

The purpose of decommissioning the ISF was to clean up a contaminated facility that was not being used by an active program and that had the potential for spreading contamination to surrounding areas. The intent was to remove contamination to the extent that no further maintenance and surveillance would be required and there would be no controls, limitations, or conditions on the future use of the ISF area due to the presence of radioactive material.

2.0 FACILITY DESCRIPTION

2.1 BUILDINGS AND SYSTEMS

The ISF (Figures 1 and 2) was located at Rockwell International's SSFL approximately 35 miles northwest of downtown Los Angeles. The ISF was near

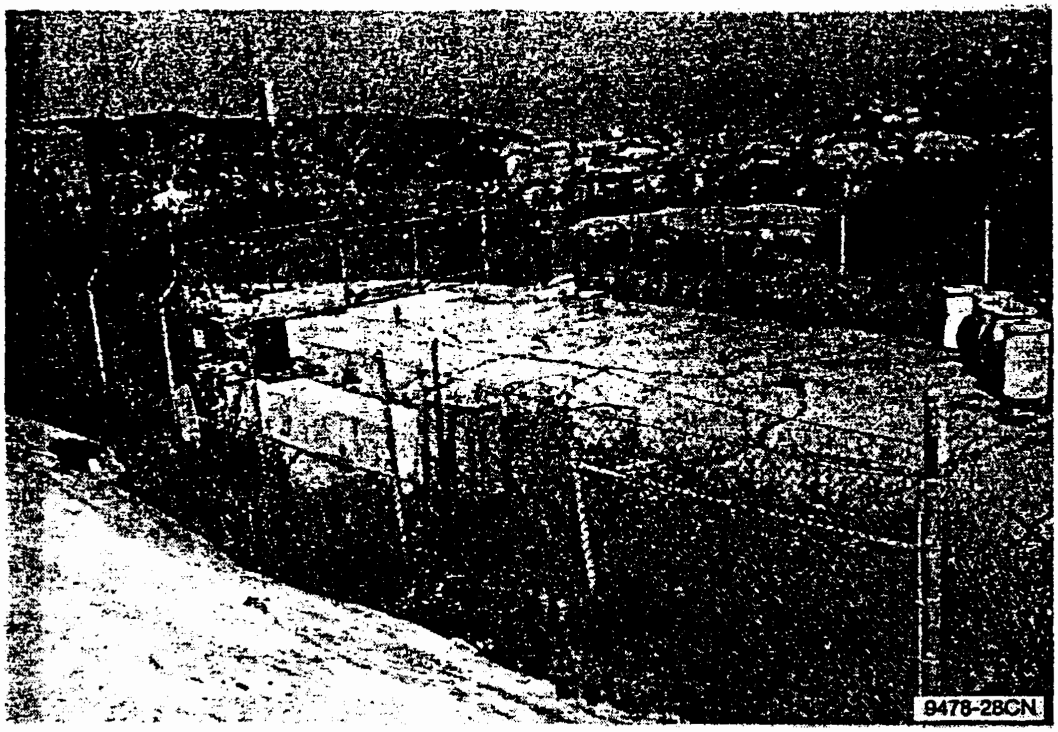

Figure 1. Interim Storage Facility (T654)

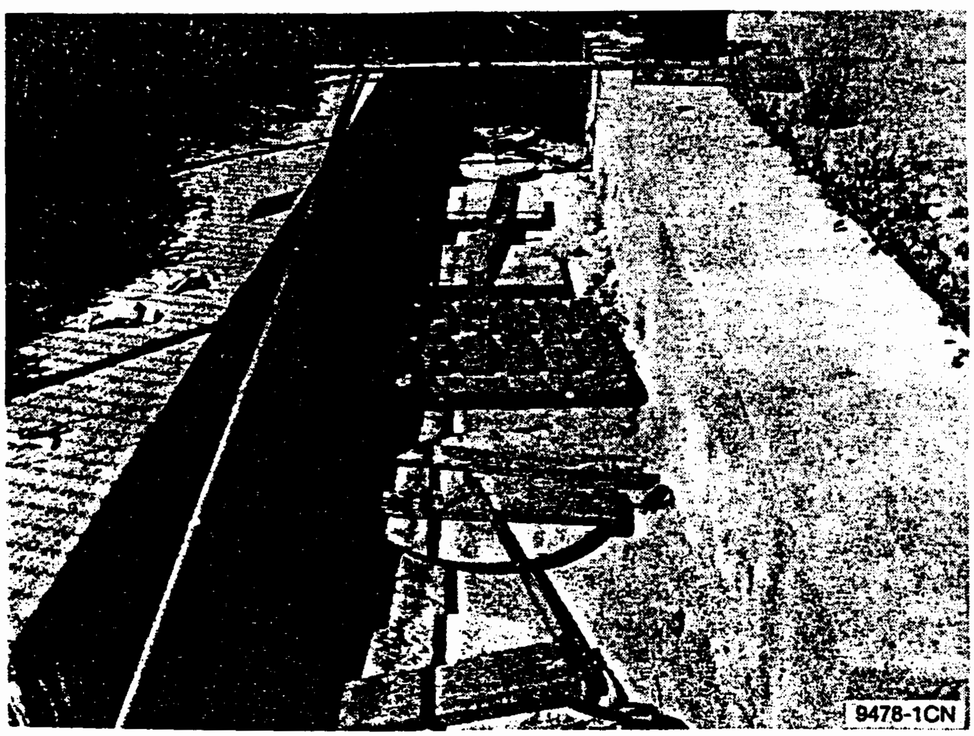

Figure 2. ISF Trench Area

the SRE and had been used to store SRE dummy fuel elements and moderator assemblies. The storage facility comprised eight 20-in.-diameter galvanized steel cells, extending 25 ft into 32-in.-diameter wells drilled into rock strata. A concrete berm encased the cells at ground level. A cross-sectional view of a single storage cell is shown in Figure 3. In the approximately 20 years during which the ISF was not used, it remained as an exclusion area (as areas of contamination were known). Surveillance and periodic maintenance were performed to contain the contamination and prevent its spread into adjoining, unrestricted areas.

2.2 PREDECOMMISSIONING STATUS

The facility had been shut down for approximately 20 years, and all stored equipment and material were removed. A radiation survey was made of the ISF area prior to decommissioning. Areas of contamination were plotted on the site map as shown in Figure 4. Fixed surface contamination ranged from 50 to 1000 cpm above background. A few localized spots in the northeast corner of the controlled area were found to be 20 mrad/h above background. The highest contamination level inside the storage cells was 7.5×10^5 dpm.

3.0 DECOMMISSIONING OBJECTIVES AND WORK SCOPE

The objective was the decontamination and decommissioning (D&D) of the ISF such that the facility could be returned to its natural state and released for unrestricted use. The work scope included removing all surface and imbedded contamination from the ISF controlled and surrounding areas, removing the dummy fuel element baskets from the storage tubes, removing structural concrete from the storage cell structure, and removing the storage cells from their imbedded positions. When all surface and imbedded contamination had been removed, the site was to be returned to a natural state. Accumulated waste was to be shipped to the Hanford Reservation in Washington State for burial.

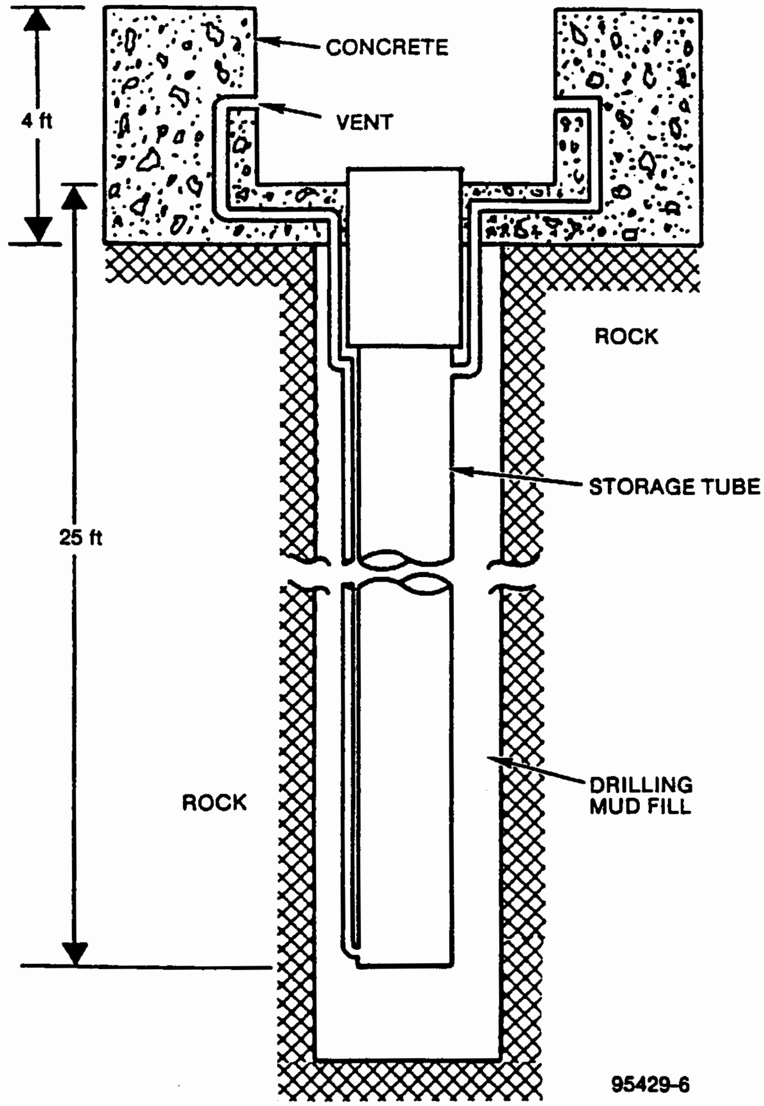

Figure 3. Cross Section of
ISF Storage Cell

4.0 WORK PERFORMED

4.1 PROJECT MANAGEMENT

The ISF decommissioning was administered by the Surplus Facilities Management Program (SFMPO) of DOE-RL working through DOE-SAN, who managed ESG's activities on the project. ESG's program office managed the implementation of the project, which began with the preparation of the top level guidance and project plans and concludes with this final decommissioning report.

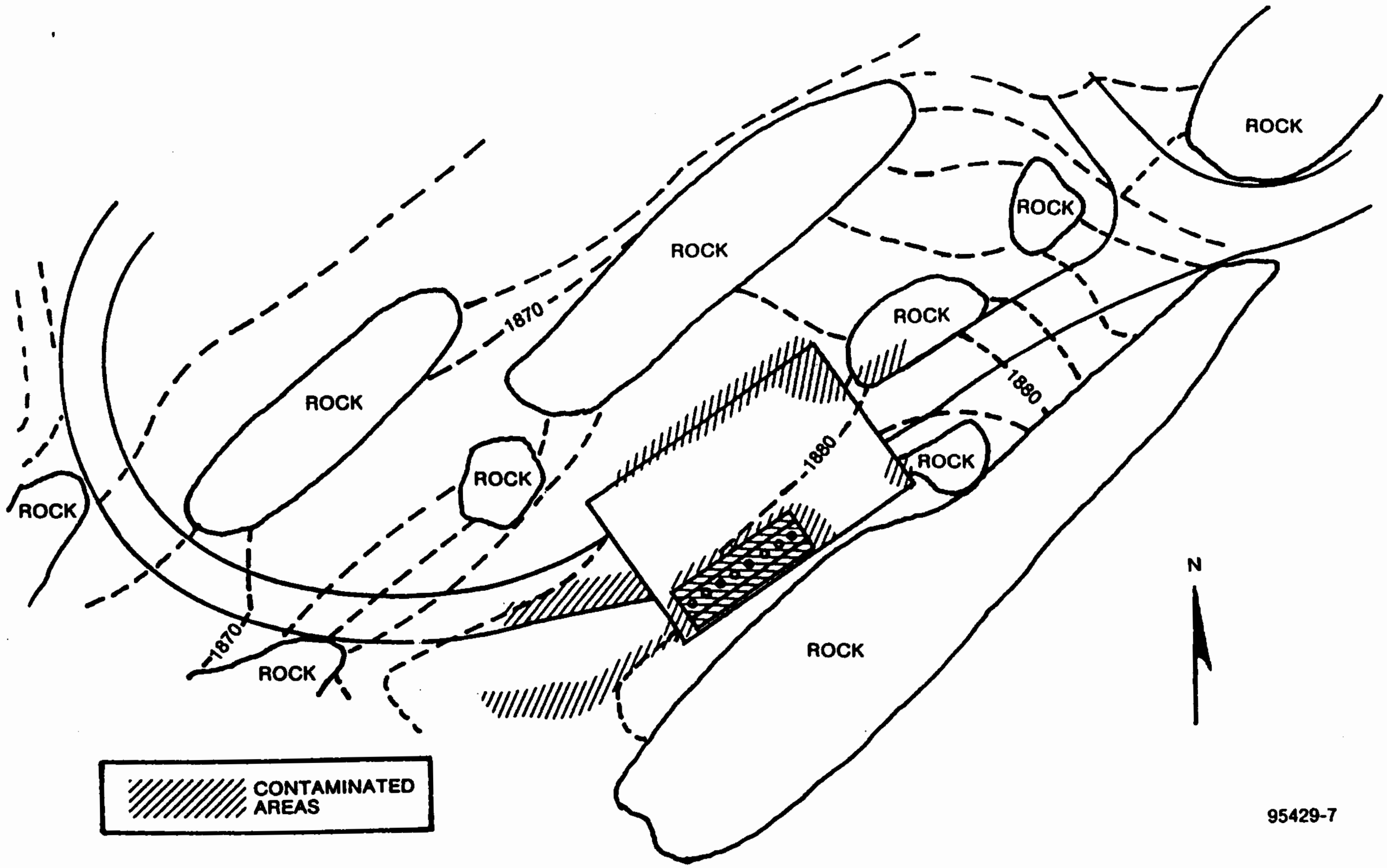

Figure 4. Contaminated Areas at ISF (pre-D&D)

The program office acted as liaison with the DOE representatives who monitored the project and with all organizations that were involved during the project. The program office was also responsible for the overall schedule and budget performance and for the submission of the schedules and budgets.

All reporting was done to DOE-SAN by the program office, including monthly, technical, and final reports.

4.2 PROJECT ENGINEERING

Project Engineering within ESG followed the guidance of the program plan and prepared the necessary documents to decommission the ISF. The top level document prepared by Project Engineering was the "Relevant Information to Support RMDF and Interim Storage Facility Decommissioning."[1] The second level document prepared for the ISF decommissioning was "Interim Storage Facility Decommissioning Plan."[2]

Project Engineering was also responsible for developing techniques to be used during the decommissioning of the ISF. Project Engineering was responsible for the technical adequacy and completeness of program documents.

Project Engineering acted as liaison with the Engineering Department and the Health, Safety, and Radiation Services Department in obtaining support for the monitoring of subcontracted efforts during decommissioning.

4.3 SITE PREPARATION

The ISF had been in a controlled surveillance mode for about 20 years. The preparation required before decommissioning could begin included:

- Procuring King-Pac solid waste disposal boxes
- Fabricating King-Pac solid waste disposal boxes
- Initiating RFQ for the excavation, removal, and landfilling of ISF storage tubes
- Performing a predecommissioning radiation survey.

4.4 DECOMMISSIONING OPERATIONS

The D&D was completed in two phases. The first phase involved removing surface contamination from the ISF concrete berm and surrounding area. The second phase required contractor equipment to excavate dirt and rock surrounding the ISF storage tubes and removal of the tubes. All D&D efforts were performed in accordance with Ref. 1.

4.4.1 Phase I D&D

A thorough radiation survey was made of the surface of the concrete berm (top, sides, and ends) to locate areas of contamination. These areas were then decontaminated using pneumatic scabblers. The concrete dust was removed by vacuuming using HEPA-filtered vacuum systems. The concrete surfaces were resurveyed and rescabbled until all surface contamination was removed. Dirt removed to expose concrete surfaces below grade level was transferred to King-Pac boxes and retained for disposal.

Sections of the asphalt within the exclusion area and a portion of the east and west entry roads were found to be contaminated. The asphalt was lifted and broken into small pieces and loaded into King-Pac containers for disposal. A survey of the soil exposed by the asphalt removal indicated local areas of contamination. This material was also removed for disposal.

Contaminated dummy fuel element baskets were found in five of the storage cells. These were removed using a Grove crane as shown in Figures 5 and 6. Each basket was drawn into a plastic bag as it was removed from its respective storage cell. These packaged baskets were transferred to the Radioactive Materials Disposal Facility (RMDF) for disassembly and disposal.

Four of the eight storage cells were found to contain water. Because the water was found to be contaminated with ^{137}Cs, it was fixed in place by adding Redimix concrete. Figure 7 shows the depth of water found in cells 2, 3, 4, and 6 and the quantity of Redimix added to fix the water.

Figure 5. Dummy Fuel Element Basket Removal

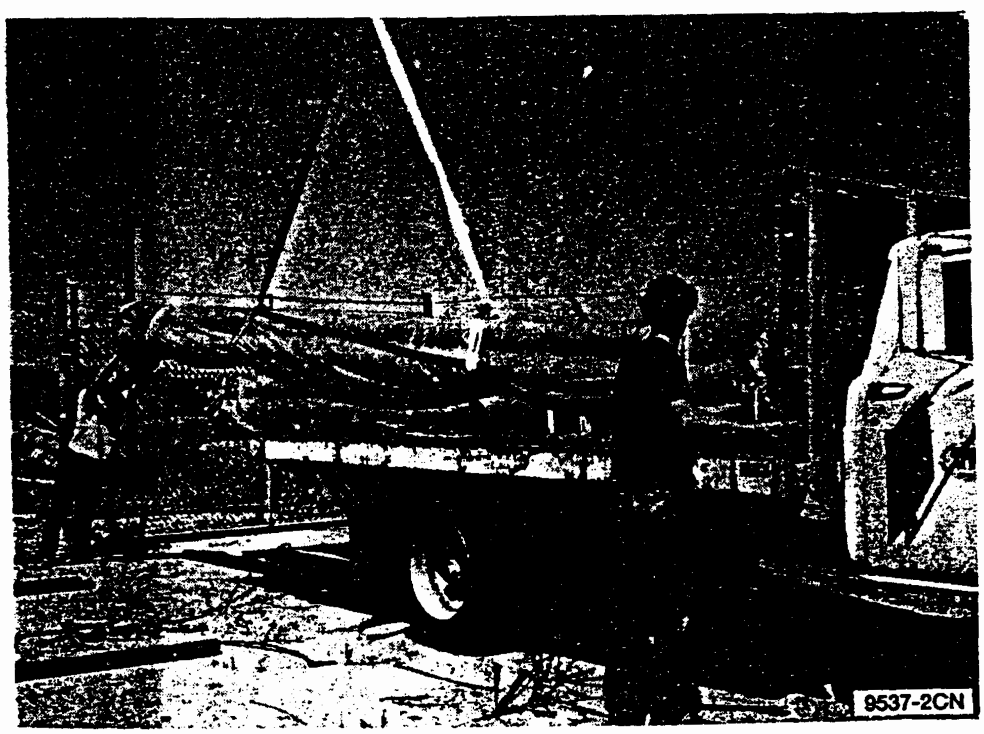

Figure 6. Dummy Fuel Element Basket Transfer

STORAGE TUBE NUMBER	1	2	3	4	5	6	7	8
WATER LEVEL	DRY	31 in.	24 in.	13.5 in.	DRY	6 in.	DRY	DRY
SACKS REDIMIX REQUIRED FOR WATER SOLIDIFICATION		25.2	19.5	11.1		4.8		

95429-8

Figure 7. ISF Cell Water Levels

The ISF controlled area and the surrounding area were resurveyed, and additional soil was found to be contaminated; this was removed and loaded into King-Pac containers for disposal. Less than 6 in. of soil in approximately 10% of the total area and up to 18 in. of soil in approximately 1% of the total area were removed during Phase I D&D operations. The final radiation survey before Phase II (see Figure 8) indicated that all surface contamination had been removed (all radiation levels were within acceptable levels).

4.4.2 Phase II D&D

Concrete Cutting International, Inc., was awarded a fixed-price contract to remove the storage tube structural concrete, perform the excavation required to remove the storage tubes, and perform backfill operations.

The first excavation operation required removing the concrete trench that contained the upper portion of the storage tubes. This uncontaminated material was temporarily stored in a retention area (Figure 9), then later used for backfill material.

The excavation of soil and rock from the north side of the storage tubes exposed the tubes for removal (Figures 10 and 11) to a depth of 23 ft. At approximately 15 ft, the hydraulic hammer mounted on the end of a backhoe punctured storage tube 7 (see Figure 12). The area was surveyed for contamination.

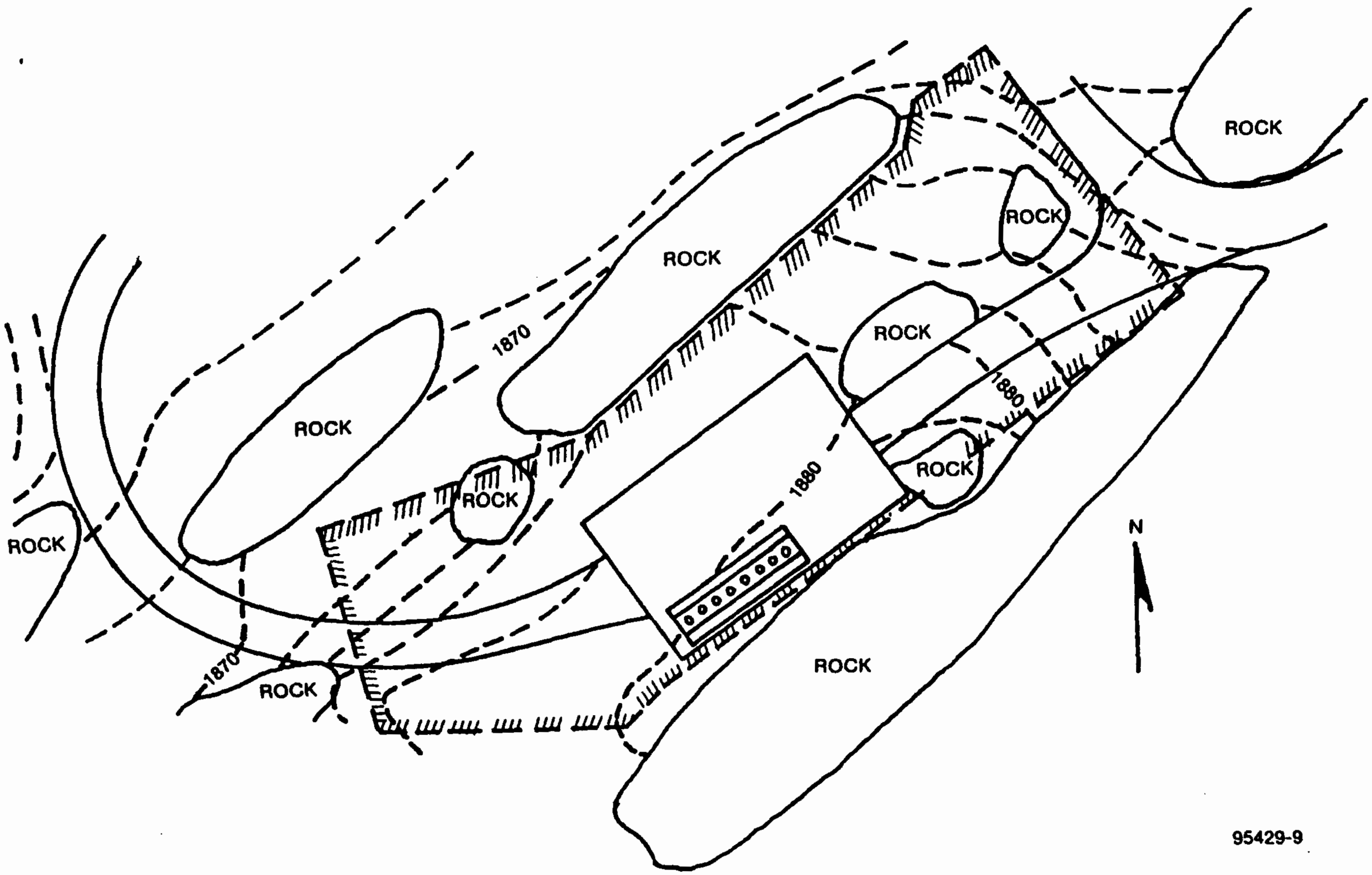

Figure 8. ISF Survey Area

Figure 9. Broken Concrete Retention Area

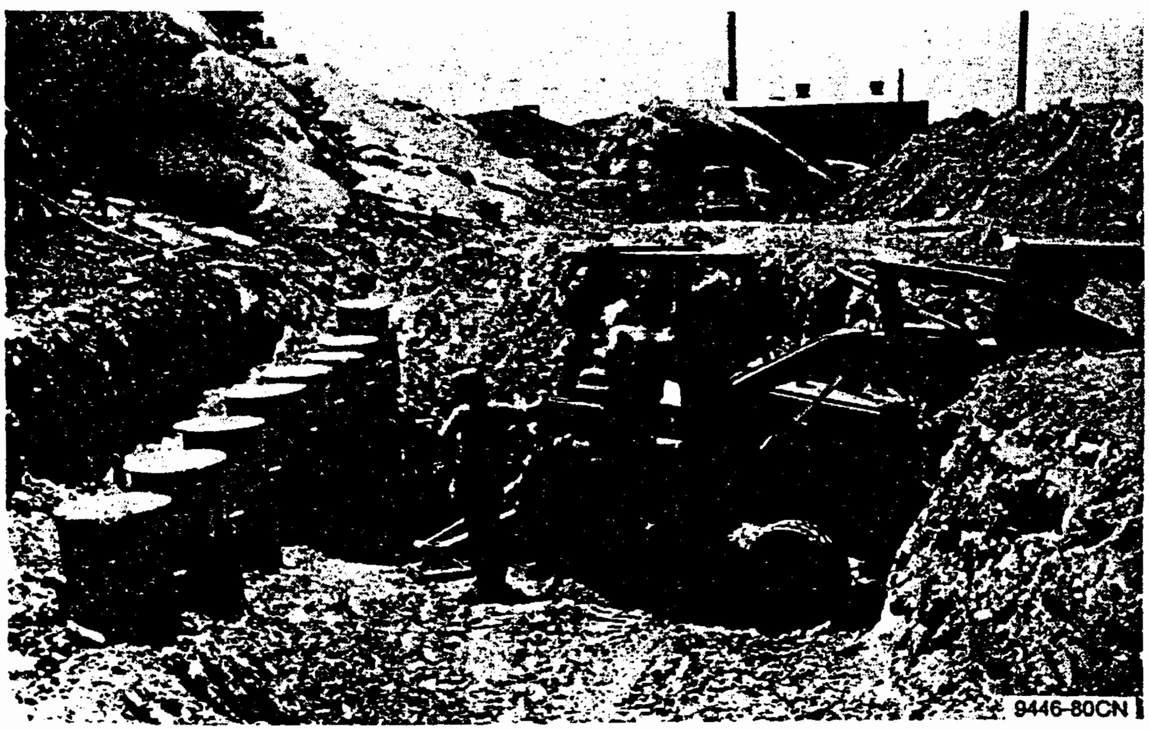

Figure 10. Soil and Rock Retention Area

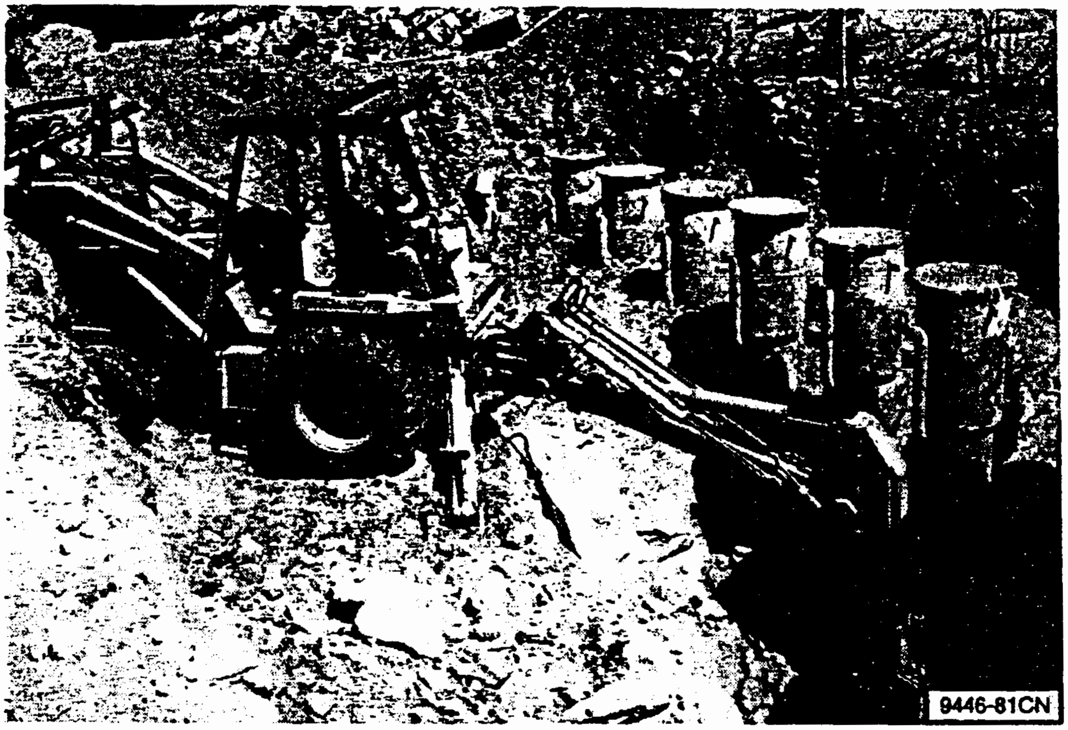

Figure 11. ISF Excavation Staging Trench

Figure 12. Damage to Cell 7 During Excavation

None was found and the excavation continued. All the dirt and rock removed during this operation were found to be free of contamination and were stored and later used as backfill material. (Samples were analyzed for ^{60}Co, ^{137}Cs, and other gamma emitters.)

A mobile crane was used to transfer each storage tube to a flatbed truck for transport to the RMDF (Figures 13 and 14). As each storage tube was removed, it was surveyed (no external contamination was detected), and a plastic bag was placed around the lower section. This secondary precaution was to prevent the spread of contamination during transit. A soil sample was taken from each of the emptied storage tube wells as the tube was removed (Figure 15). These samples were analyzed for ^{60}Co, ^{137}Cs, and other gamma emitters; the results are presented in Section 4.7.

4.5 WASTE DISPOSITION

One hundred twenty-seven King-Pacs (approximately 1 m^3 each) of soil, rock, asphalt, and concrete from the excavation were transported to RMDF for final disposition before shipment. Container integrity was verified, and plastic liners were sealed. Boxes were labeled and banded to transport and loading pallets. Six truckloads of King-Pacs were shipped to the DOE site at Richland, Washington (operated by Rockwell-Hanford). All the waste was classified as "low specific activity waste."

The 25-ft-long fuel element baskets and storage cells were transferred to RMDF for size reduction and packaging. Both storage cells and baskets were sectioned into approximately 4-ft lengths using an oxygen acetylene cutting torch in Building 021. Figures 16 and 17 show the cutting operation. A special prefilter smoke retention housing was fabricated to prevent the facility's absolute filters from plugging with the large amount of particulate matter generated during cutting activity.

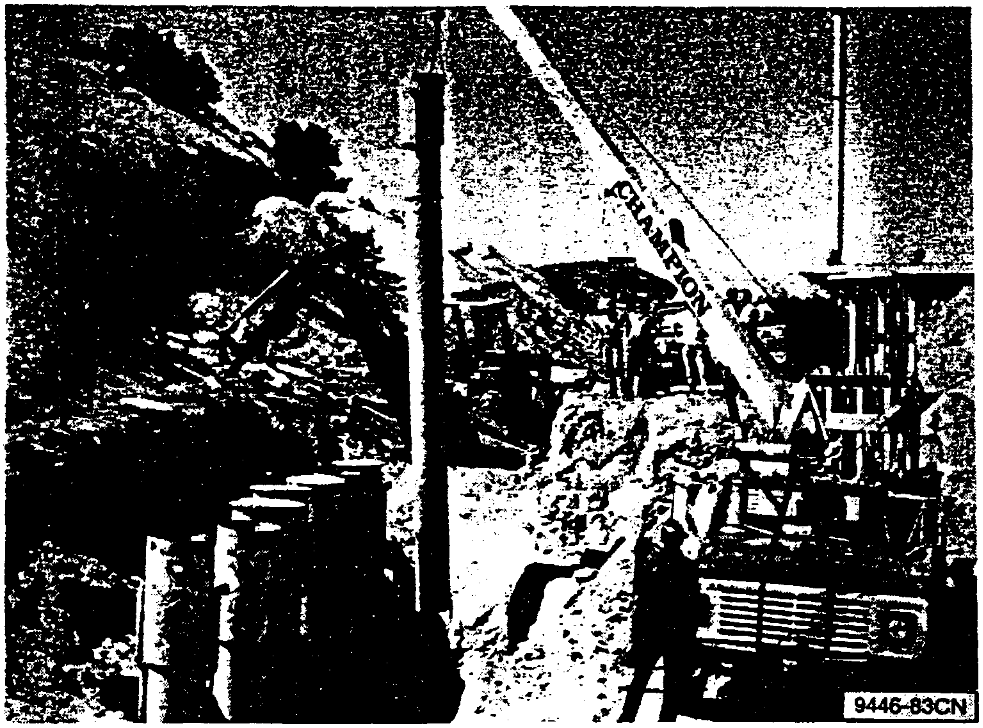

Figure 13. ISF Storage Cell Removal

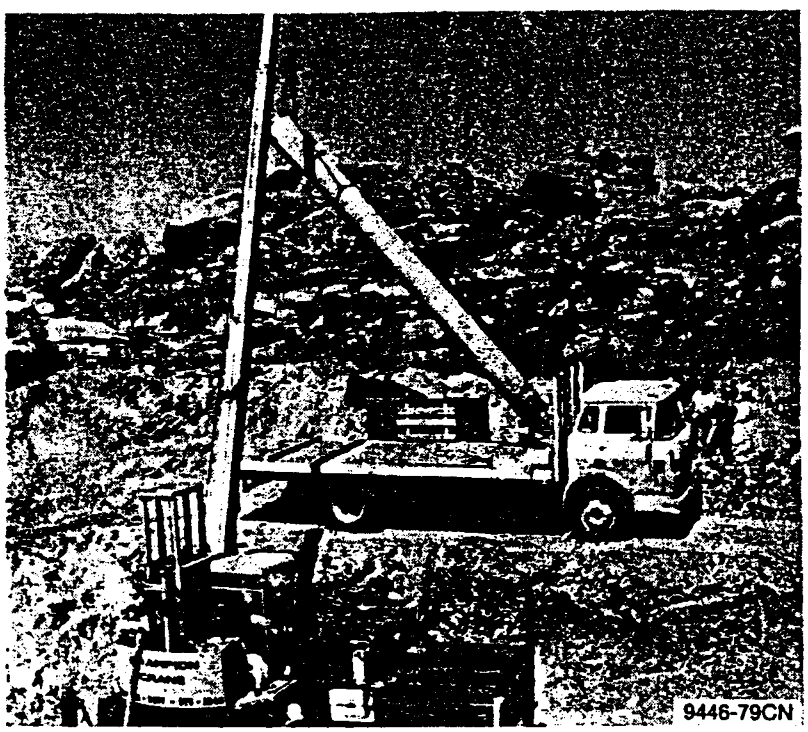

Figure 14. ISF Storage Cell Transfer

Figure 15. Collecting Dirt Sample at Bottom of Cell Shaft

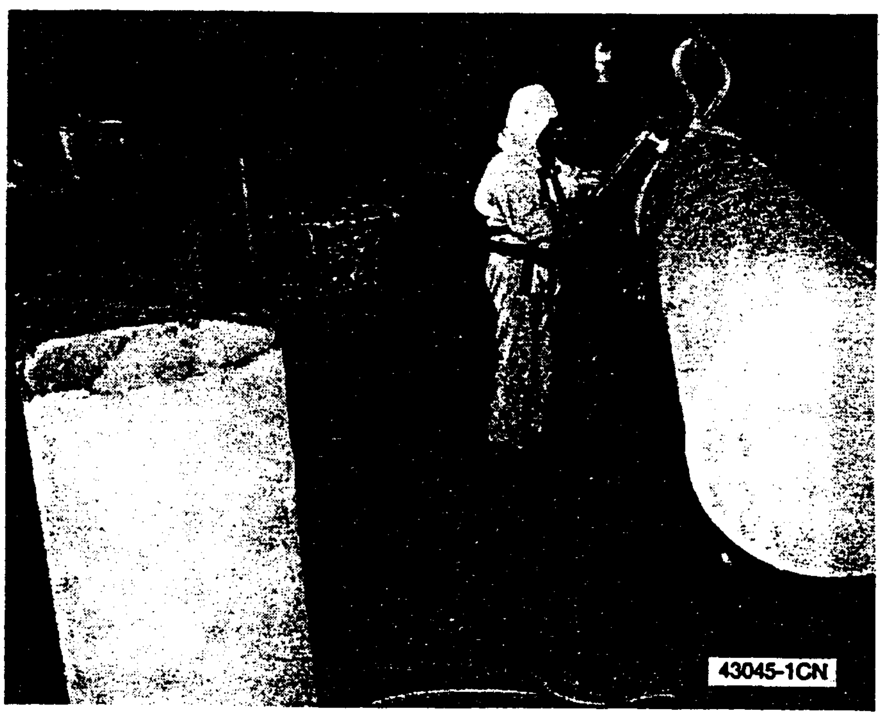

Figure 16. ISF Storage Tube Cutting

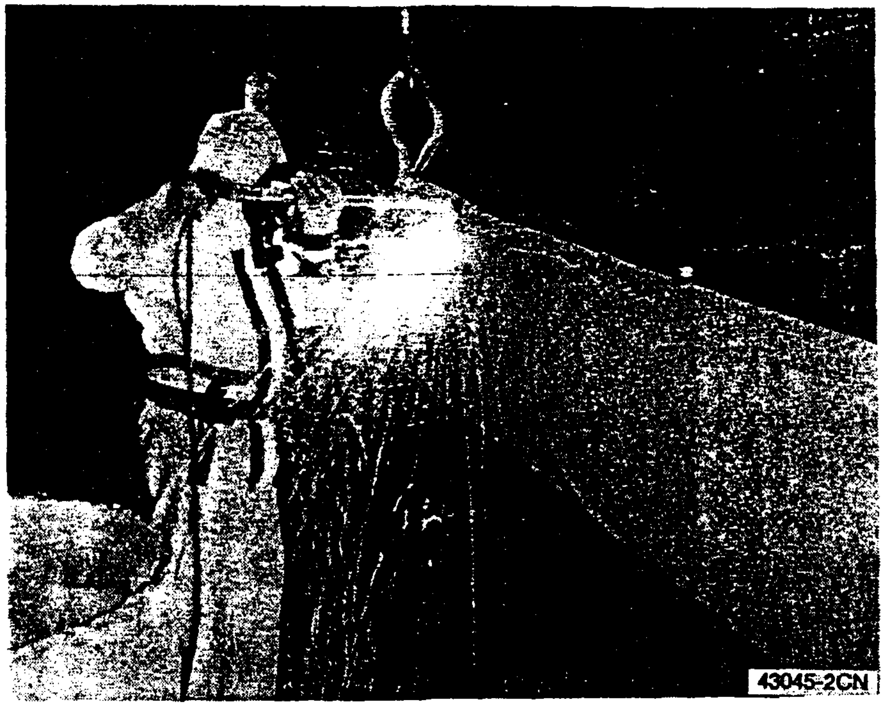

Figure 17. ISF Storage Tube Cutting

4.6 DECOMMISSIONING RADIOLOGICAL SURVEY

All soil, rock, concrete, and storage tubes and baskets were surveyed with portable radiation survey instruments, and any material with an indicated surface radiation in excess of 50 cpm of beta activity or with any detectable alpha activity was deemed to be contaminated. Soil samples with indicated ^{60}Co or ^{137}Cs net levels above 1 pCi/g activity measured on a multichannel analyzer were also considered contaminated.

4.7 POSTDECOMMISSIONING RADIOLOGICAL SURVEY

Throughout this project, Health, Safety, and Radiation Services monitoring was fully utilized. Much of this effort was directed toward discovering and eliminating residual radioactive contamination. The final radiologic survey can be broken into three phases:

- Phase A: constant monitoring of soil and structure surfaces during final phases of structure removal

- Phase B: radiometric screening and analysis of soil samples taken from excavation by gamma spectroscopy
- Phase C: Final statistical survey of ISF area including surrounding fringe areas for gross gamma activity.

Since all structural surfaces were removed, the criteria for release relate only to soil activity and ambient radiation. Each phase and its findings are discussed below.

Phase A. Constant surveillance of removed and onsite materials was conducted by Health, Safety, and Radiation Services personnel to monitor for possible alpha, beta, and gamma emitting radionuclides. No measurable contamination was found on the soil or surrounding native rock. Logical paths of possible contaminant migration (e.g., runoff channels) were followed by soil sampling and radioactive analysis as well as in situ gamma radiation surveys. No measurable contamination was found.

Phase B. Soil samples were obtained both during the soil removal process and also at the maximum extent of the excavation project. The samples were submitted to Health, Safety, and Radiation Services for radiometric screening by gamma spectroscopy.

A Canberra Series 85 multichannel analyzer with an intrinsic germanium solid-state detector system was used. Because the ISF area had been used to store spent fuel and previous in situ gamma spectroscopic measurements (made with a portable Canberra Series 10 MCA system) had identified only ^{137}Cs as present, an isotope identification library of fission-produced radionuclides was used.

Soil samples were screened for contamination by placing each bag, containing roughly 2 to 5 kg of soil, on the germanium detector housing. Any sample showing a measurable quantity of any fission-produced radionuclides was then aliquoted into a standard mass and geometry for quantitative analysis. The only nonnaturally occurring isotope encountered was ^{137}Cs. The samples with measurable cesium contamination were further investigated by placing a carefully weighed amount in a Marinelli beaker to provide a standard calibrated geometry. None of the samples contained activity in excess of 2.0 pCi/g, as shown in Table 1. Assuming a natural activity of 30 pCi/g and any undetected activity of ^{90}Sr equal to twice the measured ^{137}Cs activity, the maximum beta activity would be 36 pCi/g. This value was less than the release criterion of 100 pCi/g gross detectable beta activity.

Phase C. After completion of the final backfilling, a statistical survey was made at the surface in both the area previously occupied by the ISF facility and its environs. As in all phases of the project, particular attention was paid to routes of possible migration. Since the contamination had been previously identified as primarily ^{137}Cs, a Ludlum 2200 scaler was equipped with a 2-in. by 2-in. sodium iodide gamma scintillation crystal. A survey map was prepared, and a 10% sample of the available 1-meter-square grids was scanned. (Figure 18 gives the measurement location map.) Measurements were accomplished by moving the detector crystal back and forth across the selected square for a 1-min period and recording the gamma rays detected by the NaI crystal. Some complications to this approach were noted during the data acquisition phase of this survey. The instrumentation being used for radiation measurement was sufficiently sensitive that the scattered "skyshine" radiation from the RMDF contributed significantly to the ambient exposure rate. To compensate for this effect, linear interpolation was used to estimate local background. A Ludlum Model 12S "Micro R" meter was used in two separate locations in the ISF area to determine the mean environmental exposure rate. These data were correlated with the gross gamma measurements obtained in the same two areas to determine a conversion factor from the gross gamma measurements to relate the scaler count-rate data to exposure rate in μR/h, background exposure rate, and a background gradient from skyshine from operations at the nearby RMDF. These data are given in Table 2. After adjustment for this skyshine, background radiation was found to average 12 μR/h, slightly above the 10 μR/h found at background point 1.

TABLE 1

ISF GAMMA SPECTROSCOPY--SOIL SCREENING

Sample No.	ID No.[a]	Date (1984)	Mass (g)	^{137}Cs (pCi/g)
1	1	24 Aug	2240	ND[b]
2	2	24 Aug	2438	0.007
3	3	22 Aug	~2000	0.134
4	4	22 Aug	-	Trace
5	5	21 Aug	~2000	0.353
6	6	21 Aug	~2000	2.145
7	6-1	21 Aug	956	1.63
8	7	21 Aug	~2000	0.84
9	7-1	21 Aug	890	1.18
10	7-2	21 Aug	935	1.87
11	7-3	21 Aug	1056	1.16
12	7-4	21 Aug	812	1.56
13	8	21 Aug	~5000	0.458
14	9	22 Aug	3787	0.244
15	10	22 Aug	3426	ND
16	11	21 Aug	2700	0.063
17	12	21 Aug	4011	Trace
18	13	21 Aug	2892	ND
19	15	21 Aug	3787	0.055
20	16	21 Aug	3186	0.015
21	1	30 Aug	2593	0.006
22	ISFI	31 Aug	4528	ND
23	ISF2	31 Aug	3847	ND
24	ISF3	31 Aug	-	ND
25	ISF4	31 Aug	4026	ND
26	ISF5	31 Aug	3226	ND
27	ISF6	31 Aug	4548	ND
28	ISF7	31 Aug	4415	ND
29	ISF8	31 Aug	4181	ND
30	ISFFS1	04 Sep	3828	ND
31	ISFFS2	04 Sep	4725	ND
32	ISFFS3A	04 Sep	3186	0.016
33	ISFFS3B	04 Sep	3337	ND
34	ISFFS4	04 Sep	3714	ND
35	ISFFS5	04 Sep	3295	0.003
36	ISFFS6	04 Sep	3028	ND
37	ISFFS7	04 Sep	3467	ND
38	ISFFS8	04 Sep	3906	ND
39	1	19 Oct	3074	ND
40	2	19 Oct	2920	0.027
41	3	19 Oct	2442	0.044
42	4	19 Oct	2814	0.069
43	5	19 Oct	2943	0.069
44	6	19 Oct	2934	0.028

[a]Dash numbers (e.g., 6-1, 7-1) indicate quantitative determinations using a Marinelli beaker.
[b]ND = No detectable activity.

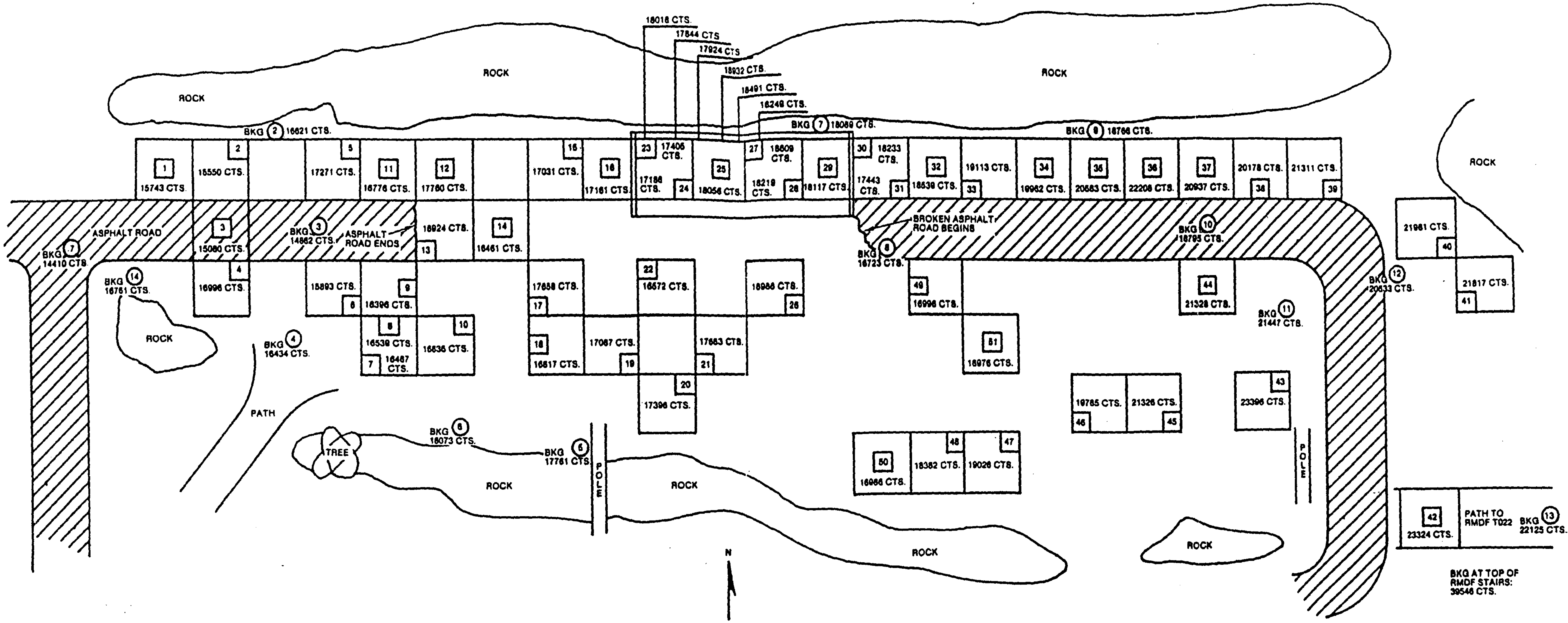

Figure 18. ISF Gross Gamma Survey Locations

RB08 158

TABLE 2

ISF BACKGROUND GAMMA, BACKGROUND AND GRADIENT DETERMINATION

Gamma Count Rate (cpm)	Exposure Rate (μR/h)	Conversion Factor (10^{-4} μR/h per cpm)
Background point 1		
13156	10.5	7.98
13561	10.2	7.52
13376	10.5	7.85
13415	10.2	7.60
13558	10.0	7.38
Average		7.76 ± 0.245
Background point 2		
33291	22.5	6.76
33057	24.0	7.26
33560	23.0	6.85
33304	25.0	7.51
33521	25.0	7.61
Average		7.20 ± 0.382
Combined average		7.43 ± 0.390

The entire data set is reproduced in Table 3, and a statistical analysis of these data is shown in Table 4. The data have been further analyzed and graphic representations produced. In Table 3, the uncorrected counts for each location shown in Figure 18 are listed, along with a "distance factor" to indicate the approximate relationship in moving from areas in which the skyshine is negligible toward areas in which it is significant. The distance factor was used in the linear interpolation to reduce the contribution of skyshine to the local exposure rate. The uncorrected counts were connected to exposure rate (in μR/h) using the conversion factor shown in Table 2. Similarly, after correction for skyshine, the corrected counts were converted to exposure rate. This provides, within the accuracy of the measurements, the best estimate of the local exposure rate. Figures 19 and 20 are for the uncorrected exposure rate and corrected exposure rate, respectively. These figures show cumulative probability distributions of the exposure rate data. In Figure 20, the values

TABLE 3

ISF FINAL GAMMA SURVEY DATA

Survey Point	Distance Factor	Uncorrected Counts	Uncorrected μR/h	Corrected Counts	Corrected μR/h
1	1	15743	11.69	15579	11.57
2	2	15550	11.55	15222	11.30
3	2	15080	11.20	14752	10.96
4	2	16996	12.62	16668	12.38
5	4	17271	12.83	16615	12.34
6	4	15893	11.80	15237	11.32
7	5	16467	12.23	15647	11.62
8	5	16539	12.28	15719	11.67
9	5	16396	12.18	15576	11.57
11	5	16770	12.46	15950	11.85
10	6	16835	12.50	15851	11.77
12	6	17760	13.19	16776	12.46
13	6	16924	12.57	15940	11.84
14	7	16461	12.23	15313	11.37
15	8	17031	12.65	15719	11.67
17	8	17658	13.11	16346	12.14
18	8	16817	12.49	15505	11.52
16	9	17161	12.75	15685	11.65
19	9	17087	12.69	15611	11.59
23	10	17405	12.93	15765	11.71
23	10	18018	13.38	16378	12.16
24	10	17186	12.76	15546	11.55
24	10	17844	13.25	16204	12.03
22	10	16572	12.31	14932	11.09
20	10	17396	12.92	15756	11.70
21	11	17685	13.13	15881	11.79
25	11	18056	13.41	16252	12.07
25	11	17924	13.31	16120	11.97
25	11	18932	14.06	17128	12.72
25	11	18491	13.73	16687	12.39
26	12	18609	13.82	16641	12.36
27	12	18609	13.82	16641	12.36
27	12	18249	13.55	16281	12.09
28	12	18219	13.53	16251	12.07
29	13	18117	13.46	15985	11.87
30	14	18233	13.54	15937	11.84
31	14	17443	12.96	15147	11.25
50	14	16986	12.62	14690	10.91
32	15	18539	13.77	16079	11.94
48	15	18328	13.61	15868	11.78
49	15	16996	12.62	14536	10.80
33	16	19113	14.20	16489	12.25

TABLE 3

ISF FINAL GAMMA SURVEY DATA
(Continued)

Survey Point	Distance Factor	Uncorrected Counts	Uncorrected μR/h	Corrected Counts	Corrected μR/h
47	16	19026	14.13	16402	12.18
51	16	18976	14.09	16352	12.14
34	17	19962	14.83	17174	12.76
35	18	20583	15.29	17631	13.09
46	18	19785	14.70	16833	12.50
36	19	22208	16.50	19092	14.18
45	19	21326	15.84	18210	13.53
37	20	20937	15.55	17657	13.11
44	20	21328	15.84	18048	13.40
38	21	20178	14.99	16734	12.43
43	21	23396	17.38	19952	14.82
39	22	21311	15.83	17703	13.15.
40	24	21981	16.33	18045	13.40
42	24	23324	17.32	19388	14.40
41	25	21817	16.21	17717	13.16

TABLE 4

STATISTICAL ANALYSIS OF DATA SET

Value	Mean	Standard Deviation
Uncorrected counts	18343	1954
Uncorrected μR/h	13.62	1.45
Corrected counts	16383	1125
Corrected μR/h	12.17	0.84

have been adjusted to correct for the skyshine from RMDF. The resulting distribution is somewhat smoother and has less variability, indicating that the adjustment method is reasonably appropriate. (In these graphs, a perfect Gaussian distribution would show as points along a straight line. The steeper the slope, the greater the variability of the data.) Figure 20 shows that:

- The values displayed are from a single population
- The criterion of 5 μR/h above background existing under NRC guidance was met.

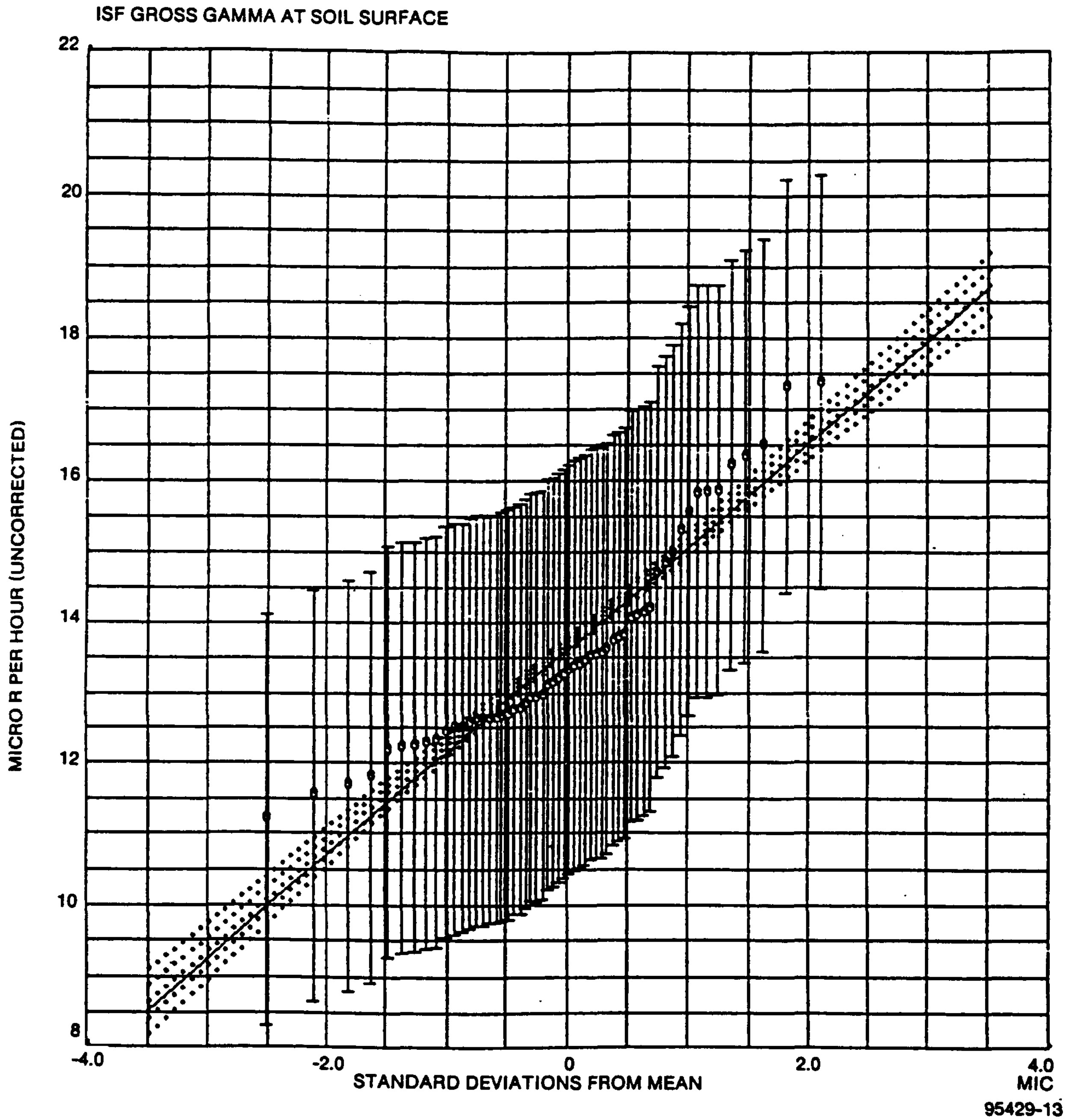

Figure 19. Cumulative Probability Distribution of Uncorrected Ambient Exposure Rate

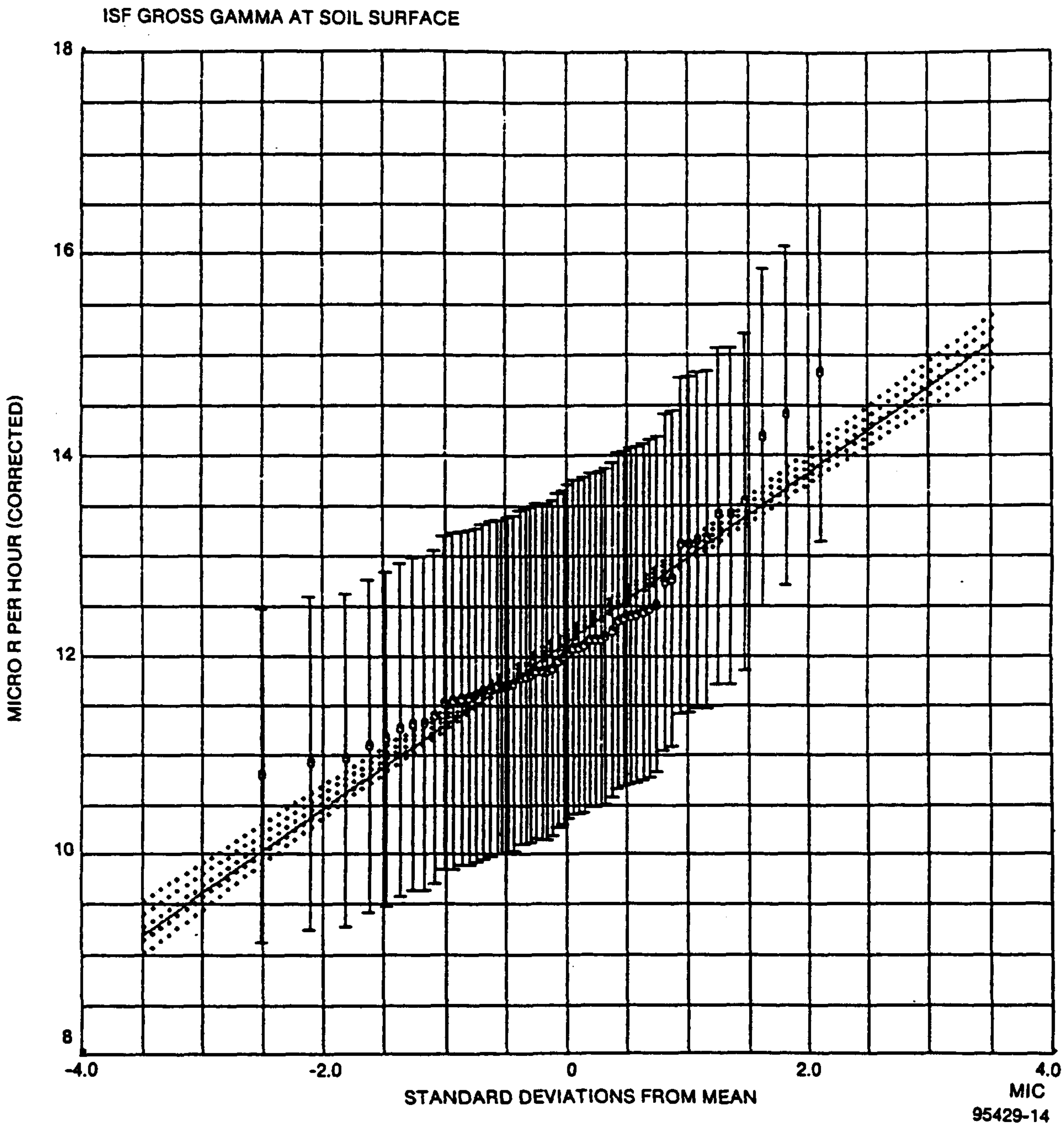

Figure 20. Cumulative Probability Distribution of Ambient Exposure Rate, Adjusted for Skyshine from RMDF

4.8 POSTDECOMMISSIONING HAZARDOUS CHEMICAL CONDITION

No hazardous chemical conditions existed in or resulted from the ISF decommissioning operation.

5.0 COST AND SCHEDULE

The budget for the ISF decommissioning was $430,000. The total cost of the ISF decommissioning was $267,000. A breakdown of the cost is as follows:

ISF decommissioning labor	$170,000
Demolition contract	48,000
Waste transportation burial	40,000
Program management	9,000
	$267,000

The schedule for the decommissioning of the ISF is given in Figure 21. The work was accomplished in accordance with this original schedule.

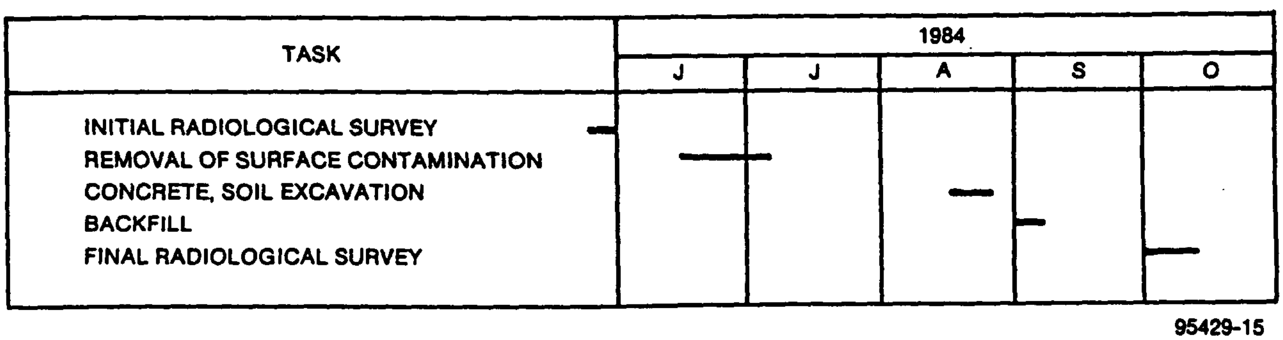

Figure 21. ISF Decommissioning Schedule

6.0 WASTE VOLUMES GENERATED

A total of 168.5 m^3 of low specific activity (LSA) waste consisting of 126 King-Pac containers (1 m^3 each) containing soil, asphalt, and concrete and 12 wood box containers (3.54 m^3 each) containing storage tube and basket sections was generated during the decommissioning of the ISF. It was shipped by truck as radioactive waste to the DOE disposal site.

7.0 OCCUPATIONAL EXPOSURE TO PERSONNEL

None of the Engineering or Health, Safety, and Radiation Services personnel assigned to the ISF decommissioning project received any measurable exposure to ionizing radiation during the decommissioning.

8.0 FINAL FACILITY OR SITE CONDITION

The ISF site was restored to its natural state after the decommissioning was complete. The excavation was backfilled and the surface graded to match the contours of the surrounding land. Figure 22 shows the postdecommissioning condition of the ISF site.

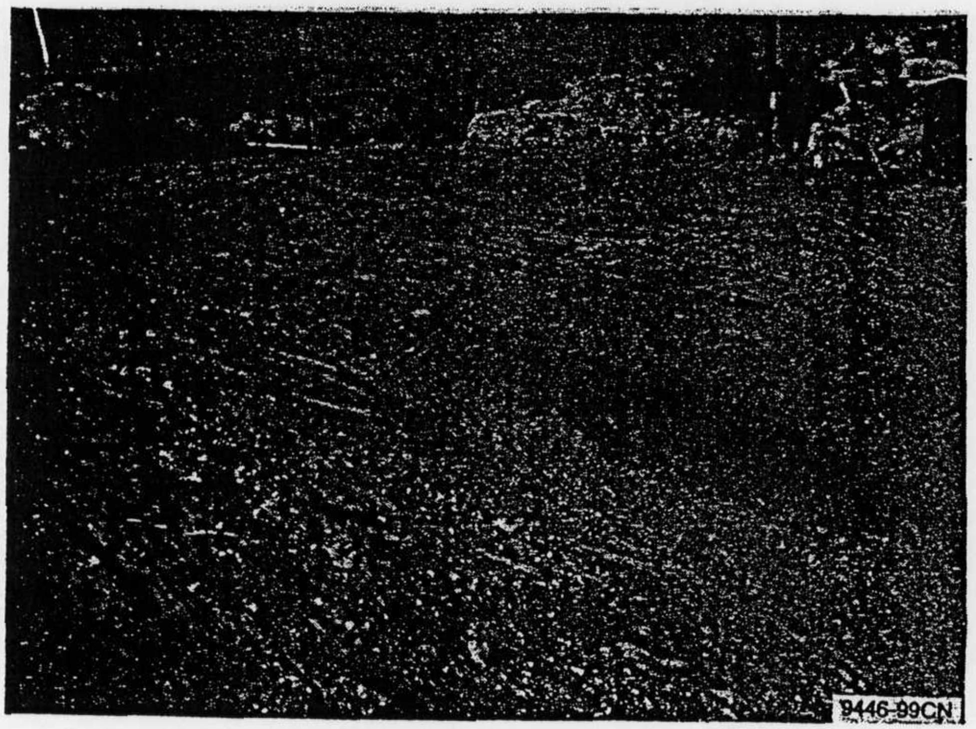

Figure 22. Postdecommissioning Condition of the ISF Site

The final survey shows that the site is suitable for unrestricted release.

9.0 LESSONS LEARNED

During the project, several observations were made that qualify as lessons learned:

- The galvanized carbon steel storage tubes did not leak, and they properly contained the contamination within the tubes even though they periodically contained water.
- The storage tubes could not be pulled from the oversized holes drilled in the sandstone without first exposing 45% of the storage tube surface and removing the backfill drilling mud.
- The backhoe and hydraulic ram equipment proved to be effective and economical for removing the tubes.
- The packaging and handling facilities at RMDF were very useful for cutting up and packaging the storage tubes.
- A special prefilter smoke retention housing was required to prevent the RMDF absolute filters from plugging due to the large quantities of particulates generated during the activity to cut up the storage tubes and internal baskets.

REFERENCES

1. J. Harris, "Relevant Information to Support RMDF and Interim Storage Facility Decommissioning," N704TI990059 (5 November 1981)

2. J. F. Lang, "Interim Storage Facility Decommissioning Plan," N001TI000188 (6 June 1983)

5874F/nth

ORISE
OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION

March 13, 1996

Mr. Don Williams
U.S. Department of Energy
EM-421
Cloverleaf Building
Washington, DC 20585-0002

SUBJECT: **FINAL REPORT - VERIFICATION SURVEY OF THE INTERIM STORAGE FACILITY; BUILDINGS T030, T641, AND T013; AN AREA NORTHWEST OF BUILDINGS T019, T013, T012, AND T059; AND A STORAGE YARD WEST OF BUILDINGS T626 AND T038; SANTA SUSANA FIELD LABORATORY, ROCKWELL INTERNATIONAL, VENTURA COUNTY, CALIFORNIA**

Dear Mr. Williams:

Enclosed are two copies of the subject report. Comments on the draft report that were provided in your December 28, 1995 memorandum have been incorporated into the final report. The report describes the procedures and results of the radiological surveys that the Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education (ORISE) performed during the period of September 11 through 14, 1995.

Please contact me at (423) 576-5073 or W. L. (Jack) Beck at (423) 576-5031 if we may provide you with any additional information.

Sincerely,

Timothy J. Vitkus
Project Manager
Environmental Survey and
Site Assessment Program

TJV:tsf

Enclosure

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VERIFICATION SURVEY OF THE INTERIM STORAGE FACILITY; BUILDINGS T030, T641, AND T013; AN AREA NORTHWEST OF BUILDINGS T019, T013, T012, AND T059; AND A STORAGE YARD WEST OF BUILDINGS T626 AND T038 SANTA SUSANA FIELD LABORATORY ROCKWELL INTERNATIONAL VENTURA COUNTY, CALIFORNIA

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Prepared for the Office of Environmental Restoration
U.S. Department of Energy

ORISE

OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION

Environmental Survey and Site Assessment Program
Environmental and Health Sciences Group

RD99-158

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VERIFICATION SURVEY OF THE INTERIM STORAGE FACILITY; BUILDINGS T030, T641, AND T013; AN AREA NORTHWEST OF BUILDINGS T019, T013, T012, AND T059; AND A STORAGE YARD WEST OF BUILDINGS T626 AND T038 SANTA SUSANA FIELD LABORATORY ROCKWELL INTERNATIONAL VENTURA COUNTY, CALIFORNIA

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Office of Environmental Restoration
U.S. Department of Energy

FINAL REPORT

FEBRUARY 1996

This report is based on work performed under contract number DE-AC05-76OR00033 with the U.S. Department of Energy.

VERIFICATION SURVEY
OF THE
INTERIM STORAGE FACILITY; BUILDINGS T030, T641, AND T013; AN AREA NORTHWEST OF BUILDINGS T019, T013, T012, AND T059; AND A STORAGE YARD WEST OF BUILDINGS T626 AND T038
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ACKNOWLEDGMENTS

The author would like to acknowledge the significant contributions of the following staff members:

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ABBREVIATIONS AND ACRONYM

AEC	Atomic Energy Commission
cm	centimeter
cm^2	square centimeter
cpm	counts per minute
DOE	Department of Energy
dpm/100 cm^2	disintegrations per minute per 100 square centimeters
EM	Environmental Restoration and Management
EML	Environmental Measurements Laboratory
EPA	Environmental Protection Agency
ERDA	Energy Research and Development Administration
ESSAP	Environmental Survey and Site Assessment Program
ETEC	Energy Technology Engineering Center
GM	Geiger Mueller
ha	hectare
ISF	Interim Storage Facility
km	kilometer
m	meter
m^2	square meter
M&O	Management and Operation
NaI	Sodium Iodide
NIST	National Institute of Standards and Technology
NW Area	Northwest Area
ORISE	Oak Ridge Institute for Science and Education
pCi/g	picocuries per gram
PIC	pressurized ionization chamber
SSFL	Santa Susana Field Laboratory
SNAP	Systems for Nuclear and Auxiliary Power
SRE	Sodium Reactor Experiment
μR/h	microroentgens per hour
ZnS	Zinc Sulfide

VERIFICATION SURVEY OF THE INTERIM STORAGE FACILITY; BUILDINGS T030, T641, AND T013; AN AREA NORTHWEST OF BUILDINGS T019, T013, T012, AND T059; AND A STORAGE YARD WEST OF BUILDINGS T626 AND T038 SANTA SUSANA FIELD LABORATORY ROCKWELL INTERNATIONAL VENTURA COUNTY, CALIFORNIA

INTRODUCTION AND SITE HISTORY

Rockwell International's Rocketdyne Division operates the Santa Susana Field Laboratory (SSFL). The Energy Technology Engineering Center (ETEC) is that portion of the SSFL, operated for the Department of Energy (DOE), which performs testing of equipment, materials, and components for nuclear and energy related programs. Contract work for the Atomic Energy Commission (AEC) and the Energy Research and Development Administration (ERDA), predecessor agencies to the DOE, began in the early 1950's. Specific programs conducted for AEC/ERDA/DOE involved the engineering, development, testing, and manufacturing operations of nuclear reactor systems and components. Other SSFL activities have also been conducted for the National Aeronautics and Space Administration, the Department of Defense, and other government related or affiliated organizations and agencies. Some activities have been licensed by the Nuclear Regulatory Commission and by the State of California Radiological Health Branch of the Department of Health Services.

Numerous buildings and land areas became radiologically contaminated as a result of the various operations which included ten reactors, seven criticality test facilities, fuel fabrication, reactor and fuel disassembly, laboratory work, and on-site storage of nuclear material. Potential radioactive contaminants identified at the site are uranium (in natural and enriched isotopic abundances), plutonium, Am-241, fission products (primarily Cs-137 and Sr-90), activation products (tritium [H-3], Co-60, Eu-152, Eu-154, Ni-63, Pm-147, Ta-182). Chemical contaminants, mainly chlorinated organic solvents, have also been identified in groundwater, primarily as a result of rocket engine testing.

Decontamination and decommissioning of contaminated facilities began in the late 1960's and continues as the remaining DOE program operations at ETEC have been terminated, effective September 30, 1995. As part of this program, Rockwell/Rocketdyne performed decommissioning and final status surveys of a number of facilities that supported the various nuclear related ETEC operations during the latter part of the 1950's and continuing through the 1980's. Environmental Management of DOE contaminated properties continues under the termination clause of the existing M&O contract. Surplus sodium facilities have been included in the current EM (Environmental Restoration and Waste Management) Program for stabilization and eventual cleanup.

The Interim Storage Facility (ISF), also referred to as DOE Facility 654, was constructed in 1958 to support the Sodium Reactor Experiment (SRE). The ISF was used to store dummy and spent fuel elements, shipping and storage casks, hot waste generated at the SRE, and items from the Organic Moderated Reactor Experiment and Systems for Nuclear and Auxiliary Power (SNAP). The ISF consisted of a concrete pad with a trench containing eight 51-centimeter diameter galvanized steel cells extending 7.6 meters into the rock strata. While the ISF was in use, a number of the items stored there deteriorated and released low-level contamination to adjacent asphalt surfaces and soil areas. Decommissioning of the ISF began in 1984 and involved removal of contaminated surfaces, soil, and the storage cells. The area was then backfilled and returned to a natural state (Rockwell 1985).

Building T030 was used from 1960 through 1964 to house a Van deGraaf accelerator facility for the performance of activation experiments. In 1965, the facility was converted for use as an office building although the accelerator remained on-site in an unused condition until at least 1966. Sometime after 1966 the facility was surveyed, and tritium contamination was identified on the accelerator. The accelerator was removed and the facility released for other uses. An asphalt area south of Building T030 was fenced and used for the storage of palletized items. It has not been verified, but items stored there may have included drums containing mixed fission products (Rockwell 1988a).

Building T641 was constructed in 1964 to serve as a shipping and receiving facility for SSFL. All radioactive and nuclear material shipments were only handled on the outdoor dock of the building. Documentation indicates that all shipments were fully packaged and never opened while on the dock. There have been no documented leaks at this facility (Rockwell 1988a).

Building T013 was constructed in 1961 for the assembly and checkout of non-nuclear SNAP reactor components. In 1970, the facility was redesignated as the ETEC Thermal Transient Facility and used for thermal testing and seismic test equipment. Rockwell/Rocketdyne classified this building as non-nuclear related.

The storage area northwest of T059, T019, T013, and T012 consists of a paved area between the buildings and the SNAP facility fence line. The property then drops sharply off to the SSFL property line. The paved portion of this Northwest Area (NW Area) was used for equipment staging and gas tanks. Site documentation identified this area as non-nuclear.

The final area was a storage yard west of Building T626 and T038 that was used for storing equipment and salvageable components. In 1978, drums containing sand contaminated with Co-60 were stored there. Rockwell/Rocketdyne performed final status surveys of each of these areas in the latter part of the 1980's and did not identify residual contamination (Rockwell 1988b).

DOE's Office of Environmental Restoration, Northwestern Area Programs is responsible for oversight of a number of remedial actions that have been or will be conducted at the SSFL. It is the policy of DOE to perform independent (third party) verification of remedial action activities conducted within Office of Environmental Restoration programs. The purpose of these independent verifications is to confirm that remedial actions have been effective in meeting established and supplemental guidelines and that the documentation accurately and adequately describes the radiological conditions at the site. The Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education (ORISE) was designated as the organization responsible for this task at SSFL and was requested by the DOE to perform verification surveys of these buildings and areas. This report describes the results of the verification surveys.

SITE DESCRIPTION

The SSFL is located in the Simi Hills of southeastern Ventura County, California, approximately 47 kilometers (29 miles) northwest of downtown Los Angeles (Figure 1). The site is comprised of approximately 1,090 hectares (ha [2,700 acres]) and is divided into four administrative areas (Areas I through IV) and a Buffer Zone. DOE operations are conducted in Rockwell International-owned and DOE-owned facilities located within the 117 ha Area IV (Figure 2). The ETEC portion of Area IV consists of government-owned buildings that occupy 36 ha.

The ISF was located in the north-central portion of Area IV. The ISF was paved with a concrete berm containing the eight storage cells. The pavement, berms, and storage cells were removed during the decommissioning and the area was backfilled and graded. Total area of the ISF is not provided in the project documentation, but is estimated to be approximately 150 m^2 based on survey maps. Figures 2 and 3 show the location and plot plan of the ISF.

Building T030 is located north of G Street on 10th Street which is north of G Street in the eastern portion of Area IV (Figure 2). The building is constructed with steel framing, siding, and roofs and consists of an east office section and a west section where the particle accelerator was located. Total floor area of the building is 215 m^2; the west section occupies 125 m^2 of the total. There is an exterior concrete wall at the northern end of the west section that provided shielding for the accelerator beam. Building T641 is located immediately to the south of T030. Total building area is 713 m^2. The loading dock area where radioactive materials were received is located on the east end of the building and occupies approximately 200 m^2. The floor plans of Buildings T030 and T641 are shown on Figures 4 and 5.

Post-It™ brand fax transmittal memo 7671	# of pages ▸ 1
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Fax # (818) 586-6142	Fax #

RD99-158

Building T013 is located on B Street and is constructed of steel framing and siding (Figure 2). The north half of the building contains office and storage areas while the south half contains the seismic test equipmen.. Total floor area is approximately 780 m^2. Figure 6 shows the floor plan.

Buildings T626 and T038 are located west of 20th Street in Area IV (Figure 2). The storage area where the contaminated sands were stored is located to the western side of these buildings (Figure 7). The entire area is paved with asphalt. The area northwest of Buildings T059, T019, T013, and T012 (the NW Area) is paved with asphalt for approximately 30 meters north of the buildings, where the asphalt ends and the area drops-off to the property line (Figures 2, 8 and 9). This portion of the NW Area is covered with brush with interspersed boulders and sandstone outcroppings.

OBJECTIVE

The objective of the verification survey was to validate that cleanup procedures and survey methods utilized by Rockwell/Rocketdyne were adequate. Perfomance of independent document reviews and evaluation of measurement and sampling data provides assurance that the post-remediation data is sufficient, accurate, and demonstrates that remedial actions were accomplished in accordance with appropriate standards and guidelines, and that authorized limits were met.

DOCUMENT REVIEW

ESSAP has reviewed Rockwell/Rocketdyne's supporting documentation concerning each building or outdoor areas final status survey procedures and results (Rockwell 1985, 1988a, and1988b).

PROCEDURES

ESSAP personnel conducted independent measurement and sampling activities at the SSFL facility during the period September 11 through 14, 1995. Survey activities were performed in accordance with a site-specific survey plan (ORISE 1995), using procedures and instruments described in the ESSAP Survey Procedures and Quality Assurance Manuals and summarized in Appendices A and B.

For this survey, ESSAP classified buildings or outdoor areas that did not have a history of radiological use or storage as unaffected (referred to as "non-nuclear use" in Rockwell/Rocketdyne documentation). Buildings and outdoor areas with a history of radiological use, or where radioactive materials were known to or suspected of having been stored, were classified as affected areas. Survey coverage was determined based on whether an area was designated as unaffected or affected in accordance with the following procedures.

SURVEY PROCEDURES: UNAFFECTED AREAS

The following survey procedures applied to Building T013 and the NW Area.

Reference System

Measurement and sampling locations were referenced to prominent building or site features, and recorded on representative area drawings.

Surface Scans

Surface scans for alpha, beta, and gamma activity were performed in Building T013 and the paved portions of the NW Area. Only gamma scans were performed in the soil portions of the NW Area. Scan area coverage was approximately 10 to 50 percent of the floors and lower walls (up to 2 meters) of Building T013 and the paved and soil areas of the NW Area. Scans were performed using gas proportional, ZnS, GM, and/or NaI scintillation detectors coupled to ratemeters or ratemeter-scalers with audible indicators.

Surface Activity Measurements

Direct measurements for total alpha and total beta activity were performed at 31 randomly selected locations within Building T013 and at 25 locations on the paved portion of the NW Area. Direct measurements were made using gas proportional, ZnS, and/or GM detectors coupled to ratemeter-scalers. A smear sample for the determination of removable gross alpha and gross beta activity was collected from each of the Building T013 direct measurement locations. Figures 6 and 8 show measurement and sampling locations in unaffected areas.

Exposure Rate Measurements

ESSAP performed exterior background exposure rate measurements at six locations within 0.5 to 10 km of the site (Figure 10) and used Rockwell's previously determined building interior background exposure rate measurements for data comparisons. Exposure rate measurements were performed at four locations in Building T013 and a total of seven locations within the NW Area. Exposure rate measurements were performed at 1 meter above the surface using a pressurized ionization chamber (PIC). Figures 6, 7, and 8 show measurement locations.

Soil Sampling

Background soil samples were collected from the six background exposure measurement locations (Figure 10). Surface (0 to 15 cm) soil samples were collected from five locations in the NW area (Figure 9).

SURVEY PROCEDURES: AFFECTED AREAS

The following survey procedures were applicable to Building T030, the Building T641 loading dock, the ISF, and the storage yard west of Buildings T626 and T038.

Reference System

Measurement and sampling locations were referenced to prominent building or site features, and recorded on representative area drawings.

Surface Scans

Surface scans for alpha, beta, and gamma activity were performed over 50 to 100 percent of the accessible floors and lower walls (up to 2 m) within Building T030, the Building T641 loading dock, and the paved portions of the storage yard. Accessible overhead surfaces where material may have settled or accumulated were also scanned. Gamma scans only were performed in the ISF and the soil area that is located west of the storage yard. The ISF was excavated to a depth of 7.5 to 9 meters when the storage cells were removed and then backfilled to grade. As a result of back-filling, the original soil was inaccessible; therefore, scans of the ISF were concentrated in the peripheral areas where contamination may have migrated. Scans were performed using gas proportional, ZnS, GM, and/or NaI scintillation detectors coupled to ratemeters or ratemeter-scalers with audible indicators.

Surface Activity Measurements

Single-point direct measurements for total alpha and total beta activity were performed on floors, walls, equipment, and on pavement in the designated areas. A total of 19, 50, and 25 measurements were performed in Building T030, the Storage Yard west of Buildings T626 and T038, and the Building T641 loading dock, respectively. Direct measurements were performed using gas proportional, ZnS, and/or GM detectors coupled to ratemeter-scalers. A smear sample for the determination of removable gross alpha and gross beta activity was collected from each direct measurement location. In the western portion of Building T030, a second smear was collected from each direct measurement location for determination of removable tritium activity levels. Measurement and sampling locations for total and removable activity are shown in Figures 4, 5, and 7.

Exposure Rate Measurements

Exterior background exposure rate measurements were made at six locations within 0.5 to 10 km of the site (Figure 10). Exposure rate measurements were performed at 17 locations in the affected areas. Figures 3, 4, 5, and 7 indicate measurement locations. Exposure rate measurements were performed at 1 meter above the surface using a PIC.

Soil Sampling

Individual soil samples were collected from four locations in the ISF area. One composite surface (0-15 cm) soil sample was collected from the T626 storage area over a 100 m^2 area. Figures 3 and 7 indicate sampling locations.

Miscellaneous Sampling

Because available field instrumentation cannot detect tritium surface activity at the guideline levels, a limited number of miscellaneous samples were collected in order to provide a quantitative indication of total tritium surface activity. Paint samples were collected from five randomly selected 100 cm^2 area on the walls of the western portion of Building T030, where the accelerator was formerly located. Sampling locations are shown in Figure 4.

SAMPLE ANALYSIS AND DATA INTERPRETATION

Samples and data were returned to ORISE's ESSAP laboratory in Oak Ridge, Tennessee for analysis and interpretation. Soil samples were analyzed by solid state gamma spectrometry. Spectra were reviewed for U-238, U-235, Th-232, Cs-137, Co-60 and any other identifiable photopeaks, particularly additional activation and fission products. Gamma spectrometry data were reported in picocuries per gram (pCi/g). Smears were analyzed for gross alpha and gross beta activity using a low background proportional counter, and for tritium by liquid scintillation. Miscellaneous samples were analyzed for tritium by liquid scintillation counting. Smear results, miscellaneous sample results, and direct measurement data were converted to units of disintegrations per minute per 100 square centimeters (dpm/100 cm^2). Exposure rates are reported in microroentgens per hour (μR/h).

FINDINGS AND RESULTS

DOCUMENT REVIEW

Based on the review of the project documents, it is ESSAP's opinion that the documentation was inadequate to satisfactorily demonstrate that each building or area meet the DOE guidelines for release to unrestricted use. Overall, the documentation for each building or area does not provide a clear description of the sequence of events necessary for demonstrating that the subject areas meet the requirements for release to unrestricted use. That is, the specification of contaminants present, selection of the appropriate guidelines, development of a sampling and analysis plan that provides adequate data for guideline interpretation, and presentation of the data in a manner that can be directly compared with the guidelines. The types of deficiencies noted in the reports included the following: all potential contaminants were not identified, final surveys were not designed to identify residual contamination of all suspected radionuclides, residual surface activity data was either absent or not reported in units of dpm/100 cm^2, radionuclide-specific sample analyses were not performed (i.e., gross beta analysis of soil samples was performed and the data used for demonstrating compliance), and appropriate guidelines were not always cited or unapproved site-specific guidelines were used. Comments on the documentation were provided to the DOE (ORISE 1996).

UNAFFECTED AREAS

The results of the verification surveys for unaffected buildings and areas are discussed below.

T013 and NW Area

Surface Scans

Surface scans did not identify any areas of elevated alpha, beta, or gamma direct radiation.

Surface Activity Levels

Surface activity levels are summarized in Table 1. Total surface activity levels in Building T013 were less than 56 dpm/100 cm^2 for alpha and less than 1,400 dpm/100 cm^2 for beta. For the paved portion of the NW Area, surface activity levels were less than 100 dpm/100 cm^2 and less than 1,400 dpm/100 cm^2 for alpha and beta, respectively. Removable activity levels were less than 12 dpm/100 cm^2 for gross alpha and less than 16 dpm/100 cm^2 for gross beta.

Exposure Rates

Exposure rate measurement data is provided in Tables 3 and 4. Background exterior exposure rates ranged from 12 to 16 μR/h and averaged 14 μR/h. Exposure rates in the NW Area ranged from 14 to 16 μR/h. Exposure rates inside of Building T013 ranged from 8 to 11 μR/h.

Radionuclide Concentration In Soil

Radionuclide concentrations in soil samples are summarized in Table 5. Background concentration ranges were as follows: Cs-137, less than 0.1 to 0.2 pCi/g; Ra-226 less than 0.2 to 1.2 pCi/g; Th-228, 0.6 to 1.4 pCi/g; Th-232, 0.6 to 1.7 pCi/g; U-235, less than 0.1 pCi/g; and U-238, less than 2.2 to 2.5 pCi/g. Radionuclide concentrations in samples collected from the NW Area were: Cs-137, less than 0.1 to 0.5 pCi/g; Ra-226, 0.8 to 1.0 pCi/g; Th-228, 1.2 to 1.5 pCi/g; Th-232, 1.5 to 1.7 pCi/g; U-235, less than 0.1 pCi/g; and U-238, less than 1.5 to 1.9 pCi/g.

AFFECTED AREAS

The survey results for Buildings T030, T641 loading dock, the storage yard west of T625 and T038, and the ISF are discussed below.

Surface Scans

Surface scans for alpha, beta and gamma activity did not identify any locations of elevated direct radiation indicative of residual contamination.

Surface Activity Levels

Surface activity levels are summarized in Table 1. Surface activity levels for Building T030 were less than 55 dpm/100 cm^2 for total alpha and less than 1,400 dpm/100 cm^2 for total beta. Of the five miscellaneous samples collected from Building T030, four were less than the minimum detectable activities of the tritium procedure which ranged from 132 to 209 dpm/100 cm^2 (Table 2). One sample, location #2 on Figure 4, had a total tritium activity level of 6,600 dpm/100 cm^2. Activity levels for the Building T641 loading dock were less than 100 dpm/100 cm^2 for alpha and less than 1,400 dpm/100 cm^2 for beta. Total surface activity for the storage yard west of Building T626 and T038 was less than 55 dpm/100 cm^2 for alpha and ranged from less than 1,000 to 1,800 dpm/100 cm^2 for beta. Removable activity levels were less than 12 dpm/100 cm^2 for gross alpha and less than 16 dpm/100 cm^2 for gross beta. Removable tritium activity in Building T030 was less than 221 dpm/100 cm^2.

Exposure Rates

Exposure rates are summarized in Tables 3 and 4. Exposure rates ranged from 10 to 12 μR/h for the interior of Building T030 and the loading dock of Building T641. Rockwell determined that the average interior background exposure rate was approximately 8 μR/h. Exterior exposure rates for the ISF, ranged from 10 to 15 μR/h. Exterior background exposure rates ranged from 12 to 16 μR/h, and averaged 14 μR/h.

Radionuclide Concentrations in Soil

Radionuclide concentrations in soil samples are summarized in Table 5. Background concentration ranges were as follows: Cs-137, less than 0.1 to 0.2 pCi/g; Th-232, 0.6 to

1.7 pCi/g; Th-228, 0.6 to 1.4 pCi/g; Ra-226, less than 0.2 to 1.2 pCi/g; U-235, less than 0.1 pCi/g; and U-238, less than 2.2 to 2.5 pCi/g. Radionuclide concentrations in samples collected from the ISF and the area adjacent to the storage yard west of Buildings T626 and T038 were: Cs-137, less than 0.1 to 0.4 pCi/g; Th-232, 1.5 to 1.7 pCi/g; Th-228, 1.2 to 1.6 pCi/g; Ra-226, 0.7 to 1.2 pCi/g; U-235, less than 0.1 pCi/g; and U-238, less than 2.0 pCi/g.

COMPARISON OF RESULTS WITH GUIDELINES

Surface activity levels in each area were compared to the appropriate residual radioactive material guidelines specified in DOE Order 5400.5 for uranium and mixed fission and activation products (DOE 1990). These guidelines are summarized in Appendix C. The applicable guidelines for uranium are as follows:

<u>Total Activity</u>

5,000 α dpm/100 cm^2, average in a 1 m^2 area

15,000 α dpm/100 cm^2, maximum in a 100 cm^2 area

<u>Removable Activity</u>

1000 α dpm/100 cm^2

and the guidelines for beta-gamma emitters are:

<u>Total Activity</u>

5,000 β-γ dpm/100 cm^2, average in a 1 m^2 area

15,000 β-γ dpm/100 cm^2, maximum in a 100 cm^2 area

<u>Removable Activity</u>

1,000 β-γ dpm/100 cm^2

and the guidelines for tritium are (DOE 1995):

<u>Removable Activity</u>

10,000 dpm/100 cm^2

Although fixed tritium contamination was identified in Building T030, the guideline only addresses removable contamination. Removable tritium activity levels were within the guideline. All other total and removable activity levels were also within the respective guidelines.

The DOE's exposure rate guideline is 20 μR/h above background, although Rockwell/Rocketdyne has elected to use a more restrictive guideline of 5 μR/h above background. Exposure rates at 1 meter above the surface were within these guidelines.

Other than the DOE's generic residual soil concentration guidelines for thorium and radium of 5 pCi/g in the first 15 cm of soil and 15 pCi/g in 15 cm thick layers of subsurface soil, guidelines for other radionuclides are developed on a site-specific basis. Currently, there are no approved site-wide guidelines at SSFL for the radionuclides of concern. As a result, radionuclide concentrations in soils were compared to the background concentration levels. There were no radionuclides identified in excess of background levels.

SUMMARY

The Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education conducted verification activities for Buildings T013, T030, the loading dock of Building T641, the NW Area, the ISF, and the storage area west of Buildings T626 and T038 at the Santa Susana Field Laboratory in Ventura County, California. Verification activities included document reviews and during the period September 9 through 12, 1995 ESSAP personnel visited the site and performed independent surface scans, surface activity measurements, exposure rate measurements, miscellaneous material sampling, and soil sampling.

ESSAP's review identified a number of deficiencies in the final status documentation that was prepared for each building or area. Deficiencies noted included inadequate final status survey methods, no discussion of specific contaminants, inconsistent specification of all applicable guidelines and presentation of data that may be compared to the guidelines, absence of quantitative laboratory data, and inconsistent presentation of adequate figures documenting remediated areas and measurement and sampling locations.

ESSAP's verification survey results showed that surface activity levels, exposure rates, and/or radionuclide concentration levels in soil in the surveyed areas of Building T013, Building T030, the loading dock of Building T641, the NW Area, the Storage Yard West of Buildings T626 and T038, and the ISF were less than the current DOE guidelines for release to unrestricted use, or in the case of radionuclide concentrations in soils, comparable to background concentration levels.

Because of documentation deficiencies, ESSAP is unable to verify the radiological status of all areas. It is ESSAP's recommendation that final status documentation be revised and additional surveys performed as necessary to address those deficiencies that were identified and provided to DOE (ORISE 1996).

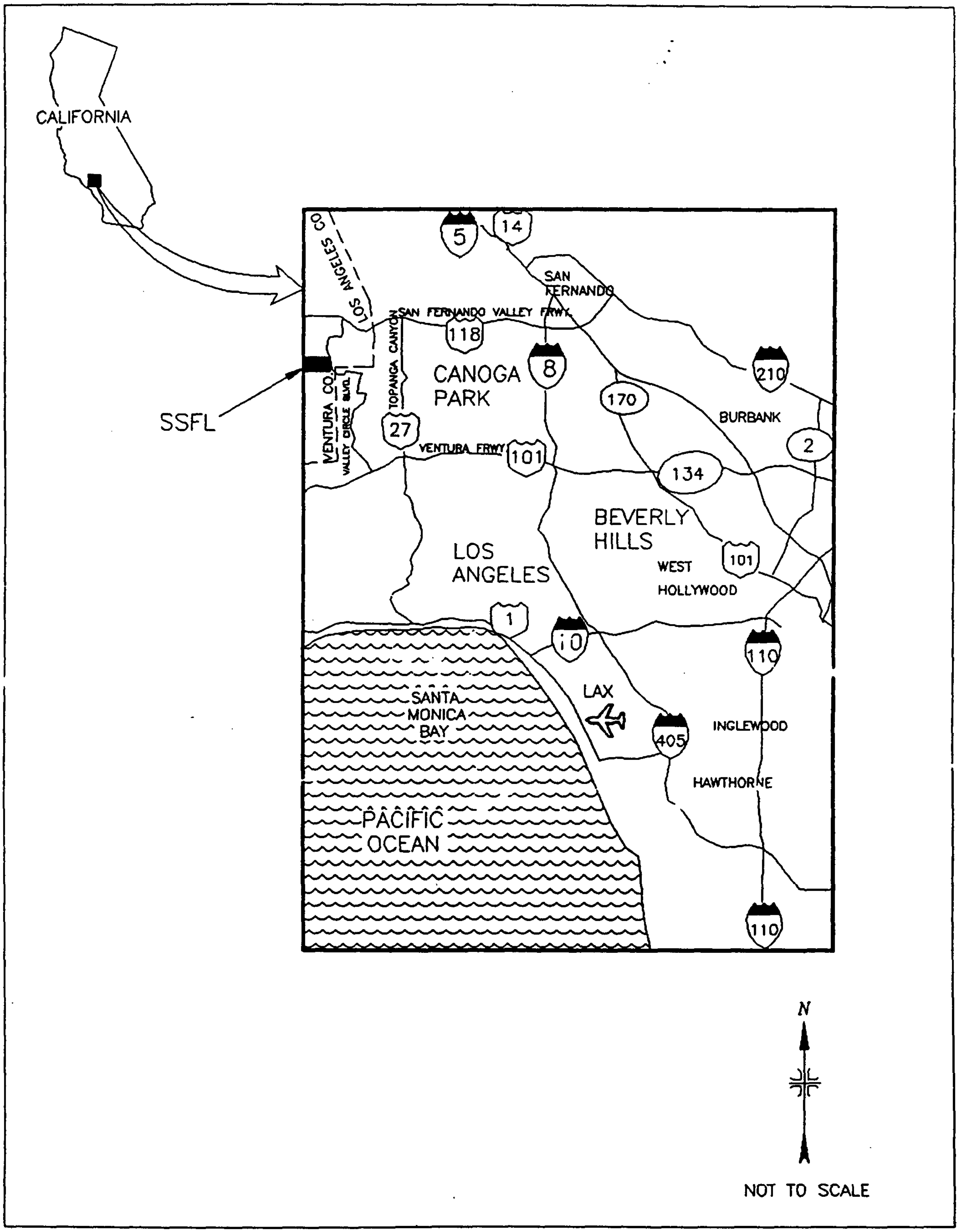

FIGURE 1: Los Angeles, California Area — Location of Santa Susana Field Laboratory Site

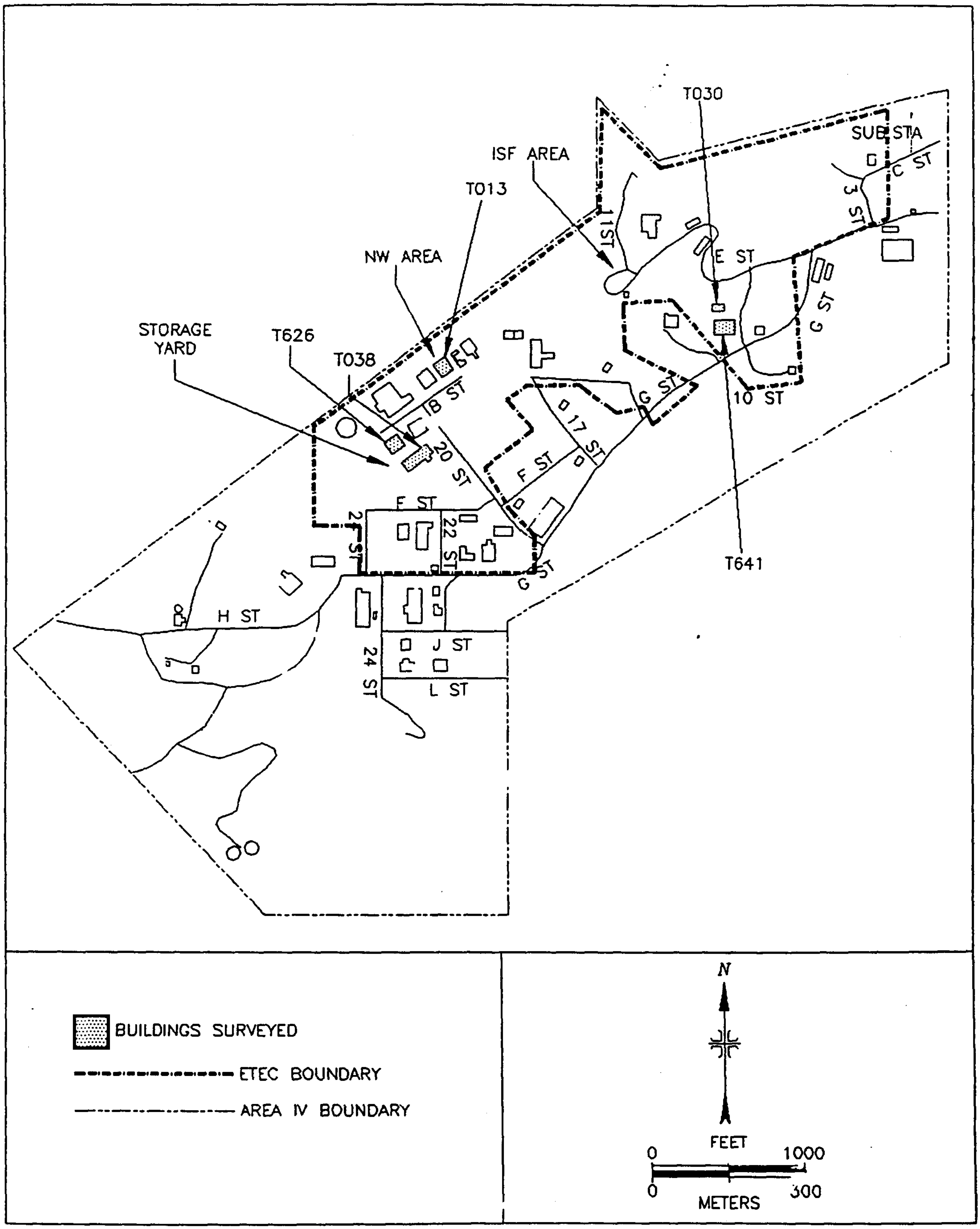

FIGURE 2: Santa Susana Field Laboratory Area IV, Plot Plan – Location of Surveyed Areas

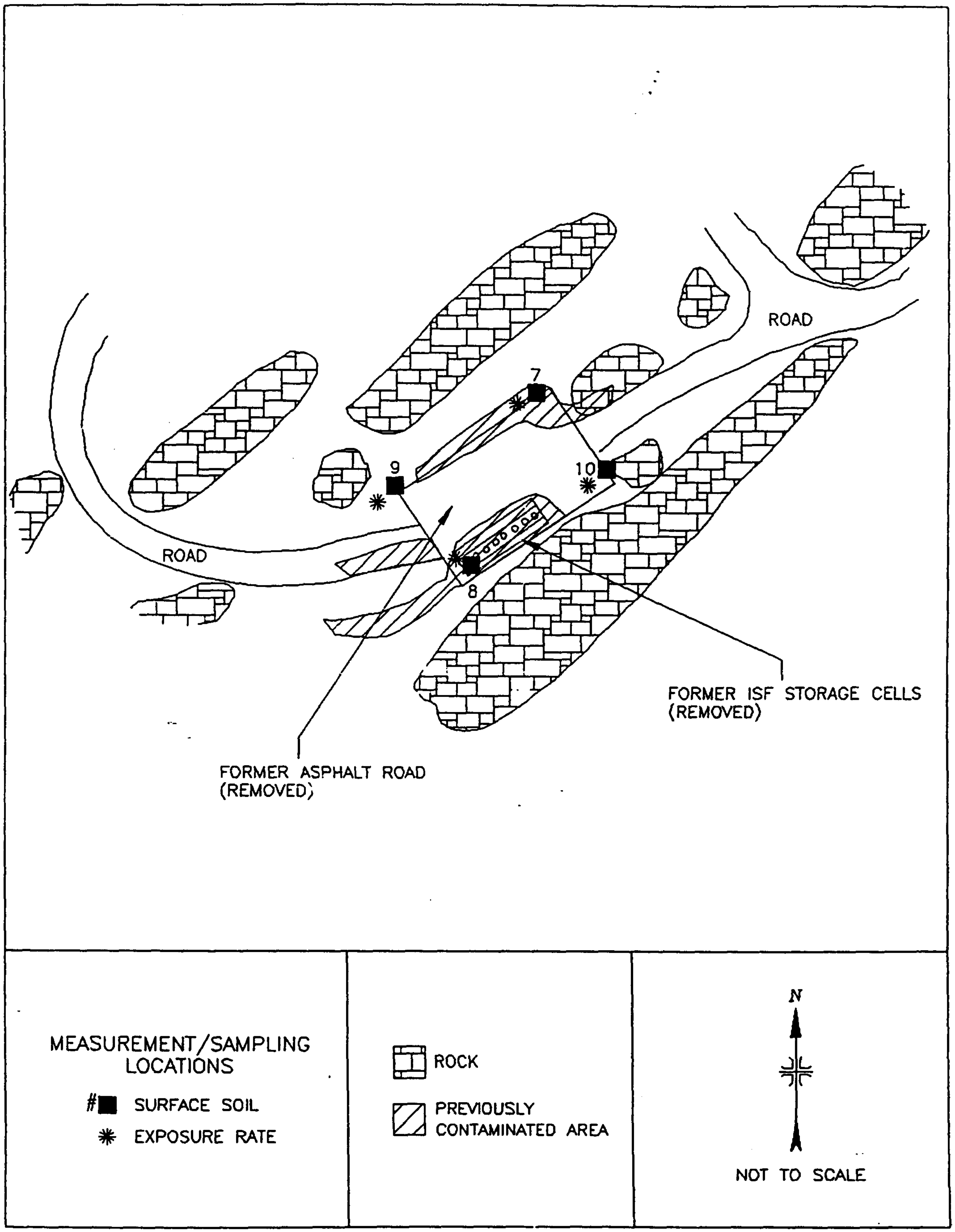

FIGURE 3: Interim Storage Facility – Plot Plan and Measurement and Sampling Locations

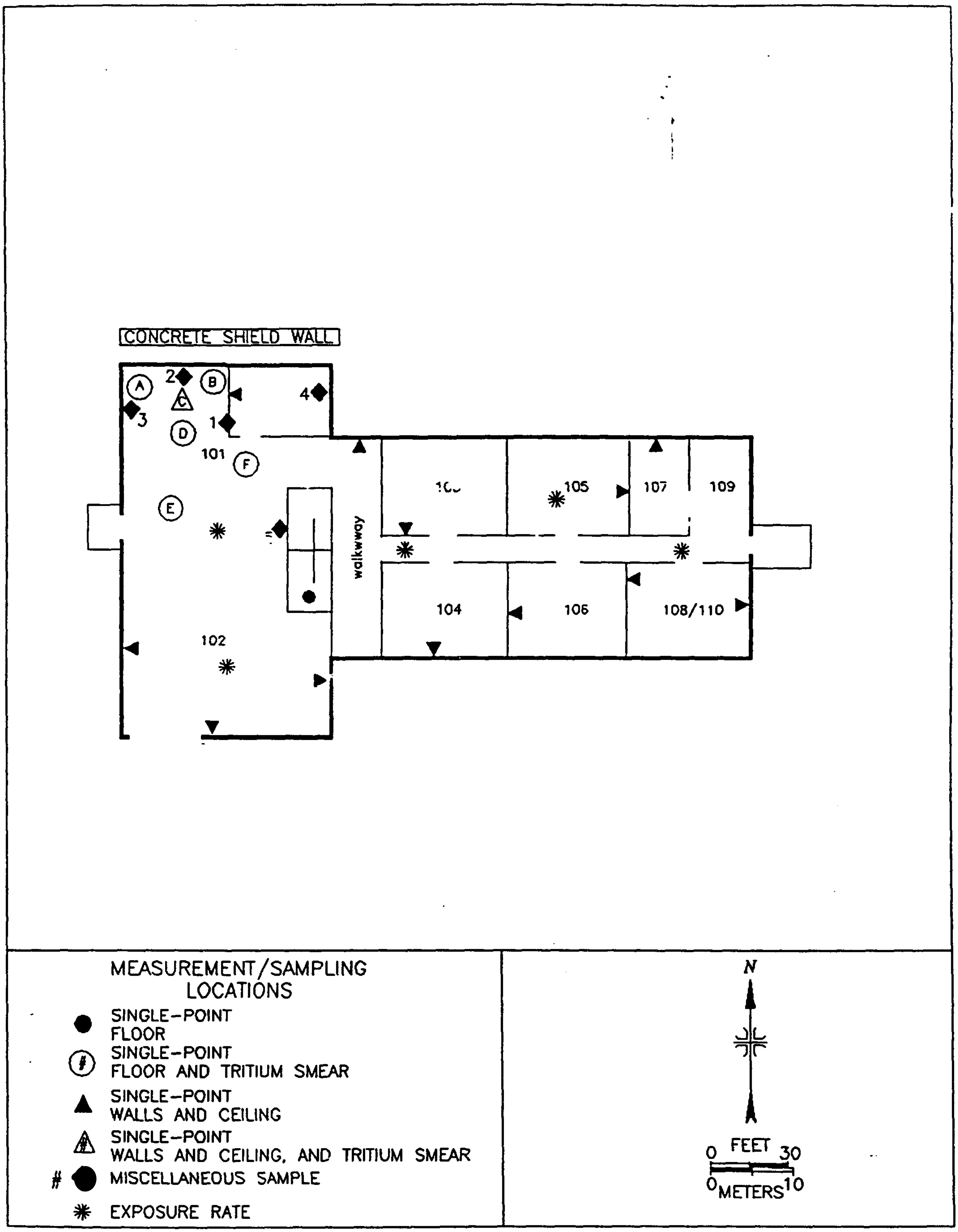

FIGURE 4: Building T030 – Floor Plan and Measurement and Sampling Locations

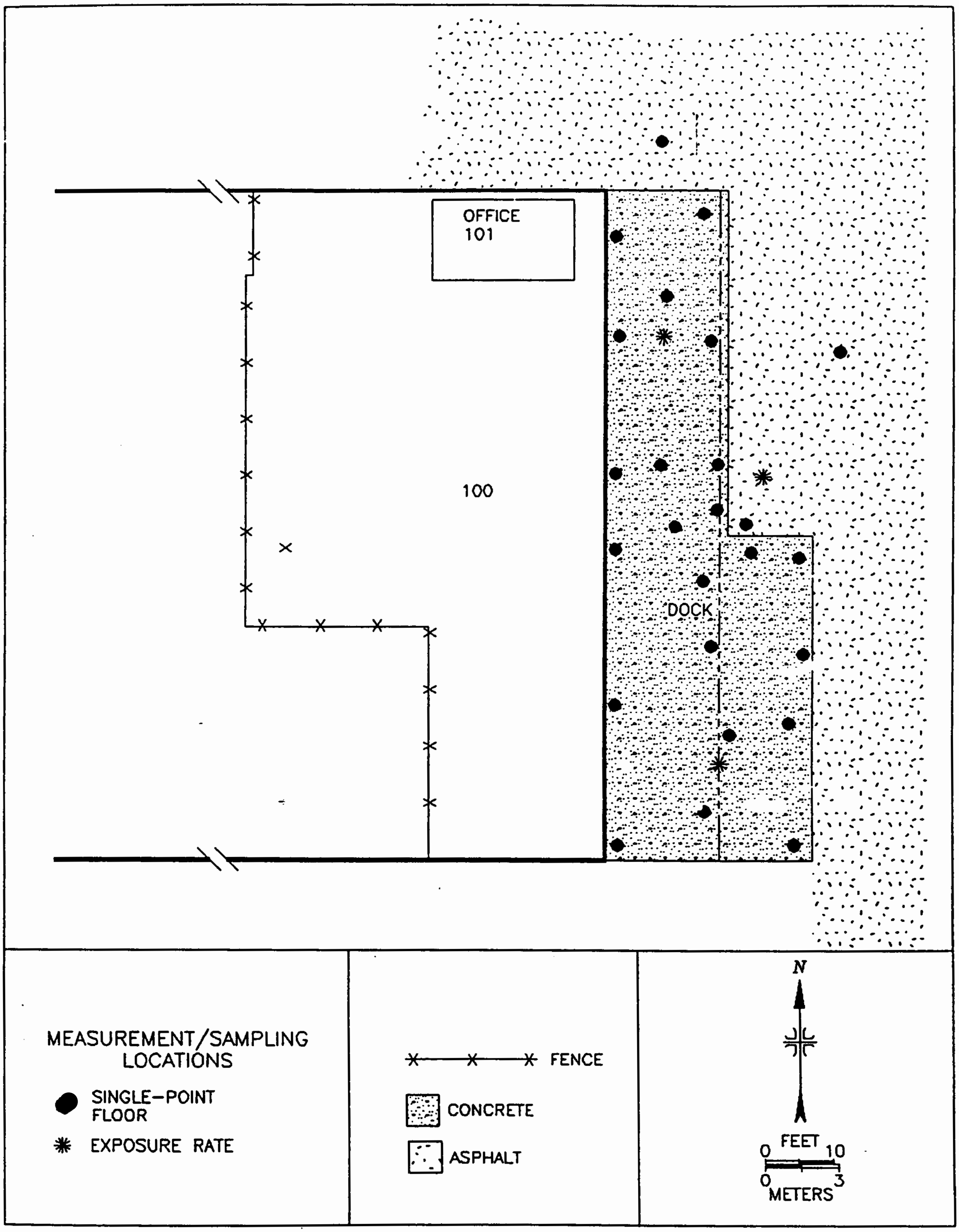

FIGURE 5: Building T641 — Floor Plan and Measurement and Sampling Locations

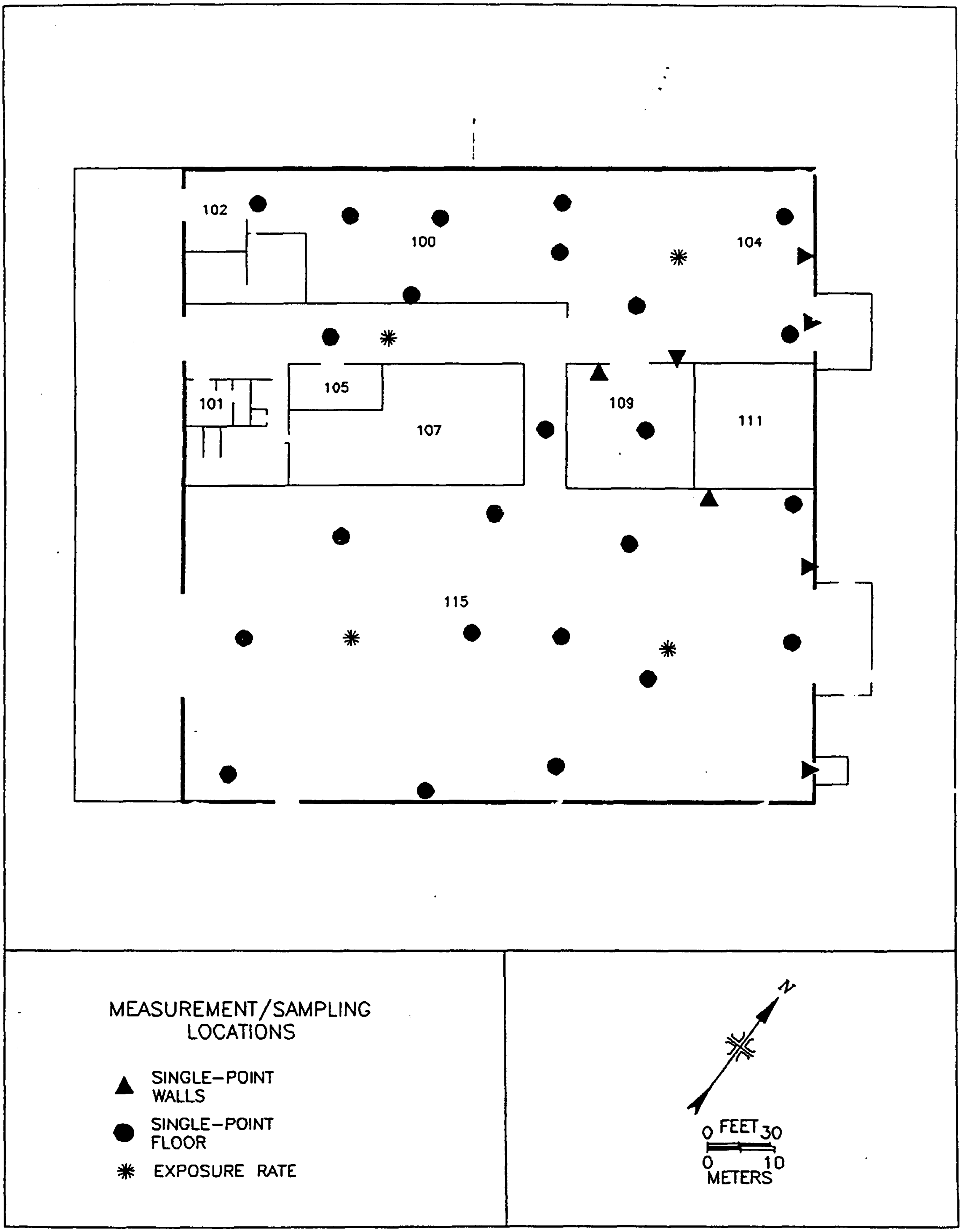

FIGURE 6: Building T013 – Floor Plan and Measurement and Sampling Locations

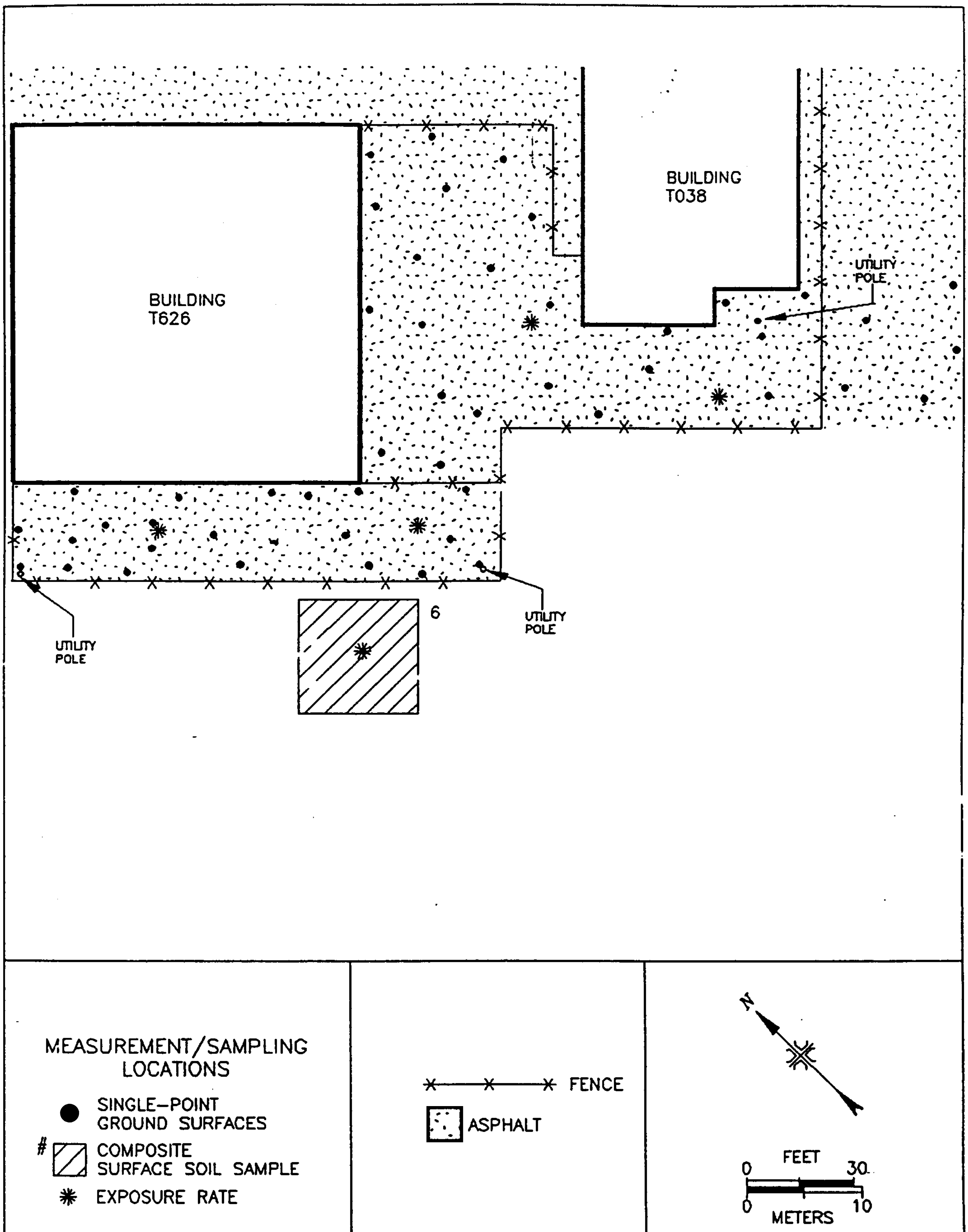

FIGURE 7: Building T626 and T038 Storage Yard – Plot Plan and Measurement and Sampling Locations

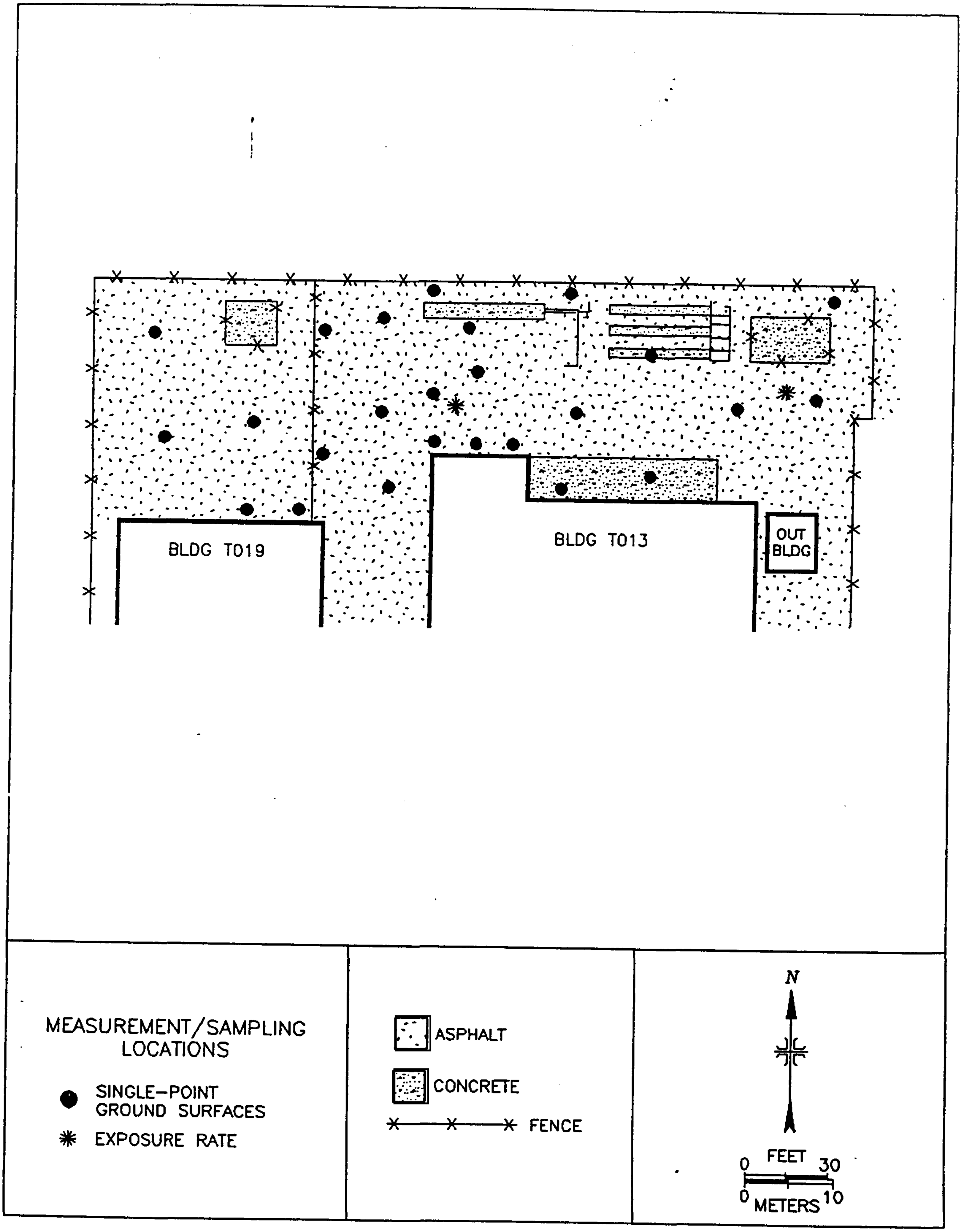

FIGURE 8: Paved Portion of the Northwest Area – Plot Plan and Measurement and Sampling Locations

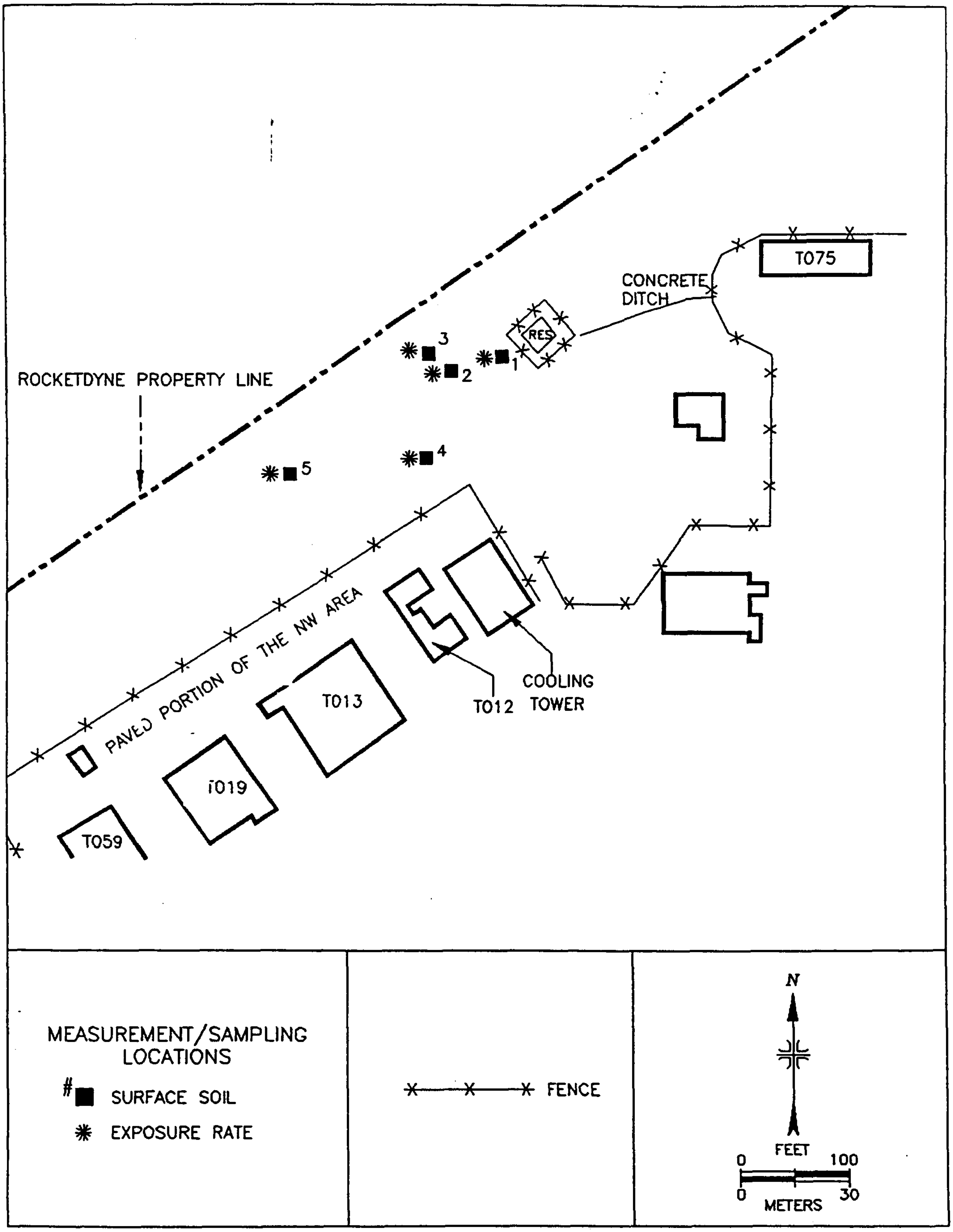

FIGURE 9: Soil Portion of the Northwest Area – Plot Plan and Measurement and Sampling Locations

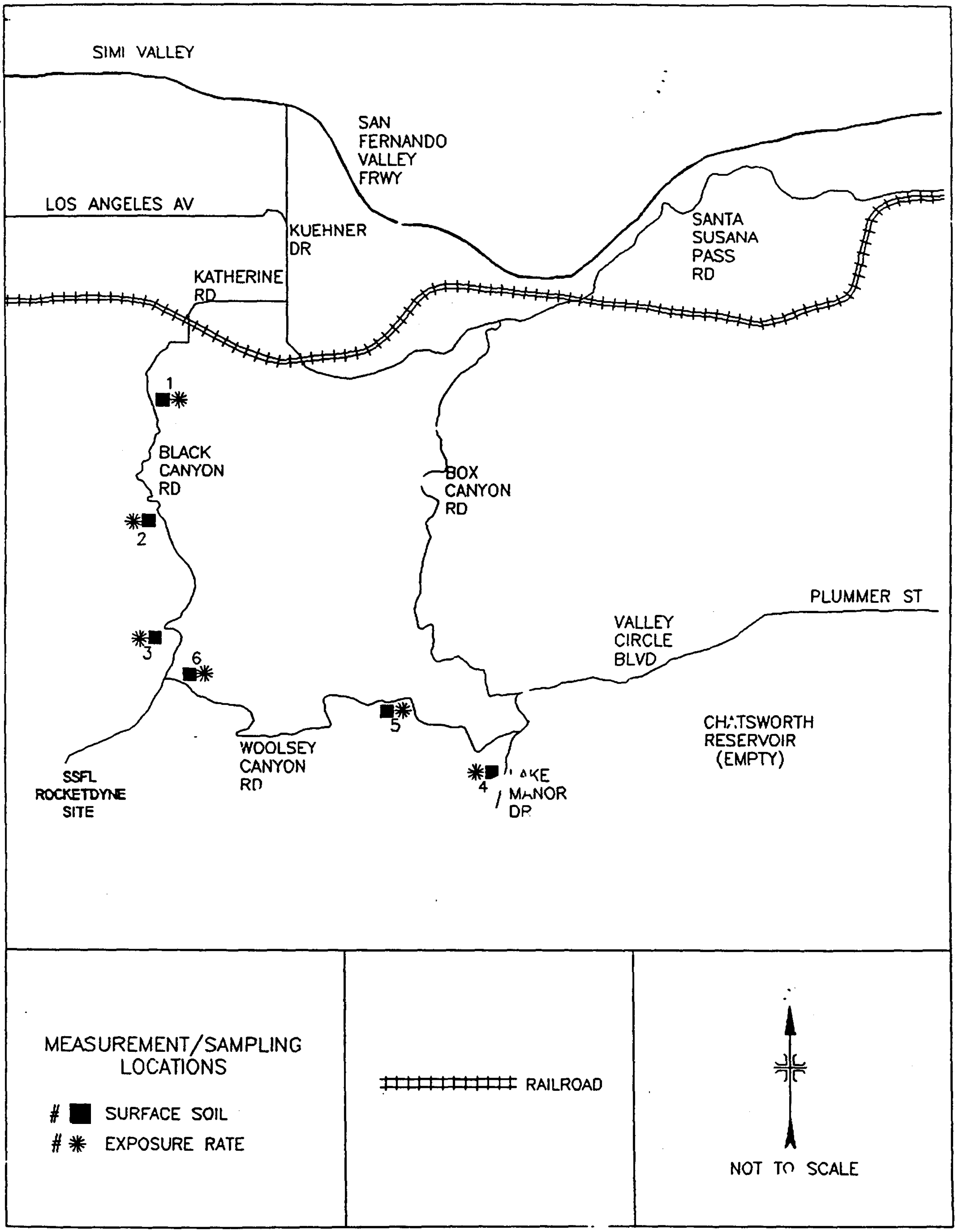

FIGURE 10: Santa Susana Field Laboratory, Ventura County, California — Background Measurement and Sampling Locations

TABLE 1

SUMMARY OF SURFACE ACTIVITY LEVELS
BUILDINGS T013, T030, T641 LOADING DOCK, NW AREA,
AND STORAGE YARD WEST OF T626 AND T038
SANTA SUSANA FIELD LABORATORY
ROCKWELL INTERNATIONAL
VENTURA COUNTY, CALIFORNIA

Location[a]	Number of Measurement Locations	Total Activity Range ($dpm/100\ cm^2$)		Removable Activity Range ($dpm/100\ cm^2$)	
	Single-Pt.	Alpha[b]	Beta[c]	Alpha[d]	Beta[e]
INTERIOR					
T013					
Floor	24	<55	<1,000 - <1,400	<12	<16
Lower Wall	7	<55	<900	<12	<16
T030					
Floor	6	<55	<1,000	<12	<16
Lower Wall	11	<55	<900 - <1,400	<12	<16
Upper Wall and Ceiling	2	<55	<1,000	<12	<16
EXTERIOR					
Storage Yard West of T626 and T038	50	<55	<1,000 - 1,800	<12	<16
T641 Dock	25	<100	<1,400	<12	<16
NWArea	25	<100	<1,400	<12	<16

[a]Refer to Figures 4, 5, 6, 7, and 8.
[b]Guidelines = 5,000 α $dpm/100\ cm^2$ average in a 1 m^2 area and 15,000 α $dpm/100\ cm^2$ maximum
[c]Guidelines = 5,000 β-γ $dpm/100\ cm^2$ average in a 1 m^2 area and 15,000 β-γ $dpm/100\ cm^2$ maximum
[d]Guideline = 1,000 α $dpm/100\ cm^2$
[e]Guideline = 1,000 β-γ $dpm/100\ cm^2$

TABLE 2

TRITIUM ACTIVITY IN MISCELLANEOUS SAMPLES
FOR BUILDING T030
SANTA SUSANA FIELD LABORATORY
ROCKWELL INTERNATIONAL
VENTURA COUNTY, CALIFORNIA

Location[a]	Type	Activity (dpm/100 cm^2)
Room 101, East Wall	Paint	<200[b]
Room 101, North Wall	Paint	6,600 ± 220[b]
Room 101, West Wall	Paint	<200[b]
Room 101B, East Wall	Paint	<200[b]
Room 101, W Restroom Wall	Paint	<160[b]
Location A	Smear	<30[c]
Location B	Smear	<33[c]
Location C	Smear	<36[c]
Location D	Smear	<57[c]
Location E	Smear	<44[c]
Location F	Smear	<65[c]
Location G	Smear	<220[c]

[a]Refer to Figure 4.
[b]Total Activity
[c]Removable Activity

TABLE 3

BACKGROUND EXPOSURE RATES
FOR THE
SANTA SUSANA FIELD LABORATORY
ROCKWELL INTERNATIONAL
VENTURA COUNTY, CALIFORNIA

Location[a]	Exposure Rate at 1 m above Surface (μR/h)
#1 Gaston Road	13
#2 Black Canyon Road	16
#3 Black Canyon Road	14
#4 Valley Circle Road	15
#5 Woolsey Canyon Road	12
#6 Woolsey Canyon Road	14

[a]Refer to Figure 10.

TABLE 4

SITE EXPOSURE RATES
FOR
BUILDINGS T013, T030, STORAGE YARD WEST OF T626, T641 DOCK.
PAVED YARD OF NORTHWEST AREA, AND INTERIM STORAGE FACILITY
SANTA SUSANA LABORATORY
ROCKWELL INTERNATIONAL
VENTURA COUNTY, CALIFORNIA

Location[a]	Exposure Rate Ranges at 1 m above Surface (μR/h)
Building T013	8 to 11
Building T030	10 to 11
Storage Yard West of T626 and T038	10 to 13
Building T641 Dock	10 to 12
Soil Portion of the NW Area	14 to 16
Paved Yard of NW Area	12
Interim Storage Facility	15

[a]Refer to Figures 4 through 8.

TABLE 5

RADIONUCLIDE CONCENTRATIONS IN SOIL
SANTA SUSANA FIELD LABORATORY
ROCKWELL INTERNATIONAL
VENTURA COUNTY, CALIFORNIA

Location[a]	Radionuclide Concentrations pCi/g					
	Cs-137	Ra-226	Th-228	Th-232	U-235	U-238
BACKGROUND						
#1 Gaston Rd.	<0.1	1.2 ± 0.2[b]	1.4 ± 0.1	1.6 ± 0.4	<0.1	2.5 ± 1.6
#2 Black Canyon	0.2 ± 0.1	1.0 ± 0.2	1.4 ± 0.2	1.7 ± 0.3	<0.1	1.4 ± 1.5
#3 Sage Ranch Park	0.2 ± 0.1	1.0 ± 0.2	1.4 ± 0.1	1.3 ± 0.3	<0.1	1.6 ± 1.1
#4 Valley Circle Road	0.2 ± 0.1	1.0 ± 0.2	1.2 ± 0.1	1.1 ± 0.4	<0.1	<2.2
#5 Woolsey Canyon 386S017	<0.1	0.9 ± 0.2	1.1 ± 0.1	1.2 ± 0.3	<0.1	2.1 ± 1.2
#6 Woolsey Canyon 386S018	<0.1	<0.2	0.6 ± 0.1	0.6 ± 0.3	<0.1	<1.0
SSFL AREAS						
NW Area #1	0.5 ± 0.1	1.0 ± 0.2	1.5 ± 0.1	1.6 ± 0.3	<0.1	0.8 ± 1.3
NW Area #2	<0.1	1.0 ± 0.2	1.4 ● 0.1	1.5 ± 0.4	<0.1	1.2 ± 1.4
NW Area #3	<0.1	1.0 ± 0.2	1.3 ● 0.1	1.7 ● 0.4	<0.1	1.9 ± 1.3
NW Area #4	<0.1	0.8 ● 0.2	1.2 ± 0.1	1.5 ± 0.3	<0.1	1.0 ± 0.9
NW Area #5	0.2 ± 0.1	1.0 ● 0.2	1.2 ± 0.1	1.6 ± 0.3	<0.1	<1.5
Storage Yard #6	0.1 ± 0.1	0.7 ● 0.2	1.2 ± 0.1	1.7 ± 0.4	<0.1	<2.0
ISF #7	<0.1	1.2 ± 0.2	1.6 ± 0.1	1.6 ± 0.3	<0.1	1.0 ± 1.5
ISF #8	0.4 ± 0.1	0.8 ± 0.2	1.4 ± 0.2	1.7 ± 0.4	<0.1	1.2 ± 1.3
ISF #9	0.1 ± 0.1	0.8 ± 0.2	1.4 ± 0.1	1.6 ± 0.4	<0.1	1.7 ± 1.4
ISF #10	0.1 ± 0.1	1.0 ± 0.2	1.3 ± 0.2	1.5 ± 0.4	<0.1	<1.5

[a]Refer to Figures 3, 7, 9, and 10.
[b]Uncertainties represent the 95% confidence level, based only on counting statistics.

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To Bob Tuttle | From Tim Vitkus
Co. Rockwell | Co.
Dept. | Phone #

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Rockwell International. Radiological Survey of Shipping/Receiving and Old Accelerator Area - Buildings T641 and T030. Ventura County, CA; August 19, 1988a.

Rockwell International. Radiological Survey of Buildings T019 and T013; An Area Northwest of T059, T019, T013, and T012; and A Storage Yard West of Buildings T626 and T038. Ventura County, CA; August 26, 1988b.

APPENDIX A

MAJOR INSTRUMENTATION

APPENDIX A

MAJOR INSTRUMENTATION

The display of a specific product is not to be construed as an endorsement of the product or its manufacturer by the authors or their employers.

DIRECT RADIATION MEASUREMENT

Instruments

Eberline Pulse Ratemeter
Model PRM-6
(Eberline, Santa Fe, NM)

Eberline "Rascal" Ratemeter-Scaler
Model PRS-1
(Eberline, Santa Fe, NM)

Ludlum Floor Monitor
Model 239-1
(Ludlum Measurements, Inc.,
Sweetwater, TX)

Ludlum Ratemeter-Scaler
Model 2221
(Ludlum Measurements, Inc.,
Sweetwater, TX)

Detectors

Eberline GM Detector
Model HP-260
Physical Area, 20 cm^2
(Eberline, Santa Fe, NM)

Eberline ZnS Scintillation Detector
Model AC-3-7
Physical Area, 74 cm^2
(Eberline, Santa Fe, NM)

Ludlum Gas Proportional Detector
Model 43-37
Physical Area, 550 cm^2
(Ludlum Measurements, Inc.,
Sweetwater, TX)

Ludlum Gas Proportional Detector
Model 43-68
Physical Area, 126 cm^2
(Ludlum Measurements, Inc.,
Sweetwater, TX)

Reuter-Stokes Pressurized Ion Chamber
Model RSS-112
(Reuter-Stokes, Cleveland, OH)

Victoreen NaI Scintillation Detector
Model 489-55
3.2 cm x 3.8 cm Crystal
(Victoreen, Cleveland, OH)

LABORATORY ANALYTICAL INSTRUMENTATION

High Purity Extended Range Intrinsic Detectors
Model No: ERVDS30-25195
(Tennelec, Oak Ridge, TN)
Used in conjunction with:
Lead Shield Model G-11
(Nuclear Lead, Oak Ridge, TN) and
Multichannel Analyzer
3100 Vax Workstation
(Canberra, Meriden, CT)

High-Purity Germanium Detector
Model GMX-23195-S, 23% Eff.
(EG&G ORTEC, Oak Ridge, TN)
Used in conjunction with:
Lead Shield Model G-16
(Gamma Products, Palos Hills, IL) and
Multichannel Analyzer
3100 Vax Workstation
(Canberra, Meriden, CT)

Low Background Gas Proportional Counter
Model LB-5100-W
(Oxford, Oak Ridge, TN)

Tri-Carb Liquid Scintillation Analyzer
Model 1900CA
(Packard Instrument Co., Meriden, CT)

APPENDIX B

SURVEY AND ANALYTICAL PROCEDURES

APPENDIX B

SURVEY AND ANALYTICAL PROCEDURES

SURVEY PROCEDURES

Surface Scans

Surface scans were performed by passing the probes slowly over the surface; the distance between the probe and the surface was maintained at a minimum - nominally about 1 cm. A large surface area, gas proportional floor monitor was used to scan the floors and paved portions of the surveyed areas. Other surfaces were scanned using small area (20 cm^2, 74 cm^2 or 126 cm^2) hand-held detectors. Identification of elevated levels was based on increases in the audible signal from the recording and/or indicating instrument. Combinations of detectors and instruments used for the scans were:

Alpha	-	gas proportional detector with ratemeter-scaler
	-	ZnS scintillation detector with ratemeter-scaler
Beta	-	gas proportional detector with ratemeter-scaler
	-	GM detector with ratemeter-scaler

Surface Activity Measurements

Measurements of total alpha and total beta activity levels were performed using ZnS scintillation and GM detectors with ratemeter-scalers.

Count rates (cpm), which were integrated over 1 minute in a static position, were converted to activity levels (dpm/100 cm^2) by dividing the net rate by the 4 π efficiency and correcting for the active area of the detector. Because different building materials (poured concrete, concrete block, steel, etc.) can have very different background levels, average background counts were determined for each material encountered in the surveyed area at a location of similar construction and having no known radiological history. The beta activity background count rates for the GM detectors averaged 95 cpm for concrete, 36 cpm for sheet rock, 33 cpm for structural steel, 96 cpm for cinder block, and 92 cpm for asphalt. Alpha background count rates for the ZnS detectors averaged 7 cpm for concrete, 1 cpm for sheet rock, 2 cpm for structural steel, 3 cpm for cinder block, and 2 cpm for asphalt. Net count rates were determined by subtracting the appropriate material background from the gross count rate for each measurement location. Beta efficiency factors ranged from 0.17 to 0.18 for the GM detector calibrated to Tc-99. The beta minimum detectable activities (MDA) for the GM detectors varied by material and ranged from 870 to 1,400 dpm/100cm^2. Alpha efficiency factors ranged from 0.18 to 0.19 for the ZnS detectors calibrated to Pu-239 and MDAs ranged from 50 to 100 dpm/100cm^2. The physical window area for the GM and ZnS detectors were 20 cm^2 and 74 cm^2, respectively.

Removable Activity Measurements

Removable activity levels were determined using numbered filter paper disks, 47 mm in diameter. Moderate pressure was applied to the smear and approximately 100 cm^2 of the surface was wiped. Tritium smears were first moistened with deionized water before the surface was wiped. Smears were placed in labeled envelopes with the location and other pertinent information recorded.

Exposure Rate Measurements

Measurements of gamma exposure rates were performed using a pressurized ionization chamber (PIC). The instrument was adjusted to one meter above the surface and allowed to stabilize. The measurement was read directly in μR/h.

Soil Sampling

Approximately 1 kg of soil was collected at each sample location. Collected samples were placed in a plastic bag, sealed, and labeled in accordance with ESSAP survey procedures.

Paint Sampling

Paint samples were obtained by chipping the paint from 100 cm^2 of surface area. The sample was then placed in a plastic specimen cup sealed, and labeled in accordance with ESSAP survey procedures.

ANALYTICAL PROCEDURES

Removable Activity

Gross Alpha/Beta

Smears were counted on a low background gas proportional system for gross alpha and gross beta activity.

Liquid Scintillation

Smears were counted in a liquid scintillation counter for low-energy beta activity to determine H-3 activity.

Gamma Spectrometry

Soil samples were dried, mixed, crushed, and/or homogenized as necessary, and a portion sealed in 0.5-liter Marinelli beaker or other appropriate container. The quantity placed in the beaker was chosen to reproduce the calibrated counting geometry. Net material weights were determined and the samples counted using intrinsic germanium detectors coupled to a pulse height analyzer system. Background and Compton stripping, peak search, peak identification, and concentration calculations were performed using the computer capabilities inherent in the analyzer system. All photopeaks associated with the radionuclides of concern were reviewed for consistency of activity. Energy peaks used for determining the activities of radionuclides of concerns were:

Co-60	1.173 MeV
Cs-137	0.662 MeV
Eu-152	0.344 MeV
Eu-154	0.723 MeV
Ra-226	0.351 MeV from Pb-214*
Th-228	0.239 MeV from Pb-212*
Th-232	0.911 MeV from Ac-228*
U-235	0.143 MeV (or 0.186 MeV)
U-238	0.063 MeV from Th-234* (or 1.001 MeV from Pa-234 m)*

*Secular equilibrium assumed.

Spectra were also reviewed for other identifiable photopeaks.

Tritium

Tritium in solid samples was exchanged with water by refluxing and the resulting liquid was distilled to remove other radionuclides and organic materials. The samples were spiked with a standard tritium solution to evaluate quenching and counted in a liquid scintillation counter.

UNCERTAINTIES AND DETECTION LIMITS

The uncertainties associated with the analytical data presented in the tables of this report represent the 95% confidence level for that data. These uncertainties were calculated based on both the gross sample count levels and the associated background count levels. Additional uncertainties, associated with sampling and measurement procedures, have not been propagated into the data presented in this report.

Detection limits, referred to as minimum detectable activity (MDA), were based on 2.71 plus 4.65 times the standard deviation of the background count $[2.71 + 4.65\sqrt{BKG}]$. When the activity was determined to be less than the MDA of the measurement procedure, the result was reported as less than MDA. Because of variations in background levels, measurement efficiencies, and contributions from other radionuclides in samples, the detection limits differ from sample to sample and instrument to instrument.

CALIBRATION AND QUALITY ASSURANCE

Calibration of all field and laboratory instrumentation was based on standards/sources, traceable to NIST, when such standard/sources were available. In cases where they were not available, standards of an industry recognized organization were used. Calibration of pressurized ionization chambers were performed by the manufacturer.

Analytical and field survey activities were conducted in accordance with procedures from the following documents of the Environmental Survey and Site Assessment Program:

- Survey Procedures Manual, Revision 9 (April 1995)
- Laboratory Procedures Manual, Revision 9 (January 1995)
- Quality Assurance Manful, Revision 7 (January 1995)

The procedures contained in these manuals were developed to meet the requirements of DOE Order 5700.6C and ASME NQA-1 for Quality Assurance and contain measures to assess processes during their performance.

Quality control procedures include:

- Daily instrument background and check-source measurements to confirm that equipment operation is within acceptable statistical fluctuations.
- Participation in EPA and EML laboratory Quality Assurance Programs.
- Training and certification of all individuals performing procedures.
- Periodic internal and external audits.

APPENDIX C

RESIDUAL RADIOACTIVE MATERIAL GUIDELINES SUMMARIZED FROM DOE ORDER 5400.5

APPENDIX C

RESIDUAL RADIOACTIVE MATERIAL GUIDELINES SUMMARIZED FROM DOE ORDER 5400.5

BASIC DOSE LIMITS

The basic limit for the annual radiation dose (excluding radon) received by an individual member of the general public is 100 mrem/yr. In implementing this limit, DOE applies as low as reasonably achievable principles to set site-specific guidelines.

STRUCTURE GUIDELINES

Indoor/Outdoor Structure Surface Contamination

Radionuclides[a]	Allowable Total Residual Surface Contamination (dpm/100 cm^2)[b] Average[c,d]	Maximum[d,e]	Removable[f]
Transuranics, Ra-226, Ra-228, Th-230 Th-228, Pa-231, Ac-227, I-125, I-129 [g]	100	300	20
Th-Natural, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1,000	3,000	200
U-Natural, U-235, U-238, and associated decay products	5,000α	15,000α	1,000α
Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above [h]	5,000β-γ	15,000β-γ	1,000β-γ

External Gamma Radiation

The average level of gamma radiation inside a building or habitable structure on a site that has no radiological restriction on its use shall not exceed the background level by more than 20 μR/h and will comply with the basic dose limits when an appropriate-use scenario is considered.

SOIL GUIDELINES

Radionuclides	Soil Concentration (pCi/g) Above Background[i,j,k]
Uranium and mixed fission and activation products	Soil guidelines are calculated on a site-specific basis, using the DOE manual developed for this use.

[a] Where surface contamination by both alpha- and beta-gamma-emitting radionuclides exists, the limits established for alpha- and beta-gamma-emitting radionuclides should apply independently.

[b] As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute measured by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

[c] Measurements of average contamination should not be averaged over an area of more than 1 m^2. For objects of less surface area, the average should be derived for each such object.

[d] The average and maximum dose rates associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/h and 1.0 mrad/h, respectively, at a depth of 1 cm

[e] The maximum contamination level applies to an area of not more than 100 cm^2.

[f] The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping an area of that size with dry filter or soft absorbent paper, applying moderate pressure, and measuring the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of surface area less than 100 cm^2 is determined, the activity per unit area should be based on the actual area and the entire surface should be wiped. It is not necessary to use wiping techniques to measure removable contamination levels, if direct scan surveys indicate that total residual surface contamination levels are within the limits for removable contamination.

[g] Guidelines for these radionuclides are not given in DOE Order 5400.5; however, these guidelines are considered applicable until guidance is provided.

[h] This category of radionuclides includes mixed fission products, including the Sr-90 which is present in them. It does not apply to Sr-90, which has been separated from the other fission products, or mixtures where the Sr-90 has been enriched.

[i] These guidelines take into account ingrowth of radium-226 from thorium-230 or thorium-232 and radium-228 and assume secular equilibrium. If either Th-230 and Ra-226 or Th-232 and Ra-228 are both present, not in secular equilibrium, the guidelines apply to the higher concentration. If other mixtures of radionuclides occur, the concentrations of individual radionuclides shall be reduced so that (1) the dose for the mixtures will not exceed the basic dose limit, or (2) the sum of ratios of the soil concentration of each radionuclide to the allowable limit for that radionuclide will not exceed 1 ("unity").

[j] These guidelines represent allowable residual concentrations above background averaged across any 15-cm-thick layer to any depth and over any contiguous 100 m^2 surface area.

[k] If the average concentration in any surface or below-surface area, less than or equal to 25 m^2, exceeds the authorized limit of guideline by a factor of $(100/A)^{1/2}$, where A is the area or the elevated region in square meters, limits for "hot spots" shall also be applicable. Procedures for calculating these hot spot limits, which depend on the extent of the elevated local concentrations, are given in the DOE Manual for Implementing Residual Radioactive Materials Guidelines, DOE/CH/8901. In addition, every reasonable effort shall be made to remove any source of radionuclide that exceeds 30 times the appropriate limit for soil, irrespective of the average concentration in the soil.

REFERENCES

"U.S. Department of Energy Guidelines for Residual Radioactive Material at Formerly Utilized Sites Remedial Action Program and Remote Surplus Facilities Management Program Sites," Revision 2, March 1987.

"DOE Order 5400.5, Radiation Protection of the Public and the Environment," February 1990.

ORISE
OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION

January 11, 1996

Mr. Don Williams
U.S. Department of Energy
EM-443
Cloverleaf Building
Washington, DC 20585-0002

SUBJECT: **COMMENTS ON THE FINAL STATUS SURVEY DOCUMENTATION FOR THE INTERIM STORAGE FACILITY; BUILDINGS T013, T019, T024, T030, AND T641; THE STORAGE YARD WEST OF BUILDINGS T626 AND T038; AND THE NW AREA; SANTA SUSANA FIELD LABORATORY, VENTURA COUNTY, CALIFORNIA**

Dear Mr. Williams:

As part of the independent verification process, the Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education (ORISE) reviewed the radiological survey documentation that Rockwell/Rocketdyne prepared for each of the subject facilities (Rockwell 1978, 1985, 1988a, and 1988b). It is ESSAP's opinion that the documents do not provide all the information necessary for the reviewer to independently assess the radiological status of the buildings or outdoor areas, relative to the U.S. Department of Energy (DOE) guidelines for release to unrestricted use. Comments on each of the documents are enclosed. Please contact me at (423) 576-5073 or W. L. (Jack) Beck at (423) 576-5031 should you have any questions.

Sincerely,

Timothy J. Vitkus
Environmental Project Leader
Environmental Survey and
Site Assessment Program

TJV:saj

Enclosure

cc: A. Kluk, DOE/HQ
M. Lopez, DOE/OAK
W. Beck, ORISE/ESSAP
File/386

COMMENTS ON THE FINAL STATUS SURVEY DOCUMENTATION FOR THE INTERIM STORAGE FACILITY; BUILDINGS T013, T019, T024, T030, AND T641; THE STORAGE YARD WEST OF BUILDINGS T626 AND T038; AND NW AREA SANTA SUSANA FIELD LABORATORY VENTURA COUNTY, CALIFORNIA

A. Rockwell International. Interim Storage Facility Decommissioning Final Report. March 15, 1985.

<u>Comments</u>

1. Section 2.0: The document should be revised to clearly state which radionuclides were potential contaminants. The reviewer must assume that the contaminants are mixed fission and activation products.

2. Section 4.4.1: The document states that water was found in four of the eight storage cells. Was the source of this water groundwater or rainwater? If the source was groundwater intrusion, was the potential for groundwater contamination investigated?

3. Section 4.4.2: The document indicates that concrete and other materials were surveyed and if found to be uncontaminated, used as backfill. The document should provide the surface activity data for this material in units of dpm/100 cm^2 and a reference for the specific DOE surface contamination guidelines used for data comparison.

4. Section 4.7, Phase B: The document should be revised to include an approved site-specific cleanup guideline, rather than the 100 pCi/g gross detectable beta activity criterion, and the available data compared directly with this guideline. Secondly, if Sr-90 is suspected as a contaminant with Cs-137, radionuclide-specific analyses should be performed to quantify the Sr-90 levels. ESSAP recommends that if the site has retained any of the samples collected during this project in an archive, a representative portion of those samples should be analyzed for Sr-90.

5. Section 4.7, Phase C: This portion of the post-decommissioning activities section describes the final status survey procedures and states that 10 percent of available grid blocks were surveyed. It is ESSAP's opinion, and common industry practice, that a final status survey include surface scans and soil sampling of 100 percent of a remediated area. In addition, the document discusses the contribution of the "skyshine" from the RMDF to the area ambient gamma activity levels. Because of the elevated background gamma activity, ESSAP questions whether the scan sensitivity of the procedure was adequate to detect residual areas of contamination

that may have exceeded the proposed site-wide Cs-137 cleanup guideline. It is ESSAP's opinion that the final status survey should have included additional soil sampling and analysis to compensate for the expected decrease in scanning sensitivity.

B. Rockwell International. Radiological Survey of Buildings T019 and T013; An Area Northwest of T059, T019, T013 and T012; And A Storage Yard West of Buildings T626 and T038. August 26, 1988.

Comments

The final status survey procedures for these facilities relied almost entirely on gamma exposure rate measurements and an exhaustive evaluation of the data generated. It is ESSAP's opinion that compliance with the exposure rate guideline has been well documented; however, overall survey procedures and radiological data are inadequate to demonstrate compliance with all applicable DOE residual surface activity and soil concentration guidelines. Additional general comments related to survey procedures and final status documentation are provided below.

1. Surface activity level data (in dpm/100 cm^2) within the buildings or on outdoor surfaces are not provided in the document. Therefore, the current radiological status can not be determined and compared with the surface activity guidelines provided in Table 3.1 on page 28.

2. For indoor areas, the document states that beta-indication-only surveys were performed where gamma activity levels exceeded the reinspection or investigation level. It is ESSAP's opinion that gamma measurements at 1 meter above the surface will not detect residual surface contamination at the guideline levels. The final status survey should have included gamma and beta surface scans; and where highly enriched uranium was a potential contaminant, alpha scans also should have been performed. In addition, direct measurements for total alpha and total beta activity, converted to dpm/100 cm^2 should be performed to provide complete radiological status documentation (see comment no. 1).

3. Final status survey procedures for outdoor areas were also inadequate to detect residual contamination. Although gamma measurements at 1 m above the surface would detect large areas of residual Cs-137 contamination in excess of 100 pCi/g or debris with mCi amounts of Cs-137 as discussed in the document, it is ESSAP's experience that gamma surface scans should have been performed over soil areas order to detect smaller areas or lower levels of residual contamination, together with systematic and bias soil sampling. In addition, rather than the proposed gross alpha and gross beta analyses, soil samples should be analyzed by gamma spectrometry and/or wet-chemistry procedures in order to quantify residual activity concentration levels for each radionuclide of concern and compared with an approved guideline (see comment no. 4 below).

4. The document does not reference an approved site-specific guideline for residual concentrations of radionuclides in soil; specifically enriched uranium and fission products.

C. Rockwell International. Radiological Survey of Shipping/Receiving and Old Accelerator Area-Buildings T641 and T030. August 19, 1988.

Comments

Overall, the general comments discussed for Reference B above apply to survey procedures and data inadequacies for Buildings T641 and T030. Other than the data provided for tritium levels in soil, exposure rates, and tritium activity on smears collected from the Van de Graaff accelerator housed in Building T030, the document does not provide total surface activity levels on building surfaces for comparison to the surface activity guidelines. The final status survey procedures described should have included more complete gamma, alpha, and beta surface scans, direct measurements for total alpha (as applicable) and beta surface activity, and additional sampling for determining removable and total tritium activity levels on surfaces in rooms 101 and 102 of Building T030.

D. Rockwell International. Radiological Survey Results—Release to Unrestricted Use, Building 024, SSFL. November 28, 1978.

Comments

There is inadequate information provided in the document for the reviewer to independently determine the adequacy of final status survey procedures or the overall radiological status of the facility. The following comments are related to crucial information that is not provided in the report. Significant detail must be added to the report before an adequate technical review can be performed.

1. The document should be revised to include information on the potential radiological contaminants and specify the current DOE guidelines for release to unrestricted use that are applicable to the facility.

2. The document indicates that final status surveys included smear sampling for removable activity and gamma radiation surface measurements. It is ESSAP's opinion that these procedures alone are not adequate to determine whether the facility meets the current DOE guidelines. Thorough alpha, beta, and/or gamma scans are necessary to detect areas of residual contamination, combined with static measurements to quantify total surface activity levels.

3. There is no data provided for total surface activity levels present within the building (see comment no. 2) or a comparison of these levels to applicable guidelines.

4. Surface dose rates are provided, rather than exposure rates at 1 m. Therefore, a comparison cannot be made with the current DOE exposure rate guideline (or more restrictive NRC guideline as has been the Rockwell practice on other decommissioning projects).

5. Radionuclide-specific activity concentration levels should be provided for soil samples collected from the liquid and gas holdup tank removal areas, rather than gross soil activity. As presented, the data cannot be compared with current generic DOE or site-specific guidelines. In addition, although the power vaults are not candidates for unrestricted release, radionuclide-specific activity levels present in the concrete should be provided in the report.

6. Additional details that should be incorporated into the report include a discussion of characterization results, specific post-remedial action survey procedures used to confirm the final radiological status of the building and outdoor areas; maps showing measurement and sampling locations, and remediated areas; data tables; and discussions of residual contamination remaining in the facility, including the power vaults and the vertical pipe mentioned on page 8.

REFERENCES

Rockwell International. Radiological Survey Results—Release to Unrestricted Use, Building 024, SSFL. Ventura County, CA; November 28, 1978.

Rockwell International. Interim Storage Facility Decommissioning Final Report. Ventura County, CA; March 15, 1985.

Rockwell International. Radiological Survey of Shipping/Receiving and Old Accelerator Area - Buildings T641 and T030. Ventura County, CA; August 19, 1988a.

Rockwell International. Radiological Survey of Buildings T019 and T013; An Area Northwest of T059, T019, T013, and T012; and A Storage Yard West of Buildings T626 and T038. Ventura County, CA; August 26, 1988b.

EXHIBIT V

FINAL DOCUMENTATION AND RADIOLOGICAL SURVEY OF BUILDING T654

MICROFILM

BOEING

Engineering Product Document

GO Number	S/A Number	Page 1 of	Total Pages	Rev. Ltr/Chg. No. See Summary of Chg.	Number
97055	37654	33	33	New	RS-00004

Program Title
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Document Title
Building 4654 Supplemental Final Status Survey Report

Document Type
Final Status Survey Report

Related Documents

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Mail/Addr: T100

Approvals	Date
P. D. Rutherford [signature]	3/12/99
Sam E. Reeder [signature]	3/12/99
Majelle E. Lee [signature]	3/12/99

IR&D Program? Yes ☐ No ☒
If Yes, Enter Authorization No.

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Abstract
This document ensures that the decommissioned Interim Storage Facility (ISF), Building 4654, meets current DOE and State of California approved criteria for release of the facility for unrestricted use.

Reserved for Proprietary/Legal Notice

Rocketdyne Form 651-F REV. 2-97

CONTENTS

1. INTRODUCTION

This document provides the results of the Supplemental Final Radiological Survey SSWA-AR-0009 (Reference 1) of the decommissioned Interim Storage Facility (ISF), Building 4654. A recent review by the DOE Independent Verification Contractor (IVC) (Reference 2) judged that the documentation of the original survey (Reference 6) was inadequate by today's standards. In addition, the effectiveness of the qualitative gamma exposure rate survey was compromised by skyshine from radioactive material at the nearby Radioactive Material Handling Facility (RMHF), then the Radioactive Material Disposal Facility (RMDF). Further, at the time of the IVC review, the subsurface soil was not accessible for sampling by ORISE.

The scope of this survey included a 100% direct qualitative scan for gamma exposure rate followed by surface soil sampling at random locations based on a uniform grid, or as indicated by the qualitative survey. Samples of soil taken by the IVC throughout the depth of the excavated storage facility determined the condition of subsurface soil. Samples taken from the surface, in accordance with Reference 1, determined the condition of the surface soil with a potential for exposure.

This report ensures that the ISF met current DOE and State of California approved criteria for release of the facility for unrestricted use by applying the current sitewide release limits for soil from (Reference 4). The sampling-inspection-by-variables method was applied to the data analyzed in this survey report. The in-house computer code "CumPlot" was used for data analysis and presentation of survey report results. Use of the results from "CumPlot" and the interpretation of the cumulative probability distribution plots have been documented in other final survey reports and is not included in this report. (See References 5 and 8 for further information.)

1.1 Facility History

The ISF consisted of a concrete structure in the ground that anchored the tops of eight storage tubes. The tubes extended into large holes drilled into the bedrock, and were embedded with drilling mud. In addition, a paved pad was adjacent to the in-ground structure and provided a fenced storage area. The decommissioning (Reference 6) was done by removal of contamination in soil and on the concrete and complete removal of the tubes and concrete.

Early surveys in 1985 showed contamination that was removed. At that time, Rocketdyne was using a gross beta limit of 100 pCi/g for soil, which was based on the existing technology that the natural activity amounted to 25 pCi/g. At this background level, we could accommodate 25-pCi/g Cs-137, 25 pCi/g Sr-90 and 25 pCi/g Y-90. All these activities are detectable by a thin-window gas-flow proportional counter. The limits were similar to the total of our current RESRAD limits (Reference 4) of 9.2 pCi/g Cs-137, 36.0 pCi/g Sr-90 and 36.0 pCi/g Y-90. During the initial work, only those soils that were above 100 pCi/g gross beta were marked for removal. However, the final gamma-spec on samples in 1985 did not show anything above 2.0 pCi/g.

The original decommissioning was documented in Reference 6 and consisted of locating and removing surface contamination from the paving and the concrete structure of the below-grade storage cells, and complete removal of the below-grade structure. The excavation was back-filled with clean concrete rubble. The excavation was then filled with the local soil that had been previously excavated, and the surface was graded to a natural form. The only remaining potentially contaminated material consists of the surface and subsurface soil.

2. SUMMARY AND CONCLUSIONS

To confirm the satisfactory radiological remediation of this area met current limits, a sampling and analysis plan was developed (Reference 1). Rocketdyne personnel performed a 100% direct qualitative scan for gamma exposure rate and collected 93 surface soil samples for analysis according to this plan. Additionally, after gamma spectroscopy analyses were completed, twelve samples with the highest Cs-137 concentrations were analyzed by an outside laboratory for Sr-90. Figure 1 maps the location of the Interim Storage Facility with respect to the Boeing Rocketdyne Santa Susana Field Laboratory. Figure 2 shows the layout of the Interim Storage Facility and its subdivision into grids to provide a basis for the sampling. (Note: Figures and Tables follow the text of this report.)

The gamma spectrometry of the surface soil showed low concentrations of Cs-137, the primary radioactive contaminant at the Interim Storage Facility, and normal amounts of natural K-40, the natural thorium and natural uranium decay chains. The Cs-137 concentrations are, similar to, though in some instances somewhat greater than local background surface soil concentrations due to global fallout from nuclear weapon testing. The average Cs-137 concentration was 0.47 pCi/g with the two highest samples at 4 and 7 pCi/g less than the Sitewide Release Criteria limit from Reference 4 of 9.2 pCi/g. One surface soil sample contained Co-60 at 0.023 pCi/g less than the Sitewide Release Criteria limit from Reference 4 of 1.94 pCi/g. Further analyses of the Rocketdyne surface soil results demonstrate that the thorium and uranium activities are a natural occurrence in all samples. Other isotopes, including Be-7, Na-22, Mn-54, Sb-125, Cs-134, Cs-136, Ba-133, Eu-152, Eu-154, Eu-155, Ir-192, Tl-210, Bi-211, Pb-211, Rn-219, Rn-220, Ra-223, Ac-227, Th-227, Th-228, Th-230, Th-231, Th-232, Pa-231 and Am-241, were analyzed for as well and all were less than the MDA and, where applicable, less than the Sitewide Release Criteria from Reference 4. The radiochemistry of the surface soil by Teledyne-Brown showed elevated Sr-90 concentrations ranging from less than 0.40 to 1.3 pCi/g slightly above background but all much less than the Sitewide Release Criteria from Reference 4 of 36.0 pCi/gram. The results are in Table 1, 2, and 3 and more specifically explained in the Results section.

In 1997, following the surface soil sampling, subsurface soil and rock samples were independently taken and were analyzed by Oak Ridge Institute for Science and Education (ORISE), and the results were reported and documented in Reference 7. Radionuclide concentrations in the ORISE subsurface sampling ranged from less than 0.61 to 1.25 pCi/g for Ra-226, less than 0.67 to 1.94 pCi/g for Th-232, less than the MDC (0.84 pCi/g) for U-235, and less than 2.35 pCi/g for U-238. All activation and fission products were less than the Maximum Detectable Concentrations (MDC) of 1.50 pCi/g for Cr-51. The radiochemistry of the subsurface soil taken by ORISE showed less than the Minimum Detectable Activity (MDA) for Sr-90 and normal amounts of natural K-40, the natural thorium and natural uranium decay chains. Sr-90 analyses were all less than the MDC ranging from 0.39 to 0.55 pCi/g. Cs-137 concentrations ranged from 0.22 to 0.43 pCi/g, which is consistent with global nuclear fallout concentrations (Reference 8). All results and MDCs were well below acceptable limits for radioactive contamination in soil (Reference 4).

No samples indicated the presence of radioactive contaminants above the Sitewide Release Criteria in Reference 4, including an analysis on the sum-of the-fractions rule. All results were below acceptable limits for radioactive contamination in soil (Reference 4). The results of this sampling and analysis program confirm that the area is acceptable for release for use without radiological restriction.

3. SAMPLING

For providing a uniform basis for sampling the Interim Storage Facility area, two areas were established, relating to the history of the facility. These areas were the affected and unaffected areas. They were divided into 3-meter square grids and further subdivided into 1-meter grids. Figures 2, 3 and 4 and Table 4 show the actual locations. Sample locations were selected within the grids by use of random numbers.

Surface soil samples were collected by hand, with a trowel, providing somewhat more than 0.5 kg of soil for each sample. Surface soil samples were placed in marinelli beakers and a Chain-of-Custody form filled out. Samples were then transported to the Boeing Rocketdyne Gamma Spectroscopy Laboratory. Subsurface samples were collected at 8 foot intervals to a depth of about 32 feet below the surface by use of a drilling truck. Samples were the transported to the ORISE laboratory. Sample locations were identified, relative to the grid shown in Figure 2.

4. ANALYSIS

The subsurface soil samples were analyzed at ORISE in Oak Ridge, Tennessee, under contract to DOE/OAK. The gamma spectrometry used a high-purity germanium detector with a computer based multichannel analyzer. The standard Canberra software for interpretation of photopeaks was used. The uncertainties reported with the results are determined by computer processing and are specified at the 2-sigma level.

The surface soil samples analyses by gamma spectrometry were analyzed at Boeing Rocketdyne under contract to DOE/OAK. The gamma spectrometry used a thin-window high-purity germanium detector with a computer based multichannel analyzer. The standard Canberra software for interpretation of photopeaks was used. The uncertainties reported with the results are determined by computer processing and are specified at the 2-sigma level.

The twelve highest Cs-137 concentration surface soil samples were analyzed by Teledyne-Brown for Sr-90. Radiochemistry was done to quantify Sr-90. Chemical separation provides a strontium precipitate, beta counting serves as the determination of the activity. The uncertainties reported with the results are determined by computer processing and are specified at the 2-sigma level.

5. RESULTS

The gamma spectrometry of the surface soil showed low concentrations of Cs-137, the primary radioactive contaminant at the Interim Storage Facility, ranging from less 0.02 pCi/g to 6.99 pCi/g, below the limit of 9.2 pCi/g. One surface soil sample contained Co-60, a potential contaminant, at 0.023 pCi/g, less than the limit from Reference 4 of 1.94 pCi/g. The radiochemistry from the twelve highest Cs-137 concentration samples of the surface soil for Sr-90 ranged from less than 0.40 pCi/g to 1.3 pCi/g, less than the limit from Reference 4 of 36.0 pCi/g Natural K-40 ranged from 17.10 to 21.66 pCi/g. The natural thorium and natural uranium decay chains summary comparison in Table 1 demonstrates that the thorium and uranium activities are a natural occurrence in all samples averaging from 0.64 to 2.22 pCi/g for the thorium chain and from 0.49 to 2.88 pCi/g for the uranium chain. Other isotopes, including Be-7, Na-22, Mn-54, Sb-125, Cs-134, Cs-136, Ba-133, Eu-152, Eu-154, Eu-155, Ir-192, Tl-210, Bi-211, Pb-211, Rn-219, Rn-220, Ra-223, Ac-227, Th-227, Th-228, Th-230, Th-231, Th-232, Pa-231 and Am-241, were analyzed for as well and all were less than the MDA and, where used in Reference 4, less than the Sitewide Release Criteria limit.

The results and sample data of the surface soil analyses by gamma spectroscopy are listed in Tables 1, 2, 3,and 4. All ninety-three surface soil samples are included here. These tables provide the sample location code number and the activity concentration and error, in pCi/g. Table 1 lists a *summary of those radionuclides detected in the samples* by gamma spectrometry. Table 2 lists the individual results. Entries in the error columns of "<MDA" indicate that the Minimum Detectable Activity for that result has been entered. Table 3 lists the Teledyne-Brown Sr-90 radiochemistry results for the twelve highest Cs-137 sample analyses that were performed. Table 4 lists other quality assurance information associated with obtaining the surface soil samples. (See Figure 4 for an explanation of the location data.)

6. INTERPRETATION

Individual results from the analysis of soil and rock for Cs-137 and Sr-90 are presented as cumulative probability plots in Figures 6 and 7. Figure 5, the results for K-40, is shown for a comparison to normal levels and provides a means to demonstrate the soil is homogeneous. In these plots, measured values are shown with an error bar associated with the data symbol. Non-detected results are plotted alongside detected results. In a cumulative probability plot, data with a normal (or Gaussian) distribution fall along a straight line. The plot shows, as a diagonal line, the theoretical Gaussian distribution calculated from the arithmetic mean and standard deviation of the dataset.

Most of the radionuclides detected show a distribution that is close to Gaussian. The distribution for Cs-137 in soil (Figure 6) shows several values that are somewhat higher than expected and outside the range of environmental fallout activity in surface soil. All results are below the SSFL site limit for Cs-137 in soil of 9.2 pCi/g, as determined by a pathway analysis using the DOE code RESRAD (Reference 4).

The results for Sr-90 in soil (Figure 7) also show some elevated values. Of the 12 surface soil sample analyses performed, five were reported at levels that were below the MDA (see Table 3). Seven surface soil samples, ranging from 0.40 to 1.30 pCi/g, are above MDA for this analysis. All results are well below the proposed SSFL site limit for Sr-90 in soil of 36 pCi/g, as determined by a pathways analysis using the DOE code RESRAD (Reference 4).

A summary of the other gamma spectroscopy results for surface soil samples are shown in Tables 1 and 2. Analysis of the data reveals normal amounts of natural K-40 and the natural thorium and natural uranium decay chains.

7. DOCUMENTATION

Backup documentation for this sampling and analysis project is stored in the Interim Storage Facility (Building 4654) decommissioning file.

8. REFERENCES

1. "Building T654 Supplemental Final Radiological Survey Plan", SSWA-AR-0009, R. J. Tuttle, 12/04/96.

2. "Verification Survey for the Interim Storage Facility; Buildings T013, T019, T024, T030; An area Northwest of Buildings T012, T013, T019, T059; and a Storage Yard West of Buildings T626 and T038; Santa Susana Field Laboratory, Rockwell International, Ventura County, California", Oak Ridge Institute for Science and Education (ORISE), Oak Ridge, TN, 9/6/95.

3. "Health and Safety Analysis Report", J. H. Wallace, 7/10/84, ISF- Scabbled Concrete Trench Top, 4654 Decommissioning File.

4. "Approved Sitewide Release Criteria for Remediation of Facilities at the SSFL", Rockwell Document N001SRR140131, February 1999.

5. "Final Radiological Survey Report of Building 023", Rockwell-Rocketdyne Document 023-ZR-0001, F. C. Dahl, 3/1/94, pages 26 through 30.

6. "Interim Storage Facility Decommissioning Final Report", Rockwell-Rocketdyne Document ESG-DOE-13507, 3/15/85.

7. ORISE 97-1900, "Verification Survey for the Interim Storage Facility (T654), Santa Susana Field Laboratory, Rockwell International, Ventura County, California", Oak Ridge Institute for Science and Education (ORISE), Oak Ridge, TN, November, 1997.

8. "Area IV Radiological Characterization Survey Final Report", Volume 1, A4CM-ZR-0011, P. D. Rutherford, August 15, 1996.

Boeing Rocketdyne Santa Susana Field Laboratory (SSFL) Area IV

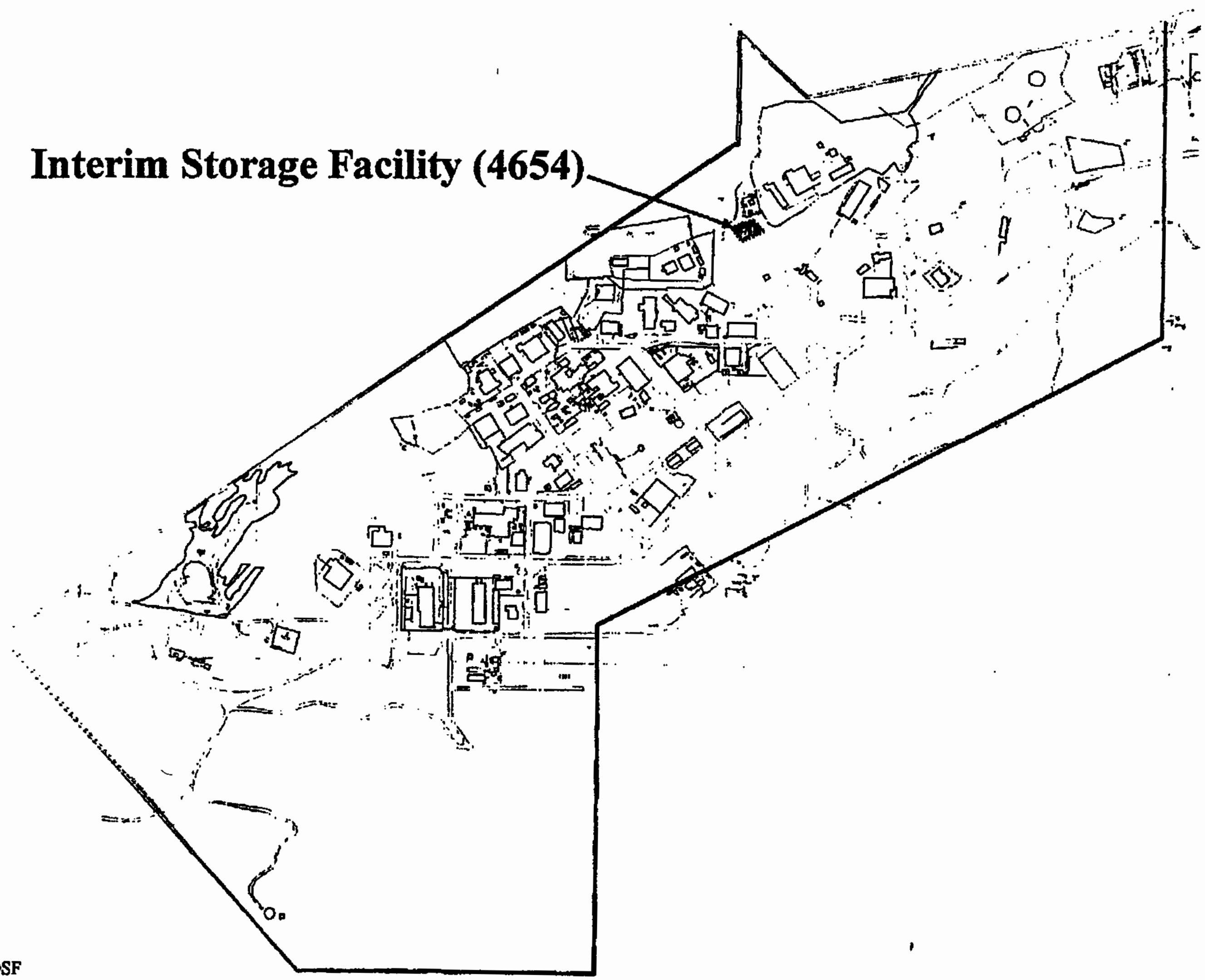
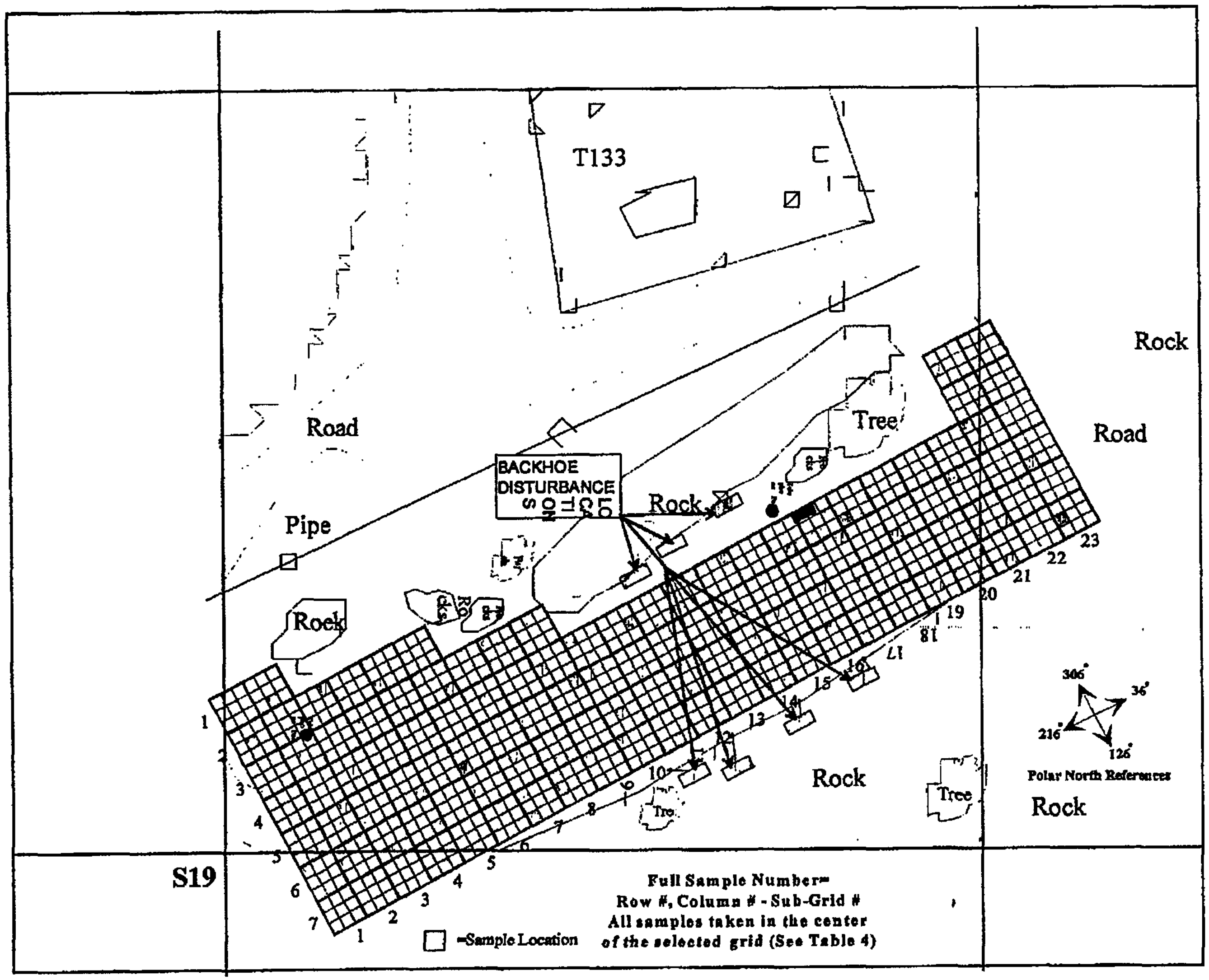


Figure 1. Location of the Interim Storage Facility.

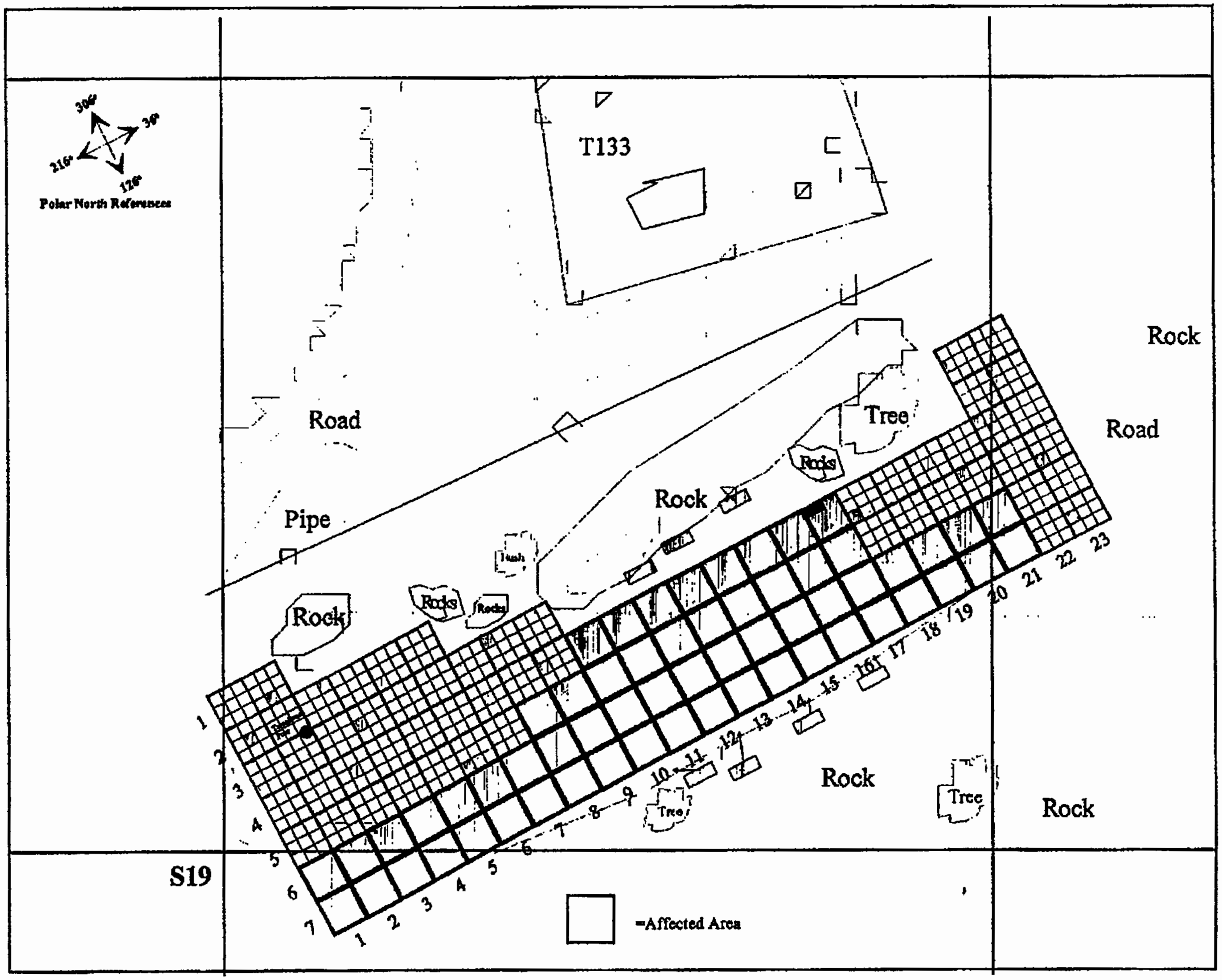
4654 Grid Survey Location Key



T654a.dsf

Figure 2. Locations of surface soil samples.

4654 · Interim Storage Facility Affected versus Unaffected Areas



T654b.dsf

Figure 3. Locations of affected and unaffected areas.

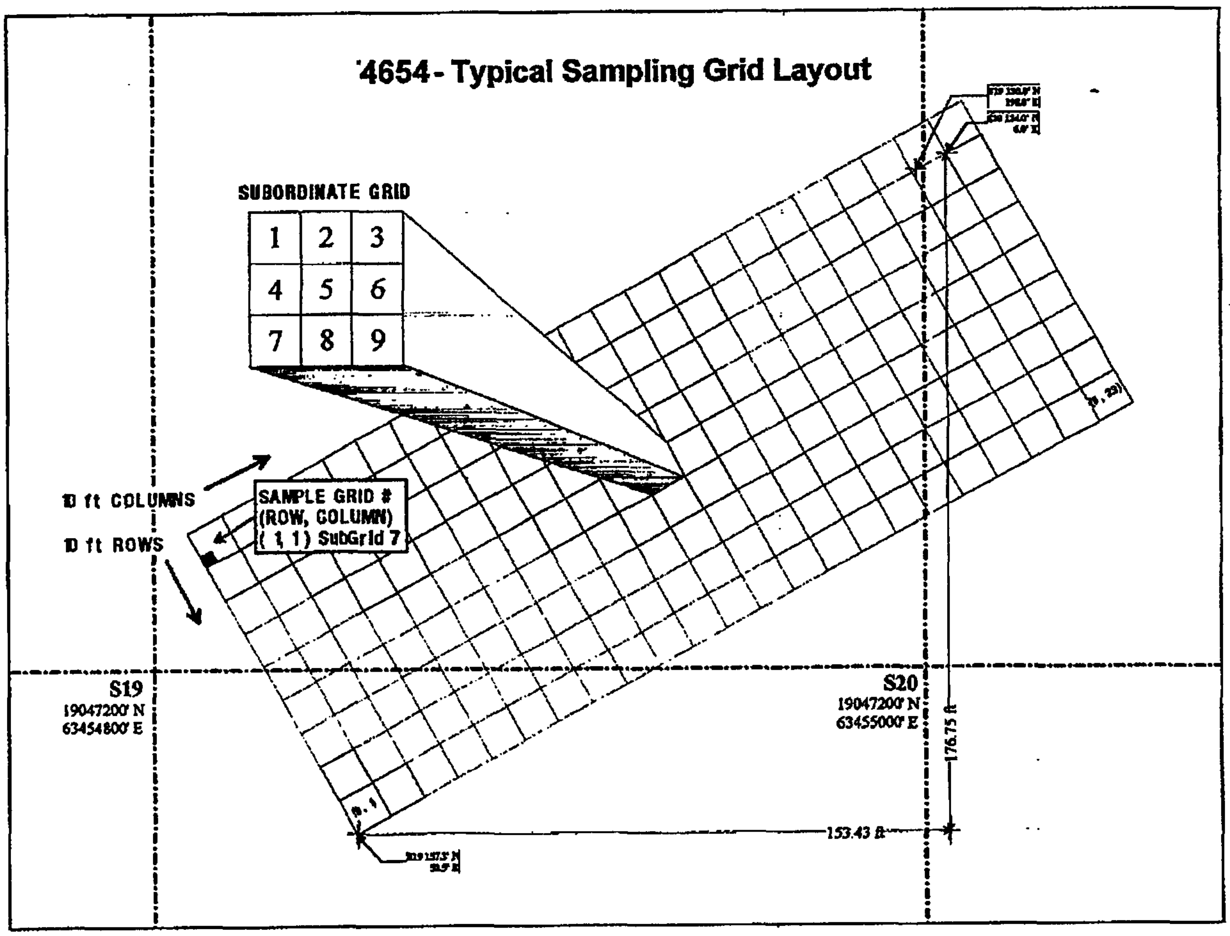


Figure 4. Typical Sampling Grid Naming Convention.

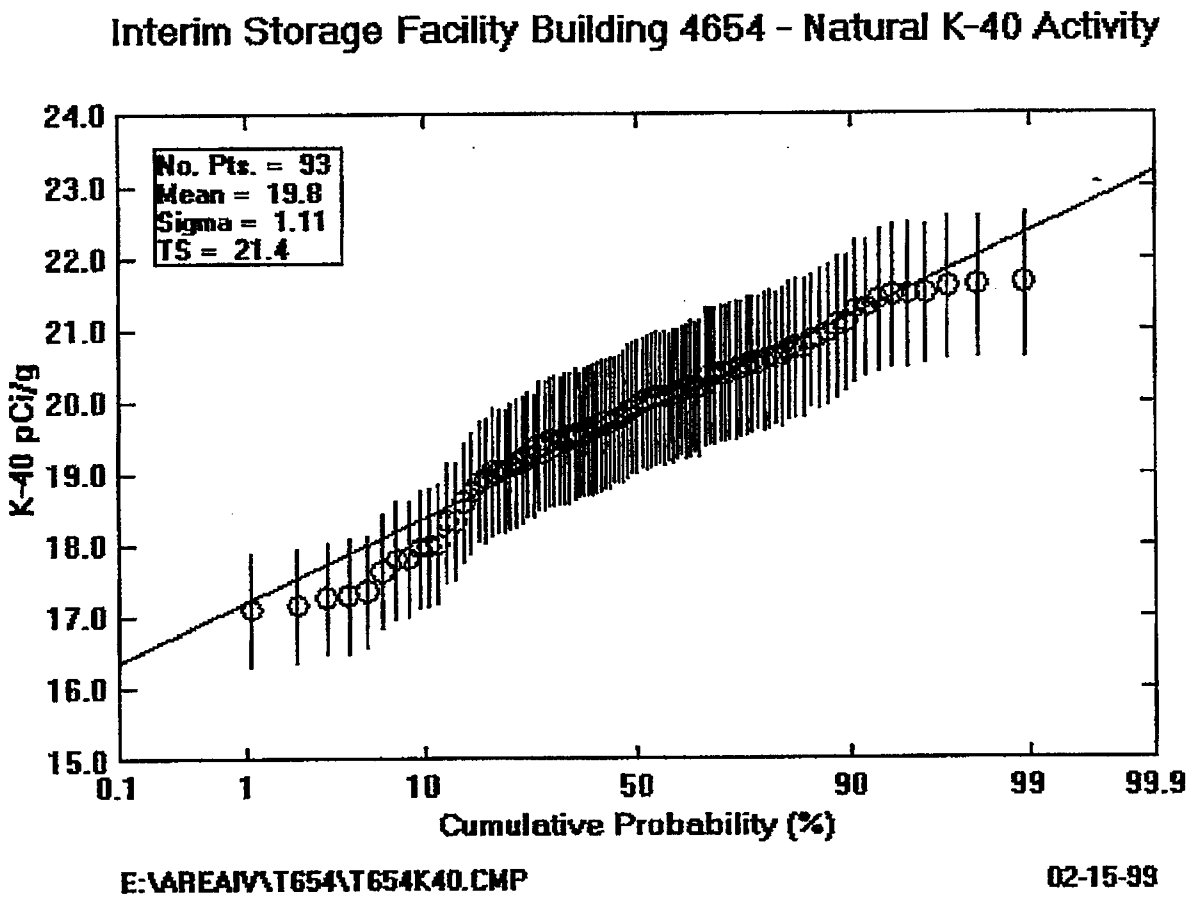


Figure 5. Distribution of K-40 in Soil and Rock at the Interim Storage Facility.

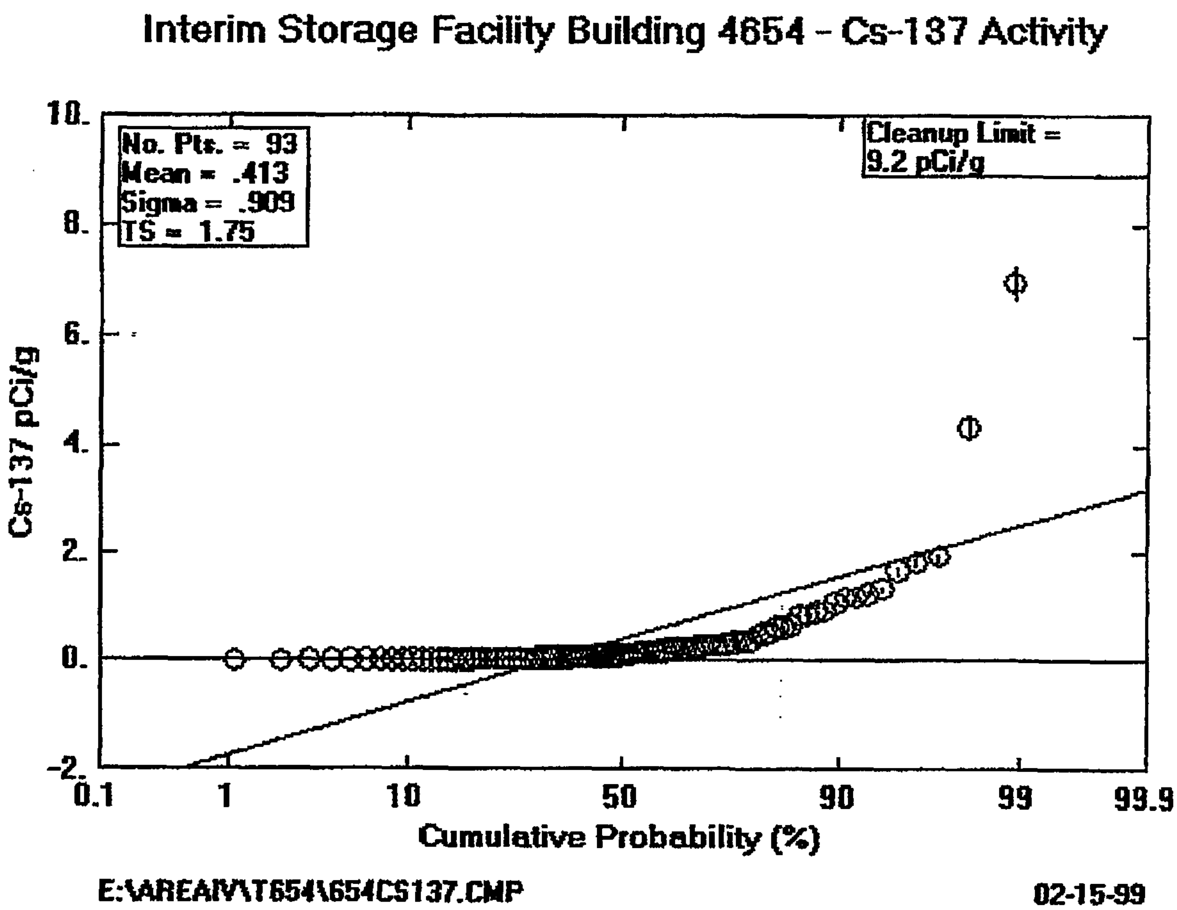


Figure 6. Distribution of Cs-137 in Soil and Rock at the Interim Storage Facility.

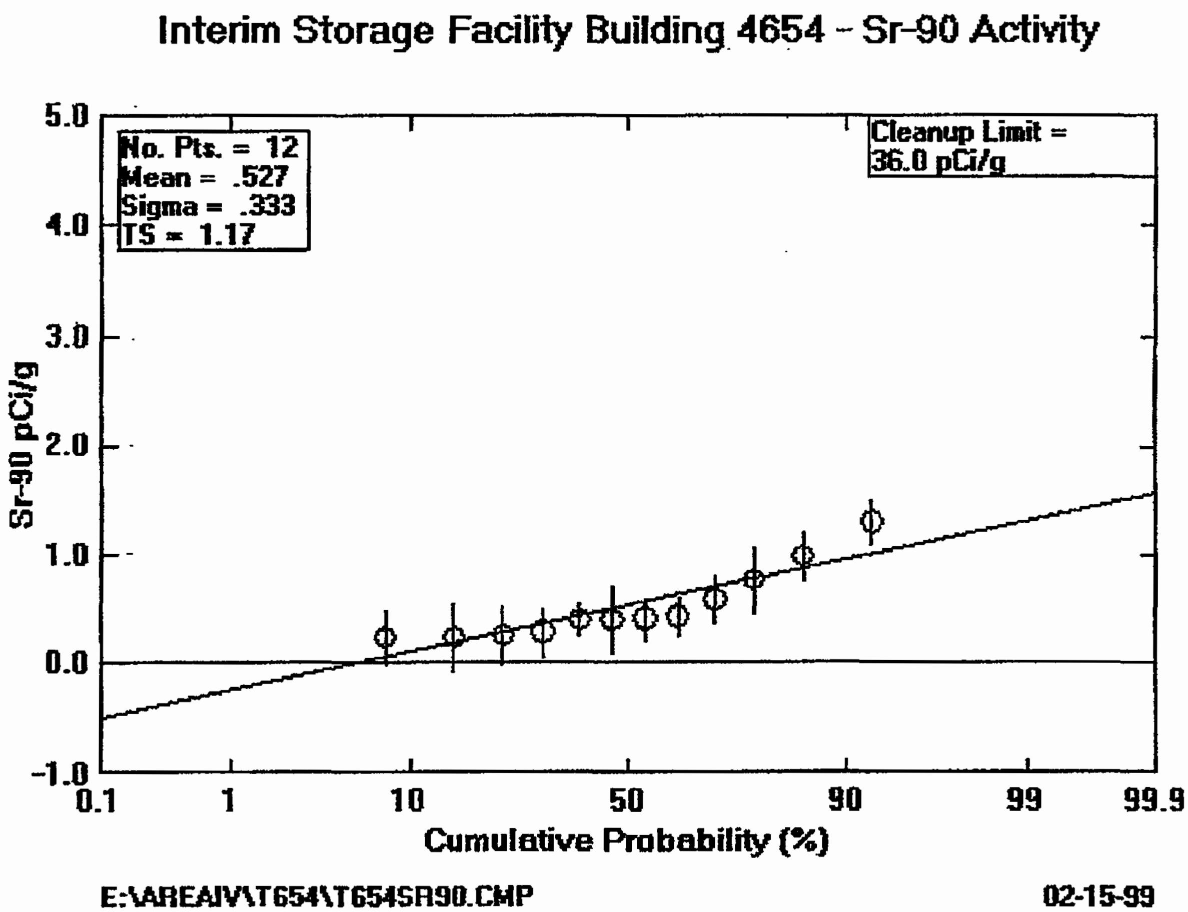


Figure 7. Distribution of Sr-90 in Soil and Rock at the Interim Storage Facility.

Table 1. Summary Surface Soil Gamma Spectroscopy Results*

					Natural Thorium Chain Gamma Emitters				
		K-40 pCi/g	Cs-137 pCi/g	Co-60 pCi/g	Tl-208 pCi/g	Pb-212 pCi/g	Bi-212 pCi/g	Ra-224 pCi/g	Ac-228 pCi/g
	Maximum	21.66	6.99	0.023	0.54	1.77	2.22	1.74	1.37
Detect	Average	19.78	0.47	0.023	0.37	1.24	0.97	1.22	1.03
	Minimum	17.10	0.01	0.023	0.23	0.79	0.52	0.69	0.66
	Detects	93	82	1	93	93	48	92	93
	Maximum		0.02	0.026			2.22	0.32	
MDA	Average		0.02	0.021			0.66	0.32	
	Minimum		0.01	0.016			0.09	0.32	
	NonDetect's	0	11	92	0	0	45	1	0

		Natural Uranium Decay Chain Gamma Emitters							
		Pb-210 pCi/g	Pb-214 pCi/g	Bi-214 pCi/g	Ra-226 pCi/g	Th-234 pCi/g	Pa-234m pCi/g	U-234 pCi/g	U-235 pCi/g
	Maximum	1.28	1.37	1.22	1.63	1.74	2.88	<MDA	0.08
Detect	Average	0.84	0.80	0.76	0.81	0.77	1.92	<MDA	0.04
	Minimum	0.49	0.37	0.35	0.30	0.24	1.40	<MDA	0.01
	Detects	59	93	93	90	93	13	0	93
	Maximum	0.87			0.88		3.12	25.91	
MDA	Average	0.72			0.54		2.56	19.29	
	Minimum	0.53			0.34		1.82	10.85	
	NonDetect's	34	0	0	3	0	80	93	0

* Other Isotopes at <MDA :
(MDA's are typical)

Isotope	MDA value	Isotope	MDA value
Be-7	0.14 pCi/g	Bi-211	0.30 pCi/g
Na-22	0.03 pCi/g	Rn-219	0.18 pCi/g
Sb-125	0.05 pCi/g	Rn-220	14.7 pCi/g
Cs-134	0.02 pCi/g	Ra-223	0.10 pCi/g
Cs-136	0.02 pCi/g	Ac-227	63.5 pCi/g
Ba-133	0.02 pCi/g	Th-227	0.13 pCi/g
Eu-152	0.04 pCi/g	Th-228	5.2 pCi/g
Eu-154	0.03 pCi/g	Th-230	5.3 pCi/g
Eu-155	0.07 pCi/g	Th-231	0.35 pCi/g
Ir-192	0.02 pCi/g	Th-232	12.6 pCi/g
Tl-210	0.02 pCi/g	Pa-231	0.58 pCi/g
Pb-211	0.05 pCi/g	Am-241	0.07 pCi/g

Table 2. Building T654 Indivdual Surface Soil Sample Results

NOTE: BOLD VALUES INDICATE DETECTED AND NON-BOLD VALUES INDICATE MDA FOR THAT SAMPLE

Sample #	Date	Grid #	Sub-Grid #	Weight (grams)		K-40 pCi/g	Error pCi/g	Cs-137 pCi/g	Error pCi/g	Co-60 pCi/g	Error pCi/g
654-97-0001	9/22/97	1,2	8	712	1	**19.95**	**0.94**	**0.36**	**0.018**	0.020	MDA
654-97-0002	9/22/97	2,1	5	759	2	**19.26**	**0.86**	**0.39**	**0.019**	0.020	MDA
654-97-0003	9/22/97	2,3	3	715	3	**20.40**	**0.96**	**0.24**	**0.013**	0.023	MDA
654-97-0004	9/22/97	2,5	7	789	4	**20.07**	**0.91**	**0.13**	**0.006**	0.021	MDA
654-97-0005	9/22/97	2,22	4	755	5	**19.50**	**0.92**	0.02	MDA	0.022	MDA
654-97-0006	9/22/97	3,2	5	733	6	**19.58**	**0.89**	**1.07**	**0.048**	0.019	MDA
654-97-0007	9/22/97	3,4	4	650	7	**20.76**	**0.98**	**0.31**	**0.015**	0.023	MDA
654-97-0008	9/22/97	3,6	9	812	8	**19.26**	**0.88**	**0.12**	**0.008**	0.021	MDA
654-97-0009	9/22/97	3,8	1	629	9	**20.35**	**0.97**	**0.16**	**0.009**	0.024	MDA
654-97-0010	9/22/97	3,23	4	953	10	**19.70**	**0.91**	**0.01**	**0.003**	0.019	MDA
654-97-0011	9/22/97	4,1	3	697	11	**20.06**	**0.95**	**0.22**	**0.014**	0.022	MDA
654-97-0012	9/22/97	4,3	5	833	12	**19.39**	**0.91**	**0.62**	**0.029**	0.020	MDA
654-97-0013	9/22/97	4,5	9	694	13	**20.52**	**0.97**	**0.16**	**0.009**	0.022	MDA
654-97-0014	9/22/97	4,7	5	811	14	**20.03**	**0.94**	**0.25**	**0.013**	0.022	MDA
654-97-0015	9/22/97	4,9	4	805	15	**19.55**	**0.92**	**0.07**	**0.005**	0.021	MDA
654-97-0016	9/22/97	4,10	1	765	16	**20.76**	**0.97**	**1.17**	**0.052**	0.021	MDA
654-97-0017	9/22/97	4,11	6	810	17	**19.62**	**0.92**	**0.02**	**0.004**	0.023	MDA
654-97-0018	9/23/97	4,12	9	814	18	**20.08**	**0.89**	**0.29**	**0.014**	0.021	MDA
654-97-0019	9/23/97	4,13	2	809	19	**19.15**	**0.90**	0.02	MDA	0.021	MDA
654-97-0020	9/23/97	4,14	3	843	20	**19.47**	**0.91**	**0.09**	**0.006**	0.019	MDA
654-97-0021	9/23/97	4,15	4	890	21	**19.76**	**0.89**	**0.53**	**0.024**	0.017	MDA
654-97-0022	9/23/97	4,16	8	819	22	**19.46**	**0.91**	**0.30**	**0.015**	0.021	MDA
654-97-0023	9/23/97	4,17	6	788	23	**19.77**	**0.89**	**0.05**	**0.004**	0.022	MDA
654-97-0024	9/23/97	4,18	7	784	24	**20.65**	**0.97**	0.02	MDA	0.022	MDA
654-97-0025	9/23/97	4,20	5	939	25	**20.11**	**0.91**	0.02	MDA	0.022	MDA
654-97-0026	9/23/97	4,22	1	988	26	**18.75**	**0.87**	0.02	MDA	0.019	MDA
654-97-0027	9/23/97	5,2	3	824	27	**20.37**	**0.95**	**0.23**	**0.013**	0.022	MDA
654-97-0028	9/23/97	5,4	9	785	28	**20.20**	**0.91**	**0.91**	**0.040**	0.019	MDA
654-97-0029	9/23/97	5,6	7	809	29	**19.39**	**0.91**	**0.16**	**0.009**	0.020	MDA
654-97-0030	9/23/97	5,8	4	848	30	**19.88**	**0.93**	**0.10**	**0.007**	0.021	MDA
654-97-0031	9/23/97	5,9	3	769	31	**20.43**	**0.96**	**0.08**	**0.005**	0.023	MDA
654-97-0032	9/23/97	5,10	1	726	32	**21.28**	**1.00**	**0.49**	**0.023**	0.022	MDA
654-97-0033	9/23/97	5,11	8	803	33	**20.16**	**0.94**	**0.04**	**0.003**	0.021	MDA
654-97-0034	9/23/97	5,12	2	861	34	**19.93**	**0.93**	**0.05**	**0.004**	0.022	MDA
654-97-0035	9/23/97	5,13	7	885	35	**20.73**	**0.96**	**0.10**	**0.006**	0.019	MDA
654-97-0036	9/23/97	5,14	4	804	36	**19.51**	**0.92**	**0.16**	**0.009**	0.022	MDA
654-97-0037	9/23/97	5,15	2	821	37	**20.01**	**0.94**	**0.04**	**0.004**	0.020	MDA
654-97-0038	9/23/97	5,16	6	715	38	**20.89**	**0.98**	**0.07**	**0.006**	0.021	MDA
654-97-0039	9/23/97	5,17	3	891	39	**18.34**	**0.83**	**0.84**	**0.037**	0.018	MDA
654-97-0040	9/23/97	5,19	7	820	40	**19.61**	**0.92**	**0.10**	**0.006**	0.022	MDA
654-97-0042	9/23/97	5,23	7	904	42	**17.82**	**0.83**	**0.02**	**0.003**	0.018	MDA
654-97-0043	9/23/97	6,1	1	820	43	**19.81**	**0.93**	**0.84**	**0.038**	0.020	MDA
654-97-0044	9/23/97	6,2	4	756	44	**20.96**	**0.98**	**1.17**	**0.051**	0.023	MDA
654-97-0045	9/23/97	6,3	8	909	45	**17.95**	**0.84**	0.01	MDA	0.018	MDA
654-97-0046	9/23/97	6,4	9	993	46	**17.36**	**0.79**	0.02	MDA	0.016	MDA

		K-40	Cs-137	Co-60
Detect	**Maximum**	**21.66**	**6.99**	**0.023**
	Average	**19.78**	**0.47**	**0.023**
	Minimum	**17.10**	**0.01**	**0.023**
	Detects	**93**	**82**	**1**
MDA	Maximum		0.02	0.026
	Average		0.02	0.021
	Minimum		0.01	0.016
	NonDetect's	0	11	92

Table 2. Building T654 Indivdual Surface Soil Sample Results

NOTE: BOLD VALUES INDICATE DETECTED AND NON-BOLD VALUES INDICATE MDA FOR THAT SAMPLE

Sample #	Date	Grid #	Sub-Grid #	Weight (grams)		K-40 pCi/g	Error pCi/g	Cs-137 pCi/g	Error pCi/g	Co-60 pCi/g	Error pCi/g
654-97-0047	9/23/97	6,5	9	955	47	**17.16**	**0.80**	0.02	MDA	0.018	MDA
654-97-0048	9/23/97	6,6	4	848	48	**17.98**	**0.84**	**0.25**	**0.012**	0.021	MDA
654-97-0049	9/23/97	6,7	2	713	49	**20.38**	**0.96**	**1.93**	**0.086**	0.020	MDA
654-97-0050	9/23/97	6,8	8	842	50	**18.33**	**0.86**	**0.29**	**0.014**	0.020	MDA
654-97-0051	9/23/97	6,9	9	839	51	**20.40**	**0.95**	**0.12**	**0.007**	0.020	MDA
654-97-0052	9/23/97	6,10	5	925	52	**18.92**	**0.88**	**0.19**	**0.010**	0.019	MDA
654-97-0053	9/23/97	6,11	3	765	53	**20.10**	**0.94**	**0.04**	**0.003**	0.021	MDA
654-97-0054	9/23/97	6,12	8	855	54	**18.60**	**0.84**	**0.08**	**0.006**	0.019	MDA
654-97-0055	9/23/97	6,13	9	764	55	**20.55**	**0.92**	**0.04**	**0.004**	0.023	MDA
654-97-0056	9/23/97	6,14	5	881	56	**17.30**	**0.81**	**0.06**	**0.005**	0.019	MDA
654-97-0057	9/23/97	6,15	2	871	57	**19.11**	**0.89**	**0.06**	**0.005**	0.019	MDA
654-97-0058	9/23/97	6,16	3	1042	58	**17.27**	**0.80**	**0.02**	**0.003**	0.017	MDA
654-97-0059	9/23/97	6,17	6	778	59	**21.51**	**0.97**	**0.09**	**0.006**	0.022	MDA
654-97-0060	9/23/97	6,18	1	784	60	**21.61**	**1.01**	**0.06**	**0.005**	0.021	MDA
654-97-0061	9/23/97	6,19	5	796	61	**18.02**	**0.85**	**0.29**	**0.014**	0.019	MDA
654-97-0062	9/23/97	6,20	2	741	62	**17.10**	**0.81**	0.02	MDA	0.021	MDA
654-97-0063	9/23/97	6,21	9	751	63	**17.64**	**0.80**	0.02	MDA	0.019	MDA
654-97-0064	9/24/97	6,22	3	885	64	**17.81**	**0.83**	**0.02**	**0.003**	0.018	MDA
654-97-0065	9/24/97	7,1	6	744	65	**19.19**	**0.90**	**0.17**	**0.011**	0.022	MDA
654-97-0066	9/24/97	7,2	9	688	66	**20.19**	**0.95**	**0.22**	**0.012**	0.024	MDA
654-97-0067	9/24/97	7,3	2	718	67	**21.11**	**0.96**	**0.26**	**0.013**	0.022	MDA
654-97-0068	9/24/97	7,4	8	774	68	**19.71**	**0.92**	**0.37**	**0.017**	0.023	MDA
654-97-0069	9/24/97	7,5	5	712	69	**20.00**	**0.90**	**1.82**	**0.082**	0.021	MDA
654-97-0070	9/24/97	7,6	9	771	70	**20.54**	**0.96**	**1.68**	**0.075**	0.022	MDA
654-97-0071	9/24/97	7,7	7	774	71	**20.20**	**0.95**	**4.35**	**0.188**	0.021	MDA
654-97-0072	9/24/97	7,8	4	773	72	**19.03**	**0.90**	**0.62**	**0.029**	0.019	MDA
654-97-0073	9/24/97	7,9	3	864	73	**18.90**	**0.85**	**0.02**	**0.003**	0.020	MDA
654-97-0074	9/24/97	7,10	1	874	74	**19.55**	**0.88**	0.02	MDA	0.019	MDA
654-97-0075	9/24/97	7,11	8	822	75	**20.07**	**0.94**	**0.27**	**0.013**	0.020	MDA
654-97-0076	9/24/97	7,12	4	813	76	**19.47**	**0.88**	**0.18**	**0.009**	0.020	MDA
654-97-0077	9/24/97	7,13	5	786	77	**21.63**	**0.98**	**1.24**	**0.055**	0.021	MDA
654-97-0078	9/24/97	7,14	9	762	78	**20.87**	**0.93**	**0.34**	**0.017**	0.021	MDA
654-97-0079	9/24/97	7,15	5	751	79	**19.69**	**0.93**	**0.05**	**0.005**	0.022	MDA
654-97-0080	9/24/97	7,16	2	800	80	**19.05**	**0.86**	**0.04**	**0.005**	0.021	MDA
654-97-0081	9/24/97	7,17	7	790	81	**20.45**	**0.96**	**0.51**	**0.024**	0.022	MDA
654-97-0082	9/24/97	7,18	3	822	82	**19.05**	**0.86**	**0.03**	**0.004**	0.021	MDA
654-97-0083	9/24/97	7,19	5	748	83	**19.66**	**0.92**	**0.04**	**0.004**	0.023	MDA
654-97-0084	9/24/97	7,20	4	767	84	**20.16**	**0.89**	**0.07**	**0.006**	0.021	MDA
654-97-0085	9/24/97	7,21	8	763	85	**21.66**	**1.01**	**0.10**	**0.006**	**0.023**	**0.005**
654-97-0086	9/24/97	7,23	4	789	86	**20.62**	**0.93**	**0.11**	**0.007**	0.022	MDA
654-97-0087	9/24/97	3,12	khoe disturba	669	87	**21.32**	**0.95**	**0.08**	**0.006**	0.023	MDA
654-97-0088	9/24/97	3,13	khoe disturba	641	88	**21.50**	**1.02**	**0.11**	**0.007**	0.026	MDA
654-97-0089	9/24/97	3,15	khoe disturba	701	89	**21.06**	**0.99**	**0.06**	**0.005**	0.022	MDA
654-97-0090	9/24/97	8,10	khoe disturba	677	90	**21.48**	**1.01**	**1.34**	**0.060**	0.022	MDA
654-97-0091	9/24/97	8,12	khoe disturba	659	91	**21.42**	**1.01**	**6.99**	**0.305**	0.023	MDA
654-97-0092	9/24/97	8,14	khoe disturba	661	92	**20.58**	**0.97**	**0.66**	**0.031**	0.024	MDA
654-97-0093	9/24/97	8,16	khoe disturba	677	93	**20.62**	**0.97**	**0.93**	**0.043**	0.023	MDA

		K-40	Cs-137	Co-60
Detect	**Maximum**	**21.66**	**6.99**	**0.023**
	Average	**19.78**	**0.47**	**0.023**
	Minimum	**17.10**	**0.01**	**0.023**
	Detects	**93**	**82**	**1**
MDA	Maximum		0.02	0.026
	Average		0.02	0.021
	Minimum		0.01	0.016
	NonDetect's	0	11	92

Table 2. Building T654 Indivdual Surface Soil Sample Results

NOTE: BOLD VALUES INDICATE DETECTED AND NON-BOLD VALUES INDICATE MDA FOR THAT SAMPLE

Sample #	Date	Grid #	Sub-Grid #	Weight (grams)		Tl-208 pCi/g	Error pCi/g	Pb-212 pCi/g	Error pCi/g	Bi-212 pCi/g	Error pCi/g
654-97-0001	9/22/97	1,2	8	712	1	**0.36**	**0.01**	**1.77**	**0.09**	0.14	MDA
654-97-0002	9/22/97	2,1	5	759	2	**0.37**	**0.01**	**1.22**	**0.06**	0.14	MDA
654-97-0003	9/22/97	2,3	3	715	3	**0.38**	**0.02**	**1.30**	**0.06**	**1.44**	**0.28**
654-97-0004	9/22/97	2,5	7	789	4	**0.40**	**0.01**	**1.26**	**0.06**	**1.14**	**0.20**
654-97-0005	9/22/97	2,22	4	755	5	**0.38**	**0.01**	**1.23**	**0.06**	**0.98**	**0.15**
654-97-0006	9/22/97	3,2	5	733	6	**0.35**	**0.01**	**1.21**	**0.06**	**0.84**	**0.20**
654-97-0007	9/22/97	3,4	4	650	7	**0.42**	**0.02**	**1.31**	**0.06**	0.14	MDA
654-97-0008	9/22/97	3,6	9	812	8	**0.39**	**0.02**	**1.27**	**0.06**	0.13	MDA
654-97-0009	9/22/97	3,8	1	629	9	**0.39**	**0.02**	**1.31**	**0.06**	0.15	MDA
654-97-0010	9/22/97	3,23	4	953	10	**0.41**	**0.02**	**1.38**	**0.06**	**1.16**	**0.22**
654-97-0011	9/22/97	4,1	3	697	11	**0.36**	**0.01**	**1.17**	**0.06**	**0.82**	**0.20**
654-97-0012	9/22/97	4,3	5	833	12	**0.44**	**0.02**	**1.36**	**0.06**	**1.27**	**0.25**
654-97-0013	9/22/97	4,5	9	694	13	**0.37**	**0.02**	**1.35**	**0.06**	0.14	MDA
654-97-0014	9/22/97	4,7	5	811	14	**0.39**	**0.02**	**1.27**	**0.06**	**0.97**	**0.19**
654-97-0015	9/22/97	4,9	4	805	15	**0.40**	**0.02**	**1.32**	**0.06**	**0.71**	**0.19**
654-97-0016	9/22/97	4,10	1	765	16	**0.38**	**0.01**	**1.27**	**0.06**	0.15	MDA
654-97-0017	9/22/97	4,11	6	810	17	**0.41**	**0.02**	**1.25**	**0.06**	0.12	MDA
654-97-0018	9/23/97	4,12	9	814	18	**0.36**	**0.01**	**1.23**	**0.06**	**0.79**	**0.18**
654-97-0019	9/23/97	4,13	2	809	19	**0.38**	**0.02**	**1.38**	**0.06**	0.12	MDA
654-97-0020	9/23/97	4,14	3	843	20	**0.39**	**0.02**	**1.29**	**0.06**	0.11	MDA
654-97-0021	9/23/97	4,15	4	890	21	**0.40**	**0.02**	**1.18**	**0.06**	**0.87**	**0.17**
654-97-0022	9/23/97	4,16	8	819	22	**0.39**	**0.02**	**1.25**	**0.06**	**0.98**	**0.18**
654-97-0023	9/23/97	4,17	6	788	23	**0.42**	**0.02**	**1.32**	**0.06**	**0.79**	**0.18**
654-97-0024	9/23/97	4,18	7	784	24	**0.39**	**0.02**	**1.37**	**0.06**	0.13	MDA
654-97-0025	9/23/97	4,20	5	939	25	**0.42**	**0.02**	**1.32**	**0.06**	**1.07**	**0.17**
654-97-0026	9/23/97	4,22	1	988	26	**0.43**	**0.02**	**1.43**	**0.06**	0.11	MDA
654-97-0027	9/23/97	5,2	3	824	27	**0.37**	**0.01**	**1.18**	**0.06**	0.13	0.06
654-97-0028	9/23/97	5,4	9	785	28	**0.40**	**0.02**	**1.30**	**0.06**	**0.88**	**0.22**
654-97-0029	9/23/97	5,6	7	809	29	**0.37**	**0.02**	**1.22**	**0.06**	**0.89**	**0.18**
654-97-0030	9/23/97	5,8	4	848	30	**0.41**	**0.02**	**1.35**	**0.06**	**1.07**	**0.20**
654-97-0031	9/23/97	5,9	3	769	31	**0.42**	**0.02**	**1.29**	**0.06**	**1.39**	**0.29**
654-97-0032	9/23/97	5,10	1	726	32	**0.38**	**0.02**	**1.22**	**0.06**	**1.06**	**0.20**
654-97-0033	9/23/97	5,11	8	803	33	**0.41**	**0.02**	**1.33**	**0.06**	**0.93**	**0.19**
654-97-0034	9/23/97	5,12	2	861	34	**0.36**	**0.01**	**1.21**	**0.06**	**0.95**	**0.18**
654-97-0035	9/23/97	5,13	7	885	35	**0.37**	**0.01**	**1.18**	**0.06**	0.12	MDA
654-97-0036	9/23/97	5,14	4	804	36	**0.38**	**0.02**	**1.26**	**0.06**	0.13	MDA
654-97-0037	9/23/97	5,15	2	821	37	**0.38**	**0.01**	**1.24**	**0.06**	0.13	MDA
654-97-0038	9/23/97	5,16	6	715	38	**0.41**	**0.01**	**1.34**	**0.06**	0.13	MDA
654-97-0039	9/23/97	5,17	3	891	39	**0.37**	**0.01**	**1.24**	**0.06**	0.11	MDA
654-97-0040	9/23/97	5,19	7	820	40	**0.39**	**0.01**	**1.35**	**0.06**	**2.22**	**0.42**
654-97-0041	9/23/97	5,21	1	853	41	**0.44**	**0.02**	**1.51**	**0.07**	**0.91**	**0.19**
654-97-0042	9/23/97	5,23	7	904	42	**0.26**	**0.01**	**0.89**	**0.04**	**0.68**	**0.16**
654-97-0043	9/23/97	6,1	1	820	43	**0.36**	**0.01**	**1.24**	**0.06**	**1.04**	**0.19**
654-97-0044	9/23/97	6,2	4	756	44	**0.38**	**0.01**	**1.28**	**0.06**	**1.28**	**0.25**
654-97-0045	9/23/97	6,3	8	909	45	**0.26**	**0.01**	**0.86**	**0.04**	0.10	MDA
654-97-0046	9/23/97	6,4	9	993	46	**0.23**	**0.01**	**0.79**	**0.04**	0.09	MDA

		Tl-208	Pb-212	Bi-212
Detect	**Maximum**	**0.54**	**1.77**	**2.22**
	Average	**0.37**	**1.24**	**0.97**
	Minimum	**0.23**	**0.79**	**0.52**
	Detects	**93**	**93**	**60**
MDA	Maximum			0.17
	Average			0.13
	Minimum			0.09
	NonDetect's	0	0	43

Table 2. Building T654 Indivdual Surface Soil Sample Results

NOTE: BOLD VALUES INDICATE DETECTED AND NON-BOLD VALUES INDICATE MDA FOR THAT SAMPLE

Sample #	Date	Grid #	Sub-Grid #	Weight (grams)		Tl-208 pCi/g	Error pCi/g	Pb-212 pCi/g	Error pCi/g	Bi-212 pCi/g	Error pCi/g
654-97-0047	9/23/97	6,5	9	955	47	**0.25**	**0.01**	**0.84**	**0.04**	**0.52**	**0.15**
654-97-0048	9/23/97	6,6	4	848	48	**0.26**	**0.01**	**0.88**	**0.05**	**0.94**	**0.17**
654-97-0049	9/23/97	6,7	2	713	49	**0.34**	**0.01**	**1.14**	**0.05**	0.13	MDA
654-97-0050	9/23/97	6,8	8	842	50	**0.32**	**0.01**	**1.00**	**0.05**	0.11	0.06
654-97-0051	9/23/97	6,9	9	839	51	**0.29**	**0.01**	**0.97**	**0.05**	**0.79**	**0.22**
654-97-0052	9/23/97	6,10	5	925	52	**0.31**	**0.01**	**1.05**	**0.05**	**0.84**	**0.17**
654-97-0053	9/23/97	6,11	3	765	53	**0.42**	**0.02**	**1.43**	**0.07**	0.12	MDA
654-97-0054	9/23/97	6,12	8	855	54	**0.38**	**0.01**	**1.17**	**0.06**	0.11	MDA
654-97-0055	9/23/97	6,13	9	764	55	**0.41**	**0.02**	**1.28**	**0.06**	0.13	MDA
654-97-0056	9/23/97	6,14	5	881	56	**0.31**	**0.01**	**1.10**	**0.05**	**0.72**	**0.17**
654-97-0057	9/23/97	6,15	2	871	57	**0.34**	**0.01**	**1.05**	**0.05**	0.11	MDA
654-97-0058	9/23/97	6,16	3	1042	58	**0.27**	**0.01**	**0.90**	**0.04**	0.10	MDA
654-97-0059	9/23/97	6,17	6	778	59	**0.45**	**0.02**	**1.41**	**0.07**	**1.07**	**0.20**
654-97-0060	9/23/97	6,18	1	784	60	**0.41**	**0.02**	**1.41**	**0.06**	0.13	MDA
654-97-0061	9/23/97	6,19	5	796	61	**0.29**	**0.01**	**0.97**	**0.04**	**0.81**	**0.19**
654-97-0062	9/23/97	6,20	2	741	62	**0.31**	**0.01**	**1.00**	**0.05**	0.13	MDA
654-97-0063	9/23/97	6,21	9	751	63	**0.25**	**0.01**	**0.85**	**0.04**	0.11	MDA
654-97-0064	9/24/97	6,22	3	885	64	**0.25**	**0.01**	**0.87**	**0.04**	0.11	MDA
654-97-0065	9/24/97	7,1	6	744	65	**0.37**	**0.02**	**1.22**	**0.06**	**1.27**	**0.19**
654-97-0066	9/24/97	7,2	9	688	66	**0.54**	**0.02**	**1.70**	**0.08**	0.17	MDA
654-97-0067	9/24/97	7,3	2	718	67	**0.38**	**0.02**	**1.29**	**0.06**	**0.84**	**0.20**
654-97-0068	9/24/97	7,4	8	774	68	**0.41**	**0.01**	**1.28**	**0.06**	**0.99**	**0.20**
654-97-0069	9/24/97	7,5	5	712	69	**0.38**	**0.02**	**1.28**	**0.06**	**0.91**	**0.20**
654-97-0070	9/24/97	7,6	9	771	70	**0.37**	**0.02**	**1.34**	**0.06**	**1.00**	**0.21**
654-97-0071	9/24/97	7,7	7	774	71	**0.41**	**0.02**	**1.24**	**0.06**	0.14	MDA
654-97-0072	9/24/97	7,8	4	773	72	**0.31**	**0.01**	**1.10**	**0.05**	0.11	MDA
654-97-0073	9/24/97	7,9	3	864	73	**0.36**	**0.01**	**1.20**	**0.06**	**0.83**	**0.17**
654-97-0074	9/24/97	7,10	1	874	74	**0.32**	**0.01**	**1.07**	**0.05**	0.10	MDA
654-97-0075	9/24/97	7,11	8	822	75	**0.41**	**0.01**	**1.29**	**0.06**	**0.91**	**0.18**
654-97-0076	9/24/97	7,12	4	813	76	**0.40**	**0.01**	**1.30**	**0.06**	**0.83**	**0.19**
654-97-0077	9/24/97	7,13	5	786	77	**0.38**	**0.02**	**1.26**	**0.06**	**0.95**	**0.19**
654-97-0078	9/24/97	7,14	9	762	78	**0.42**	**0.02**	**1.31**	**0.06**	**0.89**	**0.19**
654-97-0079	9/24/97	7,15	5	751	79	**0.41**	**0.02**	**1.35**	**0.06**	**0.89**	**0.20**
654-97-0080	9/24/97	7,16	2	800	80	**0.41**	**0.02**	**1.33**	**0.06**	**0.76**	**0.19**
654-97-0081	9/24/97	7,17	7	790	81	**0.40**	**0.02**	**1.31**	**0.06**	**1.22**	**0.26**
654-97-0082	9/24/97	7,18	3	822	82	**0.40**	**0.02**	**1.41**	**0.07**	**0.68**	**0.09**
654-97-0083	9/24/97	7,19	5	748	83	**0.40**	**0.02**	**1.34**	**0.06**	**0.93**	**0.20**
654-97-0084	9/24/97	7,20	4	767	84	**0.42**	**0.02**	**1.41**	**0.07**	**0.95**	**0.20**
654-97-0085	9/24/97	7,21	8	763	85	**0.39**	**0.02**	**1.26**	**0.06**	0.11	MDA
654-97-0086	9/24/97	7,23	4	789	86	**0.36**	**0.01**	**1.15**	**0.06**	0.13	MDA
654-97-0087	9/24/97	3,12	ckhoe disturba	669	87	**0.44**	**0.03**	**1.41**	**0.07**	0.12	MDA
654-97-0088	9/24/97	3,13	ckhoe disturba	641	88	**0.39**	**0.02**	**1.41**	**0.07**	0.11	MDA
654-97-0089	9/24/97	3,15	ckhoe disturba	701	89	**0.42**	**0.02**	**1.45**	**0.07**	**1.07**	**0.22**
654-97-0090	9/24/97	8,10	ckhoe disturba	677	90	**0.38**	**0.02**	**1.31**	**0.06**	0.13	MDA
654-97-0091	9/24/97	8,12	ckhoe disturba	659	91	**0.34**	**0.01**	**1.21**	**0.06**	0.14	MDA
654-97-0092	9/24/97	8,14	ckhoe disturba	661	92	**0.40**	**0.02**	**1.38**	**0.07**	0.14	MDA
654-97-0093	9/24/97	8,16	ckhoe disturba	677	93	**0.38**	**0.02**	**1.32**	**0.06**	0.15	MDA

		Tl-208	Pb-212	Bi-212
	Maximum	**0.54**	**1.77**	**2.22**
Detect	**Average**	**0.37**	**1.24**	**0.97**
	Minimum	**0.23**	**0.79**	**0.52**
	Detects	**93**	**93**	**50**
	Maximum			0.17
MDA	Average			0.13
	Minimum			0.09
	NonDetect's	**0**	**0**	**43**

Table 2. Building T654 Indivdual Surface Soil Sample Results

NOTE: BOLD VALUES INDICATE DETECTED AND NON-BOLD VALUES INDICATE MDA FOR THAT SAMPLE

Sample #	Date	Grid #	Sub-Grid #	Weight (grams)		Ra-224 pCi/g	Error pCi/g	Ac-228 pCi/g	Error pCi/g	Pb-210 pCi/g	Error pCi/g
654-97-0001	9/22/97	1,2	8	712	1	**1.09**	**0.13**	**0.92**	**0.02**	0.79	MDA
654-97-0002	9/22/97	2,1	5	759	2	**1.17**	**0.09**	**0.98**	**0.02**	0.75	MDA
654-97-0003	9/22/97	2,3	3	715	3	**1.41**	**0.11**	**1.04**	**0.03**	**0.79**	**0.11**
654-97-0004	9/22/97	2,5	7	789	4	**1.15**	**0.11**	**1.04**	**0.02**	**0.95**	**0.14**
654-97-0005	9/22/97	2,22	4	755	5	**1.35**	**0.12**	**1.05**	**0.03**	0.74	MDA
654-97-0006	9/22/97	3,2	5	733	6	**1.21**	**0.10**	**1.11**	**0.03**	0.87	MDA
654-97-0007	9/22/97	3,4	4	650	7	**1.40**	**0.11**	**1.14**	**0.03**	**0.81**	**0.14**
654-97-0008	9/22/97	3,6	9	812	8	**1.13**	**0.12**	**1.05**	**0.03**	**0.72**	**0.11**
654-97-0009	9/22/97	3,8	1	629	9	**1.16**	**0.12**	**1.13**	**0.03**	**1.26**	**0.13**
654-97-0010	9/22/97	3,23	4	953	10	**1.33**	**0.13**	**1.14**	**0.03**	**0.83**	**0.12**
654-97-0011	9/22/97	4,1	3	697	11	**1.00**	**0.12**	**1.03**	**0.03**	**1.04**	**0.09**
654-97-0012	9/22/97	4,3	5	833	12	**1.29**	**0.11**	**1.14**	**0.03**	**0.81**	**0.10**
654-97-0013	9/22/97	4,5	9	694	13	**1.44**	**0.14**	**1.09**	**0.03**	0.80	MDA
654-97-0014	9/22/97	4,7	5	811	14	**1.19**	**0.10**	**0.99**	**0.03**	0.72	MDA
654-97-0015	9/22/97	4,9	4	805	15	**1.06**	**0.10**	**1.05**	**0.03**	**0.84**	**0.10**
654-97-0016	9/22/97	4,10	1	765	16	**1.19**	**0.11**	**1.07**	**0.03**	**0.80**	**0.12**
654-97-0017	9/22/97	4,11	6	810	17	**1.16**	**0.11**	**1.05**	**0.03**	0.74	MDA
654-97-0018	9/23/97	4,12	9	814	18	**1.21**	**0.10**	**0.99**	**0.03**	0.73	MDA
654-97-0019	9/23/97	4,13	2	809	19	**1.29**	**0.10**	**1.08**	**0.03**	**0.88**	**0.10**
654-97-0020	9/23/97	4,14	3	843	20	**1.40**	**0.11**	**1.00**	**0.03**	**0.75**	**0.07**
654-97-0021	9/23/97	4,15	4	890	21	**1.26**	**0.10**	**1.00**	**0.03**	**0.74**	**0.12**
654-97-0022	9/23/97	4,16	8	819	22	**1.08**	**0.12**	**1.02**	**0.29**	**0.69**	**0.12**
654-97-0023	9/23/97	4,17	6	788	23	**1.32**	**0.11**	**1.14**	**0.03**	0.75	MDA
654-97-0024	9/23/97	4,18	7	784	24	**1.44**	**0.11**	**1.10**	**0.03**	0.79	MDA
654-97-0025	9/23/97	4,20	5	939	25	**1.51**	**0.12**	**1.09**	**0.03**	**0.63**	**0.15**
654-97-0026	9/23/97	4,22	1	988	26	**1.31**	**0.10**	**1.21**	**0.03**	0.68	MDA
654-97-0027	9/23/97	5,2	3	824	27	**1.24**	**0.10**	**1.01**	**0.03**	0.73	MDA
654-97-0028	9/23/97	5,4	9	785	28	**1.18**	**0.11**	**1.04**	**0.03**	**0.80**	**0.10**
654-97-0029	9/23/97	5,6	7	809	29	**1.15**	**0.10**	**1.02**	**0.03**	**0.83**	**0.10**
654-97-0030	9/23/97	5,8	4	848	30	**1.34**	**0.11**	**1.07**	**0.03**	**0.97**	**0.12**
654-97-0031	9/23/97	5,9	3	769	31	**1.33**	**0.12**	**1.13**	**0.03**	**0.77**	**0.39**
654-97-0032	9/23/97	5,10	1	726	32	**1.24**	**0.11**	**1.07**	**0.03**	**1.18**	**0.10**
654-97-0033	9/23/97	5,11	8	803	33	**1.49**	**0.12**	**1.08**	**0.03**	**0.74**	**0.08**
654-97-0034	9/23/97	5,12	2	861	34	**1.21**	**0.11**	**1.01**	**0.03**	**0.75**	**0.09**
654-97-0035	9/23/97	5,13	7	885	35	**1.34**	**0.10**	**0.94**	**0.02**	0.65	MDA
654-97-0036	9/23/97	5,14	4	804	36	**1.06**	**0.07**	**1.09**	**0.03**	**0.64**	**0.11**
654-97-0037	9/23/97	5,15	2	821	37	**1.34**	**0.11**	**1.05**	**0.03**	**0.79**	**0.15**
654-97-0038	9/23/97	5,16	6	715	38	**1.32**	**0.14**	**1.21**	**0.03**	**0.73**	**0.11**
654-97-0039	9/23/97	5,17	3	891	39	**1.41**	**0.12**	**1.02**	**0.03**	**1.01**	**0.09**
654-97-0040	9/23/97	5,19	7	820	40	**1.28**	**0.12**	**1.13**	**0.03**	**0.76**	**0.10**
654-97-0041	9/23/97	5,21	1	853	41	**1.38**	**0.11**	**1.21**	**0.03**	0.73	MDA
654-97-0042	9/23/97	5,23	7	904	42	**0.69**	**0.08**	**0.75**	**0.02**	0.58	MDA
654-97-0043	9/23/97	6,1	1	820	43	**1.06**	**0.09**	**1.04**	**0.03**	**0.73**	**0.10**
654-97-0044	9/23/97	6,2	4	756	44	**1.50**	**0.11**	**1.09**	**0.03**	**0.73**	**0.11**
654-97-0045	9/23/97	6,3	8	909	45	**0.88**	**0.08**	**0.68**	**0.02**	0.55	MDA
654-97-0046	9/23/97	6,4	9	993	46	**0.84**	**0.07**	**0.66**	**0.02**	**0.61**	**0.09**

		Ra-224	Ac-228	Pb-210
Detect	**Maximum**	**1.74**	**1.37**	**1.28**
	Average	**1.22**	**1.03**	**0.84**
	Minimum	**0.69**	**0.66**	**0.49**
	Detects	**92**	**93**	**59**
MDA	Maximum	0.32		0.87
	Average	0.32		0.72
	Minimum	0.32		0.53
	NonDetect's	1	0	34

Table 2. Building T654 Indivdual Surface Soil Sample Results

NOTE: BOLD VALUES INDICATE DETECTED AND NON-BOLD VALUES INDICATE MDA FOR THAT SAMPLE

Sample #	Date	Grid #	Sub-Grid #	Weight (grams)		Ra-224 pCi/g	Error pCi/g	Ac-228 pCi/g	Error pCi/g	Pb-210 pCi/g	Error pCi/g
654-97-0047	9/23/97	6,5	9	955	47	0.89	0.09	0.71	0.02	0.51	0.10
654-97-0048	9/23/97	6,6	4	848	48	0.32	MDA	0.82	0.02	0.63	MDA
654-97-0049	9/23/97	6,7	2	713	49	1.07	0.09	0.99	0.03	0.79	MDA
654-97-0050	9/23/97	6,8	8	842	50	0.94	0.08	0.82	0.02	0.67	MDA
654-97-0051	9/23/97	6,9	9	839	51	1.00	0.09	0.87	0.02	0.64	MDA
654-97-0052	9/23/97	6,10	5	925	52	0.99	0.11	0.90	0.02	0.89	0.10
654-97-0053	9/23/97	6,11	3	765	53	1.42	0.11	1.10	0.03	1.15	0.12
654-97-0054	9/23/97	6,12	8	855	54	1.11	0.11	1.04	0.03	0.94	0.12
654-97-0055	9/23/97	6,13	9	764	55	1.53	0.14	1.15	0.03	0.99	0.11
654-97-0056	9/23/97	6,14	5	881	56	1.27	0.11	0.88	0.02	0.81	0.08
654-97-0057	9/23/97	6,15	2	871	57	1.11	0.08	0.91	0.02	0.76	0.08
654-97-0058	9/23/97	6,16	3	1042	58	1.02	0.07	0.74	0.02	0.53	MDA
654-97-0059	9/23/97	6,17	6	778	59	1.51	0.12	1.22	0.03	0.64	MDA
654-97-0060	9/23/97	6,18	1	784	60	1.50	0.11	1.13	0.03	0.76	MDA
654-97-0061	9/23/97	6,19	5	796	61	0.96	0.08	0.80	0.02	0.49	0.09
654-97-0062	9/23/97	6,20	2	741	62	1.07	0.10	0.85	0.02	0.67	MDA
654-97-0063	9/23/97	6,21	9	751	63	0.84	0.10	0.74	0.02	0.67	MDA
654-97-0064	9/24/97	6,22	3	885	64	0.77	0.08	0.71	0.02	0.60	MDA
654-97-0065	9/24/97	7,1	6	744	65	1.26	0.13	1.10	0.03	0.65	0.11
654-97-0066	9/24/97	7,2	9	688	66	1.74	0.16	1.37	0.03	1.18	0.15
654-97-0067	9/24/97	7,3	2	718	67	1.24	0.12	1.08	0.03	0.89	0.08
654-97-0068	9/24/97	7,4	8	774	68	1.21	0.11	1.07	0.03	0.91	0.11
654-97-0069	9/24/97	7,5	5	712	69	1.37	0.12	1.13	0.03	1.01	0.12
654-97-0070	9/24/97	7,6	9	771	70	1.18	0.10	1.08	0.03	0.81	0.14
654-97-0071	9/24/97	7,7	7	774	71	1.31	0.12	1.06	0.03	0.85	MDA
654-97-0072	9/24/97	7,8	4	773	72	1.14	0.11	0.98	0.03	0.87	0.11
654-97-0073	9/24/97	7,9	3	864	73	0.92	0.08	0.95	0.03	0.52	0.12
654-97-0074	9/24/97	7,10	1	874	74	1.05	0.09	0.85	0.02	0.65	0.09
654-97-0075	9/24/97	7,11	8	822	75	1.44	0.12	1.14	0.03	0.65	MDA
654-97-0076	9/24/97	7,12	4	813	76	1.27	0.10	1.08	0.03	0.75	MDA
654-97-0077	9/24/97	7,13	5	786	77	1.46	0.13	1.12	0.03	0.91	0.07
654-97-0078	9/24/97	7,14	9	762	78	1.16	0.12	1.10	0.03	0.79	MDA
654-97-0079	9/24/97	7,15	5	751	79	1.23	0.11	1.16	0.03	0.96	0.10
654-97-0080	9/24/97	7,16	2	800	80	1.17	0.10	1.12	0.03	0.77	MDA
654-97-0081	9/24/97	7,17	7	790	81	1.13	0.11	1.15	0.03	0.90	0.12
654-97-0082	9/24/97	7,18	3	822	82	1.37	0.11	1.16	0.03	0.81	0.09
654-97-0083	9/24/97	7,19	5	748	83	1.16	0.10	1.16	0.03	0.76	MDA
654-97-0084	9/24/97	7,20	4	767	84	1.35	0.12	1.14	0.03	0.60	0.11
654-97-0085	9/24/97	7,21	8	763	85	1.18	0.11	0.98	0.03	1.06	0.12
654-97-0086	9/24/97	7,23	4	789	86	1.04	0.12	0.94	0.02	0.72	0.12
654-97-0087	9/24/97	3,12	khoe disturba	669	87	1.16	0.11	1.11	0.03	0.87	MDA
654-97-0088	9/24/97	3,13	khoe disturba	641	88	1.27	0.12	1.16	0.03	0.83	0.15
654-97-0089	9/24/97	3,15	khoe disturba	701	89	1.53	0.13	1.16	0.03	1.10	0.12
654-97-0090	9/24/97	8,10	khoe disturba	677	90	1.14	0.11	1.10	0.03	1.06	0.12
654-97-0091	9/24/97	8,12	khoe disturba	659	91	1.09	0.12	1.04	0.03	1.28	0.14
654-97-0092	9/24/97	8,14	khoe disturba	661	92	1.31	0.13	1.07	0.03	1.00	0.10
654-97-0093	9/24/97	8,16	khoe disturba	677	93	1.43	0.13	1.02	0.03	0.84	MDA

		Ra-224	Ac-228	Pb-210
Detect	Maximum	1.74	1.37	1.28
	Average	1.22	1.03	0.84
	Minimum	0.69	0.66	0.49
	Detects	92	93	59
MDA	Maximum	0.32		0.87
	Average	0.32		0.72
	Minimum	0.32		0.53
	NonDetect's	1	0	34

Table 2. Building T654 Indivdual Surface Soil Sample Results

NOTE: BOLD VALUES INDICATE DETECTED AND NON-BOLD VALUES INDICATE MDA FOR THAT SAMPLE

Sample #	Date	Grid #	Sub-Grid #	Weight (grams)		Pb-214 pCi/g	Error pCi/g	Bi-214 pCi/g	Error pCi/g	Ra-226 pCi/g	Error pCi/g
654-97-0001	9/22/97	1,2	8	712	1	**0.87**	0.03	**0.80**	0.03	**0.94**	0.06
654-97-0002	9/22/97	2,1	5	759	2	**0.85**	0.03	**0.82**	0.02	**0.99**	0.06
654-97-0003	9/22/97	2,3	3	715	3	**0.83**	0.03	**0.79**	0.02	**0.95**	0.06
654-97-0004	9/22/97	2,5	7	789	4	**0.80**	0.03	**0.84**	0.02	**0.92**	0.06
654-97-0005	9/22/97	2,22	4	755	5	**0.70**	0.02	**0.66**	0.02	**0.77**	0.05
654-97-0006	9/22/97	3,2	5	733	6	**0.86**	0.03	**0.84**	0.03	**0.90**	0.06
654-97-0007	9/22/97	3,4	4	650	7	**0.82**	0.03	**0.85**	0.04	**0.92**	0.06
654-97-0008	9/22/97	3,6	9	812	8	**0.84**	0.03	**0.79**	0.02	**0.81**	0.05
654-97-0009	9/22/97	3,8	1	629	9	**0.85**	0.03	**0.82**	0.03	**0.93**	0.06
654-97-0010	9/22/97	3,23	4	953	10	**0.81**	0.03	**0.76**	0.02	**0.85**	0.06
654-97-0011	9/22/97	4,1	3	697	11	**0.80**	0.03	**0.73**	0.03	**0.98**	0.06
654-97-0012	9/22/97	4,3	5	833	12	**0.86**	0.03	**0.84**	0.02	**0.96**	0.06
654-97-0013	9/22/97	4,5	9	694	13	**0.84**	0.03	**0.81**	0.03	**0.97**	0.08
654-97-0014	9/22/97	4,7	5	811	14	**0.80**	0.02	**0.72**	0.02	**0.83**	0.06
654-97-0015	9/22/97	4,9	4	805	15	**0.79**	0.03	**0.80**	0.02	**0.88**	0.05
654-97-0016	9/22/97	4,10	1	765	16	**0.82**	0.03	**0.76**	0.03	0.88	MDA
654-97-0017	9/22/97	4,11	6	810	17	**0.83**	0.03	**0.85**	0.03	**0.81**	0.07
654-97-0018	9/23/97	4,12	9	814	18	**0.76**	0.02	**0.67**	0.02	**0.87**	0.06
654-97-0019	9/23/97	4,13	2	809	19	**0.88**	0.03	**0.81**	0.02	**1.00**	0.06
654-97-0020	9/23/97	4,14	3	843	20	**0.84**	0.03	**0.84**	0.02	**0.89**	0.06
654-97-0021	9/23/97	4,15	4	890	21	**0.75**	0.02	**0.76**	0.02	**0.79**	0.05
654-97-0022	9/23/97	4,16	8	819	22	**0.84**	0.03	**0.81**	0.02	**0.90**	0.07
654-97-0023	9/23/97	4,17	6	788	23	**0.86**	0.03	**0.80**	0.03	**0.98**	0.08
654-97-0024	9/23/97	4,18	7	784	24	**0.94**	0.03	**0.95**	0.03	**0.95**	0.07
654-97-0025	9/23/97	4,20	5	939	25	**0.74**	0.02	**0.66**	0.02	**0.64**	0.05
654-97-0026	9/23/97	4,22	1	988	26	**0.74**	0.02	**0.76**	0.02	**0.77**	0.08
654-97-0027	9/23/97	5,2	3	824	27	**0.79**	0.02	**0.70**	0.02	**0.68**	0.05
654-97-0028	9/23/97	5,4	9	785	28	**0.80**	0.03	**0.78**	0.02	**0.83**	0.06
654-97-0029	9/23/97	5,6	7	809	29	**0.74**	0.02	**0.73**	0.02	**0.92**	0.06
654-97-0030	9/23/97	5,8	4	848	30	**0.88**	0.03	**0.84**	0.02	**0.96**	0.06
654-97-0031	9/23/97	5,9	3	769	31	**0.81**	0.03	**0.81**	0.03	**0.97**	0.07
654-97-0032	9/23/97	5,10	1	726	32	**0.82**	0.03	**0.75**	0.03	**0.74**	0.06
654-97-0033	9/23/97	5,11	8	803	33	**0.83**	0.03	**0.82**	0.02	**0.89**	0.07
654-97-0034	9/23/97	5,12	2	861	34	**0.76**	0.02	**0.72**	0.02	**0.87**	0.06
654-97-0035	9/23/97	5,13	7	885	35	**0.77**	0.02	**0.74**	0.02	**0.75**	0.05
654-97-0036	9/23/97	5,14	4	804	36	**0.80**	0.02	**0.75**	0.02	**0.77**	0.06
654-97-0037	9/23/97	5,15	2	821	37	**0.76**	0.02	**0.78**	0.02	**0.71**	0.05
654-97-0038	9/23/97	5,16	6	715	38	**0.88**	0.03	**0.78**	0.02	**0.93**	0.07
654-97-0039	9/23/97	5,17	3	891	39	**0.79**	0.03	**0.76**	0.02	**0.79**	0.06
654-97-0040	9/23/97	5,19	7	820	40	**0.91**	0.03	**0.86**	0.02	**0.97**	0.06
654-97-0041	9/23/97	5,21	1	853	41	**0.82**	0.03	**0.75**	0.02	**0.88**	0.06
654-97-0042	9/23/97	5,23	7	904	42	**0.44**	0.02	**0.42**	0.02	**0.42**	0.04
654-97-0043	9/23/97	6,1	1	820	43	**0.97**	0.03	**0.94**	0.03	**0.89**	0.06
654-97-0044	9/23/97	6,2	4	756	44	**0.89**	0.03	**0.85**	0.03	**0.95**	0.06
654-97-0045	9/23/97	6,3	8	909	45	**0.37**	0.02	**0.35**	0.01	**0.40**	0.04
654-97-0046	9/23/97	6,4	9	993	46	**0.40**	0.01	**0.39**	0.02	**0.44**	0.04

		Pb-214	Bi-214	Ra-226
Detect	**Maximum**	**1.37**	**1.22**	**1.63**
	Average	**0.80**	**0.76**	**0.81**
	Minimum	**0.37**	**0.35**	**0.30**
	Detects	**93**	**93**	**90**
MDA	Maximum			0.88
	Average			0.54
	Minimum			0.34
	NonDetect's	0	0	3

Table 2. Building T654 Indivdual Surface Soil Sample Results

NOTE: BOLD VALUES INDICATE DETECTED AND NON-BOLD VALUES INDICATE MDA FOR THAT SAMPLE

Sample #	Date	Grid #	Sub-Grid #	Weight (grams)		Pb-214 pCi/g	Error pCi/g	Bi-214 pCi/g	Error pCi/g	Ra-226 pCi/g	Error pCi/g
654-97-0047	9/23/97	6,5	9	955	47	0.41	0.01	0.38	0.01	0.38	0.03
654-97-0048	9/23/97	6,6	4	848	48	0.47	0.02	0.49	0.02	0.54	0.03
654-97-0049	9/23/97	6,7	2	713	49	0.55	0.02	0.59	0.02	0.64	0.05
654-97-0050	9/23/97	6,8	8	842	50	0.53	0.02	0.56	0.00	0.48	0.04
654-97-0051	9/23/97	6,9	9	839	51	0.55	0.02	0.57	0.02	0.52	0.05
654-97-0052	9/23/97	6,10	5	925	52	0.59	0.02	0.58	0.02	0.65	0.05
654-97-0053	9/23/97	6,11	3	765	53	0.92	0.03	0.82	0.03	0.93	0.06
654-97-0054	9/23/97	6,12	8	855	54	0.77	0.02	0.71	0.02	0.78	0.05
654-97-0055	9/23/97	6,13	9	764	55	0.91	0.03	0.88	0.03	0.88	0.07
654-97-0056	9/23/97	6,14	5	881	56	0.71	0.02	0.65	0.02	0.64	0.05
654-97-0057	9/23/97	6,15	2	871	57	0.70	0.02	0.64	0.02	0.34	MDA
654-97-0058	9/23/97	6,16	3	1042	58	0.49	0.02	0.46	0.02	0.33	0.04
654-97-0059	9/23/97	6,17	6	778	59	0.85	0.03	0.81	0.03	0.89	0.06
654-97-0060	9/23/97	6,18	1	784	60	0.86	0.03	0.84	0.02	0.82	0.06
654-97-0061	9/23/97	6,19	5	796	61	0.52	0.02	0.48	0.02	0.47	0.04
654-97-0062	9/23/97	6,20	2	741	62	0.53	0.02	0.50	0.02	0.52	0.04
654-97-0063	9/23/97	6,21	9	751	63	0.43	0.02	0.41	0.02	0.30	0.04
654-97-0064	9/24/97	6,22	3	885	64	0.39	0.02	0.40	0.01	0.43	0.03
654-97-0065	9/24/97	7,1	6	744	65	1.10	0.03	1.07	0.03	1.16	0.07
654-97-0066	9/24/97	7,2	9	688	66	1.37	0.04	1.22	0.04	1.63	0.10
654-97-0067	9/24/97	7,3	2	718	67	0.95	0.03	0.89	0.03	0.92	0.07
654-97-0068	9/24/97	7,4	8	774	68	0.97	0.03	0.92	0.03	0.96	0.07
654-97-0069	9/24/97	7,5	5	712	69	0.92	0.03	0.87	0.03	0.92	0.07
654-97-0070	9/24/97	7,6	9	771	70	0.91	0.03	0.86	0.02	0.96	0.07
654-97-0071	9/24/97	7,7	7	774	71	0.86	0.03	0.88	0.03	0.95	0.07
654-97-0072	9/24/97	7,8	4	773	72	0.72	0.03	0.67	0.02	0.71	0.05
654-97-0073	9/24/97	7,9	3	864	73	0.78	0.02	0.69	0.02	0.85	0.05
654-97-0074	9/24/97	7,10	1	874	74	0.61	0.02	0.62	0.02	0.67	0.06
654-97-0075	9/24/97	7,11	8	822	75	0.86	0.29	0.78	0.02	0.85	0.08
654-97-0076	9/24/97	7,12	4	813	76	0.92	0.03	0.84	0.03	0.87	0.05
654-97-0077	9/24/97	7,13	5	786	77	0.87	0.03	0.83	0.03	0.70	0.07
654-97-0078	9/24/97	7,14	9	762	78	0.88	0.03	0.90	0.03	0.83	0.06
654-97-0079	9/24/97	7,15	5	751	79	0.94	0.03	0.90	0.03	1.04	0.08
654-97-0080	9/24/97	7,16	2	800	80	0.89	0.03	0.82	0.02	0.99	0.06
654-97-0081	9/24/97	7,17	7	790	81	0.87	0.03	0.82	0.03	0.41	MDA
654-97-0082	9/24/97	7,18	3	822	82	1.04	0.03	0.98	0.03	0.54	0.12
654-97-0083	9/24/97	7,19	5	748	83	0.87	0.03	0.84	0.03	0.98	0.07
654-97-0084	9/24/97	7,20	4	767	84	0.90	0.03	0.84	0.02	0.92	0.07
654-97-0085	9/24/97	7,21	8	763	85	0.73	0.02	0.71	0.02	0.77	0.05
654-97-0086	9/24/97	7,23	4	789	86	0.78	0.03	0.74	0.03	0.75	0.06
654-97-0087	9/24/97	3,12	ckhoe disturba	669	87	0.97	0.03	0.87	0.03	1.01	0.07
654-97-0088	9/24/97	3,13	ckhoe disturba	641	88	0.98	0.03	0.88	0.03	1.03	0.06
654-97-0089	9/24/97	3,15	ckhoe disturba	701	89	1.02	0.03	0.96	0.03	0.42	0.03
654-97-0090	9/24/97	8,10	ckhoe disturba	677	90	0.84	0.03	0.81	0.03	0.77	0.06
654-97-0091	9/24/97	8,12	ckhoe disturba	659	91	0.87	0.03	0.84	0.03	0.77	0.06
654-97-0092	9/24/97	8,14	ckhoe disturba	661	92	1.00	0.03	0.95	0.03	0.91	0.08
654-97-0093	9/24/97	8,16	ckhoe disturba	677	93	0.88	0.03	0.82	0.03	1.02	0.08

		Pb-214	Bi-214	Ra-226
Detect	**Maximum**	**1.37**	**1.22**	**1.63**
	Average	**0.80**	**0.76**	**0.81**
	Minimum	**0.37**	**0.35**	**0.30**
	Detects	**93**	**93**	**90**
MDA	Maximum			0.88
	Average			0.54
	Minimum			0.34
	NonDetect's	0	0	3

Table 2. Building T654 Indivdual Surface Soil Sample Results

NOTE: BOLD VALUES INDICATE DETECTED AND NON-BOLD VALUES INDICATE MDA FOR THAT SAMPLE

Sample #	Date	Grid #	Sub-Grid #	Weight (grams)		Th-234 pCi/g	Error pCi/g	Pa-234m pCi/g	Error pCi/g	U-235 pCi/g	Error pCi/g
654-97-0001	9/22/97	1,2	8	712	1	**1.02**	**0.10**	2.71	MDA	**0.05**	**0.003**
654-97-0002	9/22/97	2,1	5	759	2	**0.85**	**0.30**	2.52	MDA	**0.05**	**0.003**
654-97-0003	9/22/97	2,3	3	715	3	**0.72**	**0.07**	2.69	MDA	**0.05**	**0.003**
654-97-0004	9/22/97	2,5	7	789	4	**1.17**	**0.13**	2.52	MDA	**0.05**	**0.003**
654-97-0005	9/22/97	2,22	4	755	5	**0.74**	**0.08**	2.50	MDA	**0.04**	**0.003**
654-97-0006	9/22/97	3,2	5	733	6	**0.85**	**0.13**	2.83	MDA	**0.04**	**0.003**
654-97-0007	9/22/97	3,4	4	650	7	**0.74**	**0.09**	3.02	MDA	**0.05**	**0.003**
654-97-0008	9/22/97	3,6	9	812	8	**0.64**	**0.10**	2.44	MDA	**0.04**	**0.003**
654-97-0009	9/22/97	3,8	1	629	9	**0.82**	**0.10**	3.01	MDA	**0.05**	**0.003**
654-97-0010	9/22/97	3,23	4	953	10	**0.83**	**0.12**	2.23	MDA	**0.04**	**0.003**
654-97-0011	9/22/97	4,1	3	697	11	**0.86**	**0.12**	2.76	MDA	**0.05**	**0.003**
654-97-0012	9/22/97	4,3	5	833	12	**0.93**	**0.08**	2.58	MDA	**0.05**	**0.003**
654-97-0013	9/22/97	4,5	9	694	13	**1.04**	**0.09**	**2.67**	**0.38**	**0.05**	**0.004**
654-97-0014	9/22/97	4,7	5	811	14	**0.77**	**0.09**	**1.42**	**0.41**	**0.04**	**0.003**
654-97-0015	9/22/97	4,9	4	805	15	**0.87**	**0.10**	2.54	MDA	**0.04**	**0.003**
654-97-0016	9/22/97	4,10	1	765	16	**0.80**	**0.11**	2.70	MDA	**0.05**	**0.003**
654-97-0017	9/22/97	4,11	6	810	17	**0.83**	**0.09**	2.54	MDA	**0.04**	**0.003**
654-97-0018	9/23/97	4,12	9	814	18	**0.48**	**0.09**	2.47	MDA	**0.04**	**0.008**
654-97-0019	9/23/97	4,13	2	809	19	**0.82**	**0.10**	2.71	MDA	**0.05**	**0.006**
654-97-0020	9/23/97	4,14	3	843	20	**0.81**	**0.08**	2.61	MDA	**0.04**	**0.004**
654-97-0021	9/23/97	4,15	4	890	21	**0.64**	**0.08**	2.53	MDA	**0.04**	**0.005**
654-97-0022	9/23/97	4,16	8	819	22	**0.72**	**0.11**	2.52	MDA	**0.04**	**0.007**
654-97-0023	9/23/97	4,17	6	788	23	**0.89**	**0.09**	2.71	MDA	**0.05**	**0.005**
654-97-0024	9/23/97	4,18	7	784	24	**0.92**	**0.08**	2.66	MDA	**0.05**	**0.004**
654-97-0025	9/23/97	4,20	5	939	25	**0.59**	**0.10**	2.35	MDA	**0.03**	**0.006**
654-97-0026	9/23/97	4,22	1	988	26	**0.63**	**0.09**	2.37	MDA	**0.04**	**0.006**
654-97-0027	9/23/97	5,2	3	824	27	**0.61**	**0.10**	2.69	MDA	**0.04**	**0.006**
654-97-0028	9/23/97	5,4	9	785	28	**0.81**	**0.08**	2.73	MDA	**0.04**	**0.004**
654-97-0029	9/23/97	5,6	7	809	29	**0.70**	**0.09**	2.60	MDA	**0.05**	**0.006**
654-97-0030	9/23/97	5,8	4	848	30	**0.98**	**0.09**	2.52	MDA	**0.05**	**0.005**
654-97-0031	9/23/97	5,9	3	769	31	**0.74**	**0.08**	**1.73**	**0.30**	**0.05**	**0.005**
654-97-0032	9/23/97	5,10	1	726	32	**0.71**	**0.10**	**2.36**	**0.38**	**0.04**	**0.005**
654-97-0033	9/23/97	5,11	8	803	33	**0.93**	**0.11**	2.68	MDA	**0.04**	**0.005**
654-97-0034	9/23/97	5,12	2	861	34	**0.86**	**0.10**	2.33	MDA	**0.04**	**0.005**
654-97-0035	9/23/97	5,13	7	885	35	**0.57**	**0.07**	**1.44**	**0.42**	**0.04**	**0.005**
654-97-0036	9/23/97	5,14	4	804	36	**1.04**	**0.11**	**2.31**	**0.39**	**0.04**	**0.004**
654-97-0037	9/23/97	5,15	2	821	37	**0.52**	**0.07**	**1.40**	**0.35**	**0.04**	**0.005**
654-97-0038	9/23/97	5,16	6	715	38	**0.88**	**0.08**	**1.48**	**0.39**	**0.05**	**0.004**
654-97-0039	9/23/97	5,17	3	891	39	**0.94**	**0.10**	2.39	MDA	**0.04**	**0.004**
654-97-0040	9/23/97	5,19	7	820	40	**1.13**	**0.09**	2.49	MDA	**0.05**	**0.004**
654-97-0041	9/23/97	5,21	1	853	41	**0.96**	**0.09**	2.45	MDA	**0.04**	**0.004**
654-97-0042	9/23/97	5,23	7	904	42	**0.40**	**0.07**	2.12	MDA	**0.02**	**0.004**
654-97-0043	9/23/97	6,1	1	820	43	**0.91**	**0.09**	2.82	MDA	**0.04**	**0.004**
654-97-0044	9/23/97	6,2	4	756	44	**1.14**	**0.12**	2.48	MDA	**0.05**	**0.005**
654-97-0045	9/23/97	6,3	8	909	45	**0.33**	**0.06**	2.25	MDA	**0.02**	**0.004**
654-97-0046	9/23/97	6,4	9	993	46	**0.33**	**0.05**	1.96	MDA	**0.02**	**0.003**

		Th-234 pCi/g	Pa-234m pCi/g	U-235 pCi/g
Detect	**Maximum**	**1.74**	**2.88**	**0.08**
	Average	**0.77**	**1.92**	**0.04**
	Minimum	**0.24**	**1.40**	**0.01**
	Detects	**93**	**13**	**93**
MDA	Maximum		3.12	
	Average		2.56	
	Minimum		1.82	
	NonDetect's	0	80	0

Table 2. Building T654 Indivdual Surface Soil Sample Results

NOTE: BOLD VALUES INDICATE DETECTED AND NON-BOLD VALUES INDICATE MDA FOR THAT SAMPLE

Sample #	Date	Grid #	Sub-Grid #	Weight (grams)		Th-234 pCi/g	Error pCi/g	Pa-234m pCi/g	Error pCi/g	U-235 pCi/g	Error pCi/g
654-97-0047	9/23/97	6,5	9	955	47	0.39	0.07	2.09	MDA	0.02	0.002
654-97-0048	9/23/97	6,6	4	848	48	0.62	0.07	2.20	MDA	0.03	0.002
654-97-0049	9/23/97	6,7	2	713	49	0.96	0.11	2.69	MDA	0.03	0.003
654-97-0050	9/23/97	6,8	8	842	50	0.71	0.07	2.18	MDA	0.02	0.002
654-97-0051	9/23/97	6,9	9	839	51	0.37	0.08	2.50	MDA	0.03	0.003
654-97-0052	9/23/97	6,10	5	925	52	0.60	0.08	2.34	MDA	0.03	0.002
654-97-0053	9/23/97	6,11	3	765	53	0.75	0.10	2.62	MDA	0.05	0.003
654-97-0054	9/23/97	6,12	8	855	54	0.80	0.12	2.61	MDA	0.04	0.003
654-97-0055	9/23/97	6,13	9	764	55	1.04	0.13	1.64	0.47	0.04	0.003
654-97-0056	9/23/97	6,14	5	881	56	0.72	0.09	1.41	0.36	0.03	0.002
654-97-0057	9/23/97	6,15	2	871	57	0.26	0.08	2.37	MDA	0.03	0.002
654-97-0058	9/23/97	6,16	3	1042	58	0.44	0.08	1.98	MDA	0.02	0.002
654-97-0059	9/23/97	6,17	6	778	59	0.60	0.11	2.88	0.43	0.04	0.003
654-97-0060	9/23/97	6,18	1	784	60	0.64	0.10	2.78	MDA	0.04	0.003
654-97-0061	9/23/97	6,19	5	796	61	0.50	0.07	2.13	MDA	0.02	0.002
654-97-0062	9/23/97	6,20	2	741	62	0.64	0.07	2.51	MDA	0.03	0.002
654-97-0063	9/23/97	6,21	9	751	63	0.43	0.07	2.33	MDA	0.01	0.002
654-97-0064	9/24/97	6,22	3	885	64	0.24	0.06	2.08	MDA	0.02	0.002
654-97-0065	9/24/97	7,1	6	744	65	1.11	0.10	2.97	MDA	0.06	0.003
654-97-0066	9/24/97	7,2	9	688	66	1.74	0.15	1.82	MDA	0.08	0.005
654-97-0067	9/24/97	7,3	2	718	67	1.09	0.11	2.82	MDA	0.05	0.003
654-97-0068	9/24/97	7,4	6	774	68	0.97	0.10	2.47	MDA	0.05	0.003
654-97-0069	9/24/97	7,5	5	712	69	0.77	0.09	2.91	MDA	0.05	0.004
654-97-0070	9/24/97	7,6	9	771	70	0.96	0.09	2.60	0.40	0.05	0.003
654-97-0071	9/24/97	7,7	7	774	71	0.85	0.12	2.78	MDA	0.05	0.003
654-97-0072	9/24/97	7,8	4	773	72	0.54	0.07	2.67	MDA	0.04	0.003
654-97-0073	9/24/97	7,9	3	864	73	0.86	0.10	2.14	MDA	0.04	0.003
654-97-0074	9/24/97	7,10	1	874	74	0.53	0.06	2.36	MDA	0.03	0.003
654-97-0075	9/24/97	7,11	8	822	75	0.63	0.09	2.40	MDA	0.04	0.004
654-97-0076	9/24/97	7,12	4	813	76	0.81	0.09	2.54	MDA	0.04	0.003
654-97-0077	9/24/97	7,13	5	786	77	0.70	0.07	2.82	MDA	0.03	0.003
654-97-0078	9/24/97	7,14	9	782	78	0.52	0.11	2.62	MDA	0.04	0.003
654-97-0079	9/24/97	7,15	5	751	79	0.78	0.09	1.66	0.35	0.05	0.004
654-97-0080	9/24/97	7,16	2	800	80	0.98	0.12	2.58	MDA	0.05	0.003
654-97-0081	9/24/97	7,17	7	790	81	0.68	0.08	2.77	MDA	0.05	0.003
654-97-0082	9/24/97	7,18	3	822	82	0.79	0.11	2.68	MDA	0.03	0.006
654-97-0083	9/24/97	7,19	5	748	83	0.92	0.10	2.60	MDA	0.05	0.003
654-97-0084	9/24/97	7,20	4	767	84	0.95	0.10	2.69	MDA	0.05	0.004
654-97-0085	9/24/97	7,21	8	763	85	0.49	0.11	2.77	MDA	0.04	0.003
654-97-0086	9/24/97	7,23	4	789	86	0.78	0.08	2.66	MDA	0.04	0.003
654-97-0087	9/24/97	3,12	ckhoe disturbe	669	87	0.76	0.10	2.76	MDA	0.05	0.003
654-97-0088	9/24/97	3,13	ckhoe disturbe	641	88	0.91	0.12	3.12	MDA	0.05	0.003
654-97-0089	9/24/97	3,15	ckhoe disturbe	701	89	1.21	0.11	2.81	MDA	0.05	0.003
654-97-0090	9/24/97	8,10	ckhoe disturbe	677	90	0.81	0.09	2.79	MDA	0.04	0.003
654-97-0091	9/24/97	8,12	ckhoe disturbe	659	91	0.91	0.14	3.05	MDA	0.04	0.003
654-97-0092	9/24/97	8,14	ckhoe disturbe	661	92	0.78	0.10	2.99	MDA	0.05	0.004
654-97-0093	9/24/97	8,16	ckhoe disturbe	677	93	0.54	0.10	2.90	MDA	0.05	0.004

		Th-234	Pa-234m	U-235
Detect	Maximum	1.74	2.88	0.08
	Average	0.77	1.92	0.04
	Minimum	0.24	1.40	0.01
	Detects	93	13	93
MDA	Maximum		3.12	
	Average		2.56	
	Minimum		1.82	
	NonDetect's	0	80	0

Table 3. Teledyne-Brown Sr-90 Results

Sample #	Sr-90 pCi/g	Error pCi/g	Note
654-97-0006	0.26	± 0.28	MDA
654-97-0016	**0.77**	**± 0.32**	
654-97-0028	0.24	± 0.26	MDA
654-97-0044	**0.43**	**± 0.18**	
654-97-0049	**0.41**	**± 0.19**	
654-97-0069	**1.30**	**± 0.2**	
654-97-0070	**0.99**	**± 0.23**	
654-97-0071	**0.59**	**± 0.22**	
654-97-0077	0.40	± 0.31	MDA
654-97-0090	0.24	± 0.32	MDA
654-97-0091	**0.40**	**± 0.15**	
654-97-0093	0.29	± 0.23	MDA

Maximum	**1.30**
Average	**0.70**
Minimum	**0.40**
Detects	**7**

Max MDA	0.40
Average MDA	0.29
Min MDA	0.24
NonDetect's	5

Table 4. Surface Soil Sample Data

Sample Number	Date of Collection	Sample Description	Grid #	Sub-Grid #	Area Type	Weight grams	Sampled By	Analysis Type Gamma	Sr-90
654-97-0001	22-Sep-97	Surface Soil Sample: 0" to 6" deep	1,2	8	Unaffected	712	McGinnis	X	
654-97-0002	22-Sep-97	Surface Soil Sample: 0" to 6" deep	2,1	5	Unaffected	759	McGinnis	X	
654-97-0003	22-Sep-97	Surface Soil Sample: 0" to 6" deep	2,3	3	Unaffected	715	McGinnis	X	
654-97-0004	22-Sep-97	Surface Soil Sample: 0" to 6" deep	2,5	7	Unaffected	789	McGinnis	X	
654-97-0005	22-Sep-97	Surface Soil Sample: 0" to 6" deep	2,22	4	Unaffected	755	McGinnis	X	
654-97-0006	22-Sep-97	Surface Soil Sample: 0" to 6" deep	3,2	5	Unaffected	733	McGinnis	X	X
654-97-0007	22-Sep-97	Surface Soil Sample: 0" to 6" deep	3,4	4	Unaffected	650	McGinnis	X	
654-97-0008	22-Sep-97	Surface Soil Sample: 0" to 6" deep	3,6	9	Unaffected	812	McGinnis	X	
654-97-0009	22-Sep-97	Surface Soil Sample: 0" to 6" deep	3,8	1	Unaffected	629	McGinnis	X	
654-97-0010	22-Sep-97	Surface Soil Sample: 0" to 6" deep	3,23	4	Unaffected	953	McGinnis	X	
654-97-0011	22-Sep-97	Surface Soil Sample: 0" to 6" deep	4,1	3	Unaffected	697	McGinnis	X	
654-97-0012	22-Sep-97	Surface Soil Sample: 0" to 6" deep	4,3	5	Unaffected	833	McGinnis	X	
654-97-0013	22-Sep-97	Surface Soil Sample: 0" to 6" deep	4,5	9	Unaffected	694	McGinnis	X	
654-97-0014	22-Sep-97	Surface Soil Sample: 0" to 6" deep	4,7	5	Unaffected	811	McGinnis	X	
654-97-0015	22-Sep-97	Surface Soil Sample: 0" to 6" deep	4,9	4	Unaffected	805	McGinnis	X	
654-97-0016	22-Sep-97	Surface Soil Sample: 0" to 6" deep	4,10	1	Affected	765	McGinnis	X	X
654-97-0017	22-Sep-97	Surface Soil Sample: 0" to 6" deep	4,11	6	Affected	810	McGinnis	X	
654-97-0018	23-Sep-97	Surface Soil Sample: 0" to 6" deep	4,12	9	Affected	814	McGinnis	X	
654-97-0019	23-Sep-97	Surface Soil Sample: 0" to 6" deep	4,13	2	Affected	809	McGinnis	X	
654-97-0020	23-Sep-97	Surface Soil Sample: 0" to 6" deep	4,14	3	Affected	843	McGinnis	X	
654-97-0021	23-Sep-97	Surface Soil Sample: 0" to 6" deep	4,15	4	Affected	890	McGinnis	X	
654-97-0022	23-Sep-97	Surface Soil Sample: 0" to 6" deep	4,16	8	Affected	819	McGinnis	X	
654-97-0023	23-Sep-97	Surface Soil Sample: 0" to 6" deep	4,17	6	Affected	788	McGinnis	X	
654-97-0024	23-Sep-97	Surface Soil Sample: 0" to 6" deep	4,18	7	Unaffected	784	McGinnis	X	
654-97-0025	23-Sep-97	Surface Soil Sample: 0" to 6" deep	4,20	5	Unaffected	939	McGinnis	X	
654-97-0026	23-Sep-97	Surface Soil Sample: 0" to 6" deep	4,22	1	Unaffected	988	McGinnis	X	
654-97-0027	23-Sep-97	Surface Soil Sample: 0" to 6" deep	5,2	3	Unaffected	824	McGinnis	X	
654-97-0028	23-Sep-97	Surface Soil Sample: 0" to 6" deep	5,4	9	Unaffected	785	McGinnis	X	X
654-97-0029	23-Sep-97	Surface Soil Sample: 0" to 6" deep	5,6	7	Unaffected	809	McGinnis	X	
654-97-0030	23-Sep-97	Surface Soil Sample: 0" to 6" deep	5,8	4	Affected	848	McGinnis	X	
654-97-0031	23-Sep-97	Surface Soil Sample: 0" to 6" deep	5,9	3	Affected	769	McGinnis	X	
654-97-0032	23-Sep-97	Surface Soil Sample: 0" to 6" deep	5,10	1	Affected	726	McGinnis	X	
654-97-0033	23-Sep-97	Surface Soil Sample: 0" to 6" deep	5,11	8	Affected	803	McGinnis	X	
654-97-0034	23-Sep-97	Surface Soil Sample: 0" to 6" deep	5,12	2	Affected	861	McGinnis	X	
654-97-0035	23-Sep-97	Surface Soil Sample: 0" to 6" deep	5,13	7	Affected	885	McGinnis	X	
654-97-0036	23-Sep-97	Surface Soil Sample: 0" to 6" deep	5,14	4	Affected	804	McGinnis	X	
654-97-0037	23-Sep-97	Surface Soil Sample: 0" to 6" deep	5,15	2	Affected	821	McGinnis	X	
654-97-0038	23-Sep-97	Surface Soil Sample: 0" to 6" deep	5,16	6	Affected	715	McGinnis	X	
654-97-0039	23-Sep-97	Surface Soil Sample: 0" to 6" deep	5,17	3	Affected	891	McGinnis	X	
654-97-0040	23-Sep-97	Surface Soil Sample: 0" to 6" deep	5,19	7	Unaffected	820	McGinnis	X	
654-97-0041	23-Sep-97	Surface Soil Sample: 0" to 6" deep	5,21	1	Unaffected	853	McGinnis	X	
654-97-0042	23-Sep-97	Surface Soil Sample: 0" to 6" deep	5,23	7	Unaffected	904	McGinnis	X	
654-97-0043	23-Sep-97	Surface Soil Sample: 0" to 6" deep	6,1	1	Affected	820	McGinnis	X	
654-97-0044	23-Sep-97	Surface Soil Sample: 0" to 6" deep	6,2	4	Affected	756	McGinnis	X	X
654-97-0045	23-Sep-97	Surface Soil Sample: 0" to 6" deep	6,3	8	Affected	909	McGinnis	X	
654-97-0046	23-Sep-97	Surface Soil Sample: 0" to 6" deep	6,4	9	Affected	993	McGinnis	X	
654-97-0047	23-Sep-97	Surface Soil Sample: 0" to 6" deep	6,5	9	Affected	955	McGinnis	X	
654-97-0048	23-Sep-97	Surface Soil Sample: 0" to 6" deep	6,6	4	Affected	848	McGinnis	X	
654-97-0049	23-Sep-97	Surface Soil Sample: 0" to 6" deep	6,7	2	Affected	713	McGinnis	X	X
654-97-0050	23-Sep-97	Surface Soil Sample: 0" to 6" deep	6,8	8	Affected	842	McGinnis	X	
654-97-0051	23-Sep-97	Surface Soil Sample: 0" to 6" deep	6,9	9	Affected	839	McGinnis	X	
654-97-0052	23-Sep-97	Surface Soil Sample: 0" to 6" deep	6,10	5	Affected	925	McGinnis	X	
654-97-0053	23-Sep-97	Surface Soil Sample: 0" to 6" deep	6,11	3	Affected	765	McGinnis	X	
654-97-0054	23-Sep-97	Surface Soil Sample: 0" to 6" deep	6,12	8	Affected	855	McGinnis	X	
654-97-0055	23-Sep-97	Surface Soil Sample: 0" to 6" deep	6,13	9	Affected	764	McGinnis	X	
654-97-0056	23-Sep-97	Surface Soil Sample: 0" to 6" deep	6,14	5	Affected	881	McGinnis	X	
654-97-0057	23-Sep-97	Surface Soil Sample: 0" to 6" deep	6,15	2	Affected	871	McGinnis	X	
654-97-0058	23-Sep-97	Surface Soil Sample: 0" to 6" deep	6,16	3	Affected	1042	McGinnis	X	
654-97-0059	23-Sep-97	Surface Soil Sample: 0" to 6" deep	6,17	6	Affected	778	McGinnis	X	
654-97-0060	23-Sep-97	Surface Soil Sample: 0" to 6" deep	6,18	1	Affected	784	McGinnis	X	
654-97-0061	23-Sep-97	Surface Soil Sample: 0" to 6" deep	6,19	5	Affected	796	McGinnis	X	
654-97-0062	23-Sep-97	Surface Soil Sample: 0" to 6" deep	6,20	2	Affected	741	McGinnis	X	
654-97-0063	23-Sep-97	Surface Soil Sample: 0" to 6" deep	6,21	9	Affected	751	McGinnis	X	
654-97-0064	24-Sep-97	Surface Soil Sample: 0" to 6" deep	6,22	3	Unaffected	885	McGinnis	X	

Table 4 (Continued). Surface Soil Sample Data

Sample Number	Date of Collection	Sample Description	Grid #	Sub-Grid #	Area Type	Weight grams	Sampled By	Analysis Type	
								Gamma	Sr-90
654-97-0065	24-Sep-97	Surface Soil Sample: 0" to 6" deep	7,1	6	Affected	744	McGinnis	X	
654-97-0066	24-Sep-97	Surface Soil Sample: 0" to 6" deep	7,2	9	Affected	688	McGinnis	X	
654-97-0067	24-Sep-97	Surface Soil Sample: 0" to 6" deep	7,3	2	Affected	718	McGinnis	X	
654-97-0068	24-Sep-97	Surface Soil Sample: 0" to 6" deep	7,4	8	Affected	774	McGinnis	X	
654-97-0069	24-Sep-97	Surface Soil Sample: 0" to 6" deep	7,5	5	Affected	712	McGinnis	X	X
654-97-0070	24-Sep-97	Surface Soil Sample: 0" to 6" deep	7,6	9	Affected	771	McGinnis	X	X
654-97-0071	24-Sep-97	Surface Soil Sample: 0" to 6" deep	7,7	7	Affected	774	McGinnis	X	X
654-97-0072	24-Sep-97	Surface Soil Sample: 0" to 6" deep	7,8	4	Affected	773	McGinnis	X	
654-97-0073	24-Sep-97	Surface Soil Sample: 0" to 6" deep	7,9	3	Affected	864	McGinnis	X	
654-97-0074	24-Sep-97	Surface Soil Sample: 0" to 6" deep	7,10	1	Affected	874	McGinnis	X	
654-97-0075	24-Sep-97	Surface Soil Sample: 0" to 6" deep	7,11	8	Affected	822	McGinnis	X	
654-97-0076	24-Sep-97	Surface Soil Sample: 0" to 6" deep	7,12	4	Affected	813	McGinnis	X	
654-97-0077	24-Sep-97	Surface Soil Sample: 0" to 6" deep	7,13	5	Affected	786	McGinnis	X	X
654-97-0078	24-Sep-97	Surface Soil Sample: 0" to 6" deep	7,14	9	Affected	762	McGinnis	X	
654-97-0079	24-Sep-97	Surface Soil Sample: 0" to 6" deep	7,15	5	Affected	751	McGinnis	X	
654-97-0080	24-Sep-97	Surface Soil Sample: 0" to 6" deep	7,16	2	Affected	800	McGinnis	X	
654-97-0081	24-Sep-97	Surface Soil Sample: 0" to 6" deep	7,17	7	Affected	790	McGinnis	X	
654-97-0082	24-Sep-97	Surface Soil Sample: 0" to 6" deep	7,18	3	Affected	822	McGinnis	X	
654-97-0083	24-Sep-97	Surface Soil Sample: 0" to 6" deep	7,19	5	Affected	748	McGinnis	X	
654-97-0084	24-Sep-97	Surface Soil Sample: 0" to 6" deep	7,20	4	Affected	767	McGinnis	X	
654-97-0085	24-Sep-97	Surface Soil Sample: 0" to 6" deep	7,21	8	Affected	763	McGinnis	X	
654-97-0086	24-Sep-97	Surface Soil Sample: 0" to 6" deep	7,23	4	Unaffected	789	McGinnis	X	
654-97-0087	24-Sep-97	Surface Soil Sample: 0" to 6" deep	3,12	Backhoe disturbance	Unaffected	669	McGinnis	X	
654-97-0088	24-Sep-97	Surface Soil Sample: 0" to 6" deep	3,13	Backhoe disturbance	Unaffected	641	McGinnis	X	
654-97-0089	24-Sep-97	Surface Soil Sample: 0" to 6" deep	3,15	Backhoe disturbance	Unaffected	701	McGinnis	X	
654-97-0090	24-Sep-97	Surface Soil Sample: 0" to 6" deep	8,10	Backhoe disturbance	Affected	677	McGinnis	X	X
654-97-0091	24-Sep-97	Surface Soil Sample: 0" to 6" deep	8,12	Backhoe disturbance	Affected	659	McGinnis	X	X
654-97-0092	24-Sep-97	Surface Soil Sample: 0" to 6" deep	8,14	Backhoe disturbance	Affected	661	McGinnis	X	
654-97-0093	24-Sep-97	Surface Soil Sample: 0" to 6" deep	8,16	Backhoe disturbance	Affected	677	McGinnis	X	X

EXHIBIT VI

NATIONAL ENVIRONMENTAL POLICY ACT DOCUMENTATION FOR DECONTAMINATION AND DECOMMISSIONING OF BUILDING T654 AT THE ENERGY TECHNOLOGY ENGINEERING CENTER

ERWM
LIDDLE
4/15/92

ERWM
CULLEN
4/16/92

AMEMS
DAVIS
4/16/92

OCC
BRECHBILL
4/22/92

DAMA,
LAMBERT
4/24/92

DM
VAETH
4/27/92

AMC
DAVIS
4-29-92

APR 29 1992

DOE San Francisco Field Office (ERWM)

Categorical Exclusion (CX) Determination for Environmental Remediation of Buildings and Work Areas by Decontamination and Removal and Disposal of Hazardous and Radioactive Waste

Susan Brechbill, Acting AMEMS

In accordance with DOE NEPA Guidelines, Section D, and SEN-15-90, I have determined that the subject project satisfies the requirements for exclusion from further NEPA review based on the following:

CX DETERMINATION

NEPA Document Number: ET-EM-92-12

Proposed Action: Environmental Remediation of Buildings and Work Areas by Decontamination and Removal and Disposal of Hazardous and Radioactive Waste

Location: Energy Technology Engineering Center (ETEC), Santa Susana Field Laboratory, Ventura County, CA

Description: Remove stored equipment, decontaminate facilities and adjacent grounds to remove low level radioactivity contamination, and restore them to conditions suitable for use without radiological restrictions. Also, excavate, as needed, adjacent grounds to remove hazardous and radioactively contaminated soil and debris. Package the hazardous and radioactively contaminated fixtures, surplus equipment and debris, and ship it to an approved radioactive waste disposal facility.

Buildings and Work Areas to be Remediated

Radioactive Materials Disposal Facility (ADS 4005-AC):
- Building 022, RA Materials Storage Vault
- Building 021, Decontamination and Packaging
- Building 034, Offices
- Building 044, Health-Physics Services
- Four peripheral storage structures & the storage yard

Building 023, Liquid Metals Chemistry Laboratory (ADS 5002-AC)

Buildings and Work Areas to be Remediated (Continued)

SSFL Work Areas Decontamination (ADS 4006-WC):
Sodium Reactor Experiment (SRE) Moderator Shipping Cask stored in:
Building 012, SNAP Critical Facility
Building 100 Area, Construction Work Trenches
Old Conservation Yard Packaged Waste Disposal

CX To Be Applied (from Section D, DOE NEPA Guidelines):

CX as identified in Federal Register Volume 55, Number 174, dated September 7, 1990, for "1. The removal actions and other actions described below, if it is determined that such an action would not threaten a violation of applicable statutory, regulatory or permit requirements, including requirements of DOE Orders; would not require siting and construction or major expansion of waste disposal, recovery, or treatment facilities (including incinerators and facilities for treating waste water, surface water, or ground water); and would not adversely affect environmentally sensitive areas.... c. Removal actions under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (including those taken as final response actions and those taken before remedial action) and actions similar in scope under the Resource Conservation and Recovery Act (RCRA) and other authorities (including the Atomic Energy Act, as amended) and those taken as partial closure actions and those taken before corrective action.... (12) Use of chemicals and other materials to retard the spread of the release or to mitigate its effects, where the use of such chemicals would reduce the spread of, or direct contact with, the contamination; {and}.... (16) Treatment (including incineration), recovery, storage or disposal of wastes at existing facilities permitted for the type of waste resulting from the removal action, where needed, to reduce the likelihood of human, animal, or food chain exposure."

The project will not affect historic, archaeological, or architecturally significant properties; will not impact environmentally sensitive areas or critical habitats; is not located in a floodplain, wetland, or prime agricultural land; and will not utilize special sources of water, sole source aquifers, well heads, or other resources vital to the region.

I have determined that the proposed action meets the requirements for the CX referenced above. Therefore, I have determined that the proposed action may be categorically excluded from further NEPA review and documentation.

/S/
James T. Davis
Acting Manager

cc: D. Williams, EM-443
A. Kluk, EM-443
C. Borgstrom, EH-25