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1987 ENVIRONMENTAL MONITORING REPORT

SANDIA NATIONAL LABORATORIES

LIVERMORE, CALIFORNIA

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ABSTRACT

Sandia National Laboratories at Livermore, California, is located 65 km (50 miles) southeast of San Francisco midway between the Pacific Ocean and the San Joaquin Valley. Sandia conducts various research activities related to Department of Energy interests which have the potential for release of hazardous materials or radionuclides to the environment. A strict environmental control program places maximum emphasis on limiting releases. The environmental monitoring program conducted by Lawrence Livermore National Laboratory and augmented by Sandia is designed to measure the performance of the environmental controls. The program includes analysis of air, water, soil, vegetation, sewer effluent, ground water, and foodstuffs for various toxic, hazardous, or radioactive materials. Based on these studies, the releases of materials of concern at Sandia during 1987 were well below applicable Department of Energy standards.

DISCLAIMER

FOREWORD

This report is prepared for the Department of Energy by the Hazards Control Division of Sandia National Laboratories (SNLL) at Livermore, California. Most of the data and analysis has been compiled by Lawrence Livermore National Laboratory (LLNL). The LLNL data has been summarized and augmented as appropriate to fulfill SNLL environmental monitoring and reporting requirements. In addition to the author, the following Sandia personnel made significant contributions to this report: T. B. Garcia, W. M. Rego, D. B. Ross, K. F. Siegfriedt, and D. A. Wright. W. V. Ormond III has provided overall program guidance and critical review of this document.

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ABBREVIATIONS

Acronyms

ALARA	As Low As Reasonably Achievable
BAAQMD	Bay Area Air Quality Management District
BOD	Biological Oxygen Demand
CG	Concentration Guide (DOE Standards)
CRF	Combustion Research Facility
DHS	Department of Health Services
DL	Discharge Limit (City of Livermore)
DOE	Department of Energy
EPA	Environmental Protection Agency
HTO	Tritiated Water
LLNL	Lawrence Livermore National Laboratory
LWRP	Livermore Water Reclamation Plant
RWQCB	Regional Water Quality Control Board
SNLL	Sandia National Laboratories - Livermore
TDS	Total Dissolved Solids
TLD	Thermoluminescent Dosimeter
TRL	Tritium Research Laboratory

Radioactivity Measurements

mR	milliroentgens (unit of radiation exposure)
mrem	millirem (unit of radiation dose)
Ci	Curie (unit of radioactivity)

Units

^{o}C	Celsius degree
m	meter
L	liter
g	gram
ppb	parts per billion
ppm	parts per million

System International Prefixes

Exponent	Prefix	Symbol
10^{6}	mega	M
10^{3}	kilo	k
10^{-3}	milli	m
10^{-6}	micro	u
10^{-9}	nano	n
10^{-12}	pico	p

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LIVERMORE, CALIFORNIA

INTRODUCTION

Sandia National Laboratories at Livermore (SNLL) is a prime contractor to the Department of Energy (DOE) operated under provision of a non-profit, no fee contract with AT&T Technologies Inc. SNLL employs approximately 1100 people. The site is immediately adjacent to the Lawrence Livermore National Laboratory (LLNL) which maintains a complete environmental monitoring program (Reference 1). SNLL augments the LLNL program by conducting additional monitoring and analysis to provide data specific to its operations. This report fulfills the requirement for environmental monitoring specified in DOE Order 5484.1.

SNLL is located 65 km (50 miles) southeast of San Francisco in the Central California Coastal Range Province along the southeastern portion of the Livermore Valley midway between the Pacific Ocean and the San Joaquin Valley (Figure 1). The SNLL site is situated on 1.7 km^2 (413 acres) of land located approximately 5 km (3 miles) east of the City of Livermore.

The Livermore Valley forms an irregularly shaped lowland area which slopes generally to the west at about 10 meters/km (20 feet/mile). The intermittent streams that flow into the valley drain to the southwest with outflow near Sunol into the San Francisco Bay through Alameda Creek. The Livermore Valley overlies a complex geologic region where ancient arroyos have deposited a heterogeneous combination of sand, silts, clays, and gravels. These alluvial deposits occur in interfingering lenses of higher and lower permeability overlying the older Livermore formation. The ground water of the Livermore Valley occurs in the more permeable deposits at 5 to 33 meters (17 to 110 feet) below the SNLL site with a northwesterly flow as depicted in Figure 2 (from Reference 2). Ground water flow is influenced by the Las Positas Fault which is believed to provide significant resistance to westerly movement in the upper saturated zone.

Climate in the valley is typically warm and dry with an average rainfall of 36 cm (14 inches) occurring during the winter months. Prevailing winds are from the west and southwest during April through September. The remainder of the year is characterized by variable winds. Rainfall, as well as wind patterns, exhibit a strong seasonal pattern.

SNLL has assigned the Hazards Control Division the responsibility to assure that operations are conducted with the highest regard for the safety and health of personnel and the public, the protection and preservation of the environment, and the protection of government property.

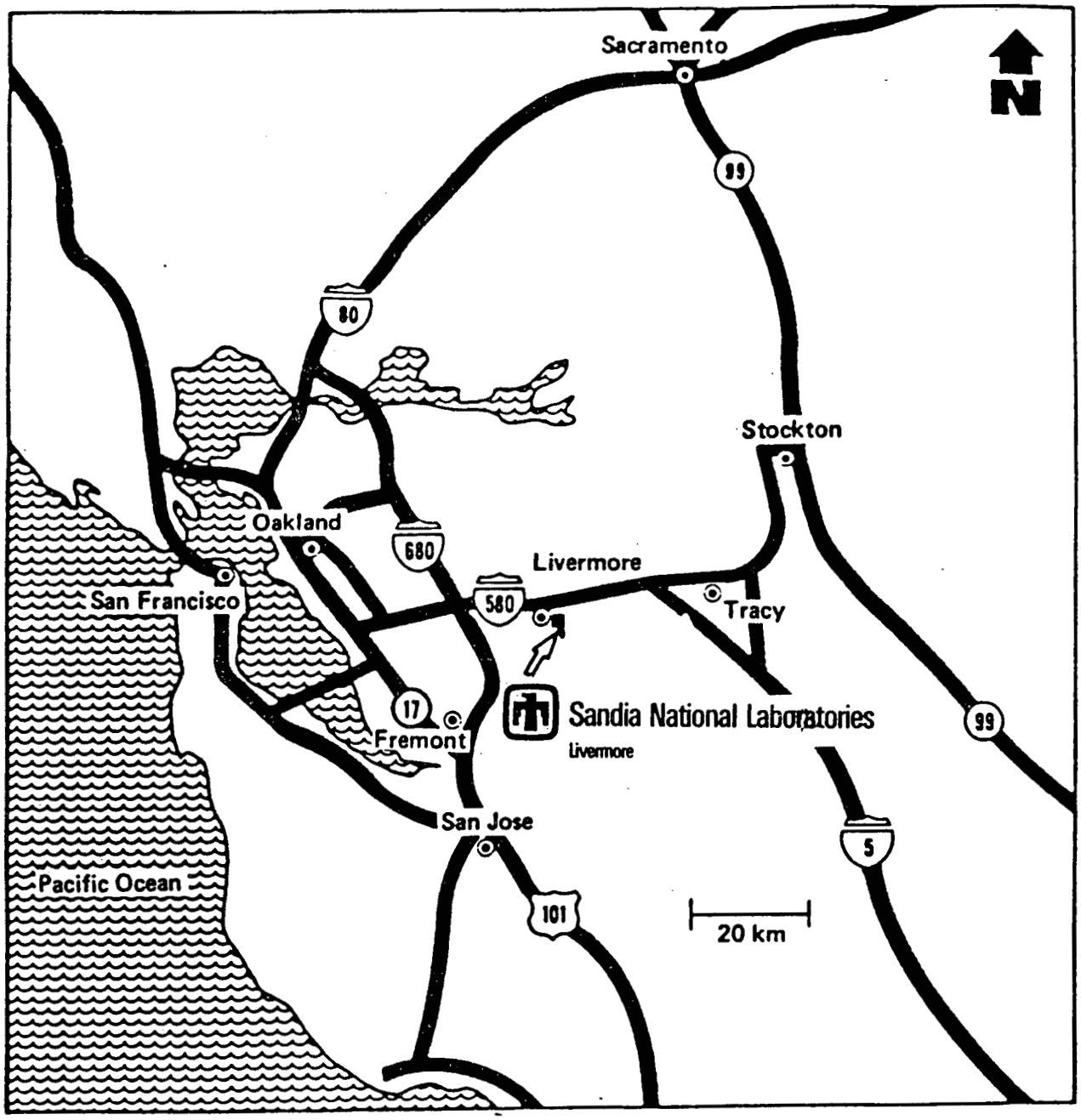

Figure 1. Regional Setting of SNLL

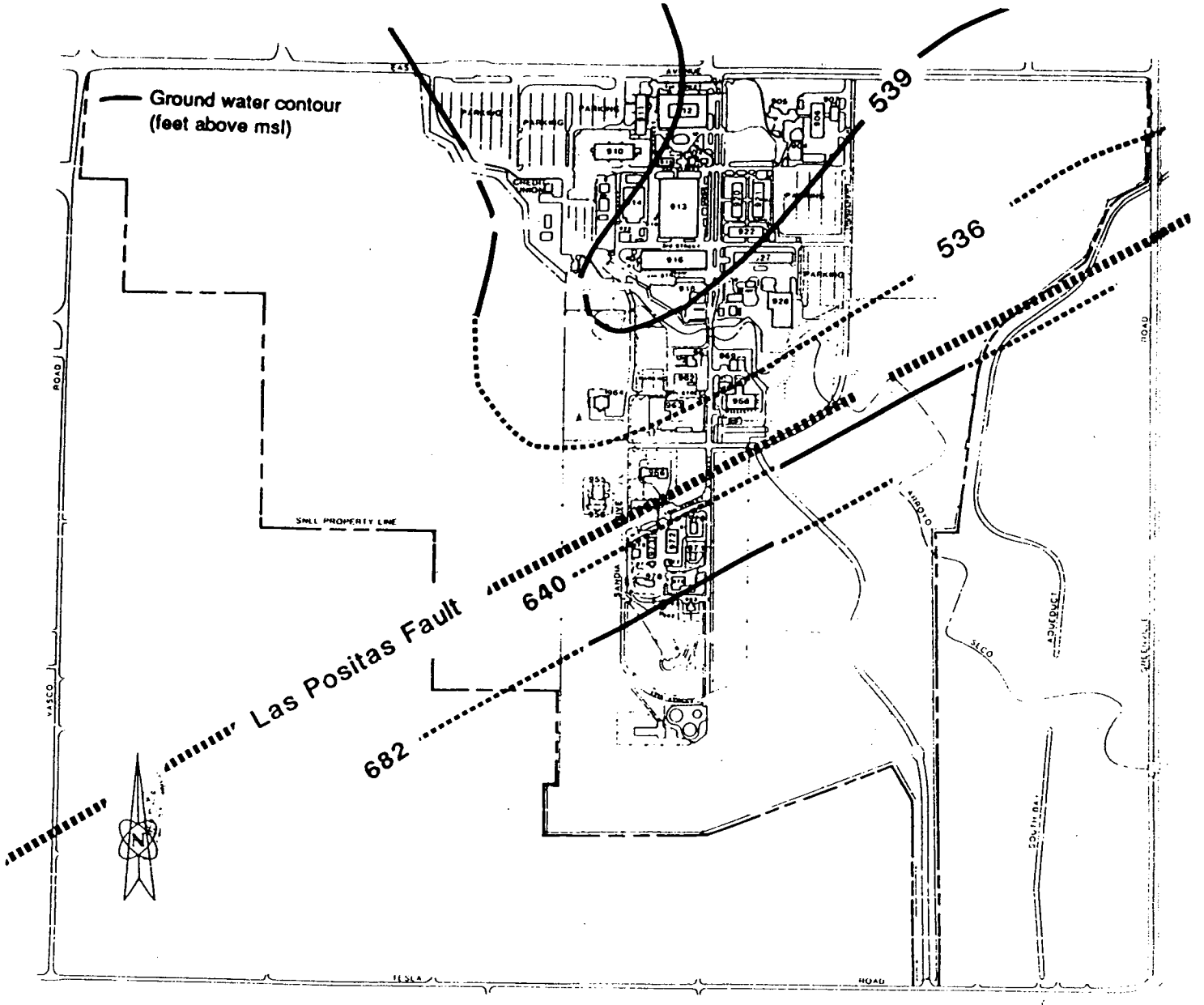

Figure 2. Piezometric Surface - October 1987

SUMMARY - Environmental Control Program

SNLL conducts various research activities related to Department of Energy interests. These activities have the potential for release of hazardous materials or radionuclides to the environment. Potential emissions include tritium, depleted uranium, metals, solvents, and common laboratory chemicals. SNLL handles gram quantities of tritium, kilogram quantities of depleted uranium (a by-product of ^{235}U enrichment - primarily ^{238}U with approximately 0.2 % ^{235}U remaining), but only microcurie quantities of other isotopes. The only radionuclides released during normal operations at SNLL are small amounts of tritium and depleted uranium. Environmental monitoring requirements specific to the Tritium Research Laboratory (TRL) activities were evaluated in 1976 (see Reference 3). A sophisticated monitoring system at the TRL measures operational and atmospheric releases due to tritium research activities (Reference 4). Airborne tritium released in 1987 during research at the TRL was a total of 1827 curies of which 570 curies were in the oxide form (HTO) and 1257 were in the molecular form (HT). A total of 235 millicuries of tritiated water (HTO) were discharged in the liquid effluent. The quantity of depleted uranium released during 1987 was less than 10 microcuries (or 22 grams - analysis near background level) from both liquid and airborne effluents.

Liquid effluent monitoring requirements for hazardous substances were established in 1982 by the Environmental Protection Agency (EPA) National Pretreatment Program provisions of the Clean Water Act. Accordingly, SNLL maintains a strict liquid effluent control program which places maximum emphasis on controlling the effluents at the source. SNLL liquid effluent is monitored at the outfall (see Table 6) and discharges directly to the LLNL sewer. The LLNL outfall is again monitored before discharge into the City of Livermore's sanitary sewer system and is processed at the Livermore Water Reclamation Plant. The treated sanitary wastewater is transported out of the Valley and discharged into the San Francisco Bay. During 1987, effluent contaminant levels were below the City of Livermore discharge limits (see Appendix A). Continuous liaison is maintained between SNLL and LLNL as to the need for changes in the sampling program and to identify any significant increases in discharge levels.

The Environmental Quality Verification Program conducted by LLNL provides environmental data to evaluate the effectiveness of control measures and to determine any operational impact on the environment. The program employs techniques with sensitivities usually capable of detecting radioactive and nonradioactive pollutants well below applicable standards and environmental background levels. This ensures that the effluent control program is restricting the releases to concentrations below the standards set forth by DOE, EPA, State of California, Alameda County, and the City of Livermore.

The LLNL program includes collection and analysis of air, soil, water, sewer effluent, vegetation, wine, and milk samples. These samples are analyzed for gross alpha and beta radioactivities as well as for specific radionuclides of interest. Environmental background due to penetrating radiation is measured at numerous locations by means of thermoluminescent dosimeters. Complete results of the various environmental evaluations (including error values and ranges) are presented in the LLNL Annual Environmental Monitoring Report (Reference 1) and summarized in Tables 1-14. These summary tables include average values of many samples from the last four years to provide a data base for trend analysis.

SNLL sought to improve the environmental protection program in 1987 by initiating various activities. In addition to the liquid effluent control system at the TRL, design was completed for two additional Liquid Effluent Control Systems (LECS) and construction initiated. The LECSs are essentially vaulted collection systems to provide hold-up and monitoring capability before release to the sanitary sewer. The Building 910 LECS will service the Printed Wiring Laboratory, and the Building 913 LECS will service electroplating, materials, and chemistry research activities. These systems are expected to be in operation by early 1988. In order to limit releases of tritiated water to the sanitary sewer system to as low as reasonably achievable, design of a low level tritium evaporator was initiated. The system was reviewed by DOE and EPA in accordance with provisions of the Clean Air Act as defined in Title 40, Code of Federal Regulations, Part 61, National Emissions Standards for Hazardous Air Pollutants and Subpart H, National Emissions Standards for Radionuclide Emissions from Department of Energy Facilities. A permit to construct the facility was granted by EPA on November 2, 1987. The system should be operational by mid-1988.

During 1987, SNLL Environmental Protection and Hazardous Waste Management Programs were appraised a number of times by various agencies including: the Department of Energy offices in Albuquerque and Washington, DC; the Environmental Protection Agency, Region IX; the California Department of Health Services; the California Regional Water Quality Control Board; the Bay Area Air Quality Management District; and the City of Livermore. These appraisals reflect a high quality SNLL program.

ENVIRONMENTAL MONITORING PROGRAM

Atmospheric Pollution

Concentrations of several airborne contaminants are continuously measured at various locations around the DOE Livermore sites and surrounding valley. The samplers are situated so that a significant release of airborne radioactivity can be detected regardless of local meteorological conditions. Glass and/or cellulose filters are used for particulate collecting media. Analysis for gross alpha and gross beta activity is not required by DOE, Federal, State, or local regulatory agencies. Specific alpha and gamma emitters are analyzed using spectrometry techniques and chemical analysis is used for beryllium determination. The results of particulate radionuclide and beryllium analyses are provided in Tables 1 and 2. Derived Concentration Guides (DCG) for radioactivity in air and water have been adopted in DOE Order 5480.XX on February 28, 1986 by memo from R. J. Stern to Heads of Field Organizations. The DCG are based on metabolic data and dosimetric models and are used in this report where appropriate.

TABLE 1
Uranium-238 Concentration in Air(10^{-5} ug/m^3)

LOCATION	Avg Prior Years 1984	1985	1986	1987 Results Samples	Average	%DCG_a*
Livermore Site	6.9	7.4	7.1	72	8.1	$2x10^{-2}$

* The Derived Concentration Guide (DCG) is 0.3 ug/m^3

TABLE 2
Beryllium Concentration in Air(10^{-5} ug/m^3)

LOCATION	Avg Prior Years 1984	1985	1986	1987 Results Samples	Average	% CG*
Livermore Site	2.5	6.8	4.2	72	3.8	0.4

*Ambient Concentration Guide set by BAAQMD = $1x10^{-2}$ug/m^3

Each month, half of the perimeter particulate filters are composited for each location and analyzed for beryllium. The concentrations, which are 3 or 4 orders of magnitude below the emission standard, can be accounted for by resuspension of surface soil containing paturally occurring beryllium. Livermore's air typically contains $5x10^{-5}$ ug/m^3 of naturally occurring beryllium.

Water vapor is collected on silica gel samplers at various locations at the LLNL perimeter and analyzed for tritiated water (HTO) concentrations in air. Two additional sampling sites were established during 1977 to provide more precise evaluation of SNLL Tritium Research Laboratory operations. Normal operations at the TRL resulted in 570 curies of HTO and 157 curies of HT released up the stack during 1987 as determined by TRL stack monitors. A single release of 1100 curies of HT on August 18, 1987 resulted from a procedural error. The total stack release for 1987 was 1827 curies. Perimeter airborne levels of HTO are summarized in Table 3.

With the promulgation of the National Emission Standards for Hazardous Air Pollutants (40 CFR 61, subpart H), DOE now requires pathway dose calculations using EPA's Clean Air Act Code which contain the AIRDOS-EPA and RADRISK models. Although 570 curies of HTO was released during 1987, AIRDOSE-EPA does not distingwish between the oxide form or the molecular form of tritium release. The contribution of HT (which comprised the remainder of the 1827 curies) to the resultant dose is insignificant. The dose to the nearest resident resulting from tritium release during 1987 was 0.49 mrem. A variety of assumptions and approximations are reflected in the "effective dose equivalents" reported here. The effective dose equivalent attributed to an average perimeter airborne concentration of $2.8x10^{-11}$ uCi/mL is calculated to be 0.01 mrem.

TABLE 3
Tritium (HTO) Activity in Air(10^{-11} uCi/mL)

LOCATION	Avg Prior Years 1984	1985	1986	1987 Results Samples	Average	%DCG$_a$*
LLNL perimeter	3.6	2.8	2.4	192	4.7	0.02
SNLL perimeter	1.6	1.6	1.8	45	2.8	0.02
Livermore Valley		1.2	1.0	96	2.2	0.01

*Derived Concentration Guide = $2x10^{-7}$ uCi/ml or $1x10^{-7}$ uCi/mL adjusted for skin absorption.

The Bay Area Air Quality Management District (BAAQMD) has issued permits to operate 18 SNLL facilities. Nonradioactive airborne effluents from selected facilities are reported to the BAAQMD on an annual basis. The primary source of nonradioactive airborne pollution is the SNLL steam plant and a small incinerator. The fuels used are natural gas or diesel #2 and the calculated releases are below applicable guide values (Reference 5).

Soil

Since 1972, soil sampling has been a part of a continuing surveillance program to document any changes in environmental radioactivity levels. During 1987, 22 locations were sampled and analyzed by radiochemical techniques for ^{239}Pu, ^{232}Th, ^{235}U, ^{238}U, and naturally occurring ^{40}K. Only depleted uranium is handled at SNLL. Soil sampling results for ^{238}U are listed in Table 4.

Table 4
Uranium-238 in Soil(ug/dry g)

LOCATION	Avg Prior Years 1984	1985	1986	1987 Results Samples	Average
Livermore Valley	2.8	4.2	2.3	22	0.8

Sewer Effluent

Sewage from SNLL is discharged into the LLNL sewer system which forms a main trunk to the City of Livermore Water Reclamation Plant (LWRP). The SNLL outfall is monitored for pH and flow on a continuing basis, and composite samples are collected weekly for metals, organics, cyanides, and dissolved solids analysis. Radioactive wastes are collected in hold tanks and sampled before discharge. LLNL continuously monitors pH, selected metals, and radioactivity at their outfall. At the LWRP, daily samples are collected from the liquid effluent and analyzed for tritiated water. Upon entering the LWRP, main flow is processed by activated sludge technique. Sludge is anaerobically digested in two digesters. Methane gas is burned and the remaining sludge is released to large sludge ponds. Reclaimed water is used for irrigation of a nearby golf course, or transported by pipeline to the San Francisco Bay. Releases to the sanitary sewer system are well below standards set forth by DOE and LWRP. Tritium levels in the bay have not changed since the effluent pipeline connection was made in 1980. Table 5 provides results of the LLNL sewer sampling. Table 6 provides the SNLL sampling results which generally meet the City Discharge Limits.

TABLE 5
Tritium (HTO) in Sewage(10^{-3} uCi/L)

LOCATION	Avg Prior Years 1984	1985	1986	1987 Results Samples	Average	% DCG*
LLNL Discharge	3.6	7.2	3.4	daily	2.3	0.1
LWRP	0.8	1.3	0.5	daily	0.4	N/A

*Derived Concentration Guide (DCG) = 2 uCi/L

TABLE 6
Physical and Chemical Studies of the SNLL Liquid Effluent

Constituent	mg/L Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	DL*
BOD	---	50	---	66	300
COD				74	
Phenolics	---	0.05	---	0.05	1.0
TDS	120	130	120	130	325
Cyanide	---	0.02	---	0.24	1.0
Oil and Grease	---	9	---	13	100
Arsenic	0.03	0.03	0.03	0.002	0.1
Cadmium	0.04	0.04	0.07	0.01	0.2
Chromium	0.7	0.1	0.2	0.2	1.0
Copper	0.1	0.5	0.1	0.03	2.0
Lead	0.2	0.06	0.03	0.1	1.0
Mercury	0.005	0.005	0.005	0.003	0.01
Nickel	0.33	0.04	0.1	0.05	1.0
Silver	0.02	0.12	0.07	0.06	0.2
Zinc	0.12	0.14	0.10	0.45	3.0
CA Title 22 Organics	--	--	--	ND**	
Purgeable Priority Pollutants (EPA 624)	--	--	--	ND**	

*City of Livermore Water Reclamation Plant Discharge Limit (DL)
** None detected above analytical detection limits.

Water Pollution

LLNL collects water samples at various locations in the Livermore Valley to ascertain that radioactivity is not entering the underground water supply. Domestic samples are collected monthly from sources surrounding the Laboratory and extending west to Pleasanton. In addition to the underground water supply, the Zone Seven Aqueduct, which is used for domestic supply, is located about 1/4 mile to the east of SNLL. There is also a water treatment plant and storage basin located 2 miles northeast of SNLL.

In 1982 LLNL began a hydrogeologic study to determine the impact of operations on ground water. Analyses were made to determine major cations and anions, dissolved solids, organic carbon, trace organic compounds, gamma emitters and tritium. The results of that study indicated that the local ground water was contaminated with various chlorinated solvents. Since 1983, LLNL and SNLL have been conducting intensive hydrogeochemical investigations. The results of gross alpha, beta, and tritium measurements are provided in Tables 7-9 and indicate that the radioactivity levels are within the EPA and California drinking water standards. Using a standard man assumption of 2 liters/day water intake, an effective dose equivalent calculated for a concentration of 0.9×10^{-4} uCi/L is 4×10^{-3} mrem.

TABLE 7
Gross Alpha Activity in Livermore Valley Water
(10^{-9} uCi/mL)

LOCATION	Avg Prior Years 1984	1985	1986	1987 Results Samples	Average
Livermore Valley	2.6	3.6	3.1	48	2.8

TABLE 8
Gross Beta Activity in Livermore Valley Water
(10^{-9} uCi/mL)

LOCATION	Avg Prior Years 1984	1985	1986	1987 Results Samples	Average
Livermore Valley	8.8	9.6	10.0	48	8.4

TABLE 9
Tritium (HTO) in Livermore Valley Water
(10^{-4} uCi/L)

LOCATION	Avg Prior Years 1984	1985	1986	1987 Results Samples	Average	% DCG*
Surface Water	2.7	1.5	0.9	36	0.9	$4x10^{-3}$
Ground Water	3.3	2.6	0.5	13	0.9	$5x10^{-3}$

*Derived Concentration Guide (DCG) = 2 uCi/L

In 1975, as a result of an accidental puncture of an underground transfer line, 225 m^3 (59,500 gallons) of #2 diesel fuel escaped from the 670 m^3 (177,000 gallon) reserve fuel tank. SNLL began a short-term ground water investigation in December 1983 to determine the extent of contamination resulting from the fuel oil spill. Detailed studies indicate that the fuel has slowly moved to the upper aquifer which is not used for either irrigation or drinking water. The plume is being closely monitored by 8 observation wells completed in the vicinity (Figure 3). Details of the spill, the hydrology of the area, and a monitoring report are found in References 6 and 7. A study of the fuel spill data base was conducted in the fall of 1985 (see Reference 2).

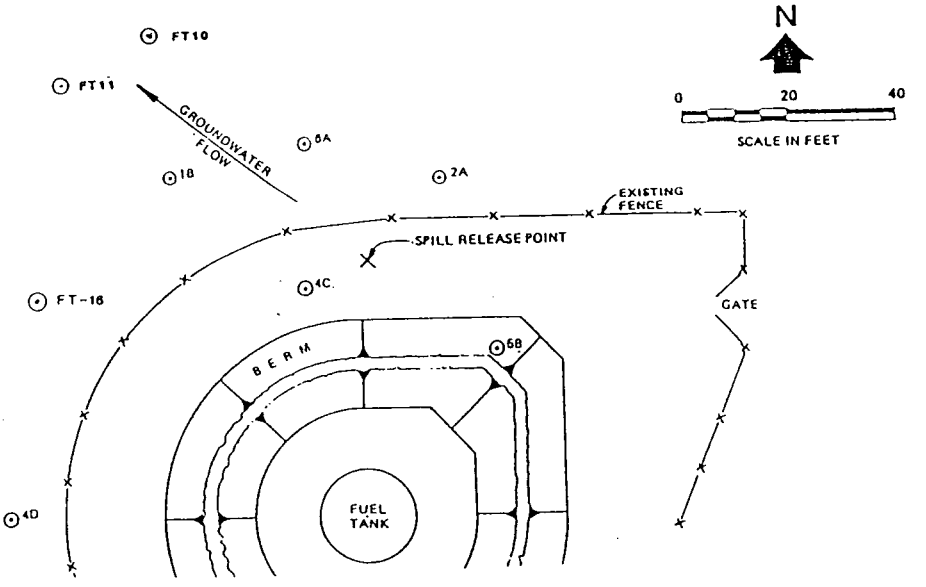

Figure 3. Fuel Spill Evaluation - Location of Wells and Boreholes

Vegetation and Foodstuffs

Vegetation samples (usually native grasses) are collected and analyzed for tritium by freeze drying and liquid scintillation counting. LLNL derived effective dose equivalents using accepted dose conversion factors (see Reference 1). For an average vegetation tritium content of 4.6×10^{-4} uCi/L, the effective dose is calculated to be 8×10^{-3} mrem. Samples of Livermore Valley wines indicate a somewhat higher level than wines produced from grapes grown outside the valley but within the range found in both European wines and surface waters throughout the world. HTO levels are also measured in honey and goat's milk. The effective dose equivalent of 2.4×10^{-4} uCi/l tritium in milk is calculated to be 4×10^{-3} mrem. Concentrations of tritium in vegetation and foodstuffs are summarized in Table 10.

TABLE 10
Tritium (HTO) in Vegetation and Foodstuffs(10^{-4} uCi/L)

LOCATION	Avg Prior Years 1984	1985	1986	1987 Results Samples	Average
Vegetation	14.4	35.1	11.8	32	4.7
Wine	2.4	3.4	2.2	4	4.6
Milk	1.2	1.5	3.0	16	2.4
Honey	4.2	4.2	1.8	2	1.5

Thermoluminescent Dosimetry

Background measurements of external penetrating radiation were made at 22 LLNL laboratory perimeter locations. In the Livermore Valley, the median annual background was 64 mrem, which is attributable primarily to naturally occurring terrestrial and cosmic background radiation. The average annual LLNL perimeter exposure was 65 mrem which is not a statistically significant difference from background. Table 11 summarizes these measurements.

TABLE 11
Environmental Radiation Measurements
DOE Livermore Site by TLD (mrem)

LOCATION	Avg Prior Years 1983	1984	1985	1987 Results Samples	Average	Maximum
LLNL perimeter	48	59	61	86	65	71

Surface Water Runoff Monitoring

LLNL initiated a pesticide monitoring program in 1975 to analyze surface runoff water samples for pesticides. In 1985, LLNL expanded the analysis to include metals and priority pollutants. SNLL began additional monitoring of surface water from Arroyo Seco in 1987.
During the winter rainy season, water is collected along Arroyo Seco at the east SNLL boundary for the influent measurement and at the west boundary for the effluent sample. Data from Arroyo Seco indicate that most pollutants were not present at detectable levels and the constituents reflect natural variability and flow properties. Selected analyses are presented in Table 12. All other constituents were below the minimum detectable level (Reference 1).

TABLE 12
Storm Water Runoff from Arroyo Seco (mg/L)

Analyses	SNLL Influent	SNLL Effluent
Cadmium	0.01	0.0001
Chromium	0.02	0.0016
Lead	0.001	0.001
Mercury	0.0001	0.0002
Silver	0.01	0.0001
Nitrate	1.2	0.8
Chemical Oxygen Demand (COD)	---	5
Oil and Grease	---	12
CA Title 22 Organics:	ND*	ND
Purgeable Priority Pollutants:	ND	ND

* None detectable above analytical detection limits.

Solid Wastes

No solid wastes are disposed of on the SNLL site. Radioactive wastes are shipped to the Nevada Test Site. The disposal of chemical wastes is achieved under contract with local waste handling companies at a Class 1 disposal site in accordance with EPA and California State Regulations (Reference 8).

Quality Assurance

During 1987, LLNL participated in several intercomparison assessments organized by EPA's Environmental Radioactivity Laboratory and the DOE Environmental Measurements Laboratory. The results were considered satisfactory. Replicate sampling and blank analysis are part of the Quality Assurance program. These results were considered acceptable reflecting normal sampling, analytical, and natural environmental variations. Reference 1 describes the procedures and results.

DOE Draft Order 5480.XX of August 15, 1986 requires that DOE facilities prepare a quality assurance plan that addresses the criteria of ANSI/ASME NQA-1. A plan was prepared by LLNL (reference 1) which establishes goals for accuracy, precision, completeness, represnetativeness, and comparability. The document also meets the quality assurance requirements of various EPA regulations.

During 1987, eight audits and appraisals were conducted by DOE, EPA, and California DHS and RWQCB looking at the SNLL Environmental Protection and Hazardous Waste Management Programs. These regulatory agency audits provide independent review and insure high quality programs at SNLL.

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APPENDIX A

SUMMARY OF DISCHARGE LIMITS
CITY OF LIVERMORE WATER RECLAMATION PLANT

Section 18.62 of the Code of the City of Livermore states the discharge limits for the sanitary sewer system. These limits are summarized:

No discharge of the following:

(a) flammables or explosives (gasoline, benzene, naphtha, fuel oil, etc.)	
(b) solid or viscous substance	
(c) pH - outside following limits	6.8 to 8.5
(d) toxic pollutants	
(e) noxious or malodorous	
(f) substances effecting sludge	
(g) fat, grease, or oil (freon extractable)	100 mg/L
(h) NPDES violation	
(i) objectionable color	
(j) temperature	40 C (104 F)
(k) flow rate restrictions	
(l) radioactive wastes exceeding state or federal limits	
(m) hazard to human life or public nuisance	
(n) TDS increment	325 mg/L
chloride increment	75 mg/L
(o) B.O.D	300
(p) suspended solids	300

Specific Pollutant Limitations

arsenic	0.1 mg/L
cadmium	0.2
copper	2.0
cyanide	1.0
lead	1.0
mercury	0.01
nickel	1.0
silver	0.2
total chromium	1.0
zinc	3.0
total Cl CH_x	0.02
phenolics	1.0
PCBs	0.01

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