FINAL
TECHNICAL MEMORANDUM
SUBAREA HSA-8
HISTORICAL SITE ASSESSMENT
SANTA SUSANA FIELD LABORATORY SITE
AREA IV RADIOLOGICAL STUDY
VENTURA COUNTY, CALIFORNIA

Prepared for:

EPA Contract Number: EP-S7-05-05
Task Order Number: 0038

U.S. Environmental Protection Agency, Region 7
901 North 5th Street
Kansas City, KS 66101
and
U.S. Environmental Protection Agency, Region 9
75 Hawthorne Street
San Francisco, CA 94105

Prepared by:

HydroGeoLogic, Inc.
Northway 10 Executive Park
313 Ushers Road
Ballston Lake, New York 12019

October 2012

Redacted

HGL
HydroGeoLogic, Inc

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LIST OF ACRONYMS, ABBREVIATIONS AND SYMBOLS

AEC	U.S. Atomic Energy Commission
AETR	Advanced Epithermal Thorium Reactor
ARRA	American Recovery and Reinvestment Act
Atomics International	Atomics International Division of North American Aviation, Inc.
CDPHE	California Department of Public Health and Environment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
Ci	curie
COC	Contaminants of Concern
D&D	decontamination and decommissioning
DHS	Department of Health Services
DOE	Department of Energy
dpm/100 cm^2	disintegrations per minute per 100 square centimeters
DTSC	Department of Toxic Substances Control
EPA	U.S. Environmental Protection Agency
EPIC	Environmental Photographic Interpretation Center
ESADA	Empire State Atomic Development Associates, Inc.
ETEC	Energy Technology Engineering Center
FOIA	Freedom of Information Request
ft^2	Feet Squared
FUSRAP	Formerly Utilized Site Remedial Action Program
HERF	High-Energy Rate Forging
HGL	HydroGeoLogic, Inc.
HSA	Historical Site Assessment
kW	kilowatt
µCi/ml	microcurie per milliliter
µR/h	microroentgen per hour
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MCP	maximum permissible concentration
MDA	minimum detectable activity
mrad/h	millirad/hour
MWd	megawatt days
NASA	National Aeronautics and Space Administration
NBZ	Northern Buffer Zone
NRC	Nuclear Regulatory Commission
OMR	Organic Moderated Reactor
ORISE	Oak Ridge Institute for Science and Education
pCi/g	picocuries per gram
pCi/L	picocuries per liter

RCRA	Resource Conservation and Recovery Act
RESRAD	Residual Radioactivity
RFI	RCRA Facility Investigation
SBZ	Southern Buffer Zone
SCTI	Sodium Components Test Installation
SGR	sodium graphite reactors
SHEA	Safety Health and Environmental Affairs
SNAP	Systems for Nuclear Auxiliary Power
SPTF	Sodium Pump Test Facility
SSFL	Santa Susana Field Laboratory
TM	technical memorandum
TO	task order
ZrH_2	zirconium-hydride

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1.0 INTRODUCTION

This technical memorandum (TM) presents a summary of the identified environmental concerns associated with past radiological operations within a portion of Area IV at the Santa Susana Field Laboratory (SSFL) site located in eastern Ventura County, California (Figure 1.1). The SSFL site consists of four areas: Areas I, II, III, and IV; and two buffer zones: the Northern Buffer Zone (NBZ) and the Southern Buffer Zone (SBZ). The U.S. Environmental Protection Agency (EPA) is conducting a radiological characterization study of SSFL Area IV and the NBZ pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). EPA's study consists of a Radiological Historical Site Assessment (HSA), gamma scanning of accessible areas, geophysical surveys, soil and water testing. EPA's gamma scanning, geophysical, soil and water testing investigations are being developed and presented in separate work plans and data reports.

HydroGeoLogic, Inc. (HGL) has been tasked by EPA to conduct the radiological characterization study within SSFL Area IV/NBZ (hereafter called the "Area IV Study"). Figure 1.2 illustrates the location of Area IV and the NBZ. EPA has elected to subdivide the Area IV Study Area into subareas. Subarea boundaries are based on existing Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) areas for the SSFL site. EPA has further subdivided some RFI areas based on features such as roads, drainage pathways, building use, and number of buildings.

Table 1.1
Area IV Study Area
Subarea Designations

Area Designation	Number of Sites
HSA-3	1
HSA-5A	26
HSA-5B	46
HSA-5C	23
HSA-5D	21
HSA-6	38
HSA-7	18
HSA-8	8
BZ-NE	2
BZ-NW	2

The objective of the HSA component of the radiological study is to provide a comprehensive investigation that identifies, collects, organizes, and evaluates historical information relevant to nuclear research operations as it pertains to radiological contamination in the Area IV Study Area. Once these areas have been identified, potential areas where radiological contamination may exist at the site will be identified for sampling.

This work is being executed by HGL under EPA Contract EP-S7-05-05, Task Order (TO) 0038 under the technical direction and oversight of EPA Region 9. In accordance House Resolution 2764, the Department of Energy (DOE) is funding EPA's Area IV Study. DOE elected to fund EPA's study with funding allocated under the American Recovery and Reinvestment Act (ARRA) of 2009. On December 6, 2010, the DOE and the State of California Department of Toxic Substances Control (DTSC) signed an Administrative Order on Consent (AOC) for cleanup of the Area IV and the NBZ. Under this AOC, radiological contaminants will be cleaned up to background concentrations as defined by EPA's July 2011 radiological background study.

1.1 Technical Memoranda and the Radiological Historical Site Assessment

This TM presents information relating solely to sites and buildings located within Subarea HSA-8. This TM is one of a series of TMs prepared for the subareas identified in Table 1.1. Each TM has been made available in draft for review and informal comment by SSFL stakeholders and the general public. EPA responded to each comment via draft "Response to Comment" tables, which were also made available to SSFL Stakeholders. Each draft TM was edited as described in the Response to Comment tables, and these edits along with any new information made available to EPA have been compiled into EPA's official Radiological HSA for the Area IV Study Area.

The content of each TM is based on guidance provided in the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM, Revision 1, August 2000). MARSSIM is used as an investigative tool to gain an understanding of the nature and extent of radiological contamination left at a site. The TMs provide preliminary recommendations for MARSSIM classifications based solely on historical information, which may be incomplete. The preliminary classifications identified in the TMs will be used to guide the subsequent gamma scanning and multimedia sampling effort. Once more complete historical environmental data have been obtained, and the results of geophysical surveys, gamma radiation scanning surveys, field observations, and the results of soil sampling and laboratory analyses are available, the preliminary classifications presented in the TMs will be revised.

1.2 Goals and Methodology of this Technical Memoranda

This TM is focused on radiological information within subarea HSA-8 and the drainage channels that lead to and from this area. The subarea HSA-8 location is shown on Figure 1.3. A summary of the features related to potential radiological sources identified within the HSA-8 subarea is provided on Plate 1. Detailed information pertaining to the use of radioactive materials and the potential release of radionuclides at sites and buildings within HSA-8 are provided in Sections 2 and 3 of this TM. Preliminary findings specific to HSA-8 presented in this TM include:

- Descriptions and locations of potential, likely, or known activities that involved radioactive material, radioactive waste, or mixed waste;

- Initial MARSSIM classifications (e.g., Class 1, 2, 3) of potentially impacted areas;
- A site-by-site assessment of the likelihood or "weight of evidence" of radiologically contaminated media;
- An assessment of the likelihood of potential migration pathways; and,
- Identification of, confirmation of, and, if appropriate, addition or subtraction to, the list of the potential radiological contaminants of concern.

As specified in MARSSIM, a "site" is defined as any installation, facility, or discrete, physically separate parcel of land, or any building or structure or portion thereof, that is being considered for survey and investigation (MARSSIM, Revision 1, August 2000). MARSSIM guidance defines all sites as either "non-impacted," or "impacted" by radiological operations. All of the sites at the Area IV Study Area are considered to have a reasonable potential for residual contamination, so none is classified as "non-impacted." Impacted areas of the Area IV Study Area are divided into one of three classifications.[1]

- *Class 1 Areas:* Areas that have, or had prior to remediation, a high potential for radioactive contamination (based on site operating history) or known contamination (based on previous radiation investigations).
- *Class 2 Areas:* Areas that have, or had prior to remediation, a medium potential for radioactive contamination or known contamination.
- *Class 3 Areas:* Areas that have a low potential radioactive contamination.

The information provided in this TM together with comments and recommendations provided by SSFL stakeholders and the general public will be used in the EPA's investigation strategy for sampling and analysis for residual radiological contamination in surface and subsurface soil within HSA-8. In addition to the HSA, information gathered by EPA's Area IV and NBZ gamma scanning program and targeted geophysical investigation will assist EPA in fine-tuning the overall investigation strategy for the Area IV Study Area, and in making the final determination of the appropriate MARSSIM classifications.

1.3 Brief Description and History of SSFL Area IV and the NBZ

The SSFL site occupies 2,850 acres of rocky terrain with approximately 700 feet of topographic relief near the crest of the Simi Hills. The Area IV Study Area comprises approximately 465 acres. Though some of the study area is relatively flat, some portions of the area exhibit steep relief and rugged terrain. The site elevation is between 1,880 feet and 2,150 feet above sea level. The overlying soils of the Area IV Study Area consist of weathered bedrock and alluvium that have been eroded primarily from the surrounding Chatsworth and Santa Susana formations. Several geological faults cross this area.

The climate in the vicinity of the SSFL site is classified as Mediterranean Subtropical, corresponding to an average temperature of 50 degrees Fahrenheit in the winter and 70 degrees Fahrenheit in the summer. Rainfall averages approximately 18 inches per year.

[1] *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), Revision 1*, NUREG-1575, Rev. 1, EPA 402-R-97-016, Rev. 1, DOE/EH-0624, Rev. 1, August 2000, pp. 2-5.

A shallow groundwater system exists in the surface soils at small isolated locations. A regional groundwater system exists in the deeper fractured Chatsworth Formation. In some areas, groundwater from the Chatsworth Formation flows through fractures in the rock and emerges at the ground surface as seeps or springs. Groundwater underlying the SSFL site is not currently used, or anticipated to be used, as a source of drinking water for the nearby communities or at SSFL, but nearby residents may in the future consume groundwater emanating from this site

In addition to rocket and small engine testing facilities in other portions of the SSFL, North American Aviation, Inc., had facilities at Area IV for researching, developing, and constructing equipment to utilize nuclear energy through its Atomics International Division (AI).[1] According to a 1959 company brochure, AI maintained a nuclear field test area covering approximately 300 acres at the SSFL site.[2] Under contract to DOE and private customers, AI supported the development of civilian nuclear power, as well as the testing of non-nuclear components related to liquid metals within 90 acres of Area IV of the SSFL site. The facilities within these 90 acres would later be referred as the Energy Technology Engineering Center (ETEC).[3]

Nuclear facilities at ETEC included 10 nuclear research reactors over the period July 1956 through February 1980. These research reactors are listed in Table 1.2.

Table 1.2
Research Reactors Located at the Santa Susana Field Laboratory[4]

Reactor Acronym	Building No.	Facility Name	Power Level (kW)	Period of Operation	Power Generated (MWd)	Radioactivity at End of Operation (10^3 Ci)
KEWB	4073	Kinetics Experiment Water Boiler	1	7/1956 to 11/1966	1	6
L-85/AE-6	4093	L-85 Nuclear Experimentation Reactor	3	11/1956 to 2/1980	2	18
SRE	4143	Sodium Reactor Experiment	20,000	4/1957 to 2/1964	6,700	120,000
SER	4010	Systems for Nuclear Auxiliary Power (SNAP) Experimental Reactor Facility	50	9/1959 to 12/1960	13	300

[1] North American Aviation, Inc., *The North American Story,* December 1960, p. 7
[2] Atomics International, A Division of North American Aviation, Inc., *Atomics International,* December 1959, p. 5.
[3] http://www.etec.energy.gov/History/Area-IV-History.html
[4] Oldenkamp, R.D. and Mills, J. C., *Nuclear Operations at Rockwell's Santa Susana Field Laboratory – A Factual Perspective*, Rockwell International; Report No. N001ER000017, September 6, 1991, p. 23.

Table 1.2 (continued)
Research Reactors Located at the Santa Susana Field Laboratory[1]

Reactor Acronym	Building No.	Facility Name	Power Level (kW)	Period of Operation	Power Generated (MWd)	Radioactivity at End of Operation (10^3 Ci)
S2DR	4024	SNAP Environmental Test Facility	65	4/1961 to 12/1962	13	390
STR	4028	Shield Test Irradiation Facility	50	12/1961 to 7/1964	1	300
S8ER	4010	S8ER Test Facility	600	5/1963 to 4/1965	215	3,600
STIR	4028	Shield Test Irradiation Facility	1,000	8/1964 to /1974	28	3,714
S10FS3	4024	SNAP Environmental Test Facility	37	1/1965 to 3/1966	16	6,000
S8DR	4059	SNAP Development Reactor Facility	619	5/1968 to 12/1969	182	220

Seven criticality test facilities (i.e., facilities housing operations involving masses of fissionable material capable of sustaining a nuclear chain reaction) were also located on Area IV.[2] These are listed in Table 1.3. Other nuclear facilities within Area IV included the Radioactive Materials Disposal Facility and the Hot Laboratory, as well as the Sodium Disposal Facility, or Area IV burn pit. Each of these facilities has been addressed as a site within the appropriate TM along with supporting buildings and adjacent open areas.

According to the DOE ETEC web site, most nuclear research related programs and operations ceased in 1988 and were replaced with decontamination and decommissioning operations.[3]

Table 1.3
Criticality Test Facilities at the Santa Susana Field Laboratory[1]

Facility Name	Building No.	Period of Operation	Notes
SNAP Critical Test	4373	1957 to 1963	First SNAP-2 criticality tests
Organic Moderated Reactor	4009	1958 to 1967	Basic tests of reactor concept
Sodium Graphite Reactor	4009	1958 to 1967	Basic tests of reactor concept
SNAP Critical Equipment	4012	1961 to 1971	Later SNAP criticality tests
Fast Critical Experiment	4100	1961 to 1972	Started as Advanced Epithermal Thorium Reactor (AETR)
SNAP Flight Systems	4019	1962	SNAP flight system criticality
SNAP Transient Test	4024	1967 to 1969	SNAP transient response tests

The NBZ is a 175-acre parcel of land that abuts the SSFL property (Figure 1.2). The NBZ is a naturally vegetated area containing drainage channels that transport surface water from the SSFL

[1] Oldenkamp, R.D. and Mills, J. C., *Nuclear Operations at Rockwell's Santa Susana Field Laboratory – A Factual Perspective*, Rockwell International; Report No. N001ER000017, September 6, 1991, pp. 23, 25.
[2] Atomics International, A Division of North American Aviation, Inc., *Atomics International*, December 1959.
[3] http://www.etec.energy.gov/History/Area-IV-History.html

down slope to surrounding populated areas.[1] The NBZ was purchased by Rocketdyne Division of Rockwell International (Rockwell) in 1998 from the adjoining Brandeis-Bardin Institute (now known as the American Jewish University) because an environmental contractor found that the NBZ contains radioactive and chemical contamination that had migrated from the SSFL.

With the exception of 452 acres owned by the U.S. Government in Areas I and II, which is outside of the Area IV Study Area, the entire SSFL site, including the NBZ, is owned and operated by The Boeing Company.

1.4 Brief Description and History of HSA-8

HSA-8 is approximately 108.8 acres of approximately half flat land and half undeveloped rocky land. Over the years, 5 buildings have been situated within HSA-8. All sites are located on or near Arness Fire Road and H Street. The drainage direction was originally to the south into Runkle Canyon, but drainage ditches later directed surface water to the north and northeast. There were three unlined retention ponds and a concrete-lined pit in this subarea that were associated with liquid waste disposal. Primary radiological operations in the HSA-8 area were related to the two criticality test facilities located in Building 4009 and the waste disposal operations at the Sodium Burn Pit, Site 4886.

1.5 Sites in HSA-8

During the peak of operations, HSA-8 comprised 8 sites, three of which were buildings. This TM addresses each of these 8 sites within HSA-8. Of the 8 sites in HSA-8, one building (Building 4009) remains today.

1.6 Site Summary Methodology

In preparing this TM, the following types of documents were reviewed:

- radiological characterization reports;
- previous radiological surveys;
- decontamination and decommissioning (D&D) reports;
- environmental monitoring reports;
- license termination reports;
- aerial photographs dating back 50 years;
- building floor plans,
- piping diagrams and construction drawings;
- RFI reports;
- unusual occurrence reports;
- incident reports;
- plant operating reports and logs;

[1] Agency for Toxic Substances and Disease Registry, *Draft Preliminary Site Evaluation, Santa Susana Field Laboratory,* Atlanta, GA, December 3, 1999, pp. 2-5.

- safety analyses reports;
- facility surveillance and maintenance reports; and
- information obtained from interviews with former workers or other persons.

Numerous documents were obtained through information requests sent to Boeing, DOE, and other parties. EPA sent formal information requests to Boeing, DOE, the Nuclear Regulatory Commission (NRC) and the California Department of Public Health and Environment (CDPHE) under § 104(e) of the CERCLA. In addition, EPA directed Boeing to identify and provide pertinent documents within a number of document databases comprising approximately 1.4 million documents relating to all areas of the SSFL site, including Area IV, as well as some off-site facilities. The information acquisition process is complete.

EPA sent Boeing its original information request letter on June 24, 2009. Boeing provided an initial response to this request on August 31, 2009, and a supplemental response on December 10, 2009. On June 8, 2010, Boeing provided relevant site drawings and maps as identified by EPA during a review of flat files at Boeing's Safety, Health, and Environmental Affairs (SHEA) building on site. Subsequently, on June 17, 2010, EPA sent Boeing a supplemental information request letter specifically requesting all maps, diagrams, and as-built drawings for past and current buildings in Area IV. On July 15, 2010, Boeing responded and provided additional documents, including maps and drawings. On November 15, 2010, Boeing provided a third supplementary group of documents. Numerous additional information requests have been ongoing and, on December 23, 2010, and January 11, 2010, Boeing provided numerous additional documents in response to both EPA original information requests and EPA queries of Boeing's document database for the SSFL. Upon receipt of supplemental documents from Boeing, EPA will carefully review the information and revise this TM and it recommendations for soil sampling, as appropriate.

In October 2010, EPA also sent the National Aeronautics and Space Administration (NASA) a formal information request letter. On November 22 and December 2, 2010, EPA received information responsive to this request.

EPA sent DOE its original information request letter on June 24, 2009. DOE provided an initial response to this information request on August 31, 2009. Subsequently, DOE has provided supplemental responses to this initial information request on a monthly basis. Additional information responsive to the EPA's information request has been received in September, October, November, and December 2009, as well as January through December 2010 and January, February, March, April, May, June, and July 2011. On June 17, 2010, EPA sent DOE a supplemental request for information, specifically requesting maps, diagrams, and as-built drawings for past and current buildings in Area IV. Starting in its July 2010 supplemental response to EPA, DOE is providing information that is responsive to both of the EPA information requests letters.

Other requests for information pertaining to the site have included § 104(e) information request letter sent to the NRC and CDPHE. The purpose of the inquiries to both the NRC and the CDPHE was to identify and obtain any nuclear materials licenses pertaining to the site that may not have been captured via the information requests sent to other parties.

In preparing the HSA-8 TM, 514 individual documents and photographs were reviewed. The review process was conducted by first screening over 80,000 documents amassed for the project. In addition, the documents requested from the document database comprising approximately 1.4 million documents were reviewed. This screening effort produced 514 documents relevant to past operations at facilities within HSA-8 and were therefore determined to warrant in-depth evaluation. Each of these 514 relevant documents was thoroughly evaluated for information considered useful for carrying out the goals listed in Section 1.2 of this TM. In addition to screening and evaluating reports and other documents, a comprehensive aerial photograph analysis of Area IV was prepared. This analysis is provided in Appendix A of the HSA.

1.6.1 Contents of EPA's Site-by-Site Analyses

The subject areas considered and addressed for each site discussed in Section 2 of this TM are presented below. For each subject area, the list of criteria evaluated and the associated parameters for the evaluation are described. The most complete available information was used to evaluate the site; no known information was omitted from each site description. In the event that known information did not conform to one of the listed subject areas, it was included in the most logical place.

Site Description
A physical description of the site including, at a minimum, the following data elements: building numbers of all buildings within the site; date of construction of building(s); buildings in the vicinity not associated with the site; location of site relative to street(s); site plan(s); and floor plan(s) from as-built or plan drawings, if available.

Building Features
Information related to dimensions or size of building(s), below-ground structures, vaults, pipelines, sumps, condensation lines, sewers, drains, swales, and leach fields. If none of these features were identified, the text "no information was located" was inserted.

Former Use(s)
Details of past use(s) of the site, including dates of activities.

Information from Interviewee(s)
This category includes information about the site provided by interviewee(s). If no information has been obtained for a particular site, the text "none to date" was inserted. Individuals who have been interviewed include:

- Former SSFL Employees (e.g., health physicists, electricians, mechanics, construction inspectors, nuclear technicians, etc.);
- Survivors of Former Employees;
- Former Contractors (and one survivor of a former Contractor);
- Community Stakeholders;
- Residents in surrounding areas.

At the discretion of the Interviewee, each interview was conducted either by representatives of the EPA only, representatives of the DOE only or jointly by EPA and DOE representatives.

EPA's primary objective of the interview program was to help direct the soil sampling crews to potential source areas of radiological contamination identified during the course of each interview. All information on potential source areas, corroborated or not, were recorded in EPA's HSA process.

At the time of writing this TM, the EPA had completed forty-nine (49) interviews. Under the DOE/EPA joint interview program, eighteen (18) interviews have been conducted. Approximately 107 former employees have requested to be interviewed by DOE only and those interviews are complete. An additional eighty five (85) people were referred to EPA and DOE by interviewees during the course of the interviews, and of these, only twenty (20) could be located, which resulted in four (4) additional interviews. DOE has provided all of their interview transcripts to EPA for use in EPA TMs.

The interview information obtained to date relevant to this TM is depicted on the relevant Plate 1 figure. Appendix B of the HSA provides a summary of the interview process and completed interview summaries of each interview.

Radiological Incident Reports
Reports on any documented incidents at the site with the potential for release of radioactivity into the environment. If no incident reports were found, the text "none found" was inserted.

Current Use
Current use of the site, or date of demolition of building/structure.

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s)
Previous radiological investigations such as surveys, decontamination activities, and cleanup activities were evaluated. The evaluation of previous investigations and cleanups addressed, at a minimum, the following elements:

- agency conducting the investigation;
- purpose of the investigation;
- dates of the investigation;
- details of releases inside building, to air, to soil, and to surface water, as applicable;
- decontamination/cleanup activities; and
- final survey results.

Radiological Use Authorizations
Use authorizations have been defined as issuance of a license for radioactive material(s) from an appropriate regulatory agency. All known licenses issued for the site were included; if none were found, the text "none found" was inserted.

Former Radiological Burial or Disposal Locations
A description of known burials and/or disposals of radiological materials on the site, including applicable dates, if known. If no documented burials and/or disposals were identified, the text "none found" was inserted.

Aerial Photographs
The applicable photographic analyses from the report prepared by the EPA's Environmental Photographic Interpretation Center (EPIC) in March 2010 were included for each site. These analyses include photographs from the following dates:

- December 22, 1952;
- August 19, 1957;
- August 21, 1959;
- Approximately 1960 plus or minus a year;
- March 1, 1965;
- August 13, 1967;
- April 20, 1972;
- May 16, 1978;
- October 21, 1980;
- August 21, 1983;
- October 10, 1988;
- June 19, 1995; and
- June 8, 2005.

Aerial photograph anomalies were interpreted as a trigger for assigning a higher scrutiny to a particular site than other information (such as historical documents) would indicate.

Radionuclides of Concern
Radionuclides used/generated at the site. This description includes, at a minimum, the types of radiological material(s) managed at the site; radionuclides known or suspected to have been handled or generated on the site; and how the identified radionuclides impact the list of radionuclides of concern in the background study. If no information was available, the text "none found" was inserted. It is important to note that not every radionuclide listed in this HSA will have a sample analysis. The radionuclides are listed for completeness, indicating that they have been mentioned or discussed in a cited document or report. However, many of the facility and site reports reflect the conditions at the time, thus every mention of a specific radionuclide does not mean it would be present now, due to decay. For this reason, the Radionuclides of Concern sections described for each facility or site list those found in historical records. The Radionuclides of Concern (Table 3.3) lists radionuclides that will be analyzed and does not include those that would have decayed in the years since operations ceased.

Drainage Pathways
This category includes information on the direction of surface water flow on the site and the presence of sanitary drains, storm drains, channels/ditches, septic systems, or leach fields on or near the site.

Radiological Contamination Potential
The potential for radiological contamination was evaluated for each site. Evaluations included consideration of the completeness of past cleanup and remedial operations. Many past clean-up efforts likely did not achieve the requirements of the DTSC/DOE AOC dated December 2010 that generally requires a cleanup to background levels for both radiological and chemical contaminants. Background studies for the site have been completed with EPA leading the

radiological background study and the DTSC leading the chemical background study. The potential for radiological contamination is quantified in this TM by assigning a preliminary MARSSIM class describing the possibility for residual radiological contamination at the site based on all information collected to date. The basis for assigning the preliminary MARSSIM classification includes an examination of the following data elements:

- historical site operations;
- previous radiological investigations;
- reported incidents of releases;
- decontamination and remediation operations at the site;
- interviews with former workers;
- drainage pathways on or near the site;
- aerial photograph interpretation; and
- site reconnaissance.

Recommended Locations for Soil/Sediment Sampling

For each site, recommendations were made for possible targeted soil/sediment sampling locations. The selection of potential sampling locations was based on locations with the highest potential for radiological contamination as well as at the particular site based on all known information collected to date. The criteria evaluated for developing recommended soil/sediment sampling locations include the following:

- topography of the site;
- historical site operations;
- radiological investigations;
- reported incidents of releases;
- decontamination/cleanup operations at the site;
- interviews with former workers;
- storm drains on or near the site;
- sewer lines on or near the site;
- aerial photograph interpretation; and
- site reconnaissance.

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2.0 FINDINGS

This section organizes the building areas within HSA-8 according to three logical "clusters" (a.k.a. groups) based on operational characteristics and geographic locations. Plate 1 depicts the entire HSA-8 subarea and should be referenced while reading Section 2. Each HSA-8 group (discussed in Sections 2.1 through 2.3, below) is depicted in an accompanying group map, which serves as a guide for the text describing the building areas in that group and also as an index for the group's site photograph and building layout drawings.

2.1 GROUP 1

The Group 1 index map is presented in Figure 2.1. Following Figure 2.1, the site photograph and layout drawings for each building area within HSA-8 Group 1 are presented. HSA-8 Group 1 includes four sites containing pistol ranges an impact test device for testing pipe bursting characteristics, and a solar concentrator test facility.

2.1.1 Building 4317/4730 Area

Site Description: The Building 4317/4730 area comprises Building 4730, which was demolished to construct Building 4317, and the land surrounding these buildings located at the southwest end of H Street. Building 4730 was constructed prior to 1965 and was demolished prior to 1980. Building 4713 was constructed on the site of former building 4730 in about 1980.[1] Figure 2.1.1a provides a current photograph. The research team could not find as-built drawings for Buildings 4730 or 4317. Plate 1 presents a summary of all identified features for this site.

Building Features: Building 4730 was a very small square building based on site drawings and aerial photographs. Building 4317 was a long rectangular roofed area with open sides from which small arms shooting practice could take place. Figure 2.1.1b presents a photograph taken in 1988. Looking north, Building 4317 is shown with a long horizontally aligned roof located to the west of a building with a shorter horizontally aligned roof. An earthen berm is located down range, i.e., south of the building, to capture discharged bullets. A plot plan for the site is presented in Figure 2.1.1c. Building 4317 is also shown in an aerial photograph looking southeast in Figure 2.1.1d.

Former Use(s): Building 4730, constructed prior to 1965, was the isotope system impact test control building for the impact test device, Building 4820. Impact testing was conducted using zirconium-hydride (ZrH_2) fuel pellets containing 10 percent by weight of uranium. The research team has located limited information regarding operations in Building 4730. It appears the building was demolished between 1978 and 1980. In about 1980, a pistol range, Building 4317, was constructed on the site. According to Montgomery Watson Harza, SSFL site security personnel conducted firearm practice by firing shotgun and hand gun rounds at targets placed in front of an earthen berm located approximately 90 feet south of the firing locations. See Figure 2.1.1b. Target practice activities were suspended prior to 1995.[1, 2]

[1] Santa Susana Area IV, Atomics International/Energy Systems Group Planning Maps, March 1962–November 1992.
[2] Montgomery Watson Harza, *Group 8 – Western Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume I – Text, Tables, and Figures*, September 2007, p. 3-7.

Information from Interviewees: None to date.

Radiological Incident Reports: None found.

Current Use: Based on aerial photographic analysis, Building 4730 appears to have been demolished between 1978 and 1980. Building 4317 appears to have been demolished between 1988 and 1995. The berm can still be seen at Site 4317.

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s): Building 4317/4730 was included in the Area IV radiological characterization survey conducted by Rockwell in 1994 and 1995. The purpose of this survey was to locate and characterize any previously unknown areas of elevated radioactivity in Area IV. Three methods were used: an ambient gamma survey, a walk-about gamma survey, and soil sampling and analysis. Rockwell and EPA background exposure measurements, taken off-site, averaged 15.6 ± 3.6 µR/h. An action limit of 5 µR/h above background was utilized to identify potential anomalies. Radiation exposure measurements in the vicinity of the Building 4317/4730 region were in the range of 8.4 to 14.5 µR/h, consistent with background.[1]

Radiological Use Authorizations: None found.

Former Radiological Burial or Disposal Locations: None found.

Aerial Photographs: Aerial photographs show undeveloped land until the 1965 photograph when a small square building is observed that is identified as Building 4730. This is also seen in the 1967, 1972, and 1978 photographs. In the 1980 photograph, a new long rectangular building is seen that is identified as Building 4317. This is also seen in the 1983 and 1988 photographs. Building 4317 appears to have been demolished in the 1995 photograph. Disturbed ground is seen in this area. In the 2005 and 2009 photographs, the site is mostly covered with vegetation although the footprint of Building 4317 can still be seen.[2]

Radionuclides of Concern: The research team did not find direct evidence that radioactive materials were used or stored within Building 4317/4730. However, Building 4730 was the isotope system impact test control building located adjacent to Building 4820 where ZrH_2 fuel pellets containing 10 percent uranium was impact tested in a granite target. Potential radioactive contaminants from this fuel include U-234, U-235, U-238, Pa-231, Th-230, Ac-227, Ra-226, Pb-210, H-3, K-40, Mn-54, Co-60, Eu-152, and Eu-154.[3] All radionuclides of concern listed, with the exception of Mn-54, are included in the August 2010 Final Field Sampling Plan for soil sampling in Area IV. Mn-54 has a very short half-life and does not meet the criteria for analysis. Table 3.3 presents a summary of contaminants of concern.

Drainage Pathways: Based on general site topography, surface water flows north from former Building 4317/4730 to a diversion channel that was constructed to divert water around the former Sodium Disposal Facility excavation area, located north of the Building 4317/4730 area.

[1] Rockwell International, *Area IV Radiological Characterization Survey*, A4CM-ZR-0011, Rev. A, August 15, 1996, pp. 22-24.
[2] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.
[3] Chapman, J. A., *Radiological Survey of Building T009*, Energy Technology Engineering Center Report No. GEN-ZR-0014, August 26, 1988, p. 66,

This drainage channel transports water north through the NBZ and Brandeis-Bardin Institute land through Meier Canyon and into Arroyo Simi in Simi Valley.[1]

Radiological Contamination Potential: The preliminary MARSSIM Classification for the Building 4317/4730 area is Class 2 due to its location next to Building 4820 where zirconium-hydrogen fuel containing 10 percent uranium was impact tested in a granite target and the unknown operations of Building 4730, the isotope system impact test control building.

Recommended Locations for Soil/Sediment Sampling:

Plate 1 and Figure 2.1 provide a convenient reference for the following recommendation.

Significant information is lacking regarding the excavation activities at Building 4317/4730. In addition, only one previous study has been conducted on the Building 4317/4730 area. Characterization was not conducted to delineate the extent of contamination consistent with the DTSC/DOE December 2010 AOC. Therefore, additional characterization is recommended for the Building 4317/4730 area. This includes the following Building 4317/4730 areas and appurtenances:

- The flat and low-lying areas within and surrounding Building 4317/4730 coordinated with sampling for Building 4820. ZrH_2 fuel fragments containing uranium and radionuclides originating from Building 4820 may have migrated to these areas via surface water flow or airborne releases.

- The remaining berm on the 4317/4730 site. Fragments from the ZrH_2 fuel pellets containing uranium may have lodged in this berm.

- The diversion channel located north of the site along H Street. Radionuclides including pulverized uranium originating from Building 4820 may have migrated to this area via surface water flow or airborne releases.

2.1.2 Building 4318/4820 Area

Site Description: The Building 4318/4820 area comprises Building 4820 that was demolished to construct Building 4318 and the land surrounding these buildings located at the southwest end of H Street. Building 4820 was constructed prior to 1965 and was demolished prior to 1980. Building 4318 was constructed on the site of former Building 4820 in about 1980.[2] Figure 2.1.2a provides a current photograph. The research team could not find as-built drawings for Buildings 4820 or 4318. Plate 1 presents a summary of all identified features for this site.

Building Features: Building 4820 was a very small square building based on site drawings and aerial photographs. Building 4318 was a rectangular roofed area with open sides from which small arms shooting practice could take place. Figure 2.1.2b presents a photograph taken in

[1] Montgomery Watson Harza, *Group 8 – Western Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume I – Text, Tables, and Figures,* September 2007, pp. 2-6 – 2-8.
[2] Santa Susana Area IV, Atomics International/Energy Systems Group Planning Maps, March 1962–November 1992.

1988. Looking north, Building 4318 is shown with a horizontally aligned roof located to the east of a building with a long horizontally aligned roof. An earthen berm is located down range, i.e., south of the building, to capture discharged bullets. A plot plan for the site is presented in Figure 2.1.2c. Building 4318 is also shown in an aerial photograph looking southeast Figure 2.1.2d.

Former Use(s): According to the site planning maps and Sapere Consulting, Inc., Building 4820 housed the isotope system impact test device. Under Use Authorization No. 5, 1 kilogram of zirconium-hydride (ZrH_2) fuel pellets containing 10 percent by weight of natural uranium was used for impact testing at Building 4820. Small masses (58.33 grams) of this fuel were fired into a granite target 12 times in a row at varying velocities. Upon impact, each radioactive projectile was pulverized. This process was conducted in an enclosed space with three openings – two for camera lenses and one for the projectile.[1] In about 1980, a pistol range was constructed on the site that became known as Building 4318. According to Montgomery Watson Harza, SSFL site security personnel conducted firearm practice by firing shotgun and hand gun rounds at targets placed in front of an earthen berm located approximately 90 feet south of the firing locations. Target practice activities were reportedly suspended prior to 1995.[1, 2]

Information from Interviewees: None to date.

Radiological Incident Reports: None found.

Current Use: Based on aerial photographic analysis, Building 4820 appears to have been demolished between 1978 and 1980. Building 4318 appears to have been demolished between 1988 and 1995. The berm can still be seen at Site 4318.

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s): Building 4318/4820 was included in the Area IV radiological characterization survey conducted by Rockwell in 1994 and 1995. The purpose of this survey was to locate and characterize and previously unknown areas of elevated radioactivity in Area IV. Three methods were used: an ambient gamma survey, a walk-about gamma survey, and soil sampling and analysis. Rockwell and EPA background exposure measurements, taken off-site, averaged 15.6 ± 3.6 µR/h. An action limit of 5 µR/h above background was utilized to identify potential anomalies. Radiation exposure measurements in the vicinity of the Building 4318/4820 region were in the range of 8.4 to 14.5 µR/h, consistent with background.[3]

Radiological Use Authorizations: On February 25, 1970, Use Authorization No. 5 was issued to permit the possession of 1 kilogram of ZrH_2 fuel pellets containing 10 percent by weight of natural uranium for impact testing of ZrH_2 fuel pellets at Building 4820.[4]

[1] Rockwell International, Use Authorization No. 5, *Impact Tests of Normal ZrH Fuel*, February 25, 1970.
[2] Montgomery Watson Harza, *Group 8 – Western Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume I – Text, Tables, and Figures*, September 2007, p. 3-7.
[3] Rockwell International, *Area IV Radiological Characterization Survey*, A4CM-ZR-0011, Rev. A, August 15, 1996, pp. 22-24.
[4] Rockwell International, Use Authorization No. 5, *Impact Tests of Normal ZrH Fuel*, February 25, 1970.

Former Radiological Burial or Disposal Locations: A granite target was used to capture discharged radioactive projectiles. The research team assumes that this was removed from the site prior to or when Building 4820 was demolished.

Aerial Photographs: Aerial photographs show undeveloped land until the 1965 photograph when a small square building is observed that is identified as Building 4820. This is also seen in the 1967, 1972, and 1978 photographs. In the 1980 photograph, a new rectangular building is seen that is identified as Building 4318. This is also seen in the 1983 and 1988 photographs. Building 4318 appears to have been demolished in the 1995 photograph. Disturbed ground is seen in this area. In the 2005 and 2009 photographs, the site is mostly covered with vegetation although the footprint of Building 4318 can still be seen.[1]

Radionuclides of Concern: ZrH_2 fuel pellets containing 10 percent uranium was impact tested in a granite target in Building 4820. Potential radioactive contaminants from this fuel include U-234, U-235, U-238, Pa-231, Th-230, Ac-227, Ra-226, Pb-210, H-3, K-40, Mn-54, Co-60, Eu-152, and Eu-154.[2] All radionuclides of concern listed, with the exception of Mn-54, are included in the August 2010 Final Field Sampling Plan for soil sampling in Area IV. Mn-54 has a very short half-life and does not meet the criteria for analysis. Table 3.3 presents a summary of contaminants of concern.

Drainage Pathways: Based on general site topography, surface water flows north from former Building 4318/4820 to a diversion channel that was constructed to divert water around the former Sodium Disposal Facility excavation area, located north of the Building 4318/4820 area. This drainage channel transports water north through the NBZ and Brandeis-Bardin Institute land through Meier Canyon and into Arroyo Simi in Simi Valley.[3]

Radiological Contamination Potential: The preliminary MARSSIM Classification for the Building 4318/4820 area is Class 1 because ZrH_2 fuel pellets containing 10 percent natural uranium was impact tested in a granite target in this area and operational information regarding these activities has not been located.

Recommended Locations for Soil/Sediment Sampling:

Plate 1 and Figure 2.1 provide a convenient reference for the following recommendation.

Significant information is lacking regarding the activities at Building 4318/4820. In addition, only one previous study has been conducted on the Building 4318/4820 area. Characterization was not conducted to delineate the extent of contamination consistent with the DTSC/DOE December 2010 AOC. Therefore, additional characterization is recommended for the Building 4318/4820 area. This includes the following Building 4318/4820 areas and appurtenances:

[1] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.
[2] Chapman, J. A., *Radiological Survey of Building T009*, Energy Technology Engineering Center Report No. GEN-ZR-0014, August 26, 1988, p. 66,
[3] Montgomery Watson Harza, *Group 8 – Western Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume I – Text, Tables, and Figures*, September 2007, pp. 2-6 – 2-8.

- The flat and low-lying areas within and surrounding Building 4318/4820 coordinated with sampling for Building 4730. ZrH_2 fuel fragments containing uranium and radionuclides originating from Building 4820 may have migrated to these areas via surface water flow or airborne releases.

- The remaining berm on the 4318/4820 site. Fragments from the ZrH_2 fuel pellets containing uranium may have lodged in this berm.

- The diversion channel located north of the site along H Street. Radionuclides, including pulverized uranium,originating from Building 4820 may have migrated to this area via surface water flow or airborne releases.

2.1.3 Site 4814 Area

Site Description: The Site 4814 area comprises an open metal structure known as the Sodium Water Reactor Test Structure, a sodium-water reaction test control hut (Building 4314), sodium-water reaction test area equipment (Site 4514), and the land surrounding these areas located at the southwest end of H Street.[1] Site 4814 was constructed in about 1964. Figure 2.1.3a provides a current photograph. Plate 1 presents a summary of all identified features for this site.

Building Features: Site 4814 was dominated by the Sodium Water Reactor Test Structure, which was a tall open metal structure three stories high topped by a crane. This structure can be seen in two 1992 photographs, Figures 2.1.3b and 2.1.3d. Figure 2.1.3b is taken at the west end of the site, looking north. The equipment located to the right of the tower is Site 4514. Figure 2.1.3c displays a plot plan showing an earth blast shield located west of Building 4314 and a pipe extending north of the site. The pipe transported waste sodium to the Sodium Disposal Facility, Site 4886. The Figure 2.1.3d photograph was taken of the majority of the site and shows the tower, equipment located to the right of the tower (Site 4514), and remediation trailers. The trailers were located on the site while Site 4886 was being remediated in the early 1990s. Figure 2.1.3e is a 1988 aerial view of Site 4814 showing an above-ground pipeline connecting a small hut (Building 4314) and bare ground with equipment at the west end (Site 4514) together with Buildings 4317 and 4318. Figure 2.1.3f shows an aerial view in which a high mound of dirt can be seen on the west side of Building 4314 between it and Site 4814.

Former Use(s): Site 4814 was part of the Empire State Atomic Development Associates, Inc. (ESADA) area. This was a group of seven New York state utilities, which was formed to investigate three reactor designs through investment and contracts with major reactor vendors. This area was used between 1964 and 1968 for testing pipe bursting characteristics under sodium-water reaction conditions at Site 4814. Underground piping connected Site 4814 to a concrete pool located at the former Sodium Disposal Facility, Site 4886, transporting waste sodium for disposal. Following the late 1960s, portions of the site were used for chemical drum storage. Approximately 50 to 100 drums were stored in the area in the 1970s. In the late 1970s, Site 4814 was known as the Large Leak Injector Device.[1, 2, 1] From 1974, under Use

[1] Santa Susana Area IV, Atomics International/Energy Systems Group Planning Maps, March 1962–November 1992.
[2] Montgomery Watson Harza, *Group 8 – Western Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume I – Text, Tables, and Figures*, September 2007, pp. 3-6 – 3-7.

Authorization No. 83, a 25-curie Cs-137 sealed source was used in a DD electronics gamma densitometer to measure steam density inside pipes and during rupture. Radiological surveys were conducted following each test if no leakage had occurred. The densitometer was inspected annually to determine if this device leaked.[2] Figure 2.1.3b shows that in 1992, a large number of Baker tanks were located on the site to transport soil from Site 4886 off site.

Information from Interviewees: A former worker interviewed by the DOE in 2010, stated as follows: "We had a test stand, located west of Building 20 and south of the sodium burn pit in the far southwestern corner of the SSFL. From this test stand, we could watch drums with residual sodium in them at the sodium burn pit exploding into the air when it rained. We could do our tests only when the wind was blowing towards the west, where the cows were, not the people."[3]

Radiological Incident Reports: None found.

Current Use: Based on aerial photographs, Sites 4814, 4514 and Building 4314 appear to have been demolished between 1998 and 1995. Concrete building foundations and road pavement remain.

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s): Building 4814 was included in the Area IV radiological characterization survey conducted by Rockwell in 1994 and 1995. The purpose of this survey was to locate and characterize and previously unknown areas of elevated radioactivity in Area IV. Three methods were used: an ambient gamma survey, a walk-about gamma survey, and soil sampling and analysis. Rockwell and EPA background exposure measurements, taken off-site, averaged 15.6 ± 3.6 µR/h. An action limit of 5 µR/h above background was utilized to identify potential anomalies. Radiation exposure measurements in the vicinity of the Building 4814 region were in the range of 11.3 to 15.1 µR/h, consistent with background.[4]

Radiological Use Authorizations: On November 7, 1974, Use Authorization No. 83 was issued for Site 4814 to permit the use of a 25-curie Cs-137 sealed source in a DD electronics gamma densitometer.[5]

Former Radiological Burial or Disposal Locations: This was a temporary storage area for chemical drums in the 1970s and for Baker tanks during Site 4886 remediation in the early 1990s.[6]

Aerial Photographs: Aerial photographs show undeveloped land until the 1965 photograph when the shadow of a tower is seen that is identified as Site 4814 and a rectangular roof is seen that is identified as Building 4314. These two areas are connected by an aboveground pipeline.

[1] Schiffman, J., *United States Department of Energy, Environmental Survey Report*, June 16, 1989, p. 23.
[2] Rockwell International, Use Authorization No. 83, *Use of DD Electronics Gamma Densitometer*, November 7, 1974.
[3] Interview No. 110 of former employee conducted by the U.S. DOE, September 2010.
[4] Rockwell International, *Area IV Radiological Characterization Survey*, A4CM-ZR-0011, Rev. A, August 15, 1996.
[5] Rockwell International, Use Authorization No. 83, *Use of DD Electronics Gamma Densitometer*, November 7, 1974.
[6] Schiffman, J., *United States Department of Energy, Environmental Survey Report*, June 16, 1989, p. 23.

Site 4814 and Building 4314 look unchanged in the 1967, 1972, 1978 photographs, except for the open storage of items in drums and Baker tanks. In the 1980 photograph, Baker tanks and probable heavy equipment are observed as well as a possible horizontal tank and a stained area south of the tower. In the 1983 photograph, Baker tanks are visible between Site 4814 and Building 4314. The 1988 photograph shows that most of these tanks have been removed. The 1995 photograph shows that both Site 4814 and Building 4314 have been removed; no Baker tanks are observed, but a mound of uniform light-toned material is visible. The 2005 and 2009 photographs show that vegetation is growing back in the area.[1]

Radionuclides of Concern: On Site 4814, a sealed 125-curie Cs-137 source was used from November 1974. Accordingly, Cs-137 is a potential radioactive contaminant of concern.[1] Table 3.3 presents a summary of contaminants of concern.

Drainage Pathways: Based on general site topography, surface water flows north from Site 4814 to a diversion channel that was constructed to divert water around the former Sodium Disposal Facility excavation area, located north of the site. This drainage channel appears to transport water north through the NBZ and Brandeis-Bardin Institute land through Meier Canyon and into Arroyo Simi in Simi Valley.[2]

Radiological Contamination Potential: The preliminary MARSSIM classification for the Site 4814 area is Class 2, due to its former use as a test structure where a sealed Cs-137 source was used.

Recommended Locations for Soil/Sediment Sampling:

Plate 1 and Figure 2.1 provide a convenient reference for the following recommendations.

The history on Site 4814 is unclear with respect to certain operations. In addition, only one previous study has been conducted for the Site 4814 area. Characterization was not conducted to delineate the extent of contamination consistent with the DTSC/DOE December 2010 AOC. Therefore, additional characterization is recommended for the Site 4814 area. This includes the following Site 4814 areas and appurtenances:

- The flat and low-lying areas within and surrounding and between Site 4814 and Building 4314, particularly on the north side of the tower where Baker tanks were identified and west side of Building 4314 where the earth blast shield was identified on Figure 2.1.3d. Radionuclides originating from Site 4814 may have migrated to these areas via surface water flow or airborne releases.

- The site of the possible horizontal tank and stained area south of Site 4814, identified in the 1980 aerial photograph.

- The location of the underground piping that transported waste sodium from Site 4814 to Site 4886. Documentation regarding the removal of this piping could not be verified. .

[1] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.
[2] Montgomery Watson Harza, *Group 8 – Western Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume I – Text, Tables, and Figures*, September 2007, pp. 2-6 – 2-8.

- The diversion drain located north of the site that passes the former Sodium Disposal Facility and traverses Brandeis-Bardin Institute land.

2.1.4 Site 4425 Area

Site Description: The Site 4425 area comprises Site 4425, a solar concentrator facility with a trailer, and the land around these facilities located at the west end of H Street. Site 4425 was constructed in 1985. During the late 1990s, a weather station and a small astronomical observatory were constructed on the site.[1, 2] Figure 2.1.4a provides a current photograph. Plate 1 presents a summary of all identified features for this site.

Building Features: Site 4425 was a mirrored parabolic dish concentrator with a 31-foot diameter swing area, a solar receiver, and a 25 kilowatt Sterling engine generator. A trailer, mounted on foundations, was also present at the site.[2, 3] A 1988 aerial photograph is presented in Figure 2.1.4b. This shows Site 4425 in the upper left side of the photograph. Figure 2.1.4c presents a plot plan with no sign of the site. Site 4425 later featured a weather station and a small astronomical observatory.

Former Use(s): Site 4425 was a solar concentrator test facility used in experiments designed to harness solar power. The parabolic dish was removed in 1995/96. During the late 1990s, a weather station and a small astronomical observatory were constructed on the site.[2]

Information from Interviewees: None to date.

Radiological Incident Reports: In the 1960s, most likely in the spring of 1965 according to Boeing, a test was conducted near Site 4425 that involved the dropping of 20 simulated SNAP fuel elements (depleted uranium clad in tantalum) from a low flying helicopter to simulate a launch pad accident. The helicopter flew over Site 4425; the impact area was believed by Boeing to be on the east side of Site 4425. See Figure 2.4.1d for the trajectory of the flight. All but one of the depleted uranium fuel slugs were retrieved. The missing slug was approximately 30 centimeters in length and 3 centimeters in diameter and contained 5 kilograms of depleted uranium. The cladding is believed by Boeing to prevent the release of uranium for a "long time."[4,5]

Between April 29, 2008, and May 22, 2008, Cabrera Services conducted a radiological survey of surface soil on the impact area to locate radiation anomalies. Cabrera Services also conducted a geophysical survey to supplement and corroborate findings from the radiological survey. Hand digging was also performed to investigate subsurface anomalies to a depth of approximately 12

[1] Santa Susana Area IV, Atomics International/Energy Systems Group Planning Maps, March 1962–November 1992.
[2] Montgomery Watson Harza, *Group 8—Western Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1-Test, Tables, and Figures*, September 2007, p. 3-5.
[3] Sapere Consulting, Inc., *Historical Site Assessment of Area IV, Santa Susana Field Laboratory, Ventura County, California, Volume2 – Area IV Site Summaries*, May 2005, p. DD-5.
[4] Rockwell International letter from R. J. Tuttle to R. Vaille, U.S. EPA, re: *Identification and Description of Areas involved with Radioactive Materials at SSFL Area IV*, dated October 2, 1989, p. 7.
[5] Cabrera Services, *Final Depleted Uranium Slug Search, Santa Susana Field Laboratory, Ventura County, California*, Contract No. 114579, Project No. 08-1011.00, June 2008, pp. v. 1-2.

inches below ground surface. The radiological survey results indicated with greater than 95 percent confidence that the depleted uranium slug was not present in the top 10 inches of soil in the expected impact area. The geophysical survey results indicated with greater than 90 percent confidence that the depleted uranium slug was not present in the top 12 inches of soil in the expected impact area. Cabrera Services recommended that no additional investigations of the impact area be conducted to locate the depleted uranium slug.[1]

Current Use: A weather station and small astronomical observatory remain on Site 4425.

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s): Site 4425 was included in the Area IV radiological characterization survey conducted by Rockwell in 1994 and 1995. The purpose of this survey was to locate and characterize and previously unknown areas of elevated radioactivity in Area IV. Three methods were used: an ambient gamma survey, a walk-about gamma survey, and soil sampling and analysis. Rockwell and EPA background exposure measurements, taken off-site, averaged 15.6 ± 3.6 µR/h. An action limit of 5 µR/h above background was utilized to identify potential anomalies. Radiation exposure measurements in the vicinity of the Building 4425 region were in the range of 10.7 to 14.8 µR/h, consistent with background.[2]

Radiological Use Authorizations: None found.

Former Radiological Burial or Disposal Locations: One SNAP fuel element went missing in or near the estimated SNAP Fuel Element Drop Zone and has not been found to date.

Aerial Photographs: Aerial photographs show undeveloped land until the 1988 photograph when a parabolic dish and trailer are observed that are identified as Site 4425. In the 1988 photograph, disturbed ground is seen associated with the construction of the dish, a probable stain is observed in the southeast corner of the site and two possible horizontal tanks are seen in the northeast corner of the site. The parabolic dish and trailer are also seen in the 1995 photograph. The parabolic dish and trailer are no longer seen in the 2005 photograph; the site is vegetated except for a small astronomical observatory and two small sheds. In the 2009 photograph, Site 4425 looks unchanged from 2005.[3]

Radionuclides of Concern: A depleted uranium fuel slug.

Drainage Pathways: A drainage channel was constructed around all four sides of Site 4425. Surface water captured in this drain flows north from this drain into the natural drainage channel located to the west of the Building 4009 leach field. The natural drainage channel ends at a rock outcrop, located approximately 150 feet north of the leach field. Surface water appears to infiltrate at this location and may resurface north of the outcrop where another channel carries it

[1] Cabrera Services, *Final Depleted Uranium Slug Search, Santa Susana Field Laboratory, Ventura County, California*, Contract No. 114579, Project No. 08-1011.00, June 2008, pp. v. 1-2.
[2] Rockwell International, *Area IV Radiological Characterization Survey*, A4CM-ZR-0011, Rev. A, August 15, 1996, pp. 22-24.
[3] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.

north through the NBZ and Brandeis-Bardin Institute land, through Meier Canyon and into Arroyo Simi in Simi Valley.[1]

Radiological Contamination Potential: The preliminary MARSSIM Classification for the Site 4425 area is Class 3 except in the area of the uranium slug drop zone, where the area is Class 1.

Recommended Locations for Soil/Sediment Sampling:

Plate 1 and Figure 2.1 provide a convenient reference for the following recommendations.

Radionuclide contamination is not expected in the area of and directly surrounding Site 4425. However, limited soil sampling is recommended to confirm this assumption. This includes the following Site 4425 areas:

- The southeast corner of the site where a probable stain was observed in the 1988 aerial photograph.
- The northeast corner of the site where two possible horizontal tanks were identified in the 1988 aerial photograph.
- The helicopter drop zone as shown in Figure 2.1.4d. Soil sampling assisted by gamma scan findings may locate the missing uranium fuel slug.
- The drainage channel surrounding Site 4425.
- The ground scar identified from aerial photographs. The nature of this feature is unclear.

2.2 GROUP 2

The Group 2 index map is presented in Figure 2.2. Following Figure 2.2, the site photograph and layout drawings for each building area within HSA-8 Group 2 are presented. HSA-8 Group 2 includes one building area containing the Building 4009 criticality test facilities, and two sites containing a pistol range and the Sodium Disposal Facility.

2.2.1 Building 4009 Area

Site Description: The Building 4009 area comprises Building 4009, substation Building 4709, and the land surrounding these two buildings located near the western end of G Street. Building 4009 was constructed in 1958-1959.[2, 3] Figures 2.2.1a through 2.2.1j provide a current photograph and building-specific drawing(s) and historical photographs Plate 1 presents a summary of all identified features for this site.

[1] Montgomery Watson Harza, *Group 8 – Western Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume I – Text, Tables, and Figures*, September 2007, pp. 2-6 – 2-8.
[2] Owens, D. E., *Radiological Survey Results – OMR-SGR Critical Assembly Facility, Santa Susana, Building 009*, N001TI990001, May 17, 1979, p. 3.
[3] Santa Susana Area IV, Atomics International/Energy Systems Group Planning Maps, March 1962–November 1992.

Building Features: Building 4009 consists of poured-in-place concrete shielded critical cells, with metal siding and metal lath and plaster offices and support laboratories. Building 4009 was constructed in two phases to first house the Organic Moderated Reactor (OMR) and later, the Sodium Graphite Reactor (SGR). Each had separate high-bay and low-bay areas and separate systems installed to handle liquid and gaseous effluents.[1] A floor plan is presented in Figure 2.2.1b. A plot plan is presented in Figure 2.2.1c. The site layout is presented in Figure 2.1.1d.

The OMR consisted of a high bay, which housed a concrete-shielded critical assembly room, and an adjoining low-bay area, which housed a control room, a counting room, laboratory, offices, support, and utility areas. The OMR critical assembly comprised a core vessel, thermal shield, fuel and control elements, source shield and drive mechanism, a moderator storage drain tank with connecting lines, and an access stand for the assembly. Boron carbide-filled shim and safety rods, activated by cables, were used for control. The core used "slightly" enriched uranium metal fuel elements in a heterogenous organic-moderated lattice. The moderator and reflector were a commercial mixture of terphenyl isomers maintained in a liquid state by electric heaters. The geometries of the fuel elements used in experiments were flat plate, box-type or concentric cylinders. The core was contained in a 6-foot-diameter by by 8.5-foot high mild-steel tank, supported above the floor by a steel stand. Figure 2.1.1e shows a perspective view of the OMR critical assembly. The entire OMR facility was approximately 110 feet long by 63 feet wide. The critical assembly room (high-bay area) was a concrete structure with shield walls extending to the roof eave (37 feet). This room was approximately 35 feet square with a ceiling height of 33 feet. Shield thicknesses varied from 4 feet to 1 foot, depending on the height and location of the wall. A 5-ton bridge crane serviced the area. Abutting the east wall of the OMR, a 19- by 12- by 10-foot deep pit (or sump) in the concrete floor held a storage tank and permitted the organic liquid moderator to drain in the event of a scram or shutdown. As-built Drawing No. 303-009-A9 indicates that the storage tank was about 9 feet in diameter and 20 feet long.[2] A drain line connected the pit to a 1,000-gallon radioactive waste hold-up tank located outside the northwest side of Building 4009. As-built Drawing No. 303-009-XPJO indicates that liquid discharged to the OMR hold-up tank could be recycled, pumped to an above-ground line for sampling and disposal by tanker truck, or could be pumped to the leach field.[3] A fuel storage room was located west of the assembly room adjacent to the west shield wall and a truck entry area. The control room in the low-bay area was located next to the south shield wall of the assembly room. The fuel storage room opened to a corridor which led from the control room to the assembly room. A change room, opening on the same corridor, was located between the control room and fuel storage room. See Figure 2.1.1b.[4, 5, 6]

[1] Chapman, J. A., *Radiological Survey of Building T009*, Energy Technology Engineering Center Report No. GEN-ZR-0014, August 26, 1988, pp. 19-28.
[2] Van Dyke and Barnes, *Building No. 9 Critical Experiment Facility Assembly Room Pit & Crane*, Drawing No. 303-009-A9, December 16, 1957.
[3] Atomics International, *Building 009 Santa Susana Proposed Modifications – R/A Waste Systems SGR & OMR Hold-up Tanks*, Drawing No. 303-009-XPJO, February 22, 1962.
[4] Owens, D. E., *Radiological Survey Results – OMR-SGR Critical Assembly Facility, Santa Susana, Building 009*, N001TI990001, May 17, 1979, p. 3.
[5] Ashley, R. L., *Evaluation of the Atomics International Nuclear Development Field Laboratory as a Location for Reactor Facilities*, Atomics International Report No. NAA-SR-7300, May 25, 1962, p. V-53.
[6] Zwetzig, G. B., *Organic Moderated Reactor Critical Experiment Hazards Summary*, Report No. NAA-SR-3220, December 15, 1958, p. 26.

The ventilation system for the OMR critical assembly room was separate from that used in the low bay of the OMR and from those used on the SGR side of the building. The OMR critical assembly room system maintained the high-bay at a negative differential pressure relative to the surrounding areas. When the OMR operated, the exhaust was discharged through a stack terminating 45 feet above grade level, and 10 feet above the roof. According to Rockwell, this effluent was continuously monitored and when measured above permissible activity levels, was automatically diverted through high efficiency particulate air (HEPA) filters. When the reactor was shut down, the high-bay area was exhausted through four roof-mounted power exhausters to provide a high air exchange rate when personnel were in the high bay. Information about filter management practices is unknown. A conventional ventilation system operated in the OMR low bay at a positive differential pressure with respect to the OMR critical assembly room.[3]

The SGR consisted of a high-bay building, which housed the critical assembly cell, a fuel storage vault and a graphite storage area. The southwest side of this high-bay abutted the northeast side of the OMR high-bay. See Figure 2.2.1b. The SRG low-bay area housed the control room, a radiochemistry laboratory known as the "Hot Lab which contained a fume hood," offices, and miscellaneous supporting laboratories. The high-bay was a concrete structure approximately 70-feet long by 40-feet wide, with a 4-inch thick reinforced concrete roof deck on steel framing, with an eave height of 39 feet. A concrete block penthouse, which housed the critical assembly control rod drive mechanisms, was located on the roof over the critical assembly cell.[1]

In the SGR, a separate 5-ton capacity overhead crane ran north and south over the high-bay area, to service the critical cell and storage area. The walls around the critical assembly room were concrete (2- to 4-feet thick) to provide shielding during reactor experiments. The critical assembly cell was 36 feet by 36 feet with a floor-to-ceiling height of 46 feet. The floor was 10 feet below grade level. A 10-foot deep hexagonal pit, 14 feet across the flats, was located in the center of the critical cell floor and provided access to the underside of the critical assembly. The bottom of the pit was 20 feet below grade level. A manhole and passageway led to the pit (or sump). A drain line connected the SGR pit to a separate 1,000-gallon radioactive waste hold-up tank located outside the northeast side of Building 4009. As-built Drawing No. 303-009-XPJO indicates that liquid discharged to the SGR hold-up tank could be recycled, pumped to an above-ground line for sampling and disposal by tanker truck, or could be pumped to the leach field. The three sides of the critical cell away from the storage area were shielded by poured-concrete walls extending to the roof.[2] Figure 2.2.1f presents a plan view of the SGR critical assembly room. Figure 2.2.1g presents an elevation view through the SGR critical facility, showing the base of the pit 20 feet below grade level. Figure 2.2.1h presents a perspective view of the SGR critical assembly room.

A 22-foot by 22-foot steel roll-up door was provided on the northeast corner of the SGR for truck entry to the graphite storage area and for the loading and unloading of materials for the SGR critical assembly room. Adjacent to this room, the fuel storage vault was 14 feet by 22 feet, and the graphite storage area was 29 feet by 24 feet. These areas were separated by 2-foot-thick concrete walls 18 feet high. The change room was located at the entrance of a corridor leading to the critical assembly room and was adjacent to the radiochemistry laboratory. The control

[1] Chapman, J. A., *Radiological Survey of Building T009*, Energy Technology Engineering Center Report No. GEN-ZR-0014,August 26, 1988, pp. 19-28.
[2] Chapman, J. A., *Radiological Survey of Building T009*, Energy Technology Engineering Center Report No. GEN-ZR-0014, August 26, 1988, pp. 19-28.

room was located next to the south shield wall of the critical assembly room. See Figure 2.1.1b. An emergency door, opening to the outside of Building 4009, was located adjacent to the roll-up door. The roof over the critical assembly room was 4-inch thick reinforced concrete on steel framing and horizontal roof members. The critical-assembly control mechanisms were housed in a penthouse located on the roof over the critical assembly room. The penthouse had concrete block walls and a 4-inch-thick concrete roof.[1, 1]

The SGR critical assembly areas had a ventilation system separate from that of the OMR critical assembly areas and separate from the low bay areas. The SGR critical assembly system maintained the high-bay at a negative differential pressure relative to the surrounding areas. Air was released through absolute filters rated to retain 99.97 percent of all particles greater than or equal to 0.3 microns.[2] The SGR low-bay area was serviced by a conventional heating and ventilation system that maintained a positive pressure in the area. The radiochemistry laboratory (hot lab) was maintained at slightly negative pressure with respect to the surrounding areas by exhausting air through a fume hood and HEPA filters.[1]

The roof on the office and laboratory areas consisted of gravel and tar on rigid insulation over metal decking. The exterior walls were insulated sheet metal, and the interior walls were metal lath and plaster. The liquid radioactive waste hold-up tanks (UT-4 and UT-5) were installed in underground reinforced concrete pits outside the SGR, and OMR, respectively.[3] A 1,500-gallon underground fuel oil tank (UT-3) was located south of Building 4009. This was removed in August 1987.[4, 5] The locations of the tanks are shown in Figure 2.2.1d. The radioactive waste hold-up tanks were designed to receive all liquids from the drains in the assembly rooms, and from the showers and sinks in the change rooms.[1]

A leach field, used for the disposal of both sanitary and radioactive liquid wastes before the central sewage system was installed in 1961, was located approximately 50 feet north of Building 4009. It contained six leach lines ranging in length from 15 to 42 feet. The leach lines extended north from a 2,340-gallon septic tank that was located outside the northwestern portion of Building 4009. The leach field comprised 4-inch diameter terra cotta clay piping surrounded by large gravel and buried at depths ranging from 4 to 5 feet below ground surface. The leach field was reported to include approximately 300 linear feet of leach lines.[1] Atomics International (AI) noted in November 1965 that while liquid waste from the hold-up tanks was being discharged to the leach field, "it would probably result in a significant quantity of insoluble activity being deposited on site."[6] Figure 2.2.1d shows the site layout including the leach field. Figure 2.1.1i shows the location of the sanitary sewer lines located around the north side of

[1] Ashley, R. L., *Evaluation of the Atomics International Nuclear Development Field Laboratory as a Location for Reactor Facilities*, Atomics International Report No. NAA-SR-7300, May 25, 1962, pp. V-48 – V-50.
[2] Letter from M. E. Remley, Atomics International, to J. V. Levy, U.S. Atomic Energy Commission, Re: *Reactor Operating Limits for Sodium Graphite Reactor Critical Facility in Building 4009*, November 4, 1964.
[3] Montgomery Watson Harza, *Group 8—Western Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1-Test, Tables, and Figures*, September 2007, pp. 3-2 – 3-3.
[4] Owens, D. E., *Radiological Survey Results – OMR-SGR Critical Assembly Facility, Santa Susana, Building 009*, N001TI990001, May 17, 1979, p. 3.
[5] Letter from A. Lenox, Boeing Corporation, to D. Salter, Ventura County Environmental Health Division, Re: *Closure Request Former Tank UT-3*, dated November 19, 1998.
[6] Atomics International Internal Letter from D. E. Owens to O. R. Hillig, Re: *Disposal of Liquid Waste from the Building 009 Holdup Tanks*, November 2, 1965.

Building 4009 that were installed in 1961. Figure 2.2.1j shows that Building 4009 had three underground fuel tanks UT-3, UT-4, and UT-5 that were discussed above.

In addition to the above details, HGL researchers located as-built Drawing No. 303-009-E17, which indicates that a Van de Graff generator was installed in the SGR graphite storage area in August 1960.[1] A note on this drawing indicates that the Van de Graff accelerator was moved to Building 4030. The note is dated May 4, 1962.

Former Use(s): Building 4009 contained the OMR and SGR critical facilities, which were pilot plants for developing large nuclear power plants for commercial power generation, such as the Hallam nuclear power plant in Nebraska and the Piqua nuclear power plant in Ohio. The OMR was used for testing uranium fueled reactors moderated and cooled by organic liquids. The critical assembly core used "slightly" enriched uranium fuel in a heterogeneous organic moderated lattice. The degree of uranium enrichment that "slightly" represents is unclear. Various types and configurations of fuel elements and core geometries were tested. The SGR was used to determine the operating characteristics of reactors with cores cooled by sodium and moderated with graphite. The basic critical assembly of the SGR was a cylindrical array of hexagonal graphite cylinders into which various amounts and configurations of fuel and sodium (in cans or simulated by aluminum) could be inserted. The fuel used in the SGR was uranium metal and uranium carbide enriched up to 2.5 percent.[2] Both reactors were low powered (less than 200 watts) critical assemblies. The OMR and SGR operated from 1959 and 1960, respectively, until 1965 and 1967, respectively.[3] In addition, as-built Drawing No. 303-009-E17 indicates that a Van de Graaff generator was installed in the SGR graphite storage area in August 1960 and was moved to Building 4030 in about May 1962.

According to Rockwell's Final Decontamination and Radiological Survey 1990 report, after the OMR and SGR programs were terminated in 1967, all materials from the two critical assemblies were removed and transferred to "other laboratories" or were disposed of at "authorized sites" in the late 1960s and early 1970s. In June 1966, AI reported that it was sending OMR irradiated fuel to the Savannah River site for "recovery."[4] Building 4009 was designated the Engineering Development Facility after decommissioning in the early 1970s. Sodium fire experiments intentionally exposing air to sodium were conducted in the OMR high bay for finding new way to extinguish sodium fires. Also, during this time, up to 800 pounds of depleted uranium were stored in the OMR counting room under the Accident Debris program. The depleted uranium was received from the Los Alamos National Laboratory.[5] This material was shipped off site in the early 1990s. From the early 1980s until the 1990s, the former SGR high bay was used for the storage and under-water testing of Rocketdyne's In-Service Inspection (ISI) equipment, which was used for inspecting commercial power reactors off-site. This equipment sometimes became contaminated off-site with low levels of radioactivity. Containers of contaminated equipment

[1] Atomics International, *Van De Graff Generator Installation SGR Building 009 Santa Susana, Electrical Plan & Details*, Drawing No. 303-009-E17, May 4, 1962.
[2] Letter from M. E. Remley, Atomics International, to J. V. Levy, U.S. Atomic Energy Commission, Re: *Reactor Operating Limits for Sodium Graphite Reactor Critical Facility in Building 4009*, November 4, 1964.
[3] Energy Technology Engineering Center, *Organic Moderated Reactor and the Sodium Graphite Reactor*, at www.etec.energy.gov/History/Major-Operations/Organic-moderated.html.
[4] Internal letter from V. J. Schaubert to F. W. Schlapp, Re: *OMR Irradiated Fuel Shipment to Savannah River*, dated June 24, 1966.
[5] Memorandum from R. S. Frazier, Rockwell International, Re: *LANL DU Received at T009*, dated September 22, 1989.

were stored in a "controlled area" in Building 4009.[1] In May 1983, Rockwell ultrasonically inspected a contaminated and activated pipe specimen using ISI equipment.[2]

In October 1988, Rockwell requested a new authorization for the use of radioactive materials and radiation producing devices for the forging of depleted uranium in the former OMR critical assembly room. This was known as the high-energy rate forging (HERF) program. It was conducted under contract to the Los Alamos National Laboratory. This work was allowed under sub-item F of the State of California license, which authorized 30,000 pounds of source material in any form for research and development. The work involved a series of approximately 114 depleted uranium blanks (some alloyed with titanium) of 1-inch in diameter. All materials were in the shape of solid bar stock. They were inserted into the HERF press that used compressed air to accelerate a piston that hammered the blanks at approximately 300 ºC. No machining, sawing, filing or other processes producing fines were involved. All material was stored in wooden boxes in the former OMR critical assembly room, with a maximum of 1,000 kg of depleted uranium in Building 4009 at any one time. Rockwell activated a non-HEPA filtered roof mounted power exhaust system and a portable HEPA filter exhaust system in a 12-ft x 12-ft x 12-ft high fire retardant plastic enclosure along with a breathing zone air sampler. Rockwell planned to ship all radioactive waste to Hanford for disposal.[3] An inventory of shipping drums indicates that 120 drums of uranium and depleted uranium were shipped from the EG&G facility at Rocky Flats, Colorado, to Building 4009 for the HERF project.[4] The material was to be returned to Rocky Flats at the conclusion of the study.[5]

A Rockwell internal letter, dated April 20, 1990, indicates that the HERF program has ended and that the former OMR critical assembly room is needed for the ISI program to store three cargo containers of radioactive equipment; each container having an external dose rate of approximately 2 mrad/h.[6] A Rockwell internal lettere dated November 13, 1990, indicates that an effort is underway to upgrade Building 4009 to make it suitable for office use. This includes moving the HERF equipment from the former OMR critical assembly room to storage.[7] On May 11, 1995, Rockwell reported that it planned to upgrade Building 4009 in support of a new proprietary sensor program. This would involve the high bays and the removal of half of the existing roof and replacing it with a new rolling roof; the installation of two electric heating, ventilation, and air conditioning systems; and piping for liquid and gaseous nitrogen systems inside the building from an outside source.[8]

[1] Rockwell Internal Letter from W. R. Johnson to W. E. Nagel, Re: *Request for Radioactive Material and Radiation Producing Device User Authorization for ISI Operations at Building T009*, June 10, 1987.
[2] Rockwell Internal Letter from R. J. Tuttle to Isotope Committee, Re: *Short-Term Approval for Work with Radioactive Sample in Building 009, Santa Susana*, May 9, 1983.
[3] Rockwell Internal Letter from R. S. Frazier and P. H. Horton to Radiation Safety Committee Chairman, Re: *Request for New Authorization for the Use of Radioactive Materials and Radiation Producing Devices (Forging of Depleted Uranium in Building 009, SSFL)*, October 27, 1988.
[4] Rockwell Internal Letter from P. H. Horton to L. J. Auge, Re: *Start Up of High Energy Rate Forge (HERF) Depleted Uranium (DU) Operations at Building 009, SSFL*, September 29, 1989.
[5] Schaubert, V. J., *Nuclear Materials Management Plan for the HERF Program*, Rockwell International Report No. N001NMP000003, October 31, 1989, pp. 3-4.
[6] Rockwell Internal Letter from J. M. Harris to R. Tuttle, Re: *Temporary RA Equipment Storage – T009*, April 20, 1990.
[7] Rockwell Internal Letter from F. C. Schrag to P. H. Horton, Re: *Plans and Work in Progress for Building 009*, November 13, 1990.
[8] Letter from R. L. Kistner, Rockwell International, to Ventura County Air Pollution Control District, Re: *Tenant Improvements Building 009 in Area IV Santa Susana Field Laboratory*, May 11, 1995.

During the late 1980s and early 1990s, ISI activities in Building 4009 were covered under State of California, Department of Public Health Radioactive Material License No. 0015-70. This license number changed from 0015-59 and then to 0015-19 and was amended 102 times before Building 4009 was released from this license for unrestricted use on January 20, 1999.[1, 2]

Building 4009 is located adjacent to Building 4100 which housed the Advanced Epithermal Thorium Reactor (AETR) and later, the Fast Critical Experiment Laboratory (FCEL). Reactor core configurations were studied including uranium, thorium, and later, high-energy fast neutrons. Laboratory rooms were used for radioactive sample counting and instrument calibration.

Information from Interviewees: In 2010, a number of former workers were interviewed about their experiences at the SSFL. Two had knowledge of Building 4009. Excerpts from their comments are presented below.

- "Building 100 and Building 9 had the OMR and graphite reactor. They were hot for a long time and they were hot when I was up there." This interviewee worked at the SSFL between 1963 and 1999.[3]

- "Uranium was the major radioactive material we handled. For the sodium-graphite and organic critical assemblies in the high bays of Building 4009, it was a solid metal of moderate enrichment in U-235. In Building 9 we had full assemblies. They were built somewhere else. I can't remember the storage for those, but I'm sure the configuration was safe. They were long cylinders that contained uranium of some enrichment. Then we put them into another cylinder tube surrounded by a heated organic liquid. There wasn't any real handling of any radiological materials like at Building 100." This interviewee worked at the SSFL between 1959 and 1981.[4]

Radiological Incident Reports: A chronology of radiological incident reports at this building is as follows:

Building 4009 Incident Report Summary

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0378	07/05/1961	SGR Fuel Vault	Uranium carbide (UC)	Can of powdered UC ignited when opened.
A0372	06/11/1964	OMR Critical Assembly Room	Tritium (H-3)	Tritium target material for accelerator changed without monitoring.
A0157	06/05/1986	High Bay (does not specify whether in OMR or SGR)	Americium-241 (Am-241)	Smoke detector source leaked after hose down by Fire Department.

[1] State of California, Department of Public Health, Radioactive Material License No. 0015-59 to Atomics International Division, North American Aviation, Inc., dated September 11, 1963.
[2] Letter from D. Wesley, California, Department of Health Services, to J. G. Barnes, Boeing North American/Rocketdyne Division, Re: releasing Buildings 4009 and 4020 for unrestricted use, dated January 20, 1999.
[3] Interview No. 3 of former employee conducted by the EPA, September 2010.
[4] Interview No. 196 of former employee conducted by the U.S. DOE, September 2010.

- On July 5, 1961, AI personnel in the SGR fuel vault noticed that two 1-gallon containers of uranium carbide fuel slugs were bulging at the top and bottom. AI personnel transferred the fuel to the SGR Hot Lab vented hood. (It was previously learned that this fume hood had HEPA filters.) The Fire Department was notified to observe the transfer. The container with the bigger protrusions was placed in a 5-gallon can with its lid secured tightly for the transfer from the vault to the Hot Lab hood. Then, the 1-gallon fuel container was removed from the 5-gallon container in the vented hood. When its lid was removed in the vented hood, a violent reaction and fire occurred with the release of gases. Uranium powder on 12 fuel slugs ignited, but the fire was put out by smothering it with G-1 powder. The second can was opened in the same manner with a less violent release of pressure. This can contained 18 slugs. All of the slugs were subsequently transferred to pans of cutting oil in the Hot Lab hood. According to AI, all contamination was in the SGR Hot Lab hood; there was no damage to personnel, equipment or property (Incident Report No. A0378).[1]

- On June 11, 1964, between 3 and 4 curies of tritium target material were replaced in the OMR critical assembly room without the required monitoring by the AI Health & Safety Department. The incident report states that the target material was for the Department 741 accelerator and that an outside vendor for the accelerator may have been involved. The employee was subsequently informed to contact the Health & Safety Department prior to any operations involving the disassembly or replacement of tritium targets (Incident Report No. A0372).[2]

- On June 4, 1986, the high bay was washed down with a fire hose. This incident report does not state whether the location was in the OMR or SGR, but both high bays had sumps connected to individual radioactive hold-up tanks connected to the leach field. A bag placed over one of the smoke detectors was not sealed and filled with water during washdown activities. Plant Services was called to repair the damage to the detector. When an electrician emptied the bag, water fell onto his hands, which subsequently registered 120 counts per minute direct reading of alpha contamination. The electrician was decontaminated. A gamma scan of both of his hands showed a very small amount of Am-241 ($4.5E^{-4}$ microcurie) (450 pCi). This was considered acceptable by Atomics International, Health Physics Department, and the electrician was released. It was recommended that on future occasions, the Radiation & Nuclear Safety Branch be consulted to ensure that precautions are adequate to perform the work (Incident Report No. A0157).[3]

Current Use: Following release for unrestricted use in 1999, Building 4009 was used for non-nuclear research and development, including laser research. Operations in Building 4009 ceased in mid-2007.

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s): A chronology of radiological investigations at this building is as follows:

[1] Atomics International Inter-office Letter from J. P. Klostermann to E. C. Hickey re: Incident in Building 009 OMR on July 5, 1961, dated July 13, 1961.
[2] Atomics International Internal Letter from E. E. Owens to R. M. Hill, Re: *Incident in Building 009 OMR on June 11, 1964*, dated June 17, 1964.
[3] Rockwell International Radiological Safety Incident Report from R. McGinnis to J. Chapman, dated June 10, 1986.

- On September 24, 1965, according to an Atomics International internal letter, it removed all radiation producing devices and radioactive material from the OMR reactor room in Building 4009 as it was proposed to become a sodium laboratory.[1] OMR irradiated fuel was shipped to Savannah River for "recovery."[2]

- In June 1969, North American Rockwell removed SGR uranium carbide fuel slugs from the SGR vault. In addition, SGR reactor graphite was removed from the reactor vessel, and SGR uranium carbide fuel was decanned. According to North American Rockwell, all equipment used was disposed of as radioactive waste or was decontaminated to "acceptable limits" used in 1969. The destination of the radioactive waste is unclear.[3]

- In August 1969, North American Rockwell conducted a "final" radioactive contamination survey in the SGR facility following the removal of all reactor fuel and the graphite moderator. The survey indicated that no removable contamination remained in excess of Rockwell standard 5 disintegrations per minute per 100 square centimeters (dpm/100 cm^2) of alpha radioactivity and 50 dpm/100 cm^2 of beta radioactivity.[4]

- In September 1969, North American Rockwell conducted an analysis of the levels of induced radioactivity in the SGR structural steel and related components to assess the potential hazards associated with demolition of the facility. Samples of steel were obtained by drilling into the cavity liner and external support members at a level of approximately 4 feet above floor level, the level at which the maximum activation was expected. In addition, the asbestos thermal shield and reinforcing wire, and assorted assembly hardware were sampled. A smear survey of the support structure and a radiation survey using an ICN Model PUG-1A survey meter were performed to complement the sampling. Sample analysis was performed by beta counting with a gas flow proportional detector and by gamma spectrometry with a Nuclear Data Model 130 multichannel analyzer and 3- by 3-inch NAI (T1) well crystal. Cobalt-60 (Co-60) was the only gamma emitting radionuclide detected in the steel with a high reading of 16 dpm/gram of steel. The smear survey found a maximum contamination level of 20 dpm/100cm^2 of beta radioactivity.[5]

- In August 1987, Rocketdyne removed the 1,500-gallon underground diesel/fuel oil storage tank with oversight from the Ventura County Environmental Health Division (Tank Abandonment Permit No. 698). Because petroleum contamination was found, 24

[1] Atomics International Internal Letter from D. E. Owens to O. R. Hillig, Re: *Reclassification of Tagged Area*, dated October 1, 1965.
[2] Internal letter from V. J. Schaubert to F. W. Schlapp, Re: *OMR Irradiated Fuel Shipment to Savannah River*, dated June 24, 1966.
[3] North American Rockwell Corporation Internal Letter from W. F. Heine to M. E. Remley, Re: *Operational Safety Unit Monthly Highlights – June 1969*, dated July 8, 1969, p. 3.
[4] North American Rockwell Corporation Internal Letter from R. K. Owen to W. F. Heine, Re: *Final Contamination Survey of SGR Facility*, dated August 13, 1969.
[5] North American Rockwell Corporation Internal Letter from J. D. Moore to W. F. Heine, Re: *Radioactivation of SGR Support Structure*, dated October 3, 1969.

tons of soil were removed from the area.[1] The excavation was not surveyed for radioactive contamination.

- In 1988, Rockwell performed a radiological survey to identify areas needing further radiological inspections or requiring remedial action. The survey covered the interior of the OMR side of the building, the SGR radioactive liquid hold-up tank and pit, the old sanitary leach field, and grease and sludge from sink clean-outs, shower drains, and machining equipment. A few locations on the OMR side of the facility were contaminated at levels below Rockwell's acceptance limits. The OMR fuel vault was contaminated with a maximum alpha activity of 92 dpm/100 cm^2 while Rockwell's "acceptable limit" in 1988 was 5,000 dpm/100 cm^2. Maximum removable activity was 15 dpm/100 cm^2 while the acceptable limit was 1,000 dpm/100 cm^2. A sludge sample collected from inside the inactive SGR radioactive liquid hold-up tank contained fission products, uranium-238 (U-238) (18 picocuries per gram (pCi/g), thorium-232 (Th-232) (25.2 pCi/g), and possibly U-235 (0.81 pCi/g). No contamination was reportedly detected in the hold-up tank pit.[2] Rockwell recommended that the tank and drain lines leading to it be removed and disposed of as radioactive waste. The OMR hold-up tank was not included in the survey. It is unclear why this was not surveyed, but the HERF program was in operation in the OMR high bay at this time. Ambient exposure data in the area of the old sanitary leach field (partially paved) showed a mean exposure rate of 13 microroentgen per hour (µR/h), which was consistent with Rockwell's background exposure rate of approximately 15 µR/h.[3, 4]

- In late 1989 and early 1990, Rockwell removed the SGR hold-up tank and drain lines for disposal at an "authorized site."[5] All contaminated material was packaged and initially moved to the Radioactive Material Handling Facility.[6] As part of this removal effort, an "indication-only" gamma survey was conducted and soil samples were collected from the drain line trenches. Rockwell backfilled the trenches with excavated soil and resurfaced the site. Gamma spectrometry was performed on 199 soil samples for cesium-137 (Cs-137), Cs-134, and Co-60, potassium-40 (K-40), Th-232, U-235, and U-238. Two samples reported Cs-137 at 0.15 and 0.18 pCi/g, otherwise no measurable activity was observed from man-made radionuclides. Rockwell concluded that no residual levels of man-made radionuclides were found in the Building 4009 drain line soil. The naturally occurring radionuclide activity results were comparable to background levels (U-238 0.64 pCi/g, U-235 0.02 pCi/g, Th-232 0.97 pCi/g, K-40 15.3 pCi/g) measured during a

[1] Ogden Environmental and Energy Services, *Closure Report, Underground Storage Tank UT-3 (LUFT #94044) Building 009, Santa Susana Field Laboratory, Ventura County, California*, Project No. 313150002, November 1998, pp. 1-2.
[2] Rockwell International Internal letter from J. A. Chapman to R. D. Meyer, Re: *Field Work Task Proposal for Remediation of Contaminated Areas Identified by the DOE SSFL Site Radiological Survey*, dated December 1, 1988, p. 5.
[3] Chapman, J. A., *Radiological Survey of Building T009*, Energy Technology Engineering Center Report No. GEN-ZR-0014, August 26, 1988, pp. 3-4, 99, 107-108.
[4] Chapman, J. A., *Executive Summary of the DOE SSFL Site Radiological Survey*, ETEC Report No. GEN-ZR-0015, October 10, 1988, pp. 19-20.
[5] Parker, D., *SGR Liquid Drain Line System Removal, Building 009*, Rockwell International Report No. 195DWP000001, October 30, 1989, pp. 3-7.
[6] Harris, J. M., *SGR Liquid Holdup Tank Decontamination and Decommissioning, T009*, Rockwell International Report No. N001DWP000025, August 1, 1989, pp. 3, 14.

Groundwater Resources Consultants' investigation of naturally occurring radionuclides in 1990.[1]

- In February 1995, the California Department of Health Services performed a 1-day confirmatory survey of the SGR high bay. This survey found that fixed and removable surface contamination was non-detectable, less than the release limits, and that gamma radioactivity levels were ambient. Subsequently, Rockwell drilled four cores in the SGR high bay floor where there was a potential for neutron activation, and analyzed these by gamma spectroscopy. According to Rockwell, trace activities of neutron activation products, Co-60 and Eu-152, were observed. These activity levels were one percent of the proposed NRC/EPA soil release limits based on uniform contamination, residential use, and a 15 millirem per year biological risk.[2] This release limit was never promulgated by the EPA.

- In March 1995, Rockwell performed a radiological survey of the Building 4009 roof. No radioactive contamination was detected above Rockwell's estimated background. Rockwell concluded that the proposed removal of the roof could proceed without the need for additional surveys of roof debris. The roof does not appear to have been removed because the building is standing.[3]

- In 1995, Parsons filled the SGR radioactive liquid waste hold-up tank pit with a cement/sand slurry and capped it with 4-inch thick asphaltic cement.[4]

- In 1995/96 Rockwell removed approximately 4 cubic yards of concrete from the SGR critical assembly room pit (sump) together with other structures such as the SGR radiochemistry fume hood and ducting. Rockwell disposed of these off site as radiological waste.[2]

- During Rockwell's 1996 Area IV Radiological Characterization Survey, two leach field soil samples were collected near Building 4009. The soil sampling results did not show elevated soil activity above Rockwell's generic soil contamination limits.[5]

- In August 1998, the California Department of Health Services performed an independent verification survey of Building 4009 in preparation for its release for unrestricted use. The following data were reviewed: survey data following the removal of the SGR radiochemistry laboratory fume hood; gamma spectroscopic analysis of a groundwater sample taken from the sump (pit) in the OMR critical assembly room, and smears from

[1] Oliver, B. M. and Subbraman, G., *Final Decontamination and Radiological Survey of Portions of Building T009*, Rockwell International Report No. N704SRR990032, December 18, 1990, pp. 1, 5-11.
[2] Letter from P. Rutherford, Rockwell International, to B. Kapel, California Department of Health Services, Re: *Request for Release of Building 009 for Unrestricted Use and Approval to Dispose of Concrete from Building 009 – License 0015-70*, dated October 26, 1995.
[3] Rockwell International Internal Letter from P. D. Rutherford to C. Butler, Re: *Building 009 Roof Survey*, dated May 4, 1995.
[4] Montgomery Watson Harza, *Group 8—Western Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1-Test, Tables, and Figures*, September 2007, pp. 3-2 – 3-5.
[5] Rockwell International, *Area IV Radiological Characterization Survey, Final Report, Volume I*, Report No. A4CM-ZR-0011, Revision A, August 15, 1996, pp. 40; Table C-1, p. 4; Table D-1, pp. 4, 11, 18, 25, 32, 39, 46, 53.

the OMR laboratory drain line and men's restroom floor drain; and gross alpha/beta analysis of wet sediment smears from a groundwater seepage in the SGR critical assembly room. Room 121, following the removal of the fume hood, and other survey locations, were reported to have met Boeing's limits for unrestricted use. According to the cited document, Boeing did not detect contamination in the groundwater sample, the drain line sediment smears, or the wet sediment smears.[1]

- In 2002, Boeing removed the leach field, leach lines, and septic tank previously used at the OMR on the northwest side of Building 4009. According to Boeing, the leach field was excavated down to bedrock. Two soil samples were collected from the excavation; one from the effluent end and the other at the downslope end, and were analyzed for metals and organic compounds. The septic tank, 18-inch leach tiles, miscellaneous demolition debris, and approximately 50 tons of soil were disposed of offsite at a Boeing approved facility.[2, 3, 4]

- In 2002, EPA contractor Tetra Tech EM, Inc. (Tetra Tech) conducted oversight, sampling, and an independent technical review of documents for Building 4009. Tetra Tech noted that because of Boeing's security considerations, Building 4009 had not been accessible to EPA or Tetra Tech to conduct confirmation surveys. Tetra Tech reviewed the results from Rockwell's 1988 survey of the OMR and noted that Rockwell had collected over 280 swipe samples in the SGR portion of Building 4009 and all results were below 5,000 dpm/100 cm^2 for beta-gamma activity, and were below 500 dpm/100 cm^2 for alpha activity. Tetra Tech reported that Building 4009 had been released from radiological controls by the CDPHE and recommended no further survey action.[5]

Radiological Use Authorizations: At various times, the following radiological use authorizations were assigned to Building 4009.

- Use Authorization No. 16 for the temporary operation of a neutron generator.

- Use Authorization Nos. 24, 24A, 24B, 24C for uranium aerosol tests using 2 kilograms of depleted uranium in a large test vessel in former OMR critical assembly Room 126. These authorizations were in effect between July 15, 1970 and February 6, 1974.

- Use Authorization No. 59 for the use of sealed sources containing sodium-24 (Na-24), Co-57, Co-60, strontium-90 (Sr-90), and Cs-137 for use in the former SGR area. This authorization was in effect between August 14, 1972 and August 14, 1973.

[1] Letter from P. Rutherford, Boeing Corporation, to P. Baldenweg, California Department of Health Services, Re: *Building 009 Survey Sampling Data, License 0015-19*, dated August 19, 1998.
[2] Interview Notes of interview with D. Trippeda conducted by S. Valenzuela, June 14, 2007.
[3] Montgomery Watson Harza, *Group 8—Western Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1-Test, Tables, and Figures*, September 2007, pp. 3-2 – 3-5.
[4] Montgomery Watson Harza, *DOE Leach Fields (Area IV AOC) RCRA Facilities Investigation Report, Santa Susana Field Laboratory, Ventura County, California, DRAFT*, October 2003, p. 3-4.
[5] Tetra Tech EM, Inc., *Final Rocketdyne Technical Support and Field Oversight Document Review for Buildings T009, T011, T019, T055, and T100*, December 20, 2002, pp. 5-7.

- Use Authorization No. 135D for the use of 160 and 320 kVolt X-ray tubes in Building 4009. This authorization was to be in effect from 1992 to 1993.

- Use Authorization Nos. 144, 144A for ISI operations involving contaminated equipment (less than 10 mCi) in the former SGR critical assembly room and fume hood, Rooms 127, 131. These authorizations were in effect between at least July 15, 1989 and 1992. In March 1992, ISI operations occupied about 70 percent of Building 4009. Upon termination of Rockwell's business interest in ISI, all contaminated Rockwell-owned equipment was to be disposed of as radioactive waste.

- Use Authorization No. 149 for the HERF project (which included the handling of depleted uranium).

- On January 20, 1999, the CDPHE released Building 4009 for unrestricted use and removed it from Radioactive Material License No. 0015-19, under Amendment No. 102.[1]

Former Radiological Burial or Disposal Locations: Until 1961, Building 4009 was connected to a 2,340-gallon septic tank on the northwest side of the building and a 6-line 300-linear-feet leach field located approximately 50 feet north of Building 4009. These were used for the disposal of sanitary and liquid wastes. Building 4009 was connected to the sewer system in 1961. Between 1961 and 1967 when OMR and SGR operations ceased, the leach field was used for the disposal of liquid waste, only. In 2002, the leach field was excavated down to fractured bedrock and removed. Figure 2.2.1d shows a second septic tank on the northeast side of Building 4009.[2, 3,4]

Aerial Photographs: Aerial photographs show undeveloped land until the 1959 photograph when a large irregularly shaped building is observed that is identified as Building 4009. This building continues to be seen in photographs from approximately 1960, 1965, 1967, and 1972. In the 1978 photograph, open storage is observed on the west and southwest sides of Building 4009. Possible stains and two possible tank pads are also seen. In the 1980 photograph, probable stains, possible debris and a probable leakage from an unknown source are observed in the open storage area in the southwest corner of the site. A drainage pathway carries liquid north through a vegetated area. This pathway then appears to be blocked by rock outcrops, resulting in a liquid collection area. In the 1983 photograph, stains are also seen at the open storage area. Open storage on the west side of Building 4009 is also seen in the 1988 photograph. Open storage is seen on the north and west sides of Building 4009 in the 1995 photograph. Building 4009 shows no signs of open storage in the 2005 and 2009 photographs.[5]

[1] Letter from D. Wesley, California, Department of Health Services, to J. G. Barnes, Boeing North American/Rocketdyne Division, Re: *Release of Buildings 4009 and 4020 for Unrestricted Use*, dated January 20, 1999.
[2] ICF Kaiser Engineers, *Current Conditions Report and Draft RCRA Facility Investigation Work Plan: Volume 1*, October 1993, pp. 4-84, 4-87.
[3] Montgomery Watson Harza, *DOE Leach Fields (Area IV AOC) RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Draft*, October 2003, pp. 2-2, 3-4.
[4] Montgomery Watson Harza, *Group 8—Western Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume 1-Test, Tables, and Figures*, September 2007, p. 3-3.
[5] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.

Radionuclides of Concern: Enriched uranium and thorium were stored in the OMR and SGR fuel vaults and were used in the two critical assembly rooms during their operation. Also up to 800 pounds of depleted uranium were stored in the OMR counting room under the Accident Debris program. In addition, a Van de Graaff accelerator was housed in the SGR graphite storage area during the early 1960s. In the 1980s, the OMR high bay was later used for HERF, which included the handling of depleted uranium. Decay products from U-235, U-238, and Th-232 decay chains include Th-234, Th-228, actinium-228 (Ac-228), radium-226 (Ra-226), lead-214 (Pb-214), bismuth-214 (Bi-214), Pb-212, Bi212, and thallium-208 (Tl-208). In addition, H-3, Sr-90 and Cs-137, Na-24, Co-57, Co-60, europium-152 (Eu-152), and americium-243 (Am-243) would have been formed.[1] All radionuclides of concern listed, with the exception of Na-24 and Co-57 (due to relatively short half-lives), are included in the August 2010 Final Field Sampling Plan for soil sampling in Area IV. Table 3.3 presents a summary of contaminants of concern.

Drainage Pathways: Surface water from Building 4009 is predominantly controlled by concrete- and asphalt-lined ditches that discharge to a natural drainage channel located to the west of the leach field. Runoff from Building 4009 is diverted into an asphalt-lined channel along its southern perimeter. See Figure 2.2.1c. This diversion ditch discharges into a storm water culvert located southeast of Building 4009 or to a concrete-lined channel to the west along the leach field. The storm water culvert discharges into the storm water drain along G Street, which passes in front of Building 4100. From G Street, surface water flows via storm drains into the R-2 Pond in Area II, and eventually discharges at Outfall 002 and subsequently to the Los Angeles River. The concrete-lined channel near the leach field drains northward to a natural channel, which ends at a rock outcrop, located approximately 150 feet north of the leach field. Surface water appears to infiltrate at this location and may resurface north of the outcrop where another channel carries it north through the NBZ and Brandeis-Bardin Institute land, through Meier Canyon and into Arroyo Simi in Simi Valley.[2]

Radiological Contamination Potential: The preliminary MARSSIM classification for the Building 4009 area is Class 1, due to its former use as housing two critical-assembly test facilities.

Recommended Locations for Soil/Sediment Sampling:

Plate 1 and Figure 2.2 provide a convenient reference for the following recommendations.

Information is lacking regarding the excavation activities for the leach field, hold-up tanks, and septic tanks at Building 4009, particularly in late 1989 and early 1990. The characterization studies for the Building 4009 area were focused on delineating the extent of contamination to previous standards. Characterization was not conducted to delineate the extent of contamination consistent with the DTSC/DOE December 2010 AOC. Therefore, additional characterization is recommended for the Building 4009 area. This includes the following Building 4009 areas and appurtenances:

[1] Chapman, J. A., *Radiological Survey of Building T009*, Energy Technology Engineering Center Report No. GEN-ZR-0014, August 26, 1988, pp. 10, 66, 97.
[2] Montgomery Watson Harza, *Group 8 – Western Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume I – Text, Tables, and Figures*, September 2007, pp. 2-6 - 2-8.

- The flat and low-lying areas surrounding Building 4009, particularly on the north, south and west sides where open storage was identified in aerial photographs. Radionuclides originating from Building 4009 may have migrated to these areas via surface water flow or airborne releases.

- The waste hold-up tank, pit, and septic tank located northwest of the OMR, as shown in Figure 2.2.1d. It is unclear whether this area was thoroughly investigated and decontaminated in 2002.

- The waste hold-up tank, pit, and septic tank located northeast of the SGR, as shown in Figure 2.2.1d. It is unclear whether this area was thoroughly investigated and decontaminated in late 1989 and early 1990.

- The fuel oil tank located on the southeast side of the OMR, as shown in Figure 2.2.1d. It is unclear whether this area was thoroughly investigated and decontaminated in 1998.

- Within and downgradient of the former 6-line 300-linear-foot leach field area and approximately 50-foot drain line located northwest of Building 4009. It is unclear whether this area was thoroughly investigated and decontaminated.

- The liquid collection area identified in the 1980 aerial photograph. A drainage pathway directs liquid north through a vegetated area. This pathway then appears to be blocked by rock outcrops, resulting in a liquid collection area.

- The storm drain located west of the site that extends onto the NBZ and Brandeis-Bardin Institute land. It is unclear whether this storm drain was thoroughly investigated and decontaminated.

- All surface water drainage pathways including the storm water culvert located southeast of Building 4009, which carries water past Building 4100. It is unclear whether these drainage pathways were thoroughly investigated and decontaminated.

- The main sanitary sewer lines located north of Building 4009. If radionuclides were released into the sanitary sewer system, residual contamination may exist in the materials surrounding the sewer lines.

2.2.2 Site 4885 Area

Site Description: The Site 4885 area comprises Site 4885 and the land surrounding it located about 800 feet north of the Sodium Disposal Facility at the end of a dirt road on the north side of the west end of H Street. Site 4885 was constructed in approximately 1962 as a pistol range.[1, 2] Figure 2.2.2a provides a current photograph. Plate 1 presents a summary of all identified features for this site.

[1] Santa Susana Area IV, Atomics International/Energy Systems Group Planning Maps, March 1962–November 1992.
[2] Montgomery Watson Harza, *Group 8 – Western Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume I – Text, Tables, and Figures*, September 2007, p. 3-8.

Building Features: Site 4885 comprised an asphalt pad, a target area with multiple shooting stations on a concrete pad, and a downfield berm located against a rock outcrop approximately 90 feet to the northwest.[2] Figure 2.2.2b presents a plot plan in an as-built drawing for Site 4885. Figure 2.2.2c presents an historical photograph of the site.

Former Use(s): Site 4885 was used as a pistol range by Rocketdyne security personnel for pistol target practice and training from about 1962 through the 1970s.[2]

Information from Interviewees: None to date.

Radiological Incident Reports: None found.

Current Use: Site 4885 appears to have been used for temporary storage after the 1970s. Figure 2.2.2a shows that the area south of Site 4885 is currently used for storage covered by a tarpaulin. The nature of the stored material is unclear. Boeing has not yet responded to a request for information.

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s): In 1994, Site 4885 was surveyed by Rockwell for ambient gamma exposure as part of the post-remediation radiological survey of the former Sodium Disposal Facility, Site 4886 area. Rockwell estimated background gamma radiation to be 15.6 µR/h. The Rockwell survey found ambient gamma measurements to read between 15.5 to 17.2 µR/h at Site 4885. This result was concluded to be below Rockwell's acceptable limit of 5 µR/h above background.[1, 2]

Radiological Use Authorizations: None found.

Former Radiological Burial or Disposal Locations: None found.

Aerial Photographs: Aerial photographs show undeveloped land until the 1957 photograph when light-toned material appears to have been deposited at this fill area that is identified as Site 4885, which is located between rock outcrops at the terminus of an access road. In the 1959 photograph, deposition activity appears to have ceased. Parts of the surface are graded and support possible vegetation. In the approximately 1960 photograph, a rectangular-shaped graded area is seen at the site. Approximately six light-toned objects can also be seen. In the 1965 and 1967 photographs, a possible shelter is identified. In the 1972 photograph, the fill area is partially vegetated. In the 1978 photograph, stains are present and a possible pit is identified immediately northwest of the fill area. In the 1980 photograph, a possible horizontal tank is identified. This possible tank is not seen in any other photographs. In the 1980, 1983, and 1988 photographs, disturbed ground is seen at the site. A vegetated area is seen in the location of Site 4885 in the 1995, 2005 and 2009 photographs.[3]

[1] U.S. Department of Energy, *Draft Docket for the Release of Building 4886 as Part of the Energy Technology Engineering Center Closure*, Report No. RD99-179R1, DOE/CD-ETEC-4886 (Revised), September 1999 (Revised March 2000), pp. 9-11 (886-ZR-0007).
[2] Dahl, F. C., *Post Remediation Ambient Gamma Radiological Survey of the Former Sodium Disposal Facility (T886)*, ETEC Report No. 886-ZR-0007, December 13, 1994, pp. 9-11.
[3] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.

Radionuclides of Concern: The research team did not find evidence that radioactive materials were used or stored within the Site 4885 area. However, radiological contamination originating from Site 4886, located approximately 800 feet upgradient, may have migrated to this area via surface water flow or airborne releases. . Potential contaminants of concern include U-238, U-234, U-235, U-236, Pu-239, Pu-240, Pu-241, Pu-242, Th-232, Na-22, Na-24, Cr-51, Mn-54, Fe-59, Co-60, Kr-85, Sr-89, Sr-90, Sb-125, I-131, Cs-134, Cs-137, Ce-141, Ce-144, Ba (La)-140, Nb-95, Ru-103, Ru-106, Xe-133, Xe-135, Pm-147, and Sm-151.[1, 2] All radionuclides of concern listed with the exception of Na-24, Cr-51, Mn-54, Fe-59, Kr-85, Sr-89, I-131, Ce-141, Ba (La)-140, Nb-95, Ru-103, Ru-106, Xe-133, Xe-135, Pm-147 and Sm-151 are included in the August 2010 Final Field Sampling Plan for soil sampling in Area IV. The radionuclides omitted from the sampling plan have very short half-lives except for Sm-151 for which no commercial analytical method is available. Table 3.3 presents a summary of contaminants of concern.

Drainage Pathways: Figure 2.2.2b shows that the topography of the site is undulating.Site 4885 is generally downstream for surface flow from Site 4886.Based on site topography, radiological contamination from Site 4886 may have been transported via surface water flows onto Site 4885 and then continued through the NBZ. Surface water flow continues onto Brandeis-Bardin Institute land through Meier Canyon and into Arroyo Simi in Simi Valley.[3]

Radiological Contamination Potential: The preliminary MARSSIM Classification for the Site 4885 area is Class 1 due to its downgradient location from Site 4886.

Recommended Locations for Soil/Sediment Sampling:

Plate 1 and Figure 2.2 provide a convenient reference for the following recommendations.

Only one previous radiological survey has been conducted on the Site 4885 area. Previous characterization efforts likely did not achieve the requirements of the DTSC/DOE December 2010 AOC. Therefore, additional characterization is recommended for the Site 4885 area. This includes the following Site 4885 areas:

- Owing to radionuclides originating from Site 4886 that may have migrated to these areas via surface water flow, soil sampling in flat and low-lying areas surrounding Site 4885 is warranted. Radionuclides originating from Site 4886 may have migrated to these areas via surface water flow or airborne releases.

- The entire fill area that was graded to create the pistol range.

- The location of the stains and possible pit immediately northwest of the fill area identified in the 1978 photograph.

[1] Hart, R. S., *Distribution of Fission Product Contamination in the SRE*, Atomics International Report No. NAA-SR-6890, March 1, 1962, pp. 8-27.
[2] Kinzer, J. and Crawford, A. C., *SRE First Core Fuel*, Atomics International Technical Data Record No. 5301, May 16, 1960, pp. 1-7.
[3] Montgomery Watson Harza, *Group 8 – Western Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume I – Text, Tables, and Figures*, September 2007, pp. 2-7 – 2-8.

- The location of the possible horizontal tank identified in the 1980 aerial photograph.

2.2.3 Site 4886 Area

Site Description: The Site 4886 area comprised approximately 2 acres located on the north side of the westernmost end of H Street. It operated as the Sodium Disposal Facility, commonly known as the Sodium Burn Pit from 1956 until 1978.[1, 2] Figure 2.2.3a provides a current photograph. Plate 1 presents a summary of all identified features for this site.

Building Features: Site 4886 covered the high ground of an alluvial flat that was roughly triangular in shape, and approximately 2 acres in area. The site was bordered by siltstone rock formations on two sides, which met at the north end of the site to form a blunted apex to the triangle. In the late 1950s, a 16,700-square-foot area on the western side of the site was developed into an unlined pond.. In the 1960s, a rectangular concrete-lined pool was constructed at the southeast corner of the site. This pool was surrounded by a concrete slab. A shed was located south of the concrete lined pool and a steel protective shield containing portholes was located at the east end of the pool. The steel shield also had a hand hole to accommodate a hose nozzle. In the late 1960s, two man-made shallow water-filled unlined ponds, known as the upper and lower ponds were constructed. The lower pond was located in the middle of the site; the upper pond was located south of the lower pond and north of the concrete-lined pool. See Figure 2.2.3b. The lower pond covered approximately 8,250 square feet and the upper pond covered approximately 6,500 square feet. The concrete pool was connected to Site 4814 by underground piping.[2,3,4] Figure 2.2.3c presents a plot plan showing the triangular shape of the Sodium Disposal Facility, with the concrete-lined pool (pit) in the southeast corner. Figure 2.2.3d shows a photograph, looking northeast, with a drainage ditch located along the south and western sides of the site. Figure 2.2.3e shows a photograph, looking west, prior to remediation of the site. Figure 2.2.3f shows a photograph, looking west, during remediation of the lower pond in around 1992.

Former Use(s): Site 4886, the Sodium Disposal Facility, was commonly known as the Sodium Burn Pit. In May 1956, Atomics International decided to locate a waste disposal area on the western region of the SSFL because this area was underlain by shale of the Santa Susana-Martinez formation. Atomics International I believed that the percolation rates in the shale were low and that the rock appeared to be unfractured.[5]

In 1987, Rockwell reported that the Burn Pit was used extensively during the 1960 to 1970 period for the disposal of combustible materials such as kerosene, Na, and NaK from scrap test components such as pumps, valves, etc., from the SRE, SNAP, and other nuclear program operations. The area comprised a concrete pad adjacent to a concrete pool containing water and

[1] Santa Susana Area IV, Atomics International/Energy Systems Group Planning Maps, March 1962–November 1992.
[2] Klein, A., *Final Report for Decontamination and Decommissioning of Former Sodium Disposal Facility (FSDF) – B4886*, Boeing Report No. EID-04628, November 17, 1999, pp. 9-10.
[3] Dahl, F. C., *Post Remediation Ambient Gamma Radiological Survey of the former Sodium Disposal Facility (T886)*, Energy Technology Engineering Center (ETEC) Report No. 886-ZR-0007, December 13, 1994, pp. 12-20.
[4] Klein, A., *Basis for Radiological Determination of No DOE-Added Radioactivity at the Former Sodium Disposal Facility*, Energy Technology Engineering Center (ETEC) Report No. 886-XT-0002, December 3, 1992, p. 3.
[5] Jarrett, A. A. and Roth, J. N., *Quarterly Progress Report, January, February, March 1956*, Atomics International, May 8, 1956, pp. 1-2.

upper and lower pond areas, both of which down-sloped from the pool. A steam lance was used to clean the equipment. Components to be cleaned were placed on the slab, opened to expose the Na or NaK, and then washed off with water. The water reacted with the sodium to generate hydrogen, which often burned in air. The washed items were placed into the concrete pool, where the reaction with water continued, and were removed from the pool and placed into the upper or lower pond, where they stayed until all residual sodium had reacted. Some items were retrieved and disposed of off-site as solid waste. An area adjacent to and west of the upper pond area was used for the storage and burial of materials. Surface water flow to the north was via a dirt road located east of the area and a gully on the west side. According to Rockwell, the pond areas were incompletely bermed and there was a potential threat of water runoff to adjacent areas.[1,2]

In 1988, Rockwell reported that "Santo-wax," used as a coolant for organic moderated reactors, was also burned in the area. The Burn Pit was mainly used for the disposal of Na and NaK by exothermic reaction with water. After draining a system, small quantities of Na and NaK were often trapped in pipe elbows, valves, vessels, or insulation material. To remove the remaining reactive sodium, the component was dropped into the concrete-lined pool or placed in the upper or lower pond and hosed down with a light spray of water and then a heavier spray as the reaction subsided. After the hose-down was complete and the reaction stopped, the items were inspected for residual material. Clean items were scrapped, and those with residual sodium were returned to the pond.[3]

Rockwell reported that occasionally, firearms were used on vessels to open containers to the atmosphere. Those items, after cleaning, were removed to a dumpster for a scrap dealer. Some large components and vessels were buried in place. Some barrels and scrap were buried on the far western side of the site. According to Rockwell, material was also dispersed onto surrounding land by explosions that extended to Building 4009. The facility was also made available for the open burning of any combustible material. In the late 1970s, Rockwell launched an effort to clean up the Burn Pit. The gate to the facility was locked and only documented items and materials were admitted, although material of unknown origin was occasionally deposited at the gate. Radiological surveys had shown that the upper and lower ponds were contaminated with Cs-137 and zirconium hydride slugs contaminated with 93 percent enriched uranium. Radioactive contamination was suspected in the area because of the potential for radionuclide transport and migration from the ponds in the direction of surface-water runoff and because of the dispersion and scattering of radioactive material during cleaning operations.[4, 5]

Rockwell reported in 1996 that the Sodium Disposal Facility was used primarily for cleaning sodium heat transfer system components (pipes, valves, tanks) and for the disposal of scrap sodium by reaction with water. During its use, small quantities of other materials were disposed

[1] Olson, P, Shepard, R., and Adler, K., *CERCLA Program Phase II – Site Characterization*, ETEC Report No. GEN-ZR-0002, May 29, 1987, p. 5.
[2] The Boeing Company, *A Radiological History of the Sodium Disposal Facility*, April 25, 2000, p. 1.
[3] Chapman, J. A., *Radiological Survey of the Sodium Disposal Facility–Building T886*, ETEC Report No. GEN-ZR-0004, June 3, 1988, pp. 7-8, 19-20.
[4] Chapman, J. A., *Radiological Survey of the Sodium Disposal Facility–Building T886*, ETEC Report No. GEN-ZR-0004, June 3, 1988, pp. 7-8, 19-20.
[5] Rockwell Internal Letter from F. H. Badger to R. J. Tuttle, Re: *Radiological Information on Old Sodium Disposal Area*, April 23, 1987.

of, including radioactively contaminated components and materials. The concrete pool and related structures, and soil in the lower basin were removed during a remediation project that was conducted between 1991 and 1994.[1]

Following remediation in the early 1990s, Site 4886 was released from California Material License No. 0015-70 in May 1998. In January 2002, Use Authorization No. 159 for remediation was terminated by the CDPHE and the U.S. DOE.[2, 3]

Information from Interviewees: In 2010, a number of former workers were interviewed about their experiences at Site 4886. Excerpts from their comments are presented below.

- "I was very familiar with the Sodium Burn Pit. When 55-gallon sodium drums were emptied, there was always residual sodium in the drums. To clean or remove the residue, we would punch holes in both ends of the drums and roll them into the water in the Sodium Burn Pit. If there were any empty drums, it was my job as a fireman to clean them weekly to eliminate any hazard to employees or personnel. Sodium doesn't so much catch fire, but you get a hydrogen explosion when the sodium and water make contact. We watched closely so that the drums did not land on any of us."[4] This former employee worked at the SSFL between 1959 and 1966 or 1967.

- "The sodium burn pit was an outdoor facility located on Jackass Flat. It consisted of a small relatively deep pool of water constructed of concrete surrounded by a concrete deck. The deck was at grade. At one end of the deck, was a single strong bulkhead with a few portholes in it. The portholes were glazed with high-strength glass. The bulkhead also had a hand hole to accommodate a hose nozzle. Debris, including scrap sodium system piping, bearing residual Na-23, was washed with water from a fire hose. The reaction was violent, and the bulkhead provided protection for the operators. The reaction product was sodium hydroxide. When cleaned of residual sodium, the sodium hydroxide and debris were washed or pushed into the pool for later disposal."[5] This former employee worked at the SSFL between 1958 and 1968.

- "As a forklift operator, I would go to any building and pick up stuff and deliver it to wherever they wanted. I would pick up a lot of things and take them to the old disposal pit, the sodium disposal pit. The "pit" as we called it was where they would take pipe that had been excised out of the sodium test facility and had some residual sodium on it. At 300 degrees, sodium is a liquid, but as it cools, it becomes solid. But get sodium wet and you get big burning explosions. I wanted to make a bomb for Vietnam out of the stuff. We would take sections of pipe out to the pit, chain it down, and we had a steam boiler out there with a steam lance and we would sit behind a shield and steam the sodium out. It was the best way to get rid of the sodium. Or if we had smaller stuff, we

[1] Tuttle, R. J., *Post-Remediation Soil Sampling and Analysis for the Former Sodium Disposal Facility,* ETEC Report No. 886-ZR-0009 Rev. A, January 13, 1997, pp. 3-5.
[2] California Department of Health Services Letter from G. Wong to P. D. Rutherford, confirming the release of the former Sodium Disposal Facility, dated May 15, 1998.
[3] Boeing Internal Letter from J. G. Barnes to Use Authorization File, stating the Use Authorization No. 159 had been terminated, dated January 14, 2002.
[4] Interview No. 154 of former employee conducted by the U.S. DOE and EPA, September 2010.
[5] Interview No. 300 of former employee conducted by the U.S. DOE and EPA, September 2010.

would throw it in the pit with water. So we took a lot of things up to the burn pit. One thing you are probably interested in is mercury. As far as I know, there was never anything radiological taken up to the burn pit. Radiological material was only taken to specific buildings with specific needs to have it."[1] This former employee worked at the SSFL between 1963 and 1999.

- "I did not work with any hazardous chemicals except for sodium. I do remember a pond we had that we used to clean sodium off. It was a lot of fun, like fireworks. They would throw items in there. They would leave the items for a while. Every once in a while they would haul the items out. It was heavy work."[2]

- "The Sodium Burn Pit was not the best place, in fact, it was a bad place. It was not supervised as it should have been. . . . There was one strange incident I remember about the Sodium Burn Pit. One day there were a bunch of generals in the area and a guy had a bunch of glass balls full of sodium. He was standing on a rock and throwing the balls into the Burn Pit and letting them explode. He was suggesting to the generals they could be hand grenades for use at the rice paddies in Vietnam."[3] This former employee worked at the SSFL between 1957 and 1989.

- "When we were done with our work, we would throw old sodium capsules into the Burn Pit and let the sodium dissolve away. Anything that wasn't good was put in the Burn Pit. A guy worked up there and he would take care of stuff at the Burn Pit and make sure everything went as planned. He would help us out if we needed it."[4] This former employee worked at the SSFL between 1953 and 1956.

- "I was licensed to drive a skip loader. One time, I was operating the skip loader in the Sodium Burn Pit digging up asbestos from old tanks. I had to be suited up in protective clothing for this work. I ran into something that was solid and shiny – it was not a rock. I got a pug and got a reading on it; it was radioactive. It pegged the dosimeter. I reported into my supervisor and he told me to cover it back up and go away. We boxed up the asbestos I had already removed and I did what my supervisor told me and covered whatever it was back up and left."[5] This former employee worked at the SSFL between 1976 and 1982 or 1983.

- "I remember the Sodium Burn Pit as a place where sodium on parts was hosed out. In the early days, we cleaned lithium hydride in the same way, which ended up leaking down to a nearby farm, and their owner detected lithium in the milk, necessitating a change to where lithium hydride was shipped out."[6] This former employee worked at the SSFL between 1961 and 1979.

- "I hauled and treated items at the Sodium Burn Pit. I recall mercury being taken there, but I don't know what they did with it. I recall sodium components taken there for

[1] Interview No. 3 of former employee conducted by the EPA only, September 2010.
[2] Interview No. 188 of former employee conducted by the U.S.DOE, September 2010.
[3] Interview No. 254 of former employee conducted by the U.S. DOE and EPA, September 2010.
[4] Interview No. 57 of former employee conducted by the U.S. DOE and EPA, September 2010.
[5] Interview No. 78 of former employee conducted by the U.S. DOE and EPA, September 2010.
[6] Interview No. 288 of former employee conducted by the U.S. DOE, September 2010.

cleaning, and NaK in cans that were disposed of by shooting them with rifles and letting them leak into the water. The Los Angeles County Fire Department also brought items, such as a cyanide cylinder, which was chained down and had the top shot off."[1] This former employee worked at the SSFL between 1964 and 1999.

- "I also worked at the sodium disposal facility. I was 23 years old and they were telling me to throw stuff in the water that had sodium on it and let it explode. We were never told if there was contamination on it or not. If something came from the SRE D&D, we wouldn't know if it was hot. I don't think anyone ever buried stuff on purpose – it may have been done by accident."[2]

- "I never went to the sodium pond, but I am aware of a pond in the western portion of Area IV used by AI and Rocketdyne to dump excess sodium or NaK used in the S8ER. It would snap, crackle, and pop like fireworks when exposed to water. When SNAP piping was steam cleaned, you could also hear the snap, crackle, and pop in the piping due to the sodium water reaction."[3] This former employee worked at the SSFL between 1961 and 1973.

- "I do not know anything about the sodium burn pit. I have heard that they shot barrels there. That was the way things were done. Sometimes it was important to let the pressure out of a barrel to expose the contents to air. It would have been dangerous for a worker to open a barrel. The safest and easiest way to puncture a barrel was to shoot it. That was done all over the country in those days."[4]

Radiological Incident Reports: A chronology of recorded incidents at this site is as follows.

Site 4886 Incident Report Summary

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0464	06/11/1964	Sodium Disposal Area	I-131	Employee spilled caustic R/A solution on ground while cleaning tank.
A0630	05/03/1968	Burn Pit		Three contaminated drums discovered being burned at the Sodium Burn Pit.
A0075	10/06/1978	Burn Pit and Shed	MFP	Scrap removed from Sodium Burn Pit found contaminated as was the pit.

- On June 11, 1964, an employee spilled approximately 2 gallons of caustic radioactive solution labeled "0.15 mrad/h," on the ground while cleaning a stainless-steel tank. The incident report did not mention any efforts made to clean up the spill. By the time Health & Safety personnel arrived, the employee was inside a tank wearing red-line coveralls, gloves, and rubber boots. He then left the tank, rinsed off his gloves and boots, and

[1] Interview No. 290 of former employee conducted by the U.S. DOE, September 2010.
[2] Interview No. 277 of former employee conducted by the U.S. DOE, September 2010.
[3] Interview No. 107 of former employee conducted by the U.S. DOE and EPA, September 2010.
[4] Interview No. 287 of former employee conducted by the U.S.DOE, September 2010.

walked around the area. The ground-surface reading measured approximately 0.1 mrad/h with a G.M. and window probe. A reading of 100 dpm/gram (units may be incorrectly presented in the source document) was recorded in the center of the spill. It was recommended that bioassays be conducted on both employees assigned to the area. There was no follow-up to the incident report concerning the bioassay (Incident Report No. A0464).[1]

- On May 3, 1968, three radiologically contaminated drums were discovered being burned in the burn pit. The site was then sampled for radiological contamination (Incident Report No. A0630 yet to be received).

- In 1978, a survey of old sodium barrels located at the Sodium Burn Pit was conducted pending outside vendor bidding for salvage rights. Three radiologically contaminated sodium barrels and a pallet with pieces of pipe, valves and trash were found. The barrels had a maximum activity of 1 mrad/h. A subsequent survey found the upper half of the walls of the concrete-lined pool to be contaminated to 1,000 counts per minute (0.4 mrad/h). The contaminated waste had spread south of the concrete-lined pool because a survey in the region of Building 4730 identified two radioactive items. The metal waste storage area at Site 4886 contained five pallets of finned tubing contaminated to 5 mrad/h. All radioactive items were removed and moved to the Radioactive Materials Handling Facility for disposal (Incident Report No. A0075).[2]

Current Use: Site 4886 is a vegetated area no longer in use.

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s): Many site investigations and cleanup operations have been undertaken over the years. The most significant investigation and cleanup operations are summarized below. Details of operations follow the summary table.

Site 4886 Previous Investigation/Action Summary

Year of Investigation/Action	Description	Outcome
1978 to mid 1980s	Rockwell conducted an initial cleanup of the western pond and concrete-lined pool, and radiologically surveyed the lower and upper ponds.	Lower and upper ponds were found to be radiologically contaminated. Cs-137 was identified as the principal gamma-emitting isotope.
1989	U.S. DOE conducts first phase of environmental survey.	Removal of contaminated equipment incomplete, diversion ditches breached, inadequate site controls.
1991 to 1994	Rockwell undertook cleanup and restoration of the lower pond in response to California Regional Water Quality Control Board Cleanup and Abatement Order No. 91-081.	Concrete pool and approximately 20,500 cubic yards of soil were removed. Liner placed over bottom of lower pond.
1997 to 1998	CDPHE collected soil samples and cores from upper pond and western area.	CDPHE releases upper pond and western area for unrestricted use.

[1] Atomics International Incident Report from D. E. Owens to R. M. Hill re: Sodium Disposal Area spill on June 11, 1964, dated June 18, 1964.
[2] Rockwell International Internal Letter from F. H. Badger to W. R. McCurnin re: Preliminary Radioactive Survey Sodium Burn Pit, dated October 6, 1978.

Site 4886 Previous Investigation/Action Summary (continued)

Year of Investigation/Action	Description	Outcome
2002	To remediate hazardous chemical contamination, soils in upper and lower ponds, western area and area south of H Street excavated to fractured bedrock (13-foot depth).	Rainwater infiltration monitoring system installed, groundwater monitoring ongoing.

A chronology of radiological investigations at this site is as follows:

- In 1978, Rockwell initiated cleanup of the Sodium Disposal Facility. Up until the mid 1980s, pieces of debris such as pipes, elbows, machined metal parts, and tubes were dug up, "pushed over," and reburied in the upper and lower ponds using bulldozers. All visible scrapped tanks were moved to Building 4133, for further disposition. The western pond area was excavated, and hazardous materials and trash were removed. The concrete-lined pool was drained of water by a hazardous waste disposal company. Its walls were found to be radioactively contaminated and were scabbled. The lower and upper ponds were surveyed; both were found to be radiologically contaminated, with the lower pond showing the highest readings. Cesium-137 was identified as the principal gamma-emitting isotope.[1, 2]

- In March 1987, Rockwell conducted a site characterization study wherein 23 trenches were excavated between 1 and 7 feet in depth inside and north of the upper and lower ponds, A trench was also excavated along the southern and western boundaries to channel precipitation around the ponds, deflect run-on rainfall, and minimize possible material dispersion. See Figure 2.2.3b, which shows the trenches on the southern and western sides of the site. Laboratory analysis of soil samples found Cs-137 activity levels as high as 200 pCi/g. While the trenches were open, items of debris were uncovered together with differing colored soils and pungent odors. The exposure rate in this area was 80 µR/h. Rockwell estimated background gamma radiation to be 15 µR/h. In one trench in the lower pond, gamma radiation levels were found to be 2 to 4 times background while beta radiation levels were up to 14 times background at a 1-foot depth. Items of radioactive debris found included zirconium hydride reactor fuel end caps contaminated with U-238 and a thoriated oxygen sensor used in the sodium loops. These items were not removed at the time of the investigation.[1]

- In February 1989, the U.S. DOE conducted the first phase of an environmental survey of Area IV. DOE concluded that the removal of contaminated equipment from Site 4886 was incomplete. Also, the diversion ditches, which had been installed to channel storm water away from the contaminated areas, had been breached during cleanup operations. As a result, storm water was free to run onto the site and potentially remove contaminated soils and sediments. This was designated a Category II finding having the potential for

[1] Klein, A., *Final Report for Decontamination and Decommissioning of Former Sodium Disposal Facility (FSDF) – B4886*, Boeing Report No. EID-04628, November 17, 1999, p. 12.
[2] Chapman, J. A., *Radiological Survey of the Sodium Disposal Facility–Building T886*, ETEC Report No. GEN-ZR-0004, June 3, 1988, pp. 7-8, 19-20.

release of contaminated runoff due to inadequate controls. Contaminant concentrations in water runoff exceeded drinking water standards for arsenic, chromium and thorium. Cs-137 was identified as the main radioactive contaminant in soil.[1]

- In May 1989, Rockwell removed approximately 2,000 pounds of debris from the ground surface of the sodium disposal facility, pumped water from the "sodium burn pit tank," and continued cleanup operations.[2]

- On July 13, 1989, Gregg Dempsey from the EPA, Office of Radiation Programs, collected duplicate moist soil samples from the upper pond. These were analyzed for gamma emitting isotopes and H-3. Results indicated normal or background levels of radioactivity in the area, for example, H-3 indicated a maximum of 0.59 pCi/g, and K-40 indicated a maximum of 28.81 pCi/g. Cs-137 was found at levels consistent with those from atmospheric fallout from nuclear weapons testing (Cs-137 maximum 0.94 pCi/g). A dry soil sample collected from the lower pond was analyzed for gamma emitting isotopes. The lower pond gamma levels were found to be roughly twice those of the upper pond. Mr. Dempsey recommended that additional water samples be collected and analyzed for H-3 and Sr-90.[3, 4]

- In April 1991, the California Regional Water Quality Control Board issued Cleanup and Abatement Order No. 91-081 to Rockwell to remove and dispose of all contaminated soil and debris in, under, and around the lower pond. Backfilling and sloping of the site for natural drainage was also required as well as the establishment of native vegetation over the site. This work was to be completed by December 31, 1992.[5, 6]

- In 1991, Rockwell conducted a baseline beta/gamma radiological survey of Site 4886, at or near the soil surface. In the lower pond, the survey found elevated gamma activity at five locations; one location measured about twice normal background (27.5 µR/h) for gamma contamination, and substantially elevated above background (6,215 dpm/100 cm^2) for surface beta contamination.[7]

- In 1992, Rockwell undertook a cleanup and restoration of the lower pond in response to Cleanup and Abatement Order No. 91-081. Rockwell excavated to bedrock and removed 9,953 cubic yards of non-hazardous waste shipped to Kettleman Hills and Adelanto, 1,202 cubic yards of hazardous waste shipped to Kettleman Hills, 295 cubic yards of low

[1] Schiffman, J., *United States Department of Energy, Environmental Survey Report*, June 16, 1989, pp. 8-10, 16, 20-21.
[2] Rockwell Internal Letter from W. R. McCurnin to J. P. Page, Re: *Highlights, Week Ending May 26, 1989*, May 30, 1989, p. 2.
[3] Dempsey, G., *Report on Environmental Samples Collected at the Rocketdyne Santa Susana Field Laboratory July 1989*, , November 8, 1989, pp. 3-4.
[4] Dempsey, G., *Site visit to Santa Susana Field Laboratory Operated by Rockwell Rocketdyne*, Memorandum, July 28, 1989, pp. 5-6.
[5] Ghirelli, R. P., California Regional Water Quality Control Board, Los Angeles Region, *Cleanup and Abatement Order No. 91-061*, dated April 29, 1991.
[6] Letter from R. P. Ghirelli, California Regional Water Quality Control Board, Los Angeles Region, to S. R. Lafflam, Rockwell International, re: Closure of Surface Impoundment in Area IV, December 29, 1992.
[7] Collins, J., *Baseline Radiological Survey of the Sodium Disposal Facility (T886)*, Rockwell International Report No. N704SRR990034, August 31, 1992, pp. 1, 6-12, 18.

level radioactive waste shipped to Envirocare, Utah and 425 cubic yards of mixed waste shipped to Envirocare, Utah. Over the period 1991 through 1994 Rockwell removed the concrete pool and related structures. Figure 2.2.3f shows heavy earth moving equipment in the lower pond, covered piles of soil, and shipping containers. The California DTSC specified that DOE protocols and procedures be used for sorting waste types. The backfill and grading were to be performed in accordance with the Ventura County Grading Ordnance.[1, 2]

- In December 1992, the California Regional Water Quality Control Board requested that a water-tight liner be placed over the bottom surface area of the lower pond to contain all rainfall entering the pond. The Board also requested that rainfall or runoff entering the pond be removed within 24 hours.[3]

- Following the lower pond excavation in 1992, Rocketdyne performed a limited excavation in the upper pond and western area. Some soil and debris from the upper pond was found to be radioactively contaminated and was disposed of as radioactive waste. Over 9,000 cubic yards of soil were removed from the upper pond.[4]

- In September 1997, the CDPHE collected soil samples from cores taken from the upper pond and the western area of Site 4886, and subsequently released the upper pond and western area for unrestricted use.[5]

- In 2000, to address elevated levels of dioxins, PCBs, mercury, and perchlorate, IT Corporation excavated soils within the upper and lower ponds, the western area and the area south of H Street, to bedrock. The areas were backfilled to depths of approximately 13 feet below ground surface with clean soil from an Area IV borrow area. A diversion ditch was constructed south of H Street to control surface water runoff. An infiltration monitoring system was installed and the areas were revegetated. A total of 14,928 tons (approximately 12,000 cubic yards) of soil, debris, bedrock, and construction materials were disposed of off-site at a Class I Landfill in Buttonwillow, California. Rainwater infiltration and groundwater monitoring are ongoing.[6]

Radiological Use Authorizations: At various times, the following radiological use authorizations were assigned to Site 4886.

- On September 11, 1963, the State of California, Department of Public Health, issued Radioactive Material License No. 0015-59 to Atomics International. This license

[1] Letter from P. B. Ramirez, Rockwell International, to K. Scoles, County of Ventura, Resource Management Agency, Re: *Sodium Disposal Facility Closure, Area IV, Santa Susana Field Laboratory*, dated August 31, 1992.
[2] Klein, A., *Final Report for Decontamination and Decommissioning of Former Sodium Disposal Facility (FSDF) – B4886*, Boeing Report No. EID-04628, November 17, 1999, p. 120.
[3] Letter from R. P. Ghirelli, California Regional Water Quality Control Board, to S. R. Lafflam, Rockwell International, Re: *Closure of Surface Impoundment in Area IV, Former Sodium Disposal Facility B/886 Lower Pond*, dated December 29, 1992.
[4] The Boeing Company, *A Radiological History of the Sodium Disposal Facility*, April 25, 2000, p. 2.
[5] California Department of Health Services, *Confirmatory Survey: Soil Samples from the Former Sodium Disposal Facility*, September 16, 1997, pp. 1-6.
[6] Montgomery Watson Harza, *Group 8—Western Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume I*, September 2007, pp. 3-7 – 3-10.

covered contractor operations at the SSFL, including Site 4886. The license number changed over the years to No. 0015-70 and then to No. 0015-19.

- On May 6, 1998, Amendment No. 98 to the California Radioactive Material License No. 0015-19 was issued releasing the former Sodium Disposal Facility to unrestricted use.[1]

- On February 6, 1989, Site 4886 was added to Use Authorization No. 125 for multiple fission product contamination in soil.[2]

- On January 14, 2002, Use Authorization No. 159 for former Sodium Disposal Facility remediation was terminated following the release from radiological controls by the California Radiologic Health Branch and the U.S. DOE.[3]

Former Radiological Burial or Disposal Locations: Site 4886 was a material disposal facility that contained over the years a western area pond, an upper pond, a lower pond, a concrete-lined pit, and a metal waste storage area.

Aerial Photographs: Aerial photographs show undeveloped land until the 1957 photograph when a small area of disturbed ground is identified on a triangular shaped region that is identified as Site 4886. In the 1959 photograph, disturbed ground, mounded material, and a probable pond are identified on the site. In the approximately 1960 photograph, disturbed ground, mounded material and a trench are identified in the western region of the site. In the 1965 photograph, a large denuded area, disturbed ground, a liquid-filled pond in the western region of the site, and a small basin in the area of the concrete pit are identified. In the 1967 photograph, the liquid-filled pond appears to have been relocated to the eastern region of the site and is larger in area. A shed appears to be located near the concrete pit. In the 1972 photograph, a second liquid-filled pond is observed north of the previously identified pond; the shed and concrete pit are also observed. In the 1978 photograph, the northern pond appears larger than before; an open storage area is identified at the southwest corner of site, and the concrete pit and shed are also observed. In the 1980 photograph, the northern pond appears to be vegetated, the middle pond appears to be dry, there is liquid in the concrete pit, the shed is observed, and the open storage area appears to have increased in size. In the 1983 and 1988 photographs, both ponds appear to be vegetated, the concrete pit appears to contain liquid, and the shed is observed. In the 1988 photograph, a drainage channel can be seen located along the southern and western sides of the site, heading north; the pit and shed can be seen. In the 1995 photograph, the concrete pit and shed appear to have been removed, and a large excavated area covers about half of the site. The 2005 and 2009 photographs show a vegetated site with a few tracks crossing it.[4]

Radionuclides of Concern: Radioactive and non-radioactive materials from the SRE, SNAP and other nuclear programs were brought to Site 4886 for disposal. Potential contaminants of concern include U-238, U-234, U-235, U-236, Pu-239, Pu-240, Pu-241, Pu-242, Am-241, Th-232, H-3, Na-22, Na-24, Cr-51, Mn-54, Fe-55, Fe-59, Co-60, Kr-85, Sr-89, Sr-90, Sb-125, I-131,

[1] California Department of Health Services Letter from G. Wong to P. D. Rutherford, confirming the release of the former Sodium Disposal Facility, dated May 15, 1998.
[2] Rockwell International Authorization Review by F. E. Begley, February 6, 1989.
[3] Boeing Internal Letter from J. G. Barnes to Use Authorization File, stating the Use Authorization No. 159 had been terminated, dated January 14, 2002.
[4] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.

Cs-134, Cs-137, Ce-141, Ce-144, Ba (La)-140, Nb-95, Ru-103, Ru-106, Xe-133, Xe-135, Pm-147, Eu-152, Eu-154, and Sm-151.[1, 2] All radionuclides of concern listed with the exception of Na-24, Cr-51, Mn-54, Fe-59, Kr-85, Sr-89, I-131, Ce-141, Ba (La)-140, Nb-95, Ru-103, Ru-106, Xe-133, Xe-135, Pm-147 and Sm-151 are included in the August 2010 Final Field Sampling Plan for soil sampling in Area IV. The radionuclides omitted from the sampling plan have very short half-lives except for Sm-151 for which no commercial analytical method is available. Table 3.3 presents a summary of contaminants of concern.

Drainage Pathways: The topography of Site 4886 was initially relatively flat**.** Three man-made ponds and a concrete-lined pool were constructed over the years. Rockwell reported that material was dispersed onto surrounding land by explosions that extended to Building 4009. In 1987, drainage channels were constructed along the west and south sites of the site to control surface-water run-on and run-off. Prior to the installation of these channels, surface water from Site 4886 drained toward the northeast. After the channels were installed, the area northwest of the lower pond drained more directly to the north. After the year 2000 when a large portion of Site 4886 was excavated to fractured bedrock, the lower and upper pond areas were backfilled and graded to slope gently toward the north-north-east. Based on general site topography, surface water from Site 4886 flows through the siltstone narrows at the north end of the site and continues flowing northward through the NBZ and Brandeis-Bardin Institute land through Meier Canyon and into Arroyo Simi in Simi Valley.[3]

Radiological Contamination Potential: The preliminary MARSSIM Classification for the Site 4886 area is Class 1 because of its former use as a disposal area for non-radioactive and radioactive materials, and because it is not apparent that a full radiologic characterization of the area has been conducted.

Recommended Locations for Soil/Sediment Sampling:

Plate 1 and Figure 2.2 provide a convenient reference for the following recommendations.

Extensive soil sampling is recommended in the Site 4886 area. As discussed above, for many years this was a radiological disposal area, there were several radiological incidents at Site 4886, and documented evidence of radiological releases. In addition, previous characterization studies for the site 4886 area were focused on delineating the extent of contamination to standards that were applicable at the time. Characterization efforts likely did not achieve the requirements of the DTSC/DOE December 2010 AOC. Therefore, additional characterization is recommended for the Site 4886 area. This includes the following Site 4886 areas and appurtenances:

- The flat land and low lying areas on Site 4886. Radionuclides originating from items of radiologically contaminated equipment disposed of at the site may have been deposited on soil via explosion, wind, and precipitation events. Rockwell reported that material

[1] Hart, R. S., *Distribution of Fission Product Contamination in the SRE*, Atomics International Report No. NAA-SR-6890, March 1, 1962, pp. 8-27.
[2] Kinzer, J. and Crawford, A. C., *SRE First Core Fuel*, Atomics International Technical Data Record No. 5301, May 16, 1960, pp. 1-7.
[3] Montgomery Watson Harza, *Group 8 – Western Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume I – Text, Tables, and Figures*, September 2007, pp. 2-7 – 2-8.

was dispersed onto surrounding land by explosions that extended to Building 4009, so the radius of impact was about 600 feet. The gamma-scan results may prove helpful for selecting soil sampling locations.

- The locations of the former western, lower, and upper ponds and the concrete-lined pit that were notable features of Site 4886.

- The location of the former barrel open storage area in the southwest corner of the site that was identified in the 1978 and 1980 aerial photographs.

- The land on the far west side of the site between two rock ridges. This may have been a dumping area that has not been fully characterized.

- The drainage channels located on the west and south sides of the site that transport surface water northward to the NBZ. If radionuclides were released at the site, they may have migrated to the drainage channels during precipitation events.

- The drainage channels that extend into and traverse the NBZ. If radionuclides were released at the site, they may have migrated outside the SSFL along these drainage channels during precipitation events.

2.3 GROUP 3

The Group 3 index map is presented in Figure 2.3. Following Figure 2.3, the site photograph and layout drawings for each building area within HSA-8 Group 3 are presented. HSA-8 Group 3 includes one site containing a landfill and building excavation pit partially filled with water.

2.3.1 Site 4056 Area

Site Description: The Site 4056 area comprises approximately 4 acres of land bordered by 23rd Street, Building 4100, F and G Streets. The topography of the site is undulating with several large ravines. There are no known buildings or structures, including utilities, in this subarea. This site was first used as a construction dumpsite and landfill in the late 1950s.[1, 2] Figures 2.3.1a through 2.3.1h provide a current photograph, a plot plan, and the best available historical photographs. Plate 1 presents a summary of all identified features for this site.

Building Features: Site 4056 was designated for "loose fill" of earth from building construction and known as the Building 4056 landfill because of its proximity to an excavated pit where Building 4056, a Systems for Nuclear Auxiliary Power (SNAP) building, was to have been built, but the building was never constructed. The pit, located east of the landfill, is a vertically walled circular excavation that extends approximately 65 feet into fractured bedrock. The pit has an elevation of about 40 feet below the groundwater table elevation, and, as a result contains water. This pit is included in Site 4056. Soil from the Sodium Components Test Installation (SCTI)

[1] Santa Susana Area IV, Atomics International/Energy Systems Group Planning Maps, March 1962–November 1992.
[2] Chapman, J. A., *Radiological Survey of the T056 Landfill; Area from 23rd Street to Building T100; and an Area Across from Building T011*, Energy Technology Engineering Center Report No. GEN-ZR-0011, August 26, 1988, pp. 3-4, 9-11.

facility was deposited on Site 4056 in the early 1970s. From the mid-1960s to the mid-1970s, the landfill became a dumping ground for garbage, trash, scrap, drums and barrels. The contents of the barrels included oils, alcohols, sodium, sodium reaction products, grease, phosphoric acid, asbestos, rags, and rope. Miscellaneous debris deposited on the site included: wood scraps, concrete, sodium cold traps, pipes, vessels, old trucks, large system components, and sheet metal.[2, 1] Figure 2.3.1b, a 1975 photograph, shows the pit and debris on the site, with a steep ravine in the foreground.

Former Use(s): Atomics International used Site 4056 as a landfill for the disposal of loose fill of earth, bedrock, and minor construction debris (asphalt, concrete, scrap metal, etc) from building construction until the early 1970s. After this time, North American Rockwell used the site as a temporary storage location for hazardous and non-hazardous waste materials. The pit is not known to have had a purpose; backfilling did not warrant the cost. Rockwell claims that no radioactively contaminated items are known to have been deposited on the site. In the late 1970s, Rockwell decided to remove all items from the landfill and ravine and dispose of them off site; however significant debris remains in this landfill to date. During 1980 and 1981, Rockwell removed 89 drums containing oils, alcohols, sodium, sodium reaction products, grease, phosphoric acid, asbestos, rags, and rope from the site. In 1987, an EPA contractor conducted a CERCLA Preliminary Assessment/Site Investigation that included non-radiological soil and groundwater sampling.[2, 3, 4] Figure 2.3.1c presents a plot plan of the site. Figure 2.3.1d, a 1979 photograph, shows drums and debris on the site. Figure 2.3.1e shows drums dumped in a ravine. Figure 2.3.1f shows that the debris has been removed and the hillside graded. The date of this photograph is unknown.

In 1999, Boeing decided to drain the pit at Site 4056 to eliminate the recharge potential to groundwater in close proximity to Building 4059. The pit was located about 250 feet southwest of Building 4059. Water levels in the pit were historically 15 to 30 feet higher than the basement elevation of Building 4059. Pit water was pumped until between 2 and 5 feet remained. Figure 2.3.1g shows men in the partially drained pit. Figure 2.3.1h shows the bottom of the pit after dewatering.

Site 4056 is located adjacent to former SNAP reactor Building 4059 and former criticality test facility Building 4100.

Information from Interviewees: One former worker interviewed by EPA in 2009 indicated that SRE primary sodium loops were deposited at the Site 4056 pit. He marked the western edge of the pit as the location.

Radiological Incident Reports: None found.

[1] Montgomery Watson Harza, *Group 8 – Western Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume I – Text, Tables, and Figures*, September 2007, pp. 3-5 - 3-6.
[2] ICF Kaiser Engineers, *Current Conditions Report and Draft RCRA Facility Investigation Work Plan, Area IV Santa Susana Field Laboratory, Ventura County, California, Part 1, Volume 1*, October 1993, p. 4-2.
[3] Ecology and Environment, Inc., *Summary Review of Preliminary Assessment/Site Inspections of Rockwell International Santa Susana Field Laboratory*, July 19, 1989, p. 15.
[4] Olson, P., Shepard, R., and Adler, K., *CERCLA Program Phase II – Site Characterization*, ETEC Report No. GEN-ZR-0002, May 29, 1987, pp. 42-47.

Current Use: The Site 4056 landfill is not closed under RCRA. Reportedly, this site has not been used for the storage of hazardous and non-hazardous waste since 1981. The pit contains water and is fenced.

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s): A chronology of radiological investigations at this site is as follows:

- Between August 1987 and October 1988, Rockwell conducted a radiological inspection of 25 locations within Area IV. Total-average alpha/beta radioactivity and the gamma exposure rate were measured using Ludlum Model 2220-ESG portable scaler instruments coupled to a Ludlum Model 43-1 alpha scintillator, Ludlum Model 44-9 Geiger-Mueller pancake probe, and Ludlum Model 44-10 NaI gamma scintillator, respectively. All radiation measurements were compared with most conservative DOE residual radioactivity limits specified in "Guidelines for Residual Radioactivity at FUSRAP and SFMP Sites," Regulatory Guide 1.86, ANSI Standard N13.12, U.S. NRC License SNM-21, and the Federal Register. Rockwell's "acceptable" ambient gamma exposure rate was 5 µR/h above background at 1 meter from the surface. Rockwell's "acceptable" soil activity concentrations, including natural background, were 21 pCi/g for Ra-226, Th-232, and Th-230. For enriched uranium alpha contamination, the level was 46 pCi/g. Subsurface sampling for radioactive contamination was not conducted. Rockwell recommended that a subsurface radiological survey be performed concurrently with subsurface sampling for chemical contamination.[1]

- In 1988, Rockwell conducted a radiological survey of the Site 4056 landfill including the pit. A 1-liter sample of surface water was collected from the Site 4056 pit and analyzed by gamma spectrometry for 10,000 seconds. The maximum acceptable water activity concentration was $1E^{-4}$ microcurie per milliliter (µCi/ml) (100,000 pCi/L) for alpha activity and $1E^{-5}$ µCi/ml (10,000 pCi/L) for beta activity. No detectable activity from man-made radionuclides was identified by gamma spectrometry. Rockwell observed a large variability in natural background radioactivity measurements. At the Site 4056 landfill, ambient background radioactivity was estimated to be 15.3 µR/h with an acceptable limit of 5 µR/h above background. Rockwell recommended that items be surveyed for radioactivity during excavation of debris in the landfill and/or during subsurface sampling for volatile organic compounds.[2]

- During Rockwell's 1996 Area IV Radiological Characterization Survey, the entire accessible flat area of the Site 4056 landfill was surface scanned using a sodium iodide gamma detector. Surface soil in the ravine at the base of the Site 4056 landfill was sampled in two locations. One soil sample was collected from an area where old photographs showed that debris had been located. The second soil sample was collected 135 feet downstream, within 50 feet of the Area IV boundary. The samples were analyzed for gamma emitting radionuclides, H-3, Sr-90, and isotopes of U, Th, and Pu. Rockwell detected no radioactivity above what it considered to be naturally occurring

[1] Chapman, J. A., *Executive Summary of the DOE SSFL Site Radiological Survey*, ETEC Report No. GEN-ZR-0015, October 10, 1988, pp. 3, 6, 13, 18-19.
[2] Chapman, J. A., *Radiological Survey of the T056 Landfill; Area from 23rd Street to Building T100; and an Area Across from Building T011*, Energy Technology Engineering Center Report No. GEN-ZR-0011, August 26, 1988, pp. 11, 79, 81.

background. The EPA/NRC regulatory limits in 1996 were as follows in pCi/g: H-3, 20,000 ; Sr-90, 12; U isotopes, 18 ; Th isotopes, 2.7; and Pu isotopes, 34. Neither of the two soil samples exceeded these limits.[1]

- During 1999, Groundwater Resources Consultants, Inc. dewatered the Site 4056 pit. Water samples were collected from the pit prior to and during dewatering operations and were analyzed for chemical and radiological parameters. Results indicated that radiological parameters were comparable to Boeing's background levels with a maximum of 0.144 +/- 0.62 pCi/L for gross alpha, 2.50 +/- 1.3 pCi/L for gross beta, and 67.4 +/- 100 pCi/L for H-3.[2]

Radiological Use Authorizations: None found.

Former Radiological Burial or Disposal Locations: Significant disposal occurred here over several decades including the potential disposal of SRE reactor components that were allegedly deposited at the Site 4056 pit.

Aerial Photographs: Aerial photographs show undeveloped land until the 1957 photograph when one possible and one probable fill area are identified in the region of Site 4056. In the 1959 photograph, one of the fill areas has increased in size since 1957. In the approximately 1960 photograph, a collection of individual dump-truck-sized mounds of medium-toned material is visible on the fill area near the location of a future pit. This fill area has increased in size in the 1965 photograph; the mounds have disappeared and a sickle-shaped partially liquid-filled excavation can be seen. In the 1967 photograph, a liquid-filled circular excavation can be seen and a former fill area is vegetated. In the 1972 photograph, the liquid-filled circular excavation or pit is again clearly seen along with more vegetation, and approximately 10 light-toned objects are observed. In the 1978 photograph, solid waste is seen in three areas. In the 1980 photograph, a dump truck and numerous mounds of material can be seen in an expanded fill area. In the 1983 photograph, ground scars are observed where the dumping previously took place. In the 1988 and 1995 photographs, ground scars are reduced in size and former dumping areas are vegetated. In the 2005 and 2009 photographs, the circular pit can still be seen, but most of the area is vegetated.[3]

Radionuclides of Concern: One interviewee indicated that SRE primary sodium loops were deposited at the Site 4056 pit. Site 4056 was located near SNAP 8 reactor Building 4059, and criticality test facility Buildings 4009 and 4100. Potential radioactive contaminants from these sources include U-233, U-234, U-235, U-236, U-238, Th-228, Th-232, Pu-238, Pu-239, Pu-240, Pu-241, Pu-242, Am-241, Ra-226, Cs-134, Cs-137, Sr-90), H-3, Fe-55, Co-58, Co-60, Ni-63, barium-133 (Ba-133), Eu-152, Eu-154, Pm-147, and Ta-182.[4] All radionuclides of concern listed, with the exception of Co-58 and Ta-182, are included in the August 2010 Final Field

[1] Rutherford, P., *Area IV Radiological Characterization Survey Final Report*, Energy Technology Engineering Center Report No. A4CM-ZR-0011, Revision A, August 15, 1996, pp. 38, 54,-64.
[2] Groundwater Resources Consultants, Inc., *Results of Dewatering Pit B/056, Boeing North American, Inc., Rocketdyne Propulsion & Power, Ventura County, California*, Report No. 8640M-408, July 23, 1999, pp. 4, 9.
[3] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.
[4] Vitkus, T. J. and Morton, J. R., *Radiological Survey of the Building 059 Reactor Vault, Santa Susana Field Laboratory, Rockwell International, Ventura County, California, Final Report*, Oak Ridge Institute for Science and Education ORISE Report No. 95/G-18, June 1995, pp. 1-2, 8-9.

Sampling Plan for soil sampling in Area IV. The radionuclides omitted from the sampling plan, Co-58 and Ta-182 (due to relatively short half-lives),,do not meet the criteria for analysis. Table 3.3 presents a summary of contaminants of concern.

Drainage Pathways: The research team has not found any formal sanitary or storm drain features such as pipes or trenches in this subarea. Based on general site topography, surface water flow at Site 4056 is predominantly to the north. East of the surface water divide, around the western boundary of the pit, surface water flows into the Site 4056 pit. West of the surface water divide, surface water discharge is via sheet flow over the topographically flat portions of the site toward a well-developed, natural drainage to the west. The northern portion of the landfill drains to an east-west tributary to the primary north-south drainage that transports water north through the NBZ and Brandeis-Bardin Institute land, through Meier Canyon and into Arroyo Simi in Simi Valley.[1]

Radiological Contamination Potential: The preliminary MARSSIM Classification for the Site 4056 area is Class 1 because of allegations of disposal of radioactive components of the SRE reactor and a comprehensive radiological survey has not been conducted on the site.

Recommended Locations for Soil/Sediment Sampling:

Plate 1 and Figure 2.3 provide a convenient reference for the following recommendation.

Information is lacking regarding the extent of fill activities at Site 4056. In addition, previous characterization studies for the Site 4056 area were limited. Characterization studies were focused on delineating the extent of contamination to previous standards. Characterization was not conducted to delineate the extent of contamination consistent with the DTSC/DOE December 2010 AOC. Therefore, additional characterization is recommended for the Site 4056 area. This includes the following Site 4056 areas:

- Geophysical surveys and soil sampling should be used to delineate the landfill.

- Sediment and surface water in the Site 4056 pit. In light of the proximity of the site to former radiological facilities (i.e. Building 4100 and Building 4059), it is not clear that sediment and surface water in the pit have been adequately sampled and analyzed for radiological contaminants.

- Sediment and surface water in the drainage channel that extends north from Building 4100 to the NBZ. It is not clear that the sediment in the drainage channel has been adequately sampled and analyzed for radiological contaminants.

- Soil in the ravines on Site 4056. It is not clear that the soil in the ravines has been adequately sampled and analyzed for radiological contaminants.

[1] Montgomery Watson Harza, *Group 8 – Western Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume I – Text, Tables, and Figures*, September 2007, pp. 2-6 – 2-8.

- Areas where hazardous waste drums were previously stored beside the dirt road opposite the pit. It is not clear that the areas where drums were previously stored have been adequately sampled and analyzed for radiological contaminants.

3.0 RADIONUCLIDE LIST

3.1 U.S. ATOMIC ENERGY COMMISSION SPECIAL NUCLEAR MATERIAL LICENSE

The first license issued by the U.S. Atomic Energy Commission (AEC) for the SSFL site was Special Nuclear Material License No. SNM-21. It was initially issued on April 6, 1956 for use at the Canoga Park site. License No. SNM-21 authorized Atomics International Division of North American Aviation, Inc. (AI) to receive and possess 50 grams of U enriched in U-235 for use in fission counter tubes. License No. SNM-21 was amended 79 times to increase the number and type of nuclear materials that could be handled at the Canoga Park, De Soto, and SSFL sites. This license was terminated on September 27, 1996. In February 1975, the AEC became known as the NRC and License No. SNM-21 became an NRC license. License No. SNM-21 applied to contractor owned facilities, only, located outside the former ETEC boundary. No sites within Subarea HSA-8 operated under License No. SNM-21.

3.2 U.S. ATOMIC ENERGY COMMISSION CRITICAL EXPERIMENTS FACILITY LICENSE

On October 3, 1960, the AEC authorized Atomics International, under License No. CX-17, to possess and operate a separable-half type critical experiments facility at power levels not exceeding 200 watts (thermal) in Building 100 (now known as Building 4100). No sites within Subarea HSA-8 operated under License No. CX-17, but Buildings 4009 and 4100 are adjacent to each other and effluent from both buildings flowed into the same drainage channel. Atomics International conducted this research under contract to the Southwest Atomic Energy Associates of Shreveport, Louisiana. The license permitted the possession "and use of special nuclear materials as follows:

- 25 kilograms of U-233 and 110 kilograms of U-235 as fuel for the reactor;
- 135 grams of U-233, 1,135 grams of U-235, and 135 grams of Pu-239 in foils and capsules for use in connection with operation of the reactor;
- 0.5 gram each of U-233, U-235, and Pu-239 in fission counters for use in connection with operation of the reactor; and
- 32 grams of Pu in encapsulated neutron sources for use in connection with operation of the reactor."

License No. CX-17 also permitted the possession "and use of source materials as follows:

- 656 kilograms of Th-232 for use in the core and buffer regions of the reactor;
- 700 grams of natural U in foils and capsules for use in connection with operation of the reactor; and
- 0.5 gram each of U-234, U-236, and U-238 in fission counters for use in connection with operation of the reactor."

License No. CX-17 also permitted the possession "and use of 0.5 gram of Np-237 in fission counters for use in connection with operation of the reactor and to possess, but not to separate such byproduct materials as may be produced by operation of the reactor."

License No. CX-17 was amended ten times before it was terminated on October 6, 1980.

3.3 CALIFORNIA DEPARTMENT OF PUBLIC HEALTH RADIOACTIVE MATERIAL LICENSE

On September 11, 1963, the State of California, Department of Public Health issued Radioactive Material License No. 0015-59 to Atomics International. This license authorized the possession and use of a wide range of radioactive materials at the De Soto Avenue, Canoga Park, and SSFL sites as listed in Table 3.1, below.

Table 3.1
Radioactive Materials Covered by License No. 0015-59

Radioactive Material (element and mass number)	Chemical and/or Physical Form	Maximum Quantity that Licensee may Possess
Any byproduct material between atomic number 3 and 83	Any	7 curies of each byproduct material between atomic number 3 and 83
Antimony-124	Any	50 curies
Iridium-192	Any	70 curies
Cobalt-60	Sealed sources	10 sources not to exceed 400 curies each
Hydrogen-3	Any	550 curies
Polonium-210	Any	150 curies
Any byproduct material	Separated from irradiated thorium and uranium samples	250 microcuries total
Hydrogen-3	Titanium tritide foil (U.S. Nuclear Corporation)	500 millicuries
Hydrogen-3	Titanium tritide foil (U.S. Radium Corporation)	1 curie
Strontium-90	Sealed source (U.S. Nuclear Corporation Model 312)	5 microcuries
Radium-226	Any	2,000 milligrams
Radium-226	Sealed neutron sources	500 milligrams
Cobalt-60	Sealed source (U.S. Nuclear Corporation Model 338)	1 source not to exceed 5 curies
Cobalt-60	Sealed source (Isotopes Specialties Company Model 338)	1 source not to exceed 5 curies
Cerium-144	Sealed source (Isotopes Specialties Company Model 160)	50 microcuries
Iridium-192	Sealed source (Technical Operations Model A424-1)	1 source not to exceed 20 curies
Radium-226	Sealed sources (NRC Equipment Corporation)	Seven sources not to exceed 0.4 milligram each
Strontium-90	Sealed sources	Two sources of 3 millicuries each
Americium-241	Any	2 millicuries
Natural or depleted uranium	Any	20,000 pounds
Natural thorium	Any	700 pounds

During the late 1980s and early 1990s, ISI activities in Building 4009 were covered under License No. 0015-70. Up until December 1969, there had been 39 amendments to this license. The radioactive materials covered in the 39th amendment are listed in Table 3.2, below.

Table 3.2
Radioactive Materials Covered by License No. 0015-59, Amendment No. 39

Radioactive Material (element and mass number)	Chemical and/or Physical Form	Maximum Quantity that Licensee may Possess
Any radionuclide with atomic number 3 through 83	Any	25 curies for any one radionuclide
Antimony-124	Any	100 curies
Iridium-192	Any	100 curies
Cobalt-60	Sealed sources	10 sources not to exceed 400 curies each
Hydrogen-3	Any	10,000 curies
Polonium-210	Any	150 curies
Krypton-85	Any	100 curies
Neptunium-237	Any	100 microcuries
Radium-226	Any except as neutron sources	5 grams
Radium-226	Sealed neutron sources	500 milligrams
Cobalt-60	Sealed source (U.S. Nuclear Corporation Model 338)	1 source not to exceed 5 curies
Cobalt-60	Sealed source (Isotopes Specialties Company Model 338)	1 source not to exceed 5 curies
Cobalt-60	Sealed source (Lockheed Nuclear Products Drawing 442-1001)	25,000 +/- 2,500 curies in 12 sources
Iridium-192	Sealed source (Technical Operations Model A424-1)	4 sources not to exceed 100 curies each
Radium-226	Sealed sources (NRC Equipment Corporation)	Seven sources not to exceed 0.4 milligram each
Califonium-252	Sealed source (Oak Ridge)	2 sources not to exceed 550 microcuries each
Any radionuclide with atomic number 3 through 83	Any	Not to exceed 100 curies for any one radionuclide
Promethium-147	Promethium oxide	150,000 curies
Americium-241	Any	10 curies
Natural or depleted uranium	Any	20,000 pounds
Natural thorium	Any	1,000 pounds
Tantalum-182	Metal	500 curies
Natural or depleted uranium	Any	50,000 pounds
Mixed fission products (Hot Lab)	Any	10,000,000 curies
Any radionuclide with atomic number 3 through 83 (Hot Lab)	Any	100,000 curies for any one radionuclide

This license was amended 64 times up until August 2, 1979 when the license number was changed to No. 0015-70. This license number was changed a second time to No. 0015-19 on December 5, 1996. As of August 27, 2010, there had been 110 amendments to this license.

3.4 RADIONUCLIDE LIST TO BE USED IN SOIL AND GROUNDWATER SAMPLING

From a review of historical documents and radioactive material licenses issued for the SSFL, all of the radionuclides selected for radiochemical analysis of soil and groundwater samples are likely to have been used or generated on the SSFL.

Table 3.3
Summary of Subarea HSA-8 Sites
Potential Contaminants of Concern

Site No.	Use(s)	Current Status	Potential Radiological Contaminants of Concern	MARSSIM Class
4009	Organic Moderated Reactor Critical Facility, Sodium Graphite Reactor Critical Facility	Standing	U-235, U-238, Th-232, Th-234, Th-228, Ra-226, Ac-228, Pb-214, Pb-212, Tl-208, Bi-214, Bi-212, Sr-90, Cs-137, Na-24, Co-57, Co-60, Eu-152.	1
4056	Landfill	Closed	U-238, U-233, U-234, U-235, U-236, Pu-238, Pu-239, Pu-240, Pu-241, Pu-242, Am-241, Th-228, Th-232, Ra-226, Cs-134, Cs-137, Sr-90, H-3, Na-22, K-40, Mn-54, Fe-55,Co-58, Co-60, Ni-59, Ni-63, Ba-133, Eu-152, Eu-154, Pm-147, Ta-182.	1
4317/4730	Pistol Range/Isotope System Impact Test Control Building	Demolished	U-238, U-234, U-235, Pa-231, Th-230, Ac-227, Ra-226, Pb-210, H-3, K-40, Mn-54, Fe-55, Co-60, Eu-152, Eu-154.	1
4318/4820	Pistol Range/Isotope System Impact Test Device	Demolished	U-238, U-234, U-235, (Pa-231, Th-230, Ac-227, Ra-226, Pb-210, H-3, K-40, Mn-54, Fe-55, Co-60, Eu-152, Eu-154.	1
4425	Solar Concentrator Test Facility/Weather Station and Astronomical Observatory/Uranium Fuel Element Drop Site	Demolished/ In Use	U-238	1 in/near Fuel Element Drop Site; 3 elsewhere.
4814	Sodium-Water Reaction Test Structure, Large leak Injector Device	Demolished	Cs-137	2
4885	Pistol Range	Demolished	U-238, U-234, U-235, U-236, Pu-239, Pu-240, Pu-241, Pu-242, Th-232, Na-22, Na-24, Cr-51, Mn-54, Fe-59, Co-60, Kr-85, Sr-89, Sr-90, Sb-125, I-131, Cs-134, Cs-137, Ce-141, Ce-144, Ba (La)-140, Nb-95, Ru-103, Ru-106, Xe-133, Xe-135, Pm-147, Sm-151.	1
4886	Sodium Burn Pit, Sodium Disposal Facility	Demolished	U-238, U-234, U-235, U-236, Pu-239, Pu-240, Pu-241, Pu-242, Th-232, Na-22, Na-24, Cr-51, Mn-54, Fe-59, Co-60, Kr-85, Sr-89, Sr-90, Sb-125, I-131, Cs-134, Cs-137, Ce-141, Ce-144, Ba (La)-140, Nb-95, Ru-103, Ru-106, Xe-133, Xe-135, Pm-147, Sm-151.	1

4.0 REACTOR/CRITICALITY FACILITIES/SIGNIFICANT SITES WORKS CITED

4.1 BUILDING 4009

Facility Name	Building No.	Period of Operation	Notes
Organic Moderated Reactor	4009	1958 to 1967	Basic tests of reactor concept
Sodium Graphite Reactor	4009	1958 to 1967	Basic tests of reactor concept

Building 4009 Cited Documents

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Letter from R. L. Kistner, Rockwell International, to Ventura County Air Pollution Control District, Re: *Tenant Improvements Building 009 in Area IV Santa Susana Field Laboratory*, May 11,

Letter from A. Lenox, Boeing Corporation, to D. Salter, Ventura County Environmental Health Division, re: Closure Request Former Tank UT-3, dated November 19, 1998.

Letter from M. E. Remley, Atomics International, to J. V. Levy, U.S. Atomic Energy Commission, Re: *Reactor Operating Limits for Sodium Graphite Reactor Critical Facility in Building 4009*, November 4, 1964.

Letter from P. Rutherford, Boeing Corporation, to P. Baldenweg, California Department of Health Services, re: Building 009 Survey Sampling Data, License 0015-19, dated August 19, 1998.

Letter from P. Rutherford, Rockwell International, to B. Kapel, California Department of Health Services, re: Request for Release of Building 009 for Unrestricted Use and Approval to Dispose of Concrete from Building 009 – License 0015-70, dated October 26, 1995.

Letter from D. Wesley, California, Department of Health Services, to J. G. Barnes, Boeing North American/Rocketdyne Division, re: releasing Buildings 4009 and 4020 for unrestricted use, dated January 20, 1999.

Montgomery Watson Harza, *DOE Leach Fields (Area IV AOC) RCRA Facilities Investigation Report, Santa Susana Field Laboratory, Ventura County, California, DRAFT*, October 2003, pp. 2-2, 3-4.

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Rockwell Internal Letter from P. H. Horton to L. J. Auge, Re: *Start Up of High Energy Rate Forge (HERF) Depleted Uranium (DU) Operations at Building 009, SSFL*, September 29, 1989.

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Rockwell International Internal letter from J. A. Chapman to R. D. Meyer, re: Field Work Task Proposal for Remediation of Contaminated Areas Identified by the DOE SSFL Site Radiological Survey, dated December 1, 1988, p. 5.

Rockwell International Internal Letter from P. D. Rutherford to C. Butler, re: Building 009 Roof Survey, dated May 4, 1995.

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Zwetzig, G. B., *Organic Moderated Reactor Critical Experiment Hazards Summary*, Report No. NAA-SR-3220, December 15, 1958, p. 26.

4.2 SITE 4886

Facility Name	Site No.	Period of Operation	Notes
Sodium Disposal Facility/ Sodium Burn Pit	4886	1956 to 1978	Waste Disposal Facility

Site 4886 Cited Documents

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Interview No. 107 of former employee conducted by the U.S. DOE and EPA, September 2010.

Interview No. 154 of former employee conducted by the U.S. DOE and EPA, September 2010.

Interview No. 188 of former employee conducted by the U.S.DOE, September 2010.

Interview No. 254 of former employee conducted by the U.S. DOE and EPA, September 2010.

Interview No. 277 of former employee conducted by the U.S. DOE, September 2010.

Interview No. 287 of former employee conducted by the U.S.DOE, September 2010.

Interview No. 288 of former employee conducted by the U.S. DOE, September 2010.

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4.3 SITE 4056

Facility Name	Site No.	Period of Operation	Notes
Site 4056 Landfill	4056	1957 to 1980s	Waste Disposal Area

Site 4056 Cited Documents

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Legend

- Subarea 8 Groups

Centerline Roads
- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings
- Demolished
- Existing
- Parking Lots

Surface Water
- Intermittent Stream
- Permanent Stream
- Surface Water
- Lined Channel

Tanks
- Above ground Storage Tank
- Underground Storage Tank
- Unknown Tank Type
- French Drain Holding Tank
- Sump
- Dry Well
- Tank Footprint
- Drain
- Well
- French Drain
- Drainage
- Leach Field
- Septic System

Aerial Photography Data
- Aerial Photography Features
- Septic Tank
- Leach Field
- Cooling Fan
- Other

Utilities
- Gas
- Storm Drain
- Sanitary Sewer
- Sanitary Waste
- Water
- Water (Removed)

Surface Features
- Channel
- Drain
- Drain
- Drainage Divide
- Gutter
- Tank
- Tank
- Vault
- Well
- Surface Water Flow (From Boeing Database, 2008)

Aerial Photography Descriptors

Type	Description
B	Building
CONT	Container
CR	Crates
DB	Debris
DG	Disturbed Ground
DTM	Dark Tone Material
EX	Excavation
FA	Fill Area
GS	Ground Scar
HT	Horizontal Tank
IM	Impoundment
LTMM	Light Toned Mounded Material
MTMM	Medium Toned Mounded Material
OS	Open Storage
PA	Processing Area
PL	Pipeline
POSS	Possible
PROB	Probable
SS	Smoke Stack
ST	Stain
S-T	Storage Tank
UO	Unidentified Object
VT	Vertical Tank
WDA	Waste Disposal Area

N

0 50 100 200

Scale In Feet

Historical Site Assessment
Final Technical Memorandum - HSA-8

Plate 1
Subarea HSA-8
Santa Susana Field Laboratory

U.S. EPA Region 9

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

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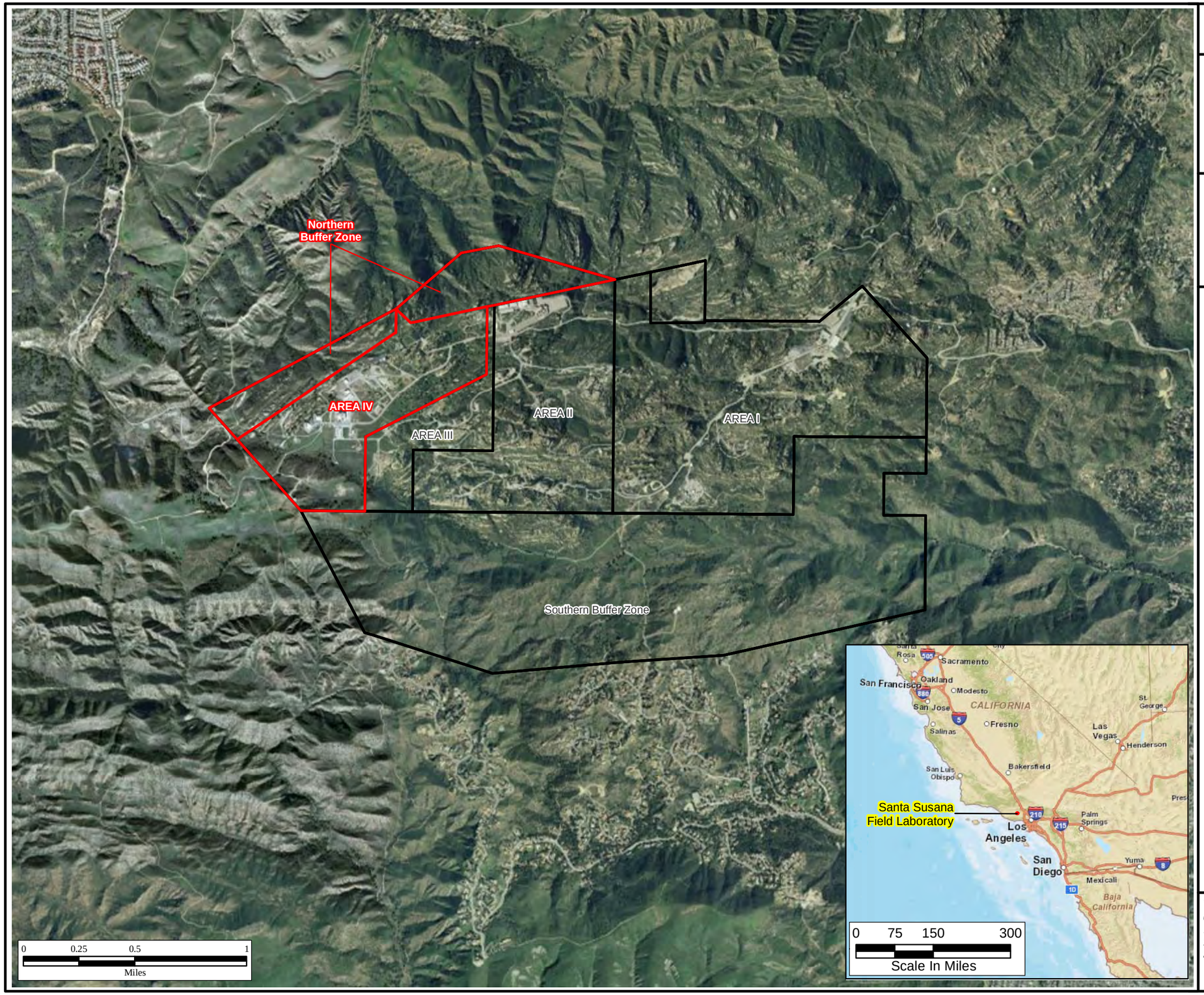
Project: EP9038
Edited: 09/14/2010 TJ
Source:Boeing Company, 2008
CIRGIS, 2007

HGL HydroGeoLogic, Inc.

Redacted

Figure 1.1
Site Location
Santa Susana Field Laboratory

U.S. EPA Region 9



Legend

EPA Study Area Boundary;
Area IV and Northern Buffer Zone

Santa Susana Field Laboratory
Property Boundary

N

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(1-01)SiteMap_Updated.mxd
11/22/2011 tjansen
Project: EP9038
Sorce: CaSil, NAIP 2009; Boeing 2008

HydroGeoLogic, Inc

Redacted

Figure 1.2
General Site Layout for
Area IV/HSA Subareas
Santa Susana Field Laboratory

U.S. EPA Region 9

Legend

HSA Subarea

Buildings

Existing
Removed

N

0 250 500 1000
Scale In Feet

Y:\Santa_Susana\EP9038\TM\HSA_8
(1-02)site_layout.mxd
11/22/2011 tjansen
Project: EP9038
Sorce: Boeing Company, 2008
CIRGIS, 2007

HGL HydroGeoLogic, Inc

Redacted

Figure 1.3
Subarea HSA-8
Santa Susana Field Laboratory

U.S. EPA Region 9

Legend

Buildings

- Existing
- Removed
- Lined Channel
- Intermittent Stream*
- Pipe (Unknown Type)
- Surface Water Flow
- Drainage Divide

*Intermittent streams also represent unlined channels.

N

0 100 200 400
Scale In Feet

Y:\Santa_Susana\EP9038\TM\HSA_8
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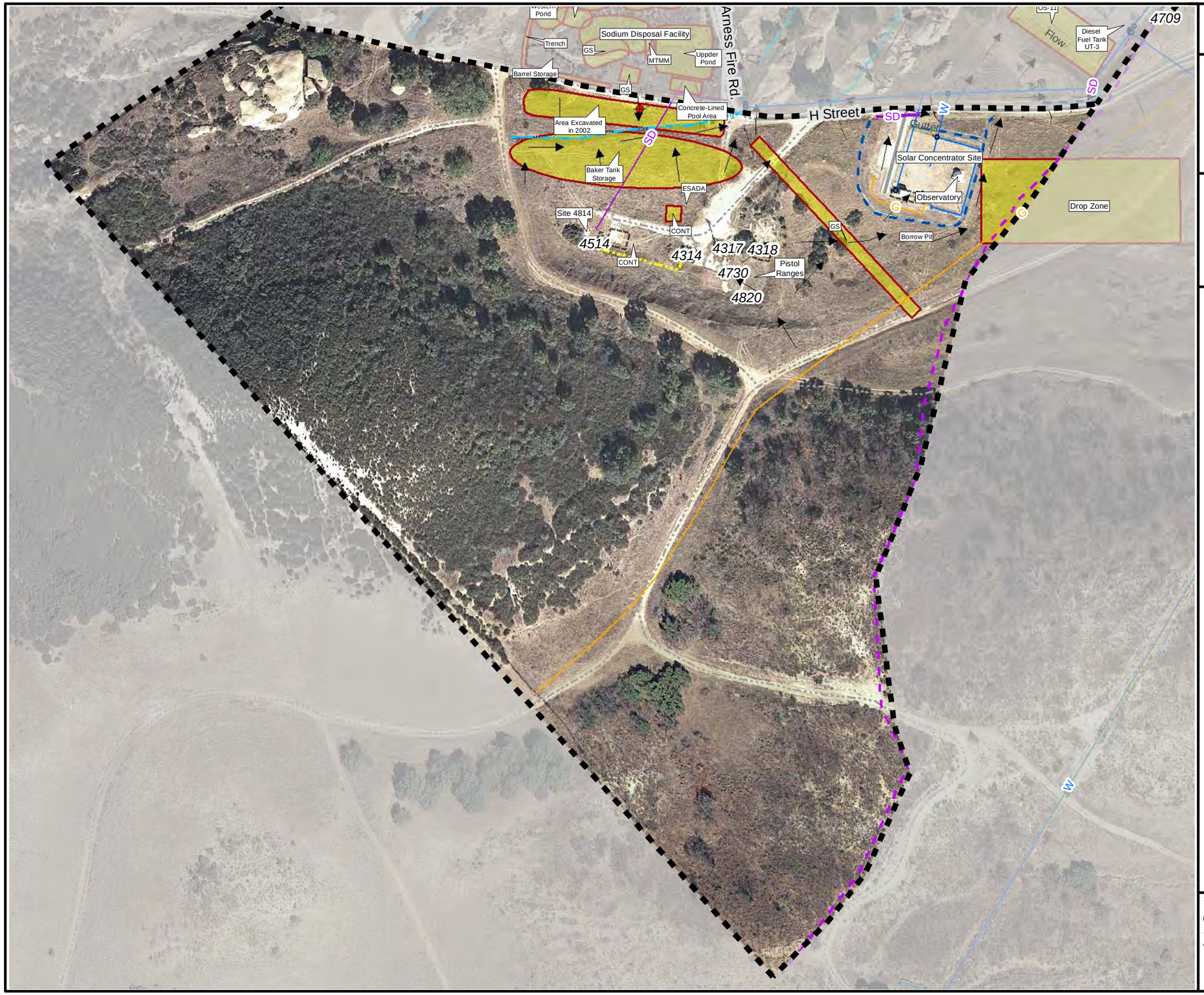
11/22/2011 tjansen
Project: EP9038
Source:Boeing Company, 2008
CIRGIS, 2007

HydroGeoLogic, Inc

Redacted

Figure 2.1
Area IV Subarea 8-1
Santa Susana Field Laboratory

U.S. EPA Region 9



Legend

- Subarea 8-1 Boundary
- Primary Roads
- Secondary Roads
- Underground Storage Tank
- Unknown Tank Type
- Sump
- Dry Well
- Tank Footprint
- Above ground Storage Tank
- Demolished Bldg.
- Existing Bldg.
- Parking Lots
- Drainage
- Drain
- Well

Aerial Photo Features

- Aerial Photography Features
- Leach Field
- Other

Surface Water

- Intermittent Stream
- Permanent Stream
- Surface Water
- Lined Channel
- French Drain
- Drainage
- Leach Field
- Septic System

Utilities

- Channel
- Drain
- Drain
- Drainage Divide
- Gutter
- Tank
- Tank
- Vault
- Well
- G Gas
- SD Storm Drain
- SS Sanitary Sewer
- W Water

B	Building
CONT	Container
CR	Crates
DB	Debris
DG	Disturbed Ground
DTM	Dark Tone Material
EX	Excavation
FA	Fill Area
GS	Ground Scar
HT	Horizontal Tank
IM	Impoundment
MTMM	Medium Toned Mounded Material
OS	Open Storage
PA	Processing Area
PL	Parking Lot
POSS	Possible
PROB	Probable
S-T	Storage Tank
SS	Smoke Stack
ST	Storage
UO	Unidentified Object
VT	Vertical Tank
WDA	Waste Disposal Area

N

0 25 50 100
Scale In Feet

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12/1/2011 tjansen
Sorce: Boeing Company, 2008
CIRGIS, 2007

HydroGeoLogic, Inc

Redacted

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Project:EP9038
Revised: 01/27/2011 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

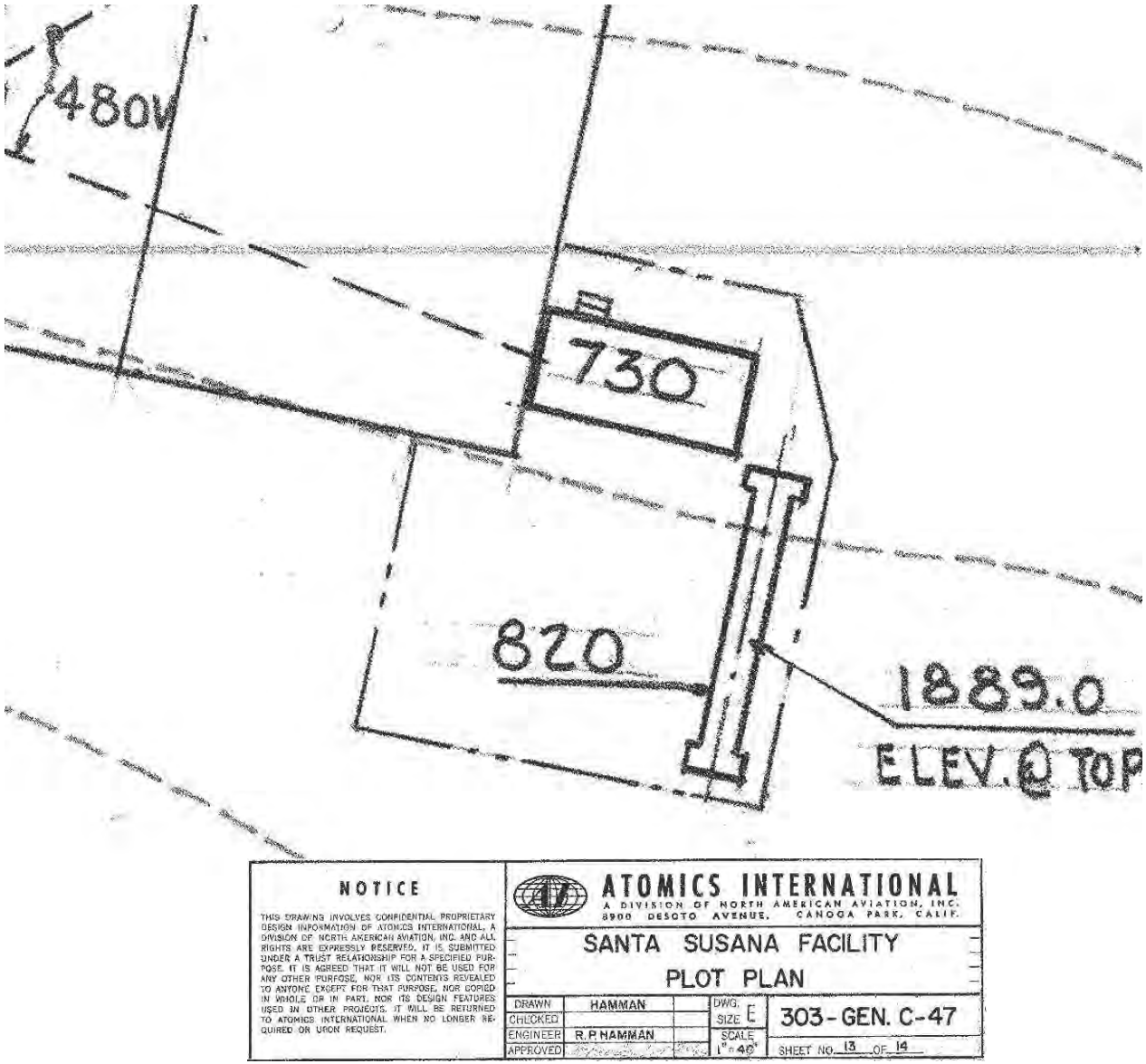
Figure 2.1.1a
Building 4317/4730
Site Photograph

Y:/Santa_Susana/EP9038/TM/HSA_8 (2-1-1b)bldgSite4814SP1988.cdr
Project:EP9038
Revised: 12/23/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.1.1b
Buildings 4317, 4318
Site 4814
1988 Photograph

Redacted



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Revised: 12/23/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.1.1c
Building 4317/4730
Plot Plan

Y:/Santa_Susana/EP9038/TM/HSA_8 (2-1-1d)bldgSite4814AP.cdr
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Revised: 12/23/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.1.1d
Buildings 4317, 4318
Sites 4814, 4425
Aerial Photograph
August 1988

Y:/Santa_Susana/EP9038/TM/HSA_8 (2-1-2a)Bldg4318-4820AP.cdr
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Revised: 01/27/2011 TJ
Source: Boeing Company, 2008

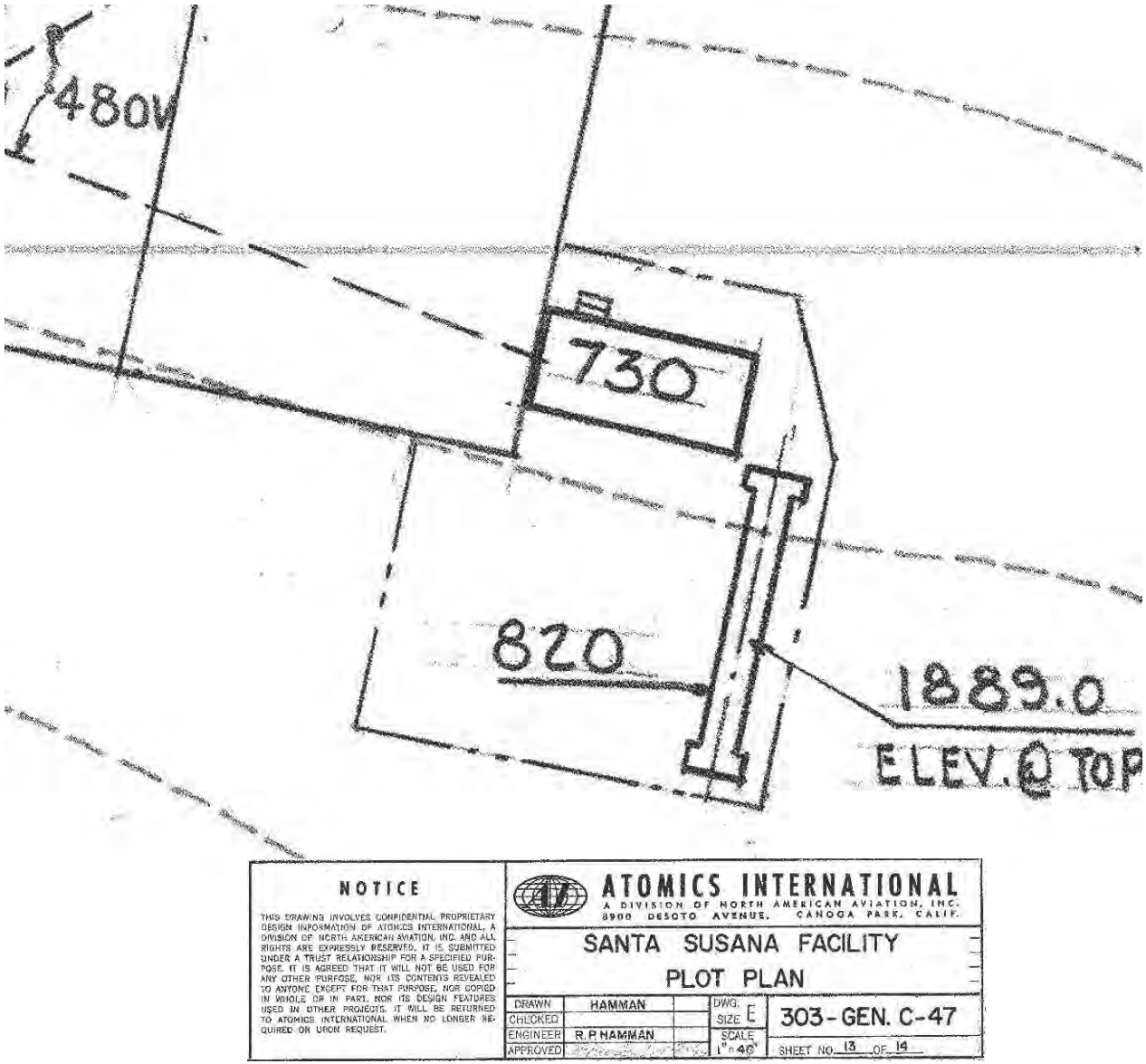
U.S. EPA Region 9

Figure 2.1.2a
Building 4318/4820
Site Photograph

Y:/Santa_Susana/EP9038/TM/HSA_8 (2-1-2b)bldgSite4814SP1988.cdr
Project:EP9038
Revised: 12/23/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.1.2b
Buildings 4317, 4318
Site 4814
1988 Photograph



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Revised: 12/23/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.1.2c
Building 4318/4820
Plot Plan

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Project:EP9038
Revised: 12/23/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.1.2d
Buildings 4317, 4318
Sites 4814, 4425
Aerial Photograph
August 1988

Y:/Santa_Susana/EP9038/TM/HSA_8 (2-1-3a)Site4814AP.cdr
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Revised: 01/27/2011 TJ
Source: Boeing Company, 2008

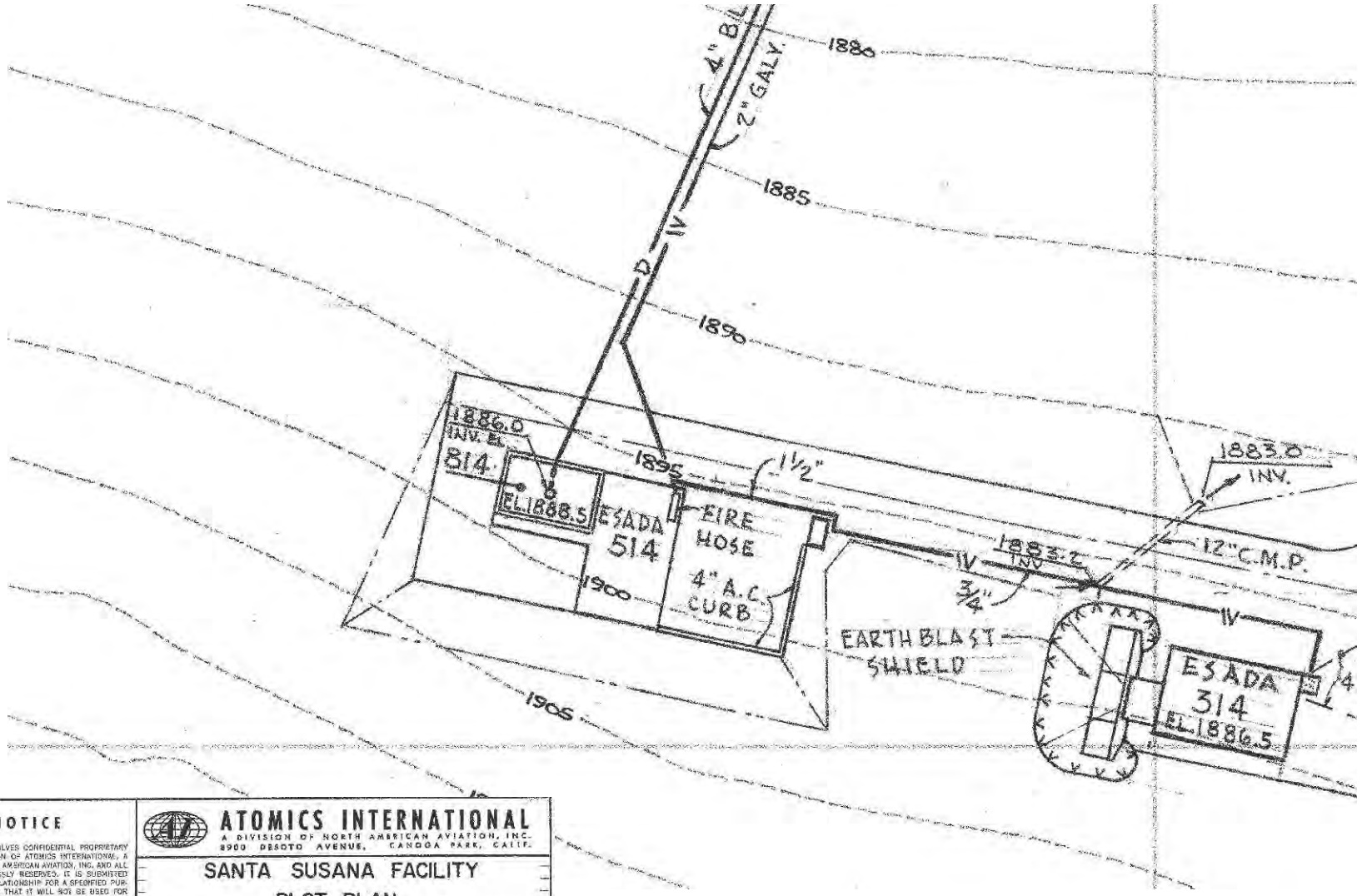
U.S. EPA Region 9

Figure 2.1.3a
Site 4814
Site Photograph

Y:/Santa_Susana/EP9038/TM/HSA_8 (2-1-3b)Site4814.cdr
Project:EP9038
Revised: 12/23/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.1.3b
Site 4814
West End
Looking North
August 1992



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Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.1.3c
Site 4814
Plot Plan

Y:/Santa_Susana/EP9038/TM/HSA_8 (2-1-3d)Site4814RT.cdr
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Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.1.3d
Site 4814
Remediation Trailers

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Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.1.3e
Buildings 4317, 4318
Site 4814
1988 Photograph

Y:/Santa_Susana/EP9038/TM/HSA_8 (2-1-3f)bldgSite4814AP.cdr
Project:EP9038
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Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.1.3f
Buildings 4317, 4318
Sites 4814, 4425
Aerial Photograph
August 1988

Y:/Santa_Susana/EP9038/TM/HSA_8 (2-1-4a)Site4425AP.cdr
Project:EP9038
Revised: 01/27/2011 TJ
Source: Boeing Company, 2008

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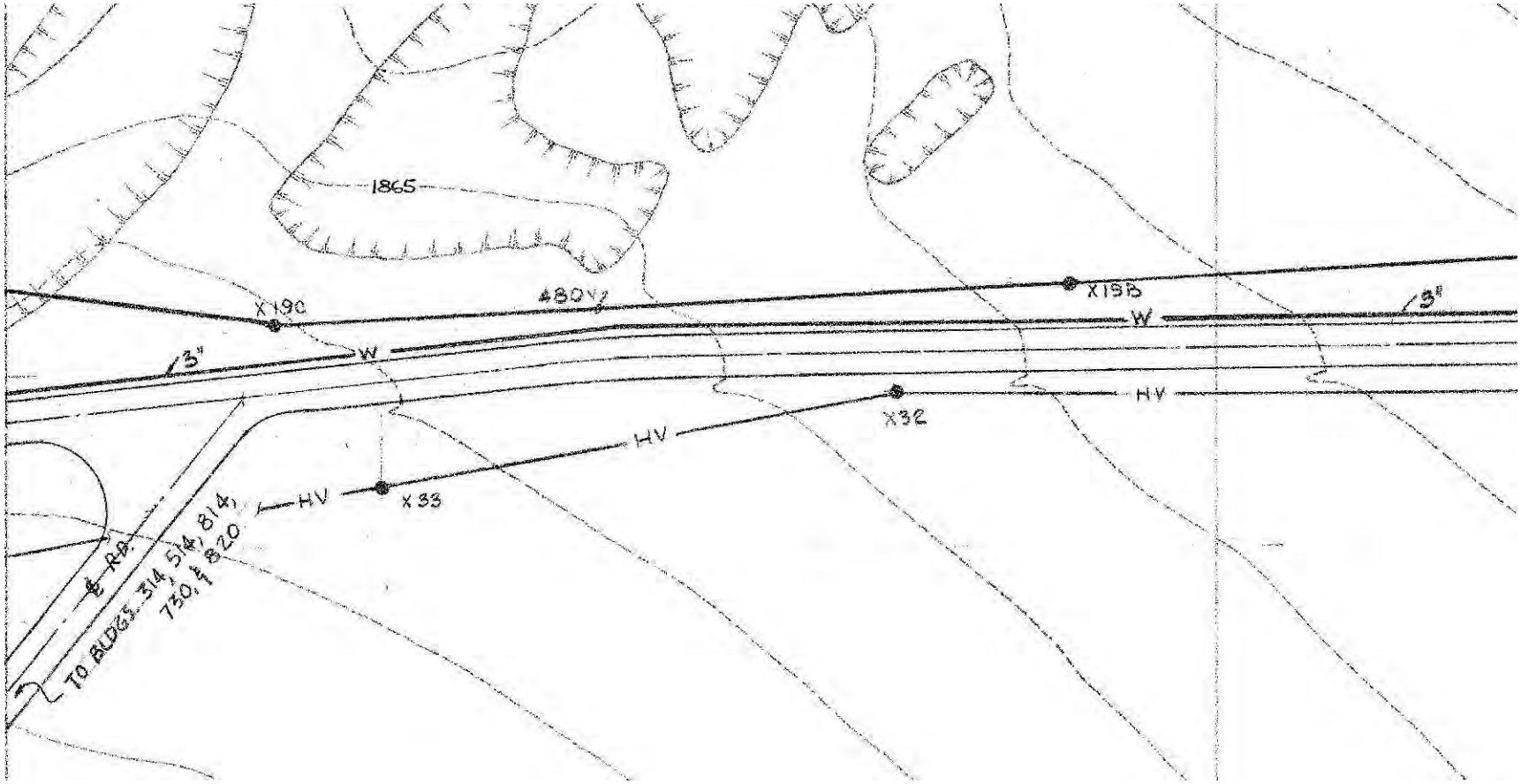
Figure 2.1.4a
Site 4425
Site Photograph

Y:/Santa_Susana/EP9038/TM/HSA_8 (2-1-4b)bldgSite4814AP.cdr
Project:EP9038
Revised: 12/23/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.1.4b
Buildings 4317, 4318
Sites 4814, 4425
Aerial Photograph
August 1988



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SANTA SUSANA FACILITY
PLOT PLAN

DRAWN	HAMMAN	DWG. SIZE E	303-GEN.-C 45
CHECKED			
ENGINEER	R.P.HAMMAN	SCALE 1"=40'	SHEET NO. 11 OF 14
APPROVED			

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Revised: 12/23/2010 TJ
Source: Boeing Company, 2008

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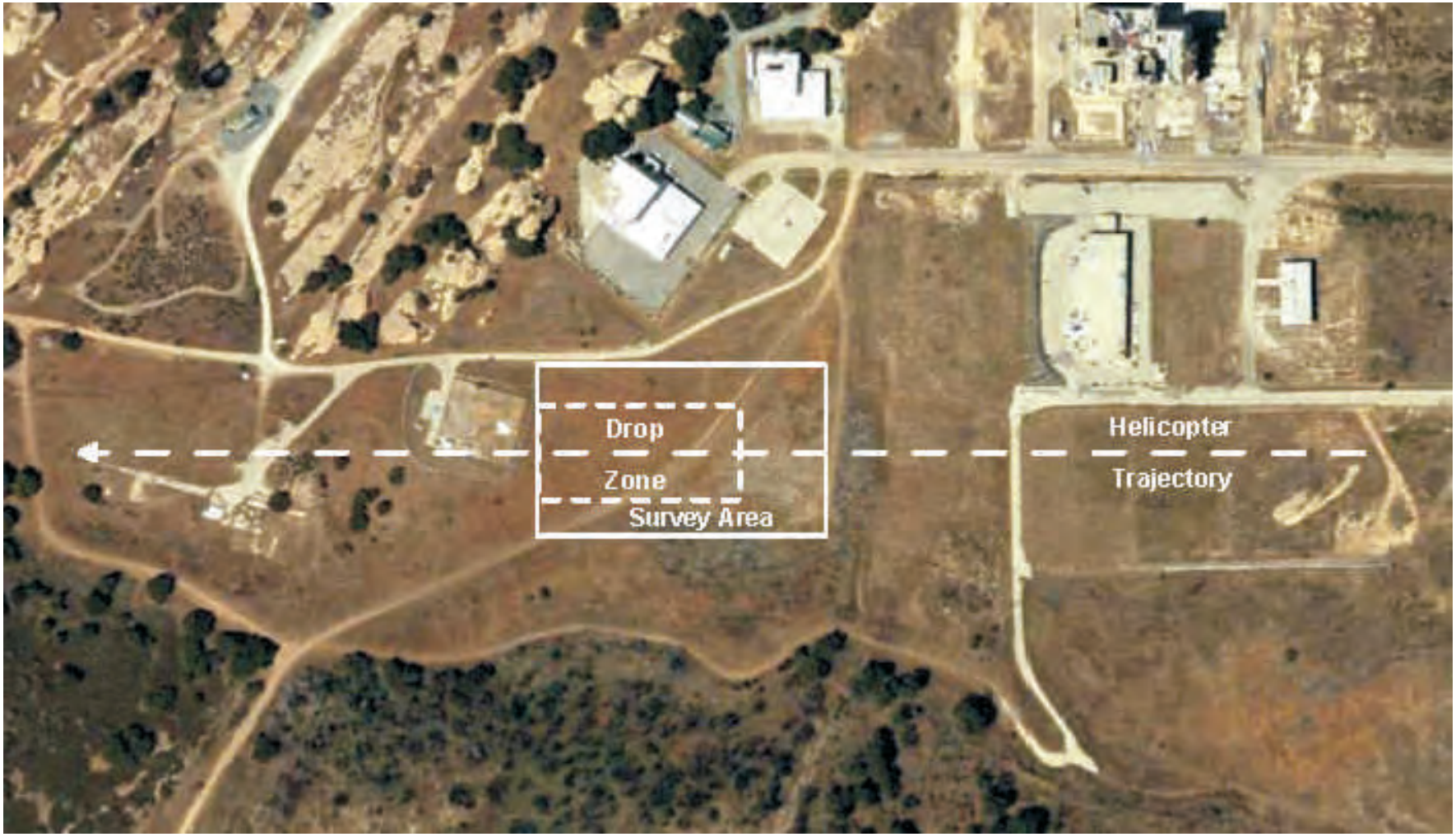
Figure 2.1.4c
Site 4425
Plot Plan



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Revised: 12/23/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.1.4d
Site 4425
Aerial View of
Depleted Uranium
Slug Trajectory

Figure 2.2
Area IV Subarea 8-2
Santa Susana Field Laboratory

U.S. EPA Region 9

Legend

- Subarea 8-2 Boundary
- Primary Roads
- Secondary Roads
- Underground Storage Tank
- Unknown Tank Type
- Sump
- Dry Well
- Tank Footprint
- Above ground Storage Tank
- Demolished Bldg.
- Existing Bldg.
- Parking Lots
- Drainage
- Drain
- Well

Aerial Photo Features

- Aerial Photography Features
- Leach Field
- Other

Surface Water

- Intermittent Stream
- Permanent Stream
- Surface Water
- Lined Channel
- French Drain
- Drainage
- Leach Field
- Septic System

Utilities

- Channel
- Drain
- Drain
- Drainage Divide
- Gutter
- Tank
- Tank
- Vault
- Well
- Gas
- Storm Drain
- Sanitary Sewer
- Water

B	Building
CONT	Container
CR	Crates
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FA	Fill Area
GS	Ground Scar
HT	Horizontal Tank
IM	Impoundment
MTMM	Medium Toned Mounded Material
OS	Open Storage
PA	Processing Area
PL	Parking Lot
POSS	Possible
PROB	Probable
S-T	Storage Tank
SS	Smoke Stack
ST	Storage
UO	Unidentified Object
VT	Vertical Tank
WDA	Waste Disposal Area

0 25 50 100
Scale In Feet

N

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12/1/2011 tjansen
Sorce: Boeing Company, 2008
CIRGIS, 2007

HydroGeoLogic, Inc

Redacted

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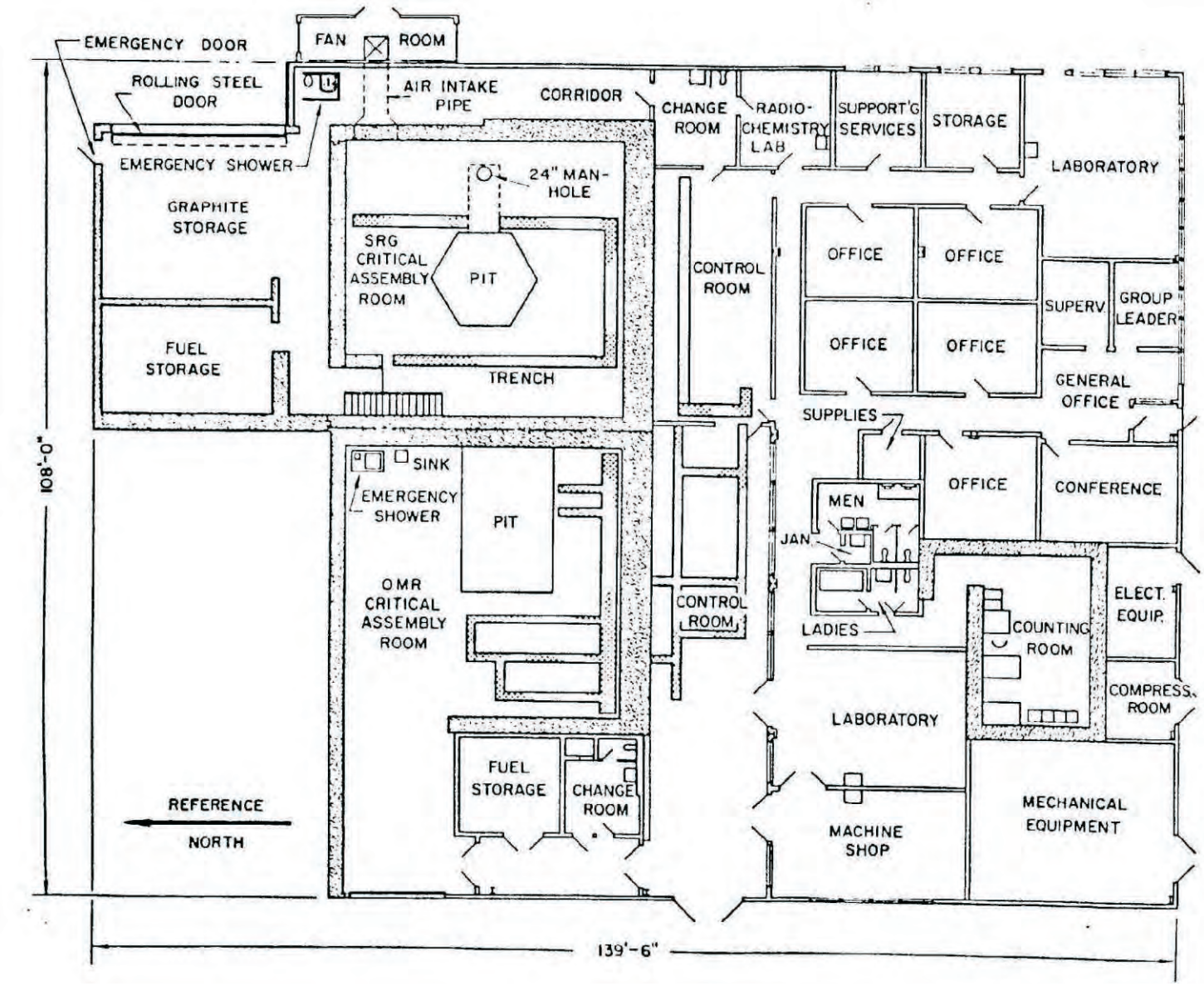
Revised: 01/27/2011 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.2.1a
Building 4009
Site Photograph



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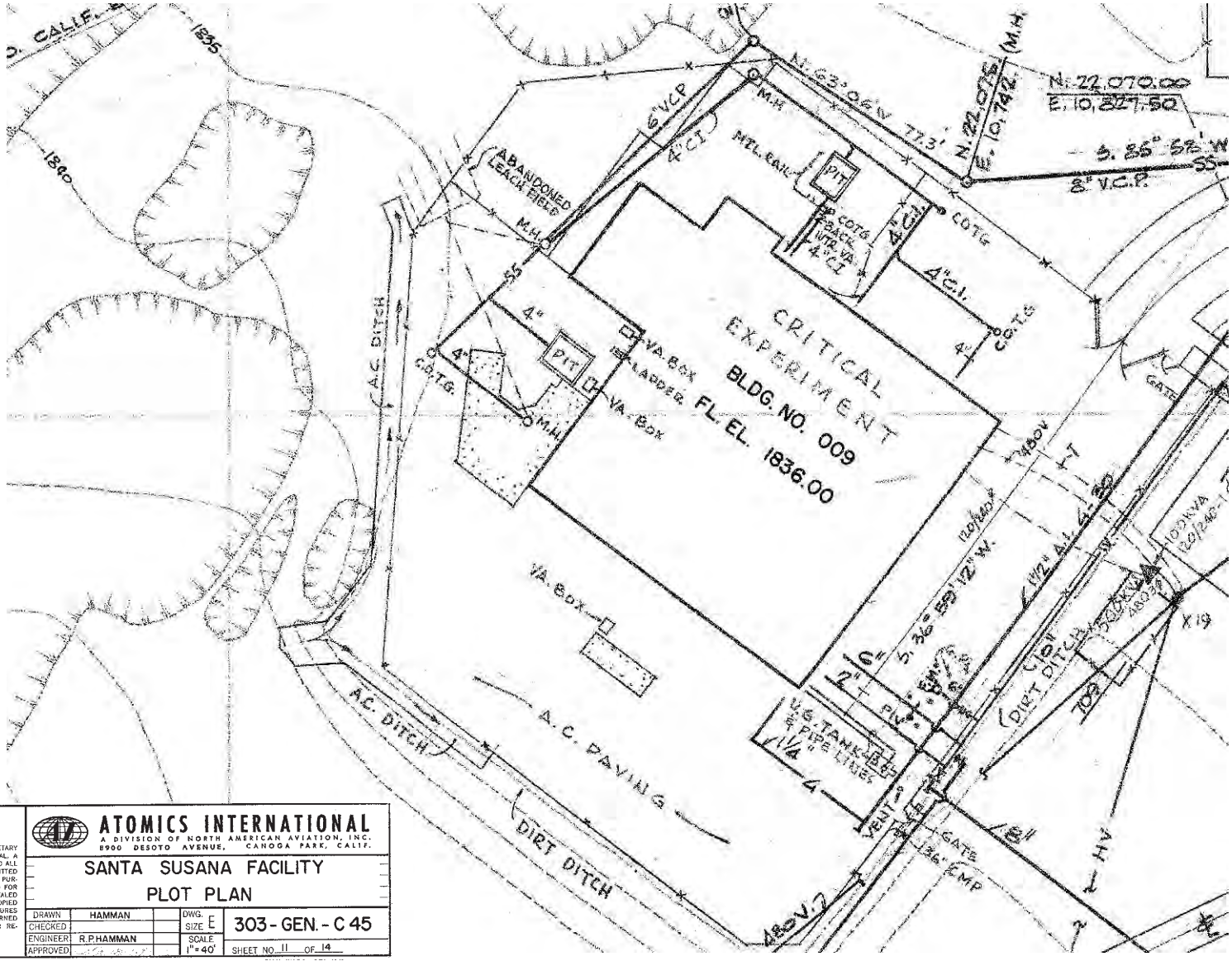
U.S. EPA Region 9

Figure 2.2.1b
Building 4009
Floor Plan



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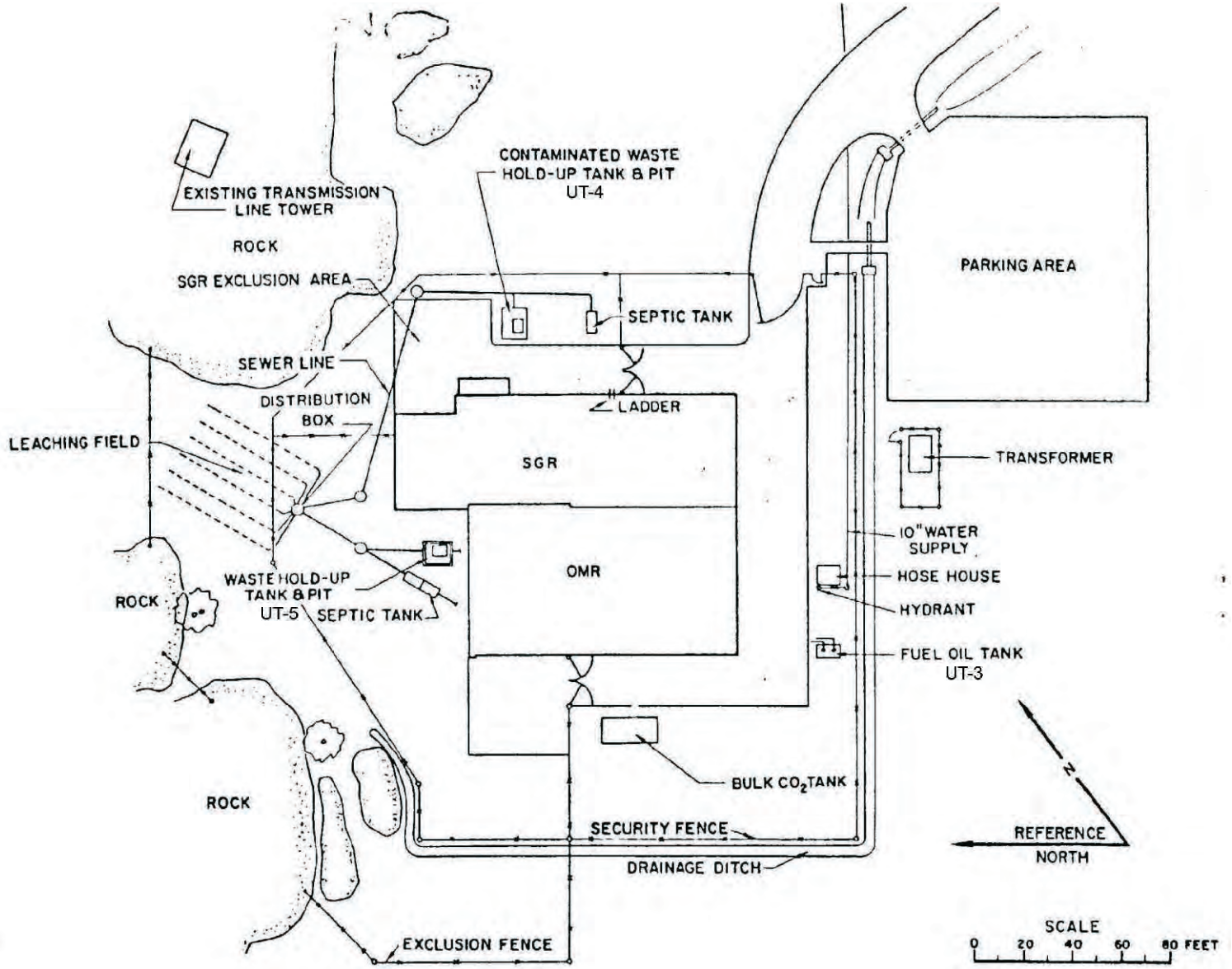
SANTA SUSANA FACILITY
PLOT PLAN

DRAWN	HAMMAN	DWG. SIZE E	303 - GEN. - C 45
CHECKED			
ENGINEER	R.P.HAMMAN	SCALE 1"=40'	
APPROVED			SHEET NO. 11 OF 14

Y:/Santa_Susana/EP9038/TM/HSA_8 (2-2-1c)bldg4009PP.cdr
Project:EP9038
Revised: 12/23/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.2.1c
Building 4009
Plot Plan



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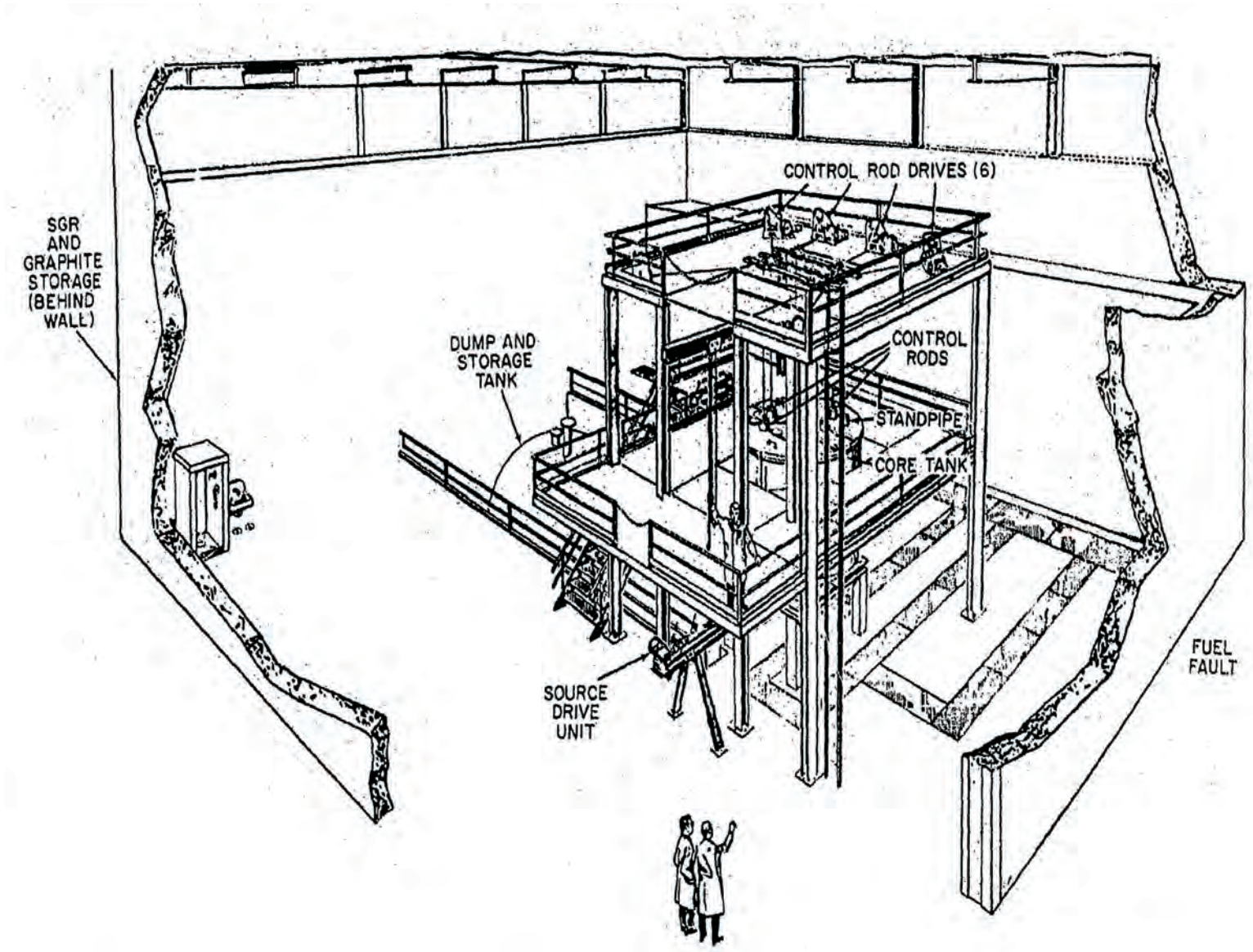
Revised: 12/23/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.2.1d
Building 4009
Site Layout
Showing Leach Field
And Waste Tanks



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Project:EP9038
Revised: 12/23/2010 TJ
Source: Boeing Company, 2008

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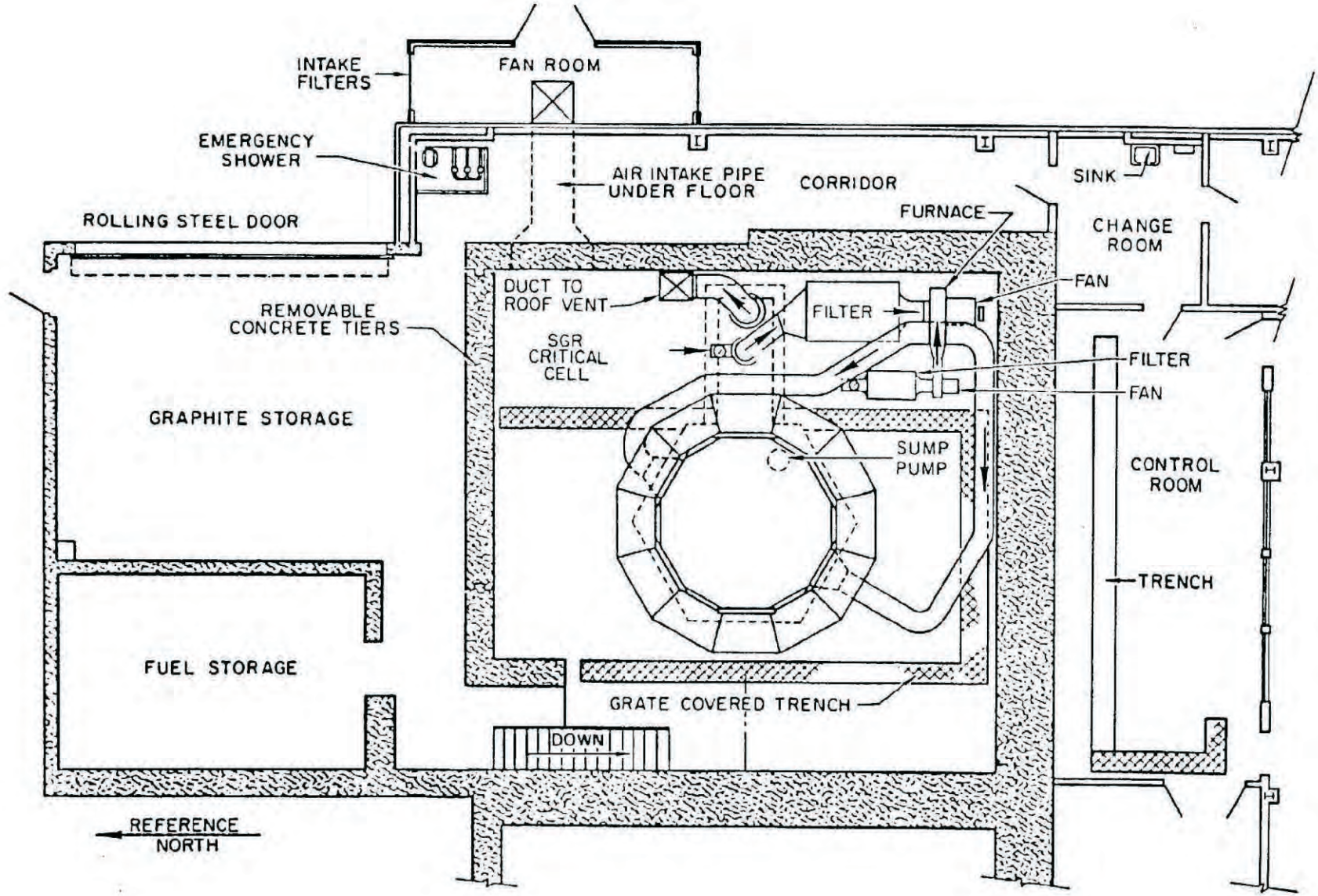
Figure 2.2.1e
Building 4009
Perspective View of
OMR Critical Assembly



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Project:EP9038
Revised: 12/23/2010 TJ
Source: Boeing Company, 2008

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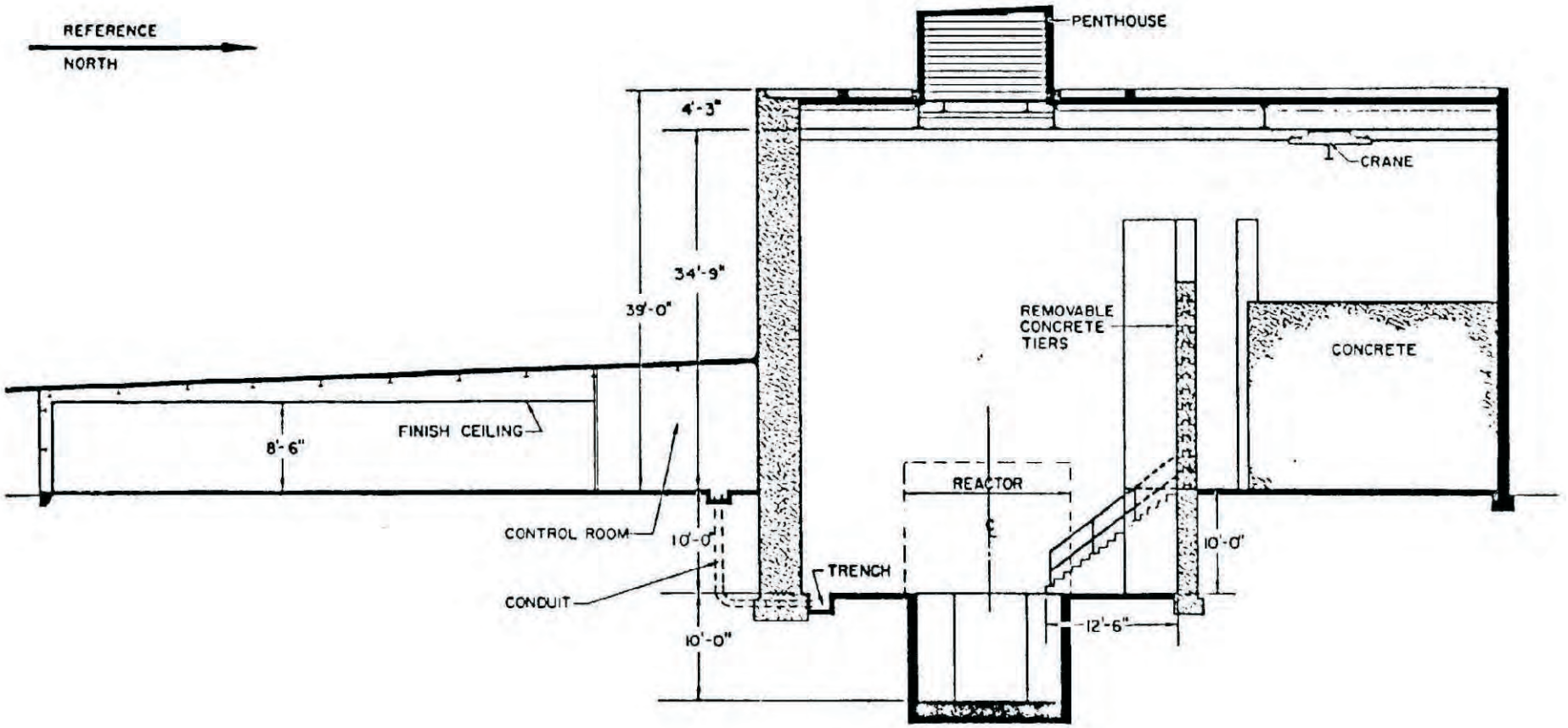
Figure 2.2.1f
Building 4009
Plan View of
SGR Critical
Assembly Room



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Project:EP9038
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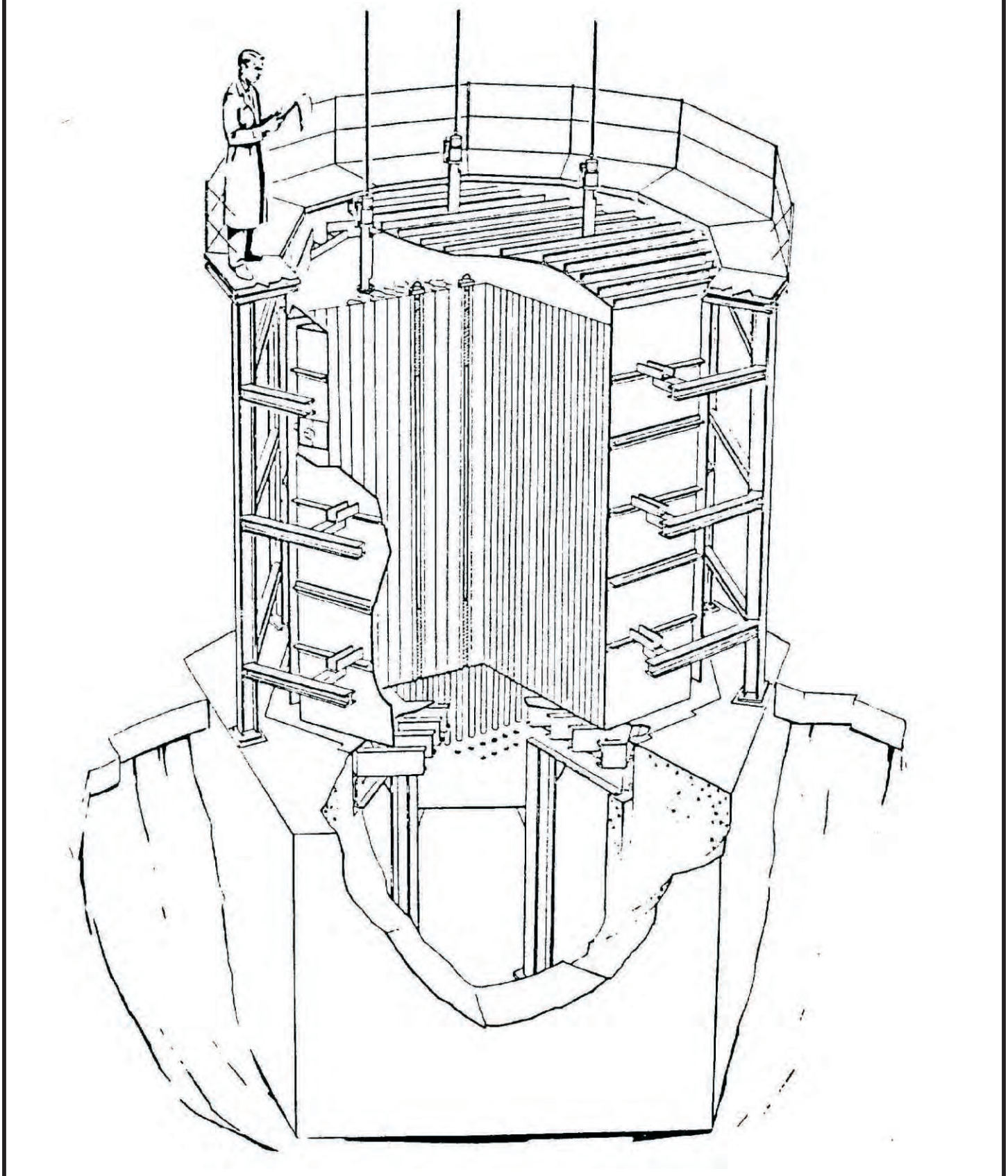
Figure 2.2.1g
Building 4009
Elevation Through
SGR Critical Facility
(Looking West)



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Project:EP9038
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Source: Boeing Company, 2008

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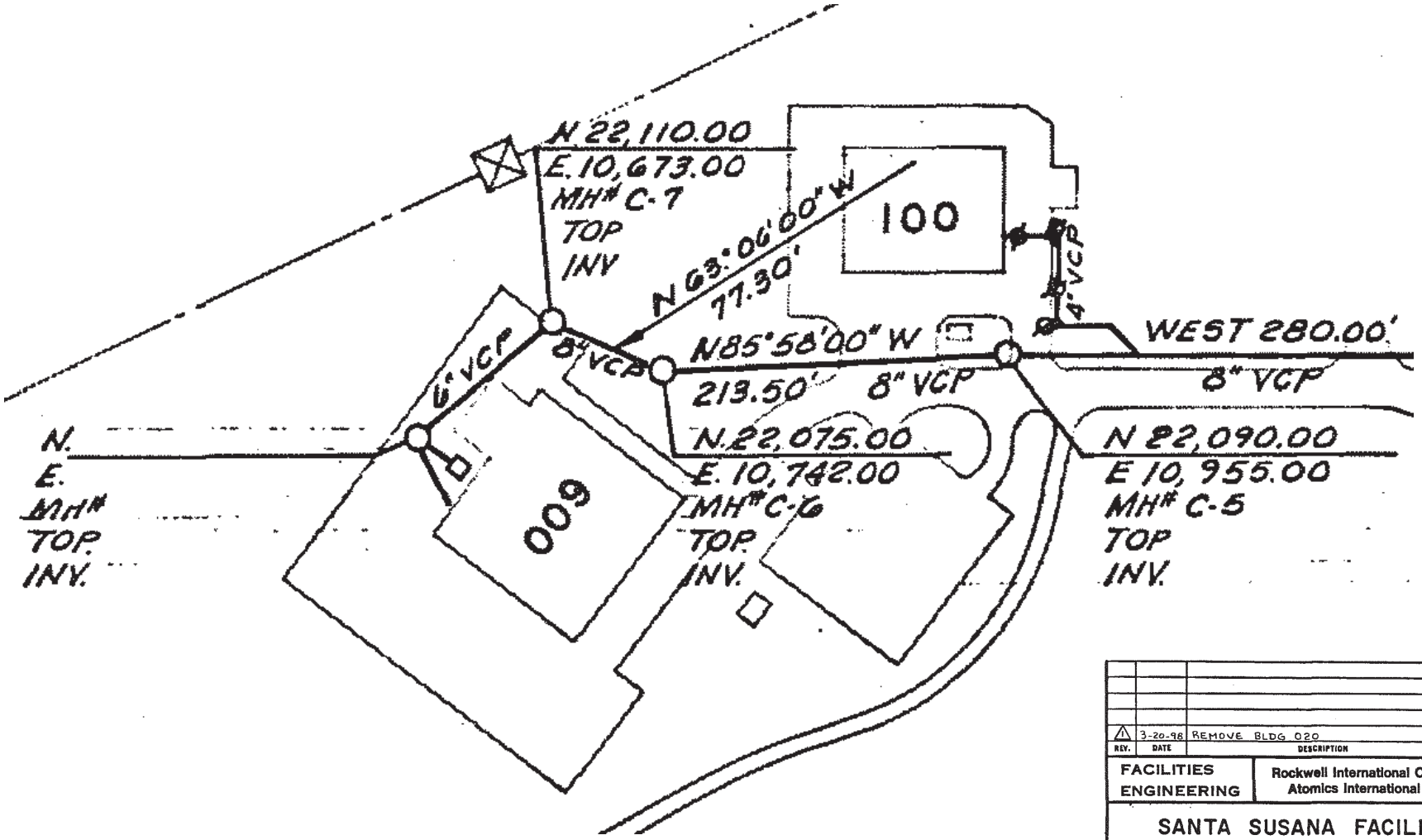
Figure 2.2.1h
Building 4009
Perspective View of
SGR Critical Assembly



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Project:EP9038
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Source: Boeing Company, 2008

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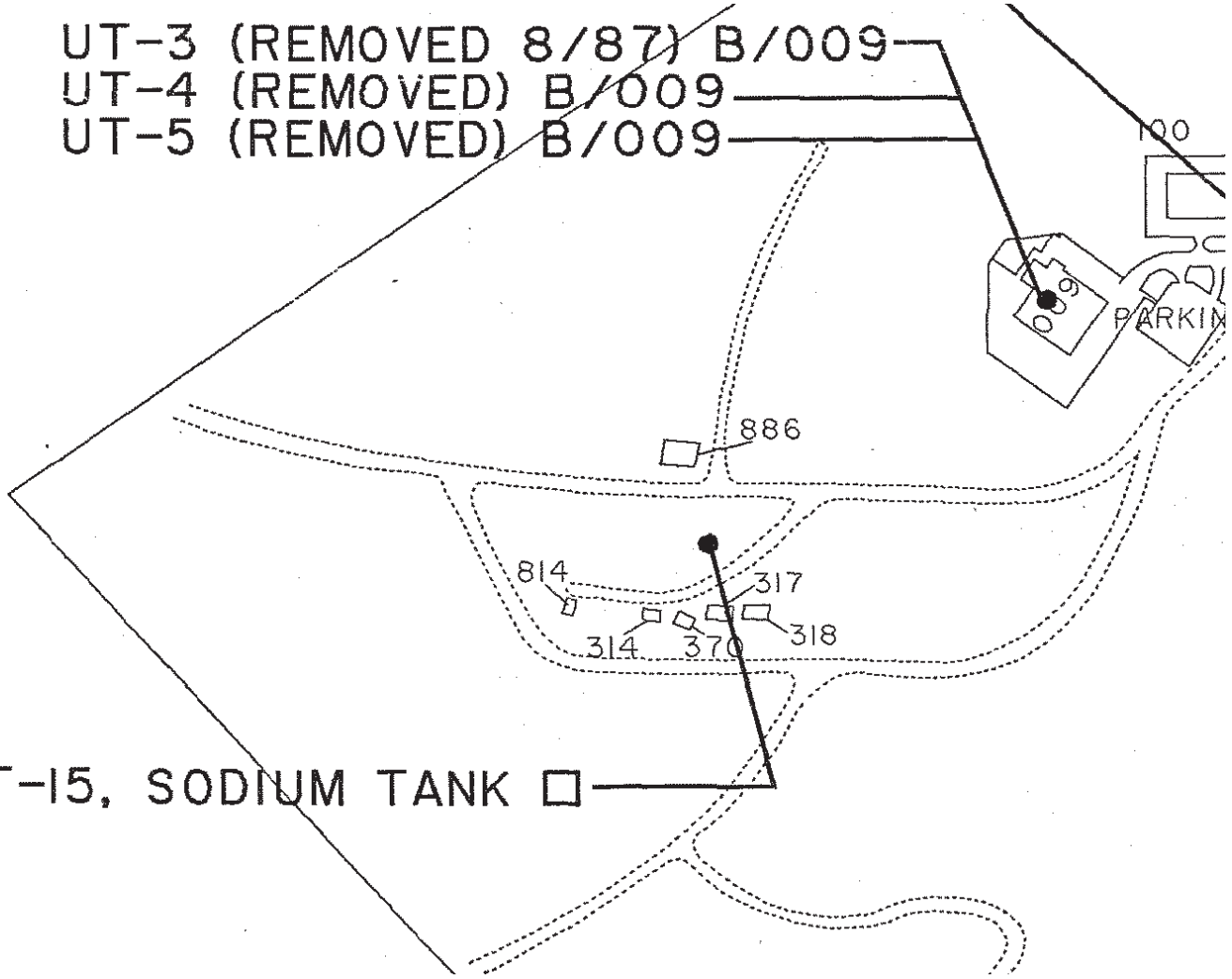
Figure 2.2.1i
Building 4009
Sanitary Sewer



REV.	DATE	DESCRIPTION	BY	BY	BY

FACILITIES ENGINEERING — Rockwell International, Rocketdyne Division, 6633 Canoga Avenue, Canoga Park, California 91303

SSFL ALL — SSFL

ENVIROMENTAL
TANKS

DESIGNED BY	APPROVED BY	APPROVED BY	DATE
ALAN NELSON			SEPT.18,1989
DRAWN BY N.D.B.	APPROVED BY	APPROVED BY	
CHECKED BY	APPROVED BY	DRAWING NO.	REV. NO.
MANAGER	APPROVED BY	SHEET #4	0

Y:/Santa_Susana/EP9038/TM/HSA_8 (2-2-1j)bldg4009TU.cdr
Project:EP9038
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Source: Boeing Company, 2008

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Figure 2.2.1j
Building 4009
Tanks

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Project:EP9038
Revised: 01/27/2011 TJ
Source: Boeing Company, 2008

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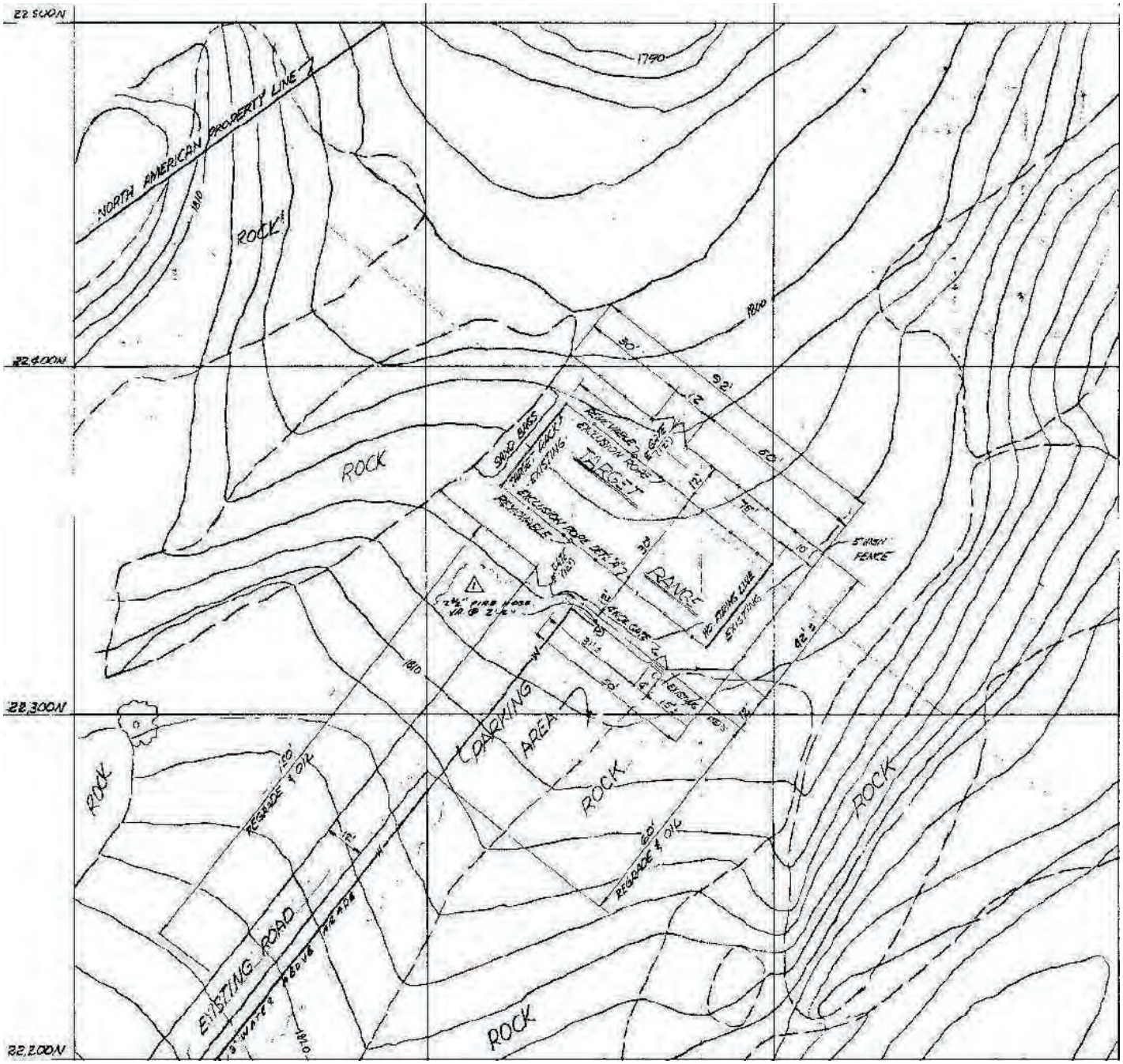
Figure 2.2.2a
Site 4885
Site Photograph



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Project:EP9038
Revised: 012/23/2010 TJ
Source: Boeing Company, 2008

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Figure 2.2.2b
Site 4885
Plot Plan

Y:/Santa_Susana/EP9038/TM/HSA_8 (2-2-2c)Site4885HP.cdr
Project:EP9038
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Source: Boeing Company, 2008

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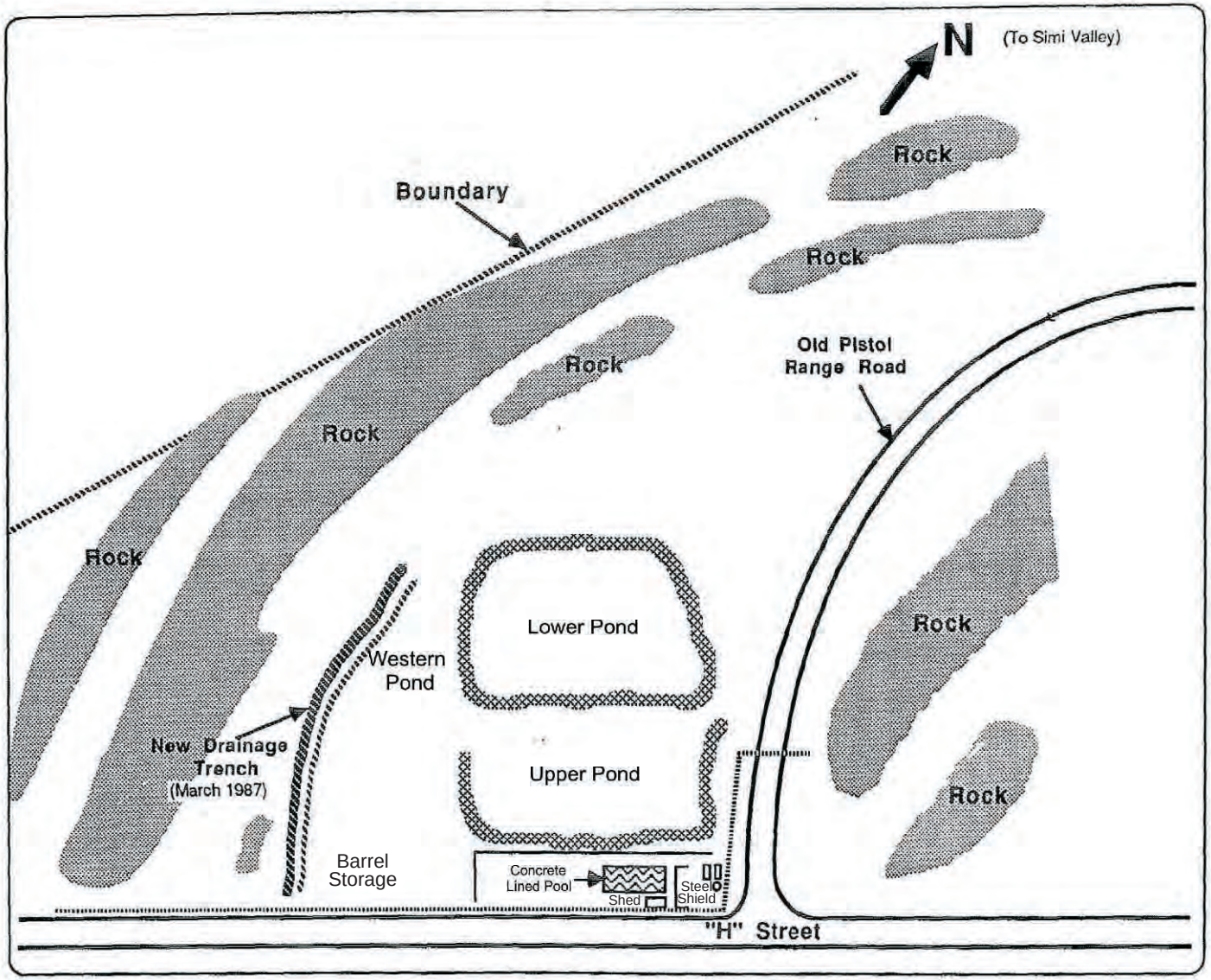
Figure 2.2.2c
Site 4885
Historical Photograph
Date Unknown

Y:/Santa_Susana/EP9038/TM/HSA_8 (2-2-3a)Site4886AP.cdr
Project:EP9038
Revised: 01/27/2011 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.2.3a
Site 4886
Site Photograph



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Project:EP9038
Revised: 12/23/2010 TJ
Source: Boeing Company, 2008

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Figure 2.2.3b
Site 4886
Site Layout Map

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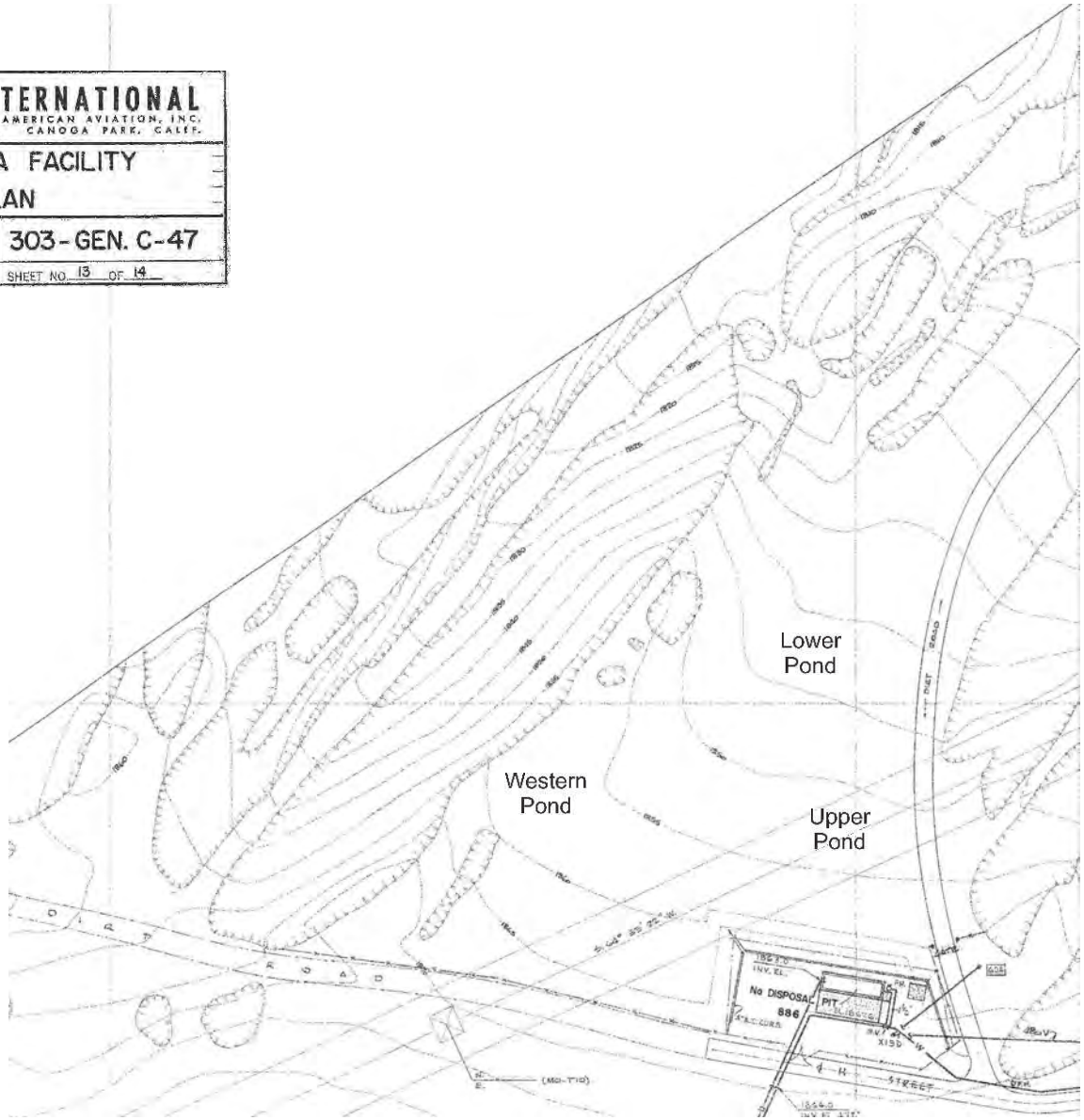
8900 DESOTO AVENUE, CANOGA PARK, CALIF.

SANTA SUSANA FACILITY
PLOT PLAN

DRAWN	HAMMAN	DWG. SIZE	E
CHECKED			303-GEN. C-47
ENGINEER	R.P. HAMMAN	SCALE	1"=40'
APPROVED		SHEET NO.	13 OF 14



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Revised: 12/23/2010 TJ
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Figure 2.2.3c
Site 4886
Plot Plan

Y:/Santa_Susana/EP9038/TM/HSA_8 (2-2-3d)Site4886DD.cdr
Project:EP9038
Revised: 12/23/2010 TJ
Source: Boeing Company, 2008

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Figure 2.2.3d
Site 4886
Drainage Ditch
Date Unknown

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Project:EP9038
Revised: 12/23/2010 TJ
Source: Boeing Company, 2008

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Figure 2.2.3e
Site 4886
Prior to Remediation
Date Unknown

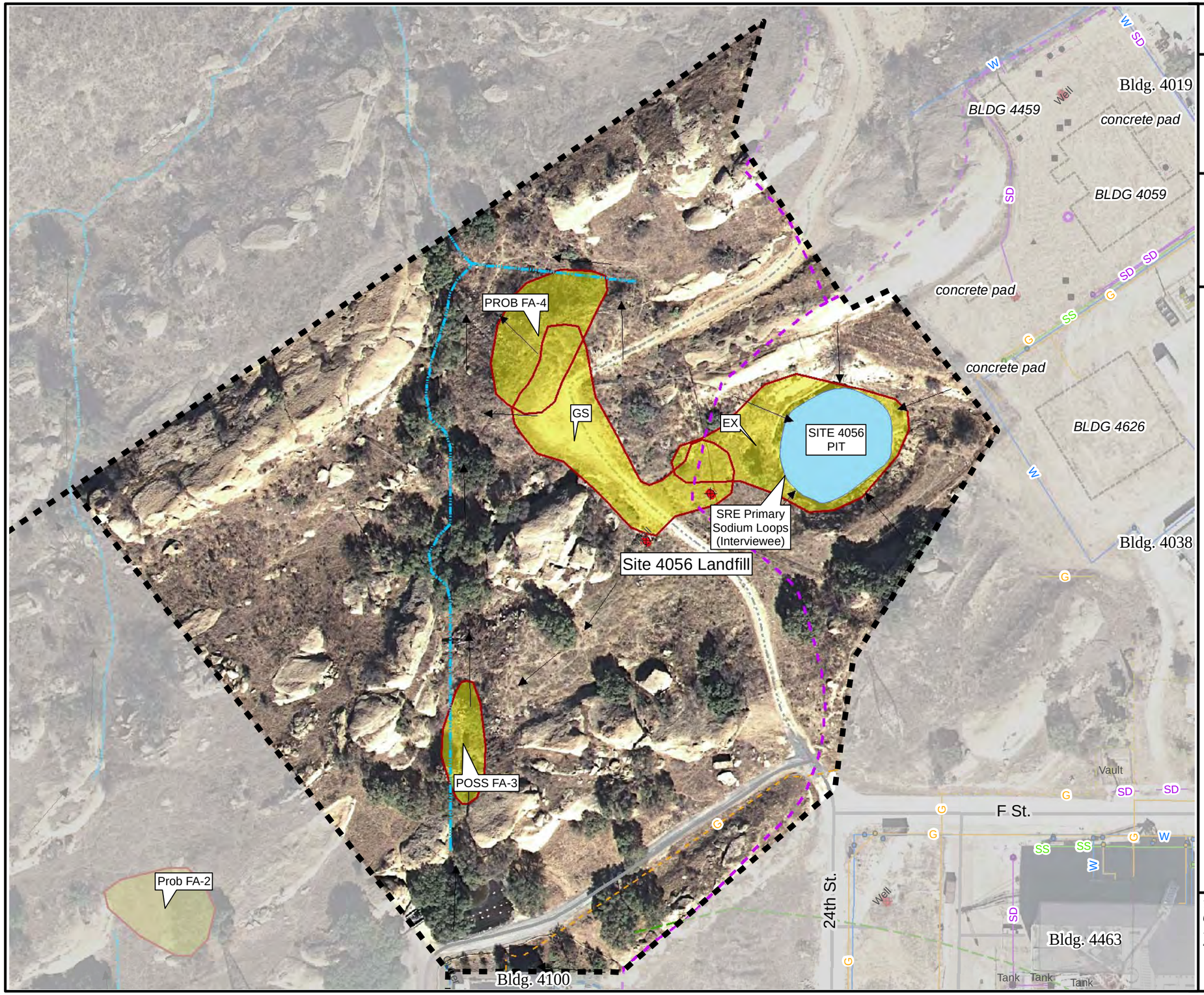
Y:/Santa_Susana/EP9038/TM/HSA_8 (2-2-3f)Site4886DR.cdr
Project:EP9038
Revised: 12/23/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.2.3f
Site 4886
During
Remediation
Circa 1992

Figure 2.3
Area IV Subarea 8-3
Santa Susana Field Laboratory

U.S. EPA Region 9



Legend

- Subarea 8-3 Boundary
- Primary Roads
- Secondary Roads
- Underground Storage Tank
- Unknown Tank Type
- Sump
- Dry Well
- Tank Footprint
- Above ground Storage Tank
- Demolished Bldg.
- Existing Bldg.
- Parking Lots
- Drainage
- Drain
- Well

Aerial Photo Features

- Aerial Photography Features
- Leach Field
- Other

Surface Water

- Intermittent Stream
- Permanent Stream
- Surface Water
- Lined Channel
- French Drain
- Drainage
- Leach Field
- Septic System

Utilities

- Channel
- Drain
- Drain
- Drainage Divide
- Gutter
- Tank
- Tank
- Vault
- Well
- Gas
- Storm Drain
- Sanitary Sewer
- Water

B	Building
CONT	Container
CR	Crates
DB	Debris
DG	Disturbed Ground
DTM	Dark Tone Material
EX	Excavation
FA	Fill Area
GS	Ground Scar
HT	Horizontal Tank
IM	Impoundment
MTMM	Medium Toned Mounded Material
OS	Open Storage
PA	Processing Area
PL	Parking Lot
POSS	Possible
PROB	Probable
S-T	Storage Tank
SS	Smoke Stack
ST	Storage
UO	Unidentified Object
VT	Vertical Tank
WDA	Waste Disposal Area

0 25 50 100
Scale In Feet

N

Y:\Santa_Susana\EP9038\TM\HSA_8\(2-3)8-3.mxd
12/1/2011 tjansen
Sorce: Boeing Company, 2008
CIRGIS, 2007

HGL HydroGeoLogic, Inc

Redacted

Y:/Santa_Susana/EP9038/TM/HSA_8 (2-3-1a)Site4056AP.cdr
Project:EP9038
Revised: 01/27/2011 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.3.1a
Site 4056
Site Photograph

Y:/Santa_Susana/EP9038/TM/HSA_8 (2-3-1b)Site4056SP1975.cdr
Project:EP9038
Revised: 12/23/2010 TJ
Source: Boeing Company, 2008

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Figure 2.3.1b
Site 4056
1975 Photograph of Pit and Debris

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SANTA SUSANA FACILITY
PLOT PLAN

DRAWN	HAMMAN	DWG. SIZE E	303-GEN. C-44
CHECKED			
ENGINEER	R.P. HAMMAN	SCALE 1"=40'	SHEET NO. 10 OF 14
APPROVED			

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Project:EP9038
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Figure 2.3.1c
Site 4056
Plot Plan

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Project:EP9038
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Source: Boeing Company, 2008

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Figure 2.3.1d
Site 4056
1979 Photograph of Drums and Debris

Y:/Santa_Susana/EP9038/TM/HSA_8 (2-3-1e)Site4056SP.cdr
Project:EP9038
Revised: 12/23/2010 TJ
Source: Boeing Company, 2008

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Figure 2.3.1e
Site 4056
Photograph of Drums in Ravine
Date Unknown

Y:/Santa_Susana/EP9038/TM/HSA_8 (2-3-1f)Site4056SPGH.cdr
Project:EP9038
Revised: 012/23/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.3.1f
Site 4056
Photograph of Graded Hillside
Date Unknown

Y:/Santa_Susana/EP9038/TM/HSA_8 (2-3-1g)Site4056PD.cdr
Project:EP9038
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Source: Boeing Company, 2008

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Figure 2.3.1g
Site 4056
Partially Drained Pit

Y:/Santa_Susana/EP9038/TM/HSA_8 (2-3-1h)Site4056PB.cdr
Project:EP9038
Revised: 12/23/2010 TJ
Source: Boeing Company, 2008

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Figure 2.3.1h
Site 4056
Pit Bottom