ADDENDUM TO RCRA FACILITY INVESTIGATION WORKPLAN FOR OPERABLE UNIT 1086:

SAMPLING AND ANALYSIS PLAN FOR TA-15 FIRING SITES R-44, R-45

PRSs 15-006(c), 15-006(d), and 15-008(g)

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3909

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SAMPLING AND ANALYSIS PLAN
TA-15 FIRING SITES R-44, R-45
PRS 15-006(c), 15-006(d), and 15-008(g)

1.0 INTRODUCTION, DESCRIPTION AND HISTORY

Technical Area (TA)-15, also known as R-Site, occupies a portion of Three-Mile Mesa on Pajarito Mesa near the southwestern boundary of Los Alamos National Laboratory (LANL). It is located entirely on Department of Energy (DOE) land. Much of TA-15 has been used from the mid-1940s until the present time for explosives experiments. In that capacity, test explosions ranging from a few kilograms of high explosive to as much as 650 kg were conducted in arrangements that duplicate many of the components of a nuclear weapon, with the exception of the fissionable materials. These components sometimes contained multi-kilogram quantities of natural uranium metal, depleted uranium metal, and lesser quantities of beryllium and other metals. In most cases, the tests were carried out aboveground, which resulted in the test materials being scattered over areas with radii up to several hundreds of meters. Based upon LANL records, some 75 metric tons of natural and depleted uranium have been expended at the firing sites on TA-15 since the Mid-1940s. These resulting products of testing are now considered potential environmental contaminants.

LANL has a RCRA Hazardous waste permit. Module VIII of the permit, known as the HSWA Module, was issued by EPA to address potential corrective action requirements (including investigations of potential contaminants remaining in the soil) for Solid Waste Management Units (SWMUs) at the Laboratory. A RCRA Facilities Investigation (RFI) work plan for the characterization of SWMUs within TA-15 was prepared by LANL in July of 1993 and approved by the EPA after revision on January 9, 1995 (LANL 1993, 1087). During the period between the initial submittal of the work plan and the acceptance, Firing Sites R-44 and R-45 were deactivated. Because of the change in status from active to inactive, EPA requested a sampling plan be developed for R-44 and R-45 as part of the acceptance of the RFI work plan . This Sampling and Analysis Plan is submitted in order to meet the requirement.

Firing Sites R-44 and R-45 (described below and depicted in Figure 1-1) are located at TA-15, and contain Potential Release Sites (PRS) 15-006(c), 15-006(d), and 15-008(g).

1.1 Firing Site R-44

Firing Site R-44 contains PRS 15-006(c), a former firing site, and a smaller firing site used for optical diagnostic tests (ICF KE 1995). These sites, the third most extensively used firing sites at TA-15, were named after the control room present there (Figure 1-2). The firing sites were built in 1951 and used extensively from 1956 through 1978 for diagnostic tests of weapon components. They were designed for hydrotests and authorized to go to the highest shot size (Level C, ICF KE 1995). Since the development of other firing sites within TA-15 (PHERMEX and Ector), the R-44 and R-45 sites have been used for small experiments, most recently in September 1992. The diagnostic capabilities at R-44 are different from and are extremely modest when compared with those at PHERMEX and Ector.

The two firing sites located at R-44 are shown on Figure 1-2. They consist of the main site (15-006(c), and the optical diagnostic firing site which is located approximately 60 ft north of TA-15-138. The firing sites are located on a relatively open, flat area on a very narrow mesa jutting over Three-Mile Canyon. Consequently, some debris from the explosions has been scattered through the air into the canyons on either side of the firing sites.

1.2 Firing Site R-45

Firing Site R-45 contains PRS 15-006(d), former firing sites, and associated sandbags PRS 15-008(g) that were used to shield the equipment from the explosions. This site (Figure 1-3) was the least used of the firing sites at TA-15. The area, originally built in 1951, was used only for small quantities of explosives, and was designed for smaller, pure science shots. The existence of nearby trees attests to the small size of the explosions conducted at this site.

A 1958 photograph (ICF KE 1995) showed 2 X-units*, a western and eastern unit about 100 ft apart. The eastern X-unit has been removed and a metal and concrete block house erected to hold optical diagnostics. The explosions at this site were usually 20 to 25 ft from the X-units. After the shots, any unexploded high explosives (HE) were picked up and the area regraded (ICF KE 1995). The sandbags [PRS 15-008(g)] are considered to be a part of the firing site [PRS 15-006(d)] and not as a separate PRS. They surrounded optical diagnostic shots dating from the 1970s.

* X-Unit: an electrical pulse generator to detonate explosion, usually located approximately 20 ft from firing site.

2.0 CONCEPTUAL EXPOSURE MODEL

The conceptual exposure model for these firing sites (Figure 2-1) describes historical sources of contamination, migration pathways and conversion mechanisms, potential current sources of contamination and release mechanisms, receptor contact media, and exposure routes for released contaminants. These are described in the following subsections.

2.1 Nature and Extent of Contamination

2.1.1 Firing Site R-44

From 1953 to 1978 approximately 7,000 kg of uranium [largely depleted uranium (DU)], 350 kg beryllium, and 15 kg of lead have been used at Firing Site R-44 (Rasmussen 1992, 10-0005). Substantial quantities of tritium also have been used in component tests.

The aerial radiological survey (Fritzsche 1989, 10-0033) can be used to estimate that in 1982 the amount of uranium in the soil at Firing Site R-44 was approximately 2,300 kg, 0.04 of the amount at Firing Site E-F (also located at TA-15). A 1991 land-based radiological survey found small pieces of uranium in the R-44 firing site area (Schlapper 1991, 10-0009). Measured exposure rates ranged from 50 mR/h on contact (due to lumps of DU) to as low as 0.1 mR/h (background values). The area was partially cleaned up and large chunks of uranium were removed.

A more extensive sampling effort is described in the draft Los Alamos National Laboratory Sampling and Analysis Data Document (DOE 1989, 0271). This work was conducted under EPA CLP protocols, and used the EPA 1987 CLP SOW for inorganic analytes. Four composite samples of surface soil (0 to 3 in. deep) were collected at each of four radii from the center of the firing site (10, 100, 250, and 450 ft). None of the samples contained detectable quantities of high explosives (HE). Of the inorganic analytes tested (antimony, arsenic, barium, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium, zinc), only lead , beryllium , and uranium were present above screening action levels (SALs). Antimony, arsenic, cadmium, mercury, selenium, silver, and thallium were not detected in any sample. Other metals present but below SALs had the following decreasing concentration patterns with distance: barium, 225 mg/kg at the center to 55.4 mg/kg at 450 ft (SAL 5,600 mg/kg); chromium, 13.5 mg/kg to 5.2 mg/kg (95% UTL background 34.2 mg/kg); copper, 747 mg/kg to 4.1 mg/kg (SAL 3,000 mg/kg); nickel, 12.6 mg/kg to essentially non-detected at 100 ft (SAL 1,600 mg/kg); zinc, 194 mg/kg to 21.0 mg/kg (SAL 24,000 mg/kg).

As shown in Figure 2-2, uranium, lead, and beryllium concentrations decreased roughly exponentially with distance from the center of the firing point. Lead decreased from 513 mg/kg in the center of the test area to 12.1 mg/kg at the greatest radius. Beryllium decreased from 16.3 mg/kg at the center to 0.56 mg/kg at the greatest radius. Total uranium also decreased with distance from the center (726 to 7 mg/kg). The SAL comparison (background for beryllium) for these results shows that the measured concentrations decrease below SAL levels between 10 ft and 100 ft from the center of the firing point for lead, and between 100 ft and 250 ft for beryllium and uranium. No subsurface sampling was conducted.

Preliminary results from sampling and analysis of soil at PRS 15-008(b) [located on the canyon edge to the north of PRS 15-006(c)] conducted during 1994 are reported in Table 2-1. The sampling locations and identification numbers are shown in Figure 2-3. The results indicate that uranium, beryllium, and lead appear to be present at concentrations above SALs in certain samples. The PRS 15-008(b) area is unique, however, in that the debris from the shots was bulldozed off the mesa top in this area. Therefore, PRS 15-008(b) is expected to have higher concentrations than other areas.

2.1.2 Firing Site R-45

The quantities and types of materials used at this site are unknown. The 1991 radiological survey found exposure rates up to 10 mR/h on the surface of TA-15-141 closest to the firing point (Schlapper 1991, 10-0009). Background levels were approximately 0.1 mR/h at one ft from the building. However, localized radiological readings can be obtained because of the presence of uranium.

The aerial radiological survey at Firing Site R-45 did not detect any gamma radioactivity above background from Protactinium -234 (Fritzsche 1989, 10-0033). Protactinium-234 is a gamma-emitting daughter product of uranium-238.

2.2 Potential Pathways and Exposure Routes

Contamination from firing activities is greatest near the firing points. Concentrations of contaminants decrease with distance and depth from the shot area. Although some test shots were contained within sandbags, contaminated particles could have traveled outside the immediate firing area as a result of explosion-related air dispersion. Transport of contaminants in runoff/drainage channels by soil erosion and dissolution in surface water runoff is also possible. Potential contaminants of concern (PCOCs) are likely to accumulate in sediment catchment areas within any drainage channel. In addition, contaminants may have leached into subsurface soils by percolating precipitation. Resuspension and transport by wind erosion may also play a minor role in contaminant migration from the firing areas.

Current potential human receptors are limited to on-site workers. Future human exposure could occur through contact with contaminated media such as surface soils and runoff water. In addition, exposure could occur through excavation and/or erosion of subsurface soils.

3.0 REMEDIATION DECISIONS AND INVESTIGATION OBJECTIVES

3.1 Firing Site R-44

Previous results from R-44 (DOE 1989, 271) indicate that contamination above SALs exists out to 250 ft from the firing site (Figure 2-2). All three contaminants in composited samples are above SALs (uranium and lead) or substantially above background (beryllium). A Phase I RFI to determine the extent of contamination is necessary to establish whether an expedited cleanup can be conducted or a baseline risk assessment is appropriate for the site. The previous results are not sufficient to determine the extent of contamination, due to composited samples, and a lack of samples collected at depth. The Phase I investigation is focused to produce data suitable for kriging, contouring, and to produce volume estimates of contaminated material.

A Phase I RFI sampling effort is proposed at the optical diagnostic site at R-44, because no information is presently available on the contamination that may be present there. If results of the investigation indicate that concentrations of PCOCs are below background, no further action will be proposed. If concentrations of PCOCs are above background, but below SALs (background for beryllium) and a multiple constituent evaluation is less than 1, then no further action will be proposed. If concentrations of PCOCs are above background, but below SALs (background for beryllium) and a multiple constituent evaluation is greater than 1, then a Phase II investigation or a baseline risk assessment will be implemented. If measured concentrations exceed SALs (background for beryllium), a Phase II investigation or a baseline risk assessment will be implemented.

3.2 Firing Site R-45

R-45 has been used routinely for diagnostic instrumentation tests involving small quantities of explosives and was last used in 1992 for an explosive test involving less than 1 lb of HE. If RFI Phase I sampling at Firing Site R-45 indicates that concentrations of PCOCs are below background, no further action will be proposed. If concentrations of PCOCs are above background, but below SALs (background for beryllium) and a multiple constituent evaluation is less than 1, then no further action will be proposed. If concentrations of PCOCs are above background, but below SALs (background for beryllium) and a multiple constituent evaluation is greater than 1, then a Phase II investigation or a baseline risk assessment will be implemented. If measured concentrations exceed SALs (background for beryllium), a Phase II investigation or a baseline risk assessment will be implemented.

3.3 Other Locations

Sampling at other locations (drainages, sandbags) will take place as a Phase I RFI. The same decision logic for evaluation described above will apply.

4.0 DATA NEEDS AND DATA QUALITY OBJECTIVES

The data needs of the studies of PRSs 15-006(c), 15-006(d), 15-008(g), drainages, and sandbags discussed in this chapter are presented in Table 4-1. The Phase I RFI data needs at PRS 15-006(c) include: sampling for determination of the PCOCs 95% UCL of the mean for risk assessment, and defining boundaries and RCRA waste types for any future EC or CMS activities. For the other PRSs and locations (sandbags, drainages) the data needs include determining the maximum concentration of PCOCs for SAL comparisons, and defining a more limited list of PCOCs for any necessary Phase I RFI work.

Because depleted uranium, beryllium, and lead represent the most significant contaminants at these PRSs, they are the primary focus of the investigations. Other known or suspected contaminants exist in limited quantities and are generally associated with the depleted uranium, beryllium and lead. Thus, sampling plans will maximize the effectiveness of the RFI by focusing on a set of TA-15 screening indicator analytes. TA-15 first will be field surveyed by radiological methods for alpha, beta and gamma contaminants. Samples will be collected along grid systems at the firing points. Portable X-ray fluorescence and laser-induced breakdown spectrometry will be used (along with the radiological screening) to bias sample locations submitted for fixed laboratory analysis. A vertical sampling interval of 0 to 6 in. will be used for surface soil samples.

No significant concentrations of HEs or HE residues are thought to be present at TA-15 firing sites because the tests used HE to drive implosion or explosion. Therefore, the HE is expected to have been completely expended. Also, chemical spot tests for HE at TA-15 firing sites showed no evidence of unexploded HE (DOE 1989, 0271; Hatler 1990, 10-0038; and preliminary results of HE spot test and fixed laboratory sampling during FY 94). However, confirmatory HE field spot tests will be conducted on 100% of the sampling locations. If any samples are positive for HE, they will be submitted for fixed laboratory analysis of HE.

During the field sampling, any locations consisting of obvious contamination (stained soil, etc.) will be field screened for metals, radioactivity and HE, and submitted for fixed laboratory analysis if warranted.

Analytical data quality levels will be as follows: HE field spot test and field radiological screening, Level I; portable X-ray fluorescence [LANL-ER-SOP 10.8 (draft)]and portable Laser Induced Breakdown Spectroscopy (LIBS), Level II; fixed laboratory analysis, Level III/IV.

Analytical methods and precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters will follow the LANL generic Quality Assurance Project Plan (QAPjP) (LANL 1993, 1017).

5.0 SAMPLING AND ANALYSIS PLAN

This sampling and analysis plan describes field screening and sampling that will be conducted and the fixed laboratory analyses that will be performed. Table 5-1 summarizes the analytical samples to be collected. The approach is to field screen 100% of the samples for radiation, metals, and HE, and select 20% of the highest concentration samples for fixed laboratory analysis.

5.1 Land Survey

A land survey will be performed in accordance with the LANL Survey Manual (LANL 1992, 0688). The surveyed location points will be logged on 2-ft-interval contour maps and the information transferred to the Facility for Information Management, Analysis, and Display (FIMAD).

5.2 Health and Safety Screening

Portable field screening instrumentation will be used to monitor potential hazards and health and safety conditions for on-site workers. Portable field instruments will be used to screen all samples for gross alpha, beta, and gamma radiation. All samples will be visually inspected and field spot-tested for HE using the LANL HE spot test kit.

5.3 Sampling at Firing Site R-44, PRS 15-006(c)

An orthogonal grid (Figure 5-1) will be laid out by a surveyor over the sampling area, which extends 250 ft in four directions from the main firing point. The grid will be spaced at 25-ft intervals from 0 to 100 ft and then at 50-ft intervals from 100 to 250 ft. At the firing point itself, three samples will be collected at each of three depths for a total of nine samples: 0-6 in., 18-24 in., and at the soil/tuff interface.

Sampling will be biased toward collecting all samples within a 250 ft radius, based on sampling results from the draft Los Alamos National Laboratory Sampling and Analysis Data Document (DOE 1989, 0271) as depicted in Figure 2-2. Regular sample spacing is proposed because it is the most appropriate form for spatially correlated variables (Flatman et al., 1988). The radial form with spokes is proposed because this design provides a collection of collinear observations along four different axes and the opportunity to evaluate directional anisotropies as well as correlation as a function of separation (Flatman and Yfantis 1984, 0504).

Sampling locations along the entire grid will be selected using the spacing described above. Surface and subsurface samples (0 to 6 in., 18 to 24 in., and at the soil/tuff interface) will be collected. It is thought that 18 to 24-in. sampling depth, is sufficient to include all regraded material. This sampling is to determine whether that PCOCs have infiltrated into the soil or been covered during regrading. To obtain these subsurface soil samples, a stainless steel hand auger will be used. A total of 31 surface, subsurface and soil/tuff interface samples will be collected.

Drainages at R-44 will be subjected to a Phase I investigation. As shown in Figure 5-2, surface soil samples will be collected within each drainage leading away from the firing sites, for a total of 22 samples. The surface soil sampling locations will be biased toward sediment catchments and elevated radiological and metal field-screening readings.

At the optical diagnostic shot location at Firing Site R-44, the Phase I reconnaissance sampling will be conducted as follows. A polar grid with a 100-ft radius will be established over the center of the firing site. Ten surface and soil/tuff interface samples will be collected at random locations within this grid and an additional sample at the center of the firing site. The locations shown in Figure 5-1 were selected by using a random grid starting orientation and randomly generated sampling points.

5.4 Fixed Laboratory Analyses for Firing Site R-44

Twenty percent of the samples will be analyzed (using EPA SW846 methods) for metals [target analyte list (TAL)], total U, tritium (using a scintillation method), and HE. The TAL metals include: aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium cobalt, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, selenium, silver, sodium, thallium, vanadium, zinc, and total cyanide.

5.5 Sampling at Firing Site R-45, PRS 15-006(d) and PRS 15-008(g)

For this Phase I reconnaissance sampling, the following strategy will be employed. A polar grid (Figure 5-3), which extends a nominal 200 ft in each direction from the mid-point of the two main firing points will be laid out over the sampling areas. At each of the two firing points three samples will be collected at 0 to 6 in, 18 to 24 in, and at the soil/tuff interface. Fifteen sampling locations over the rest of the grid will be selected at random. Each of these 15 random sampling points will include a surface sample, a 18 to 24 in. sample, and a sample at the soil/tuff interface. The sample locations shown in Figure 5-3 were selected by using a random grid starting location and randomly generated sampling points.

During the 1970s small optical diagnostic shots were conducted at R-45 from TA-15-141. At PRS 15-008(g), where this third firing site is located, two surface and soil/tuff samples will be collected at the center of the firing point.

This sampling scheme results in a total of 23 samples from each of three depths: three samples from each of two firing points (total six samples), 15 samples randomly located, and two samples from the center of the optical diagnostic shot.

One sample from the remains of the sandbag [PRS 15-008(g)] located to the south of the firing site will also be sampled.

Drainages at R-45 will be subjected to a Phase I investigation. As shown in Figure 5-3, surface soil samples will be collected within each drainage leading away from the firing sites, for a total of 8 samples. The surface soil sampling locations will be biased toward sediment catchments and elevated radiological and metal field-screening readings.

5.6 Fixed Laboratory Analyses for Firing Site R-45

Twenty percent of the samples will be analyzed (using EPA SW846 methods) for metals [target analyte list (TAL)], total U, and HE. The TAL metals include: aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium cobalt, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, selenium, silver, sodium, thallium, vanadium, zinc, and total cyanide.

6.0 REFERENCES

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Schlapper. G., August 14, 1991. 'GMX-11's Explosive Dispersal of U, Be, and Pb (Via Weapons-Related Testing, Through March 1971)," Los Alamos National Laboratory Memorandum HS-1-91:OHP-22 to Frank Jackson (M-DO) from Gerald Schlapper (HS-1), Los Alamos, New Mexico. (Schlapper 1991, 10-009)

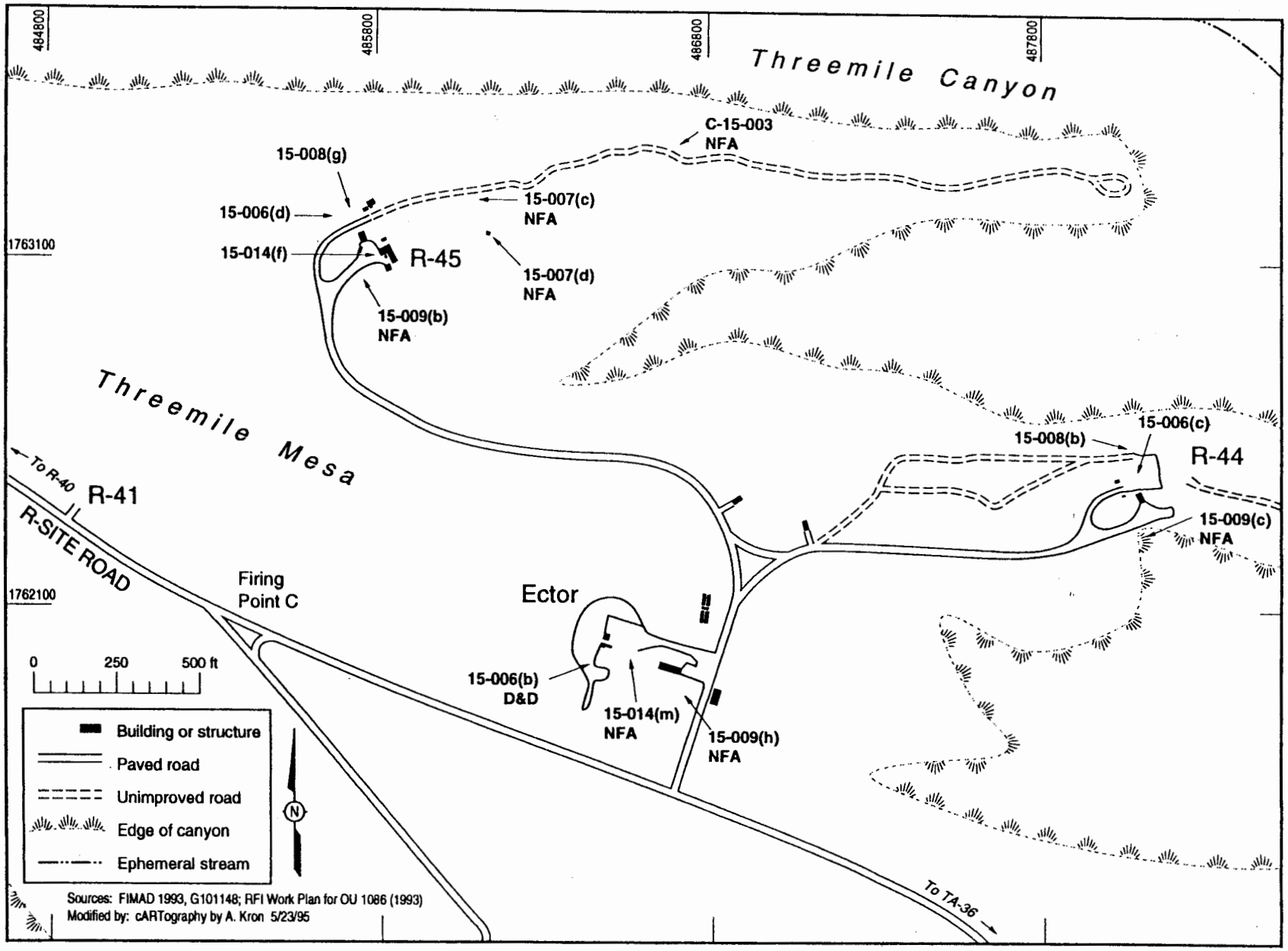

Figure 1-1. Site diagram for Firing Sites Ector, R-41, R-44, and R-45.

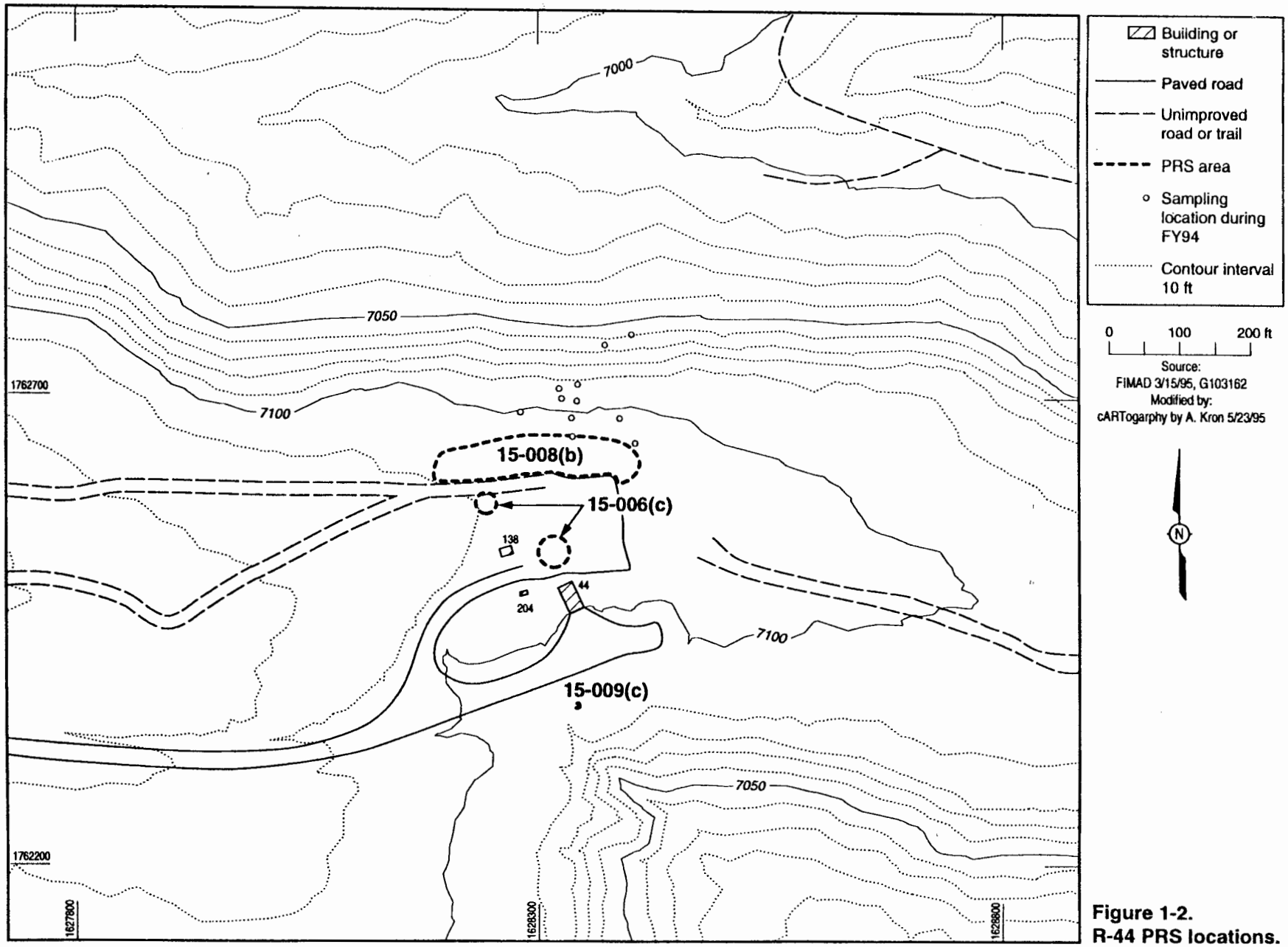

Figure 1-2.
R-44 PRS locations.

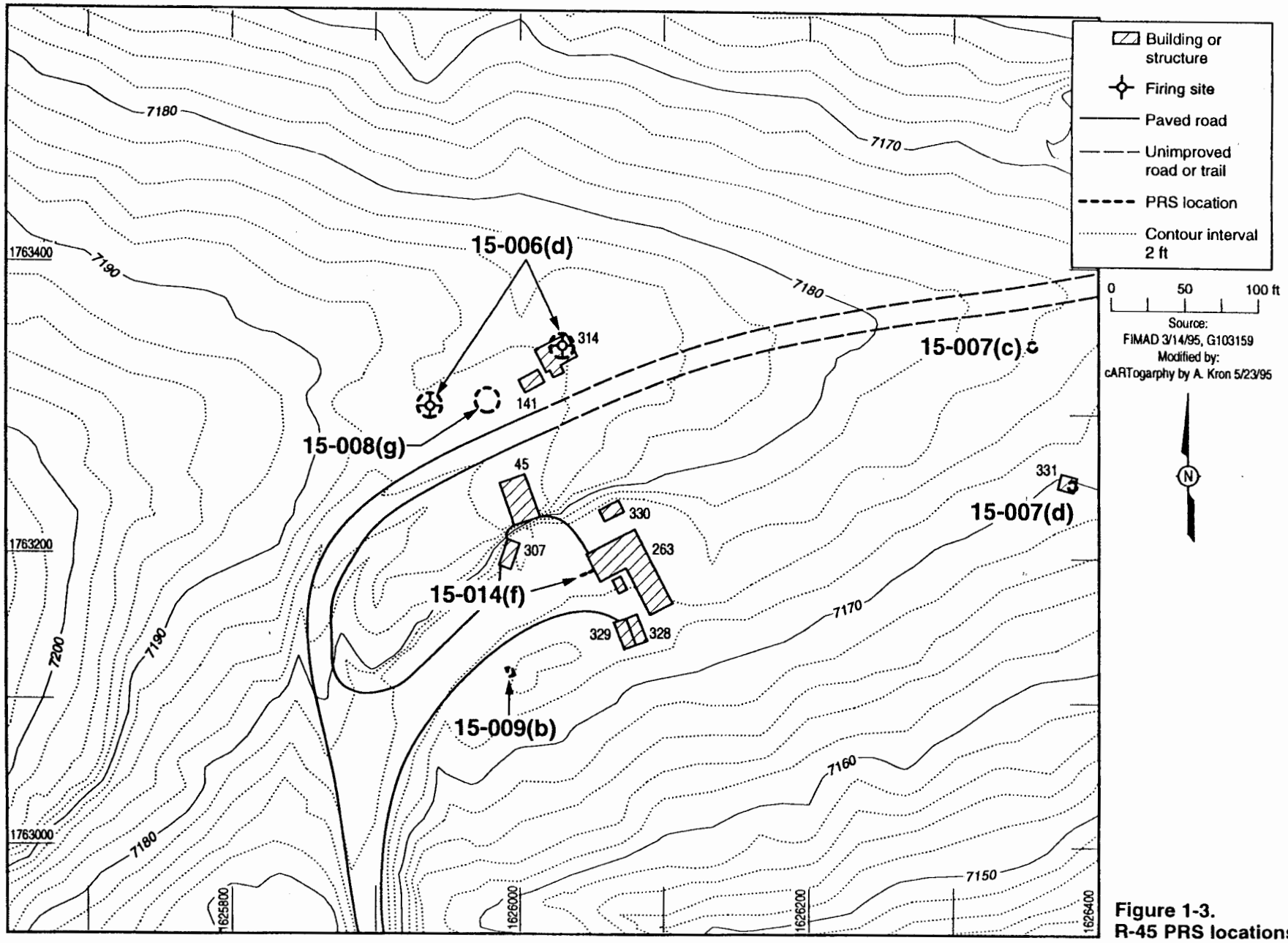

Figure 1-3.
R-45 PRS locations.

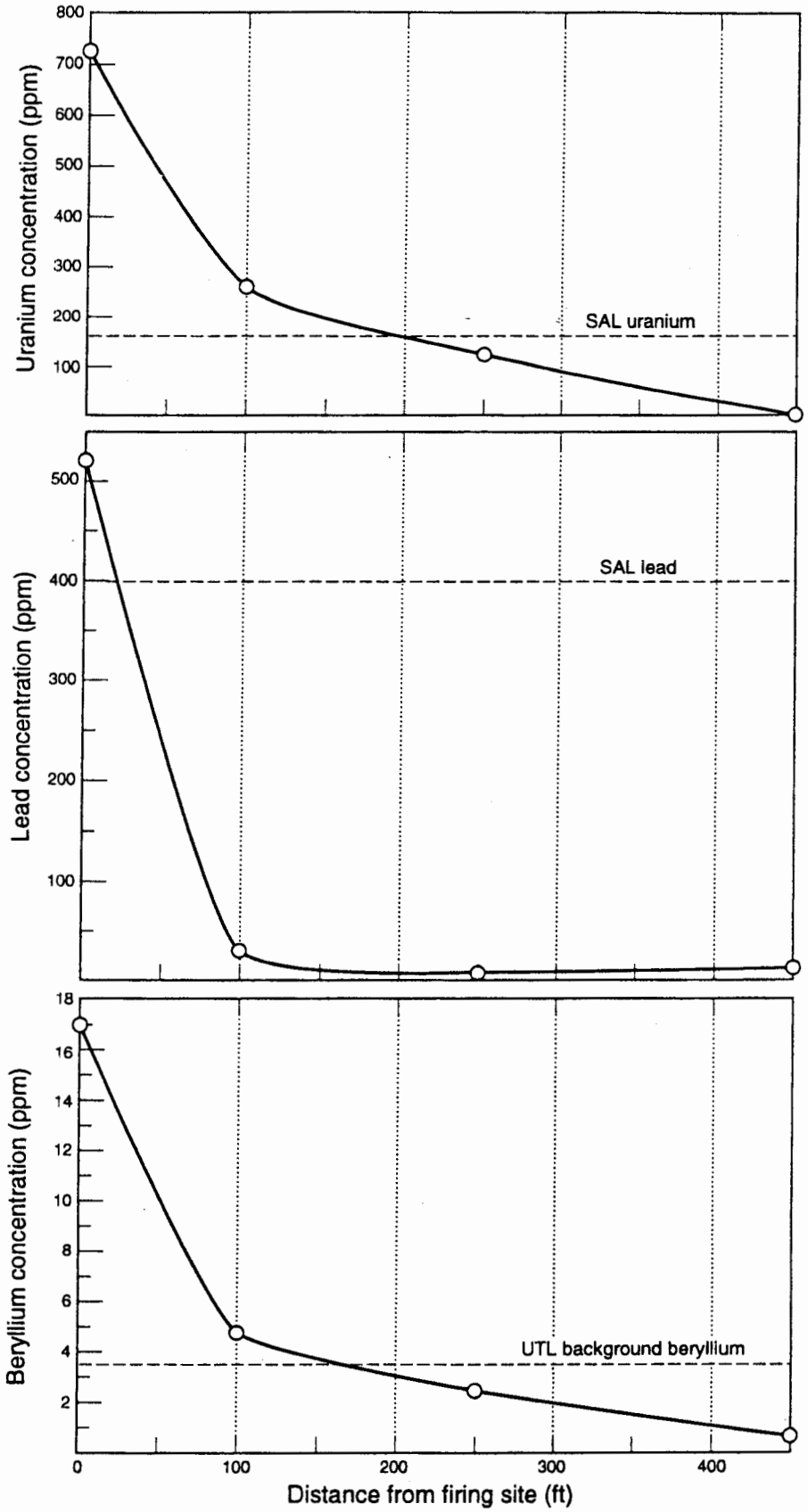

Figure 2-2. Graphs showing uranium, lead and beryllium concentrations with respect to distance from Firing Site R-44 (source: DOE 1989, 0271).

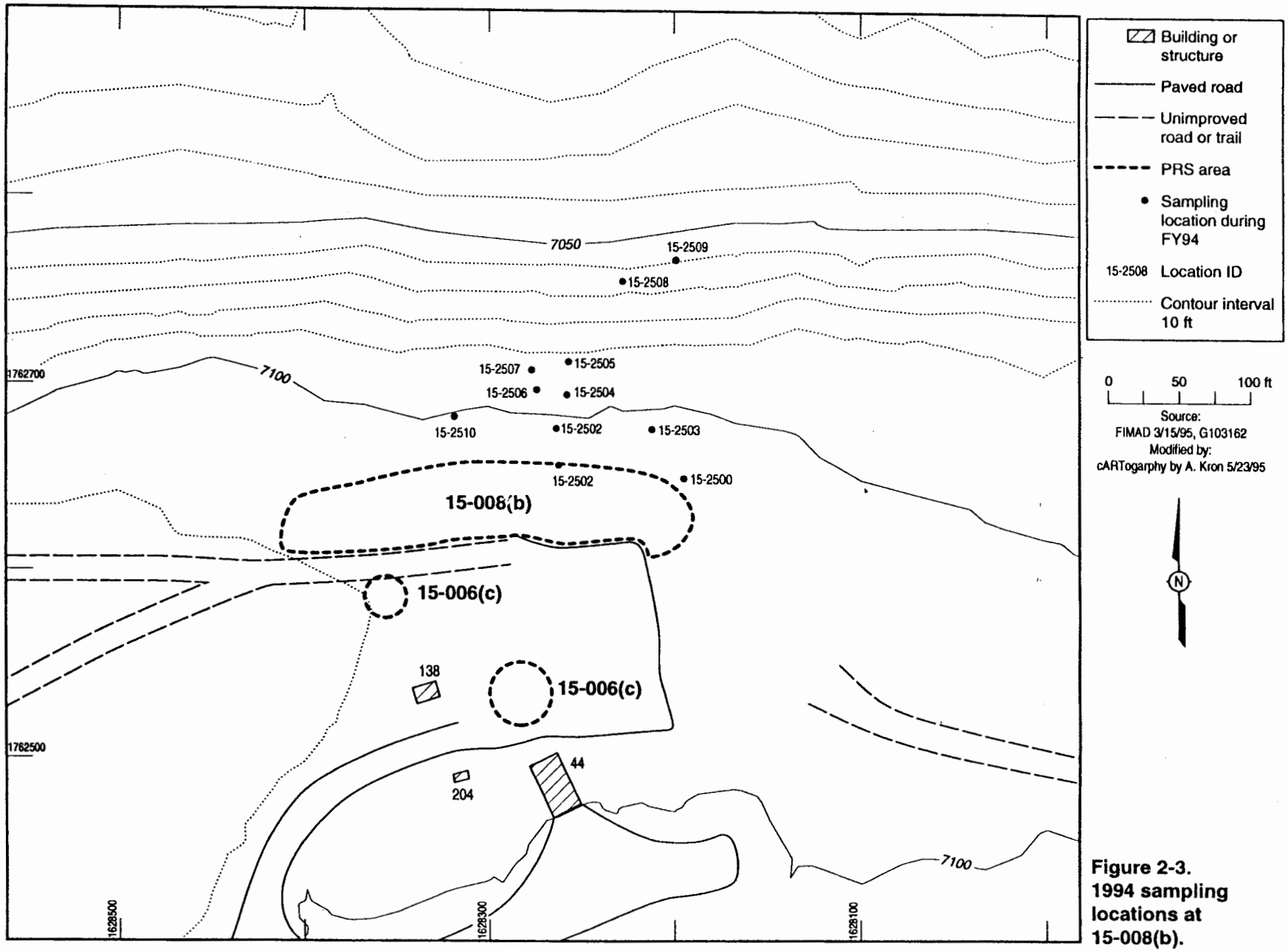

Figure 2-3. 1994 sampling locations at 15-008(b).

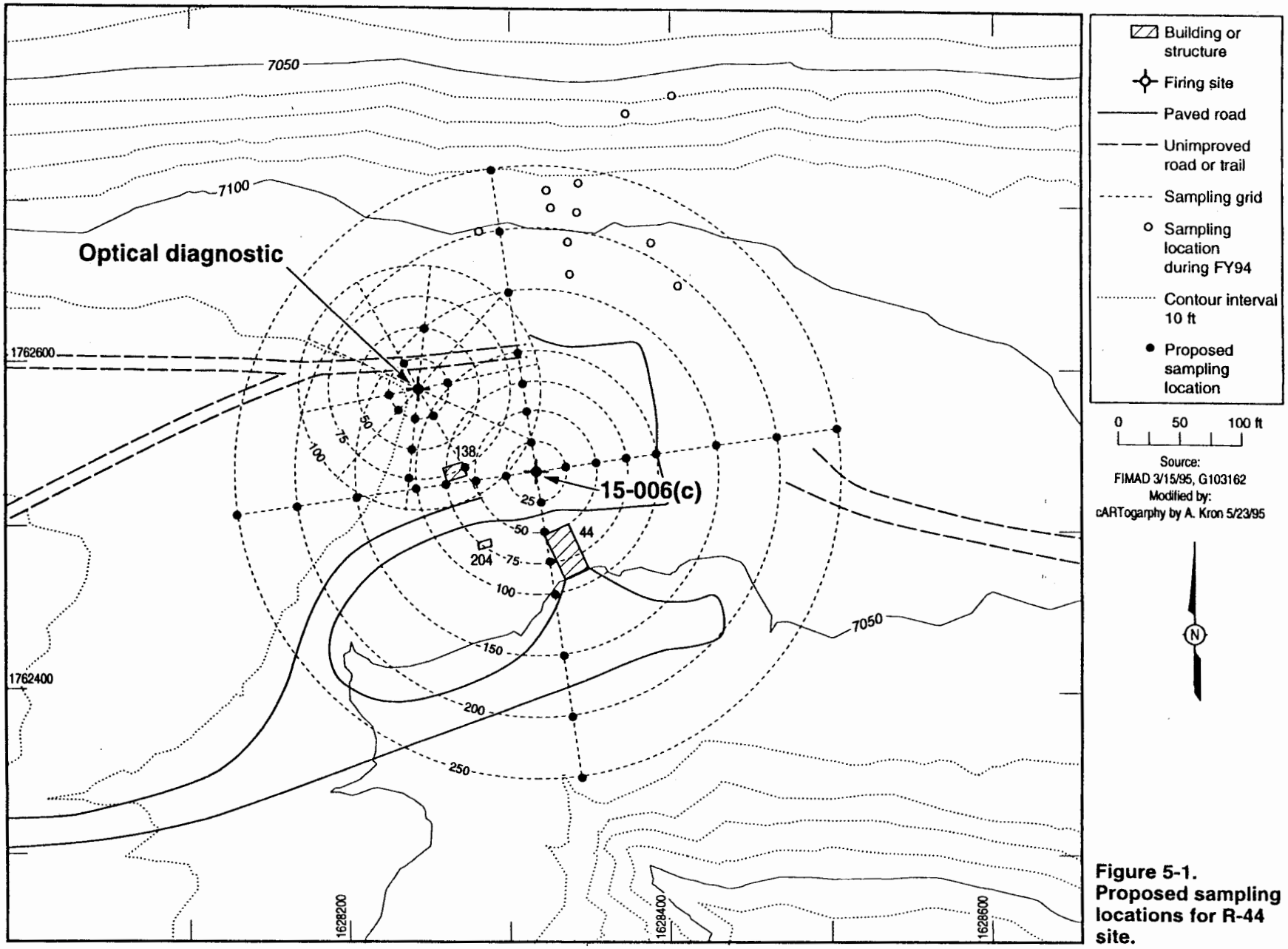

Figure 5-1. Proposed sampling locations for R-44 site.

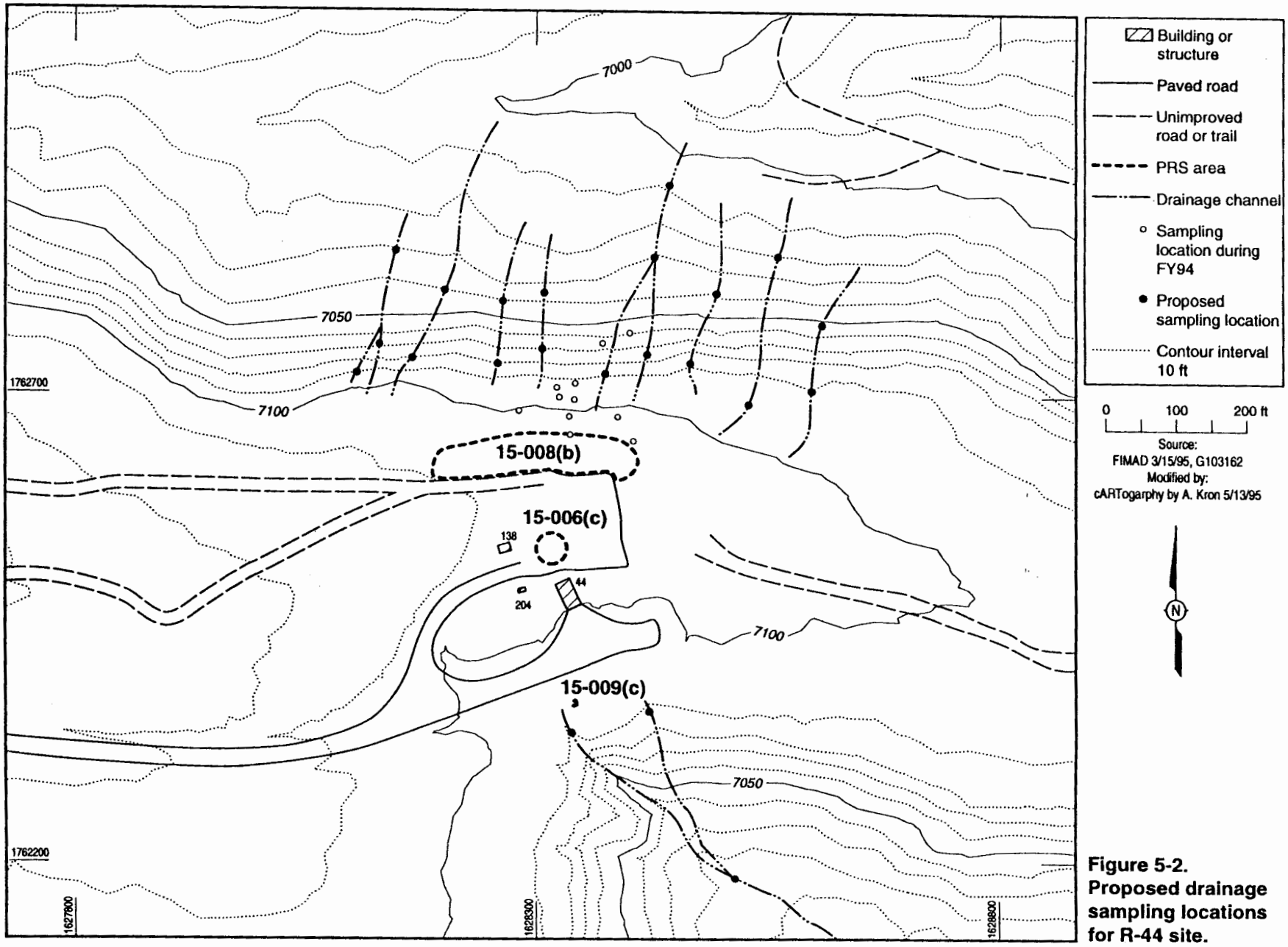

Figure 5-2. Proposed drainage sampling locations for R-44 site.

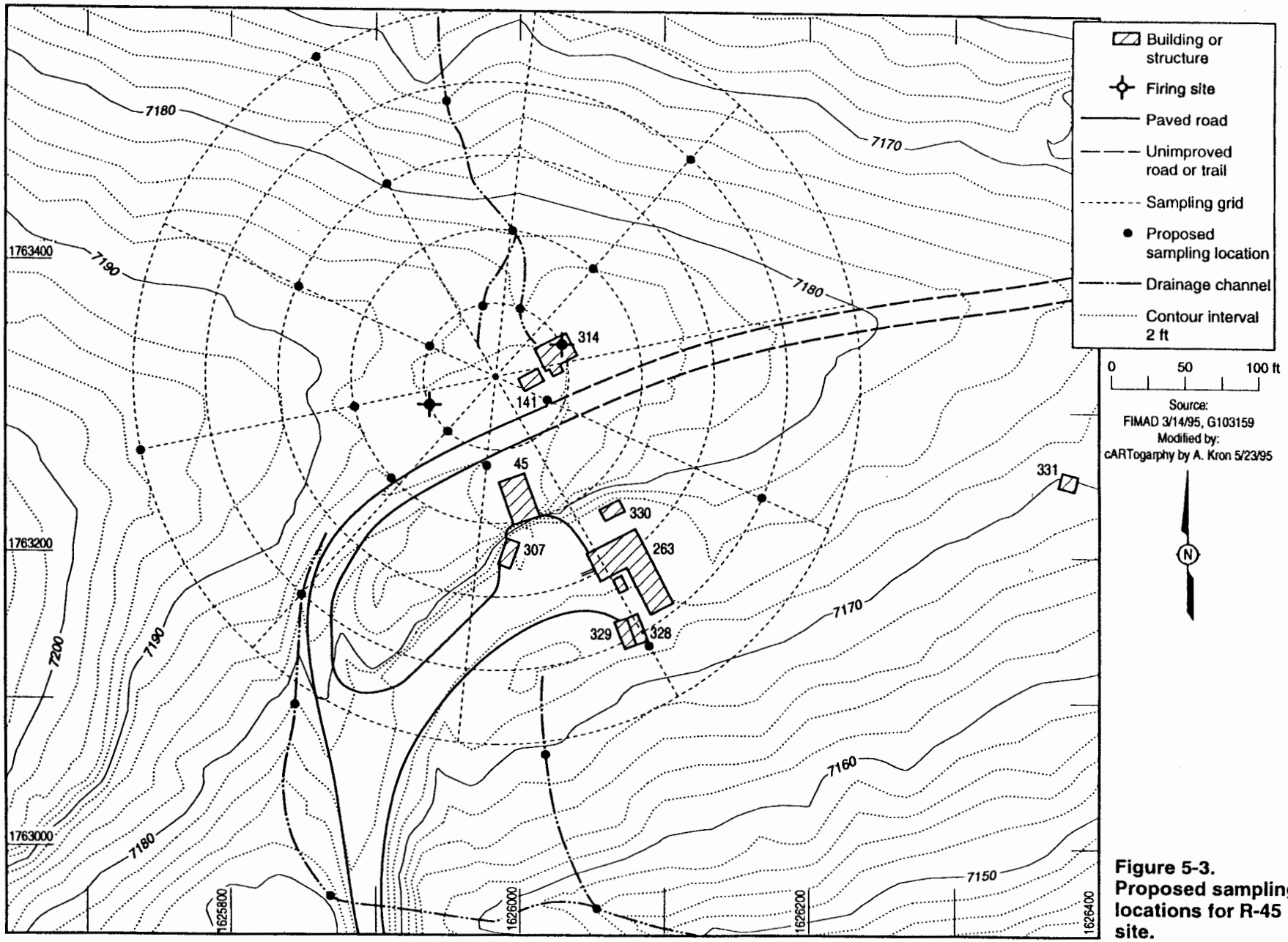

Figure 5-3. Proposed sampling locations for R-45 site.

Table 2-1
1994 Sampling Results from 15-008(b)

Location ID	Depth	Sample ID	Be (mg/kg)	Pb (mg/kg)	U (ug/g)
15-2500	0-6 in	AAB 3503	3.3	**413**	NR
15-2500	0-6 in	AAB 3503	**3.5**	**575**	NR
15-2500	18-24 in	AAB 3504	0.41	12.4	NR
15-2501	0-6 in	AAB 3398	**10.6**	77.9	NR
15-2501	18-24 in	AAB 3530	0.36	3.1	NR
15-2502	0-6 in	AAB 3355	**35.5**	175	NR
15-2502	18-24 in	AAB 3401	**11.9**	67	NR
15-2503	0-6 in	AAB 3353	**17.1**	**1250**	NR
15-2503	18-24 in	AAB 3352	0.93	14	NR
15-2504	0-6 in	AAB 3400	**35.1**	**754**	**890**
15-2504 (duplicate)	0-6 in	AAB 3354	**18.3**	**665**	**865**
15-2506	0-6 in	AAB 3531	**13.1**	110	**402**
15-2506	0-6 in	AAB 3531	**15.3**	**421**	**417**
15-2507	0-6 in	AAB 3399	**12.5**	233	**536**
15-2508	0-6 in	AAB 3402	**6.4**	61.8	**184**
15-2510	18-24 in	AAC 0995	**115**	**74400**	**160**

Highlighted values are above SALs or UTL
NR = Data not received from analytical laboratory

The two values shown for sample ID AAB3503 were duplicates chosen by the fixed analytical lab. Location ID 15-2504 was chosen by the field team randomly as a duplicate.

TABLE 4-1

SUMMARY OF DATA NEEDS FOR FIRING SITES R-44 AND R-45

PHASE I RFI AT PRS 15-006(c)	PHASE I RFI AT OTHER PRSs AND LOCATIONS
Determine 95% UCL of mean PCOCs for possible risk assessment	Determine maximum concentration of PCOCs for SAL comparison
Define potential cleanup boundaries of PCOCs	Define more limited list of PCOCs for any necessary Phase II investigation
Determine RCRA waste types to support future ECs or CMS	

TABLE 5 -1
SUMMARY OF SAMPLING AND ANALYSES
FOR PRS 15-006(c), PRS 15-006(d), and PRS 15-008(g)

OUTLINE OF SAMPLING PLAN FOR FIRING SITE S R-44 AND R-45 PRS 15-006(c), PRS 15-006(d), AND PRS 15-008(g)	FIELD SCREENING						LABORATORY ANALYSIS			
	Alpha/Beta/Gamma	Uranium	Tritium	Beryllium	Lead	HEs	Total Uranium	Tritium	TAL Metals	HEs
A. PRS 15-006(c)										
Surface Sampling	31	31	31	31	31	31	6	6	6	6
Subsurface Sampling (18"-24")	31	31	31	31	31	0	6	6	6	0
Soil/Tuff Sampling	31	31	31	31	31	0	6	6	6	0
Drainage Samples	22	22	22	22	22	22	4	4	4	4
Optical Diagnostic Shot Site Surface Sampling	11	11	11	11	11	11	2	2	2	2
Optical Diagnostic Shot Site Subsurface Sampling	11	11	11	11	11	0	2	2	2	2
B. PRS 15-006(d)										
Surface Sampling	23	23	0	23	23	23	5	0	5	5
Subsurface Sampling (18"-24")	23	23	0	23	23	0	5	0	5	5
Soil/Tuff Sampling	23	23	0	23	23	0	5	0	5	5
Drainage Samples	8	8	0	8	8	8	2	0	2	2
C. PRS 15-008(g)	1	1	0	1	1	1	1	0	1	1
Totals	215	215	137	215	215	96	44	26	44	32