DMA-TR-34

Dade Moeller & Associates, Inc.

Technical Report

Strontium-90 Soil Sampling in Runkle Canyon Simi Valley, California

Tracy A. Ikenberry, CHP

December 18, 2007

Prepared for
Runkle Canyon, LLC

Dade Moeller & Associates, Inc.
1835 Terminal Drive, Suite 200
Richland, WA 99354

Strontium-90 Soil Sampling in Runkle Canyon, Simi Valley, California

Executive Summary. A new soil sampling campaign was conducted in areas of proposed residential development of Runkle Canyon, south of Simi Valley, California for the presence of the radionuclide strontium-90 (^{90}Sr). Other sampling locations identified by the California Department of Public Health were also included. Sixty-three soil samples were collected during October 2007 using a MARSSIM-based sampling plan. The distribution of ^{90}Sr soil concentrations in Runkle Canyon soils is comparable to and generally less than the average background level determined in 1995 under U.S. EPA oversight.

All soil concentrations results, which range from -0.001 to 0.078 pCi/g ^{90}Sr, are much less than the default U.S. EPA Preliminary Remediation Goal (PRG) concentration of 0.231 pCi/g. Generally, where contaminant concentrations fall below PRGs (which are risk-based concentrations), no further action or study is warranted. The average soil concentration of 0.014 pCi/g ^{90}Sr determined during this sampling campaign would result in an annual fatal cancer risk of 6×10^{-8}, which is about 0.06 in 1,000,000. Moreover even the single highest sample result of 0.078 pCi/g ^{90}Sr would be well below the default PRG annual fatal risk level of 1×10^{-6} (1 in one-million). For comparison, the fatal cancer incidence in California is 1,725 per 1,000,000.

The overall conclusion is that there is effectively no health risk from ^{90}Sr in Runkle Canyon soil. The concentration of ^{90}Sr in Runkle Canyon soil is very low and is much less than the target fatal cancer risk level established by the EPA. The potential health risk to future Runkle Canyon residents is very low, and the risk to nearby residents from inhalation of dust from construction activities is even lower by orders of magnitude. No further sampling of soils at Runkle Canyon for the detection of ^{90}Sr is necessary.

Strontium-90 Soil Sampling in Runkle Canyon, Simi Valley, California

1.0 INTRODUCTION

A new soil sampling campaign was conducted in Runkle Canyon during October 2007 to detect the presence of the radionuclide strontium-90 (^{90}Sr). There have been continuing concerns raised by a small number of Simi Valley residents about the potential presence of ^{90}Sr in the Runkle Canyon surface soils and the level of risk to which residents might be exposed. The sampling campaign described in this report focused on the proposed areas of a new residential development and included other areas in the northwest portion of the Runkle Canyon property where few soil samples had previously been taken. These additional samples were taken at the recommendation of the California Department of Public Health (DPH). Soil sampling locations and methods were determined and selected independently of previous soil sampling results, which were not considered. Sampling results are used to make estimates of the potential risk to future Runkle Canyon residents and estimates of the risk to nearby residents from inhalation of dust raised during construction activities.

2.0 BACKGROUND

Runkle Canyon is the site of a proposed residential development adjacent to existing neighborhoods on the southern edge of Simi Valley, California. From 1999 to 2003 several sampling campaigns were conducted of the environmental media on the property to test for the presence of various contaminants. Several of these samples seemed to indicate the presence of low levels of the radionuclide strontium-90 (^{90}Sr) at a few scattered locations. In a follow-up to these earlier tests, additional sampling was also conducted in June 2005 at the request of the California Department of Health Services (now DPH) at five selected locations where the highest results had previously been detected. Analysis of these samples indicated no elevated results. The minimum detectable concentration (MDC) analytical capabilities of the earlier tests were not low enough to conclusively demonstrate that the levels of ^{90}Sr in soil were at or below the lower limit of the U. S. Environmental Protection Agency's (EPA's) acceptable risk range of 1×10^{-4} to 1×10^{-6} annual fatal cancer risk. Concerns were voiced by a small number of Simi Valley residents that EPA's default Preliminary Remediation Goal (PRG) of 0.231 pCi/g for ^{90}Sr, with a risk of 1×10^{-6}, should be the highest acceptable concentration. The default PRG can be calculated using the default assumptions of EPA's PRG calculator and is the soil concentration that corresponds to an annual fatal cancer risk of 1×10^{-6}(1 in one-million). This default PRG value incorporates conservative estimates of exposure and resident lifestyle that would tend to overestimate the actual risk to a resident, i.e., the risk to an actual resident would likely be lower than estimated using the default PRG.

3.0 SAMPLING APPROACH AND METHODS

A sampling plan was developed and randomly selected sampling locations were established using a MARSSIM-based sampling approach (EPA 2001) in the area of planned residential development. Also included in the sampling plan was an area in the northwest corner of the property where no residential development is planned but which was included at the request of DPH because of the DPH opinion that insufficient sampling had been conducted in this area. The total area sampled was about 398 acres of the 1,595 acres in the property. The remainder of

the property is planned to remain undisturbed for use by community residents and members of the public after the residential development is completed. Fifty-seven sample locations were established. These sample locations are shown in Figure 1.

In addition to establishing new, independent sample locations, this sampling campaign differed from previous campaigns because of the more sensitive analytical techniques used. An independently contracted analytical laboratory used the HASL-300 technique (EML 1997) with *a priori* MDCs of 0.03 to 0.05 picocuries (pCi) of ^{90}Sr per gram of soil (pCi/g). This analytical technique with these MDCs was selected because it provides the capability to readily detect ^{90}Sr soil concentrations at or below the generally referenced ^{90}Sr soil background level of 0.052 pCi/g (EPA 1995) and the default PRG of 0.231 pCi/g.

Separate, independent firms were contracted to prepare the sampling plan, conduct the soil sampling, and perform the analytical analysis for ^{90}Sr. A representative of the City of Simi Valley, CA was on site at all times while sampling was being conducted. This representative was responsible for collecting split samples for the City and maintaining the sample chain of custody on these samples. A separate chain of custody was maintained on the remainder of the samples by the contracted sampling firm and analytical laboratory.

Fifty-seven surface soil samples were collected using a modified ASTM C998-05[1] sampling procedure to account for collection of ^{90}Sr which could be in the surface soil layer from 0 to 6 inches (0 to 15 cm) in depth. An additional 6 samples were taken from 6 to 12 inches (15 to 30 cm) depth at six of the sampling locations to assist in determining if the ^{90}Sr may have migrated or leached to deeper soil layers. A total of 63 soil samples were collected and submitted to the laboratory for analysis.

4.0 RESULTS

The results of the soil sampling campaign are presented in Table 1, showing the quantitative result in pCi/g, the 2 standard deviation uncertainty, and the MDC for each sample. Only 19 of the 63 results were considered to be "positive" by the analytical laboratory, where the sample result exceeds the MDC and 2 standard deviations. However, quantitative sample results were provided for all samples and all values are included in this analysis, as recommended (EPA 1980). Seven of the samples were reported with negative values, indicating the total number of counts in the sample were lower than the number of background counts. This is not unexpected in samples where there is a very low level of activity and the sample activity is near zero. The individual sample MDCs ranged from 0.0076 to 0.033 pCi/g, proving to be better than the *a priori* MDCs estimated prior to analysis.

Sample results ranged from -0.02 pCi/g to 0.078 pCi/g, with arithmetic mean of 0.014 pCi/g and standard deviation of 0.0145 pCi/g. The sample results were also evaluated for a log-normal

[1] ASTM Standard C 998, 2005, "Standard Practice for Sampling Surface Soil for Radionuclides," ASTM International, West Conshohocken, PA, www.astm.org.

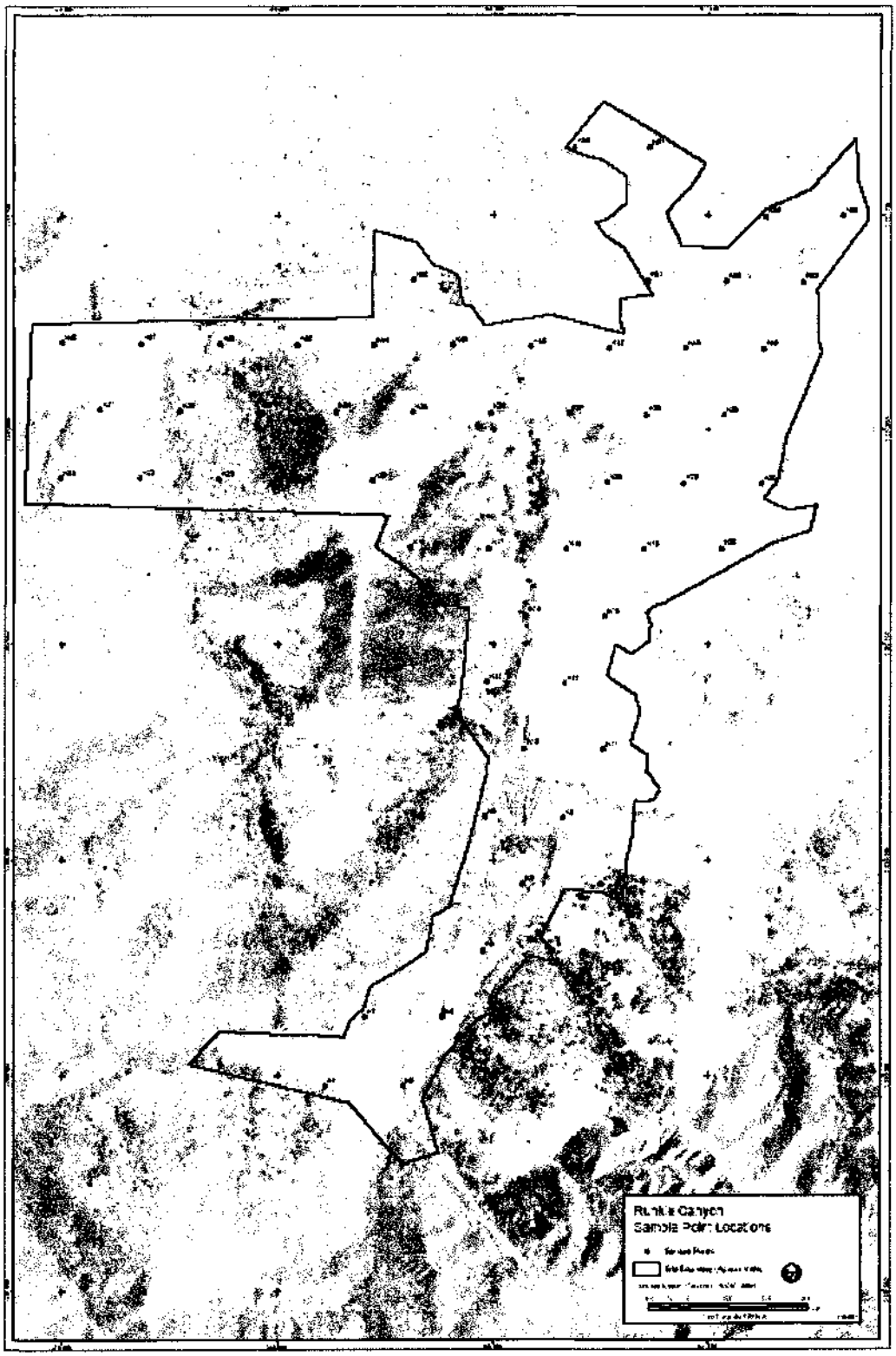

Figure 1. Field Sampling Map Showing Runkle Canyon Sample Locations.

Table 1. Results of ^{90}Sr Soil Sampling in Runkle Canyon, October 2007.

Sample Number		Depth[1]	Concentration (pCi ^{90}Sr/g soil)	Uncertainty (2 std dev)[2]	Minimum Detectable Concentration (pCi/g)	Positive[3]
K	1	S	0.0185	0.0162	0.0245	
K	1	D	0.0449	0.0213	0.0302	+
K	2		0.0169	0.0195	0.0304	
K	3		0.0181	0.0166	0.0252	
K	4		0.0218	0.0212	0.0322	
K	5		0.0247	0.0197	0.0299	
K	6		0.0012	0.0174	0.0285	
K	7		0.0320	0.0183	0.0268	+
K	8		-0.0037	0.0197	0.0329	
K	9		0.0203	0.0165	0.0249	
K	10		0.0161	0.0171	0.0265	
K	11		0.0132	0.0183	0.0286	
K	12		0.0130	0.0051	0.0076	+
K	13	S	0.0397	0.0186	0.0257	+
K	13	D	0.0084	0.0161	0.0255	
K	14		0.0129	0.0097	0.0153	
K	15		-0.0004	0.0086	0.0143	
K	16		0.0055	0.0052	0.0081	
K	17		0.0084	0.0149	0.0235	
K	18		0.0384	0.0138	0.0203	+
K	19		0.0072	0.0117	0.0184	
K	20	S	0.0393	0.0164	0.0271	+
K	20	D	0.0147	0.0082	0.0139	+
K	21		0.0112	0.0212	0.0334	
K	22		0.0186	0.0074	0.0110	+
K	23		0.0142	0.0199	0.0309	
K	24		0.0420	0.0089	0.0122	+
K	25		0.0041	0.0152	0.0246	
K	26		0.0087	0.0059	0.0093	
K	27	S	0.0780	0.0215	0.0262	+
K	27	D	0.0272	0.0146	0.0206	+
K	28		0.0013	0.0057	0.0107	
K	29		0.0067	0.0060	0.0107	
K	30		0.0236	0.0184	0.0328	
K	31		0.0039	0.0117	0.0190	
K	32		0.0141	0.0154	0.0244	
K	33		0.0262	0.0167	0.0240	+
K	34		0.0032	0.0059	0.0095	
K	35		0.0115	0.0164	0.0256	
K	36		-0.0018	0.0105	0.0174	

Sample Number	Depth[1]	Concentration (pCi ^{90}Sr/g soil)	Uncertainty (2 std dev)[2]	Minimum Detectable Concentration (pCi/g)	Positive[3]
K 37		-0.0025	0.0071	0.0118	
K 38		0.0002	0.0058	0.0109	
K 39		0.0016	0.0062	0.0116	
K 40	S	0.0130	0.0102	0.0161	
K 40	D	-0.0100	0.0165	0.0285	
K 41		0.0059	0.0075	0.0120	
K 42		0.0070	0.0141	0.0223	
K 43		0.0046	0.0049	0.0077	
K 44		0.0059	0.0056	0.0089	
K 45		0.0232	0.0075	0.0109	+
K 46		0.0325	0.0122	0.0197	+
K 47		0.0084	0.0069	0.0121	
K 48		0.0091	0.0063	0.0109	
K 49		0.0115	0.0055	0.0091	+
K 50		-0.0006	0.0109	0.0180	
K 51		0.0053	0.0117	0.0217	
K 52	S	0.0158	0.0065	0.0107	+
K 52	D	0.0122	0.0059	0.0097	+
K 53		0.0115	0.0062	0.0103	+
K 54		-0.0003	0.0104	0.0198	
K 55		0.0020	0.0055	0.0101	
K 56		0.0132	0.0062	0.0103	+
K 57		0.0097	0.0094	0.0167	

[1] For samples taken at two depths at the same location, S = shallow, D = deep.
[2] std dev = standard deviation of the sample value.
[3] Activity concentration exceeds the MDC and 2 standard deviations.

distribution using the "Lognormal Fitting Utility Program[2]." The results of the soil sampling appear to show a log-normal distribution with geometric mean of 0.011 pCi/g ^{90}Sr and geometric standard deviation of 2.8. The 95 percent confidence interval for the data set is -0.002 pCi/g to 0.04 pCi/g. The maximum sample result, 0.078 pCi/g in the shallow sample portion at sample location K27, was determined be near the 99th percentile of the data distribution. Table 2 presents a summary of the sampling statistics.

[2] Strom, DJ. 2006. "Lognormal Fitting Utility Program." PNWD-SA-7625, Battelle, Richland, Washington. http://qecc.pnl.gov/Lognormal_Fitting_Utility.htm.

Table 2. Summary of Results from the October 2007 Runkle Canyon Soil Sampling[1].

Statistical Parameter	^{90}Sr in Soil, pCi/g
Geometric mean (log-normal distribution)	0.011
Geometric standard deviation (log-normal distribution)	2.8[2]
Average (normal distribution)	0.014
Standard deviation (normal distribution)	0.0145
Minimum	-0.001
Maximum	0.078
5th percentile, 95th percentile	-0.002, 0.04

[1] The total number of samples, n, = 63.
[2] The geometric standard deviation is unitless.

Statistical tests were performed to check for significant differences between the shallow and deep soil samples. T-tests were performed to check for significant difference between the means of the six paired shallow and deep samples and also between the sets of shallow (n = 57) and deep (n = 6) samples. No statistical difference was noted at the 0.05 level for either normal or log-transformed data. There is no indication that ^{90}Sr has migrated from the surface soil layer to into the deeper soil.

The background level of ^{90}Sr in the Runkle Canyon area has been reported to be 0.052 pCi/g (EPA 1995). There is additional information available on the data collected during 1992 and 1994 that help provide a more complete description of the background ^{90}Sr level (McLaren Hart 1995). Summary statistics presented in the report are shown in Table 3.

Table 3. Additional Information on ^{90}Sr Background Soil Levels around Runkle Canyon[1].

Statistical Parameter	^{90}Sr in Soil, pCi/g
Average (EPA 1995)[2]	0.052
Standard deviation	0.031
5th percentile, 95th percentile	0.005, 0.11

[1] Source: McLaren Hart 1995.
[2] EPA 1995 presents the same average value.

Figure 2 presents a graphical representation of the 2007 Runkle Canyon sampling data and also presents a comparison to the background data from the 1995 reports. This figure shows that the distribution of ^{90}Sr soil concentrations in the Runkle Canyon soil is comparable to and generally less than the average background level from 1995. The current set of sample results and the background distribution would be even more comparable if the background data parameters were decay-corrected for the 13 years between 2007 and the time of last sample collection in 1994. Also shown is a background data point that was not included in the background determination because it was concluded to be statistically different from other sample results.

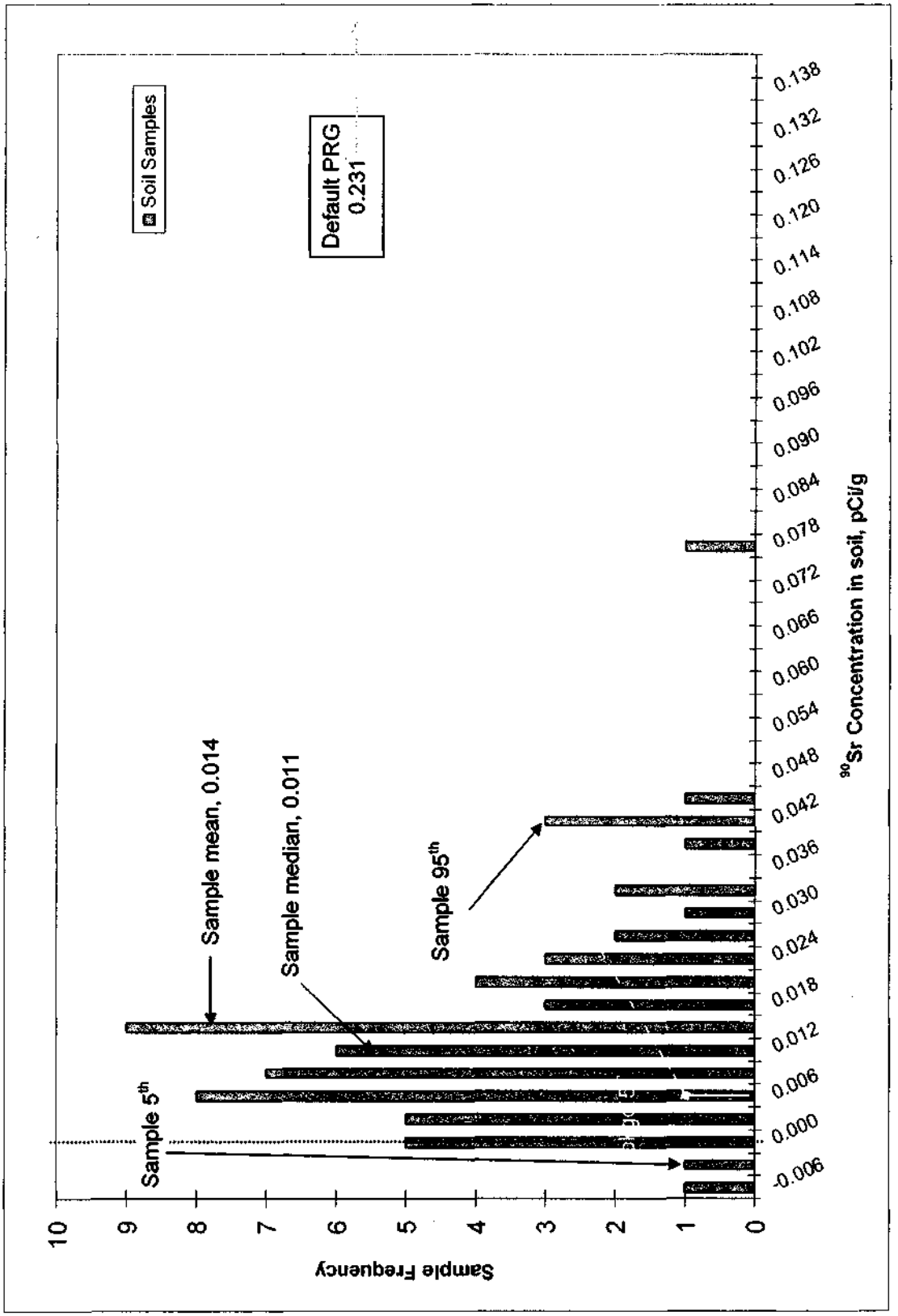

Figure 2. Runkle Canyon Sampling Results Histogram and Comparison to Background Statistics.

All soil concentrations results are much less than the default PRG concentration of 0.231 pCi/g. The average soil concentration of 0.014 pCi/g determined during this sampling campaign would conservatively indicate an annual fatal cancer risk of 6×10^{-8}, less than 0.06 in 1,000,000 to a Runkle Canyon resident. Even if the soil were widely contaminated at the level indicated by the single highest sample result, the annual fatal cancer risk would be about 3×10^{-7} (about 0.3 in 1-million), still below the lower limit of EPA's acceptable risk range of 1×10^{-4} to 1×10^{-6}. For comparison, the fatal cancer incidence in California is 172.5 per 100,000 persons (CDC and NCI 2007) or 1,725 per 1,000,000 persons.

The potential risk to nearby residents during construction activities would be even lower than the risks presented above for future Runkle Canyon residents, likely about 1,000 times less potential exposure. Nearby residents would be exposed only while the soil was disturbed and only via the inhalation exposure pathway, which is a minor exposure pathway compared to ingestion. In contrast, the exposure scenario for potential Runkle Canyon residents – at the health risk level described above of less than 1 in one-million – includes nearly continuous residency and exposure from consumption of homegrown fruits and vegetables and inadvertently ingesting soil. Ingestion is the main exposure pathway for ^{90}Sr.

5.0 CONCLUSIONS

Sampling results from the October 2007 Runkle Canyon soil sampling campaign indicate that the the concentration of ^{90}Sr in Runkle Canyon soil is comparable to and generally less than the average background level determined in 1995 under EPA oversight. These results indicate effectively no potential health risk from ^{90}Sr in soil. The potential risk to future Runkle Canyon residents would be much less than the 1×10^{-6} (much less than 1 in one-million) annual fatal cancer risk that is the lower limit of EPA's target risk range, even using the conservative assumptions of the default PRG. The actual risk to future Runkle Canyon residents would likely be even lower. Similarly, the potential risk to nearby residents would be even smaller by orders of magnitude and is considered negligible. No further sampling of soils at Runkle Canyon for the detection of ^{90}Sr is necessary.

6.0 REFERENCES

Centers for Disease Control and Prevention *and* National Cancer Institute (CDC and NCI) 2007. U.S. Cancer Statistics Working Group. *United States Cancer Statistics:* 1999–2003 *Incidence and Mortality Web-based Report*. Atlanta: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention *and* National Cancer Institute. www.cdc.gov/uscs.

Environmental Measurements Laboratory (EML) 1997. *EML Procedures Manual*, 28th Edition. HASL-300. Environmental Measurements Laboratory, U.S. Department of Energy. http://www.eml.st.dhs.gov/publications/procman/

McLaren Hart Environmental Engineering Corporation, 1995. *Additional Soil and Water Sampling The Brandeis-Bardin Institute and Santa Monica Mountains Conservancy*. January 15, 1995. http://www.etec.energy.gov/Health-and-Safety/Brandeis-Bardin.html

U.S. Environmental Protection Agency (EPA) 1980. *Upgrading Environmental Radiation Data*. EPA 520/1-80-012. U.S. Environmental Protection Agency, Office of Radiation Programs, Washington, D.C.

U.S. Environmental Protection Agency (EPA) 1995. EPA Update July 1995. U.S. Environmental Protection Agency Region IX, San Francisco, California. http://www.etec.energy.gov/Health-and-Safety/Brandeis-Bardin.html

U.S. Environmental Protection Agency (EPA). 2001. *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)*. EPA-402-R-97-016, Rev.1 (also NUREG-1575, Rev. 1, DOE/EH-0624, Rev. 1). U.S. Environmental Protection Agency, Washington, DC. www.epa.gov/radiation/marssim/obtain.htm

7.0 ACRONYMS AND DEFINITIONS

MARSSIM. Multi-Agency Radiation Survey and Site Investigation Manual.

minimum detectable concentration (MDC). The level of radioactivity concentration which is practically achievable by an overall measurement method. It considers not only the instrument characteristics (background and efficiency) but all other factors and conditions which influence the measurement.

picocurie (pCi). A unit of radioactivity, corresponding to 0.037 radioactive disintegrations per second.

picocurie per gram (pCi/g). A measure of the concentration of radioactivity per unit mass, also called activity concentration. Used to measure the activity of ^{90}Sr in soil.

preliminary remediation goal (PRG). Initial cleanup goals that (1) are protective of human health and the environment and (2) comply with applicable or relevant and appropriate requirements (ARARs). They are developed early in the process based on readily available information and are modified to reflect results of the baseline risk assessment. They are also used during analysis of remedial alternatives in the remedial investigation/feasibility study (RI/FS). Health-based radionuclide or chemical concentrations in an environmental media are associated with a particular exposure scenario. PRGs may be developed based on ARARs or exposure scenarios evaluated prior to or as a result of the baseline risk assessment.

strontium-90 (^{90}Sr). A radioactive isotope of the element strontium. Strontium-90 has a half-life of 29 years and emits beta radiation. Its radioactive progeny is yttrium-90, which also emits beta radiation and is included in radiation dose calculations for ^{90}Sr.

LIMITATIONS

This technical report was prepared in accordance with the terms of our engagement letter with Runkle Canyon, LLC. This report is based upon best information available at the time of document submittal.