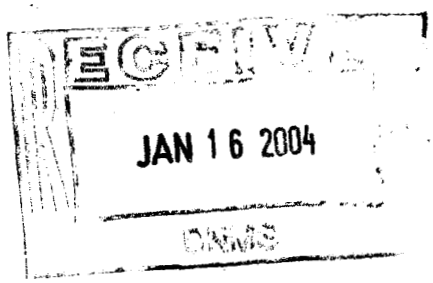
ORISE
OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION

January 12, 2004



Mr. Robert Evans
U.S. Nuclear Regulatory Commission
Region IV: DNMS:NMLB
611 Ryan Plaza Drive
Arlington, TX 76011

SUBJECT: FINAL REPORT—RADIOLOGICAL SCOPING SURVEY OF THE SALMON RIVER URANIUM DEVELOPMENT, INC. PROCESSING MILL, NORTH FORK, IDAHO [DOCKET NO. 040-03400, RFTA NO. 03-020]

Dear Mr. Evans:

The Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education (ORISE) conducted a radiological scoping survey of the subject facility during the period October 6 through 8, 2003. Enclosed is the final report detailing the procedures and results of the survey. Comments on the draft report have been incorporated.

Please contact me at (865) 576-5073 or Eric Abelquist at (865) 576-3740 should you require any additional information.

Sincerely,

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

TJV:ar

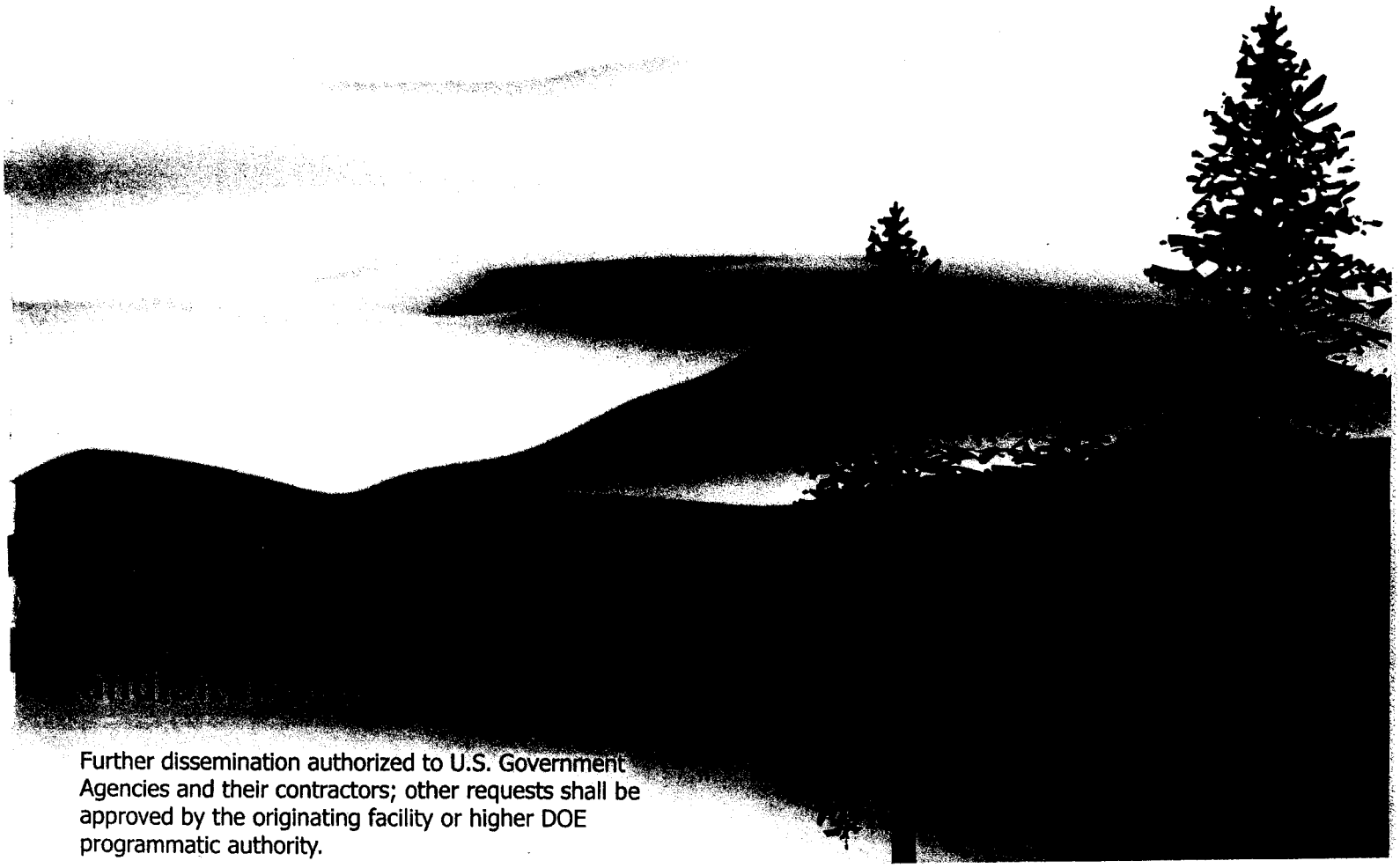
Enclosure

cc: T. McLaughlin, NRC/NMSS/TWFN 7F27
E. Knox-Davin, NRC/NMSS/8A23
E. Pogue, NRC/NMSS/TWFN 7F27
E. Abelquist, ORISE/ESSAP
T. Brown, ORISE/ESSAP
R. Morton, ORISE/ESSAP
File/874

RADIOLOGICAL SCOPING SURVEY OF THE SALMON RIVER URANIUM DEVELOPMENT, INC. PROCESSING MILL NORTH FORK, IDAHO [DOCKET NO. 040-03400, RFTA NO. 03-020]

T. J. VITKUS

Prepared for
Region IV
U.S. Nuclear Regulatory Commission



RADIOLOGICAL SCOPING SURVEY OF THE SALMON RIVER URANIUM DEVELOPMENT, INC. PROCESSING MILL NORTH FORK, IDAHO

Prepared by

T. J. Vitkus

Environmental Survey and Site Assessment Program
Radiological Safety, Assessments, and Training
Oak Ridge Institute for Science and Education
Oak Ridge, Tennessee 37831-0117

Prepared for

Region IV
U.S. Nuclear Regulatory Commission

FINAL REPORT

JANUARY 2004

This report is based on work performed under an Interagency Agreement (NRC Fin. No. J-5403) between the U.S. Nuclear Regulatory Commission and the U.S. Department of Energy. Oak Ridge Institute for Science and Education performs complementary work under contract number DE-AC05-00OR22750 with the U.S. Department of Energy.

RADIOLOGICAL SCOPING SURVEY
OF THE
SALMON RIVER URANIUM DEVELOPMENT, INC. PROCESSING MILL
NORTH FORK, IDAHO

Prepared by: Smith J Vitkus Date: 1/2/2004
T. J. Vitkus, Survey Projects Manager
Environmental Survey and Site Assessment Program

Reviewed by: R.D. Condra Date: 1/2/2004
R. D. Condra, Laboratory Manager
Environmental Survey and Site Assessment Program

Reviewed by: Ann Payne Date: 1/5/2004
A. T. Payne, Quality Manager
Environmental Survey and Site Assessment Program

Reviewed by: Eu W. Abelquist Date: 1/2/2004
E. W. Abelquist, Program Director
Environmental Survey and Site Assessment Program

ACKNOWLEDGMENTS

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

FIELD STAFF

T. L. Brown
J. R. Morton

LABORATORY STAFF

R. D. Condra
W. P. Ivey
J. S. Cox
E. M. Ball

CLERICAL STAFF

D. K. Herrera
K. L. Pond
A. Ramsey

ILLUSTRATOR

T. D. Herrera

TABLE OF CONTENTS

LIST OF FIGURES

PAGE

LIST OF TABLES

ABBREVIATIONS AND ACRONYMS

AEC	Atomic Energy Commission
ε_i	instrument efficiency
ε_s	surface efficiency
ε_{total}	total efficiency
µrem/h	microrem per hour
µR/h	microroentgens per hour
b_i	number of background counts in the interval
cm	centimeter
cm^2	square centimeter
cpm	counts per minute
d′	index of sensitivity
DOE	U.S. Department of Energy
dpm	disintegrations per minute
dpm/100 cm^2	disintegrations per minute per 100 square centimeters
EML	Environmental Measurements Laboratory
ESSAP	Environmental Survey and Site Assessment Program
ISO	International Standards Organization
ITP	Intercomparison Testing Program
JHA	job hazard analysis
keV	kiloelectron volts
kg	kilogram
m	meter
m^2	square meter
MAPEP	Mixed Analyte Performance Evaluation Program
MDC	minimum detectable concentration
MDCR	minimum detectable count rate
MeV	million electron volts
mm	millimeter
NaI	sodium iodide
NIST	National Institute of Standards and Technology
NRC	Nuclear Regulatory Commission
NRIP	NIST Radiochemistry Intercomparison Program
ORISE	Oak Ridge Institute for Science and Education
pCi/g	picocuries per gram
SRUD	Salmon River Uranium Development, Inc.

RADIOLOGOCAL SCOPING SURVEY
OF THE
SALMON RIVER URANIUM DEVELOPMENT, INC. PROCESSING MILL
NORTH FORK, IDAHO

INTRODUCTION AND SITE HISTORY

While conducting a review of previously terminated U. S. Nuclear Regulatory Commission (NRC) licenses, it was determined that the Salmon River Uranium Development, Inc. (SRUD) records were incomplete. Specifically, details describing the final status conditions of the facility did not indicate whether or not residual radioactive contamination from licensed material was still present. During the period of October 1958 to October 1959, the SRUD worked under two licenses issued by the U. S. Atomic Energy Commission (AEC), a predecessor to the NRC. The first license entitled SRUD to transfer, deliver, possess and have title to raw source material from the Sunnyside Claims at North Fork, Idaho. The second license authorized SRUD to process raw source material from the Agency Creek Thorium Corporation of Salmon, Idaho. All of the operations were to take place at the SRUD facility located near North Fork. Since the expiration of the two licenses, the property ownership has been transferred to Minerals Refining Company, the Joyce Pipeline Company, and later to an individual.

Documents from the State of Idaho investigations suggest that the site was used for the milling of copper, molybdenum, and possibly gold ore. The documents also indicated, as of January 1998, the presence of jugs of concentrated liquid thorium, piles of processed thorium ore, unprocessed thorium ore, and thorium processing equipment. An inspection of the SRUD site by the NRC on May 22, 2001, indicated the presence of radioactive materials in multiple locations throughout the facility at both interior and exterior locations.

The NRC's Division of Nuclear Materials Safety Region IV office requested that the Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education (ORISE) perform a radiological scoping survey of the SRUD facility in North Fork, Idaho.

SITE DESCRIPTION

The SRUD site is located on Forest Service Developed Road 030 approximately 8 kilometers (5 miles) west of State Highway 93 in North Fork, Idaho (Figure 1). The property consists of one main processing building (Building 1) and several attached and unattached storage sheds, support buildings (Buildings 2 and 3), and trailers (Figures 2 and 3). The facility is located on a leveled area approximately half-way up a steep hillside on the north side of the Forest Service road and the Salmon River.

Building 1 is a 750 square meter (m^2) wooden structure with sheet metal exterior siding on a poured concrete floor with some exposed soil areas (Figure 4). An equipment trench is located in the floor in the center of the building. A large ore hopper is located in the northwest corner of the building. There are also numerous concrete pedestals interspersed throughout the building. A small skid-mounted hopper and tank are staged in the southeast corner. A drying oven is located near the east end of the trench. A large amount of debris covers the floor of the building in several areas. Building 2 is a 42 m^2 wooden structure with a concrete floor located to the west of Building 1 (Figure 5). Building 3, located to the east of Building 1, is a 58 m^2 wooden building with sheet metal siding on a concrete floor (Figure 6). A raised platform is located on the north side where fiberglass insulation is stored.

The site's exterior property has two above-ground corrosive storage tanks, two dilapidated camper trailers, an ore inlet chute structure (located on the northwest corner of Building 1 and extending up the hillside), and an approximately 0.3 hectare (0.8 acre) dry tailings pond (Figures 2 and 3). There are numerous piles of what appear to be unprocessed and processed ores dumped around the property. The exterior grounds of the facility include a total of approximately 2 hectares (5 acres), but only 0.8 hectare (2 acres) is believed to have been impacted during the processing activities.

OBJECTIVES

The objectives of the radiological scoping survey were to provide sufficient independent contractor field data for use by the NRC in evaluating the radiological condition of the SRUD site. Additionally, the data may be used to support dose modeling of current site conditions and development of decommissioning cost estimates and site-specific derived concentration guideline levels.

DOCUMENT REVIEW

ESSAP reviewed the limited site documentation which included the site status report from an NRC May 22, 2001 site visit and used the information gathered from that review to plan the scoping survey activities.

PROCEDURES

ESSAP personnel visited the SRUD facility on October 6 through 8, 2003 and performed visual inspections and independent measurements and sampling of portions of the site. Survey activities were conducted in accordance with a site-specific survey plan and the ORISE/ESSAP Survey Procedures and Quality Assurance Manuals (ORISE 2003a, b and c). Appendices A and B provide additional information on instrumentation and procedures.

INTERIOR AND ADJACENT SURFACES

ESSAP used the following procedures to conduct radiological survey activities on building and equipment surfaces.

Reference System

A 5 meter (m) × 5 m reference grid was established in Building 1. In Buildings 2 and 3, a grid was not established. Rather, to-scale drawings were prepared for referencing measurement and sampling locations. ESSAP also used prominent site features to reference measurement and sampling locations.

Surface Scans

Surface scans for beta and gamma radiation were performed on 100% of the accessible floor areas in each building. Surface scans of the lower walls (less than two meters) were limited to approximately 1 to 5% of the area based on findings as the survey progressed. Upper surfaces could not be safely accessed for survey. Particular attention was given to horizontal surfaces and areas where material had accumulated. Additional scans were also performed on suspect equipment. Interior scans were performed using gas proportional and NaI scintillation detectors coupled to ratemeters or ratemeter-scalers with audible indicators. Locations of elevated direct radiation detected by surface scans were marked for further investigation.

Surface Activity Measurements

Construction material-specific backgrounds were determined in an area of Building 2 that was of similar construction to Buildings 1 and 3, but where surface scans did not identify residual activity. Both shielded and unshielded measurements were made to separate the ambient gamma background and construction material background components. These background measurements were used to correct gross beta surface activity measurements.

Direct measurements for total beta surface activity were performed at 43 locations associated with the main processing building (Building 1). Measurements were made on interior surfaces on an exterior concrete pad abutting the north wall, and on the ore inlet chute structure. Six measurements were made within Building 2 and five were made within Building 3. Measurements were performed in both a shielded and unshielded configuration due to the high

gamma count rates encountered in many areas. Measurement locations were selected systematically and judgmentally, and are shown on Figures 7 through 9. Direct measurements were performed using gas proportional detectors coupled to ratemeter-scalers. Smear samples, for determining removable gross alpha and gross beta activity levels, were collected from all but one direct measurement location—measurement location 36 where residue exhibiting high radiation levels was present within a galvanized tub. Direct measurements were not performed on surfaces where significant buildup of processed ore material was present.

Exposure Rate Measurements

Interior exposure rate measurements were performed at nine locations within Building 1 corresponding to soil and miscellaneous material sampling locations where elevated gamma radiation was detected by scans (Figure 7). Exposure rate measurements were performed at one meter from the surface using a microrem meter. Exposure rates within Buildings 2 and 3 were approximated based on the gamma count rates observed during scanning, and by comparing the gamma count rates to known gamma count rates and the corresponding microrem meter responses around the site.

Miscellaneous Material Sampling

Six samples of representative miscellaneous material that included apparent processed material residues and ore were collected from interior surfaces and equipment where elevated direct radiation was detected by surface scans (Figures 7 and 8). It should be noted that not all such locations identified were sampled. Five samples were collected within Building 1 that included the equipment trench, equipment pieces, floor area, and a tub; one sample was collected from within a floor crack in Building 2.

Soil Sampling

Surface (0 to 15 cm) soil samples were collected from four representative interior locations where exposed soils with elevated direct radiation were present inside Building 1 (Figure 7). One additional soil area in the northwest corner was not sampled as the observed gamma radiation levels were similar to those found within the soils of the central portion of Building 1.

EXTERIOR

ESSAP used the following radiological survey procedures to conduct survey activities on exterior areas.

Reference System

ESSAP established a 10 m × 10 m reference grid system of the affected areas within the SRUD site, with the exception of the steep slope immediately north of the building complex and extending to the upper access road (Figure 3). Ungridded areas were referenced to the existing grid, prominent site features, or using a global positioning system.

Surface Scans

Gamma scans were conducted over approximately 100% of accessible soil surfaces adjacent to the buildings, the access road, and within the tailings pond. Gamma scans were also performed over portions of the remainder of the 2-hectare (5-acre) site, primarily down-gradient of the building complex extending to the dry tailings pond, and the land area where the ore chute began up-hill of the complex. Gamma scans were performed using NaI scintillation detectors coupled to ratemeters with audible indicators. Locations of elevated radiation were marked and identified for further investigation.

Exposure Rates

Exterior background exposure rate measurements were performed at five locations within 0.5 to 10 kilometers of the site (Figure 10). Site exposure rates were measured at 37 judgmental (areas of elevated direct radiation) or systematic locations within the established reference grid and at locations of elevated direct gamma radiation identified by surface scans outside of the grid area, including the tailings pond (Figures 11 and 12). Exposure rates were also measured at two miscellaneous sampling locations associated with the main ore chute and next to the exterior, north wall of Building 1 (Figure 7). Exposure rate measurements were performed at one meter above the surface using a microrem meter.

Miscellaneous Material Sampling

Two miscellaneous material samples were collected from exterior locations. One sample was collected from a metal support of the main ore chute hopper and a second was collected from the apparent processed material pile against the exterior, north wall of Building 1 (Figure 7).

Soil Sampling

Background surface soil samples were collected from each of the five background exposure rate measurement locations (Figure 10). Within the building complex land area, 25 surface soil samples were collected from judgmental locations and seven were collected from systematic locations (Figure 11). Five samples were collected from judgmental locations within the tailings pond (Figure 12).

SAMPLE ANALYSIS AND DATA INTERPRETATION

Samples and data were returned to ORISE's ESSAP laboratory in Oak Ridge, Tennessee for analysis and interpretation. Sample analyses were performed in accordance with the ORISE/ESSAP Laboratory Procedures Manual (ORISE 2003d). Soil and miscellaneous material

samples were analyzed by gamma spectroscopy and results reported in units of picocuries per gram (pCi/g). The radionuclide of interest is primarily natural thorium; however, spectra were reviewed for uranium and other identifiable photopeaks. Smears were analyzed for gross alpha and gross beta activity using a low-background gas proportional counter. Direct measurement data and smear data were converted to units of disintegrations per minute per one hundred square centimeters (dpm/100 cm^2). Exposure rates were reported in microroentgens per hour (μR/h).

Because site-specific guidelines have not been developed, soil concentration results are compared to the NRC soil screening level values (NRC 2003). Surface activity levels are reported as net values after subtraction of an appropriate background. Exposure rates are reported as gross values for informational purposes.

FINDINGS AND RESULTS

INTERIOR AND ADJACENT SURFACES

The scoping survey results for the buildings and associated structures are provided below.

Surface Scans

Gamma and beta surface scans identified elevated direct radiation at multiple locations in Building 1, primarily in the southeast quadrant, as well as other isolated locations in the northern half of the building (Figure 13). The elevated radiation was detected in the soil in the central portion and northeast corner; the residue that was on the floor around the skid-mounted tank; the ore material in the skid hopper and the large hopper; and residue deposits in the equipment trench, a tub currently staged beneath the oven and a second tub in front of the skid hopper, and against the north wall. Elevated radiation that was not specifically associated with obvious residue deposits was found in a shallow floor depression that ran between the skid-mounted tank and skid hopper, at the lip of the equipment trench next to the oven, and next to the alcove wall in the northwest corner.

Elevated direct radiation in Building 2 was detected on the west side in a floor crack containing an ore-like material and also against the west wall where residue was noted (Figure 14). Building 3 exhibited elevated direct radiation levels throughout the building (Figure 15). The contribution to the observed levels was the result of both radiation "shine" from contaminated soils outside of the building and contaminated building surfaces, although there were no apparent residue deposits within the building.

Surface Activity Levels

Surface activity levels for each of the buildings are summarized in Table 1. Surface activity in Building 1, on the exterior concrete pad, and on the ore inlet chute structure ranged from -160 to 34,000 dpm/100 cm^2. In Building 2, the surface activity ranged from 44 to 11,000 dpm/100 cm^2 and in Building 3 ranged from 820 to 27,000 dpm/100 cm^2. Removable activity levels for all measurement locations ranged from 0 to 18 dpm/100 cm^2 for gross alpha and -5 to 10 dpm/100 cm^2 for gross beta.

Exposure Rates

Exposure rates in Building 1 ranged from 21 to 140 μR/h. Tables 2 and 3 provide the exposure rates associated with the soil and miscellaneous material sample locations. Although not quantitatively measured, based on similar observed gamma count rates and measured exposure rates, the estimated exposure rates in Building 2 ranged from 15 to 350 μR/h at contact and in Building 3 ranged from 40 to 470 μR/h at contact.

Radionuclide Concentrations in Soil and Miscellaneous Samples

Tables 2 and 3 provide the summary of radionuclide concentrations in interior soil samples and miscellaneous samples. The Th-228 concentration in soils ranged from 4.3 to 35.8 pCi/g and Th-232 ranged from 4.62 to 39.9 pCi/g. Uranium concentrations are also reported in Table 2

and ranged from -0.8 to 0.11 pCi/g for U-235 and from -0.1 to 4.6 pCi/g for U-238—all of which were below the respective minimum detectable concentrations.

Thorium was the principal radionuclide in five of the six interior miscellaneous samples. The semi-quantitative thorium concentrations ranged from 104.2 to 12,200 pCi/g and 96.2 to 13,400 pCi/g for Th-228 and Th-232, respectively. Miscellaneous material sample 4 also had elevated levels of U-238 plus decay progeny. The semi-quantitative U-238 concentration was 965 pCi/g.

EXTERIOR

The scoping survey results for the exterior areas that were investigated are provided below.

Surface Scans

Surface scans of the site grounds identified elevated direct gamma radiation levels over a significant portion of the property (Figure 16). These areas were associated with the soils around the buildings, as well as a number of soil/ore piles that had been dumped on the property. Also, deteriorated bags of processed material were noted next to the exterior north wall of Building 1. The slope to the north of Building 1 also was noted to have individual rocks (ore) that exhibited elevated gamma radiation.

Exposure Rates

The site exposure rates are provided in Tables 2 and 3. Background exposure rates ranged from 11 to 20 μR/h. The exposure rates at systematic soil sampling locations ranged from 19 to 43 μR/h and ranged from 22 to 1000 μR/h at judgmental and miscellaneous material sample locations. The tailings pond rates ranged from 22 to 55 μR/h.

Radionuclide Concentrations in Soil and Miscellaneous Samples

The concentrations of radionuclides in soil samples are provided in Table 2 and are summarized below.

Site Area/Type	Th-228	Th-232	U-238
Background	1.4 to 2.15 pCi/g	1.29 to 2.09 pCi/g	-0.2 to 1.3 pCi/g
Building area/systematic	2.23 to 24.0 pCi/g	2.42 to 23.3 pCi/g	0.2 to 3.6 pCi/g
Building area/judgmental	3.18 to 1,030 pCi/g	6.2 to 1,018 pCi/g	-6 to 110 pCi/g
Tailings pond/judgmental	3.46 to 66.4 pCi/g	3.35 to 67.0 pCi/g	-0.2 to 1.4 pCi/g

In addition to the above, Ra-226 was identified at elevated concentrations in one sample—but not at secular equilibrium levels with the decay chain parent, U-238. Therefore, Tables 2 and 3 also include the results for Ra-226 for which the concentrations ranged from 0.65 to 452 pCi/g.

The semi-quantitative thorium concentrations in the two exterior miscellaneous samples were 563 and 1,229 pCi/g for Th-228 and 560 and 1,380 pCi/g for Th-232.

EVALUATION OF RESULTS

The evaluation of the surface activity levels in Building 1 shows the presence of fixed contamination on the floor, lower wall, and equipment areas in the southeast corner. Lower levels of surface activity contamination were also evident on the metal chute within the equipment trench and on the floor near the oven. Again, measurements were not made on surfaces where residues were present. In Building 2, surface activity levels on bare surfaces did not indicate elevated activity. The two measurement locations with elevated activity shown in Table 1 were associated with the ore material noted in the floor crack and the residue at the western floor/wall interface. Surface activity levels in Building 3 showed the entire floor had residual contamination. Smear results in all buildings showed that the activity was not

removable. For comparison of surface activity levels, the interim NRC screening value for Th-232 plus progeny in secular equilibrium is 6.03 dpm/100 cm^2 (NRC 1999).

Elevated exposure rates up to 50 times the background levels were present throughout the site. The areas with the highest exposure rates—greater than 100 μR/h—were immediately south and west of the corrosive boxes, the area surrounding Building 3, the ore piles on top of the hill, near the Building 1 exterior north wall, and in the vicinity of the skid hopper inside Building 1.

The miscellaneous material samples confirmed primarily thorium activity in most of the deposits present on building and equipment surfaces. U-238 plus decay progeny was the primary radioactive material in one of the samples.

The NRC surface soil screening value for Th-232 in equilibrium with the decay progeny, which includes Th-228, is 1.1 pCi/g above background (NRC 2003). The average background Th-232 concentration was 1.6 pCi/g. Th-232 concentrations in all but one sample exceeded 2.7 pCi/g (the screening value plus background). One sample was noted (sample location 4) with significant U-238 activity of 110 pCi/g. The decay progeny were also present indicating the contamination was most likely from uranium ore. Also, the sample from location 19 had elevated Ra-226 activity of 452 pCi/g. Because U-238 was not present at a correspondingly elevated concentration, it is surmised that the observed Ra-226 may be present as the tailings from uranium ore processing. The above background surface soil screening values for U-238 and Ra-226, both with decay progeny, are 0.5 pCi/g and 0.6 pCi/g, respectively.

SUMMARY

The Environmental Survey and Site Assessment Program of the Oak Ridge Institute for Science and Education conducted a radiological scoping survey of the former Salmon River Uranium Development site near North Fork, Idaho during the period October 6 through 8, 2003. The survey included scans of building and soil surfaces, direct and removable surface activity measurements, exposure rate measurements, and surface soil sampling and analysis.

The survey identified fixed surface contamination in Buildings 1 and 3, with Building 3 exhibiting the most widespread contamination. Residues with thorium and uranium contamination were noted at numerous locations in and around Building 1 and at two locations in Building 2. Most site soils near the process buildings were contaminated at varying levels with a mixture of thorium, uranium, and uranium progeny, but predominantly thorium. Perimeter areas of the site near the access road were also impacted where material had been dumped. Additionally, localized areas of elevated thorium activity were identified in the tailings pond, although there are no indications that the pond was used.