ADDENDUM C

Church Rock Project Areas Radiological Surveys

DWELLING UNIT RADIATION SURVEY
CHURCH ROCK / PINEDALE CHAPTERS
NAVAJO NATION

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1.0 EXECUTIVE SUMMARY

In May 2009, ***iiná bá***, Inc. (***iiná bá***), in conjunction with Radiation Physics and Engineering (RPE), performed a soil and building materials radiation survey for the Navajo Nation Environmental Protection Agency (NNEPA). The scope of work included conducting a gamma-ray radiation survey of surface soil at 32 different sites in the Pinedale and Church Rock Chapters containing 57 individual structures.

No sites were found where the Radium 226 soil concentration was higher than twice the observed background concentrations. In addition, none of the exterior building materials indicated gamma-ray radiation contamination.

2.0 INTRODUCTION AND SCOPE OF WORK

iiná bá was contracted by NNEPA to perform soil radiation surveys of dwelling units and associated out buildings in the Church Rock and Pine Dale Chapters of the Navajo Nation as shown on Figure 1. NNEPA was concerned about possible contamination of dwelling units from sources of naturally occurring radiation and from uranium mine and mill operations in the area. The surveys were designed to test the soil around the residential units and the exterior building materials for radiation contamination. The surveys were grid-based around specific dwelling units identified on Table 1.

The general survey area has had a history of contamination resulting from uranium mines and milling operations; specifically, the Old Church Rock Mine and Mill and the Northeast Church Rock Mine and Mill. The primary rational for conducting the radiation soil survey was the concern that wind-blown dust originating from the mine and mill areas may have potentially contaminated the land and housing located down-wind from these mining facilities. Adding to the concern is the fact that one mine tailings dam structurally failed discharging radioactive tailings into the adjacent arroyo, which eventually discharges into the Puerco River. The contaminated arroyo sediments thereby became an additional source of potential wind-blown radioactive dust.

Building material radiation contamination was also a concern because nearby stone outcrops and sand pit aggregates have been sources for building materials used in constructing local housing and associated out buildings. A concern was that the sandstone and/or sand aggregate could contain naturally occurring radioactive elements, or may have become contaminated via radioactive wind-blown dust.

It is common knowledge that local residents have scavenged building materials from the old mine and mill buildings, and used them in erecting their personal residences. Another concern was that the remnant mine and mill materials may have been contaminated during the mining and milling processes; thus the residents may have unknowingly contaminated their dwellings. Therefore, one of the radiation survey objectives was to assess whether contamination originating from salvaged building materials and wind-blown dust has resulted in hazardous levels of radiation in the homes and associated out buildings.

At the request of NNEPA, ***iiná bá*** also provided limited oversight of the geophysical and radiation investigative work conducted by Intera on Section 17; the Old Church Rock Mine and Mill location. Intera's scope of work included: 1.) conducting a GPS based gamma surveys and subsequent surface soil sampling based on the gamma survey findings, 2.) establishing radioactive background concentrations by digging twelve downgrade soil test pits to a depth of 4 feet then taking gamma count-rate measurements (Photo 7), and 3.) advancing several direct push bore holes through the surface alluvial materials to bedrock to evaluate whether paleo-channel containing ground water might exist at depth that are transporting radioactive contamination.

Due to time constraints, ***iiná bá*** provided minimal oversight on May 18, 2009; the first day of the Intera and Uranium Resources, Inc.'s (URI) survey. Oversight for the duration of the Intera/URI investigation entailed tracking personnel, logging operating times, and recording weather conditions. On May 28, 2009, ***iiná bá,*** URI and NNEPA representatives, Salvador Chavez and Stanley Edison collectively observed the completion of Intera's Section 17 investigation, which included soil sampling at some contaminated sites as determined by their gamma/Ground Positions Satellite (GPS) surveys (Photo 8).

3.0 METHODOLOGY

Nomenclature

During the project kick-off meeting, NNEPA decided to define a "dwelling unit" as a residence or an out building, but excluded feed and hay barns, animal shelters, wood sheds and corrals with tack buildings. NNEPA further specified that each out building survey protocol was to be identical to that used for residences. The Chapter House initials (e.g. Church Rock = CR and Pinedale = PD) were assigned identification numbers (e.g. 001, 002, etc.) corresponding to each building that reflected the order in which the residences were surveyed. If more than one "dwelling unit" was present on the same property, then a subsequent letter (e.g. A, B, C, etc.) was assigned to reflect the order in which the set of buildings were surveyed. For example: the first "dwelling unit" surveyed in the Church Rock Chapter was labeled CR-001A. The first out building surveyed on the same parcel was labeled CR-001B. The primary resident dwelling unit was surveyed first followed by any out buildings (Photo 4).

Instrumentation

Radiation measurement locations were recorded using ground positioning satellite (GPS) instruments that included one of the following types: a Garmin, a Trimble Backpack, or a Leica Total Station. The Leica unit used by ***iiná bá*** was tied by survey to a United States Bureau of Land Management Cadastral Survey Section Corner Marker. The Trimble unit used by NNEPA surveyor, Jerry Begay, was tied to a survey station located west of the project areas.

Each radiation survey data point at individual dwellings was located using a GPS instrument; the Trimble or Leica unit when they were available or the Garmin if necessary.

For the two background survey locations, the handheld Garmin GPS unit was used to provide the beginning and end points of each linear tract. The radiation data point locations were inferred between the two end points on each tract.

The Universal Transverse Mercator Coordinate System (UTM) data from the Garmin and Trimble instruments were converted to State Plane coordinate data for use in drafting the survey tracts at each dwelling unit. Longitude and latitude, or degree, minute, second (DMS) data from the Leica instrument was also converted to State Plane coordinates for drafting purposes.

Anthony Piccirillo and Jeff Johnson of Radiation Physics and Engineering (RPE), under contract to ***iiná bá***, performed direct radiation surveys at the NNEPA specified sites (Table 1). RPE used a Ludlum Model 2350 single channel analyzer with a sodium iodide scintillation probe. The analyzer and probe were set to preferentially detect the 609 keV gamma-ray from the decay of bismuth-214, and the measured gamma-ray counts were correlated to known concentration of radium-226 in soil. All measurements were made with the probe in contact with the soil surface. The probe and analyzer had been calibrated to determine radium-226 gamma counts by using a soil sample with a known amount of radiation.

Also used were Ludlum 19 MicroR meters to check the building materials at each building surveyed for soil radiation contamination. The instruments were provided and operated by Salvador Chavez of Uranium Resources, or by Eugene Esplain or Michelle Dineyazhe of NNEPA. The Ludlum 19 meter, an internal scintillation, 1" x 1" NAL detector, is typically used for low level MicroR gamma surveys. The instruments sensitivity is based on Cs-137 (cesium) gamma-rays. The meter is equipped with two scales that are able to read in 0 to 25 or 0 to 50 µR/hr (microentgens per hour). Most dwelling surveys for this project were conducted using the lower 0 to 25 µR/hr scale setting.

4.0 RADIATION SURVEY

Background Radioactivity Levels

To determine baseline radioactivity soil parameters, Ludlum 2350 measurements were collected at two different locations, one near Happy Valley Road and one near Red Top Road (Photo 1, Appendix A). Both locations were specified/selected by the NNEPA. The sites are undeveloped and undisturbed areas a few miles from the dwelling survey locations, and were assumed to be representative of naturally occurring radioactivity conditions (i.e. not impacted by uranium mining operations). Each background measurement consisted of a 50 foot straight line survey with measurements collected every 10 feet including the zero, or starting point. The "mean" Ra-226 concentration background level was 2,033 counts per minute (CPM) or 1.2 picocuries per gram (pCi/g), with a range of 0.3 pCi/g. The "mean" concentration is considered to be less than levels where radon gas issues typical develop.

Ludlum 19 MicroR meter, used for the building materials survey, was also calibrated for conditions at these sites. Cs-137 readings collected at the two background tracks ranged from 12 to 18 µR/hr with a "mean" value of 15 µR/hr.

NNEPA established that any Ra-226 of Cs-137 reading less than twice the background "mean" would be considered non problematic.

Soil Survey

The radiation survey commenced at the front of the residence and proceeded in a clockwise direction around the residence. The survey consists of four linear tracks, each beginning at the mid-point of each exterior dwelling unit wall extending out for 50 feet perpendicular to the wall. Radiation measurements were taken every 10 feet (maximum of six individual measurements per track or 24 per building). Appendix B contains individual maps for each dwelling unit radiation survey showing instrument readings for both soil and building materials. Photo 2 shows the typical survey activity.

In situations where obstacles were encountered along the linear survey track, the sampling point was off-set a few feet in a perpendicular direction from the original track. The distance moved was the minimum necessary to avoid the obstacle. Once passed the obstacle, the survey reverted back to the original track as close as possible. Obstacles typically included: wood piles, stacks of cement blocks and lumber, campers, inoperative vehicles, corrals, and small sheds. If the survey encountered a second residence or out building within 50 feet of the first building, then the survey was terminated at that point.

When radiation surveys were performed during or immediately after periods of precipitation, the measured surface soil radiation levels were observed to increase. Literature research revealed that rain occurring during a ground-based gamma-ray survey will temporarily increase observed gamma-ray levels. According to RPE personnel, rain removes radiation daughter products from the atmosphere and deposits them on the ground surface. However, within approximately 3 hours the radioactive daughter products decay to insignificant levels. The following paragraph describes the typical precipitation effect observed during the May surveys.

During the May, 2009 radiation survey, two dwelling unit (PD-021A and PD-021B) were surveyed during periods of heavy rainfall yielding elevated gamma-ray readings. When the two dwellings were resurveyed under dry conditions, both yielded readings consistent with background gamma-ray levels. The results of the repeat testing exercise was confirmation that rainfall events artificially elevated measurements; therefore, all survey measurements made during or immediately after heavy rainfall events were carefully scrutinized. All dwelling unit surveys conducted during periods of precipitation are noted in Table 1 and Table 2 of RPE's report (Appendix C).

RPE and ***iiná bá*** believe that "the slightly elevated measurements observed at certain locations during periods of rain are not indicative of actual surface soil radiation levels and/or the presence of uranium contamination". The RPE report notes that although measurements taken during rainy periods are elevated, none were greater than twice the background "mean" of 1.2 pCi/g. The maximum "mean" measurement collected during rainy periods was 2.2 pCi/g. All dwelling units surveyed during periods of no rain or light rain showed a "mean" Ra-226 reading of between 0.9 and 1.4 pCi/g. Only six dwelling units surveyed during periods of no rain exceeded the "mean" background reading; all six were concluded to be insignificant based on NNEPA criteria.

Two dwelling units, PD-013A and PD-020A, were surveyed during heavy rain conditions but not resurveyed during dry conditions because the "mean" Ra-226 reading was 2.1 pCi/g at each dwelling, which was less than twice the background "mean" and therefore statistically insignificant.

Building Material Survey

A Ludlum 19 MicroR meter was used to scan building materials to identify possible radiation contamination. The meter reads Cs-137 gamma-rays, which was used as a proxy to signify uranium contamination. The meter was held next to the building walls and moved vertically and horizontally scanning the foundation and wall materials.

The majority of the dwelling unit Cs-137 readings ranged from 10 to 17 µR/hr, which is consistent with the observed background track measurements of 12 to 18 µR/hr with a "mean" value of 15 µR/hr. However, two dwellings produced slightly elevated readings and one building attachment yielded highly elevated readings. None of the structures surveyed produced a Cs-137 reading more than twice the "mean" background reading.

One Ludlum 2350 reading taken at dwelling unit PD-001A produced a value of 11,647 µR/hr at the structure's north side. It was discovered that a small propane tank, located outside the structure and attached to the interior through the north wall, was the source of the high readings (Photo 3). Once the tank was moved, the soil Ra-226 levels immediately dropped to 1,711 µR/hr.

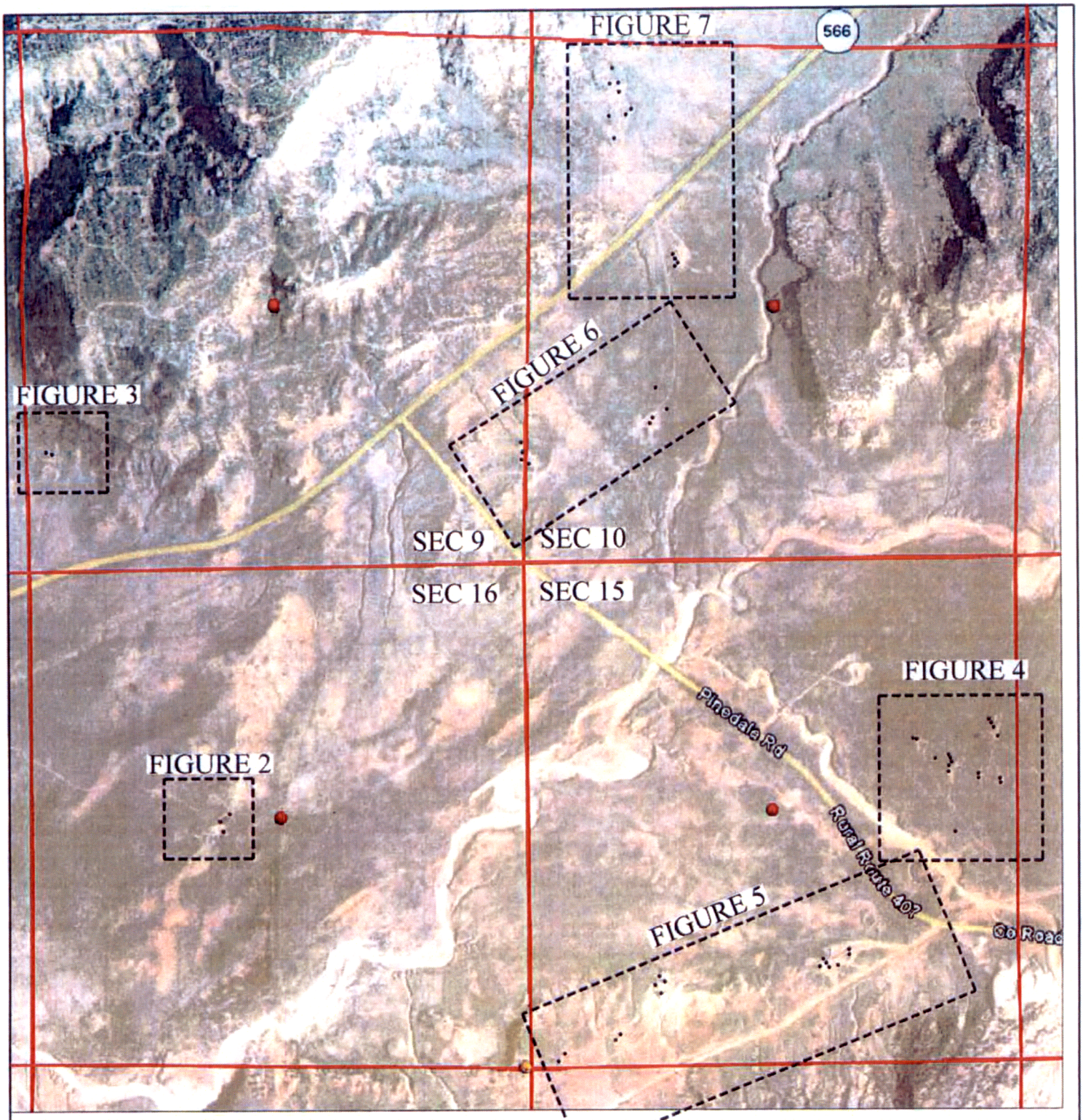
5.0 CONCLUSIONS

Gamma-ray radiation soil surveys were conducted at 57 individual "dwelling units" on 32 different properties in the Church Rock and Pinedale Chapters. The NNEPA had established that a Ra-226 concentration more than twice the background concentration was to be considered an unsafe level of radiation. The measured soil Ra-226 concentrations were lower than twice the observed background levels at all locations surveyed.

Building material radiation surveys were conducted on the 57 "dwelling units"; no exterior building materials revealed gamma-ray contamination based on the criteria that any reading less than two times the "mean" background concentration is statistically insignificant.

Literature research indicates that structures built on soils with radium concentrations greater than 2 pCi/g have a moderate chance of exceeding the EPA recommended radon action level of 4 pCi per liter of indoor air. For the radon to accumulate inside the building: 1.) the structure must be built on soils with abnormally high concentrations of Ra-226, 2.) the structure must incorporate a basement or slab foundation that is cracked thus providing a pathway for upward radon migration, and 3.) the building must be sealed reasonably well to allow the radon gas to build up.

RPE believes that the Ra-226 levels measured during the Church Rock and Pinedale surveys make it unlikely that structures built on these sites will accumulate elevated radon levels.



NOT TO SCALE

LEGEND

- FIGURE FRAME
- HOUSE LOCATIONS

N

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APPROVED: KLS	DATE: 10/28/09
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PROJECT # 0900027	FIGURE 1

VICINITY MAP

SECTION 9,10,15&16

CHURCH ROCK & PINEDALE CHAPTERS, NEW MEXICO