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Home Environmental Assessments
Manual of Procedures

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Section I — Background and Overview

The overall purpose of the Navajo Birth Cohort Study (NBCS) home environmental assessment (HEA) is to determine if pregnant women are being exposed, in and around their homes, to radioactive materials, heavy metals and other environmental toxicants that may be harmful to their health and the health of their babies. Data derived from the HEAs will be used to estimate environmental exposures of Participants enrolled in the study — mothers, fathers and their babies. The environmental data, plus other health, biological, socioeconomic and behavioral data derived from extensive surveys, laboratory tests on Participants' biological specimens, and information in Participants' medical records, will form a complete "exposure" profile for each Participant. The totality of these exposures to will be analyzed statistically against two categories of outcomes: reproductive health and child development.

The Navajo Birth Cohort Study was funded by Congress to address the effects of non-occupational exposures to uranium wastes on the Navajo Nation. The objective of the three-year study is to enroll and follow 1,500 mother-infant pairs for up to one year after birth. The NBCS has been approved by the University of New Mexico (UNM) Human Research Review Committee, the Navajo Nation Human Resources Review Board, and the Centers for Disease Control and Prevention Institutional Review Board.

Section II — General Procedures

The home environmental assessments will be conducted largely by the professional field staff of Southwest Research and Information Center (SRIC), which is part of the UNM Community Environmental Health Program team. Collectively, the UNM-SRIC team is known as the DiNEH Project, and UNM and SRIC personnel conducting field operations is called the NBCS Research Field Staff (RFS)

RFS members are expected to act professionally and with high respect of all Participants. Establishing and maintaining traditional kinship greetings and recognitions (i.e., *k'é*) is appropriate and recommended at first contact with Participants. All field staff have been trained and certified to ensure the confidentiality and privacy of a Participant's personal health information. Field staff must be certain that a prospective Participant has completed and signed a Consent/Assent Form and HIPAA Form before a home environmental assessment is conducted. This certainty will be achieved through access to the UNM REDCap scheduling database.

Field staff will be given an appointment time to conduct a home environmental assessment by the regional Cohort Clinical Liaison. In most cases, field staff will be accompanying a Community Health and Environmental Research Specialist (CHERS) employed by the Navajo Nation Division of Health (NNDOH), who will administer a lengthy questionnaire to both the expectant mother and father (if he is available) while RFS personnel are conducting the home environmental assessment.

In the initial stages of the study, it is anticipated that two trained RFS will conduct home environmental assessments in tandem. As competencies increase, individual field staff will conduct HEAs by themselves. This will require RFS personnel to safely and effectively manage handling a radiation meter, Global Positioning System (GPS) device, clip board and other materials simultaneously. Utility jackets or belts and storage boxes will be provided to ease the use and management of these materials.

Field staff should always carry water, use sunscreen, and wear hats during outdoor operations. Field staff should NEVER go inside barns, sheds, corrals or other ancillary structures; the HEAs are to be conducted only around and in Participants' homes. The Ludlum Instruments Model 19 MicroR meter used for gamma radiation assessments doubles as personal health and safety equipment because it can detect elevated levels of radiation several orders of magnitude greater than background. Additional health and safety practices for RFS are outlined in the sections that follow.

RFS will use NBCS Form HEA-1, *Home Environmental Assessment Summary Sheet and Site Map*, to record information about the Participant(s) and her home, including Participant Interim ID Number, location (in decimal-degree latitude and longitude coordinates), type of home, and locations of all assessments conducted around and inside the home. At no time should the Participant's name be recorded on any forms used to record the home environmental assessment. RFS will communicate the Participant's name to the NBCS co-investigator for environmental assessments, Chris Shuey, by telephone only. Mr. Shuey will not combine the Participant's interim ID number with the Participant's name on any document in his position, and will use the Participant's name only in communicating results of the assessment to the Participant in written form.

The expectant mother must consent to allowing NBCS to share results of the home environmental assessment with the Navajo Nation EPA and to allow NNEPA to share results of any previous assessments with the NBCS. This consent/assent is accomplished on page 4 of the NBCS consent form for the mother only. NBCS staff will not share any data, nor make referrals to NNEPA, without such consent. Where consent has been granted, NBCS will make referrals for follow-up tests and assessments where an environmental result exceeds a regulatory standard, exposure guideline or investigation level. These critical values are discussed in each section of this protocol.

Attachment 17: Environmental Home Assessment Protocols

Section III — Procedures for Conducting Gamma Radiation Screenings at NBCS Participants' Homes Using Ludlum Model 19 MicroR Meter

Introduction

This section covers procedures used to conduct outdoor and indoor gamma radiation assessments at participants' homes using a Ludlum Instruments, Inc., Model 19 MicroR Meter. Outdoor and indoor gamma surveys are intended to be first-level screenings to identify any areas around and in the home that may contain radioactive materials above "background," or what is considered "normal" or "naturally occurring." As discussed in paragraph 13 below, field staff will select an undisturbed area near the home to obtain 3 to 5 readings for calculation of a background gamma exposure rate, expressed in microRoengtens per hour (µR/hr). Two methods to calculate background are given.

This protocol draws from procedures and current practices used by the Navajo Nation Environmental Protection Agency (NNEPA) Superfund Program, the U.S. Environmental Protection Agency (USEPA) Region IX Superfund Program, and the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM). These procedures and practices are based on assuring regulatory compliance and are not always applicable or appropriate for primary environmental public health research. The procedures set forth here are modified to ensure that the data generated are valid and appropriate to estimate participants' exposures to gamma radiation.

Specific Procedures

(1) Install two "D" cell batteries in the battery compartment at the top of the Ludlum-19 instrument. Batteries should be removed and stored in the instrument case at the end of each day of use.

(2) Before performing a gamma radiation survey at a Participant's home, conduct all operational tests outlined on page 2-2 of the Ludlum-19 operating manual to ensure the instrument is operating and responding properly. These tests include a battery test, radiation check-source test, audible alarm test, lamp test, and demonstration of the fast ("F") and slow ("S") response time switch. Conduct these tests *before* leaving for the Participant's home to avoid unnecessary delays in the home assessment.

> ***CAUTION**: The check-source test involves using a 1 microCurie Cesium-137 (µCi Cs-137) radiation source, contained in a plastic box inside the instrument case. This source emits gamma radiation at levels between 10 and 15 times higher than "normal" (i.e., background), and therefore should be handled with care and used only for periodic instrument checks. Be sure to return the check source to its plastic box and store the source securely inside the instrument case. Do not leave this check source out, even in its box, and do not let children or any unauthorized individual handle this source.*

(3) During the initial greeting with the Participant, explain the purpose of the study's home environmental assessment, and in particular, the gamma radiation survey, and obtain any pertinent information from the Participant about the presence of uranium wastes in or around the home:

> *"I will be conducting a home environmental assessment that will identify any radiation or heavy metals that may be at levels that are harmful to your health and the health of your family. The instruments we will use and the tests we will conduct will identify substances you cannot see, touch, smell, taste or hear, but are present everywhere, usually in very small levels. This particular instrument detects a type of radiation, called gamma radiation, which comes from the earth and passes through virtually all objects, including our bodies. The readings we obtain allow us to determine if any materials emitting radiation greater than normal are present around*

or in your home. To help focus our survey, do you know if any uranium wastes may be present on the property or may have been used in the construction of the home?"

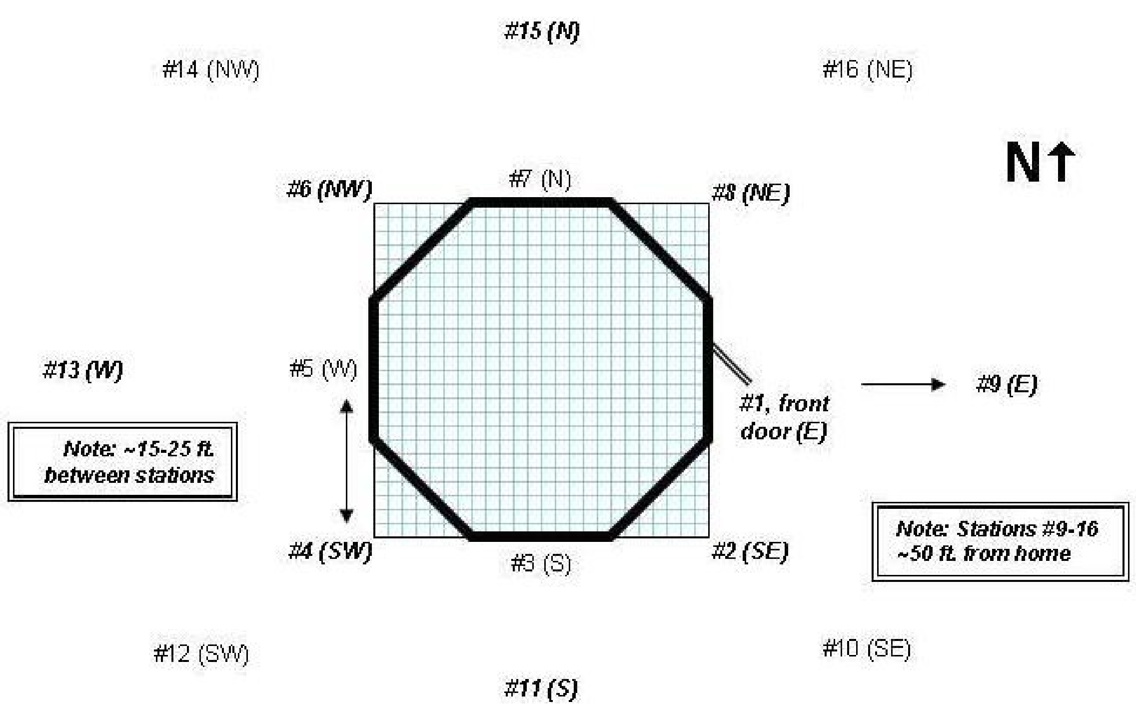
(4) Before starting the survey, fill in all required information on the *Home Environmental Assessment Summary Sheet and Site Map* form (NBCS Form-1). Be sure to fill in the Participant Interim ID number provided by the NBCS staff who set up the appointment with the Participant. *NEVER put the name of the Participant on a form or piece of paper containing the Participant Interim ID number*.

(5) Turn the range selector switch to the 25 µR/hr setting and read exposure rate readings from the red scale in the display window. If readings exceed 25 µR/hr, move the switch to the 50 µR/hr setting and read from the **black scale** in the needle window.

6) Record all gamma radiation exposure rates, meter settings and latitude-longitude coordinates taken outside of the home on the *Outside Gamma Radiation Survey Data Sheet* form.

(7) *To the extent possible*, follow the gamma radiation survey station sequence shown in **Figure 1**. **A minimum of 16 readings, taken in concurrent circles or ovals around the home, is the preferred survey protocol at each home**. This number should provide enough data points to give us confidence in finding an accurate *maximum* exposure rate and valid *average* exposure rate for the immediate surroundings of the home. In cases where fences, vehicles, other structures or topography limit your ability to conduct the gamma survey, use your professional judgment and common sense when deviating from the preferred survey protocol. Record as many gamma readings as possible, conducting the survey as systemically as possible (i.e., concentric circles around the house) and documenting all survey locations and the reasons for their selections. *Do not take unnecessary physical risks to obtain survey readings; be safe and protect others around you.*

Figure 1



(8) Obtain the first gamma radiation reading at the front door, labeled station #1. Take waist-level and contact-level (i.e., 2" above ground) readings at each station, and record these readings on the *Outside Data Sheet*. Mark the approximate locations of the stations, along with their number, on the map *HEA Summary Sheet and Site Map*. At stations 1 through 8, take readings as close to the home as possible. Stations 9 through 16 form a second circle or oval around the home, in the eight cardinal directions. If site conditions permit, locate this second circle of stations at least 50 feet (appx. 15.2 meters or 17-18 steps) from the edge or corner of the home.

(9) Obtain latitude-longitude coordinates at the front door and at 8 other stations as indicated *bold italic* type in **Figure 1**. Set your GPS device to decimal-degree coordinates. The coordinates are expressed as minutes and fractions of minutes, North Latitude and West Longitude. Place a minus sign (-) in front of the longitude coordinate to correctly locate the point west of the Prime Meridian.

(10) As you walk slowly between stations, turn the response switch to the "F" setting (i.e., rabbit icon) to observe rapid spikes in activity; switch back to the "S" setting (i.e., turtle icon) at each station, allowing the needle to stabilize before recording the exposure rate.

(11) In addition to the 16 data points preferred in Step 7 above, survey any outside materials identified by the participant as possibly contaminated with uranium wastes, or any materials that look different or out of place, such as piles of gray-colored dirt, pieces of petrified wood, or flag stones used for walk ways. Record GPS locations of any additional readings. ***DO NOT survey inside sheds or corrals***.

(12) Upon completing the outdoor gamma survey, request entry to the home to conduct the interior radiation survey. Use the *Interior Gamma Radiation Survey Data Sheet* to record all interior gamma radiation readings.

> *Before entering any bedroom, work area or storage space, request permission of the Participant.*

(13) Select between 3 and 5 locations to obtain background gamma radiation readings. Ideally, these locations should appear to be undisturbed by human activity and be within sight of the surveyed home. They should have similar topographic, geologic, and vegetative characteristics as the area around the home. Observe the surroundings as you drive to the home and make a mental note of possible candidate locations for background readings. If possible, conduct the background survey *before* conducting the home assessment. Orient the 3, 4 or 5 locations in a triangle, square or pentagram with the points about 50 feet (appx. 15.2 meters) apart. Record gamma rates and GPS coordinates for *all* background locations.

> Conduct the background survey *either before or after* the home environmental assessment; *do not interrupt* the home environmental assessment to perform background screenings.

(14) At the conclusion of the survey, the Participant or her family is likely to ask, "Did you find anything?" In most cases, you will have not found a radiation exposure that is significantly higher than the "background," or normal rate. To gauge whether any of the rates you recorded may constitute a possible health risk, compare the *maximum* exposure rate you recorded around or inside the home with the *lowest* rate. Is the maximum rate more than 2 times the lowest rate? If you have already assessed background, compare the *maximum* rate at the home to the *lowest background* rate. Is it more than 2 times greater? If you do not know or cannot honestly estimate if a possible problem exists, tell the Participant you do not know and that you will have senior project staff contact them as soon as possible.

(15) If at any time during the survey you encounter a gamma rate of 100 µR/hr or greater, either outside of or inside the home, note the coordinates of the location on the *HEA Summary Sheet and Site Map* and move away from the location as soon as possible. If this rate is encountered in the home, inform the Participant to stay out of the room or away from the area. Tell the Participant that you will be making a "referral" to senior project staff, who will notify NNEPA. As soon as possible, call senior NBCS staff (principally, co-investigator Chris Shuey) to inform them of your findings and their location(s).

> ***Investigation Level*** (calculation): The "investigation level" is the gamma radiation rate that triggers a referral by the NBCS staff to the appropriate NNEPA program for a follow-up survey. It indicates the presence of radioactive materials that are significantly greater than background. Senior staff will calculate average background gamma radiation rates using the data provided by field staff, and calculate a site-specific IL using two different methods:
>
> (A) IL = mean background rate x 2
> (B) IL = mean background rate + 10 x standard deviation of the mean background rate

Data Analysis

Based on the gamma radiation screening, each Participant will be assigned *average* and *maximum* gamma radiation rates for both the outside of the home and the inside. These data will be used as independent variables in the overall exposure analysis.

Report-backs to Participants; Helpful Information

RFS are not only trained in gamma radiation assessment, but also in conducting rudimentary interpretation of survey data. They will be able to tell the Participant whether the gamma rates they detected are "normal" or may not be normal. In the latter case, they will advise the Participant that senior NBCS staff will communicate the results of the survey as soon as possible to the Participant. NBCS staff will use the Participant Report-back letter shown in Appendix A to prepare and send a written report to the Participant. In cases involving gamma rates that necessitate a referral to NNEPA's Superfund Program, senior staff will notify the Participant by phone, email or mail as soon as possible.

A CDC fact sheet, "Radiation and Pregnancy" (http://emergency.cdc.gov/radiation/prenatal.asp), provides helpful information on the potential health effects of different levels and types of radiation that pregnant women may encounter, either in and around the home or in clinical settings. This is one educational resource that RFS personnel may provide to the Participant.

Section IV — Procedures for Indoor Radon Testing

Background

The presence of natural uranium deposits, more than 500 abandoned uranium mines and the documented use of mine wastes in the construction of dozens of homes on the Navajo Nation necessitate monitoring for radioactive radon gas in homes of participants in the Navajo Birth Cohort Study. Radon – a colorless, odorless radioactive gas that occurs in rocks, soils, air and water from the radioactive decay of uranium – is the second leading cause of lung cancer in the U.S., according to the U.S. Environmental Protection Agency. Exposure to radon and its short-lived radioactive decay products is the primary risk factor for lung cancers and respiratory diseases among underground uranium miners, particularly the Navajo miners. Even small increases in indoor radon levels substantially increase lifetime lung cancer risks, even among people who never smoked cigarettes.

No systematic testing for indoor radon has been conducted on the Navajo Nation. Indoor radon monitoring has been limited to public buildings used by sensitive members of the population, such as preschools and senior center, homes located within a quarter mile of abandoned mines, and homes identified as having or possibly having been constructed with uranium waste materials. About 25% of 143 homes tested in the Churchrock area in 2003-2005 had indoor radon levels exceeding the USEPA action level of 4 picoCuries radon per liter of air (pCi/l-air) (CRUMP, 2007). This level represents an unacceptable lifetime lung cancer risk of 1 in 143. More than 40% of homes tested in the CRUMP study had indoor radon levels exceeding the World Health Organization's more stringent guideline of 2.7 pCi/l. The potential for elevated levels of radon in homes in the uranium mining regions of the Navajo Nation is great.

Physical Transport and Biokenetic Mechanisms

Radon enters homes through several mechanisms. It moves through rocks and soils directly into homes or through cracks in foundations. Homes built on top of uraniferous rocks often have elevated radon levels. Radon may be emitted from uranium wastes incorporated in the construction of the home, or come from materials brought into the home, such as granite countertops and petrified wood. Radon may be dissolved in water and emitted along with water vapor in showers and washers. Homes having crawl spaces, tight-fitting windows and other energy-loss features, and little air flow are prone to elevated indoor radon levels. The principal mitigation for indoor radon is increased ventilation, either naturally or by mechnical means.

Radon enters the human body primarily through inhalation of the gas itself and of solid radon decay products attached to dust particles. Radon emits alpha particles, which are stopped by human skin but are deposited in the breathing sacs of the deepest part of the lung. There, they emit large bursts of electrical energy to surrounding tissue, either killing cells or damaging their reproductive controls.

Radon Testing Methods

Indoor radon will be assessed using charcoal canisters purchased from Radon Testing Corporation of America (RTCA). See, http://www.rtca.com/about_rtca.asp. NNEPA's Radon Program uses RTAC test kits and laboratory services for more than half of its indoor radon monitoring conducted in support of the NNEPA's Contaminated Structures Program. RTAC's test kits and laboratory analytical methods have been validated through millions of repeated analyses of samples collected from throughout the U.S.

Trained NBCS Research Field Staff will place two canisters in each participant's home as part of a larger home environmental assessment. Placement will occur in colder months when homes are less ventilated to obtain maximum radon exposure levels. Placement locations will be noted by research field staff on field data forms. Both canisters will be placed in rooms having the highest expected occupancy by family members – a living or family room and in the participant's bedroom.

Placement and retrieval will be conducted according to the manufacturer's recommended protocols, with minor variations to comport with home layouts and living arrangements typical on the Navajo Nation. Protective seals will be placed on the perforated "intake" side of the canister at the time of retrieval and prior to shipment to the RTCA lab. In most cases, canisters will be placed on solid surfaces, such as shelves or dresser tops, and away from ventilation sources, such as windows, fireplaces, heating and cooling vents, and at breathing level. Canisters will be retrieved from the home on the sixth day after placement, and mailed to RTCA for analysis. All labeling and record keeping procedures for placement, retrieval and shipment of the canisters will follow the manufacturer's recommended procedures. Results will be reported by RTCA in 4 to 7 days, and sent to senior NBCS staff for review and interpretation.

Reporting, Referrals and Data Analysis

All indoor radon test results will be shared with the participant as soon as practical after being reported to NBCS staff. Results will be placed on a form, along with results of other environmental tests done at the participant's home, and mailed to the participant (See Attachment 18 for Reporting Form).

Results will be shared with NNEPA only if the participant consents to data sharing as part of a signed study consent form, administered at the time of enrollment in the study. In cases where a radon level exceeds a health-based "action level" or calculated "investigation level" and the participant has refused to consent to data sharing between NNEPA and NBCS, NBCS staff will provide the participant with educational information and contact information for NNEPA's Radon Program.

Referrals for re-testing or other followup will be made by NBCS to NNEPA if either of the two reported indoor Rn levels exceeds 2.7 pCi/l-air, the WHO guideline. The use of this guideline for referrals was agreed to by NBCS and NNEPA Radon Program staff, and reflects a more conservative approach than using the USEPA's 4.0 pCi/l-air action level. Information will be provided by NBCS staff to the participant on options for mitigating indoor radon levels. This information will note that NBCS cannot pay for the costs of repairing or renovating a home to lessen indoor radon levels. Referrals to NNEPA will also alert the agency to potential "hot spots" – places where mine wastes may have been used in home construction or where homes were built on uraniferous rocks and soils.

Indoor radon levels will be reported to the study's secure database and analyzed statistically as independent variables in the participant's overall exposure assessment. All exposure inputs will be assessed against both reproductive health outcomes (mother and baby) and developmental milestones (baby only).

Section V — Procedures for Collecting Dust Samples at Participants' Homes

Overview

Dust samples will be collected in participants' homes to identify heavy metals they may be exposed to on a continuous, chronic basis. The primary pathway of exposure is inhalation of potentially contaminated dust particles. Sources of dust in Navajo homes include:

* potentially contaminated outdoor dirt blown in to the home
* coal- and wood-burning stoves
* silversmithing and jewelry making
* rug weaving
* other arts and crafts, including pottery making
* erosion of inadequately sealed cement or earthen building materials
* uranium mine and/or mill wastes used in home construction materials

Methods

Dust samples will be collected using pre-moistened Ghost Wipes purchased from Environmental Express. Ghost Wipes are certified form compliance with regulatory requirements for testing dusts for lead and beryllium.

Standard practice is to use one wipe over a 10cm-x-10cm area (appx. 4 x 4 inches) by wiping vertically on the first swipe, folding the wipe over and wiping horizontally on the second swipe, and folding the wipe over again and wiping the four corners of the sample area. This procedure is designed to ensure that the surface area inside the 10x10-cm area is wiped. The exposed wipe is placed in a 3-inch long by 1-inch wide plastic vial, sealed and labeled with the date, time and unique identifier. Samples will be shipped to the USEPA laboratory in Richmond, CA for analyses by ICP-MS.

Three to four samples were be collected from each participant's home to measure a wide range of environmental exposure scenarios:

1. One sample will be taken from a high-occupancy place in the home, such as a living room or bedroom, and from a specific location where dust often accumulates: storage shelf, dresser top, lamp shade, fan blade or window sill. This sample will be taken usually at breathing height.

2. One sample will be taken from a place where dust and dirt accumulate but is only infrequently cleaned, such as under major appliances or pieces of furniture. This sample is intended to measure metals levels in dust that has built up over many years to represent a long-term exposure condition.

3. One sample will be taken in a potentially high-exposure area or where potentially high-exposure activities may be conducted, such as the floor next to a coal-or wood-burning stove that routinely releases ash and soot and that is frequently emptied of ash and combustion remains.

4. One sample will be taken from an in-home work area, such as a silversmithing/ jewelry-making bench, pottery wheel or rug-weaving area. Previous studies have indicated significantly higher metals concentrations in dusts in these in-home work areas than in other areas of the home. This sample will not be necessary if the participant conducts no in-home work activities.

List of Analytes

The list of preferred analytes is shown in Table 1. Metals selected for analyses in dust samples are keyed to their concurrent measurement in either blood, serum-plasma and urine of enrolled participants. This will allow correlation of environmental levels with concentrations in biological specimens. Most of the metals were selected because they are common in uranium wastes, which is the environmental exposure of interest in the Navajo Birth Cohort Study. As shown in the second column of Table 1, other metals were selected because they may be released in in-home work associated with silversmithing, pottery making or rug weaving, in ash and soot from the burning of coal or wood in indoor stoves, and from deposition of contaminants released from coal-burning power plants or oil and natural gas production and processing facilities.

Table V.1.
METALS ANALYSIS FOR IN-HOME DUST SAMPLES
CORRELATED WITH BIOLOGICAL SAMPLE ANALYSES

Metal	Environmental Source(s)	In-home dust	Blood	Serum-Plasma	Urine
	Laboratory →	**EPA-9**	**CDC**	**UNM**	**CDC**
Antimony (Sb)	Jewelry making	●			●
Arsenic (As)	U mine & mill wastes	●			●
Barium (Ba)	U mine & mill wastes	●			●
Beryllium (Be)		●			●
Boron (B)	Jewelry making	●			
Cadmium (Cd)	U mine & mill wastes; Jewelry making	●			●
Cesium (Cs)	Atmospheric testing	●			●
Cobalt (Co)	U mine & mill wastes	●			●
Copper (Cu)	U mine & mill wastes	●		●	
Lead (Pb)	U mine & mill wastes	●			●
Manganese (Mn)	U mine & mill wastes	●			
Mercury (Hg)	Coal plant emissions	●	●		
Molybdenum (Mo)	U mine & mill wastes	●			●
Nickel (Ni)	U mine & mill wastes	●			
Platinum (Pt)	Jewelry making	●			●
Selenium (Se)	U mine & mill wastes	●		●	
Silver (Ag)	Jewelry making	●			
Thallium (Tl)	U mine & mill wastes	●			●
Tin (Sn)	Jewelry making	●			
Tungsten (W)		●			●
Uranium (U)	U mine & mill wastes	●			●
Vanadium (V)	U mine & mill wastes	●			
Zinc (Zn)	U mine & mill wastes; jewelry making	●		●	

Data and Exposure Variables

Screening values for metals in dusts are being developed based on methodologies used by local, state and federal agencies, including USEPA, in assessment of dusts accumulated in buildings and offices next to the World Trade Center in New York City. The USEPA Region 9 laboratory is assessing Ghost Wipes for trace metal levels and will process actual dust samples from volunteer homes to develop reference values prior to enrollment of participants in the study. All results will be entered into the

CDC's secure database for later statistical analysis. The DiNEH NBCS team will provide written summary of the results to individual participants.

Screening Guidance for Metal Dust Samples

Metal	WTC Screening Value (µg/m²)	NBCS Screening Guidance (µg/m²)	CSF (mg/kg/day)⁻¹	RfD (mg/kg/day)
Aluminum	1567888	653720		1.0
Antimony	627	261		0.0004
Arsenic	387	163	1.5	0.0003
Barium	109752	45760		0.07
Beryllium	3136	1307		0.002
Cadmium	1557	649		0.001
Chromium	4704	1961		0.003
Cobalt	31358	13074		0.02
Copper	62716	26148		0.04
Iron	940733	392232		0.6
Lead*	270	270	HUD standard	
Manganese	31358	13074		0.02
Mercury	157	65		0.0001
Nickel (Ni)	31358	13074		0.02
Selenium	7839	3269		0.005
Silver	7839	3269		0.005
Thallium	110	46		0.00007
Vanadium	10975	4576		0.007
Zinc	470366	196116		0.3
Uranium		3135.78		0.002
Tin		470366		0.3
Boron		313578		0.2

Section VI — Procedures for Monitoring Hydrogen Sulfide in Participants' Homes Using Single-Point Monitor Gas Tape Meters (last revision 8/18/12)

Background

Hydrogen sulfide (H_2S) is a colorless gas that, at low concentrations in air (i.e., less than 1 part per billion or 0.001 part per million), has a characteristic "rotten eggs" or "swamp gas" smell. It can affect the body if it is inhaled or it comes in contact with the eyes, skin, nose or throat. At moderate concentrations (from 0.001 ppm to 0.015 ppm), prolonged exposure can cause eye, nose and throat irritation and has been linked to neurological effects and developmental delays in children. At higher concentrations (0.015-30 ppm), hydrogen sulfide causes nausea, headaches, vomiting and occasionally loss of consciousness. Exposure to very high concentrations (30-1,000 ppm), even for short periods, can result in loss of consciousness, respiratory failure, and death. Oilfield workers are especially susceptible to the acute effects of hydrogen sulfide in enclosed work spaces, such as tanks and underground vaults. Since H_2S is heavier than air, it hugs the land surface and accumulates in low-lying area and below-grade structures.

At concentrations of 20-30 ppm, hydrogen sulfide deadens the sense of smell by paralyzing the respiratory center of the brain and olfactory nerve, resulting in an overwhelming sense of "sweetness". This is why odor should not been used as an indicator of the presence of hydrogen sulfide. Some industrial facilities that generate H_2S have automatic alarms and flashing lights that provide audio and visual indications of the presence of dangerous levels of hydrogen sulfide.

Occurrence on the Navajo Nation

While hydrogen sulfide is released in several natural settings (such as from "hot springs" and other thermal water sources) and from such industrial operations as geothermal power plants and animal confinement facilities, the principal sources of H_2S on the Navajo Nation are oil and natural gas production, storage, transportation and processing facilities. The facilities are located in two areas of Navajo Country: in the Aneth-Montezuma Creek area in southeastern Utah and in the broad area south of Shiprock and extending eastward through the oil and gas fields near Huerfano Chapter, south of Farmington and Bloomfield, New Mexico. Oilfield waste management facilities, such as produced water ponds and tank batteries, may also generate hydrogen sulfide.

A wastewater disposal facility between the towns of Bloomfield and Aztec east of Farmington released hydrogen sulfide over a two-week period in the summer of 1985, sending several nearby residents to local hospitals suffering from dizziness, headaches, nausea and vomiting. Peak indoor concentrations in homes next to the facility were around 20 ppm, the level at which humans begin to lose their sense of smell of H_2S and experience a sense of "sweetness" in air around them. This incident resulted in a lawsuit against the operator of the disposal facility and eventually the buy-out of residential properties located adjacent to the facility.

Methods

Since hydrogen sulfide is often present in areas of the Navajo Nation where populations are concentrated, the Navajo Birth Cohort Study will monitor H_2S in the homes of enrolled pregnant women who live in these communities. To obtain comparison data, for every enrolled woman who lives in an oil-and-gas producing area, the NBCS staff will find another enrolled Participant who does not live in an area where hydrogen sulfide is generated by human sources.

Indoor hydrogen sulfide levels will be monitored in Participants' homes using a Honeywell Single-Point Monitor (SPM) gas tape meter. This instrument uses a lead acetate-impregnated filter paper tape to identify hydrogen sulfide optically as an air mass passes through the instrument. The lowest limit of detection is about 1 ppb, or 0.001 ppm, according to the manufacturer. SPMs are operated for 15 to 30 days to account for daily variations in concentrations. In general, H_2S levels are higher between midnight and dawn when atmospheric conditions are calm and air masses stagnate. This period also corresponds to the time most people sleep.

USEPA's Environmental Response Team (ERT), in cooperation with CDC-ATSDR and the UNM-SRIC Team, has loaned 11 SPMs to the Navajo Birth Cohort Study for use as long as the study continues. USEPA-ERT will send an expert in SPM operation and maintenance to New Mexico in September or October 2012 to provide training in instrument assembly, deployment, operation, maintenance and data recovery. This schedule meets the needs of the study staff, which does not anticipate enrolling women who live in the oil and gas areas of the Navajo Nation until late Fall 2012.

Critical Values for Exposure; Tiered System

In recognition of the low threshold of human detection of hydrogen sulfide, and based on a survey of the available literature, NBCS has adopted a tiered system for informing participants of the results of in-home testing. Table VI.1 shows the level of “risk” of long-term and short-term health effects resulting from exposure to increasing concentrations of H_2S. NBCS staff will use these risk levels to advise Participants on steps they may take to lessen their exposures. In the rare cases that Very High or Unacceptable risks are detected, NBCS will help the Participant make immediate contact with the appropriate health and environmental regulatory agencies.

Table VI.1

Concentration Range	Human Detection and Health Impacts	Participant Advisory
<0.001 ppm (1 ppb)	Natural levels of H_2S in outside air; faint but detectable odor to humans	**LOW RISK**: Lowest level of detection of SPM Gas Tape Meter
0.001 ppm-0.15 ppm	Detectable “rotten eggs” odor range; eye irritation, cough, throat irritation	**MODERATE RISK**: minor eye, nose, throat, upper respiratory irrigation
0.15-8 ppm	Malaise, irritability, headaches, insomnia, nausea, throat irritation, shortness of breath, eye irritation, diarrhea, and weight loss	**HIGH RISK**: May have long-term adverse neurological effects on children; likely source(s) are industrial facilities
8-30 ppm	Fatigue, nausea, migraine headaches, vomiting; loss of sense of smell by paralyzing the olfactory nerve; in some cases, loss of consciousness	**VERY HIGH RISK**: Immediate removal from area of exposure; emergency treatment and/or hospitalization may be needed
10-50 ppm	• NIOSH Recommend Exposure Limit (REL): 10 ppm • OSHA worker exposure limit: 20 ppm for 10 minutes	**UNACCEPTABLE ACUTE RISK FOR MEMBERS OF THE PUBLIC**; Removal of the source or physical separate of people from near the hydrogen sulfide source is recommended.
50-500 ppm	Prolonged exposure leads to eye irritation, painful conjunctivitis, clouding of vision; serious eye injury (permanent scarring of the cornea); pulmonary edema; damage to nervous system; depression of cellular metabolism	
500-1,000 ppm	Rapid unconsciousness and death through respiratory paralysis and asphyxiation.	**FATAL DOSE**: Deaths results in minutes, especially in confined spaces

Section VII — Procedures for Sampling and Testing Water Quality in Unregulated Water Sources

Background

Ingestion of heavy metals, radionuclides and other contaminants through drinking water is a significant source of exposure for people on the Navajo Nation, including and especially pregnant women. Arsenic and uranium have been identified in previous studies as the principal contaminants of concern from a health perspective. Arsenic is a human carcinogen (skin, liver and lung cancers) and uranium is a kidney toxicant as a heavy metal. (Uranium is also classified by USEPA as a human carcinogen because, as a radioactive substance, it releases alpha particles that deposit deep inside the lungs.) About 25 different water sources had As and U exceeding their respective MCLs in the same samples, giving rise to concerns about the potential combined or synergistic effects of exposures to both metals.

Studies conducted by federal agencies in the 1990s indicated that between 14% and 25% of unregulated water sources located in the different parts of the western area of the Navajo Nation had uranium concentrations exceeding federal preliminary remediation goals and drinking water standards (called "Maximum Contaminant Levels", or MCLs). A more recent compilation of water quality data by SRIC showed that arsenic exceeded the federal MCL in 17% of water sources and uranium exceeded its MCL in 10% of water sources distributed throughout the Navajo Nation. In the Eastern Agency where the UNM-SRIC team conducted a cross-sectional study of environmental exposures between 2003 and 2011, the As and U frequencies were 10% and 9%, respectively.

Purpose and Scope of NBCS Water Sampling

The purpose of water testing is to ascertain Participants' exposures to water-borne inorganic and heavy metal contaminants. Drinking water from both regulated and unregulated sources is the primary exposure pathway and ingestion is the route of exposure. Participant responses to questions on the intake survey will guide the NBCS water quality assessment protocol. If the Participant drinks exclusively from a regulated source, such as the Navajo Tribal Utility Authority (NTUA) water system, the NBCS staff will use water quality data reported by NNEPA for the NTUA system in the Participant's exposure assessment. If the Participant indicates that she drinks from, or has drunk from, unregulated water sources, the CHERS conducting the survey will ascertain the specific well or wells the Participant names and will help the Participant locate the well or wells on a map. NBCS staff will examine existing water quality databases to determine if water quality already exists for the named water sources, and if it does, those data will be used in the exposure assessment for the Participant. If no such data exist, NBCS senior staff will work with RFS personnel to schedule a date for collection of samples from the water source or sources identified by the Participant. Samples will be tested in the field and at the USEPA Region 9 laboratory in Richmond, California, as discussed in the methods section that follows.

Water Quality Analytical Methods

NBCS staff uses field tests with portable equipment and laboratory analyses to measure water quality in unregulated water sources. Field tests are performed using a Yellow Springs Instrument (YSI) Model 63 pH-temperature-conductivity meter and a Hach 2000 Spectrophotometer. The YSI 63 is calibrated according to manual instructions, and periodically at the factory. Field tests for fluoride (F), iron (Fe), nitrate (NO_3) and sulfate (SO_4) are performed using the Hach kit. The Hach kit contains a "standard blank" test procedure that is used before each individual test; as such, calibration occurs on a parameter-by-parameter basis. Not all samples collected are subject to field tests using the Hach kit because results for those analytes are reported by the laboratory. Laboratory analyses of water samples will be performed at the USEPA laboratory in Richmond, Calif. Field test parameters and laboratory analytes, along with laboratory test methods, used by the Project between 2003 and 2007 are listed in **Table 1**. Constituents analyzed at the USEPA Richmond laboratory, along with the analytical methods used, are listed in **Table 2**.

Seven metals associated with kidney toxicity — As, Cd, Cr, Cu, Pb, Ni, U — are tested to assess and control for exposures of interest among Participants, particularly to uranium. Radionuclides are not been included in study list of analytes due to budget constraints and because the EPA-9 laboratory does not have radiometric capabilities. NBCS will not analyze water samples for bacteriological parameters, petroleum constituents, pesticides or solvents unless funds become available for these parameters.

Water Sampling Protocols

The NBCS water sampling protocols and procedures were used by the UNM-SRIC Team in the DiNEH Project and gleaned from guidelines published by NTUA, the Carlsbad Environmental Monitoring and Research Center, and USEPA. SRIC staff is responsible for carrying out sample collection, preservation, chain-of-custody and shipping activities.

Prior to sample collection in the field, SRIC obtains clean 250-milliliter bottles from the USEPA Richmond lab. Samples collected for analysis of major ions are placed in clean bottles that do not contain an acid preservative. For metals analyses, SRIC staff prepares each 250-ml bottle with 2 to 3 ml of nitric acid (HNO_3; 71% strength) provided by the UNM Pharmacy College's laboratory in Albuquerque. The acid acts as a preservative to prevent dissolution of analytes and longer shelf life before laboratory analyses are performed. Bottle preparation is done at SRIC's Albuquerque office or in the field prior to sampling using rubber gloves, safety goggles and glass pipettes. Each pair of sample bottles, one acidified and one not, is placed is a quart zip-lock plastic bag, which is placed in a cooler for transport to the field. These bags are not opened until samples are collected in the field.

Sample collection in the field follows these steps:

1A. For water sources with easily accessible spigots, values at troughs, or open tanks, a 3-gallon bucket is rinsed with water from the water source several times to avoid cross-contamination between water sources. The bucket is filled with 3 to 4 gallons of water from the water source; this volume is used for all subsequent field tests and samples collected for laboratory analysis.

1B. In cases where the water source is different to reach with a large bucket, the water sample is collected in a smaller container (such as a gallon water jug), or even in the sample bottle itself, following the procedures set forth in #4 below.

2. Tests for pH, temperature, conductivity, specific conductance and salinity are performed using the YSI 63. The entire probe is submerged in the water sample in the bucket. Results are recorded on data sheets. Deionized water is used to rinse the probe once these field tests are completed.

3. For tests using the Hach 2000 kit, a water sample is collected from the 5-gallon bucket in a 4-cup pyrex measuring cup. Tests for fluoride, iron, nitrate and sulfate are performed using pre-programmed light wave lengths specific to each analyte. Specific reagents purchased from the Hach Co. are used for each analyte. Sample vials placed in the kit are rinsed with deionized water before and after each test. Results are recorded on data sheets. For waters high in conductivity or dissolved solids, samples tested for sulfate must be diluted because of the relatively low detection level (about 70-80 mg/l) of the Hach 2000. For example, if 10 ml of sample is diluted by adding 90 ml of deionized water, then the Hach results are multiplied by 10.

4. Samples are collected in 250 ml bottles for laboratory analyses. Each bottle is labeled with two unique sample identifiers as follows:

- Name or well number of water source
- Date and time sample collected, expressed in military hours. This generates a unique identifier for each sample; e.g., 0709121530 means the sample was collected in 2007 on September 12th at 3:30 p.m.
- Name of person who collected sample
- Indication that the sample is acidified (“HNO_3”) or non-acidified (“No acid”)

Water in the 3-gallon bucket is poured into each bottle. For samples placed in the pre-acidified bottle, care is taken to prevent overtopping that could harm field personnel and invalidate the sample. Periodically, pH strips are used to ensure that the pH of the sample solution is less than 2.0. Latex gloves are worn by each member of the sampling team for personal safety and to prevent cross-contamination. Each set of acidified and non-acidified samples is returned to the 1-quart or 1-gallon zip-lock bag, which is sealed and placed in an ice chest. The remaining sample water in the bucket is discarded and the bucket is rinsed with deionized water.

5. During sample collection, a member of the sample team takes a GPS reading for the latitude and longitude of the water source. For windmills, the team member stands as close to the wellhead (top of the borehole) as possible. These coordinates are recorded on the data sheet for each water source.

6. In winter months when weather and road conditions have been poor and field access and time were limited, Project staff collect bulk water samples in 1-gallon or 2-gallon distilled water jugs, placed the sample containers on ice in coolers, and transported the bulk samples to a central location, such as a local chapter house or SRIC’s office in Albuquerque, for field tests and sample preparation. All sample collection, identification, preservation and shipping procedures listed above are repeated for bulk sampling. This method is used only when conditions warrant.

7. For laboratory samples, the sample bottles are kept in a refrigerator at SRIC’s Albuquerque office until sent to the USEPA Richmond lab. Before shipment, clear tape is affixed to the tops and sides of the sample bottles to create a security seal and permit the Project staff member to place his or her initials on the tape. Upon shipment, chain-of-custody forms are completed by SRIC staff (usually, Chris Shuey), who transports the samples in a sturdy and sealed cooler to Federal Express for next-day delivery to the USEPA Richmond laboratory.

Table VII.1. Analytical Methods for Field and Laboratories Analyses

Location	Equipment	Parameters*
Field (same methods used in 2008 and beyond)	Yellow Springs Instruments Model 63	❑ Conductivity ❑ PH ❑ Specific Conductance ❑ Temperature
Field (same methods used in 2008 and beyond)	Hach 2000 Spectrophotometer	❑ Fluoride ❑ Iron ❑ Nitrate ❑ Sulfate
Carlsbad Environmental Monitoring and Research Center (CEMRC), Carlsbad, NM	❑ ICP-MS ❑ Cold-vapor AA for Cu	❑ **Arsenic (As)** ❑ Bicarbonate (HCO_3) ❑ **Cadmium (Cd)** ❑ Calcium (Ca) ❑ Carbonate (CO_3) ❑ Chloride (Cl) ❑ **Chromium (Cr)** ❑ **Copper (Cu)** ❑ **Lead (Pb)** ❑ Magnesium (Mg) ❑ **Mercury (Hg)** ❑ **Nickel (Ni)** ❑ Potassium (K) ❑ Sodium (Na) ❑ Sulfate (SO_4) ❑ **Uranium (U)**
Navajo Tribal Utility Authority, Ft. Defiance, AZ	❑ Gravimetric analysis ❑ Anion chromatography ❑ Cation chromotography ❑ Dual titration	❑ Total Dissolved Solids ❑ Calcium, Magnesium, Potassium, Sodium ❑ Chloride, Sulfate ❑ Bicarbonate, Carbonate,
Stanford University Environmental Engineering Laboratory (water only)	❑ ICP-MS	❑ As, Cd, Cr, Cu, Pb, Hg, Ni, U for QA/QC (lab comparisons)
Stanford University Environmental Engineering Laboratory (soils only)	❑ ICP-OEP	❑ 29 heavy metals (including U)
EPA-Las Vegas, NV	❑ Alpha spectroscopy	❑ uranium, uranium isotopic
N.M. Scientific Laboratory Division, Albuquerque, NM	❑ Gas proportional counting, gas scintillation	❑ gross alpha, gross beta, radium-226 + -228

*Radionuclides and bacteriological parameters are not included in the DiNEH Project protocol, but may be analyzed periodically through other programmatic and budgetary sources; those listed here were performed as part of the CRUMP program in 2003-2004.

Metals shown in **boldface type** are kidney toxicants prioritized specially for the DiNEH Project.

AA = atomic adsorption; ICP-MS = Inductively coupled plasma mass spectrometer; ICP-OEP = Inductively coupled plasma optic emission spectrometer

Table VII.2. USEPA REGION 9 Richmond, CA Laboratory Analytical Methods

Analyte	Method
Alkalinity, Bicarbonate	EPA Method SM2320/SOP560
Alkalinity, Carbonate	EPA Method SM2320/SOP560
Alkalinity, Hydoxide	EPA Method SM2320/SOP560
Alkalinity, Total	EPA Method SM2320/SOP560
Aluminum	EPA Method 200.8/SOP507
Antimony	EPA Method 200.8/SOP507
Arsenic	EPA Method 200.8/SOP507
Barium	EPA Method 200.8/SOP507
Beryllium	EPA Method 200.8/SOP507
Boron	EPA Method 200.7/SOP505
Bromide	EPA Method 300.0/SOP530
Cadmium	EPA Method 200.8/SOP507
Calcium	EPA Method 200.7/SOP505
Chloride	EPA Method 300.0/SOP530
Chromium	EPA Method 200.8/SOP507
Cobalt	EPA Method 200.8/SOP507
Copper	EPA Method 200.8/SOP507
Fluoride	EPA Method 300.0/SOP530
Hardness, as CaCO3	Calculated
Iron	EPA Method 200.7/SOP505
Lead	EPA Method 200.8/SOP507
Magnesium	EPA Method 200.7/SOP505
Manganese	EPA Method 200.8/SOP507
Mercury	EPA Method 245.1/SOP515
Nickel	EPA Method 200.8/SOP507
Nitrite as N	EPA Method 300.0/SOP530
o-Phosphate, as P	EPA Method 300.0/SOP530
Potassium	EPA Method 200.7/SOP505
Selenium	EPA Method 200.8/SOP507
Silica	EPA Method 200.7/SOP505
Silver	EPA Method 200.8/SOP507
Sulfate	EPA Method 300.0/SOP530
Thallium	EPA Method 200.8/SOP507
Total Dissolved Solids	EPA Method 2540/SOP461
Vanadium	EPA Method 200.8/SOP507
Zinc	EPA Method 200.8/SOP507

APPENDIX A

Home Environmental Assessment Record Forms

NBCS Form HEA-1

Navajo Birth Cohort Study
Home Environmental Assessment Summary Sheet and Site Map

Participant Interim ID: __________________________ Date of Assessment: ______________________________
Rural Address or Description of Home Location: ____
____
Decimal-degree latitude-longitude at turnoff from nearest highway or dirt road: N_____________, W_____________
Decimal-degree latitude-longitude coordinates at **front door**: N___________________, W____________________

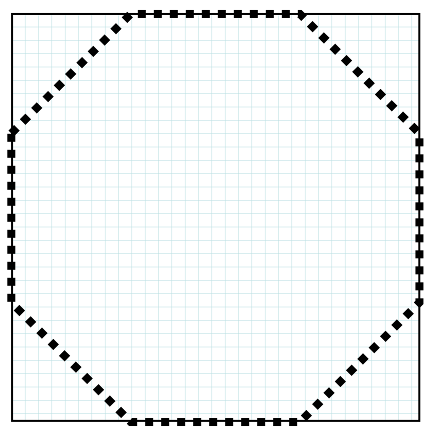
Type of Home: ☐ single-story cement slab ☐ single-wide mobile home ☐ double-wide mobile home
☐ hogan ☐ wood frame, stucco ☐ abode ☐ logs and mud ☐ cement/cinder block

Instructions: Using the symbols in the box below, note locations of outdoor gamma radiation stations and places inside the home where radon canisters and hydrogen sulfide meters were placed and where dust samples were collected. Include radon and dust sample ID numbers in the spaces provided below. Sketch in rooms as needed.

● Radon canister(s) ☐ | ☐ Dust wipe sample(s) ☐ | ⦿ Hydrogen sulfide tape meter ☐

Δ Gamma radiation station ☐ | • Indoor stove: C = coal-burning; P= pellet; W = wood burning ☐

N



Radon Canister Log:

Sample ID No.	Time Placed

Dust Wipe Log:

Sample ID No.	Time Sampled

NBCS Form HEA-2

Outside Gamma Radiation Survey Data Sheet

Participant Interim ID: ___________________________ Date: ____

Instrument Serial No. (last 3 digits): ___________________

Station No.	DD Latitude	DD Longitude	Meter Dial Setting (µR/hr)	Gamma Rate (µR/hr)		Comment
				Waist	Contact	
1 Front door						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
Bckg-1						
Bckg-2						
Bckg-3						

Bckg-4						
Bckg-5						

NBCS Form HEA-3

Interior Gamma Radiation Survey Data Sheet

Participant Interim ID: ______________________ Date: ____________________________________

Instrument Serial No. (last 3 digits): ________________

INSTRUCTIONS: For each room surveyed, fill in the meter setting for each reading and record the gamma rate at both waist level and at contact (i.e., appx. 2 inches from the surface). Readings for floors and ceilings should be taken only at contact distance. Floor and ceiling locations should be in the middle of the room. Place an X through rooms that do not exist or were inaccessible for surveys.

Livingroom 1	**Meter Dial Setting**	**μR/hr @ waist level**	**μR/hr @ contact**	**Bedroom 1**	**Meter Dial Setting**	**μR/hr @ waist level**	**μR/hr @ contact**
East wall				East wall			
South wall				South wall			
West wall				West wall			
North wall				North wall			
Floor				Floor			
Ceiling				Ceiling			
Livingroom 2	**Meter Dial Setting**	**μR/hr @ waist level**	**μR/hr @ contact**	**Bedroom 2**	**Meter Dial Setting**	**μR/hr @ waist level**	**μR/hr @ contact**
East wall				East wall			
South wall				South wall			
West wall				West wall			
North wall				North wall			
Floor				Floor			
Ceiling				Ceiling			
Dining or Storage	**Meter Dial Setting**	**μR/hr @ waist level**	**μR/hr @ contact**	**Bedroom 3**	**Meter Dial Setting**	**μR/hr @ waist level**	**μR/hr @ contact**
East wall				East wall			
South wall				South wall			
West wall				West wall			
North wall				North wall			
Floor				Floor			
Ceiling				Ceiling			
Work Room	**Meter Dial Setting**	**μR/hr @ waist level**	**μR/hr @ contact**	**Kitchen**	**Meter Dial Setting**	**μR/hr @ waist level**	**μR/hr @ contact**
East wall				East wall			
South wall				South wall			
West wall				West wall			
North wall				North wall			
Floor				Floor			
Ceiling				Ceiling			

COMMENTS:

____
____
____
____

REVIEWED BY: ______________________________

NBCS Form HEA-4

Indoor Radon Test Summary Sheet

Participant Interim ID: ____________________________ Date: ____

Participant Mailing Address (Box, City, State, Zip Code): ____
____

Phone Number(s): ____

INSTRUCTIONS: Label radon samples alphabetically, using the Participant Interim ID number followed by a letter. For example, if the PIID# is WR001, the first radon canister would be WR001A, the second WR001B, etc. Affix the RTCA Canister Bar Code sticker in the places provided. Do NOT include Participant's name on this form. Use the NBCS *Internal Radon Testing Log* only for that purpose.

CANISTER A

Affix RTCA Canister Bar Code Here →

State Date: ______________________________________ Stop Date: _______________________________________

Start Time: ______________________________________ Stop Time: _______________________________________

Room Placed: ___________________________________ Duplicate? _________________ Blank? ______________

CANISTER B

Affix RTCA Canister Bar Code Here →

State Date: ______________________________________ Stop Date: _______________________________________

Start Time: ______________________________________ Stop Time: _______________________________________

Room Placed: ___________________________________ Duplicate? _________________ Blank? ______________

CANISTER C

Affix RTCA Canister Bar Code Here →

State Date: ______________________________________ Stop Date: _______________________________________

Start Time: ______________________________________ Stop Time: _______________________________________

Room Placed: ___________________________________ Duplicate? _________________ Blank? ______________

CANISTER #D

Affix RTCA Canister Bar Code Here →

State Date: ______________________________________ Stop Date: _______________________________________

Start Time: ______________________________________ Stop Time: _______________________________________

Room Placed: ________________________________ Duplicate? _______________ Blank? ____________

NBCS Form HEA-5

NBCS Internal Radon Testing Log
[FOR INTERNAL USE ONLY BY STUDY PI OR CO-PI]
Do not include Participant Interim ID number on this form

Participant Name	Phone No.	DD Latitude	DD Longitude	Canister Serial #	Lab Result

NBCS Form HEA-6

NBCS Dust Wipe Sample Log
[FOR INTERNAL USE ONLY BY STUDY PI OR CO-PI]
Do not include Participant name on this form

Participant Interim ID No.	Home DD Latitude	Home DD Longitude	Sample Date	Sample Time	Sample ID No.

NBCS Form HEA-7

Hydrogen Sulfide Test Summary Sheet

Participant Interim ID: ______________________________ Meter Serial No.: ______________________________

Start Date: ______________________________ Start Time: ______________________________

End Date: ______________________________ End Time: ______________________________

Location in Home/Building Where Placed: ______________________________

Source of electricity: ______________________________

Operational check performed at placement: ☐ Working properly

Operational check performed at retrieval: ☐ Working properly ☐ Not working

NBCS Form HEA-8

Chapter:_______________
Well ID: _______________

Navajo Birth Cohort Study
WATER QUALITY ASSESSMENT FORM

Date/Time:________________________________

Water Source No.:________________________

T-R-S-quarter: ____________________________

Lat/Long: _________________________________

Directions to location: ____________________

____

Water Source Description: ________________

____

Physical Characteristics: __________________

____

Field Parameters:

pH: _____________ @ (Temp. °C) ___________

Conductivity: ______________________________

Specific Conductance: ____________________

Instrument: ________________________________

F (Fluoride): _______________________________

Fe (Iron): __________________________________

NO_3 (Nitrate): ____________________________

SO_4 (Sulfate): ____________________________

Instrument: ________________________________

Samples Collected for Laboratory Tests (sample ID, container size, preservation):

____

____

____

____

____

Technicians (print): _______________________

Retest Date/Time: _________________________

Reason(s) for retest: _______________________

____

____

____

____

____

____

Physical Characteristics: __________________

____

Field Parameters:

pH: _____________ @ (Temp. °C) ___________

Conductivity: ______________________________

Specific Conductance: ____________________

Instrument: ________________________________

F (Fluoride): _______________________________

Fe (Iron): __________________________________

NO_3 (Nitrate): ____________________________

SO_4 (Sulfate): ____________________________

Instrument: ________________________________

Samples Collected for Laboratory Tests (sample ID, container size, preservation):

____

____

____

____

____

Signature: _____________________________