

HEALTH CONSULTATION

BONANZA MINE

NONPAREIL, DOUGLAS COUNTY, OREGON

Prepared by:

Oregon Department of Public Health
Under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

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Purpose/Objectives

The Superfund Health Investigation and Education (SHINE) program of the Oregon Department of Human Services (DHS), under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR), conducted an exposure investigation at the Bonanza Mine site in Douglas County, Oregon.

The primary objectives of this exposure investigation study were

1. to determine the levels of arsenic and mercury in the urine of residents of the Bonanza Mine site,
2. to determine behavioral and demographic information about the residents of the Bonanza Mine site,
3. to provide health education materials about heavy metals and ways to reduce exposure to heavy metals to the residents of the Bonanza Mine site, and
4. to fill existing data gaps in the evaluation of exposure pathways for the assessment of the public health impact on residents at Bonanza Mine.

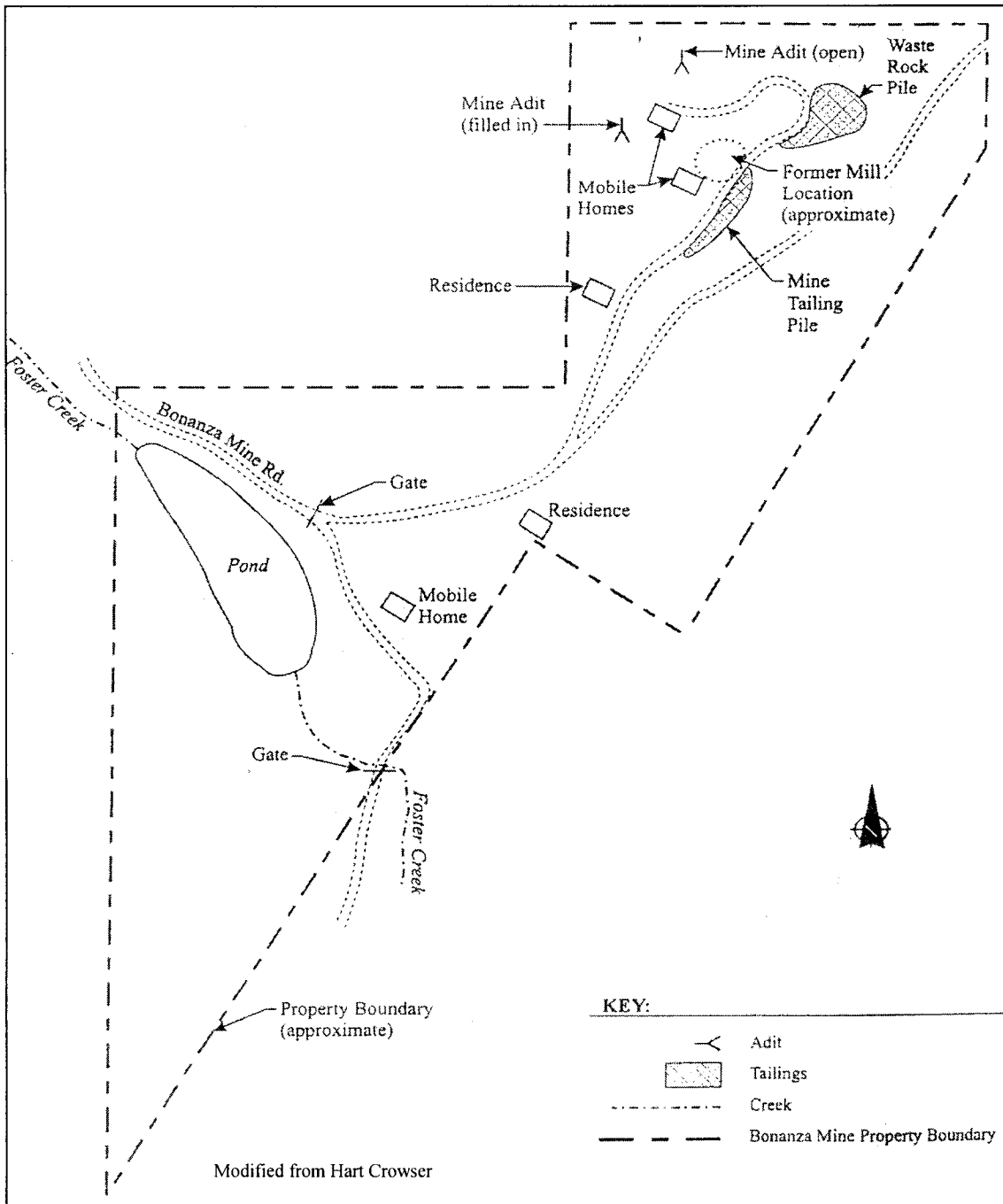
Background

Bonanza Mine is located near the small community of Nonpareil, 6 miles east of Sutherlin, Oregon. The mine sits in Douglas County, in a region that contains a 20-mile belt of scattered mercury ore deposits [1]. The site is located in the SW Quarter of Section 16 of Township 25 South, Range 4 West, Willamette Meridian (latitude N43°23'46", longitude W123°10'54"). The area surrounding Bonanza Mine is rural, and the climate is semiarid. Five residences are located close to the mine site, including two residences within 200 feet of the former mill. For this exposure investigation, the residents of these five homes were considered the target population. The primary contaminants of concern at the site are mercury and arsenic [2].

Rich deposits of cinnabar, metacinnabar, and other forms of natural mercury were found on the Bonanza Mine site in 1865, and limited mining and smelting began in 1870. Large-scale mining began in 1937 when H.C. Wilcot acquired the mine and established Bonanza Mines, Inc. The mine had 12 adits and more than 3 miles of subterranean shafts, with a smelter at the main adit. In 1940 the mine was reported to be the second largest producer of quicksilver in the United States. Total mercury production was just below 40,000 flasks. Mining ceased at the end of 1960, and the site has been inactive since that time.

The buildings have been removed, leaving only foundation slabs, piles of tailings, waste rock, and a temporary waste storage cell (Figure 1). Several adits remain open, and residents continue to access them. Numerous falling hazards exist in the subterranean tunnels.

Figure 1. The Bonanza Mine and Surrounding Residences.



SHINE identified an elderly citizen, several adults and teenagers, and at least one toddler as the target population for this exposure investigation. At least a dozen persons live among the five homes. SHINE was unable to contact all of the residents, so the exact number is not known. The target population has the following characteristics: 1) residences close to the mine; 2) young adults or children as part of the population of concern; and 3) as determined by past testing of the soil near the homes, high levels of mercury and arsenic. In a prior health consultation for Bonanza Mine [3], the extent to

which metals in the soil and tailings were bioavailable to the residents was unknown, constituting a major data gap in the exposure pathway analysis.

In September 2000, a contractor for the Oregon Department of Environmental Quality (DEQ) excavated approximately 240 cubic yards of mercury-contaminated soil from the site using a trackhoe based on the high amount of arsenic and mercury (Table 1). The mill's concrete foundation was scraped to remove soil and debris, and then portions of the hillside were excavated [4]. Table 2 shows the levels of mercury and arsenic in the soils at the Bonanza Mine site following soil clean-up activities.

Table 1. Concentrations of Arsenic and Mercury at Bonanza Mine prior to the 2000 Oregon Department of Environmental Quality Soil Removal Activities (representative of past environmental conditions)

<i>Contaminant</i>	<i>Range in Soil (ppm)*</i>	<i>Samples > DL†/Total</i>	<i>Samples > CV‡</i>	<i>CV in ppm</i>	<i>CV Source</i>
Arsenic	109-182	4/4	4/4	0.5	CREG§
Mercury	1150-12000	4/4	4/4	23	PRG¶

ppm = parts per million of chemical in soil. ppm = mg (milligram) per kg (kilogram of soil).

†DL = detection limit

‡CV = comparison value

§CREG = cancer risk evaluation guide

¶PRG = preliminary remediation goal for residential soils

The contaminated soils were stockpiled in a temporary storage cell near the homes. The storage cell was posted with warning signs and covered with a PVC liner. During the initial SHINE visit on August 11, 2003, it was noted that the temporary waste storage cell was in an unsecured state. The PVC liner was pulled back from the soil pile, the plastic fencing was torn down, and the warning signs were removed. There was evidence of human activity at the storage site, including discarded beverage cans, a bike jump, and a nearby bike helmet. Since the SHINE site visit in August 2003, DEQ issued a time-critical removal order for the waste pile. Within 2 weeks of the visit, DEQ relined the soil pile with PVC, enclosed it with a 6-foot cyclone fence, and posted warning signs about the toxicity of arsenic, mercury, and lead.

Table 2. Concentrations of Arsenic and Mercury at Bonanza Mine and the Surrounding Hillside Following The 2000 Oregon Department Of Environmental Quality Soil Removal Activities (representative of current environmental conditions).

<i>Contaminants</i>	<i>Range in Soil (ppm[*])</i>	<i>Samples > DL[†]/Total</i>	<i>Samples > CV[‡]</i>	<i>CV in ppm</i>	<i>CV Source</i>
Arsenic	21.8-125	9/9	9/9	0.5	CREG [§]
Mercury	67.7-5100	13/13	13/13	23	PRG [¶]

*ppm = parts per million of chemical in soil. ppm = mg (milligram) per kg (kilogram of soil).

†DL = detection limit

‡CV = comparison value

§CREG = cancer risk evaluation guide

¶PRG = preliminary remediation goal for residential soils

Mercury

The ability to absorb ingested mercury depends on the form of mercury. Organic mercury is almost totally absorbed if swallowed. Insoluble forms of mercury such as elemental (metallic) mercury and mercury sulfide (cinnabar) are absorbed poorly through the gut. If no gut absorption occurs, the mercury will be eliminated unchanged and will not result in adverse toxicological effects. Cinnabar and metacinnabar are the primary forms of mercury found at Bonanza Mine.

Dermal exposure to mercury for people who work or live around soils with higher mercury levels is possible [5]. However, less than 3% of the contacted mercury would absorb through the skin, compared with the 80% of mercury vapor retained by the lungs [6]. In addition, half of the dermal uptake would be lost through normal shedding of skin layers [6].

The primary exposure route of concern for elemental mercury at the Bonanza Mine site is inhalation. The body retains approximately 80% of inhaled mercury vapors [6] because the mercury in inhaled vapors accumulates in fatty tissues such as the brain, liver, and kidneys. Breathing in metallic mercury vapors can affect neurobehavioral and psychological performance. Tremors, personality changes, lack of muscle coordination, disturbances in vision, and difficulty with memory have been attributed to mercury vapor inhalation. In addition, the kidneys are sensitive to the effects of mercury because they are a major site for mercury accumulation. If exposure is high, effects on the cardiovascular, gastrointestinal, and respiratory systems are possible as well. Chronic exposure studies of elemental mercury inhalation from spills in homes have noted abdominal pain, weight loss, diarrhea, and painful mouth [7]. A special form of hypersensitivity has been observed in some children aged 4 months to 4 years. This syndrome, known as acrodynia or pink disease, is characterized by a generalized rash [7]. Other symptoms of acrodynia include chills and swelling and irritation of the hands, feet, cheeks, and nose. In addition, the disease can cause irritability, photophobia, sleeplessness, and profuse perspiration with the possibility of dehydration. Inhalation of elemental mercury and mercury compound vapors can also result in contact dermatitis.

Arsenic

High exposure to arsenic can result in hyperpigmentation of the trunk and extremities, tumors on the soles and palms, severe abdominal pain, diarrhea, skin lesions, and numerous cancers [8]. The bioavailability of arsenic varies, depending on environmental conditions, exposure pathway, and other factors. One of the most common exposure pathways to inorganic arsenic is ingestion of contaminated well water. Organic arsenic, which is thought to be nontoxic, is ingested primarily through seafood; therefore, abstaining from seafood prior to a urine test for arsenic is important.

Collection Methods and Results

During the week of September 7, 2003, residents of Bonanza Mine were sent a letter notifying them that SHINE staff would leave urine collection containers, instructions for collecting urine, and information about heavy metals the following week (Appendix A). On September 15, SHINE visited each of the five homes at or near the Bonanza Mine site. SHINE staff found someone at home in two of the homes and instructed them on the proper procedures for collecting urine. Each participant was offered an incentive of a \$20 gift certificate redeemable at a local grocery if they agreed to participate. All adult participants were asked to complete the applicable informed consent forms (Appendix B). The parents/guardians of children were asked for permission to have their eligible children/wards participate as well. Six consent forms were returned.

In addition to consent forms, SHINE staff administered a participant survey to adult residents at home during the site visit to gather information needed to help interpret the test results (Appendix C). If residents were away during the site visit, the surveys and consent forms were left at their front doors. The survey was designed to identify sources of mercury or arsenic not attributable to exposure from contaminated soil, vapors, or dust on the mine site, and to obtain behavioral patterns and uses at the site. Three surveys were filled out and returned.

Plastic acid-washed urine collection containers, coolers, and ice packs were provided with the surveys and the consent forms. Written instructions were provided to participants about proper methods to collect and store urine samples (Appendix C). The participants were advised not to eat any fish or shellfish for at least 3 days before collecting a urine sample.

On September 18, SHINE returned to Bonanza Mine to gather the urine samples, coolers, surveys, and consent forms. Six adults submitted urine. The mother of the toddler was unable to collect a urine sample from her child. Another participant provided an insufficient volume of urine for analysis. Two adults and three young adults had suitable volumes of urine for analysis.

Oregon Medical Laboratories received the urine samples on September 18 and reported the results to SHINE on September 23 (Table 3). The concentration of arsenic and mercury were reported in micrograms of metal per gram of creatinine ($\mu\text{g/g}$ creatinine) to account for varying levels of urinary dilution. Levels of mercury were compared with the data reported in CDC's *Second National Report on Human Exposure to Environmental Chemicals* 0. In this report, the 95th percentile of the national background range for

mercury was 3.27 $\mu\text{g/g}$ creatinine for female adults aged 16–49 years. Levels of arsenic were compared to the reference range for total arsenic identified in the literature 0,0.

Table 3. Urinary Concentrations of Arsenic and Mercury in Participants from the Bonanza Mine Site.

<i>Participant</i>	<i>Mercury ($\mu\text{g/g}$ creatinine)</i>	<i>Mercury Reference Range 0 ($\mu\text{g/g}$ creatinine)</i>	<i>Arsenic ($\mu\text{g/g}$ creatinine)</i>	<i>Arsenic Reference Range 0,0 ($\mu\text{g/g}$ creatinine)</i>
Resident 1	1.1	<3.27	14.0	< 50.0
Resident 2	0.0	<3.27	28.6	< 50.0
Resident 3	0.0	<3.27	18.8	< 50.0
Resident 4	0.0	<3.27	22.4	< 50.0
Resident 5	0.8	<3.27	38.1	< 50.0

After reviewing the test results, SHINE staff wrote to the residents, informing them of their results (Appendix D). Confidentiality was protected to the fullest extent of law. No reports produced during this exposure investigation identified specific individuals or residences, and no documents were preceded or followed by public comment versions, press releases, or other forms of public dissemination. The informed consent forms state that SHINE/ATSDR will share only non-identifying medical information with other federal, state, and local public health and environmental agencies if individual participants agree. These agencies also must protect this confidential information.

As indicated in Table 3, the arsenic and mercury concentrations in all samples were below the reported reference ranges. Persons living on or near the Bonanza Mine site who were tested are not being exposed to significant levels of arsenic and mercury. The fractions of arsenic detected in urine that resulted from exposure to contaminated soil and tailings from Bonanza Mine or from other sources are unknown—the urine was analyzed for total arsenic rather than for different species of arsenic.

Conclusions:

1. The arsenic and mercury concentrations in all samples were below the reported reference ranges. The residents living on or near the Bonanza Mine site who were tested are not being exposed to significant levels of arsenic and mercury.
2. Because arsenic was not speciated, the fractions of arsenic detected in urine that resulted from of exposure to contaminated soil and tailings from Bonanza Mine and from other sources are unknown.

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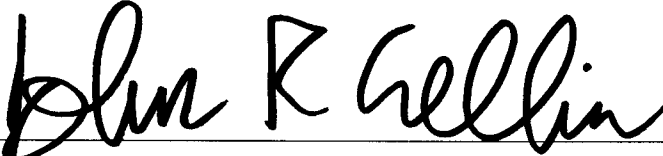
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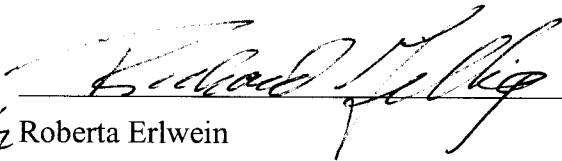
The Superfund Health Investigation and Education Program of the Oregon Department of Human Services prepared the Health Consultation on the Bonanza Mine Exposure Investigation under a cooperative agreement with the Agency for Toxic Substances and Disease Registry. This document is in accordance with approved methodology and procedures.



John R. Crellin, Ph.D.

Technical Project Officer for Oregon, SSAB, DHAC

I have reviewed this health consultation, as the designated representative of the Agency for Toxic Substances and Disease Registry and concur with its findings.



Roberta Erlwein

Leader, Cooperative Agreement Team, SSAB, DHAC

References:

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**Appendix A:
Intent for Collection of Urine Letter**

«FirstName» «LastName»
«Address1»
«City», «State» «PostalCode»

July 25, 2003

Dear «FirstName» «LastName»,

You are receiving this letter from the Department of Human Services, Public Health Program because you live near Bonanza Mine. We want to inform you that a small group from the state health department will be in your neighborhood on the 15th of September. We would like to stop by your home to talk to you about the metals found near your house and to discuss a simple way to determine if you or your family is being exposed. All that is required from you are a few answers to a questionnaire and a one-time urine sample. The results from this sample will remain strictly confidential and allow us to determine if you have been exposed. As a courtesy for your participation, we would like to give each member of your family that participates a gift certificate worth \$20 to a local store.

We have included some fact sheets about the health effects of exposure to arsenic, lead, and mercury. These are the three metals that we will be looking for in the urine samples.

If you have any questions about this letter or concerns about the area in which you live, please call Dave Stone at 503-731-4012.

Thank you,

Amanda Guay, MPH
Public Health Educator

Jessica Van-Arsdale, MD
Public Health Physician

Dave Stone, PhD
Toxicologist

Appendix B: Informed Consent Forms

**Urine Testing for Mercury, Arsenic, and Lead,
Bonanza Mine, Sutherlin, Douglas County, Oregon Exposure Investigation
Adult Informed Consent & Parental/Guardian Assent Form.**

Purpose

The Superfund Health Investigation and Education program (SHINE) of the Oregon Department of Human Services (DHS) and the Agency for Toxic Substances and Disease Registry (ATSDR) are doing an exposure investigation to learn if you or your family are being exposed to high amounts of mercury, arsenic, or lead in soil. We are doing this because soil collected from the mine site found high levels of mercury, arsenic and lead. We do not know if you or your family are being exposed to these chemicals. You or your family could be exposed by inhalation, accidental ingestion, or by contact with the skin. That is why we would like to test your urine for mercury, arsenic, and lead. We will also test your urine for creatinine as a measure of urine dilution.

We are offering free urine testing for all people who live in your home and might be exposed to these chemicals. Along with the free testing, we will also ask you some questions so we can better understand your test results.

Procedures

Urine testing. A person from ATSDR and SHINE will tell you how to collect and store urine samples. You will also be told how to help any of your small children collect their urine. On the day of the test, everyone in your family will collect his or her first morning urine in the containers we gave you. You will put the containers in your refrigerator until ATSDR staff can pick them up. It should take 10 minutes or less for each person to collect his or her urine sample.

Survey

A person from ATSDR and SHINE will ask you some questions, which will help us understand the results better. The survey will only take about 5 minutes or less.

Benefits

I will benefit from being tested because I will find out if I (or my child/ward) have been exposed to mercury, arsenic or lead at levels of health concern. If the tests show high levels of these chemicals, ATSDR and SHINE will give me information on the health effects of these chemicals and will give me tips to lower my current and future exposure to mercury, arsenic or lead.

Risks

I know that ATSDR, and SHINE will not be able to tell me if my family or I were exposed to arsenic in the past. This is because the urine tests only measure arsenic in the last couple of days. We do not know if urine testing for mercury and lead show past or recent exposure. ATSDR also will not be able to tell me if any mercury, arsenic or lead in my urine will make my family or me sick later. The short time it takes to collect the urine and answer questions may also be a burden.

Participation

I know that my family and I are free to join this investigation. Even if I agree to be in the investigation and I sign this form, I or my child/ward can stop being part of this investigation at any time without penalty or loss of benefits. I know and agree that

ATSDR and SHINE cannot offer medical treatment based on the test results. I know that I must sign this form for me or my family to join the investigation.

Results

I know that ATSDR and SHINE will try to give me the test results for my family and me in writing within 3 months. However, delays might occur. If ATSDR finds high levels of any of these chemicals in my urine, they will tell me my results as soon as they learn them. In some cases, ATSDR may ask me to repeat the urine testing. I will be given the actual test results for me and my family along with information on what the results mean. If my results show a high level of any of the chemicals tested, I know I should tell my personal physician. I know I will be responsible for the cost of any follow-up testing done by my physician.

Confidentiality/Privacy

Information collected in this test will be kept private to the fullest extent allowed by state and federal laws. Any reports written using this information will give only group information. The reports will not identify me or my family by name or address. If I participate, any forms with my name or address will be kept in locked cabinets at ATSDR or in password-protected computer files. If I say it is OK, my test results may be given to other federal, state, and local public health and environmental agencies. These agencies must also protect this information.

Contact

If I have any questions or I feel my family or I have been harmed by this investigation, I can call Dr. Lourdes Rosales-Guevara of ATSDR toll-free at 1-888-442-8737. I can also call Dr. Dave Stone with SHINE, DHS at 503-731-4012

Consent

All of my questions about this exposure investigation have been answered. I agree to be a part of this investigation.

I _____ (print), agree to urine sampling and completing questionnaires for:

Myself

My child/ward, _____, age _____

My child/ward, _____, age _____

My child/ward, _____, age _____

I want my tests results to be sent to my home address below:

Street

City. State. Zip.

Home phone number: _____
(Area code)

Assent Form for Children

(7 - 17 years of age)

Read this statement to children in the presence of the parent/guardian:

“We want to find out if you have been exposed to the chemicals called mercury, arsenic or lead. You cannot see these chemicals but they may be bad for your health. To find out if you have mercury, arsenic or lead in your body, we need some urine from you. Your mom/ dad/ or guardian can help you collect the urine in a cup. It is very safe. Your mom/dad/guardian said that it is OK for you to do this.”

“It will take less than 10 minutes to collect your urine. It is your choice to give the urine and you can stop at anytime. “Do you have any questions?”

We will also ask you some questions. Your mom/dad/guardian said it will be OK to answer.

The above information has been read to me and I want to be a part of this testing.

Name of Child: _____ Signature of Child
_____ Age _____

Name of Child: _____ Signature of Child
_____ Age _____

Name of Child: _____ Signature of Child
_____ Age _____

Date: _____

Witness: _____
(Print name)

(Signature).

Appendix C: Behavioral/Use Survey for Urine Collection

Date: _____

Name: _____

Telephone number: _____

Address: _____

1. How long have you lived at your current address? _____ Years _____ Months
2. Within the past week, how many nights have you spent away from home? _____
Other family members? _____
3. Do you smoke tobacco products? _____ Yes _____ No
4. In the last 3 days have you eaten fish or shellfish, including shrimp, clams, oysters or
canned tuna? _____ Yes _____ No Other family members _____ Yes _____ No
5. In the past 6 months have you eaten fish caught from a stream/lake located in
Douglas County? _____ Yes _____ No
If Yes, how many fish meals per month? _____
6. In the past 6 months have you used well water for drinking or food preparation?
_____ Yes _____ No Family members? _____ Yes _____ No
7. In the past 6 months have you eaten vegetables grown from soil in your yard?
_____ Yes _____ No Family members? _____ Yes _____ No
8. Do you have children living in your home? _____ Yes _____ No
9. In the past 6 months, have any family members engaged in the following activities
within your neighborhood?
_____ Recreational use of dirt-bikes, ATV's, 4x4's
_____ Digging in the soil
_____ Gardening
_____ Eating/placing dirt or rocks in mouth
_____ Visiting or playing around mine sites
_____ Playing in bare soil
10. Does anyone in your household have the following hobbies?
_____ Making fish weights

_____ Making or reloading ammunition

_____ Working with leaded glass

_____ Soldering or welding

11. Does anyone in your household work with lead, arsenic, or mercury?

_____ Yes _____ No

12. Does anyone in your household do any prospecting or mining?

_____ Yes _____ No

13. Do you have any health concerns that you would like to share with us?

September 15, 2003

Dear Bonanza Mine Resident,

Testing your urine is a simple way to determine if you or your family is being exposed to heavy metals, such as mercury, arsenic and lead, found near your house neighboring Bonanza Mine. All that is required from you are a few answers to a questionnaire and a one-time urine sample. The results from this sample will remain strictly confidential and allow us to determine if you have been exposed. As a courtesy for your participation, we would like to give each member of your family who participates a gift certificate worth \$20 to a local store. Below is some useful information to remember about the testing. Thank you for agreeing to participate.

Preparing for the collection

Be sure all members of your family avoid eating any kind of fish including canned tuna, shellfish, or other seafood for at least three days before you collect your urine samples. Fish, shellfish and seafood all contain organic arsenic compounds, which are not harmful, but will interfere with the urine arsenic test. These foods also contain mercury that could affect your urine test.

Collection day

The second time you urinate after you wake up in the morning, collect your urine in the collection bottle provided. Please do not touch the inside of the urine bottle and cap it after the collection. If your children are toilet trained, please help them to collect the urine too.

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Follow the instructions provided with the sample bottle carefully. If you have any questions about the instructions or this information sheet, please call Dave Stone at 503-731-4012.

On _____, September ____, we will come by your home to pick up the urine samples. Until then, please keep the samples in the refrigerator.

Instructions for urine collection:

1) Store collection containers at room temperature before collection day. Do not eat seafood for three days before urine collection.

2) On the collection day, collect the first morning urine in the container and cap the container. Please try not to touch the inside of the container.

3) If your child is toilet trained, please assist them in collecting their urine too.

4) Please place the containers in the refrigerator after you are finished.

5) We will come by to collect the urine before lunchtime on _____.

Appendix D: Results Letter

____ Bonanza Mine Road
Sutherlin, OR 97479

October 6, 2003

Dear _____,

This letter is to inform you of the results of your recent urine test for heavy metals. We are pleased to let you know that all of your tests were in the normal range for the general population. Your medical information is protected under federal privacy laws and will not be released, posted or shared with anyone without your consent.

Mercury Urine Level:

_____ Normal
_____ Abnormal
_____ Other

Arsenic Urine Level:

_____ Normal
_____ Abnormal
_____ Other

Information:

Your result for mercury in urine was _____ micrograms per gram of creatinine. For this test, most of the general population will have a result less than 35. Your results were far

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below the level that would cause concern. While no high levels of mercury were detected in your urine, it does not mean that you are not being exposed to low levels of mercury or that past exposure did not occur. Urine tests are a screening method to detect high exposures. If you continue to be concerned about the risk of mercury exposure at Bonanza Mine, you may wish to seek a blood test from your health provider. A blood test may be more sensitive, but is also limited to detecting recent exposure only.

Your result for arsenic in the urine was _____ micrograms per gram of creatinine. For this test, most of the general population will have a result that is less than 50. Arsenic levels can be influenced by diet, especially if you eat a lot of seafood. Urine arsenic tests cannot tell us whether past exposures have occurred.

Included with this letter are some simple steps you can take to decrease the possibility of exposure to heavy metals at Bonanza Mine. If you have further questions regarding your test results, please contact Dave Stone at 503-731-4012.

Sincerely,

Dave Stone, PhD

Amanda Guay, MPH

Jessica van-Arsendale, MD