Public Health Assessment for

RED ROCK ROAD
SUTHERLIN, DOUGLAS COUNTY, OREGON
EPA FACILITY ID: OR0002367191
MAY 30, 2007

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
Agency for Toxic Substances and Disease Registry

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment was prepared by ATSDR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) section 104 (i)(6) (42 U.S.C. 9604 (i)(6)), and in accordance with our implementing regulations (42 C.F.R. Part 90). In preparing this document, ATSDR has collected relevant health data, environmental data, and community health concerns from the Environmental Protection Agency (EPA), state and local health and environmental agencies, the community, and potentially responsible parties, where appropriate.

In addition, this document has previously been provided to EPA and the affected states in an initial release, as required by CERCLA section 104 (i)(6)(H) for their information and review. The revised document was released for a 30-day public comment period. Subsequent to the public comment period, ATSDR addressed all public comments and revised or appended the document as appropriate. The public health assessment has now been reissued. This concludes the public health assessment process for this site, unless additional information is obtained by ATSDR which, in the agency's opinion, indicates a need to revise or append the conclusions previously issued.

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PUBLIC HEALTH ASSESSMENT

RED ROCK ROAD

SUTHERLIN, DOUGLAS COUNTY, OREGON

EPA FACILITY ID: OR0002367191

Prepared by:

Oregon Department of Human Services
Superfund Health Investigation and Education Program (SHINE)
Under a cooperative agreement with the
Agency for Toxic Substances and Disease Registry

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I. Executive Summary

The Superfund Health Investigation and Education (SHINE) program, part of Oregon Public Health Division (OPHD), developed this Public Health Assessment (PHA) to evaluate the public health risk of exposure to contaminants present in soil at Red Rock Road (RRR) in Sutherlin, Oregon. The public health implications of exposure to arsenic and mercury were evaluated for residents living near RRR and people who use the road for recreational purposes. SHINE concluded that ingestion of arsenic-contaminated soil at RRR may occur at levels that pose a health concern when exposure occurs over a long period of time for the following scenarios: 1.) Non-cancer effects in areas where original tailings are exposed at the surface for children who live on or near RRR, and 2.) Increased cancer risk for both children and adults who either live on or near RRR or use it for recreational purposes. Because arsenic-contaminated soil at RRR poses a public health risk, SHINE recommends that remediation technology and/or capping be applied to various locations along the road where tailings are exposed at the surface, or where capping is wearing away. SHINE also recommends that residents avoid areas of Red Rock Road where mine tailings are exposed at the surface until adequate remediation actions are completed. Although there is an increased risk from ingestion of arsenic-contaminated soil along RRR, adverse health effects are not expected to result in exposed individuals unless a person experiences an unusually high and frequent exposure. Mercury in soil at RRR was not found to pose a health concern.

II. Purpose and Health Issues

The Superfund Health Investigation and Education (SHINE) Program prepared this Public Health Assessment (PHA) to evaluate the human health risk from potential exposure to contaminants in mine tailings used to construct Red Rock Road (RRR). SHINE is part of the Oregon Department of Human Services (DHS) Public Health Division and evaluates the human health risks of exposure to environmental contaminants in Oregon through a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR).

RRR runs partially through the town of Sutherlin in Douglas County, Oregon. It is a mixed-use road with areas used by the public for recreation. Other parts of the road are privately owned and used as driveways for private residences, or are covered in vegetation making them less accessible. RRR was constructed with mine tailings from Bonanza Mine. These tailings are now known to contain elevated levels of Arsenic and Mercury. The purpose of this health assessment is to evaluate whether exposures to elevated levels of arsenic and mercury in the soil at RRR pose a health risk for residents living near the road and people who use the road for recreational purposes.

III. Background

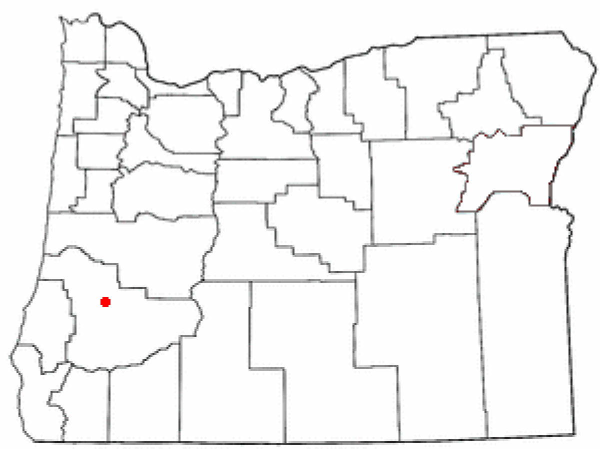
SHINE learned of this site while investigating the health risks posed by mine tailings for residents living at the Bonanza mine, located six miles east of Sutherlin. When SHINE became aware that these tailings were also used in the construction of RRR, it was determined that an additional assessment was needed to evaluate the health risks related to the road.

III.A. Site History

RRR extends east from the town of Sutherlin, which is located in Douglas County, Oregon (Figures 1 & 2). According to the 2000 census, the town of Sutherlin has a population of 6,669 but many additional residents live scattered throughout rural areas in Sutherlin Valley in the direction of RRR. The area is rural and the climate is semi-arid. Approximately 1654 people live within one-mile of RRR [1].

In 1865, rich deposits of cinnabar, metacinnabar, and other forms of mercury were found six miles east of Sutherlin at the site now known as Bonanza Mine [2]. The discovery resulted in the development of a large mercury mining and smelting operation. By 1940 it became the second largest producer of quicksilver in the United States. The mine shut down operations in 1960 and has been inactive since then. In 2000, DEQ removed highly contaminated tailings and soil from portions of the Bonanza Mine property [3].

Figure 1. Map of Oregon Showing the location of Sutherlin within Douglas County.



In the early 1900s, tailings from Bonanza Mine were used to construct a 17-mile railroad grade near Sutherlin, named Red Rock Road (RRR) because of the red color of the soil. RRR road borders Calapooya Creek on the east end and Sutherlin Creek on the west end. The mine tailings were also used in the construction of two reservoirs outside of Sutherlin known as Plat I and Cooper Creek [4].

RRR was purchased by Weyerhaeuser in the 1940s and was used for logging purposes [5]. The railroad was shut down in 1966 at which time Weyerhaeuser began to sell sections of the road to private landowners and the city of Sutherlin. Today, Weyerhaeuser owns 8 short parcels along the road totaling 2.6 miles of the original 17-mile road. The remaining sections of the road are both privately and publicly owned with sections that are inaccessible to the public.

Mine tailings are exposed at some sections of the road; some have been capped with a gravel cover, and others are covered with vegetation. The heaviest use of the road appears to be where it is used as a driveway for access to a few residences and also near the town of Sutherlin where it serves as a recreational path.

SHINE visited the site in July of 2005 along with Weyerhaeuser's contractor and an Environmental Health Specialist from Douglas County Health Department, both familiar with the history of RRR. Based on the information gathered during the site visit, SHINE determined that residents living near the road and recreational users were potentially exposed to the tailings and, therefore, are the focus of this evaluation. Several residents living in close proximity of the road use it as a driveway to their homes. There are areas known to be used for recreational purposes, and during the visit, SHINE observed children playing near the creek at the start of RRR in Sutherlin. Photos taken at sections where the original mine tailings are exposed at the surface taken during the site visit can be seen in Figures 3 – 6 on page 5.

Figure 2. Red Rock Road.

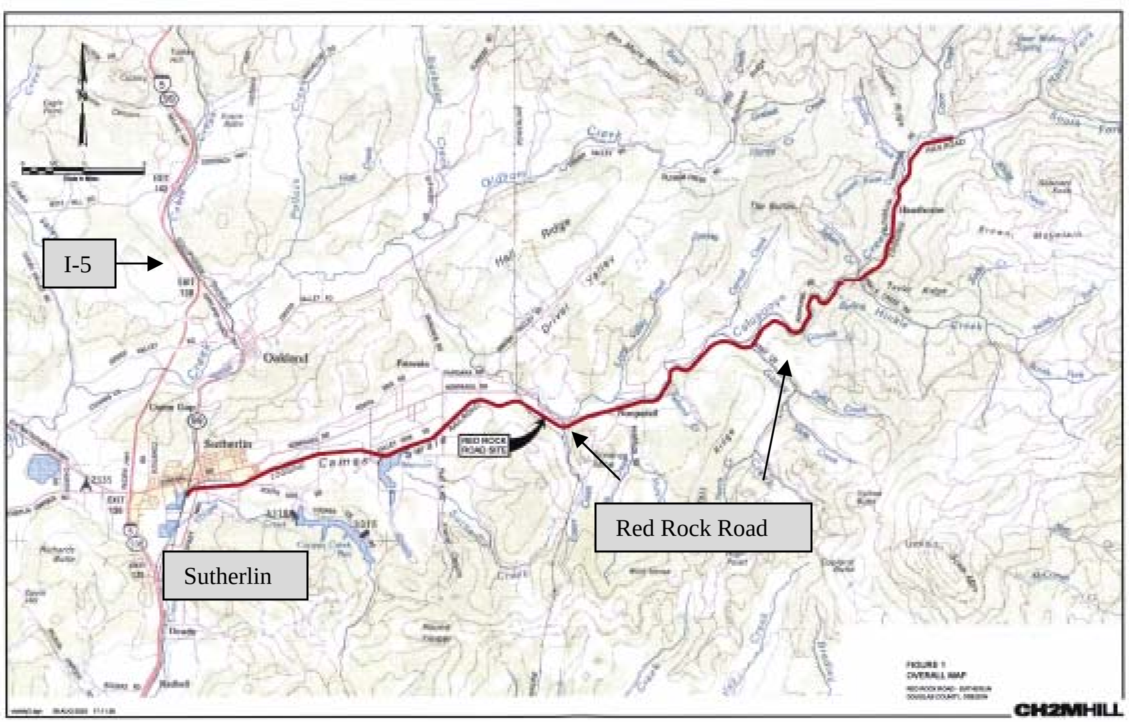


Image from: CH2M Hill's *Investigative Data Report and Human Health Risk Assessment*

III.B. Site Investigations

DEQ, EPA, and Weyerhaeuser have all been involved in activities related to RRR prior to this health assessment. In December 1995, the Oregon Department of Environmental Quality (DEQ) collected two samples from RRR in response to various complaints regarding concern about mine tailings being the source of the road material [4]. Additional sampling was conducted by DEQ between 1995 and 2004 around RRR and nearby creeks and reservoirs to characterize the media impacted by the use of mine tailings from Bonanza Mine throughout Sutherlin Valley. In 1998, the U.S. Environmental Protection Agency (EPA) conducted a site visit, and the Superfund Technical Assessment and Response Team (START) prepared a preliminary assessment for RRR [1]. Based on the findings of the previous investigations, Weyerhaeuser, as an owner of several sections encompassing portions of RRR, agreed to conduct additional site evaluations in cooperation with DEQ. CH2M Hill, a contractor for Weyerhaeuser, collected surface soil samples in August 2001 at various locations along the 17-mile stretch of RRR (Appendix A), and prepared a risk assessment and draft feasibility study (not yet finalized) for RRR [5, 6]. Appendix B provides a more thorough summary on EPA, DEQ, and Weyerhaeuser investigations to date.

III.C. Community Concerns

The primary concerns that community members have expressed regarding RRR are how it might affect their children's health. Sections of RRR run close to neighborhoods and are attractive places for children to play and ride bikes. Residents who have lived in the neighborhoods near RRR for more than 5 years are aware of the road being contaminated. They were told at one point not to let their children play on the road. One resident, whose youngest is 4 years old, said that he does his best when he's around to keep his children from playing on the road, but they probably play there when he's not around. Residents who have moved to this area of Sutherlin more recently may not know about the road being contaminated. One resident SHINE staff spoke with became aware of the contamination of the soil by a newspaper reporter this summer. It concerned her that she had been allowing her children to play on the road. She suggested that signs be posted to warn parents about letting their children play there. The residents we spoke with would like the area to be cleaned up so that their children can play there safely in the future.

The primary questions of concern regarding RRR appear to be:

- Are my children at danger from playing at RRR?
- Are there times of the year that are more dangerous for my child to play on the road?
- If my child digs underneath the gravel covering, will he/she be exposed to arsenic?
- Are the levels of arsenic changing? Are they higher or lower now than when samples were taken years ago?
- What can I do to reduce my exposure from contaminants present at RRR?

Figure 3. RRR used as a driveway – spotty gravel cap.

Figure 4. Privately owned section of RRR - no cap.

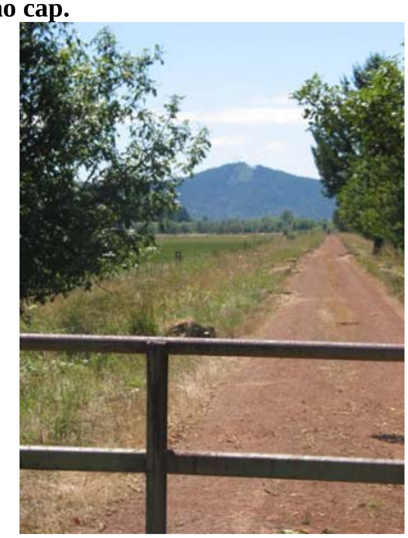


Figure 5. Plum tree along exposed section.

Figure 6. Tailings just under surface of light grass cover at a section located along a housing development.

IV. Discussion

This discussion describes the process used to assess whether contaminants in the tailings used to construct RRR pose a public health risk. This assessment was conducted for adults and children who live near the road (within 100 feet) and those who use it for recreational purposes. It includes a brief description of the environmental sampling conducted at the site, the selection of contaminants of concern, a toxicological review of the contaminants of concern, and an analysis of the pathways of human exposure to the contaminants of concern. The public health implications related to potential exposures were assessed by comparing exposure estimates to established health guidelines. A summary of the health assessment process can be found in Appendix C.

IV.A. Environmental Sampling

CH2M Hill collected soil samples at various locations along RRR in 2001 (Appendix A) [5]. They collected samples at depths ranging from zero to twelve inches below the surface. The data for samples collected at a depth between zero and six inches were used for this evaluation. Samples were collected at locations where original tailings used to construct the road was exposed and at locations where cover material was placed over the original tailings. The concentrations found at the locations where original tailings were exposed at the surface were used for the evaluation in this document.

A wide variety of metals were tested and a summary of the sampling results can be found in Table 1. The highest arsenic concentration was detected within the Sutherlin city limits and the highest mercury concentration was found east of Nonpareil Mine near Gassy Creek. Based on the given information, there does not appear to be a trend between sampling location and contaminant concentration. Background soil samples were also collected at ten locations within 50 to 100 feet from RRR. A summary of the background sampling results can also be found in Table 1.

The concentrations in soil in Table 1 are expressed as parts per million (ppm). One ppm is equivalent to one milligram (mg) of a substance per kilogram (kg) of soil, usually expressed as mg/kg.

Table 1. Summary of Soil Sampling Results [5].

Analyte	Number of Samples n	Number of Detections N	Mean Concentration [ppm]	Maximum Concentration [ppm]	Maximum Background Concentration [ppm]
Aluminum	10	10	32840.0	46400.0	35400
Antimony	20	13	15.9	33.0	0.73
Arsenic	20	20	131.9	233.0	**24**
Barium	20	20	59.7	398.0	342
Beryllium	20	11	0.6	1.1	0.83
Cadmium	20	15	0.8	1.4	0.23
Calcium	10	10	4224.4	17000.0	9280
Chromium	20	20	65.1	88.0	59
Cobalt	20	20	32.4	47.0	23
Copper	20	20	137.3	191.0	114
Iron	10	10	60140.0	73900.0	48200
Lead	20	19	14.2	53.0	51
Magnesium	10	10	4558.9	12000.0	6250
Manganese	20	20	759.8	1770.0	2490
Mercury	20	20	42.5	131.0	**0.59**
Nickel	20	20	72.0	93.0	40
Potassium	10	10	1092.9	1790.0	1650
Selenium	20	20	1.6	2.9	2
Sodium	10	3	1138.2	4750.0	-
Thallium	20	10	6.1	16.0	9.6
Vanadium	20	20	134.5	230.0	116
Zinc	20	20	107.5	170.0	121

IV.B. Contaminants of Concern

The contaminants of concern at RRR are arsenic and mercury. They were identified using the following criteria:

- Contaminant concentration,
- Comparison of maximum contaminant concentrations with background levels,
- And comparison of contaminant concentrations with health comparison values (CVs) and/or preliminary remediation goals (PRGs).

Appendix C summarizes the comparison of maximum concentrations of contaminants found in RRR with maximum background concentrations, CVs, and PRGs. Arsenic and mercury are highlighted in bold in the table. Arsenic and mercury exposure were only considered to be a concern in sections of the road where mine tailings are exposed at the surface. Areas with well-maintained gravel cover, dense vegetation, and asphalt were not evaluated further in this health consultation because it was assumed these sections of RRR do not pose a health concern. Limited sampling of areas with gravel showed maximum concentrations of arsenic and mercury at 37 ppm and 2.7 ppm respectively. These concentrations are significantly lower than the areas where the tailings were exposed at the surface which showed maximum concentrations of arsenic at 233 ppm and mercury at 131 ppm.

Mercury exists in the environment in elemental, inorganic, and organic forms and arsenic exists in organic and inorganic forms. These different forms, also known as species, move differently through the environment and can have different effects on humans. Analyzing a sample to identify the different forms of substance in a given media is known as speciation. Mercury and arsenic sample results used in this investigation have not been speciated. The primary forms of mercury found in the samples from RRR are assumed to be cinnabar (mercury sulfide) and metacinnabar based on the forms of mercury found in tailings at Bonanza Mine [7].

Arsenic is a natural component of the earth's crust. It can be found in both organic and inorganic forms and exists as many different compounds [8]. Trace amounts of arsenic exist in all foods, with the highest concentrations usually found in seafood [9]. Inorganic arsenic is released into the environment from human sources through smelting operations, mining, pesticide application, wood treatment, and chemical manufacturing [10]. The hazards posed by arsenic in soil depend on the type of arsenic present, the pathway of exposure, and the amount of exposure a person experiences.

Mercury is a metal that also exists naturally in the earth's crust and can be found in different forms throughout the environment – elemental, organic, and inorganic forms [11]. In aquatic environments, mercuric mercury is transformed into a stable organic compound known as methylmercury, which accumulates in fish tissue [8]. Mercury has many industrial uses that include mining, chemical, electrical, and medical applications [11].

IV.C. Pathway Analysis & Public Health Implications

Five elements of an exposure pathway were evaluated to determine whether people are being exposed to arsenic and mercury in the soil at RRR. If all the criteria are met for the five elements, then the exposure pathway is considered "completed". The five elements for a completed exposure pathway are listed below.

- A contaminant source or release
- A way for the chemical to move through the environment to a point of exposure
- Exposure point or area
- Route of exposure or a way for the contaminant to reach a population
- A population that comes in contact with the contaminant

<u>Completed Exposure Pathways</u>

The significant, completed exposure pathways of exposure at RRR are incidental ingestion of soil and inhalation of contaminated dust from the road. The public health implications of exposure to arsenic and mercury from these pathways will be evaluated further in this document for both residents living adjacent to the road and recreational users of the road. Exposures will be estimated for young children, older children, and adults. Exposure estimates will only be calculated for areas along the road where the original tailings are exposed and not at locations that have a gravel cover, a dense vegetation cover, or an asphalt cover.

Although dermal contact, or skin contact, with contaminated soil is a completed pathway at RRR, it is not considered a pathway of concern and will not be evaluated further. Dermal absorption of arsenic from soil is minimal [9] and is not a concern at RRR. Dermal absorption of inorganic mercury can occur for people who come in contact with elevated levels of mercury in soil but it is only a fraction of the amount absorbed after inhalation of inorganic mercury [11] and is also not a pathway of concern at RRR. Skin irritation from contact with contaminants in soil at RRR is also not expected to be a health concern.

<u>Potential Exposure Pathways</u>

Inhalation of mercury vapors from mercury in soil at RRR is a potential completed pathway of concern at RRR but will not be evaluated further in this document due to a lack of data. This pathway was determined to be the primary exposure pathway of concern at Bonanza Mine but the maximum mercury concentration there was 5100 ppm in soil versus 131 ppm at RRR. Mercury would not be expected to emit mercury vapor at concentrations that would pose a health risk based on concentrations in soil at RRR [6].

Another potential pathway of exposure at RRR is ingestion of dusts on produce grown in gardens adjacent to the site or on fruit grown on trees growing along the road. There is also a possibility that arsenic or mercury could be taken up into produce grown in contaminated soil. However, intake of arsenic and mercury from home-grown vegetables is believed to be a minimal risk and within the a normal dietary range [12, 13]. This pathway will not be evaluated in this investigation due to a lack of data.

Cancer and Non-Cancer Risk Evaluation for Completed Exposure Pathways
Exposure estimates for the contaminants of concern were calculated and compared to non-cancer health guidelines to evaluate non-cancer risk (see Appendix C). Cancer risk was evaluated by comparing site-specific cancer risks to accepted cancer risks. The health guidelines for non-cancer referred to in this document are ATSDR's minimal risk level (MRL) and EPA's reference dose (RfD). Site-specific exposure estimates were used to calculate the maximum increase in risk of developing cancer after 70 years of exposure to the contaminant. Generally speaking, the acceptable cancer risk for a single carcinogen at a site is a risk of one additional cancer case in a million people (1/1,000,000). If the cancer risk is five additional cancer cases per one million (5/1,000,000) for a given site, then there is considered to be an elevated cancer risk from exposure to a particular contaminant. On the other hand, if the cancer risk is one additional cancer case in five million (1/5,000,000), the cancer risk would be considered acceptable. The exposure estimates, calculations, and health guidelines used to evaluate the public health impacts of arsenic and mercury at RRR for residential and recreation scenarios are listed in Appendix D.

IV.C.1. Incidental Ingestion of Soil

The estimated exposure calculation for incidental ingestion assumed that a young child, less than five-years-old weighs 15 kg and ingests 200 mg of soil per day over a five-year period. An older child less than 12-years-old was assumed to weigh 41 kg and ingests 200 mg of soil per day for a 10-year period. An adult was assumed to weigh 70 kg and ingests 100 mg of soil per day over a 30-year period. See Appendix D for sources of exposure factors.

Arsenic

In this evaluation, the bioavailability from incidental ingestion of arsenic in soil at RRR was assumed to be 80% because it is protective of health and is consistent with the percentage used by SHINE in other health assessments including at Bonanza Mine [7, 14, 15]. CH2M Hill used a bioavailability of 3% for incidental ingestion in their Risk Assessment for Red Rock Road. Their percentage of 3% was derived from the *in vitro*, "Physiologically-Based Extraction Test," used to estimate the fraction of arsenic in soil that is available for uptake into the human body. SHINE determined that a bioavailability of 3% was not reasonably protective of health because there is a lack of standardization for *in vitro* (as well as *in vivo*) methods, such as the one used by CH2M Hill. Many studies indicate that arsenic in soil is much less soluble than arsenic in drinking water [16]. Therefore, arsenic in soil has considerably less than 100% bioavailability. However, in order to be health protective, it is important that bioavailability of arsenic in soil not be underestimated [15]. DEQ supports SHINE's use of 80% bioavailability and they indicated that they plan to update their risk calculations for RRR based on this value.

The estimated exposures for ingestion of arsenic in soil from RRR for young children and older children that live along RRR exceed the ATSDR chronic oral minimal risk level (MRL) of 0.0003 milligrams arsenic per kilogram body weight per day (mg/kg/day) (Table 2). The MRL is the daily dose that is not expected to result in any non-cancer adverse effects over a lifetime of exposure. Therefore, maximum arsenic concentrations found at RRR pose an increased risk for non-cancer health effects from incidental ingestion among younger and older children who live on or along (within 100 feet) RRR and younger children who use the road for recreational purposes. Incidental ingestion of arsenic at RRR does not pose a non-cancer health risk for adults who either live along the road or use it for recreational purposes, nor for older children who only use the road for recreational purposes.

The calculations also indicate there is an elevated cancer risk for young children, older children, and adults that live along RRR as well as those who use the road for recreational purposes (Table 3). All calculations for excess lifetime cancer risk were above the acceptable risk of one excess cancer per one million people (1/1,000,000). Because the exposure assumptions are meant to be protective of health and the cancer slope factors are developed to also be protective of health, the ingestion of small amount of soil from RRR are not expected to result in cancer. A cancer risk of excess cancer cases at a rate of one in 10,000 people is considered low and a risk of excess cancer cases per 1,000,000 people is considered a negligible risk.

Arsenic is associated with both cancer and non-cancer health effects [17]. Symptoms of a high dose acute arsenic exposure, from a poisoning for example, can include fever, cardiac arrhythmia, enlargement of the liver, respiratory symptoms, gastroenteritis, and loss of appetite. Arsenic has also been linked with increased risk of high blood pressure and diabetes [17]. Long-term exposure to arsenic in drinking water at concentrations over 50 parts per billion (ppb) has been associated with skin, lung, and bladder cancer. Hyperpigmentation, or darkening of the skin, has been observed at daily doses of 0.01 mg/kg/day over an exposure period of five to 15 years. The daily doses calculated for individuals exposed to arsenic at RRR are all less than 0.01 mg/kg/day.

Although there is an increased health risk from ingestion of arsenic-contaminated soil along RRR, adverse health effects are not expected in exposed individuals unless a person experiences an unusually high and frequent exposure.

Mercury

The toxicity of mercury is dependent on the form of mercury to which an individual is exposed as well as the route of their exposure [11]. The primary health concern related to chronic mercury exposure is its effect on the nervous system [8]. Mercury sulfide found in soil at RRR is insoluble, is poorly absorbed by the gut and likely eliminated by the body unchanged. Mercury is not a known carcinogen. There is not a well-defined estimate for the bioavailability of mercury sulfide but it is considered to be less bioavailable than mercury chloride, with a bioavailability range of 10-30% demonstrated in animal studies [11]. A value of 10% bioavailability was used for ingestion of soil containing mercury at RRR.

Estimated exposures for incidental ingestion of mercury in soil from RRR for young children, older children, and adults were less than EPA's chronic oral reference dose (RfD) of 0.0003 mg/kg/day (this is the RfD for mercuric chloride because no value was available for mercuric sulfide) (Table 2). Incidental ingestion of mercury at RRR is not expected to result in any adverse health effects for both residents living along the road and recreational users of the road.

Table 2. Estimated daily doses/intakes for residential and recreational scenarios for non-cancer endpoints expressed in mg/kg/day.*

Scenario	Young Child	Older Child	Adult
RECREATIONAL USERS			
Incidental Ingestion$_{Arsenic}$	**0.00061**	0.00023	0.00007
Incidental Ingestion$_{Mercury}$	0.00004	0.00002	0.00000
Inhalation$_{Arsenic}$	0.00000	0.00000	0.00000
Inhalation$_{Mercury}$	0.00000	0.00000	0.00000
RESIDENTS			
Incidental Ingestion$_{Arsenic}$	**0.00238**	**0.00087**	0.00026
Incidental Ingestion$_{Mercury}$	0.00017	0.00006	0.00002
Inhalation$_{Arsenic}$	0.00001	0.00000	0.00000
Inhalation$_{Mercury}$	0.00000	0.00000	0.00000

*Items in bold exceed the MRL

Table 3. Calculated increased cancer risk for residential and recreational scenarios.

Scenario	Young Child	Older Child	Adult
RECREATIONAL USERS			
Incidental Ingestion$_{Arsenic}$	**7.88E-05**	**4.92E-05**	**4.22E-05**
Inhalation$_{Arsenic}$	1.22E-07	1.28E-07	3.14E-07
RESIDENTS			
Incidental Ingestion$_{Arsenic}$	**3.06E-04**	**1.92E-04**	**1.64E-04**
Inhalation$_{Arsenic}$	8.42E-07	8.88E-07	**2.17E-06**

*Items in bold exceed are above the acceptable lifetime cancer risk of 1 excess case per one million people (1.00E-06)

IV.C.2. Inhalation of Airborne Dust

Both arsenic and mercury can be adsorbed to soil particles and when disturbed, the smaller diameter particles can be released into the air and inhaled into the lungs. The fraction of dust that is inhaled deep enough into the lungs and absorbed into the body is largely dependent on particulate size. Airborne soil generally consists of larger particles that won't penetrate deep into the lungs. A lot of dust is created when soil at RRR is disturbed and the respirable fraction of that dust could potentially be inhaled deep into the lungs, particularly at locations where vehicles drive on the road.

The bioavailability of mercury and arsenic absorbed to respirable particles was assumed to be 100%. This is consistent with the percentage used in CH2M Hill's risk assessment [5]. Inhalation rates were 8.3, 14, and 20 m^3/day for young children, older children, and adults respectively. A model was used to generate a particulate emission factor (PEF) that is used to convert a soil chemical concentration to a concentration of respirable particles emitted from soil at RRR [5]. The PEF generated for RRR is $5.3 * 10^{-8}$ kg/m^3 and was based on the dust that would be emitted by 10 vehicles that use portions of RRR every day.

There is not an increased non-cancer and cancer risk from inhalation of dust from RRR containing arsenic or mercury for people of all ages that either live on or along the road or use it for recreational purposes (Tables 2 & 3). Adults who live on or along the road were the only group that had a slightly increased cancer risk of 2.2 excess cancer cases per one million ($2.2x10^{-6}$) people over the commonly accepted risk guideline of one excess cancer case per one million people ($1x10^{-6}$). Since excess cancer risk for adults who live on or along Red Rock Road is just slightly above the acceptable health risk, a health protective guideline, and is therefore not considered to be a health concern at this site.

IV.C.3. Other Potential Sources of Arsenic and Mercury Exposure in the Sutherlin Valley

The Sutherlin Valley is known to contain naturally high concentrations of arsenic in soil and bedrock [18]. Arsenic is found at elevated levels in groundwater throughout Southern Oregon [4] as well as other locations throughout the western U.S. Two drinking water investigations were conducted by the Douglas County Health Department in the 1970's because of concerns about the naturally elevated concentrations in private drinking water wells. 21% of all drinking water wells in Douglas County were tested (over 900 samples collected). Groundwater located west of Roseburg appeared to contain little or no arsenic. The highest concentration detected during the investigations was 375 ug/L, equivalent to 375 parts per billion (ppb). 118 samples from the second investigation were in the range of 10 to 40 ppb and 16 samples were over 50 ppb. The 16 samples over 50 ppb represented seven different wells, six of which were located within the same area east of the city of Sutherlin. It is unknown whether those wells are near RRR. The areas with elevated arsenic levels were found to be located near mercury mine sites but groundwater in the area does not appear to be impacted by RRR. Testing by CH2M Hill did not show evidence of arsenic leaching from RRR into groundwater.

In 2002 EPA adopted a maximum contaminant level (MCL) for arsenic in drinking water of 10 ppb. Prior to 2002, the MCL was 50 ppb. It is possible that some residents in the Sutherlin Valley and other part of Douglas County still consume drinking water from wells with arsenic concentrations above 10ppb, the current MCL, and even above 50 ppb, EPA's old MCL.

Other potential sources of arsenic and mercury exposure in the Sutherlin Valley are Plat I and Cooper Creek Reservoirs. It was previously mentioned in this document that mine tailings from Bonanza Mine were used in the construction of two reservoirs and fish caught in these reservoirs contain elevated levels of mercury. Fish advisories have been issued at both of these reservoirs warning the public against consuming fish because they may be contaminated with elevated levels of mercury.

IV.C.4. Limitations

A limitation of the calculation of incidental ingestion is the determination of an appropriate value for arsenic bioavailability. The uptake of and health impact from ingestion of inorganic mercury is less influenced by media type than the impact of various media on the uptake and health impacts from ingestion of inorganic arsenic. Bioavailability is influenced by the form of the contaminant present, the media the contaminant is dissolved in or absorbed to, and site-specific conditions such as moisture and organic content [19]. When evaluating public health impacts of exposure to contaminants at a site, it is better to overestimate bioavailability than underestimate bioavailability in order to be protective of health.

Another limitation is the use of a particulate emission factor (PEF) to estimate the concentration of arsenic present in respirable particles emitted by soil at RRR. This model only provides an estimate of a concentration based on various assumptions. It would be more accurate to conduct air sampling while simulating a typical site activity when determining the concentration of a contaminant that is available through inhalation of respirable particles.

There are several limitations to consider when calculating and evaluating cancer risk. The actual risk of cancer is probably lower than the calculated number. The method used to calculate EPA's Cancer Slope Factor assumes that high-dose animal data can be used to estimate the risk for low dose exposures in humans. The method also assumes that there is no safe level for exposure. Little experimental evidence exists to confirm or refute those two assumptions. Lastly, the method computes the 95% upper bound for the risk, rather than the average risk, suggesting that the cancer risk is actually lower, perhaps by several orders of magnitude.

V. Children's Health Considerations

SHINE and ATSDR recognize that infants and children may be more vulnerable to exposures than adults in communities faced with contamination of their air, water, soil, or food. This vulnerability is a result of the following factors:

- Children are more likely to play outdoors and bring food into contaminated areas.
- Children are shorter, resulting in a greater likelihood to breathe dust, soil, and heavy vapors close to the ground.
- Children are smaller, resulting in higher doses of chemical exposure per body weight.
- The developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages.

Because children depend on adults for risk identification and management decisions, ATSDR is committed to evaluating their special interests at sites such as RRR where their behaviors or sensitivity to contaminants could put them at great risk. Since children have a greater hand-to-mouth tendency and they may spend a significant amount of time digging and playing in soil, their activity along RRR should be monitored by an adult to minimize exposures to contaminated soils. There is no indication that children have a heightened biological sensitivity to arsenic exposure over adults [17] but some children between the age of four months and four years of age may have a heightened sensitivity to mercury [20]. This is known as acrodynia or pink disease that results in a pink rash that begins in the fingers and toes [21]. Other symptoms may also include, listlessness irritability, sleeplessness, intolerance to light, and excessive perspiration. It is unknown whether any children exposed to soil at RRR could experience acrodynia but it is unlikely to result from exposure to mercury-contaminated soil from RRR.

VI. Conclusions

Where original tailings are exposed at the surface (this includes areas where tailings are only covered by light grass or other vegetation or where capping is wearing away), incidental ingestion exposure estimates for arsenic-contaminated soil at RRR indicate that the exposure levels could result in health effects in people exposed over a long period of time for the following scenarios:

- Non-cancer health effects among younger (less than 5-years-old) and older children (less than 12-years-old) who live on or along (within 100 feet) RRR;
- Increased cancer risk among young children, older children, and adults that live along RRR or who use it for recreational purposes.

Although there is an increased risk from ingestion of arsenic-contaminated soil along RRR, adverse health effects are not expected in exposed individuals unless a person experiences an unusually high and frequent exposure.

There is no apparent public health hazard from exposure to soil at RRR where original tailings are exposed at the surface for the following scenarios:

- Incidental ingestion of arsenic-contaminated soil regarding non-cancer health risks for adults who either live along the road or use it for recreational purposes, and for older children who only use the road for recreational purposes;
- Incidental ingestion of mercury at RRR for both residents living along the road and recreational users of the road;

- Inhalation of arsenic and mercury-contaminated dust from particulates emitted from RRR.

Areas along RRR where gravel cover, dense vegetative cover, or asphalt capping are well maintained also pose no apparent public health hazard.

It is possible that some residents in the Sutherlin Valley are still consuming drinking water from wells with naturally elevated arsenic concentrations above the MCL and even above 50 ppb that could present a health risk.

VII. Recommendations

SHINE recommends that remediation and/or capping technologies be applied along RRR where tailings are exposed at the surface, or where capping is wearing away. This is especially crucial at locations where people live on the road or use it as a driveway. At locations where vehicles use the road, capping must be durable enough to withstand the erosion caused by, and dusts emitted from vehicles. The appropriate technology should be based on feasibility as well as community needs. SHINE also recommends that residents avoid areas of Red Rock Road where mine tailings are exposed at the surface until adequate remediation actions are completed. These areas appear reddish in color and even when lightly covered by vegetation contain higher levels of arsenic-contaminated soil.

It is recommended that residents with private drinking water wells who live in the Sutherlin Valley test their drinking water for arsenic (please refer to resources listed below about arsenic in drinking water).

Resources for private well water testing:
If residents of Sutherlin or Douglas County have questions specifically related to testing their drinking water, please contact Terry Westfall with the Douglas County Health Department (541-440-3569) or SHINE (503-731-4025).

EPA’s Arsenic in Drinking Water Website:
http://www.epa.gov/safewater/arsenic/basicinformation.html

EPA’s Private Drinking Water Wells Website:
http://www.epa.gov/safewater/privatewells/index2.html

DEQ Drinking Water Protection Program – Private Well Owners Frequently Asked Questions:
http://www.deq.state.or.us/WQ/dwp/dwppwofaqs.htm

VIII. Public Health Action Plan

The Public Health Action Plan ensures that the public health consultation identifies public health risks along with providing a plan of action designed to reduce and prevent adverse health effects from exposure to hazardous substances in the environment. This plan includes a description of actions that will be taken by SHINE in collaboration with other agencies to pursue the implementation of the recommendations outlined in this document.

In 2003, SHINE prepared an initial health consultation to evaluate public health risks related to mine tailings for residents living at Bonanza Mine. In that document, it was determined that additional data should be collected to evaluate the residents' risk of exposure to arsenic and mercury in soil following DEQ remedial actions at the site in 2000. Since there was limited environmental data following the cleanup, SHINE collected urine samples from residents living at the mine site to characterize exposure. SHINE prepared a second health consultation in 2004 based on the sampling results and determined that the site did not pose a public health risk to the residents. It is unknown at this time whether the difference in the findings from the previous health consultation for Bonanza Mine and the current determination for RRR may be due to the fact that contaminated soil had already been removed from the Bonanza Mine property prior to SHINE's investigation. Despite this possibility, the investigation at Bonanza Mine was limited in scope and the public health risk posed by mine tailings at the site may be revisited in the future.

SHINE visited RRR in July of 2005 along with Weyerhaeuser's contractor and an Environmental Health Specialist from Douglas County Health Department. Following the release of this health assessment, SHINE plans to hold a community meeting to discuss the findings.

Future work in and around RRR will include:

- Informing residents about risk reducing behaviors to protect against exposure to arsenic contamination at RRR;
- Conducting outreach activities to encourage residents in the Sutherlin Valley to monitor their drinking water for arsenic; and
- Working with agency and community partners to promote remedial technologies that are health protective.

IX. Site Team

Oregon Department of Human Services
Superfund Health Investigation & Education (SHINE) program team

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XI. Response to Comments

The public comment of the draft version of Red Rock Road Health Assessment was open from October 10, 2006 to December 11, 2006. SHINE received comments from two different stakeholders. Comments pertaining to this health assessment report are addressed below.

Comment 1
SHINE's assessment of the mercury and arsenic contamination in Red Rock Road (RRR) should be considered very limited due to the fact that so much is still unknown and/or controversial among experts and the general public regarding what are safe and dangerous levels for arsenic and mercury. The assessment is also limited because the data for the mercury contamination in RRR was provided by only one source, which was a contractor employed by Weyerhaeuser.

Response 1
SHINE appreciates your comment. It is true that there are uncertainties about the levels of arsenic and mercury found in the environment that will cause harm. The health assessment process used by SHINE and ATSDR is based on a weight-of-evidence approach; it is designed to make a determination about health risks with the available environmental data and toxicological information for the chemicals we are evaluating. It is also very common that a contractor hired by a responsible party collects data for sites such as Red Rock Road. Contractors hired by businesses are expected to maintain the same data standards as those expected of universities or government for the collection and analysis of samples and generation of data.

Comment 2
SHINE's recommendations, regarding the arsenic contamination in RRR, for remediation technology and/or capping for certain portions of RRR and for public avoidance or certain areas of RRR until the arsenic health risk has been resolved, should be followed.

Response 2
SHINE appreciates your comment.

Comment 3
[Commenter] does not agree with SHINE's finding, as expressed in the Executive Summary, that mercury in the soil in RRR does not pose a health concern. Regardless of whether or not they should have health concerns, the fact that there is mercury and arsenic in RRR will pose concerns for some people.

Response 3
SHINE acknowledges that some people may still feel concerned about mercury in soil from RRR. Although people may still have concerns, it is important to consider that the science about the absorption and health affects of different types of mercury is well understood. The type of mercury found at RRR, an inorganic compound, is not well absorbed by the body either by skin contact of inhalation and therefore poses less of a

health risk than other types of mercury. The vapors from elemental mercury can be inhaled and it is a form more readily absorbed into the body through the lungs than the inorganic forms.

Comment 4

SHINE's statement on page 1 that the tailings in RRR are now known to contain elevated levels of arsenic and mercury poses a health concern with some people. A DEQ staff person stated that the stuff in the road (RRR) is two to four times health based levels for residential exposure. The DEQ fact sheet from December, 2000, states that mercury and arsenic contamination along RRR are at concentrations that exceed safe levels for residential exposures.

Response 4

SHINE agrees that the levels of arsenic and mercury are present at levels above background levels for most of the Sutherlin Valley and are elevated above those acceptable for residential exposures. It is also worth noting that the levels used to designate whether these compounds are elevated are designed to be protective of human health and are generally above levels where health effects have been observed in the scientific literature.

Comment 5

SHINE stated that there was a possibility of mercury contamination on, or in produce grown along RRR, but was not evaluated due to lack of air data. Perhaps it would be worthwhile to follow up on this, along with the fact that there is some irrigation from Plat I Reservoir.

Response 5

Although SHINE did not evaluate this pathway of exposure due to a lack of data, we do not expect that arsenic and mercury potentially taken up into produce that is grown along RRR would concentrate at levels above the normal dietary range (p.8, last paragraph). Different forms of arsenic and mercury are commonly found in the food supply. Additionally, memorandums from DEQ and CH2M Hill in 2003 state that the risks from arsenic and mercury taken up into produce grown in soils along RRR would be low (see Appendix F in the *Investigation Data Report and Human Health Risk Assessment* prepared for Weyerhaeuser by CH2M Hill).

Comment 6

SHINE's assessment states that mercury is not a known carcinogen. Because of the unknown, you should have also stated that it also has not yet been proven that mercury <u>is not</u> a carcinogen.

Response 6

There is enough scientific information to determine that mercury is not likely to be carcinogenic. The understanding of a chemical's carcinogenicity is usually based on laboratory assays or animal studies. Mercury is a chemical that has not ever been shown to be a carcinogen in these studies. There have also been several epidemiological (human) studies on mercury and none of these have indicated that it is carcinogenic. Methyl mercury and elemental mercury are known to cause neurological and developmental affects at levels above those found for inorganic mercury at RRR.

Comment 7
[Commenter] thinks DEQ should push Weyerhaeuser to complete and present the finalized risk assessment and feasibility study for RRR because they have had enough time to complete these documents.

Response 7
SHINE will inform DEQ of this comment.

Comment 8
[Commenter] understands the City of Sutherlin is considering the possibility of converting a portion of RRR into a main street to help relieve a very serious traffic flow problem. If RRR is used, then proper measures should be taken to deal with the construction and arsenic and mercury contamination in RRR.

Response 8
SHINE agrees with this comment.

Comment 9
SHINE collected urine samples to characterize exposure to mercury and arsenic. [Commenter] believes SHINE should also have collected blood, hair, and nail samples. SHINE should have also assessed and presented an explanation for the data that show maximum mercury contamination at the Bonanza Mine at 5100 ppm in soil versus 131 ppm at RRR.

Response 9
The urine analysis was conducted for an investigation at Bonanza Mine. Biological monitoring for Red Rock Road was not warranted based on the arsenic and mercury concentrations found at RRR.

In terms of the difference in mercury concentrations in soil at Bonanza Mine versus the soil at RRR, please see the last sentence of comment 13 for a possible explanation of why such a difference exists.

Comment 10
SHINE has no regulatory authority to specify cleanup options for any contaminated site in Oregon. DEQ holds the delegated Federal authority for determining the need for remedial action and deciding what specific type of risk-management option(s) may be needed, based on feasibility and cost. Given SHINE's lack of regulatory authority, it is inappropriate for SHINE to recommend a specific remedial action, but only to identify that some means of limiting exposure should be evaluated (which could include institutional controls).

Response 10
SHINE recommended that the exposure pathway be interrupted, and provided the kind of remedial options that would accomplish this recommendation. This is directly in line with SHINE's responsibilities. Through a cooperative agreement program funded by the Agency for Toxic Substances and Disease Registry (ATSDR), SHINE carries out ATSDR's work at the state level in Oregon. This work includes making recommendations that protect public health. Although SHINE does not have the authority to enforce their recommendations, they may indicate to environmental agency partners the type of cleanup option that is most protective for public health.

Comment 11

[Commenter] has worked cooperatively with DEQ to complete a feasibility study for the site. This study identifies and evaluates various remedial technology alternatives. [Commenter] requests that SHINE remove any references to specific remedial actions from their report on RRR.

Response 11
SHINE appreciates your comment but will still maintain references to remedial options in the report.

Comment 12
[Commenter] urges Oregon DEQ and SHINE to develop an interagency Memorandum of Understanding to define each organization's regulatory roles and responsibilities and establish rules of engagement for interactions with responsible parties and the public.

Response 12
Thank you for your suggestion. SHINE and DEQ have worked, and continue to work, in a very collaborative manner at numerous sites. An umbrella MOU was developed between the Oregon Public Health Division and DEQ in 2004 to foster effective collaboration between the agencies. The ATSDR cooperative program in Oregon, referred to as SHINE , is currently developing a more specific MOU with the DEQ clean-up program.

Comment 13
The distinction between the materials used to construct Red Rock Road, which were processed tailings, versus untreated "tailings" should be noted in the report. A clarification should be added to the paragraph, "In the early 1900s...," at the bottom of page 2. The materials used at RRR that went through a roasting process in a retort which should have served to minimize some of the variability regarding the forms (hence bioavailability) of mercury and arsenic in the road materials. The higher mercury concentrations seen at the Bonanza mine site (as mentioned on page 8) likely reflect unretorted mine tailings.

It should also be noted that levels in the Sutherlin background soil exceed background levels found in most other areas of the state. It should also be noted that these levels also exceed acceptable risk levels.

Response 13
Your comment has been noted. SHINE listed the background levels around the Sutherlin area in the report in Table 1 on page 6.

Comment 14
Page 5, Section IV – should change all tenses throughout report to past tense

Response 14
SHINE appreciates your comment and made the suggested change when applicable.

Comment 15
Page 6 – "Grassy Creek" likely refers to "Gassy Creek"

Response 15
The change to Gassy Creek has been made (p.6, second paragraph).

Comment 16
[Commenter] agrees that the hazards posed by arsenic in soil depend on the mineral form of arsenic present. The inability of the body to absorb insoluble forms of soil-bound arsenic should be considered in evaluating the cancer risk posed by arsenic. SHINE's default assumption around arsenic bioavailability yields an inappropriately conservative risk estimate and should be modified to reflect the currently emerging science around bioavailability.

Based on results of sequential extraction testing of RRR soils, the appropriate value for arsenic availability is low. The 80% values used by SHINE is 24 times higher than the 3.3 value suggested by the test results as being appropriate. Although SHINE's overestimation may be protective of health, it is not realistic for the RRR site when site specific data are available.

Response 16
For this assessment, SHINE thought it was most appropriate to take a conservative approach for arsenic given the uncertainties about its bioavailability and distribution of the different forms in the body. It is also consistent with what has been used at other SHINE sites, by colleagues in Washington, and at ATSDR (they often use 100% bioavailability for arsenic). SHINE can revisit the selection of 80% arsenic bioavailability used in this assessment at a later date if an appropriate study is conducted for the primary forms of arsenic found at RRR which adequately accounts for the complex distribution of arsenic in the body. If this information becomes available, the oral exposure estimates in this assessment may be re-evaluated if the bioavailability estimates will significantly alter SHINE's conclusions and recommendations.

Comment 17
The report should segregate the toxicity assessment information from the actual risk characterization from RRR. A common reader is likely to misconstrue statements such as, "*Ingestion of large doses of arsenic from acute exposure can be fatal,"* (page 10, paragraph 3), that refer to materials found in RRR as acutely toxic.

Response 17
SHINE recognizes that it can be difficult for readers to understand the difference in risks due to large dose exposures such as poisonings, from lower, environmental exposures. The sentence that states, "Ingestion of large doses of arsenic from acute exposure can be fatal," has been removed from the third paragraph on page 10. The other information in that paragraph will remain in the document. SHINE's health assessment process outlines a requirement to discuss associated health effects with chemicals of concern and the likelihood that exposed individuals could experience those effects given their exposure levels at sites.

Comment 18
SHINE acknowledges that the toxicity of arsenic and mercury are dependent on the forms to which an individual is exposed. SHINE specifically recognizes that the low bioavailability of mercury is based on its low solubility. The same should be true for arsenic. However, the calculated ingestion risk for mercury is based on the low end of the literature values for mercury bioavailability (10%), but the calculated ingestion risk for arsenic is based on a seemingly arbitrary high relative bioavailability (80%).

Response 18
After review of the scientific literature, SHINE concluded that at this time, the scientific information about the bioavailability and absorption of elemental and inorganic mercury is better understood and contains less uncertainty than the scientific information about how different types of arsenic compounds are absorbed and distributed in the body. The choice to use 10% bioavailability for mercury is based on animal studies which show that mercuric sulfide, the primary form of mercury at RRR, is less bioavailable than mercuric chloride (p.164), which has well established range of 10 to 30% bioavailability in animal studies [1].

Please see the response to comment 16 about SHINE's approach for arsenic bioavailability in this assessment.

Comment 19
Page 11, bottom of page – "Both arsenic and mercury can be absorbed" should be changed to "Both arsenic and mercury can be adsorbed."

Response 19
Thank you for this recommended correction. This sentence has moved to the top of page 12 and now reads: "Both arsenic and mercury can be adsorbed to soil particles…."

Comment 20
Page 12, paragraph 4 – Shouldn't the units for groundwater be ug/L rather than ug/kg where the document states, "The highest concentration detected during the investigation was 375 ug/kg…"

Response 20
Thank you for pointing this out. The concentration has been changed to 375 ug/L.

Comment 21

Page 14, Conclusions Section, Paragraph 1 states – "…incidental ingestion of arsenic-contaminated soil at RRR is occurring at levels that could result in health effects in people exposed over a long period of time."

This statement implies that hazardous exposures at RRR are a certainty, whereas exposure estimates used are based on hypothetical and conservative assumptions. [Commenter] suggests changing this sentence to, "calculations of incidental ingestion exposure from arsenic-contaminated soil at RRR indicate estimated intake at levels that could result in health effects in people exposure over a long period of time may theoretically be occurring."

Response 21
This first sentence of the "Conclusions" section on page 14 now reads, "….incidental ingestion exposure estimates for arsenic-contaminated soil at RRR indicate that the exposure levels could result in health effects in people exposed over a long period of time for the following scenarios:…"

Comment 22
[Commenter] suggests changing the paragraph 3 on page 15 to read: "SHINE recommends that measures be taken to minimize unacceptable exposure from areas along RRR where tailings are exposed at the surface, or where capping is wearing away. This is especially crucial at locations where people live on the road or use it as a driveway, or at locations where vehicles use the road. The appropriate mitigation should be based on feasibility as well as community needs. SHINE also recommends that residents avoid areas of Red Rock Road where mine tailings are exposed at the surface until adequate evaluation of remedial options is completed. These areas appear reddish in color and even when lightly covered by vegetation, contain higher levels of arsenic contaminated soil."

Response 22
SHINE appreciates this comment, however, the recommendations will remain as stated in the original document. The final sentence of the first paragraph of the *Recommendation* section of the assessment was revised slightly and now reads as follows: "The areas to be avoided appear reddish in color and even when lightly covered by vegetation, they contain higher levels of arsenic-contaminated soil."

Comment 23

Please clarify the sentence on page 16, paragraph 2 that starts, "Since there was limited following the cleanup…"

Response 23
Thank you for your comment. The sentence on page 16, in the second paragraph now reads, "Since there was limited environmental data following the cleanup, SHINE collected urine samples from residents living at the mine site to characterize exposure. SHINE prepared a second health consultation in 2004 based on the sampling results and determined that the site did not pose a public health risk to the residents."

Comment 24
In Appendix D, page 29, SHINE notes that the bioavailability factor of 80 percent is consistent with that used for the Taylor Lumber site in Sheridan, OR. However, the form of arsenic used for wood treating would be expected have higher solubility, and thus higher bioavailability, than the form found in retorted mine tailings. Even animal testing of soils at wood treatment plants indicate that the relative oral bioavailability of arsenic from these soils can be in the range of 16% (Roberts et al. 2002), which is significantly lower than the default specified by SHINE.

Response 24
Thank you for your comment. SHINE's reasoning for using a general arsenic bioavailability of 80% has been discussed the report and in previous comments.

Comment 25
Appendix D, Page 30. The assessment used a chronic reference dose (RfD) and Minimal Risk Level (MRL) to assess risk for exposure that are technically less than the exposure duration defined by EPA as "chronic" (greater than 7 years exposure). Presumably this was done because an intermediate MRL is unavailable. However, since intermediate toxicity factors are typically 5-10 fold higher than chronic values, this alone could shed question on the unacceptable risks reported for the young child scenario.

Response 25
SHINE follows ATSDR guidelines and used their definition of chronic exposure, which states that chronic exposure is an exposure lasting more than one year (http://www.atsdr.cdc.gov/glossary.html). In the Public Health Assessment, SHINE assumed that children and adults were exposed to soils for periods of more than one year and we feel comparisons to the RfD and MRL are appropriate comparisons for these chronic exposure scenarios.

APPENDIX A. Soil sampling locations along Red Rock Road.

The figures in this appendix are part of CH2M Hill's *Investigative Data Report and Human Health Risk Assessment [5]*.

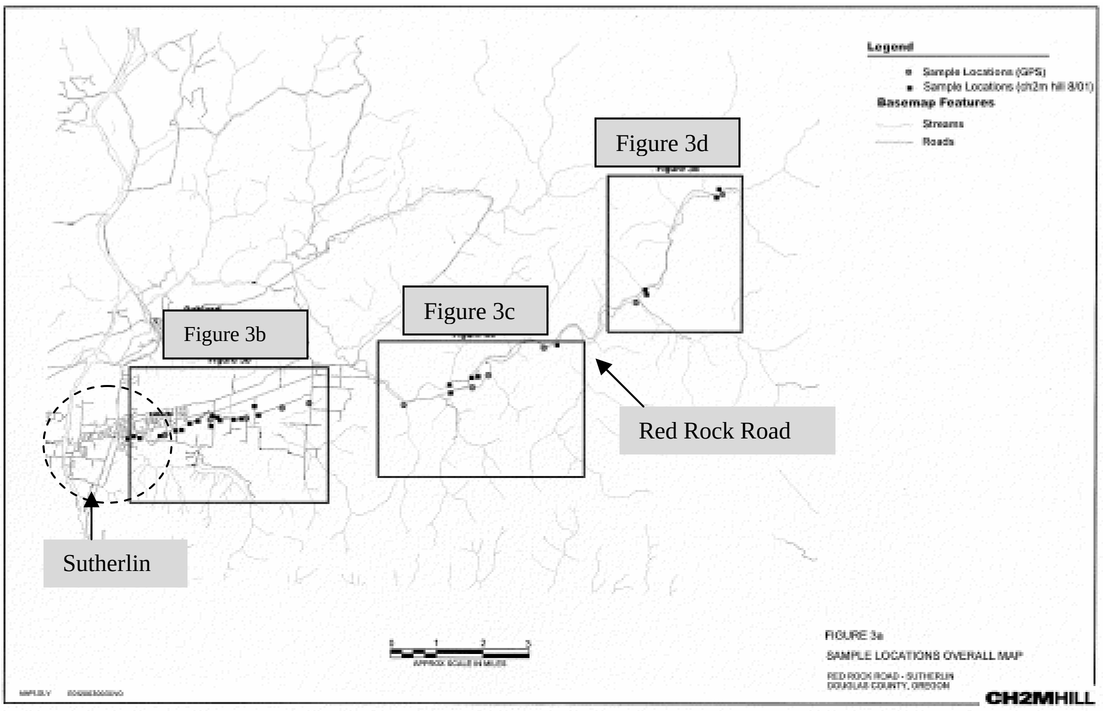


Figure 3b

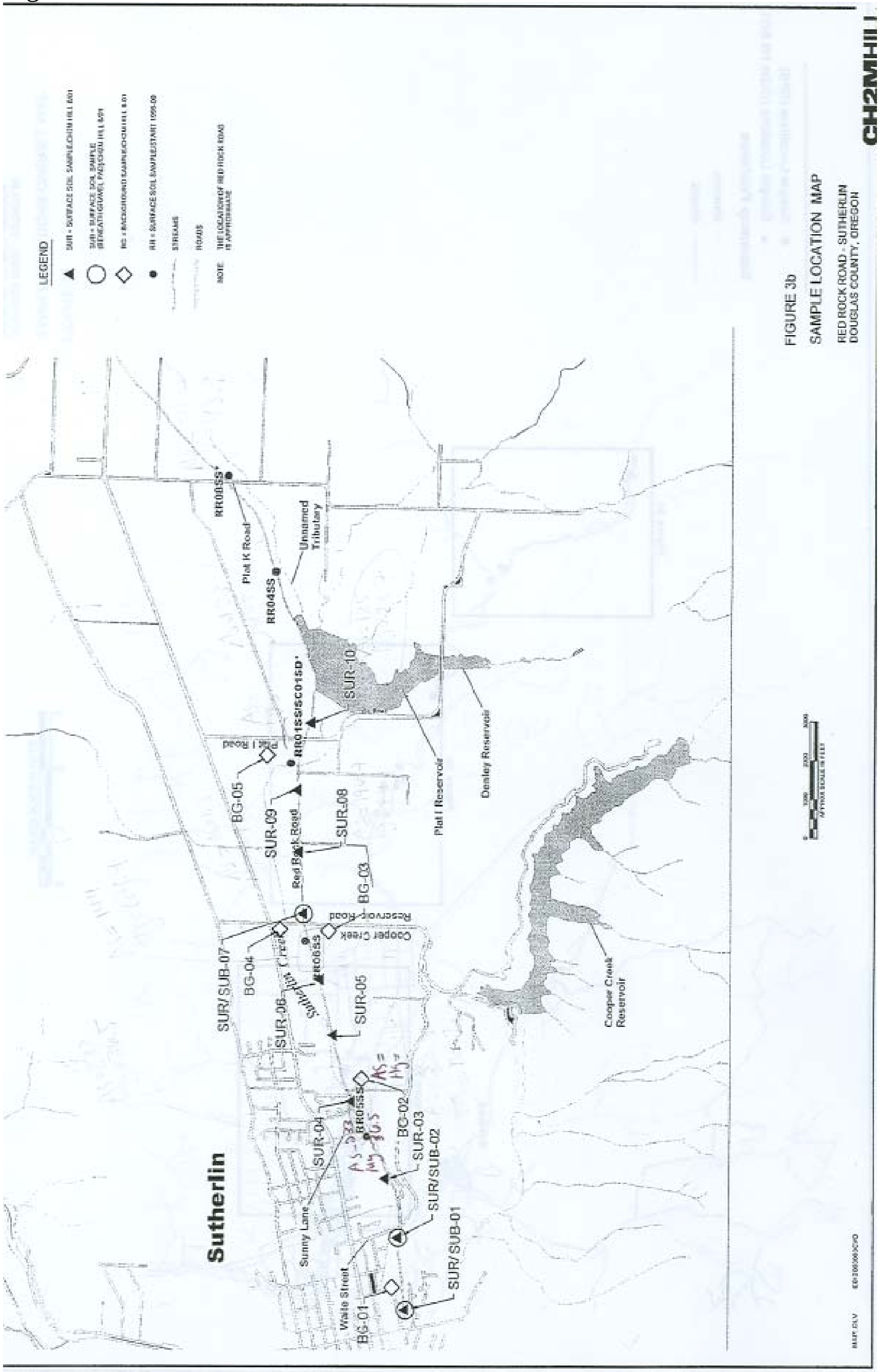

LEGEND
FIGURE 3b
SAMPLE LOCATION MAP
RED ROCK ROAD - SUTHERLIN
DOUGLAS COUNTY, OREGON
CH2MHILL
Sutherlin
Sunny Lane
Waite Street
BG-01
BG-02
BG-03
BG-04
BG-05
SUR/SUB-01
SUR/SUB-02
SUR-03
SUR-04
SUR-05
SUR-06
SUR/SUB-07
SUR-08
SUR-09
SUR-10
RR05SS
RR04SS
RR08SS
Red Rock Road
Reservoir Road
Cooper Creek
Plat I Road
Plat K Road
Unnamed Tributary
Plat I Reservoir
Denley Reservoir
Cooper Creek Reservoir

Figure 3c

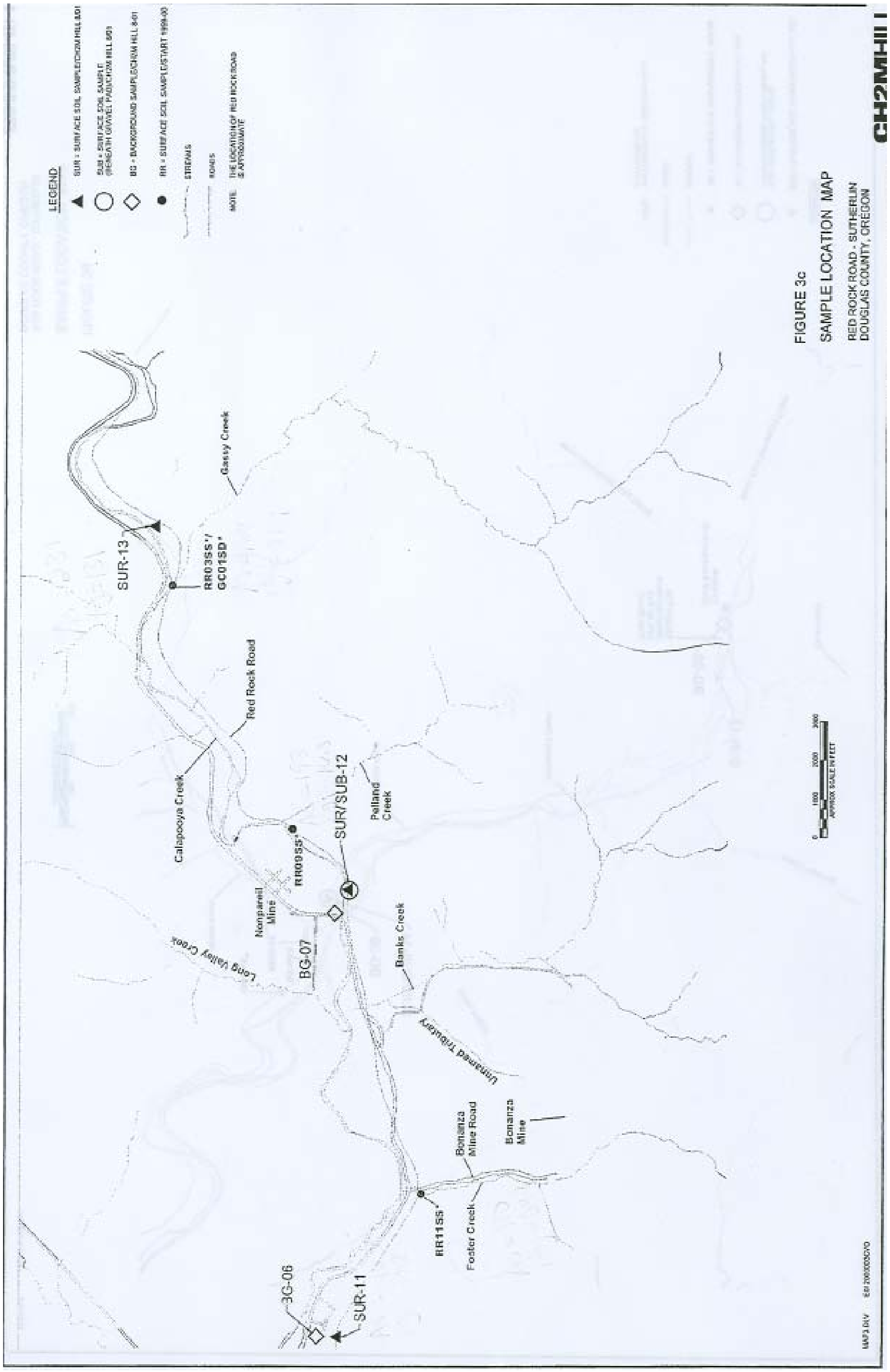
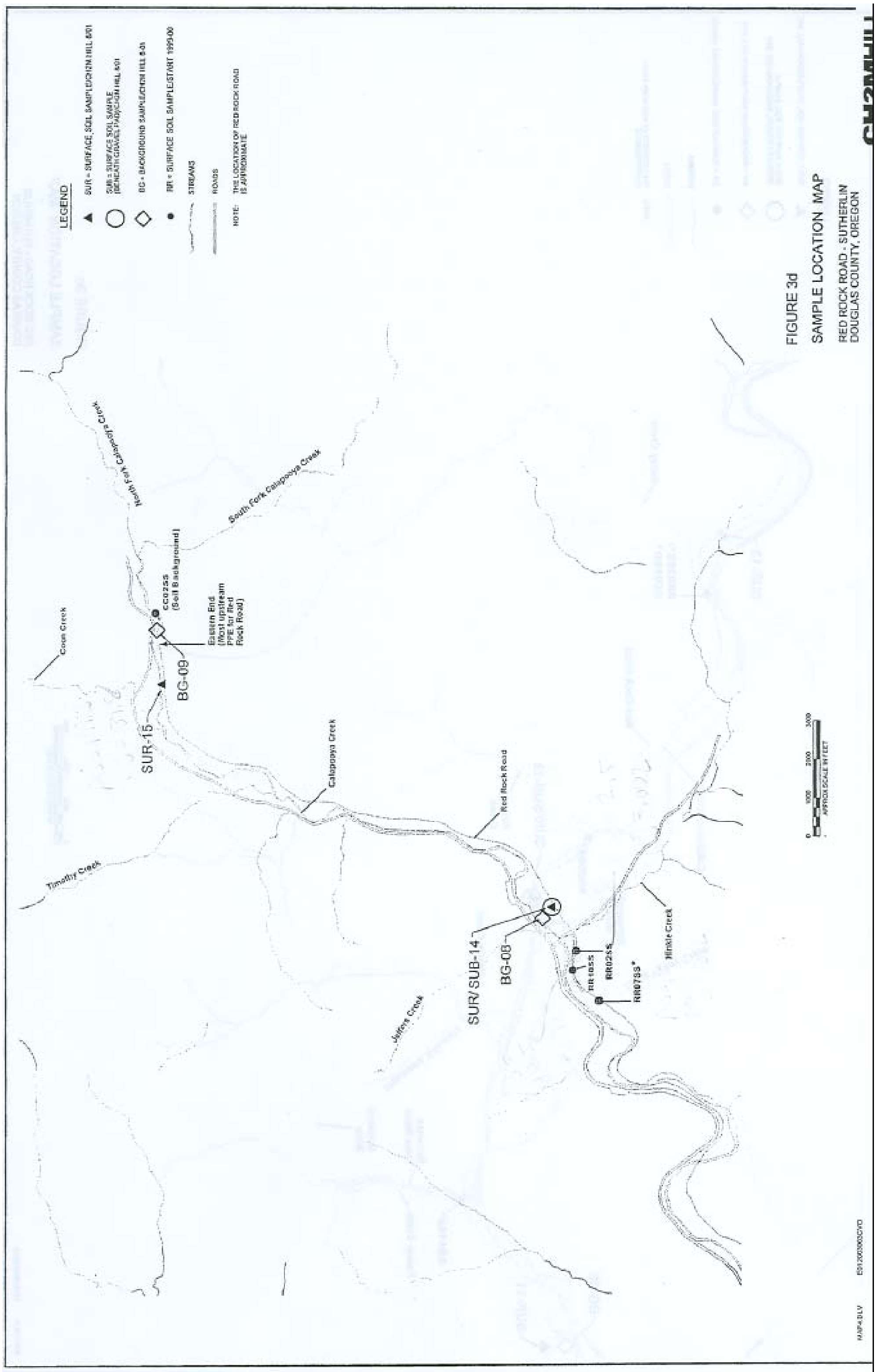

LEGEND
STREAMS
ROADS
SUR-13
RR03SS'/
GC01SD'
Gassy Creek
Red Rock Road
Calapooya Creek
SUR/SUB-12
Pelland
Creek
RR09SS'
Nonpareil
Mine
BG-07
Long Valley Creek
Banks Creek
Unnamed Tributary
Bonanza
Mine Road
Bonanza
Mine
Foster Creek
RR11SS'
BG-06
SUR-11
FIGURE 3c
SAMPLE LOCATION MAP
RED ROCK ROAD - SUTHERLIN
DOUGLAS COUNTY, OREGON

Figure 3d



LEGEND
STREAMS
ROADS
FIGURE 3d
SAMPLE LOCATION MAP
RED ROCK ROAD - SUTHERLIN
DOUGLAS COUNTY, OREGON
North Fork Calapooya Creek
South Fork Calapooya Creek
Coon Creek
CC02SS
(Soil Background)
BG-09
SUR-15
Calapooya Creek
Red Rock Road
Timothy Creek
SUR/SUB-14
BG-08
RR10SS
RR02SS
RR07SS*
Hinkle Creek
Jeffers Creek

Appendix B. Red Rock Road activities and investigations conducted by DEQ, EPA, and Weyerhaeuser.

In December 1995, the Oregon Department of Environmental Quality (DEQ) collected two samples from RRR in response to various complaints regarding concern about mine tailings being the source of the road material. Additional sampling was conducted by DEQ between 1995 and 2004 around RRR, Calapooya Creek, Sutherlin Creek, Plat I Reservoir, and the Cooper Creek Reservoir to characterize the media impacted by the use of mine tailings from Bonanza Mine throughout Sutherlin Valley. Some evidence suggested that the tailings from RRR could be leaching into the nearby creeks but it is difficult to pinpoint the actual source due to naturally-occurring mineralized zones that may also be contributing to elevated levels of arsenic and mercury [4].

In 1998, the U.S. Environmental Protection Agency (EPA) conducted a site visit and the Superfund Technical Assessment and Response Team (START) prepared a preliminary assessment for RRR. This report identified potential impacts to public health and the environment by RRR and evaluated the potential for RRR to be placed on the National Priorities List (NPL). To date, RRR has not been placed on the NPL and was not declared a Superfund site by the EPA.

As a part owner of RRR and based on the findings of the previous investigations, Weyerhaeuser agreed to conduct additional site evaluations in cooperation with DEQ. CH2M Hill, a contractor for Weyerhaeuser, collected surface soil samples in August 2001 at various locations along the 17-mile stretch of RRR (Appendix A). In September of 2004, CH2M Hill prepared the *Investigation Data Report and Human Health Risk Assessment* for Weyerhaeuser. In March of 2005 they prepared a *Draft Feasibility Study* that had not yet been finalized. The *Draft Feasibility Study* identifies appropriate remediation technologies that can be used to reduce the contamination along the Weyerhaeuser-owned sections of the road. The report was also developed to be general enough so additional owners can apply the recommended technologies for cleanup along other sections of RRR. DEQ is currently working with Weyerhaeuser to finalize the Feasibility Study and develop a plan for implementing final cleanup measures.

APPENDIX C. Summary of the risk assessment process.

Screening Process

In evaluating these data, ATSDR used comparison values (CVs) to determine which chemicals to examine more closely. CVs are the contaminant concentrations found in a specific media (soil or water) and are used to select contaminants for further evaluation. CVs incorporate assumptions of daily exposure to the chemical and a standard amount of air, water, and soil that someone may inhale or ingest each day.

As health-based thresholds, CVs are set at a concentration below which no known or anticipated adverse human health effects are expected to occur. Different CVs are developed for cancer and non-cancer health effects. Non-cancer levels are based on valid toxicological studies for a chemical, with appropriate safety factors included, and the assumption that small children (22 pounds) and adults are exposed every day. Cancer levels are the media concentrations at which there could be a one in a million excess cancer risk for an adult eating contaminated soil or drinking contaminated water every day for 70 years. For chemicals for which both cancer and non-cancer numbers exist, the lower level is used to be protective. Exceeding a CV does not mean that health effects will occur, just that more evaluation is needed.

Identification of Contaminants of Concern for RRR*†‡.

Analyte	Maximum Concentration [ppm]	PRG* [ppm]	CV* [ppm]	CV Source	Contaminant of Concern?
Aluminum	46400	-	100,000	Intermediate EMEG, child	no
Antimony	33	31	20	RMEG, child	no
Arsenic	**233**	**0.39**	**0.5**	**CREG**	**yes**
Barium	398	5375	30,000	chronic EMEG, child	no
Beryllium	1.1	154	100	chronic EMEG, child	no
Cadmium	1.4	37	10	chronic EMEG, child	no
Calcium	17000	-	-	-	no
Chromium	88	100000	200	RMEG, child (hexavalent chromium)	no
Cobalt	47	4693	500	Intermediate EMEG, child	no
Copper	191	2905	500	Intermediate EMEG, child	no
Iron	73900	-	-	-	no
Lead	53	400	400	EPA Screening Level for residential soil at CERCLA and RCRA sites	no
Magnesium	12000	-	-	-	no
Manganese	1770	1762	3000	RMEG, child	no
Mercury	**131**	**23**	**20**	**RMEG, child (mercuric chloride)**	**yes**
Nickel	93	1564	1000	RMEG, child	no
Potassium	1790	-	-	-	no
Selenium	2.9	391	300	chronic EMEG, child	no
Sodium	4750	-	-	-	no
Thallium	16	-	-	-	no
Vanadium	230	547	200	Intermediate EMEG, child	no
Zinc	170	23463	20000	chronic EMEG, child	no

* A comparison value (CV) is a health protective environmental guideline that does not necessarily represent a health concern and are used to select contaminants that require further evaluation

† Items in bold are above the comparison value or PRG

‡ A blank fields indicates that no value was available

CV sources used in this document are listed below:

Environmental Media Evaluation Guides (EMEGs) are estimated contaminant concentrations in a media where non-carcinogenic health effects are unlikely. The EMEG is derived from the Agency for Toxic Substances and Disease Registry's (ATSDR) minimal risk level (MRL).

Remedial Media Evaluation Guides (RMEGs) are estimated contaminant concentrations in a media where non-carcinogenic health effects are unlikely. The RMEG is derived from the Environmental Protection Agency's (EPA's) reference dose (RfD).

Cancer Risk Evaluation Guides (CREGs) are estimated contaminant concentrations that would be expected to cause no more than one additional excess cancer in one million persons exposed over a lifetime. CREGs are calculated from EPA's cancer slope factors (CSFs).

Preliminary Remediation Goals (PRGs) are the estimated contaminant concentrations in a media where carcinogenic or non-carcinogenic health effects are unlikely. The PRGs used in this public health assessment were derived using provisional reference doses or cancer slope factors calculated by EPA's Region 9 toxicologists.

Evaluation of Public Health Implications

Estimation of Exposure Dose

The next step is to take those contaminants that are above the CVs and further identify which chemicals and exposure situations are likely to be a health hazard. Child and adult exposure doses are calculated for the site-specific exposure scenario, using our assumptions of who goes on the site and how often they contact the site contaminants. The exposure dose is the amount of a contaminant that gets into a person's body.

Non-cancer Health Effects

The calculated exposure doses are then compared to an appropriate health guideline for that chemical. Health guideline values are considered safe doses; that is, health effects are unlikely below this level. The health guideline value is based on valid toxicological studies for a chemical, with appropriate safety factors built in to account for human variation, animal-to-human differences, and/or the use of the lowest adverse effect level. For non-cancer health effects, the following health guideline values are used.

Minimal Risk Level (MRLs) - developed by ATSDR
An estimate of daily human exposure – by a specified route and length of time – to a dose of chemical that is likely to be without a measurable risk of adverse, non-cancerous

effects. An MRL should not be used as a predictor of adverse health effects. A list of MRLs can be found at http://www.atsdr.cdc.gov/mrls.html.

Reference Dose (RfD) - developed by EPA
An estimate, with safety factors built in, of the daily, lifetime exposure of human populations to a possible hazard that is not likely to cause non-cancerous health effects. The RfDs can be found at http://www.epa.gov/iris/.

If the estimated exposure dose for a chemical is less than the health guideline value, then the exposure is unlikely to cause a non-carcinogenic health affect in that specific situation. If the exposure dose for a chemical is greater than the health guideline, then the exposure dose is compared to known toxicological values for that chemical and is discussed in more detail in the public health assessment (see Discussion Section). These toxicological values are doses derived from human and animal studies which are summarized in the ATSDR Toxicological Profiles. A direct comparison of site-specific exposure and doses to study-derived exposures and doses found to cause adverse health effects is the basis for deciding whether health effects are likely or not.

Risk of Carcinogenic Effects

The estimated risk of developing cancer from exposure to the contaminants was calculated by multiplying the site-specific adult exposure dose by EPA's corresponding Cancer Slope Factor (which can be found at http://www.epa.gov/iris/). The results estimate the maximum increase in risk of developing cancer after 70 years of exposure to the contaminant.

The actual risk of cancer is probably lower than the calculated number. The method used to calculate EPA's Cancer Slope Factor assumes that high-dose animal data can be used to estimate the risk for low dose exposures in humans. The method also assumes that there is no safe level for exposure. Little experimental evidence exists to confirm or refute those two assumptions. Lastly, the method computes the 95% upper bound for the risk, rather than the average risk, suggesting that the cancer risk is actually lower, perhaps by several orders of magnitude.

Because of uncertainties involved in estimating carcinogenic risk, ATSDR employs a weight-of-evidence approach in evaluating all relevant data. Therefore, the carcinogenic risk is described in words (qualitatively) rather than giving a numerical risk estimate only. The numerical risk estimate must be considered in the context of the variables and assumptions involved in their derivation and in the broader context of biomedical opinion, host factors, and actual exposure conditions. The actual parameters of environmental exposures must be given careful consideration in evaluating the assumptions and variables relating to both toxicity and exposure.

APPENDIX D. Exposure factors, health guidelines, dose calculations, daily dose estimates, hazard quotients, and increased cancer risk calculations.

Exposure Factors

Exposure Factor	Symbol	Value			Source/Notes
		Young Child – less than 5-years-old	Older Child - less than 12-years-old	Adult	
Body Weight [kg]	BW_{yc}	15	40	70	A, Adult weight = default value
Exposure Frequency – Recreation [days]	EF_{Rec}	90	90	90	Based on daily use during summer months
Exposure Frequency - Residential [days]	EF_{Res}	350	350	350	D; Away for 2 weeks per year
Exposure Duration [years]	ED	6	10	30	D
Averaging Time - Noncancer [days]	AT_{nonc}	2190	3650	10950	D
Averaging Time - Cancer [days]	AT_c	25550	25550	25550	D
Soil Ingestion Rate	SIR	200	200	100	E
Oral Bioavailable Fraction - Arsenic [%]	BV_a	0.8	0.8	0.8	F
Oral Bioavailable Fraction - Mercury [%]	BV_m	0.1	0.1	0.1	G
Conversion Factor	CF	0.000001	0.000001	0.000001	Converts contaminant mass from milligrams (mg) to kilograms (kg)
Inhalation Rate [m^3/day]	IR	8.3	14	20	A, B
Particulate Emission Factor [kg/m^3]	PEF	5.30E-08	5.30E-08	5.30E-08	H

A = EPA Child-specific exposure factors handbook (Sections 7 and 11)
B = EPA IRIS default inhalation rate
C = Estimate based on daily use during summer months
D = DEQ Deterministic HHRA Guidance, Appendix B
E= DEQ Risk Based Decision Making, Appendix C - Child and Adult
F = Oregon Public Health Consultations – Bonanza Mine & Taylor Lumber
G = Mercury Toxicological Profile (ATSDR)
H = Risk Assessment for RRR

Health Guidelines

	Maximum Soil Concentration [mg/kg]	**Oral MRL or RfD (chronic)** [mg/(kg-day)]	**Cancer Potency Factor** [mg/(kg-day)]$^{-1}$
Arsenic	233	0.0003	1.5
Mercury	131	0.0003	-

Daily Dose Calculations

Incidental Ingestion Dose$_{non\text{-}cancer}$ (mg/kg/day) =	$\dfrac{C \times CF \times SIR \times EF \times ED \times BV}{BW \times AT_{nonc}}$
Incidental Ingestion Dose$_{cancer}$ (mg/kg/day) =	$\dfrac{C \times CF \times SIR \times EF \times ED \times BV}{BW \times AT_{c}}$
Inhalation Dose$_{non\text{-}cancer}$ (mg/kg/day) =	$\dfrac{C \times IR \times (1/PEF) \times EF \times ED}{BW \times AT_{nonc}}$
Inhalation Dose$_{cancer}$ (mg/kg/day) =	$\dfrac{C \times IR \times (1/PEF) \times EF \times ED}{BW \times AT_{c}}$

DOSE ESTIMATES			
RECREATIONAL USERS - Non-Cancer Risk	**Young Child**	**Older Child**	**Adult**
Incidental Ingestion$_{Arsenic}$	0.00061	0.00023	0.00007
Incidental Ingestion$_{Mercury}$	0.00004	0.00002	0.00000
Inhalation$_{Arsenic}$	0.00000	0.00000	0.00000
Inhalation$_{Mercury}$	0.00000	0.00000	0.00000
RECREATIONAL USERS - Cancer			
Incidental Ingestion$_{Arsenic}$	0.00005	0.00003	0.00003
Inhalation$_{Arsenic}$	0.00000	0.00000	0.00000
RESIDENTS - Non-Cancer Risk			
Incidental Ingestion$_{Arsenic}$	0.00238	0.00089	0.00026
Incidental Ingestion$_{Mercury}$	0.00017	0.00006	0.00002
Inhalation$_{Arsenic}$	0.00001	0.00000	0.00000
Inhalation$_{Mercury}$	0.00000	0.00000	0.00000
RESIDENTS - Cancer			
Incidental Ingestion$_{Arsenic}$	0.00020	0.00013	0.00011
Inhalation$_{Arsenic}$	0.00000	0.00000	0.00000

HAZARD QUOTIENTS & CANCER RISKS			
RECREATIONAL USERS - Non-Cancer Risk	**Young Child**	**Older Child**	**Adult**
Incidental Ingestion$_{Arsenic}$	**2.04**	0.77	0.22
Incidental Ingestion$_{Mercury}$	0.14	0.05	0.02
Inhalation$_{Arsenic}$	0.01	0.00	0.00
Inhalation$_{Mercury}$	0.00	0.00	0.00
RECREATIONAL USERS - Cancer Risk*			
Incidental Ingestion$_{Arsenic}$	**7.88E-05**	**4.92E-05**	**4.22E-05**
Inhalation$_{Arsenic}$	1.22E-07	1.28E-07	3.14E-07
RESIDENTS - Non-Cancer Risk			
Incidental Ingestion$_{Arsenic}$	**7.94**	**2.98**	0.85
Incidental Ingestion$_{Mercury}$	0.56	0.21	0.06
Inhalation$_{Arsenic}$	0.02	0.01	0.01
Inhalation$_{Mercury}$	0.01	0.01	0.01
RESIDENTS - Cancer Risk*			
Incidental Ingestion$_{Arsenic}$	**3.06E-04**	**1.92E-04**	**1.64E-04**
Inhalation$_{Arsenic}$	8.42E-07	8.88E-07	2.17E-06

* Cancer Risk only evaluated for arsenic (mercury is not considered a carcinogen)

APPENDIX E. ATSDR glossary of environmental health terms.

The Agency for Toxic Substances and Disease Registry (ATSDR) is a federal public health agency with headquarters in Atlanta, Georgia, and 10 regional offices in the United States. ATSDR serves the public by using the best science to take responsive public health actions and provides trusted health information to prevent harmful exposures and diseases related to toxic substances. ATSDR is not a regulatory agency, unlike the U.S. Environmental Protection Agency (EPA), which is the federal agency that develops and enforces environmental laws to protect the environment and human health.

This glossary defines words used by ATSDR in communications with the public. It is not a complete dictionary of environmental health terms. If you have questions or comments, call ATSDR's toll-free telephone number, 1-888-42-ATSDR (1-888-422-8737).

Absorption:	How a chemical enters a person's blood after the chemical has been swallowed, has come into contact with the skin, or has been breathed in.
Acute Exposure:	Contact with a chemical that happens once or only for a limited period of time. ATSDR defines acute exposures as those that might last up to 14 days.
Additive Effect:	A response to a chemical mixture, or combination of substances, that might be expected if the known effects of individual chemicals, seen at specific doses, were added together.
ATSDR:	The **A**gency for **T**oxic **S**ubstances and **D**isease **R**egistry. ATSDR is a federal health agency in Atlanta, Georgia that deals with hazardous substance and waste site issues. ATSDR gives people information about harmful chemicals in their environment and tells people how to protect themselves from coming into contact with chemicals.
Background Level:	An average or expected amount of a chemical in a specific environment. Or, amounts of chemicals that occur naturally in a specific environment.
Bioavailability:	See **Relative Bioavailability**.
Cancer:	A group of diseases which occur when cells in the body become abnormal and grow, or multiply, out of control
Carcinogen:	Any substance shown to cause tumors or cancer in experimental studies.

CERCLA: See **C**omprehensive **E**nvironmental **R**esponse, **C**ompensation, and **L**iability **A**ct.

Chronic Exposure: A contact with a substance or chemical that happens over a long period of time. ATSDR considers exposures of more than one year to be *chronic*.

Completed Exposure Pathway: See **Exposure Pathway**.

Comparison Value: **(CVs)** Concentrations of substances in air, water, food, and soil that are unlikely, upon exposure, to cause adverse health effects. Comparison values are used by health assessors to select which substances and environmental media (air, water, food and soil) need additional evaluation while health concerns or effects are investigated.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA): **CERCLA** was put into place in 1980. It is also known as **Superfund**. This act concerns releases of hazardous substances into the environment, and the cleanup of these substances and hazardous waste sites. This act created ATSDR and gave it the responsibility to look into health issues related to hazardous waste sites.

Concern: A belief or worry that chemicals in the environment might cause harm to people.

Concentration: How much or the amount of a substance present in a certain amount of soil, water, air, or food.

Contaminant: See **Environmental Contaminant**.

Delayed Health Effect: A disease or injury that happens as a result of exposures that may have occurred far in the past.

Dermal Contact: A chemical getting onto your skin. (see **Route of Exposure**).

Dose: The amount of a substance to which a person may be exposed, usually on a daily basis. Dose is often explained as “amount of substance(s) per body weight per day”.

Dose / Response: The relationship between the amount of exposure (dose) and the change in body function or health that result.

Duration: The amount of time (days, months, years) that a person is exposed to a chemical.

Environmental Contaminant: A substance (chemical) that gets into a system (person, animal, or the environment) in amounts higher than the **Background Level**, or what would be expected.

Environmental Media: Usually refers to the air, water, and soil in which chemicals of interest are found. Sometimes refers to the plants and animals that are eaten by humans. **Environmental Media** is the second part of an **Exposure Pathway**.

U.S. Environmental Protection Agency (EPA): The federal agency that develops and enforces environmental laws to protect the environment and the public's health.

Epidemiology: The study of the different factors that determine how often, in how many people, and in which people will disease occur.

Exposure: Coming into contact with a chemical substance.(For the three ways people can come in contact with substances, see **Route of Exposure**.)

Exposure Assessment: The process of finding the ways people come in contact with chemicals, how often and how long they come in contact with chemicals, and the amounts of chemicals with which they come in contact.

Exposure Pathway: A description of the way that a chemical moves from its source (where it began) to where and how people can come into contact with (or get exposed to) the chemical.

ATSDR defines an exposure pathway as having 5 parts:
1. Source of Contamination,
2. Environmental Media and Transport Mechanism,
3. Point of Exposure,
4. Route of Exposure, and
5. Receptor Population.

When all 5 parts of an exposure pathway are present, it is called a **Completed Exposure Pathway**. Each of these 5 terms is defined in this Glossary.

Frequency: How often a person is exposed to a chemical over time; for example, every day, once a week, twice a month.

Hazardous Waste: Substances that have been released or thrown away into the environment and, under certain conditions, could be harmful to people who come into contact with them.

Health Effect: ATSDR deals only with **Adverse Health Effects** (see definition in this Glossary).

Indeterminate Public Health Hazard: The category is used in Public Health Assessment documents for sites where important information is lacking (missing or has not yet been gathered) about site-related chemical exposures.

Ingestion: Swallowing something, as in eating or drinking. It is a way a chemical can enter your body (See **Route of Exposure**).

Inhalation: Breathing. It is a way a chemical can enter your body (See **Route of Exposure**).

LOAEL: **L**owest **O**bserved **A**dverse **E**ffect **L**evel. The lowest dose of a chemical in a study, or group of studies, that has caused harmful health effects in people or animals.

MRL: **M**inimal **R**isk **L**evel. An estimate of daily human exposure – by a specified route and length of time -- to a dose of chemical that is likely to be without a measurable risk of adverse, noncancerous effects. An MRL should not be used as a predictor of adverse health effects.

NPL: The **N**ational **P**riorities **L**ist. (Which is part of **Superfund**.) A list kept by the U.S. Environmental Protection Agency (EPA) of the most serious uncontrolled or abandoned hazardous waste sites in the country. An NPL site needs to be cleaned up or is being looked at to see if people can be exposed to chemicals from the site.

NOAEL: **N**o **O**bserved **A**dverse **E**ffect **L**evel. The highest dose of a chemical in a study, or group of studies, that did not cause harmful health effects in people or animals.

No Apparent Public Health Hazard: The category is used in ATSDR's Public Health Assessment documents for sites where exposure to site-related chemicals may have occurred in the past or is still occurring but the exposures are not at levels expected to cause adverse health effects.

No Public Health Hazard: The category is used in ATSDR's Public Health Assessment documents for sites where there is evidence of an absence of exposure to site-related chemicals.

PHA: **P**ublic **H**ealth **A**ssessment. A report or document that looks at chemicals at a hazardous waste site and tells if people could be harmed from coming into contact with those chemicals. The PHA also tells if possible further public health actions are needed.

Point of Exposure: The place where someone can come into contact with a contaminated environmental medium (air, water, food or soil). Some examples include: the area of a playground that has contaminated dirt, a contaminated spring used for drinking water, or the backyard area where someone might breathe contaminated air.

Population: A group of people living in a certain area; or the number of people in a certain area.

PRP: **P**otentially **R**esponsible **P**arty. A company, government or person that is responsible for causing the pollution at a hazardous waste site. PRP's are expected to help pay for the clean up of a site.

Public Health Assessment(s): See **PHA**.

Public Health Hazard: The category is used in PHAs for sites that have certain physical features or evidence of chronic, site-related chemical exposure that could result in adverse health effects.

Public Health Hazard Criteria: PHA categories given to a site which tell whether people could be harmed by conditions present at the site. Each are defined in the Glossary. The categories are:
– Urgent Public Health Hazard
– Public Health Hazard
– Indeterminate Public Health Hazard
– No Apparent Public Health Hazard
– No Public Health Hazard

Reference Dose (RfD): An estimate, with safety factors (see **safety factor**) built in, of the daily, life-time exposure of human populations to a possible hazard that is <u>not</u> likely to cause harm to the person.

Relative Bioavailability: The amount of a compound that can be absorbed from a particular medium (such as soil) compared to the amount absorbed from a reference material (such as water). Expressed in percentage form.

Route of Exposure: The way a chemical can get into a person's body. There are three exposure routes:
– breathing (also called inhalation),
– eating or drinking (also called ingestion), and
– getting something on the skin (also called dermal contact).

Safety Factor: Also called **Uncertainty Factor**. When scientists don't have enough information to decide if an exposure will cause harm to people, they use "safety factors" and formulas in place of the information that is not known. These factors and formulas can help determine the amount of a chemical that is <u>not</u> likely to cause harm to people.

SARA: The **S**uperfund **A**mendments and **R**eauthorization **A**ct in 1986 amended CERCLA and expanded the health-related responsibilities of ATSDR. CERCLA and SARA direct ATSDR to look into the health effects resulting from chemical exposures at hazardous waste sites.

Sample Size: The number of people that are needed for a health study.

Sample: A small number of people chosen from a larger population (See **Population**).

Source (of Contamination): The place where a chemical comes from, such as a landfill, pond, creek, incinerator, tank, or drum. Contaminant source is the first part of an **Exposure Pathway**.

Special Populations: People who may be more sensitive to chemical exposures because of certain factors such as age, a disease they already have, occupation, sex, or certain behaviors (like cigarette smoking). Children, pregnant women, and older people are often considered special populations.

Statistics: A branch of the math process of collecting, looking at, and summarizing data or information.

Superfund Site: See **NPL**.

Survey: A way to collect information or data from a group of people (**population**). Surveys can be done by phone, mail, or in person. ATSDR cannot do surveys of more than nine people without approval from the U.S. Department of Health and Human Services.

Toxic: Harmful. Any substance or chemical can be toxic at a certain dose (amount). The dose is what determines the potential harm of a chemical and whether it would cause someone to get sick.

Toxicology: The study of the harmful effects of chemicals on humans or animals.

Tumor: Abnormal growth of tissue or cells that have formed a lump or mass.

Uncertainty Factor: See **Safety Factor**.

Urgent Public Health Hazard: This category is used in ATSDR's Public Health Assessment documents for sites that have certain physical features or evidence of short-term (less than 1 year), site-related chemical exposure that could result in adverse health effects and require quick intervention to stop people from being exposed.

Certification

This Red Rock Road Public Health Assessment was prepared by the Oregon Department of Human Services, Superfund Health Investigation and Education Program under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). It was completed in accordance with approved methodologies and procedures existing at the time the public health assessment was initiated. Editorial review was completed by the Cooperative Agreement partner.

Alan W. Yarbrough
for
Technical Project Officer, CAT, CAPEB, DHAC

The Division of Health Assessment and Consultation (DHAC), ATSDR, has reviewed this health consultation and concurs with its findings.

Alan W. Yarbrough
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