Health Consultation

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Pathway Assessment for Churchill County Surface Soils
And Residential Indoor Dust

FALLON LEUKEMIA PROJECT

FALLON, CHURCHILL COUNTY, NEVADA

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Background and Statement of Issues

In July 2000, the Nevada Department of Human Resources, Nevada State Health Division (NSHD), identified an increase in the incidence rate of leukemia in children from Churchill County, Nevada. Most of the leukemia cases were from the city of Fallon, the largest population center in the county. Approximately 7,540 residents live in Fallon and about 24,000 people live in the surrounding unincorporated parts of Churchill County. The entire area comprises 5,000 square miles [1].

In March 2001, the NSHD requested that the Agency for Toxic Substances and Disease Registry (ATSDR) and the National Center for Environmental Health (NCEH) evaluate environmental risk factors that might be linked to the childhood leukemia cluster in the Fallon, Churchill County, Nevada area. NCEH was asked to design and conduct a cross-sectional exposure assessment of selective contaminants using environmental (household) and biologic specimens for case-families and a reference population [2].

ATSDR was asked to evaluate contaminant releases in Churchill County and provide an assessment of completed exposure pathways for the case-families. This health consultation addresses the potential environmental pathways for human exposure to contaminated soil and residential indoor dust in Churchill County.

ATSDR and NCEH developed a Public Health Action Plan identifying the pathways to be evaluated for available sampling data, data gaps, and potential human exposures [3]. These pathways include groundwater, air, soil, surface water, sediment, and biota [3].

ATSDR evaluated the available environmental sampling information for potential exposure to contaminants found in residential soils and indoor dust as well as non-residential soils. The information reviewed includes data collected by the U.S. Geological Survey (USGS), U.S. Environmental Protection Agency (EPA), Nevada Division of Environmental Protection (NDEP), Nevada Department of Agriculture (NDOA), and other local agencies.

Discussion

ATSDR's primary goal in this investigation is to identify completed exposure pathways. Exposure pathways are related to the different ways that contaminants move in the environment and the different ways that people can come into contact with these contaminants (i.e., touching, breathing, or accidentally eating them). A completed exposure pathway exists when information shows that people have come into contact with a contaminant in soil, air, or water. Completed exposure pathways can be either in the past, present, or possibly in the future. The exposure pathways associated with soil and residential indoor dust are presented below. While dermal and inhalation exposure can sometimes be a concern for soil and dust, ingestion is the primary pathway of concern in a non-occupational setting.

SOIL INGESTION

The accidental ingestion (i.e. swallowing) of contaminated soil and household dust by both children and adults is a potential exposure pathway. This exposure occurs when people have direct contact with soils in their environment. When children play outside, or crawl on floors, or when adults work in yards and gardens, contaminated soil or dust particles cling to their hands. Children or adults may accidentally swallow the contaminants when they put their hands on or into their mouths. Because both people and pets track contaminated soils from outdoors into their homes, exposures can occur while people are in their homes and in their yards. Factors that affect whether people have contact with contaminated soil include the amount of grass cover, weather conditions, the amount of time spent outside, and personal habits.

The amount of chemicals that people are exposed to via ingestion depends on many factors, such as the level of contamination at their homes and the type of activities engaged in while at home. Another factor that affects people's exposure is the amount of soils they accidentally ingest on a daily basis. Although people might not be aware of it, everyone ingests some soil or dust every day, but some people tend to swallow more soil or dust than others. Preschool children often have close contact with soil and dust when they play and because they tend to engage frequently in hand-to-mouth activity. Children in elementary school, teenagers, and adults are also exposed to soil and dusts, but generally in much smaller amounts.

SOIL-PICA

When evaluating exposures, ATSDR also considers a wide range of human activities that might increase exposure to contaminants in soil. One activity of potential concern - particularly in preschool children - is a behavior called soil-pica, i.e., the eating or ingestion of large amounts of soil. This behavior occurs as part of their normal exploratory behavior for 1- and 2- year old children or as part of intentional behavior in older preschool children (3 to 6 year olds). The reasons why some children engage in soil-pica behavior are unknown. Soil-pica behavior is most likely to occur in preschool children, but it can occur in older children and even in adults. Various studies have reported that this behavior occurs in as few as 4% of children or in as many as 21% of children [4,5,6,7].

Soil-pica children eat varying amounts of soil ranging from 600 to 5000 or more milligrams (about 1/8 teaspoon to 1 teaspoon) [8, 9,10,11]. Due to the limited number of such studies, there is some uncertainty about the estimates to use for the amount of soil intake for a soil-pica child.

For this health consultation, ATSDR used a range of soil intakes from 600 to 5000 milligrams of soil to estimate soil exposure for soil-pica children.

Information is limited regarding how often (frequency) and how long (duration) soil-pica children will have this behavior. Some preschool children might eat soil once during their preschool years while others might go through a stage of eating soil several times during a week or over several months. It is reasonable to assume that soil-pica behavior might occur for several days in a row, or a child might skip days between eating soil [10,12,13]. As stated, general pica behavior is greatest in 1- and 2- year old children and decreases as children age.

EATING HOME-GROWN PRODUCE

Eating fruits, vegetables, herbs, or other produce grown locally in gardens with contaminated soil can cause exposure. This type of exposure occurs because many plants slowly absorb small amounts of the chemicals found in soils, or because contaminated soil can adhere to the exterior surface of produce. Some of these absorbed chemicals are essential nutrients and are actually good for people to eat. Other chemicals, however, can present health hazards if they are found at high enough levels and are consumed on a regular basis.

ATSDR's EVALUATION PROCESS

ATSDR's approach to evaluating a potential health concern has two components. The first component involves a screening process that may indicate the need for further analysis. The second component involves a weight of evidence approach that integrates estimates of likely exposure with information about the toxicology and epidemiology of the substances of interest.

Screening is a process of comparing appropriate environmental concentrations and doses to ATSDR or EPA comparison values. These comparison values include

- ATSDR Environmental Media Evaluation Guides (EMEGs)
- Reference Media Evaluation Guides (RMEGs)
- Minimum Risk Levels (MRLs)
- Cancer Risk Evaluation Guidelines (CREGs)

- EPA Reference Concentrations (RfCs)
- EPA Reference Doses (RfDs)
- Risk-Based Concentrations (RBCs)

These health-based comparison values (CVs) are media-specific concentrations considered "safe" using default conditions of exposure. Default conditions are typically based on estimates of exposure in most (i.e., the 90^{th} percentile or more) of the general population. Comparison values are not thresholds of toxicity. Rather, they are levels at which ATSDR believes even long-term exposure to sensitive populations would not result in an increase in the likelihood of developing adverse health effects. When a level is above a comparison value, it does not mean that health effects could be expected – it does, however, represent a point at which further evaluation is warranted.

Comparison values are based on a variety of toxicological and exposure assumptions that might or might not reflect actual exposure conditions and risk of adverse health outcomes. If warranted, ATSDR evaluates a number of parameters depending on the contaminant and site-specific exposure conditions. Such parameters can include biological plausibility, mechanisms of action, cumulative interactions, health outcome data, strength of epidemiological and animal studies, and toxicological and pharmacological characteristics.

DATA EVALUATION

Residential Surface Soil

In late 2001, NDEP conducted residential soil sampling as part of NCEH's cross-sectional exposure assessment. NDEP personnel collected a three-point composite surface soil sample from a children's play area at each of 79 case and control residences. These samples were analyzed for metals, semi-volatile organic compounds, pesticides, herbicides, polychlorinated biphenyls (PCBs), and radioactive isotopes [14].

Metals

ATSDR compared the levels found in residential surface soil with comparison values (CVs) to identify potential contaminants of concern (COCs). Several metals were found at levels below the ATSDR soil screening value and were thus eliminated from the list of potential COCs. These metals were aluminum, beryllium, cadmium, chromium, cobalt, copper, iron, manganese, mercury, nickel, selenium, thallium, vanadium, and zinc.

The other metals found in residential surface soil include arsenic, barium, calcium, lead, magnesium, potassium, and sodium. These metals along with their measured levels and comparison values are shown in Table 1. Calcium, magnesium, potassium, and sodium are mineral nutrients necessary for a healthy human diet; they are not of concern under typical exposure scenarios. Lead in soil can be a concern primarily for chronic exposure, especially in children. Drinking fluids contaminated with arsenic or barium can cause both acute and chronic effects [15,16]. However, arsenic and barium are less likely to be a concern in soils because of

bioavailability and dose. In addition, exposures to arsenic and barium have not been associated with leukemia.

Table 1. Summary of Potential Metals of Concern in Soil

Substance	Minimum Concentration (ppm)	Maximum Concentration (ppm)	Average Concentration (ppm)	ATSDR Comparison Value (ppm)
Arsenic	2.4	23.9	6.8	20
Barium	39.7	8560	198.2	4000
Calcium	1470	35,300	7498	NA
Lead	1.9	74.8	10.9	NA
Magnesium	1270	7270	3497	NA
Potassium	414	5800	2490.7	NA
Sodium	322	4850	1598.3	NA

NA means “not available”.
ppm means “parts per million”.

Arsenic

The concentrations of total arsenic detected in the soil samples ranged from 2.4 - 23.9 parts per million (ppm). The highest level found (23.9 ppm) exceeds the ATSDR Environmental Media Evaluation Guide (EMEG) for a child’s chronic (long-term) ingestion of arsenic in soil. ATSDR based this EMEG on a Taiwanese drinking water study and determined the lowest intake amount most likely to result in an adverse non-cancerous effect (or LOAEL) [15]. In this case, the LOAEL is a daily intake of about 800 micrograms of arsenic a day. Because arsenic is several times more bioavailable in drinking water than in soil, the soil EMEGs for arsenic, which do not take bioavailability into account, are more conservative than the drinking water EMEGs which are based on the same study.

The estimated intake from soil ingestion of the highest total arsenic level found (23.9 ppm) is less than the chronic oral MRL (0.0003 mg/kg/day) for all estimated intake except that associated with extreme soil-pica behavior. The MRL is, however, based on lifetime exposure which is not consistent with soil pica exposure. As a result, even a worst-case soil-pica daily intake rate is not expected to produce exposure to arsenic that would cause adverse health effects. Accordingly, ATSDR does not expect adverse health effects in children or adults from exposure to the levels of arsenic found in residential soil.

Barium

Barium was found at levels ranging from 39.7 - 200 ppm in all but one residential location. The highest level of barium found (8,560 ppm) was from a residence located adjacent to a former barite processing mill. Barite is the mineralogical name for barium sulfate. Barite is principally used as a weighting agent in oil well drilling mud, which accounts for about 90% of its use. The mill in Fallon included equipment for crushing, grinding, and packaging [17].

Barium is relatively abundant in the earth's crust and is found in most soils at concentrations ranging from about 15 - 3,000 ppm [18,19,20]. Barium is also present in many foods at low levels – one exception being Brazil nuts, which have notably high concentrations of barium (3,000-4,000 ppm) [21]. Barium sulfate is used as a medical diagnostic aid and has limited bioavailability.

The Reference Dose Media Evaluation Guide (RMEG) for a child's daily exposure to barium in soil (4,000 ppm) is based on a "no adverse effect level" and incorporates an uncertainty factor of 3. Therefore, the typical levels of barium found in Churchill County's residential soil are not expected to pose a health threat. Also, the highest barium level found (8560 ppm) is below levels for which adverse effects have been demonstrated and is not expected to pose a health threat under normal exposure conditions.

Lead

The lead concentrations detected in surface soil ranged from about 2 - 75 ppm. ATSDR has not established a Minimal Risk Level (MRL) for lead nor has EPA established a reference concentration for lead. Nevertheless, the EPA Office of Solid Waste and Emergency Response recommends a 400 ppm screening level for lead in residential soil at Superfund sites [22]. In Nevada, the typical levels of lead in soil range from 10-70 ppm, with Churchill County levels typically measuring about 20 ppm [23]. Based on the EPA screening level, none of the lead levels found in soil are expected to be a public health threat.

Calcium, Magnesium, Potassium, Sodium

No public health standards have been established for calcium, magnesium, potassium, and sodium in soil. However, these metals are major mineral nutrients that humans need in their daily diet. Table 2 shows the Recommended Dietary Allowance (RDA) from the new Dietary Reference Intakes for each of these minerals [24]. These RDAs are amounts that infants, children, and adults need on a daily basis in order to stay healthy. Ingestion of as much as 5 grams (5000 mg or about one teaspoonful) of soil a day containing the maximum amount of these metals would contribute significantly less than the RDA for each mineral. ATSDR does not anticipate any adverse health effects from exposure to these metals at the levels found in residential surface soil samples.

Table 2. Recommended Dietary Allowances (RDA) for Selected Nutrients

Mineral Nutrient	RDA for Infants (milligram or mg)	RDA for Children (mg)	RDA for Adults (mg)	Equivalent Concentration in 5 g of Soil for Children's RDA (ppm)
Calcium	270	800	1200	160,000
Magnesium	75	130	320-420	26,000
Potassium	700	1600	2000	320,000
Sodium	200	400	500	80,000

Semi-volatile Organics

Most semi-volatile organic compounds were found at levels below the appropriate ATSDR screening comparison value. The one exception, dibenzo(a,h)anthracene, was found at levels ranging from 0.032 - 0.11 ppm. ATSDR has not established a CV for this polycyclic aromatic hydrocarbon (PAH). However, the highest detected level of dibenzo(a,h)anthracene (0.11 ppm) is only slightly greater than the EPA Region III Risk Based Concentration (RBC) for soil ingestion (0.09 ppm). This RBC is calculated using conservative exposure assumptions and a one-in-a-million risk for excess cancer [25]. In addition, this level is typical of PAH background levels in agricultural soils and significantly less than urban soil background levels [26]. As a result, even the maximum level found in soil is not likely to pose a health threat.

Polychlorinated Biphenyls

With one exception, all polychlorinated biphenyls (PCBs) detected in residential surface soil were found at levels below available screening levels. At one residence, a grab surface soil sample taken from a garden area showed an estimated PCB (Arochlor 1260) level of 28 ppm. This estimated level exceeds the USEPA residential cleanup goal of 1 ppm in soil. The laboratory reported an estimated value for this sample as a result of a high instrument calibration range [27]. Even if PCBs are actually present at 28 ppm in garden soil, there is little likelihood that the nature of exposure or the doses achieved would result in adverse health effects based on both toxicological and epidemiological studies. Because, however, the actual levels present in the soil are uncertain, ATSDR has recommended that NDEP collect an additional, confirmatory sample for PCB analysis. The play yard soil at this residence did not show any elevated PCB levels.

Radioactive Elements

The radioactive elements, or radionuclides, ^{234}U, ^{235}U, and ^{238}U, were present in residential soil at levels ranging from 0.4 to 2.4 picocuries per gram (pCi/g) with a geometric mean of 0.9 pCi/g [28]. These results show the normally expected levels of these naturally occurring radionuclides. The soil results are either at or below the minimum detectable activity (MDA) or are consistent with background concentrations for naturally occurring radioactive material (NORM) such as ^{40}K, ^{234}U, ^{235}U, ^{238}U, ^{226}Ra, ^{57}Co, ^{60}Co, and ^{234m} Pa. Other man-made radionuclides found, including ^{137}Cs and ^{228}Ra, also appear consistent with regional concentrations from global fallout.

Pesticides

All pesticides detected in residential surface soil were found at levels below available screening levels. The sampling results are summarized in Appendix A.

Indoor Dust

NDEP collected indoor dust samples from living areas in each case home and in each home that served as a control. Samples were collected using the EPA ERT Nilfisk® Vacuum method to collect bulk dust samples from the floor of a living room, dining room, bedroom, hallway, or kitchen.

This sampling method involves the use of a Nilfisk® vacuum cleaner equipped with a high efficiency particulate (HEPA) filtration system. HEPA filtration uses three filters to prevent particulates from passing through the system and exhausting into the ambient air. The first filter is a pre-filter (sample bag) that traps particles greater than 0.3µm in size. It collects the bulk of the dust sample. The second filter is a micro-filter located at the front end of the exhaust system of the vacuum. It is 98% efficient in preventing particles of 0.3 µm in size from being exhausted into the ambient air. The HEPA filter is the third and final filter in the series. Located in the exhaust of the vacuum, it is 99.97% efficient in preventing particles of 0.3 µm in size from exhausting into the ambient air. Samples from the first and second filter (and sometimes the third) are combined for analysis [29]. Once collected, these indoor dust samples were analyzed for metals, pesticides, and PCBs [14].

Metals

Public health agencies have not established screening values specifically for indoor dust levels for most contaminants. As a result, ATSDR used soil screening values to identify potential contaminants of concern (COCs). Several metals were found at levels below the appropriate ATSDR soil screening value and were eliminated from the list of potential COCs. These metals were aluminum, beryllium, cadmium, chromium, cobalt, copper, mercury, nickel, selenium, thallium, and vanadium. As a result, ATSDR does not expect any adverse health effects in children or adults from exposure to the levels of these metals found in indoor dust. In addition, exposure to these metals has not been shown to cause leukemia.

Table 3 summarizes the metals detected in indoor dust. Metals found above screening values include antimony, arsenic, barium, iron, and zinc. No screening values are available for calcium, lead, magnesium, molybdenum, potassium, and sodium.

Table 3. Summary of Potential Metals of Concern in Indoor Dust

Substance	Minimum Concentration (ppm)	Maximum Concentration (ppm)	Average Concentration (ppm)	ATSDR Comparison Value (ppm)
Antimony	10	150	32.9	20
Arsenic	1	60	7.4	20
Barium	20	4200	201	4000
Calcium	5000	110,000	17,402.5	NA
Iron	1000	25,000	10,479.7	23,000
Lead	2	170	30.6	NA
Magnesium	1100	9000	3632.9	NA
Molybdenum	9	9	9	NA
Potassium	2000	13,000	4738	NA
Sodium	2400	240,000	33,276	NA
Zinc	42	33,000	1181.2	20,000

NA means “not available”.

Antimony

Antimony was detected in only seven indoor dust samples. The highest level found (150 ppm) is the only concentration that exceeded the ATSDR Environmental Media Evaluation Guide (EMEG) for chronic soil ingestion in children (20 ppm). Although limited toxicological data exist for antimony, it is known that the most common form in the environment, is the most likely antimony-containing compound found in household dust. Effect levels for antimony trioxide are about 500 mg/kg/day in animals. Even assuming a worst-case exposure (a 10 kg child consuming 5 grams of contaminated soil/dust a day), a child is not likely to ingest more than 0.002 mg/kg/day. Only a small amount of additional antimony (0.0003 mg/kg/day) is obtained from the diet. Although there are limited data showing that antimony is a dermal irritant, this effect occurs at much higher concentrations (i.e., greater than 5,000 ppm) [30].

Arsenic

The concentrations of arsenic detected in the dust samples ranged from 1 - 60 ppm with an average of 7.4 ppm. The highest level of arsenic found in indoor dust (60 ppm) is three times higher than the ATSDR's soil screening value for chronic non-cancer effects in children (20 ppm). The ATSDR Environmental Media Evaluation Guides (EMEGs) for arsenic in soil and water were based on a Taiwanese drinking water study [15]. Because arsenic is several times more bioavailable in drinking water than in soil or dust, the soil EMEGs, which do not take bioavailability into account, are more conservative than the drinking water EMEGs which are based on the same drinking water study. Assuming a bioavailability of 40% and the typical mass loading for indoor dust, a child would have to consume dust from an area about half the size of a standard room to ingest an amount equal to the chronic dose (MRL) on which the EMEG is based. It is unlikely that a child would consume dust from that large an area on a daily basis. As a result, no adverse health effects are expected to result from the ingestion of household dust containing up to 60 ppm arsenic.

Barium

Levels of barium ranged from 20 - 4200 ppm, with an average value of 201 ppm. Only one barium level exceeded the appropriate comparison value (4000 ppm). This level was found at the same residence where the highest surface soil level of barium (8560 ppm) was found. Because an estimated 31% or more of household dust is comprised of outdoor soil [31], this result is not surprising.

As with arsenic, a child would have to consume dust every day from an area measuring about 100 square feet to receive a potentially harmful dose. It is unlikely that every day a child would collect and consume dust from an area that large. Therefore, even the highest level of barium found in Churchill County's residential indoor dust is not expected to pose a health threat.

Iron

Dust samples contained levels of iron ranging from 1000 - 25,000 ppm. ATSDR has not established a Minimum Risk Level (MRL) for iron. However, these levels are similar to the USEPA Region III RBC for iron in residential soil (23,000 ppm). RBCs are daily exposures not expected to result in any adverse health effects [25]. Therefore, ATSDR does not anticipate that adverse health effects would occur from exposure to iron levels found in indoor dust.

Lead

The lead concentrations detected in indoor dust ranged from 2 - 170 ppm. ATSDR has not established a Minimal Risk Level (MRL) for lead nor has EPA established a reference concentration for lead. However, the EPA Office of Solid Waste and Emergency Response recommends a 400 ppm screening level for lead in residential soil at Superfund sites [22]. Based on the EPA screening level, the lead levels found in indoor dust are not expected to be a public health threat.

Zinc

Zinc is one of the most common elements in the earth's crust and is found in air, soil, and water. It is present in all foods and is an essential food element needed by the body in small amounts [32].

Zinc was found at levels ranging from 42 - 33,000 ppm. The U.S. Recommended Daily Allowance (RDA) for zinc is 15 milligrams per day. This RDA is for adults (except pregnant or lactating women) and children over 4 years of age [33]. No RDA is provided for younger children (less than four years old). Even the highest measured level of zinc, an essential nutrient, is not expected to present a public health threat.

Calcium, Magnesium, Molybdenum, Potassium, Sodium

No public health standards have been established for calcium, magnesium, molybdenum, potassium, and sodium in dust or soil. These metals are, however, major mineral nutrients humans need in their daily diet. Table 4 shows the Recommended Dietary Allowance (RDA) from the new Dietary Reference

Intakes for these minerals [24]. These are amounts that infants, children, and adults need on a daily basis in order to stay healthy. Daily ingestion of 100 milligrams of dust containing the maximum amount of these metals would contribute only a small fraction of the RDA for each of these constituents. ATSDR does not anticipate any adverse health effects from exposure to them at the levels found in the indoor dust samples.

Table 4. Recommended Dietary Allowances (RDA) for Selected Nutrients

Mineral Nutrient	RDA for Infants (mg)	RDA for Children (mg)	RDA for Adults (mg)	Equivalent Concentration in 5 g of Soil for Children's RDA (ppm)
Calcium	270	800	1200	160,000
Magnesium	75	130	320-420	26,000
Molybdenum	20-40	50-150	75-250	30,000
Potassium	700	1600	2000	320,000
Sodium	200	400	500	80,000

Pesticides

Several pesticides were found in indoor dust at levels below the appropriate soil screening value and were eliminated from the list of potential COCs. These pesticides were chlorpyrifos, cyfluthrin, cypermethrin, diazinon, malathion, permethrin, and propoxur. As a result, ATSDR does not expect any adverse health effects in children or adults from exposure to the levels of these pesticides found in indoor dust.

No ATSDR screening values are available for deltamethrin, 1-naphthol, and n,n-diethyl-3-methylbenzamide. ATSDR evaluated these chemicals using other available reference data.

Deltamethrin was found in one indoor dust sample at a concentration of 0.96 ppm. The World Health Organization's Acceptable Daily Intake (ADI) for deltamethrin in food is 0.01 ppm [34]. A 10-kg child daily consuming 100 milligrams of dust containing 0.96 ppm of deltamethrin would ingest 0.000096 milligram of deltamethrin. This amount is more than one thousand times lower than the ADI and would not be a health threat.

1-Naphthol was found in 26 indoor dust samples at levels ranging from 0.7-5.2 ppm. The U.S. Department of Agriculture has established residue tolerances for the insecticide carbaryl (1-naphthyl N-methylcarbamate), including its metabolite, 1-naphthol. These tolerances range from 0.1-10.0 ppm depending on the foodstuff [35]. Based on these tolerance values and the likely amount of indoor dust that children would consume, ATSDR does not consider the levels of 1-naphthol to be a public health threat.

The chemical, n,n-diethyl-3-methylbenzamide (DEET), was found in 66 indoor dust samples at levels ranging from 0.002-1.78 ppm. DEET is the active ingredient in many insect repellent products and is used to repel biting pests such as mosquitoes and ticks. Products containing DEET are currently available to the public in a variety of liquids, lotions, and sprays. Formulations registered for direct application to human skin contain from 4 - 100% DEET. Ingestion of DEET-containing insect sprays and prolonged, excessive dermal application has caused serious central nervous system effects in young children [36]. However, the doses required for these serious effects greatly exceed the doses likely to result from ingestion of the DEET levels found in indoor dust. Therefore, exposure to indoor dust containing the maximum detected concentration of DEET (1.78 ppm) is not considered a public health threat.

Table 5. Summary of Potential Pesticides of Concern in Indoor Dust

Substance	Minimum Concentration (ppm)	Maximum Concentration (ppm)	Average Concentration (ppm)*	ATSDR Comparison Value (ppm)
Deltamethrin	ND	0.96	0.51	NA
1-Naphthol	ND	5.2	0.87	NA
N,N-Diethyl-3-methyl-benzamide	ND	1.78	0.78	NA

* Average values are calculated using one-half the detection limit for samples reported as non-detects.

All reported indoor dust levels are summarized in Appendix B. The reported detection limits for most analytes were lower than or similar to the available comparison value (CV). The pesticide toxaphene had the most notable difference between a CV and reported detection limit. In 21 out of 79 dust samples, the detection limit for toxaphene exceeded the Cancer Risk Evaluation Guideline (0.6 ppm), the most conservative CV. The highest reported sample detection limit was 7 ppm. ATSDR examined the possibility that the actual amount of toxaphene in this sample approached 7 ppm. Assuming the most plausible exposure scenarios for children and adults, the dose from ingesting indoor dust containing 7 ppm toxaphene is 30 times less than the appropriate Minimal Risk Level (MRL). Therefore, the pesticide levels found in indoor dust are not likely to be a public health concern.

Polychlorinated Biphenyls (PCBs)

None of the indoor dust samples showed detectable levels of polychlorinated biphenyls (PCBs). However, the detection limits for the results at some residences were significantly higher than the comparison values. The high detection limits are likely to be due to matrix interference, which is commonly encountered in the analysis of soil and dust samples. Matrix interference can occur when there are physical or chemical interferences within a sample. These interferences prevent the analytical instruments from detecting the true concentration of a sample's target compound.

In most cases, even PCBs present at levels equal to the detection limit would not exceed the typical USEPA site-specific cleanup-level for total PCBs in residential soil (1 ppm). However, the results from samples collected at four residences showed summed PCB detection limits exceeding the comparison value. Therefore, it is theoretically possible that PCB levels approaching 9, 2.4, 2.4, and 2.07 ppm, respectively, in household dust were present at these four residences.

However, no PCBs were detected in the surface soils at any of these four residences (with summed soil detection limits < 1 ppm). An estimated 31% or more of household dust is comprised of outdoor soil [31]. As a result, ATSDR does not expect PCBs in dust to present a public health hazard.

Table 6. Summary of PCBs in Indoor Dust

Substance	Reported Concentration (ppm)	Minimum Detection Limit (ppm)	Maximum Detection Limit (ppm)	Comparison Value (ppm)
Arochlor 1016	ND	0.048	1	0.1
Arochlor 1221	ND	0.096	3	0.22
Arochlor 1232	ND	0.048	1	0.22
Arochlor 1242	ND	0.048	1	0.22
Arochlor 1248	ND	0.048	1	0.22
Arochlor 1254	ND	0.048	1	0
Arochlor 1260	ND	0.048	1	0

Wipe Samples

NDEP also collected a dry wipe sample from a television screen or computer monitor in the family room of each case and control residence. These samples were then submitted for gamma spectrometry and were analyzed for radioactive elements, or radionuclides [14]. The radionuclides measured were ^{57}Co, ^{60}Co, ^{137}Cs, ^{40}K, ^{234m}Pa, ^{226}Ra, ^{228}Ra, $^{233/234}U$, ^{235}U, and ^{238}U.

Radionuclide levels in dust were found to be either at or below the minimum detectable activity (MDA) or were consistent with background concentrations for naturally occurring radioactive material (NORM). For man-made radionuclides, the findings are consistent with regional concentrations from global fallout.

Some of the dust/wipe results indicated a gross alpha activity level slightly above the MDA (64.6 picocuries [or pCi] per sample). For example, ^{226}Ra shows a gross activity of 68.0 pCi/sample. However, ^{226}Ra is typically found in soil at levels ranging from 0.3 to 5 pCi per gram. Because no decay products of ^{226}Ra were found, the slightly elevated results are likely to be a counting anomaly and not actual ^{226}Ra concentrations. As a result, ATSDR recommended that the samples associated with the anomalous results be recounted.

Surface Soil Data for Churchill County

ATSDR evaluated data from the USGS National Geochemical Database, including soil data from the PLUTO geo-chemical database. These data represent analyses of soil samples collected in support of various USGS programs throughout the U.S. from 1971 - 1994 [37]. These soil samples were collected by USGS personnel and analyzed for metals in the analytical laboratories of the Geologic Division of the USGS.

ATSDR evaluated the surface soils data collected for Churchill County. A total of 431 samples were collected and analyzed for a variety of metals, but not all metals were tested for in each sample. In most cases, a given metal was tested in a large number of samples (182-431). However, for some metals (antimony, boron, tellurium, thallium, tungsten, and zirconium), results were available from only one sample collected in 1990. The typical levels for all analyzed metals were below ATSDR screening values. While the maximum levels for two metals (100 ppm arsenic and 32 ppm mercury) exceeded the most conservative ATSDR screening levels, the frequency of exposure in these non-residential areas would be less than for soils in residential settings. The conservative nature of the screening values suggests that no public health hazard exists.

Overall, these data serve to provide perspective on the background levels of metals in Churchill County soils. The area's mineral soils typically contain metals at levels not expected to cause adverse health effects for children or adults.

NON-CANCER HEALTH EFFECTS

Based on this evaluation, ATSDR does not expect an increase in the likelihood of developing non-cancer health effects due to long-term (chronic) exposure to chemicals found in soil or indoor dust.

CANCER HEALTH EFFECTS

Many reported cancer health effects are from epidemiological studies of occupational workers, which could represent the healthiest segment of the population. More sensitive segments of the population, such as children or the elderly, might be susceptible at levels below these reported levels. However, ATSDR considers comparison values such as ATSDR MRLs to be protective of these more sensitive segments of the population.

Levels above a comparison value, but below levels of reported health effects, are in an area of uncertainty requiring further evaluation. ATSDR reviewed the current literature on the toxicity and exposure to residential soils and household dust for both children and adults. Based on this further evaluation, ATSDR has concluded that exposure to soil or indoor dust at the reported levels would not be expected to result in a detectable increase in the incidence of cancer above background levels.

Pesticides in Soil

Among the community concerns raised by residents are the potential health effects from extensive use of pesticides in the Fallon area. Throughout Churchill County, several organized control mechanisms have been established for weeds, insects, and other pests. These mechanisms are used for agricultural fields, roadways, irrigation canals, as well as mosquito breeding and emerging areas. ATSDR evaluated a variety of information sources about pesticide usage in Churchill County. These data do not, however, include information about the levels in soil or other media to which residents might be exposed.

When important information about an exposure pathway is missing or incomplete, ATSDR classifies it as a possible (or potential) exposure pathway. In these cases, not enough information is available to conduct detailed analyses of the amount of exposures to contaminants in areas where people live, work, and play. This issue is addressed in greater detail in the ATSDR Health Consultation entitled "Human Exposure Pathway Analysis of Pesticide Use in Churchill County".

Contaminant Spills/Releases

NDEP reported that no noteworthy fuel or solvent spills have been documented in the Fallon area, although numerous small incidents have occurred. Many of these incidents have involved underground storage tank (UST) leaks. Typically, the resulting groundwater plumes only spread 100-200 feet from the source the result of a low gradient that causes slow groundwater movement [38]. ATSDR reviewed the database provided by NDEP for tracking all contaminant spills and releases reported from 1992-

2001. Table 10 lists the most significant documented fuel, solvent, or other spills in Churchill County [39]. Figure 1 shows the locations where NDEP has undertaken environmental cleanup activities.

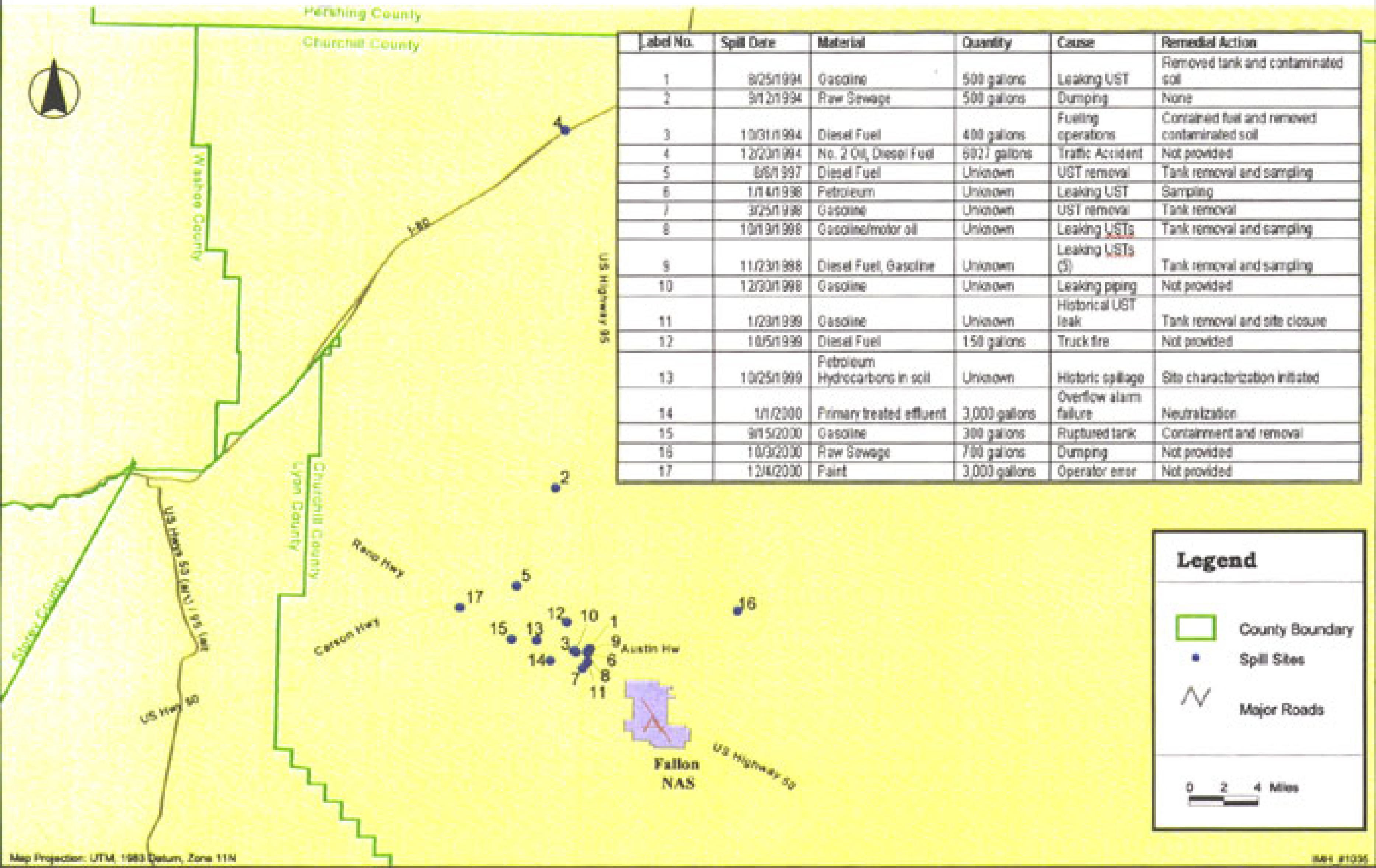
Table 10. Major Spills Reported in Churchill County from 1992-2001 [39]

Spill Date	Material	Quantity	Cause	Remedial Action
8/25/1994	Gasoline	500 gallons	Leaking UST	Removed tank and contaminated soil
9/12/1994	Raw Sewage	500 gallons	Dumping	None
10/31/1994	Diesel Fuel	400 gallons	Fueling operations	Contained fuel and removed contaminated soil
12/20/1994	No. 2 Oil, Diesel Fuel	6027 gallons	Traffic Accident	Not provided
8/6/1997	Diesel Fuel	Unknown	UST removal	Tank removal and sampling
1/14/1998	Petroleum	Unknown	Leaking UST	Sampling
3/25/1998	Gasoline	Unknown	UST removal	Tank removal
10/19/1998	Gasoline/motor oil	Unknown	Leaking USTs	Tank removal and sampling
11/23/1998	Diesel Fuel, Gasoline	Unknown	Leaking USTs (5)	Tank removal and sampling
12/30/1998	Gasoline	Unknown	Leaking piping	Not provided
1/28/1999	Gasoline	Unknown	Historical UST leak	Tank removal and site closure
10/5/1999	Diesel Fuel	150 gallons	Truck fire	Not provided
10/25/1999	Petroleum Hydrocarbons in soil	Unknown	Historic spillage	Site characterization initiated
1/1/2000	Primary treated effluent	3,000 gallons	Overflow alarm failure	Neutralization
9/15/2000	Gasoline	300 gallons	Ruptured tank	Containment and removal
10/3/2000	Raw Sewage	700 gallons	Dumping	Not provided
12/4/2000	Paint	3,000 gallons	Operator error	Not provided

Figure 1

NDEP Environmental Cleanup Locations in Churchill County

NDEP Environmental Cleanup Locations in Churchill County, Nevada



Label No.	Spill Date	Material	Quantity	Cause	Remedial Action
1	8/25/1994	Gasoline	500 gallons	Leaking UST	Removed tank and contaminated soil
2	9/12/1994	Raw Sewage	500 gallons	Dumping	None
3	10/31/1994	Diesel Fuel	400 gallons	Fueling operations	Contained fuel and removed contaminated soil
4	12/20/1994	No. 2 Oil, Diesel Fuel	6027 gallons	Traffic Accident	Not provided
5	8/6/1997	Diesel Fuel	Unknown	UST removal	Tank removal and sampling
6	1/14/1998	Petroleum	Unknown	Leaking UST	Sampling
7	3/25/1998	Gasoline	Unknown	UST removal	Tank removal
8	10/19/1998	Gasoline/motor oil	Unknown	Leaking USTs	Tank removal and sampling
9	11/23/1998	Diesel Fuel, Gasoline	Unknown	Leaking USTs (3)	Tank removal and sampling
10	12/30/1998	Gasoline	Unknown	Leaking piping	Not provided
11	1/20/1999	Gasoline	Unknown	Historical UST leak	Tank removal and site closure
12	10/5/1999	Diesel Fuel	150 gallons	Truck fire	Not provided
13	10/25/1999	Petroleum Hydrocarbons in soil	Unknown	Historic spillage	Site characterization initiated
14	1/1/2000	Primary treated effluent	3,000 gallons	Overflow alarm failure	Neutralization
15	9/15/2000	Gasoline	300 gallons	Ruptured tank	Containment and removal
16	10/3/2000	Raw Sewage	700 gallons	Dumping	Not provided
17	12/4/2000	Paint	3,000 gallons	Operator error	Not provided

Fallon Freight Yard

The Fallon Freight Yard occupies 6.35 acres at 380 North Taylor Street. The Southern Pacific Railroad line runs from east to west along the southern boundary of the site. The site is located ¼ mile north of U.S. Highway 50 and ¼ mile west of State Highway 95. Situated in a multi-use industrial, residential, and limited commercial area, it is surrounded by a chain-link fence. The site consists of a one-story chemical storage shed, an elevated roadway used for loading railcars, and a railroad spur [40].

Since 1920 the property has been owned by the U.S. Bureau of Reclamation (BOR). From 1926 to 1983, the Truckee Carson Irrigation District (TCID) used it as a maintenance and storage area. The city of Fallon has leased the property since 1984. The site has been used for the storage and maintenance of heavy equipment, hazardous waste, vehicles, chemicals, pipes, pumps, surplus traffic control equipment, and light poles, as well as above-ground storage tanks for diesel and for gasoline [40].

Since 1992 several environmental surveys have been conducted at the site. In January 2000, soil samples confirmed the presence of waste oil, diesel fuel, and PCBs (Arochlor 1254). To determine whether site remediation is needed, the Bureau of Reclamation will conduct a more extensive site sampling investigation in 2003 [40].

ATSDR's Child Health Initiative

ATSDR's Child Health Initiative recognizes that the unique vulnerabilities of infants and children require special emphasis in communities faced with environmental contamination. For this evaluation, ATSDR has taken into account that children could be exposed to environmental contaminants.

Conclusion

Based on the currently available information, ATSDR concludes that the contaminant levels found in residential play yard soils, indoor dust, and non-residential soils are not a public health concern.

Recommendations

None.

Appendix A. Pesticide Levels in Residential Surface Soil

Substance	Number of Detections	Minimum Concentration (ppm)	Maximum Concentration (ppm)	Detection Limit (ppm)	Comparison Value (ppm)
2,4-D	0			0.5	NA*
Aldrin	0			0.0017–0.0027	0.04
Atrazine	1	0.046	0.046		70
Carbofuran	0			0.015	10
Chlorpyrifos	3	0.0057	0.825		2
Cis-Chlordane	21	0.0026	0.13		1**
Coumaphos	0			0.3	NA
Cyfluthrin	0			0.15	50
Cypermethrin	0			0.15	20
Deltamethrin	1	0.179	0.179		NA
Diazinon	19	0.0003	0.807		55
Dieldrin	4	0.0026	0.19		0.2
Dimethoate	0			0.002	0.4
Methyl-Chlorpyrifos	0			0.003	610
DDD, P,P’	10	0.0022	0.0064		3
DDE, P,P’	23	0.0019	0.095		2
DDT, P,P’	10	0.0039	0.16		2
Alpha-Endosulfan	2	0.00068	0.0008		NA
Beta-Endosulfan	2	0.004	0.02		NA
Endosulfan Sulfate	2	0.0021	0.0024		NA
Endrin Aldehyde	3	0.0018	0.0022		NA
Endrin Ketone	1	0.0037	0.0037		NA
Endrin	0			0.0033-0.017	0.6
Guthion	0			2	NA
Heptachlor Epoxide	17	0.00099	0.017		0.08
Heptachlor	2	0.0017	0.0019		0.2
Hexachlorocyclohexane, alpha	2	0.0084	0.001		0.1
Hexachlorocyclohexane, beta	3	0.0029	0.0041		0.4
Hexachlorocyclohexane, delta	0				0.4
Hexachlorocyclohexane, gamma	4	0.00098	0.014		0.02
Isazophos	0			0.001	NA
Isophorone	0			0.003	400
Karbutilate	0			0.33-0.53	NA
Lasso	0			50	0
Malathion	1	0.229	0.229		40
Methyl Parathion	1	0.0087	0.0087		0.6
Methamidophos	0			0.01	0.1
Methoxychlor	0			0.019	10
1-Naphthol	0			0.015	NA
N,N-Diethyl-3-Methylbenzamide	15	0.0005	0.045		NA
Orthene	0			0.6	80
Parathion	0			0.005	0
Permethrin	3	0.025	0.112		100
Pirimiphos	0			0.005	610
Methyl-Pirimiphos	0			0.003	NA
Propoxur	0			0.01	8
Sevin	3	0.058	0.628		200
Toxaphene	1	0.28	0.28		0.6
Trans-chlordane	24	0.0018	0.054		NA

* Not Available
** Comparison Value for Chlordane

Appendix B. Summary of Pesticides in Indoor Dust

Substance	Number of Detections	Minimum Concentration (ppm)	Maximum Concentration (ppm)	Detection Limit (ppm)	Comparison Value (ppm)
Aldrin	0			0.002-0.07	0.04
Atrazine	0			1	70
Carbofuran	0			0.25	10
Cis-chlordane	0			0.002-0.21	1*
Chlorpyrifos	21	0.006	0.53		2
Coumaphos	0			2	NA**
Cyfluthrin	3	24	61		1000
Cypermethrin	1	240	240		500
Deltamethrin	1	0.96	0.96		NA
Diazinon	65	0.001	1.3		55 (EPA R9)
Dieldrin	0			0.005-0.1	0.04
Dimethoate	0			0.5	0.4
Gamma-chlordane	0			0.002-0.3	NA
Methyl-chlorpyrifos	0			1	610 (EPA R9)
DDD, P,P'	0			0.005-0.1	3
DDE, P,P'	0			0.005-0.1	2
DDT, P,P'	0			0.005-0.11	2
Alpha-Endosulfan	0			0.002-0.014	4***
Beta-Endosulfan	0			0.005-0.09	4***
Endosulfan Sulfate	0			0.005-0.1	4***
Endrin Aldehyde	0			0.005-0.27	NA
Endrin Ketone	0			0.005-0.1	NA
Endrin	0			0.005-0.1	0.6
Heptachlor Epoxide	0			0.002-0.09	0.08
Heptachlor	0			0.002-0.4	0.2
Hexachlorocyclohexane, alpha	0			0.07	0.1
Hexachlorocyclohexane, beta	0			0.07	0.4
Hexachlorocyclohexane, delta	0			0.07	NA
Hexachlorocyclohexane, gamma	0			0.07	0.5
Isazophos	0			0.05	NA
Karbutilate	0			50	NA
Lasso	0			0.25	0
Malathion	6	0.2	14		40
Methyl parathion	0			2	0.6
Methoxychlor	0			0.2-0.7	10
1-Naphthol	26	0.7	5.2		NA
N,N-Diethyl-3-Methylbenzamide	66	0.002	1.78		NA
Orthene	0			6	80
Parathion	0			0.2	0
Permethrin	7	0.13	8.8		100
Pirimiphos	0			0.75	610 (EPA R9)
Methyl-pirimiphos	0			0.5	NA
Propoxur	2	0.285	1		8
Toxaphene	0			0.2-7	0.6

* Comparison Value for Chlordane
** Not Available
*** Comparison Value for Endosulfan

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