Asbestos Exposure and Human Health Risk Assessment, Asbestos Air Sampling, Conducted September 27th through 29th, 2005, Clear Creek Management Area, California: Adult and Child Exposures

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DATE: September 5, 2007

Executive Summary

This memorandum evaluates the asbestos exposure levels and potential human health cancer risks caused by inhaling asbestos generated by recreational activities at the Clear Creek Management Area (CCMA), based on September 27 through September 29, 2005 sampling results. Asbestos exposure concentrations, expressed as Phase Contrast Microscope equivalent fibers per cubic centimeter (PCMe fibers/cc) are presented for adult and child receptors. Potential Excess Lifetime Cancer Risks (ELCR), based on United States Environmental Protection Agency's (U.S. EPA) and California Environmental Protection Agency's (Cal/EPA) asbestos inhalation unit risk value for carcinogenic effects, are estimated for adult receptors assuming 30 years of recreational exposures. Additionally ELCRs are estimated for adult receptors assuming 18 years and for child receptors assuming 12 years of recreational exposures. The risks are totaled for the adult (18-year exposure duration) plus child receptors based on results evaluated with EPA's unit risk value for carcinogenic effects. Finally, risks are estimated for combined activities that could be experienced by an adult or child during recreational visits to the CCMA using results based on the U.S. EPA unit risk value.

Asbestos air samples were collected using activity-based sampling techniques for the following adult and child recreational use and adult worker scenarios commonly conducted at the CCMA (Table 1):

- Motorcyclists and trailing riders
- ATV (4-wheel all terrain vehicle) riders and trailing riders
- SUV (sport utility vehicle) driver/riders and trailing vehicle riders (windows open and closed)
- Hiker (lead and trailing)
- Camper

- Sleeping Camper
- Vehicle washers and vacuumers (adults only)
- Post decontamination drivers and riders (windows open and closed)
- Fence builder/repair (adult only)

The Hazardous Asbestos Area (HAA) at the CCMA is a 30,000 acre area that is designated as hazardous by the Bureau of Land Management (BLM) due to elevated soil concentrations of naturally occurring asbestos. The rugged terrain at the CCMA is a popular and challenging riding spot for off-road vehicles including motorcycles, all terrain vehicles (ATVs) and sport utility vehicles (SUVs). Ambient air samples were also collected using high volume, stationary pumps at four locations. Six ambient air samples (Section 8 and Oak Flat Campground) were collected outside of the HAA at the CCMA, and five samples were collected inside the hazardous zone at Staging Areas 2 and 6. Ambient air concentrations were not quantitatively evaluated in this memorandum but in comparison to the activity-specific asbestos concentrations, the ambient air concentrations are generally lower.

Off highway vehicle (OHV) usage for the purposes of this study include motorcycle, ATV and SUV riding on the unpaved roads and trails found within the CCMA. Since BLM employees engage in OHV riding, hiking, vehicle cleaning activities, and fence building/repair while working within the hazardous zone, adult minimum and maximum asbestos air concentrations based on activity-based samples, are compared with airborne asbestos standards established by Occupational Safety and Health Administration (OSHA) (Table 2A). These standards include the Permissible Exposure Limit (PEL) and the 30-minute Maximum Excursion Limit. Adult and child minimum and maximum asbestos air concentrations, based on activity-based samples, are reported in Tables 2A and 2C, respectively. Ambient airborne asbestos concentrations, based on stationary sampling, are reported in Table 2B.

Excess Lifetime Cancer Risk (ELCR) values are estimated, for minimum and maximum asbestos air concentrations, using exposure assumptions appropriate for adult (30 years exposure duration, Tables 4A through 4D); child (12 years exposure duration, Tables 5A through 5D) and a second adult scenario (18 years exposure duration, Tables 6A through 6D) recreational users at this site. These ELCR values are compared to the risk management range of 1E-06 to 1E-04, which is used by EPA's Superfund Program to define an acceptable risk, if managed appropriately. Estimated ELCR values exceeding this range are considered unacceptable, requiring a more aggressive approach to mitigate risk.

Exposures for trailing adult OHV riders frequently exceeded OSHA's PEL (0.1 fiber/cc) and, in one case, exceeded the 30-minute excursion limit (1 fiber/cc) (Table 2A). However, it should be noted that the OSHA PEL is an 8-hour time weighted average (TWA) and the exposure scenarios in this study were run for less than 8 hours. Child maximum measured asbestos air concentrations for the motorcycle rider, ATV rider, and SUV passenger exceeded adult maximum air concentrations for most riding activities except the second trailing motorcycle rider, the lead SUV driver/rider, and the camper (Table 2C). Additionally, child minimum asbestos air concentrations exceeded adult values for all motorcyclist positions, all ATV rider positions, the trailing SUV rider (windows closed), and both the lead and trailing hiker.

Results Using the U.S. EPA IRIS Inhalation Unit Risk:

For the 30-year exposure duration, the estimated ELCRs using the U.S. EPA Integrated Risk Information System (IRIS) inhalation unit risk for the adult trailing motorcycle, ATV, and SUV (Windows Open) riders exceeded 1E-04 (100 in a million), for minimum and maximum air concentrations, when the user is assumed to ride more than 12 days/year (Tables 4A and 4B). The ELCRs for lead vehicle riders were often less than for trailing riders and sometimes less than 1E-06, for minimum air concentrations. The trailing rider followed at a safe distance for the riding conditions, typically 100 to 200 feet back, in the dust cloud of the previous rider, but far back enough to maintain visibility. For the 18-year exposure duration, a majority of the ELCRs for the adult trailing motorcycle, ATV, and SUV riders exceeded 1E-04. The adult camper that camps more than 5 days/year had ELCRs that exceeded 1E-04, for maximum air concentrations. The fence builder/repairer that works more than 12 days/year had an ELCR that exceeded 1E-04, for maximum air concentrations. The ELCRs for the child motorcycle, ATV, and SUV riders were less than 1E-04 but greater than 1E-06, for minimum and maximum air concentrations in the lead and trailing positions (Tables 5A and 5B). Due to the exposure assumptions used for a child, the child ELCRs were lower than the adult ELCRs even though the child exposure concentrations were higher. Asbestos cancer risks for both adult and child hiking, vehicle cleaning, and post-decontamination driving scenarios were all less than 1E-04, with many minimum asbestos concentrations exhibiting risks of less than 1E-06.

The total ELCRs for child (12 year) plus adult (18 year) receptors were summed for individual activities. Child exposure was estimated by having an adult use the sampling device at a lower height representative of a child's breathing height. The total ELCRs for adult plus child for the trailing motorcyclist (both first and second trailing motorcycles), ATV, and SUV riders (windows open and closed) equaled or exceeded 1E-04 (100 in a million), for maximum asbestos concentrations, when the user is assumed to ride 12 or more days/year (Table 8B). The total ELCRs for the lead motorcycle rider were less than 1E-04 in all cases evaluated (Tables 8A and 8B). Total asbestos cancer risks for hiking scenarios were all less than 1E-04. The total ELCRs for the camper exceeded 1E-04, for maximum asbestos concentrations, when the user is assumed to camp 5 or more days/year.

Finally, risks are estimated for combined activities that could be experienced by an adult or child during recreational visits to the CCMA. Those combined activities include driving to the vehicle staging areas in an SUV, motorcycling (or hiking/hunting), camping, and camping overnight. The total risks for combined activities are found to be significantly greater than that for any single activity.

Results Using Cal/EPA's OEHHA Unit Risk:

For the 30-year exposure duration, the estimated ELCRs using the OEHHA unit risk for the adult trailing motorcycle and ATV, and SUV riders equaled or exceeded 1E-04 (100 in a million), for minimum and maximum air concentrations, when the user is assumed to ride more than 12 days/year (Tables 4C and 4D). The ELCRs for lead vehicle riders were often less than for trailing riders and almost always less than 1E-04, for minimum air concentrations. The ELCRs for the child trailing motorcycle, ATV, and SUV riders exceeded 1E-04, for maximum air concentrations (Table 5D). For the 18-year exposure duration, the ELCRs based on the OEHHA unit risk for the adult motorcycle, ATV, and SUV riders equaled or exceeded 1E-04, for maximum air concentrations, when the rider is exposed for more than 5 days/year (Table 6D). The ELCRs for the adult camper that camps for more than 1 day/year exceeded 1E-04, for maximum air concentrations (Table 6D).

The ELCRs for adult campers for maximum air concentrations all exceeded 1E-04 as did the ELCR for child campers for maximum air concentrations and high estimate exposures. The ELCRs for adult hikers (30 year exposure duration) for maximum air concentrations also exceeded 1E-04. Additionally, the ELCR for adult fence builders/repairer equaled or exceeded 1E-04 for maximum air concentrations. Asbestos cancer risks for child hiking, vehicle cleaning, and post-decontamination driving scenarios were all less than 1E-04, with many minimum asbestos concentrations exhibiting risks of less than 1E-06.

ELCRs for recreational users and BLM workers indicate unacceptable cancer risks for OHV riders, especially those in trailing positions, using EPA's Superfund risk assessment guidance as a standard. The ELCRs based on the OEHHA unit risk were almost an order of magnitude greater than the U.S. EPA's IRIS-based ELCRs. However, child hiking and most adult hiking, vehicle cleaning, and post-decontamination driving activities were within or less than EPA's risk management range, indicating that these risks could, potentially, be mitigated through appropriate management decisions.

<u>Background</u>

The CCMA, located in San Benito County, California, is an approximately 76,000 acre area that contains the New Idria Serpentine Formation. This 30,000 acre geological area, which has been designated a Hazardous Asbestos Area (HAA) by the Bureau of Land Management (BLM), has soils with large amounts of naturally occurring asbestos. The CCMA is one of four geographically distinct areas of the Atlas Asbestos Mine Superfund Site. It is managed by the BLM, Hollister, California. The naturally barren slopes, bald ridges, network of bulldozed mining trails, and isolated location make the CCMA a popular location for recreational use by OHV users, hunters, hikers, and campers, including many families with children.

Since the 1970's investigators have studied asbestos dust exposures of recreational users and BLM employees within the HAA (Cooper et al., 1979, Popendorf and Wenk, 1983). The "Human Health Risk Assessment for the Clear Creek Management Area" was developed for the BLM by PTI Environmental Services (1992) to assess the potential hazards and risks posed to public health associated with the inhalation of airborne asbestos generated during OHV use, as well as other uses that generate less dust. The current work is part of the task to update BLM's 1992 Human Health Risk Assessment (HHRA). This study differs from the BLM study in using transmission electron microscopy, rather than phase contrast microscopy, to analyze air samples for asbestos. In addition, this study specifically evaluates asbestos exposures to children. Children were not actually used during the sampling efforts; instead, exposures were estimated by having an adult use the sampling device at a lower height representative of a child's breathing height.

Introduction

Asbestos air sampling was conducted at the CCMA on September 27 through 29, 2005. The asbestos air sampling and analysis approach and methodology are presented in the "Sampling and Analysis Plan for Asbestos Air Sampling, Clear Creek Management Area" (CH2M HILL, 2004).

Breathing zone air samples were collected by adult study participants while performing recreational and occupational activities (i.e. activity-based samples), listed in Table 1. Using standard asbestos sampling techniques, air was sampled from the personal breathing space of the participants. This was done using a calibrated air pump attached to a plastic cassette, which contained an asbestos fiber-sampling filter. Concurrently, samples were collected at assumed child's breathing zone levels, by the adult study participants, for similar recreational activities, as appropriate.

The collected samples were sent to an analytical laboratory, EMSL Analytical, Inc., which analyzed the filters for asbestos type and concentrations in air by Transmission Electron Microscopy (TEM), using ISO 10312 methodology. The analytical results were compiled and reported as PCMe (Phase Contrast Microscope equivalent) fibers by Lockheed Martin REAC. The number of samples counted, and both minimum and maximum measured air concentrations of asbestos (exposure point concentrations) in units of PCMe fibers/cc (which are equivalent to fibers/ml), are presented for adult and child receptors (Table 2A and 2C). Minimum and maximum chronic exposure concentrations were derived from these measured air concentrations of asbestos as presented below.

For this HHRA, exposures and risks were calculated using EPA based approaches and methodology as presented in the PTI Environmental Services HRA (1992), as described in the following sections.

Quality Control Data Utilization:

The laboratories that performed the asbestos counts reported a number of Quality Control (QC) sample types. Because of these differences in reporting, the sample results, and how they were utilized in the risk calculations, were treated differently depending upon their QC designation. On Table A1, non-detected values are reported as less than the sensitivity analysis value. The equation used to calculate the sensitivity analysis value is:

$$\text{Sensitivity (S)} = Af / (k*Ag*V)$$

Where:
Af = the area, in square millimeters, of sampling collection filter;
Ag = the area, in square millimeters, of TEM specimen grid opening;
k = the number of grid openings examined;
V = the volume of air sampled, in liters

Listed below are the QC sample types, how they were used or considered in the risk calculations, and the rationale:

- Not QC sample, revised count: Use the latest revision, since multiple analysts determined the best definitions for fibers and the latest revision is their consensus opinion
- Recount same grid (RS) - Average the recounted sample results since they are independent samples and there is no reason to expect one count to be more reliable than another
- Recount different grid (RD) - Average the recounted sample results for same reason as for the RS sample results
- Interlab (IL) - Average the result of the interlab sample results with the result of the original sample (not QC), since they are independent samples and there is no reason to expect one count to be more reliable than another
- Repreparation (RP) - Average the result of the repreparation sample with the result of the original sample (not QC), since they are independent samples and there is no reason to expect one count to be more reliable than another
- Verified Analysis (VA) – Use Verified Analysis result over original sample results
- Field Duplicates – Take the average of the sample results, since they are independent samples

Table A2 provides a summary of the multiple sample results and the action taken.

Asbestos Dose-Response:

The EPA weight of evidence classification for asbestos is known human carcinogen (Table 7). The basis of the classification, the observation of increased mortality and incidence of lung cancer, mesotheliomas, and gastrointestinal cancer in occupationally exposed workers, are consistent across investigations and study populations (U.S. EPA, 2007a).

The U.S. EPA IRIS inhalation unit risk for asbestos is 2.3E-01 $(f/ml)^{-1}$ $[fibers/milliliter]^{-1}$. According to EPA guidance, the unit risk should not be used if the air concentration exceeds 4E-02 fibers/ml, since above this concentration the slope factor may differ from that stated (U.S. EPA 2007a). In this risk assessment the calculated chronic exposure concentrations were compared to 4E-02 fibers/ml and none of the values were found to exceed that value. The unit risk is based on fiber counts made by phase contrast microscopy (PCM). In this study PCM equivalent (PCMe) fibers are measured using transmission electron microscopy (TEM) and are defined as asbestos fibers > 5 microns long, $\geq$ 0.25 microns and $\leq$3 microns in width, with an aspect ratio $\geq$ 3:1. These dimensions are used because they are equivalent to the range of fiber dimensions that can be detected with PCM.

The Cal/EPA OEHHA (Office of Environmental Health Hazard Assessment) inhalation unit risk for asbestos of 1.9 $(f/ml)^{-1}$ was also used in the risk calculations as a comparison to the IRIS inhalation unit risk results. It is useful to compare the two unit risk results because the two values can be used to bracket the range of toxic effects from asbestos exposures at CCMA. IRIS used a combination lung cancer and mesothelioma model for the population whereas OEHHA used mesothelioma incidence in non-smoking females only for its derivation. Also, OEHHA considers different health endpoints than IRIS. The quantitative unit risk estimate is limited by uncertainty in the exposure estimates, which results from a lack of data on early exposure in occupational studies and the uncertainty of conversions between various analytical measurements for asbestos (U.S. EPA, 2007b).

Exposure Estimate:

The following airborne asbestos inhalation exposure algorithm is based on the 1992 PTI HRA:

$$EC = \frac{C_a \times ET \times EF \times ED}{AT}$$

Where,

EC = Chronic Exposure Concentration (averaged over a 70-year lifetime) [f/ml]
C_a = Asbestos Concentration in fibers per cubic centimeter (f/ml)
ET = Exposure Time in hours/day
EF = Exposure Frequency in days/year
ED = Exposure Duration in years
AT = Averaging Time of 24 hours/day x 365 days/year x 70 years (lifetime).

Asbestos exposures are estimated for adult receptors assuming 18 and 30 years of recreational exposures and for child receptors assuming 12 years of recreational exposures. These exposures are based on the assumption that an individual is exposed to airborne asbestos at the CCMA during recreational activities for a total of 30 years. This can be allocated as 12 years as a child, experiencing the child exposure levels measured at the CCMA, and 18 years as an adult, experiencing the adult exposure levels. The rationale for this allocation of years is based on the assumption that asbestos exposures are related to breathing height. A child, who starts recreating at the CCMA at age 6, will spend about 6 years at a height less than 5 feet, and another 6 years before reaching full height, which equals 12 total child years of exposure. Then as an adult, this same receptor will then spend 18 years (from age 18 to 36) at full height, experiencing adult exposure levels.

Exposure assumptions appropriate for recreational users are presented in Table 3A (adult - 30 year exposure duration), Table 3B (child – 12 year exposure duration) and Table 3C (adult – 18 year exposure duration). All Chronic Exposure Concentrations estimated in this study (Tables 9 through 18 for the adult – 30 year exposure, Tables 19 through 26 for the child – 12 year exposure, and Tables 27 through 34 for the adult – 18 year exposure) were less than 4E-02 fibers/ml.

Risk Calculation:

The upper-bound excess lifetime cancer risks were calculated using the following equation described in EPA risk assessment guidance documents (EPA 1989) and is presented in the 1992 PTI HRA:

$$ELCR = EC \times URF$$

Where,

ELCR = Excess Lifetime Cancer Risk
EC = Chronic Daily Exposure Concentration (averaged over a 70-year lifetime) [f/ml]
URF = IRIS Unit Risk Factor for inhalation of asbestos [0.23 $(f/ml)^{-1}$] and OEHHA Unit Risk Factor for inhalation of asbestos [1.9 $(f/ml)^{-1}$].

For the 30-year exposure duration, estimated ELCRs using the IRIS inhalation unit risk for individual adult scenarios are presented in Tables 9 to 18 and summarized in Tables 4A and 4B (risk results using the OEHHA unit risk are summarized in Tables 4C and 4D). Estimated potential cancer risks for individual child scenarios are presented in Tables 19 to 26 and summarized in Tables 5A and 5B (risk results using the OEHHA unit risk are presented in Tables 5C and 5D). For the 18-year exposure duration, ELCRs based on the IRIS inhalation unit risk for adult scenarios are presented in Tables 27 through 34 and summarized in Table 6A and 6B (OEHHA unit risk results in Table 6C and 6D).

Results

Adult and child activity-based asbestos air sampling, conducted on September 27 through 29, 2005, included off highway vehicle riding (OHV) (motorcycles, ATVs and SUVs), hiking, camping, vehicle washing and vacuuming, post-decontamination driving, and fence building/repairing (Table 1). Adult OHV riders in trailing positions were exposed to airborne asbestos concentrations, in their breathing zone, that frequently exceeded the OSHA PEL of 0.1 fiber/cc (Table 2A). However, most exposures for lead adult OHV riders did not exceed the PEL. It should be noted that the OSHA PEL is an 8-hour time weighted average (TWA) and the exposure scenarios in this study were run for less than 8 hours. One trailing adult motorcyclist was exposed to a concentration (1.3 PCMe fibers/cc) which is greater than OSHA's 30-minute "not to exceed" excursion level of 1.0 fiber/cc. Adult hiking and camping exposures did not exceed OSHA's PEL except for the maximum asbestos concentration for the camper.

Child maximum measured asbestos air concentrations for the motorcycle rider, ATV rider, and SUV passenger exceeded adult maximum measured air concentrations for most riding activities (Table 2C). The highest asbestos air concentration was for a trailing child motorcyclist air sample which had a concentration of 1.2 PCMe fibers/cc. Additionally, child minimum asbestos air concentrations exceeded or equaled adult values for trailing motorcyclists and trailing ATV rider positions.

In this memorandum, risks are evaluated for both child and adult recreational exposures assuming exposure durations of 12 years and both 18 and 30 years, respectively. Two adult exposure durations are evaluated so the risks to the receptor that starts exposure as an adult can be compared with the risks to the receptor that begins exposure as a child and continues to be exposed as an adult. Risks are estimated using both the U.S. EPA IRIS and the Cal/EPA OEHHA unit risk values. Then, only for results based on the IRIS unit risk value, the risks are summed for a child plus adult recreational exposure duration of 30 years at the CCMA.

For both adult and child exposures, ELCRs are calculated from exposure parameters for 1-day per year, 5-day per year (Reasonable Maximum Exposure [RME]) and 12-days per year (high estimate) exposure frequencies (Table 3A [adult – 30 year exposure duration], Table 3B [child – 12 year exposure duration] and Table 3C [adult – 18 year exposure duration]). For both adult and child exposures, ELCRs are calculated using both the IRIS and OEHHA unit risk factors.

Calculations for individual adult activities (30 year exposures) are shown in Tables 9 to 18, and ELCR values are presented based on the IRIS and OEHHA unit risks in Tables 4A through 4D. These values indicate that, for maximum asbestos air concentrations, trailing OHV riders always exceeded the upper limit (1E-04) of EPA Superfund Program's risk management range (1E-06 to 1E-04), when 12 or more riding days per year are assumed (Tables 4B and 4D). Cancer risks for lead OHV riders were less than for trailing riders, with the maximum risks usually falling within the risk management range for minimum asbestos air concentrations (Tables 4A and 4C). Some hiker, camper and sleeping camper, vehicle washing and vacuuming, post-decontamination driver, and fence builder/repairer exposures exceeded an ELCR of 1E-06 for minimum asbestos air concentrations, but no exposures for these receptors exceeded the upper limit of the risk management range of 1E-04 (Tables 4A and 4C). The ELCR values using the OEHHA unit risk were an order of magnitude greater than ELCR values based on the IRIS unit risk factor.

Calculations for individual child activities (12 year exposures) are shown in Tables 19 to 26, and the ranges of ELCR values are presented in Tables 5A through 5D. These values indicate that ELCRs based on the OEHHA unit risk factor, for maximum asbestos air concentrations, trailing OHV riders always exceeded the upper value (1E-04) of EPA Superfund Program's risk management range (1E-06 to 1E-04), when 12 or more riding days per year are assumed (Tables 5B and 5D). The ELCRs based on the IRIS unit risk factor were all less than 1E-04, but exceeded 1E-06 most of the time. Except for the high estimate exposure camper, all hiker, camper, sleeping camper, or post-decontamination rider ELCRs are within or less than the risk management range. The ELCR values using the OEHHA unit risk were almost an order of magnitude greater than ELCR values based on the IRIS unit risk value.

Calculations for individual adult activities (18 year exposures) are presented in Tables 27 through 34, and ELCRs are summarized in Tables 6A through 6D. For maximum air concentrations, the trailing OHV riders exceeded 1E-04 a majority of the time, when riding for more than 12 days/year. The ELCRs for the adult camper also exceeded 1E-04 for exposures to maximum air concentrations. The ELCR values using the OEHHA unit risk were almost an order of magnitude greater than ELCR values based on the IRIS unit risk factor.

There was not significant difference in measurements between when SUV riders had their windows open and when their windows were closed. The maximum concentrations for each SUV scenario evaluated ranged from 0.17 to 0.98 PCMe fibers/cc. For individual recreational activities, the ELCRs for child (12 year) and adult (18 year) recreational users were summed. Total child plus adult ELCRs were only estimated for risks evaluated using the EPA IRIS unit risk (see Table 8a and 8b). The total ELCRs for adult plus child for the trailing motorcyclist, ATV, and SUV riders equaled or exceeded 1E-04 (100 in a million), for maximum asbestos concentrations, when the rider is assumed to be exposed 12 or more days/year (Table 8B). The total ELCRs for the camper exceed 1E-04, for maximum air concentrations, when camping 5 or more days/year. Finally, risks are estimated for selected combined activities that could be experienced by an adult or child during recreational visits to the CCMA, based on risks evaluated using only the U.S. EPA IRIS unit risk (Tables 35 through 38). Those combined activities include driving to the vehicle staging areas in an SUV, motorcycling (or hiking/hunting), camping, and camping overnight. The summed risks for combined activities are significantly greater than that for any single activity. These values indicate that, for combined activities including an adult motorcyclist and hiker exposed to maximum asbestos concentration, cancer risks exceeded the upper value (1E-04) of EPA Superfund Program's risk management range (1E-06 to 1E-04), when 3 or more riding days per year combined with overnight camping are assumed (Tables 35B and 36B). The adult motorcyclist and hiker exposed to minimum concentrations had cancer risks within EPA's risk management range (Tables 35A and 36A). All of the combined activities for the child motorcyclist and hiker scenarios were either well below or within EPA's risk management range (Tables 37 and 38). These results indicate that motorcycling, SUV driving to a staging area, camping, and hiking/hunting all can contribute significantly to risks during recreational visits to the CCMA.

Uncertainty Analysis:

This risk assessment presents quantitative estimates of some potential current and future cancer risks for recreational users of the CCMA. However, it is important to note that these numbers do not predict individual exposures, or actual health outcomes. Specific uncertainties should be considered when interpreting the results for this risk assessment, as follows:

- SAMPLING UNCERTAINTY

  - Seasonal Variability

  Soil moisture is likely to affect dust generation and asbestos exposure during recreational activities, such that dry season samples are likely to over-estimate exposure during the wet season and wet season samples are likely to underestimate exposure during other times of the year. This uncertainty is addressed in this study by sampling during different seasons, ranging from very dry to very wet. Three activity-based asbestos sampling events were completed at the CCMA during November 2004, February 2005, and September 2005. The sampling event that occurred in September 2005 represents climate conditions during the dry season while the November 2004 and February 2005 represent the wet season. The dry season is assumed to contribute more asbestos fiber-containing dust to air which may overestimate the risk results, while the wet season is assumed to have comparably less asbestos containing dust in air. More motorcycle riders use the CCMA during cooler weather. Seasonal asbestos air concentrations will be compared in a future report. In addition, soil samples were collected along all routes traveled during activity-based sampling, and analyzed for soil moisture (soil data will be presented and interpreted in a future report).

- Within Season Variability

    - Time of Day, Style of Riding, Vehicle Type, Window Position, Other Non-seasonal Factors. Exposure concentrations may vary due to time of day, style of riding, vehicle type, if the vehicle windows are open or closed, distance from preceding rider, height of rider, etc. These sources of variation could result in exposure concentrations greater or less than those observed during this sampling event. This uncertainty was addressed by performing each sampling scenario (e.g., ATV riding at the tail of three riders) more than once per day and on consecutive sampling days, to obtain a range of asbestos air concentrations for each scenario within a sampling event. Risks were then estimated based on minimum and maximum chronic exposure concentrations that were derived from the measured minimum and maximum air concentrations. Due to logistic and cost considerations, sample sizes were limited. Therefore, it is likely that the observed range in exposure concentrations is narrower than would be observed if more samples had been taken with a variety of riders and riding styles.

    - Child vs. Adult Exposures. Children may experience different exposures than adults for three reasons: First, they are shorter, so their distance from the asbestos source (ground) is less than for adults engaged in the same activity. Second, they tend to be trailing, rather than lead motorcycle or ATV riders. Third, in the case of SUVs, children will often ride in the back, rather than front seat. To address this source of uncertainty, asbestos filter cassettes were placed on adult study participants at heights to simulate a child's breathing zone. In the SUV scenario, filter cassettes were placed on the backrest of the back seat to simulate a child's breathing zone.

    - Scenario Routes. Exposure concentrations could, potentially, vary with the route traveled during the sampling activity. The potential for variability within a particular activity scenario (motorcycle, ATV, SUV, hiking) was limited by selecting routes for each scenario and repeating those routes, to the extent possible, during all sampling events. This approach reduced sampling variability within activity scenarios (e.g. ATV riding). However, different routes were selected for each activity (the ATV route was different from the SUV route), which could contribute to variability in asbestos concentrations across scenarios. To address this source of variation, soil samples were taken along each route and analyzed for soil moisture and asbestos concentration, since these parameters could, potentially, be linked to differences in asbestos dust generation. Soil samples were collected from discrete sample locations but activities, by their nature, integrated over a larger area and are representative of actual exposures. The results of soil sampling will be presented and interpreted in a future report.

► ANALYTICAL UNCERTAINTY

- Overloaded Filters. The analysis of asbestos fibers on filters has inherent limitations and uncertainties. If samples are overloaded with asbestos fibers or dust, it may not be possible to analyze them accurately. To address this concern, since overloading of the filters can only be determined by the analytical laboratory, two different sample volumes were collected concurrently for each sampling event, based on anticipated air concentrations from previous site-specific experience. For this sampling event (September 2005), at least one filter, per activity sampling, not over-loaded was obtained, thereby eliminating this source of uncertainty.

- Laboratory Uncertainty. Laboratory uncertainty may result in either over- or underestimates of exposure concentrations. There are numerous potential sources of uncertainties in analyzing asbestos samples using transmission electron microscopy. These uncertainties are addressed to a large degree by the protocol for preparing and analyzing asbestos samples, developed by the International Organization for Standardization, known as ISO 10312. This method includes very specific definitions of structure types, which minimizes subjective decisions by analysts. In addition, it contains very specific counting rules and Quality Assurance/Quality Control (QA/QC) procedures. These include field duplicates, field blanks, and internal checks for consistency among analysts. Laboratory uncertainty may result in either over- or underestimates of exposure concentrations.

- Quality Control Sample Result Utilization. Selected QA/QC sample results were used to calculate the asbestos exposure concentrations for use in the risk assessment. For example, the QC samples classified as RD (recount different), RP (repreparation), and IL (interlab) were averaged with their original sample results. These samples results were independent evaluations of the same filter. The VA (verified analysis) results were used instead of the original sample result since the VA is a more accurate count. Use of QC sample counts may result in either over- or underestimates of exposure concentrations.

► UNCERTAINTIES IN CALCULATING RISK

- Exposure Parameters. The exposure parameters used in these risk calculations (hours/day, days/year use of the CCMA) were based on estimates reported by recreational motorcyclists at a CCMA public meeting (PTI, 1992). EPA also provided exposure parameters for some of the receptor activities including the post-decontamination driving and fence builder/repairer scenarios. The estimates by the recreational riders at the CCMA public meeting included the high use estimates of long-term OHV use by attendees. Variations in exposure parameters will exist. For example, the range of use (1 to 12 days per year), used herein, probably does not include extreme uses of the CCMA. The BLM ranger who patrols the CCMA, for example, may ride many more than 12 days per year. Uncertainties in exposure parameters can be easily addressed by producing tables of risk that encompass the broadest expected range of use. Future reports may expand the range of exposure parameters used to calculate risk, if warranted.

- U.S. EPA IRIS and OEHHA Cancer Inhalation Unit Risk for Asbestos Fibers. The U.S. EPA IRIS and OEHHA unit risk are derived from occupational studies where elevated rates of cancer were observed in workers whose occupations exposed them to high concentrations of asbestos for extended periods of time. Neither the actual dose each individual received in these studies nor the actual extent of their individual exposure was measured directly, which can lead to some uncertainty in the derived unit risk. The derivation of the unit risk was performed using health protective assumptions. That is, where uncertainties are encountered, health protective assumptions are used so as not to underestimate the risk. Also, there is an uncertainty in extrapolating from high occupational doses over extended times to lower environmental exposures for much shorter time periods. Since occupational exposures are chronic, they are different from the less frequent, intermittent exposures assessed at CCMA. This type of extrapolation may over-estimate but should not underestimate the potential risks.

- Risks for Individual vs. Combined Activities. This assessment estimates risks for both individual recreational activities and combined activities. Combined activities (e.g., SUV driving to reach a staging area, then motorcycling, followed by camping), are more likely to occur for users of the CCMA. Estimated risks for individual activities are likely to underestimate total risks for users of the CCMA. Risks of selected combined activities are estimated and presented in this report and show that SUV driving to a staging area, motorcycle riding or hiking/hunting and camping activities all can be significant contributors to risk during recreational visits to the CCMA.

Conclusions:

Asbestos air concentration data for the September 27 through 29, 2005 sampling event at the CCMA ranged from 0.00027 PCMe fibers/cc to 1.3 PCMe fibers/cc, depending upon the receptor/activity. Adult trailing OHV riders (motorcycle, ATV and SUV) were exposed to asbestos concentrations that exceeded occupational standards established by OSHA (PEL and 30-minute maximum excursion limit - for the trailing motorcyclist).

Child trailing OHV riders (motorcycle, ATV and SUV) were exposed to measured asbestos air concentrations that generally exceeded adult asbestos air concentrations. Chronic exposure concentrations were calculated for the risk calculations for adults and children based on the minimum and maximum measured air concentrations of asbestos. In this memorandum, risks are calculated for both child and adult recreational exposures assuming an exposure duration of 12 years for a child and 18 and 30 year exposure duration for adults. The resulting risks are then summed for a child plus adult (18 year exposure) recreational exposure duration of 30 years at the CCMA, based on results using the IRIS unit risk only. The adult 30 year exposure duration calculations are presented as a basis for comparison to other sampling events previously conducted. These comparisons are anticipated to be presented in future reports.

The estimated ELCRs for adult motorcycle trailing riders, and lead and trailing ATV and SUV riders exceeded 1E-04 (100 in a million), for maximum air concentrations, when the user is assumed to ride more than 12 days/year. The ELCRs for lead vehicle riders were often less than for trailing riders and sometimes less than 1E-06, for minimum air concentrations. The ELCRs for both adult camper scenarios (18 and 30 exposure durations) also exceeded 1E-04, for maximum air concentrations. Asbestos cancer risks for adult hiking, vehicle washing and vacuuming, and post-decontamination driving scenarios were all less than 1E-04, with many minimum asbestos air concentrations exhibiting risks of less than 1E-06. The ELCR values using the OEHHA unit risk were an order of magnitude greater than ELCR values based on the IRIS unit risk factor.

The ELCR values for individual child activities based on the OEHHA unit risk factor, for trailing OHV riders with maximum asbestos air concentrations, always exceeded 1E-04, when 12 or more riding days per year are assumed. The ELCRs based on the IRIS unit risk factor also exceeded 1E-04 for the trailing riders with the exception of the SUV rider with closed windows. The child hiker, camper, sleeping camper, and post-decontamination rider ELCRs were all within or below EPA's risk management range (except for the high estimate exposure camper).

These values indicate that, for combined activities including an adult motorcyclist and hiker exposed to maximum asbestos concentration, cancer risks exceeded the upper value (1E-04) of EPA Superfund Program's risk management range(1E-06 to 1E-04), when 3 or more riding days per year are assumed. The adult motorcyclist and hiker exposed to minimum concentrations had cancer risks within EPA's risk management range. All of the combined activities for the child motorcyclist and hiker scenarios were either well below or within EPA's risk management range. These results indicate that motorcycling, SUV driving to a staging area, camping, and hiking/hunting all can contribute significantly to risks during recreational visits to the CCMA.

Asbestos exposure and cancer risks for selected combined adult recreational scenarios (e.g., weekend SUV travel to campsite combined with motorcycle riding (or hiking/hunting) and camping within the hazardous zone) were estimated in this report and were found to be a significant contributor to total recreational user risks at the CCMA.

ELCRs for adult and child recreational users of the CCMA indicate unacceptable cancer risks for recreational OHV riders, especially those in trailing positions, using EPA's Superfund risk assessment guidance as a standard. However, hiking, camping, vehicle cleaning, and post-decontamination driving activities were within EPA's risk management range, indicating that these risks could, potentially, be mitigated through appropriate management decisions.

<u>References</u>:

Agency for Toxic Substances and Disease Registry (ATSDR). 2005. Asbestos Exposures at Oak Ridge High School, 1120 Harvard Way, El Dorado Hills, California, Health Consultation, Public Comment Release. U. S. Department of Health and Human Services, Public Health Service. May 6.

California Environmental Protection Agency, Office of Environmental Health Hazard Assessment. 2004. Department of Toxic Substances Control (DTSC) Slodusty Road Study: Airborne Asbestos Quantitative Cancer Risk Assessment. Air Toxicology and Epidemiology Section. September.

California Environmental Protection Agency, Office of Environmental Health Hazard Assessment. 2007. CH2M HILL. 2004. Sampling and Analysis Plan for Asbestos Air Sampling, Clear Creek Management Area, San Benito County, California. October.

CH2M HILL. 2005. Asbestos Exposure and Human Health Risk Assessment, Asbestos Air Sampling, November 2nd and 3rd, 2004, Clear Creek Management Area, California – Part 1: Adult Individual Activities. November 4.

Cooper, W.C., J. Murchio, W. Popendorf, and H. R. Wenk. 1979. Chrysotile asbestos in a California recreational area. Science 206: 685-688.

EMSL Analytical, Inc. 2005. CCMA - FINAL REPORT, November 2004 Samples. July.

ICF Technology, Inc. 1994. Evaluation of Risks Posed to Residents and Visitors of Diamond XX Who are Exposed to Airborne Asbestos Derived for Serpentine Covered Roadways. May 24.

Popendorf, W and H. R. Wenk. 1983. In: Environmental effects of off-road vehicles: impacts and management in arid regions. R.H. Webb and H.G. Wilshire (eds.). Springer-Verlag, New York.

PTI Environmental Services. 1992. Human Health Risk Assessment for the Clear Creek Management Area. Prepared for: U.S. Department of the Interior, Bureau of Land Management, Hollister, CA. Bellevue, Washington. September.

U. S. EPA (U. S. Environmental Protection Agency). 1989. Risk Assessment Guidance for Superfund (RAGS), Volume 1, Human Health Evaluation Manual (Part A), Interim Final. EPA/540-1-89/002. December 15.

U. S. EPA (U. S. Environmental Protection Agency). 2005. Guidelines for Carcinogen Risk Assessment. Risk Assessment Forum. March.

U. S. EPA (U. S. Environmental Protection Agency). 2005. Supplemental Guidance for Assessing Susceptibility from Early-Life Exposures to Carcinogens. Risk Assessment Forum. March.

U. S. EPA (U. S. Environmental Protection Agency). 2007a. Integrated Risk Information System (Asbestos), internet database. April 1.

U. S. EPA (U. S. Environmental Protection Agency). 2007b. Email from Dan Stralka providing State of California OEHHA unit risk for asbestos. February 23.