RUST ENVIRONMENT & INFRASTRUCTURE

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August 13, 1993
Project No. 80123.910

Mr. Randy Ogg
EG&G Rocky Flats, Inc.
Post Office Box 464, Building 080
Golden, Colorado 80402-0464

Re: Transmittal of Comments and Responses to the Draft Final Human Health Risk Assessment/Exposure Scenarios Technical Memorandum No. 4

Dear Randy:

Enclosed are Environmental Protection Agency and Colorado Department of Health Comments and Responses to the Draft Final Human Health Risk Assessment/Exposure Scenarios Technical Memorandum No. 4.

Please call me or Wendy Johnson at 469-6660 if you have any questions.

Sincerely,

RUST ENVIRONMENT & INFRASTRUCTURE

Barbara J. Neary

Barbara J. Neary, PE
Project Manager

cc: S. Paris - EG&G
K. Ruger - EG&G
J. Sosebee - RUST E&I
W. Johnson - RUST E&I
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OPERABLE UNIT 4: SOLAR EVAPORATION PONDS
COLORADO DEPARTMENT OF HEALTH
COMMENTS ON TECHNICAL MEMORANDUM NO. 4

GENERAL COMMENTS

Technical Memorandum Number 4 was well written. Tables, Figures, and Appendices were clearly referenced in the document and included in marked sections at the end of the document. The summary tables enhance readability.

In general, the technical memorandum lacks appropriate evaluation of exposures to subsurface soils. At times, soil exposures (surface and subsurface soil) are assessed generically. For example, potentially complete human exposure pathways for the current onsite workers are listed as inhalation of airborne particulates; incidental soil ingestion from direct contact; direct dermal contact with site soils; and groundshine (Direct Contact). The soil pathway does not distinguish between surface and subsurface soil. This is not acceptable.

SPECIFIC COMMENTS

Comment 1: Section 1.0: The term "source materials" is vague. As the Division, EPA, and DOE may have different interpretations of the term, DOE should define how it characterized "source materials" for evaluation.

Response: Source materials refers to soils and sediments associated with past operation of the Solar Ponds.

Comment 2: Section 2.4: The wind rose shown in Figure 2-3 is different from that used for OU1 for supposedly the same year.

Response: The wind rose shown in Figure 2-3 is the same one presented in the Final Phase I RFI/RI Work Plan, Rocky Flats Plant, Solar Evaporation Ponds (Operable Unit No.4).

Comment 3: Section 2.7: Understanding of the ecology will be enhanced with a brief summary (6-7 sentences) of the ecology in the public health evaluation rather than a reference to the RFI/RI Work Plan for OU4 or to the Ecological Evaluation.

Response: Summary text describing area ecology can easily be added to this Technical Memo.

Comment 4: Section 3.0: The reference cited throughout this section of the TM, DOE 1990, uses 1980 census data. Census data for 1990 has been available for some time and should be incorporated in all RFP documents, including this one.

Response: The 1989 (DOE 1990) document was used for consistency with other risk assessments at RFP. Although that document was based on 1980 data, actual growth rates and more recent population estimates were used as the basis for projections into the future. It is therefore, incorrect to characterize the data presented in the technical memorandum as being based on outdated information. Furthermore, the data were not relied upon for either quantitative purposes or as a basis for eliminating a potential exposure scenario from consideration. DOE will continue to reference the 1989 document but will use more recent demographic information where appropriate in preparing the revised technical memorandum. Updated data will be included for OU4 after review and approval by EPA and CDH of similar revisions in the technical memorandum for OU3. However, it is important to remember that the census data are used only to establish a qualitative framework for describing future land use scenarios. Moreover, the assumption of residences with gardens at the RFP fenceline along Woman Creek and Walnut Creek conservatively address the agricultural issue.

Comment 5: Section 3.1: An elementary school is identified as a sensitive subpopulation facility located near the plant. Consequently, this group should be evaluated separately for all complete exposure pathways.

Response: Exposures to children are encompassed in the offsite residential scenario.

Comment 6: Is the information in this section and in the 3.2 Offsite Land Use section consistent with the latest information and projections available? For example, W-470 is defunct. Why is this highway still being used as part of the rationale for assuming commercial, light industrial and office parks will be built in the area rather than residential development?

Response: Although W-470 is currently "dead", the continued growth in northeastern Jefferson County and southeastern Boulder County make its resurrection possible.

Comment 7: Using a 1989 population projection from 1980 data is not acceptable. In addition, the estimate of zero population growth in the area immediately adjacent to the plant boundary is highly suspect given the change in plant mission.

Response: We do not see anything in the text that would be affected by more recent census data, except perhaps for the number of people serviced by the City of Broomfield's water treatment plant east of Great Western Reservoir. We will verify the number and revise if appropriate. Suggested revisions to the text are as follows:

"Future land use east, southeast, and south of RFP is expected to consist mostly of open space and commercial/industrial, with smaller areas of mixed commercial/rural residential. Suburban residential developments are expected to occur farther east, probably at least 2 miles from RFP. The timing for transition of some existing agricultural lands to open space is not known."

Recent land use surveys conducted for OU3 also indicate a preponderance of open space and commercial/industrial land uses adjacent to RFP in the downwind direction. The revised technical memorandum will address the anticipated residential growth in the areas between Indiana Street and Standley Reservoir and east of Great Western Reservoir. Both of these areas will be conservatively represented by hypothetical residential receptors at the RFP fenceline in the predominant downwind direction (east-southeast) along Woman Creek and at the closest offsite location along Walnut Creek.

Comment 8: A map should be provided showing the locations of the schools, hospitals and nursing homes within a 10-mile radius of RFP.

Response: Development and inclusion of such a map would not add to the technical memorandum. Future onsite and offsite receptors depicted in Figure 3-7 have been selected at the direction of the agencies as being appropriate and conservative.

Comment 9: Section 3.2.1: The last sentence in the first paragraph of this section should be changed to read "The northeastern Jefferson County and RFP includes one of the most...".

Response: The meaning of the sentence is more accurately reflected by the present language than the suggested revision. However, we would agree that the sentence may over-emphasize the present or expected future extent of industrialization in the area surrounding RFP, and we will therefore revise it.

Comment 10: Section 3.2.2: Industrial land-use will probably not "dominate" future land-use in northeastern Jefferson County, particularly given the plant mission change and the pace of residential development in the area.

Response: The paragraph accurately summarizes what was projected by Jefferson County in their 1989 document and thus is correct as written. However, we agree that recent changes in the mission of RFP may result in changes in the pattern and prevalence of land use. Other activities that may affect future land use will also be discussed. Examples include possible developments such as the Jefferson Center, W-470, Jefferson County Airport expansion, and Tucker Lake Golf Course expansion and their potential influence on future land use in the area east of RFP.

It is clear that the authors of this section of the text need to receive clarification on these issues from knowledgeable DOE sources. this information should not be coming from the cited sources (Denver Post, Boulder Daily Camera, RFLII).

Response: The text will be modified to present the range of future land use options currently being discussed for RFP. Furthermore, the preceding text in this section, which references DOE (1980) and DOE (1992), will be rewritten as historical background. However, we believe that is appropriate to describe DOE's former position relative to use of portions of the RFP industrial area by private industry, as expressed by Admiral Watkins, because the present Secretary has not yet expressed a different position.

Comment 15: The second paragraph on page 3-8 states that the buffer zone is being considered as a potential ecological preserve. What the text does not state, but needs to, is that this is only one of several potential uses under consideration. In light of the mission change, many more land use options have become viable.

Response: While DOE agrees that the full range of currently viable options for future onsite land use should be mentioned, we believe that the referenced text concerning possible establishment of some type of ecological preserve in the buffer zone is appropriate. Certainly the ecological preserve and private industrial park options have received the greatest attention to date and thus would appear to be more likely at this time than residential or agricultural options.

Comment 16: At the bottom of page 3-8 the text states that extensive development of the area is unlikely. Again, mission change has made this statement less certain.

Response: This sentence will be revised.

Comment 17: The last paragraph of this section is entirely wrong for the previously stated reasons.

Response: This paragraph will be deleted.

Comment 18: Section 3.4: In general, the agricultural scenario bounds the residential scenario. The state has taken this position in response to technical memorandum for OU2 and OU7. Unlike the residential scenario, the agricultural scenario always includes consumption of homegrown produce and sometimes includes consumption of homegrown livestock.

The justification for not evaluating the agricultural scenario is inconsistent with previous statements. One, industrial development takes as much or more water as ranching. Two, the plant is currently surrounded by agriculture.

Response: Use of OU4 for agriculture would be constrained for practical reasons, including the physically obtrusive Solar Pond structures and the highly disturbed nature of the ground. In addition, farming or ranching would offer poor economics compared to commercial/industrial development.

Offsite agriculture is considered to be less likely than residential or commercial/industrial uses because of economics and less likely than recreational use because of public interest in preserving some open tracts in areas of development as set-asides for passive or active recreation. This is consistent with existing regional zoning and land use designations. Therefore, although agriculture currently occurs in nearby offsite areas, it is anticipated that this use will gradually diminish and eventually disappear from parcels closest to the site.

Comment 19: Future on-site residential uses are not inconsistent with planned off-site industrial and commercial development. The RFP buffer zone is very large and could easily allow both residential and industrial/commercial land-uses to co-exist. Residential developments are the predominant land-use off-site and are increasingly encroaching on the immediate borders of the buffer zone. The Standley Lake-Louisville-Superior residential area is one of the fastest growing portions of the Denver-Metro area. Water resources are presently not a limiting factor for development and are not anticipated to be in the future. Given the change in plant mission, future on-site residential developments are no longer "improbable". Whether residential land-use is consistent with outdated DOE plans is no longer relevant.

The text states "EPA guidance does not require an exhaustive assessment of every potential receptor and exposure scenario". This may be true; however, all potential receptors must be identified and compared to determine the likelihood of harm.

Response: Current and future human population groups on and near the site are potential candidates for evaluation based on their likelihood of exposure to site-related chemicals of concern. EPA guidance does not require an exhaustive assessment of every potential receptor and exposure scenario (EPA 1992a). Rather, the highest potential exposures that are reasonably expected to occur (reasonable maximum exposures) should be evaluated, along with an assessment of any associated uncertainty (EPA 1989a). However, all potential receptors will be identified and evaluated to determine if important exposure pathways or receptors have been overlooked.

Comment 20: Section 3.5: Figure 3-7 is not clear. The scale on the map is too small, and the markers for the three future onsite receptors are too large to delineate the location. The current onsite worker marker could not be found on this map. The future onsite worker location must be clarified. A more appropriate map would

external irradiation is accounted for in the other potentially complete exposure pathways described for this receptor."

Response: This change will be made.

Comment 40: The Division does not agree that, "Chemicals bound to soil particles suspended and transported by the wind" necessarily "represent negligible oral and dermal exposure pathways:. They may be negligible relative to inhalation exposures to windborne contaminants, but this doesn't necessarily mean they are negligible in an absolute sense. Dermal absorption of some organic compounds can occur rapidly, and depends upon such factors as the amount of soil on the skin surface, the lipid solubility of the chemical and the volatility of the chemical (T. McKone. Dermal Uptake of Organic Chemicals for a Soil Matrix. Risk Analysis, 10 (3): 407-418, 1990). DOE must justify such statements in order for them to be comprehensively reviewed and accepted.

Response: The original text has been deleted. A sentence has been added which explains that suspended particulate which settles on the skin is indistinguishable from the source soil and is included in the entire mass of constituents available for ingestion and dermal absorption.

Comment 41: Section 4.5.2.4: Simply because "the impact of incidental ingestion of contaminated soil and dermal absorption of chemicals in soil following wind deposition are considered to be negligible" compared to direct ingestion and dermal exposure to site soils does not mean that these pathways can be ignored. Assess them and then determine whether they are significant or not.

Response: See response to previous comment.

Comment 42: Section 4.5.2.5: Subsoil exposures must be considered for this receptor. Simply because a pathway is minor relative to another does not mean it should not be assessed. This is a baseline risk assessment which requires a complete estimate of the sitewide risk.

Response: The text has been revised to specify potential exposures to both surface and subsurface soils.

Comment 43: The construction worker scenario enables the evaluation of potential acute and subchronic exposures in addition to chronic exposures.

Response: The construction worker is assumed to experience subchronic exposures.

Comment 44: Section 4.5.2.6: To suggest that oral and dermal exposures from wind deposition of particulates to the future onsite resident will be negligible compared to direct contact with the soils does not dismiss the need for the evaluation of the additive effects of exposure to both media. The Division would like to see the contribution to the total risk resulting from this exposure pathway as well as the major pathways in this baseline risk assessment. Exposure to airborne contaminants is considered by DOE to the major exposure pathway for current offsite residents (page 4-8 this report). It should also be considered for onsite receptors.

Response: Airborne particulates which settle on the skin and are subsequently ingested or inhaled are assumed to be encompassed by the intake parameters for dermal contact and incidental ingestion of soil. For the purposes of estimating intake, it is irrelevant whether the soils are *in-situ* or suspended and then redeposited on the skin.

Comment 45: What are the washoff factors for evaluating particulate deposition pathway mentioned in the last sentence on page 4-14? These factors have not been previously discussed.

Response: DOE believes that a risk assessment should include an evaluation of the amount of soil-bound contaminants that would be expected to be washed off various types of produce prior to consumption or canning.

Only limited data are available that discuss washing as a mechanism for removal of atmospherically deposited particulates. Most studies have addressed the effectiveness of washing for removal of pesticides and fungicides and of weathering (wind and rain) as a natural removal mechanism.

Weathering involves the loss of surface contaminants to the ground surface from physical processes such as rain. A study of fumigation with $PbCl_2$ of soybean leaves has shown that rainfall can remove up to 95 percent of the deposited material (Favretto et al. 1986, *Surface lead pollution of roadside crops in relation to distance from an emitting line source*, Jour. of Sci. of Food and Agric., volume 37, number 5). Studies of washing to remove pesticides and fungicides have shown removal efficiencies ranging from 1.07 to 100 percent, with an average of 58 percent and a median of 61 percent.

The few studies that have investigated washoff efficiencies for aerially deposited particulates show ranges of 30 to 60 percent for lead from vehicle exhaust (Favretto et al. 1986), 28 to 85 percent for metals on oak leaves (Little 1973, *A study of heavy metal contamination of leaf surfaces*, Env. Poll., volume 5) and 90 percent for radionuclides (EPA 1986, Methods for Assessing Environmental Pathways of Food Contamination, EPA 560/6-85/008).

In light of the available studies, DOE believes that using a washoff factor of 0.5 is reasonable and conservative in evaluating potential exposure from ingestion of homegrown produce contaminated by atmospherically deposited contaminants.

Comment 46: Section 5.0: The Division does not agree with the idea that "Because contact rates (except for soil ingestion) are approximately proportional to body weight, child residential intakes are not estimated separately for any exposure pathway except soil ingestion, for which children are assumed to have higher daily intake rates". Children are often among the more sensitive populations to the risks resulting from chemical or radionuclide exposure. Inhalation exposures are a case in point. Total deposition of air particles in the respiratory tract for children is higher than that for adults (Xu and Yu, Aerosol Science and Technology, 5:349-357, 1986). In addition, because of their higher activity levels and lower body weights compared to adults, children generally receive greater total daily intakes of air pollutants than either infants or adults. Therefore, DOE must quantitatively estimate child residential exposures for all exposure pathways, not just for soil ingestion. In general, the Division requests that childhood exposures be assessed at all sites for which risk assessments are performed in Colorado.

Response: DOE believes that evaluating soil ingestion for young children is consistent with USEPA guidance, and that it is the pathway where differences between children and adults is most significant.

Comment 47: Section 5.1.1: The RME exposure duration for current ponds workers should consider the time involved in future monitoring activities and the possibility that the ponds will not be closed as scheduled.

Response: Unless information to the contrary becomes available, it will be assumed that the ponds will be closed within 5 years.

Comment 48: The Division is uncomfortable with the use of 60 day snowcover to decrease the number of days exposed to dust. There is always some exposure to indoor dust, and snow creates mud. Moreover, it is not clear if the 60 day groundcover includes all ground or neglects south-facing slopes which melt more quickly? Before the Division can accept this factor, a stronger justification needs to be made by DOE.

Response: The 60 days of snow cover or frozen ground, is based on historical meteorological data for the Denver area.

The inclusion of snow cover is inherent in the 0.5 value. The ratio of contaminants on indoor dust versus outdoor soil was derived from data for Butte, Montana, which has a climate similar to that of Denver.

Comment 49: Section 5.1.2: Tables 5-2, 5-6, 5-10. 5-14, 5-19. Twenty-five percent of inhaled particles are deposited in the deep tissue of the lung; seventy-five percent of inhaled particles are deposited in the upper respiratory passages and subsequently swallowed and retained in the body. (MRI 1985)

Because baseline risk assessments are concerned with overall health effects of inhalation and not simply lung effects the usual value used for depositional fractions is 75%. A wide variety of sources indicate that 25% is too low a value for a depositional fraction. These include the soil dust inhalation estimates of Hawley (Risk Analysis 5: (4) 289-302, 1985), the US EPA's "Second addendum to air quality criteria for particulate matter and sulfur oxides (1982)", (EPA 600/8-86-020f), and the International Commission on Radiological Protection, (ICRP, 1980) study which states that for aerosols with a mean aerodynamic diameter between 0.2 um and 20 um, the sum of the fractions deposited in the three regions of the respiratory tract varies for about 60% to 90%. If applied to all, a value of 75% is recommended.

Response: DOE agrees to use the recommended deposition fraction of 75%.

Comment 50: The factor for exposure duration should reflect the actual time the current pond workers are at the site which is eight hours.

Response: The exposure duration will be based on an 8-hour workday.

Comment 51: Section 5.1.3: Soil matrix effects are dependent on a variety of factors including soil loading, surface area exposed, site of application, soil organic content, and the chemical of concern. Without the appropriate site specific and chemical specific data to justify the use of a soil matrix factor, such factors will not be accepted.

Contaminants of concern must be identified after the soil matrix factor has been applied. Otherwise, the concentration-toxicity screen may be biased. A chemical that is extremely toxic but tightly bound to soil may bump another contaminant that is less toxic but more bioavailable.

Response: The ability of soils to bind some compounds, including both organics and inorganics, can significantly reduce the availability of the compounds for dermal exposure. Chemical-specific information regarding adsorption on soil and its effect on availability to human receptors via the dermal pathway will be submitted to CDH and EPA for review and approval prior to inclusion in the revised technical memorandum.

Comment 52: The use of any fraction intakes is unacceptable if:

1. site-specific data is not used to support the value. Literature values alone do not constitute site-specific data.

2. it causes considerable deviation from an RME estimate.

The Division will not accept any intake value that is based on area instead of time. DOE is proposing to use the relative areas of OU4 to the whole buffer area to calculate the 0.006 fractional intake value for the ecological worker and construction worker receptors. Depending upon the research project, it is entirely conceivable that an ecological researcher could spend the vast majority to time in one area like OU4, without going to another area of the buffer zone at all. A similar situation could also apply to a construction worker. Averaging the exposure over the whole RFP buffer zone will essentially dilute out any exposure, and is not protective in the remotest sense.

The 0.125 fractional intake for future onsite workers assumes that the worker is outside for one hour (lunch) out of an eight hour day. The factor must consider indoor dust which is affected by outdoor dust.

The 0.5 fractional intake values do not reference any supporting data for the assumption that people spend only half their time at home. The assumption is inappropriate. The inhalation values used from EPA's guidance assume 24 hour exposure and were derived with housewives, invalids, and children (some of whom make up the most susceptible populations), who would be at home 24 hours/day.

Response: DOE agrees to base exposure for the ecological worker and site workers on time rather than area.

With regard to the FI value for the residential scenario, we have conducted an analysis of the relationship between contaminant concentrations on outdoor soil versus indoor dust. The data for this analysis were taken from the Butte-Silver Bow County, Montana, Environmental Health and Lead Study. As part of the Butte study, concentrations of lead (Pb) and arsenic (As) were measured in a variety of media and locations, including indoor dust and outdoor soil.

Linear regression analysis was used to explore the relationship between indoor dust and outdoor soil. The results for Pb and As were similar, with regression slopes of 0.30 and 0.33, respectively. The slope values indicate that contaminants on outdoor soil indoor dust are positively correlated (i.e., as one increases, the other increases) but that indoor dust has contaminant concentrations only one-third as high. The explained variance for the Pb regression was low (R^2 = 0.22), indicating that the variation in outdoor soil concentrations accounted for only 22 percent of the variation in indoor dust concentrations. The explained variance for As was very low (R^2 = 0.06). From these results, a conservative estimate of the

contaminant concentration in indoor dust is approximately 35 percent of the concentration on outdoor soil Thus, assuming that indoor dust and outdoor soil concentrations are the same is overly conservative, based on the study recommended by EPA.

In computing an FI for children ages 1 to 6, we estimated the fraction of time available for activities that allow for ingestion based on survey data compiled by Juster and Strafford 1985 (*Time, goods, and well-being*, Survey Research Center, University of Michigan). For children 3 to 11 years old, approximately 10 hours per day is spent sleeping. This allows for 14 hours to be spent in other activities. Based on the activity category for weekends (because ages 1 to 6 are preschool), approximately 1 hour is spent in sports and outdoor activity. This could be a low estimate, so we conservatively assume that 4 hours per day is spent outdoors and 10 hours per day in various indoor activities, all of which take place in the home. Given the Colorado climate, DOE believes that the use of 4 hours per day is not appropriate for the full year. For this analysis, we therefore assumed that weather conditions would not permit outside play in contact with site soils for 3 months of the year (i.e., winter).

Based on the assumptions described above, we computed the following FI value:

$$FI = [(T_i \times S_i) + (T_o \times S_o)] \times f_y$$

where T_i is fraction of time indoors
S_i is assumed indoor dust concentration of outdoor contaminants
T_o is fraction of time outdoors
S_o is contaminant concentration in outdoor soil
F_y is fraction of year exposed

For the non-winter months, the FI would be:

$$FI_s = [(10hrs/14hrs \times 0.35S_o) + (4\ hrs/14hrs \times S_o)] \times 9\ mo/12mo = 0.402$$

For the winter months, the FI would be:

$$FI_w = [14hrs/14hrs \times (o.25S_o] \times 3mo/12\ mo = 0.0875$$

The total FI is the sum of FI_s and FI_w = 0.4895 = 0.5

Although adults probably spend an average of well under one hour per day outside while at home (EPA 1989b), DOE will conservatively assume that the ratio of outdoor and indoor activities is the same for adults as for children and will therefore use an FI value of 0.5 for both subpopulations.

Comment 53: Section 5.2.4: The duration of exposure to homegrown produce is not limited to the four month harvesting season. Many people preserve the produce by canning

or drying it.

DOE did not calculate the ingestion of homegrown produce correctly. EPA guidance (the same one referenced by DOE) recommends a typical consumption of 140 g/day of fruit and 200 g/day of vegetables. The reasonable worst case proportion of produce that is homegrown is assumed to be 30% and 40%, respectively. This guidance recommends exposure for 350 days/year.

Concerning the soil matrix factors, see comments on Section 5.1.3.

Response: Exposure to homegrown produce will be assumed to occur 350 days/year. Calculation errors will be corrected. DOE anticipates that much of the exposure to site-related contaminants via ingestion of home-grown produce would result from aerial deposition of particulates onto the plant surfaces, rather than uptake through the roots or leaf stomata. Therefore, DOE will conservatively assume that the bioavailability of contaminants in soil will also apply to contaminants in resuspended soil deposited on plants or taken up through the roots.

Comment 54: Section 5.1.5: The Division must review the chemical specific data on which the absorbed fractions are based before these fractions can be approved.

Response: Agree.

Comment 55: Why has DOE chosen to use the midpoint of the range (0.6 mg/cm^2)?

Response: DOE will use the default soil adherence factor of 1.0 mg/cm^2 presently recommended by U.S. EPA.

Comment 56: The Division does not agree with the choice of 2190 cm^2 surface area for all receptors. It is not reasonable that residents would expose only the face, forearms, and hands (15% of total body surface). An adult default value of 5000-5800 cm^2 is recommended in EPA's Dermal Exposure Assessment (1992). This value was derived by applying 25% to the total average adult body surface area. A 25% factor was used instead of 15% because some studies have suggested that exposure can occur under clothing.

Response: DOE agrees to use the default value of 5,000 cm^2 for skin surface area in contact with contaminants in the soil.

Comment 57: Concerning the soil matrix factors, see comments on Section 5.1.3.

Response: The ability of soils to bind some compounds, including both organics and inorganics, can significantly reduce the availability of the compounds for dermal

exposure. Chemical-specific information regarding adsorption on soil and its effect on availability to human receptors via the dermal pathway will be submitted to CDH and EPA for review and approval prior to inclusion in the revised technical memorandum.

Comment 58: Section 5.1.6: Given that an estimate of the radionuclide intake will be expressed in units of radioactivity, intake must be a function of the energy emitted from the radionuclide and the frequency and duration of exposure to the radioactive material. The use of the work concentrations is imprecise.

Response: Agree. This has been clarified in the text.

Comment 59: How will internal and external exposure be combined so that pathways can be summed to estimate total exposure and risk?

Response: According to the *Risk Assessment Guidance for Superfund*, Volume 1: Human Health Evaluation Manual (EPA, 1989), the dose equivalent for external and internal exposures are considered to be additive. Consequently, radionuclide dose equivalents will be summed for all pathways of exposure for each receptor evaluated in the Baseline Risk Assessment.

Comment 60: The approach does not consider known effects of the radionuclides. For example, plutonium is a lung carcinogen. Why not use a systemic body burden of a lung count?

Response: The proposed approach is consistent with U.S. EPA risk assessment procedures.

Comment 61: Section 5.2: The estimates of dose equivalent do not need to be compared to radiation protection standards and criteria. They should simply be used to calculate risk.

Response: The text states that dose estimates will be used to calculate risk.

Comment 62: Section 5.2.1: It seems reasonable that different fractional exposures could be applied to the Hillside areas and to the Solar Ponds area based on relative times the workers use each site. This seems a more reasonable approach than basing fractional intakes on area.

Response: Fractional intakes will be based on estimated time of contact rather than relative area.

Comment 63: Table 3-2: What does the zoning code M-C mean?

Response: Mineral conservation.

Comment 64: Table 3-4: Footnote "c" for Current offsite agricultural receptors is inconsistent with previous statements made in 3.4. It states that this receptor, which is not being considered, bounds the current offsite residential land use scenario. If this is true, then the agricultural scenario should be evaluated.

Response: Response: This footnote has been corrected. Cattle grazing occurs near RFP on an irregular, short-term basis. For example, dairy cattle are typically grazed to the east of RFP for one summer as heifers before being sent to another location for breeding or milk production. Cattle are not raised and slaughtered for consumption by local ranchers. Therefore, DOE believes that characterizing an offsite (downwind) residential receptor who consumes garden fruits and vegetables is adequately conservative.

Comment 65: Tables 5-1, 5-5, 5-9, 5-15, 5-17, 5-18: The fraction ingested from contaminated sources should always be considered to be 1.0.

Response: DOE agrees to base exposure for the ecological worker and site workers on time rather than area.

With regard to the FI value for the residential scenario, we have conducted an analysis of the relationship between contaminant concentrations on outdoor soil versus indoor dust. The data for this analysis were taken from the Butte-Silver Bow County, Montana, Environmental Health and Lead Study. As part of the Butte study, concentrations of lead (Pb) and arsenic (As) were measured in a variety of media and locations, including indoor dust and outdoor soil.

Linear regression analysis was used to explore the relationship between indoor dust and outdoor soil. The results for Pb and As were similar, with regression slopes of 0.30 and 0.33, respectively. The slope values indicate that contaminants on outdoor soil indoor dust are positively correlated (i.e., as one increases, the other increases) but that indoor dust has contaminant concentrations only one-third as high. The explained variance for the Pb regression was low ($R^2 = 0.22$), indicating that the variation in outdoor soil concentrations accounted for only 22 percent of the variation in indoor dust concentrations. The explained variance for As was very low ($R^2 = 0.06$). From these results, a conservative estimate of the contaminant concentration in indoor dust is approximately 35 percent of the concentration on outdoor soil Thus, assuming that indoor dust and outdoor soil concentrations are the same is overly conservative, based on the study recommended by EPA.

In computing an FI for children ages 1 to 6, we estimated the fraction of time

available for activities that allow for ingestion based on survey data compiled by Juster and Strafford 1985 (*Time, goods, and well-being*, Survey Research Center, University of Michigan). For children 3 to 11 years old, approximately 10 hours per day is spent sleeping. This allows for 14 hours to be spent in other activities. Based on the activity category for weekends (because ages 1 to 6 are preschool), approximately 1 hour is spent in sports and outdoor activity. This could be a low estimate, so we conservatively assume that 4 hours per day is spent outdoors and 10 hours per day in various indoor activities, all of which take place in the home. Given the Colorado climate, DOE believes that the use of 4 hours per day is not appropriate for the full year. For this analysis, we therefore assumed that weather conditions would not permit outside play in contact with site soils for 3 months of the year (i.e., winter).

Based on the assumptions described above, we computed the following FI value:

$$FI = [(T_i \times S_i) + (T_o \times S_o)] \times f_y$$

where T_i is fraction of time indoors
S_i is assumed indoor dust concentration of outdoor contaminants
T_o is fraction of time outdoors
S_o is contaminant concentration in outdoor soil
F_y is fraction of year exposed

For the non-winter months, the FI would be:

$$FI_s = [(10hrs/14hrs \times 0.35S_o) + (4\ hrs/14hrs \times S_o)] \times 9\ mo/12mo = 0.402$$

For the winter months, the FI would be:

$$FI_w = [14hrs/14hrs \times (o.25S_o] \times 3mo/12\ mo = 0.0875$$

The total FI is the sum of FI_s and FI_w = 0.4895 = 0.5

Although adults probably spend an average of well under one hour per day outside while at home (EPA 1989b), DOE will conservatively assume that the ratio of outdoor and indoor activities is the same for adults as for children and will therefore use an FI value of 0.5 for both subpopulations.

Comment 66: Table 5-2, 5-6, 5-10, 5-14, 4-19: See comment to Section 5.1.2.

Response: DOE agrees to use the recommended deposition fraction of 75%.

Comment 67: Table 5-11, 5-15, 5-20: EPA recommends 5,000-5800 cm^2 for surface area. It is reasonable to assume that these receptors only expose their faces, forearms, and hands to surface soil.

Response: The Division does not agree with the choice of 2190 cm^2 surface area for all receptors. It is not reasonable that residents would expose only the face, forearms, and hands (15% of total body surface). An adult default value of 5000-5800 cm^2 is recommended in EPA's dermal Exposure Assessment (1992). This value was derived by applying 25% to the total average adult body surface area. A 25% factor was used instead of 15% because some studies have suggested that exposure can occur under clothing.

APPENDIX A:

Comment 68: Page A-2. In the second paragraph, "These samplers are part of..."

Sampler S-4. Sampler S-4 is due north of the B-series ponds. Thus this sampler may measure plutonium concentrations that reflect worker exposures in OU4. However, this sampler is not downwind from the predominant wind direction. Therefore, is must be remembered that higher concentrations of plutonium, other radionuclides and chemicals may be evaporating off the solar ponds than indicated by this monitor.

Response: Agree. This information was only included to provide some indication of present site conditions.

Comment 69: Table 1. It is not clear why the volumes sampled on the different dates vary. If samples are taken only until a set level of radioactivity is detected, it should be stated somewhere. Are these samples normalized before they are compared?

Response: The volume samples is a function of the time the sampler was running not a set level of radioactivity detected.

Comment 70: Page A-10. The text here states, "The measurements were taken from January through December 1991", and refers to Table V. Table V states the measurements are for 1992. Which is the correct year?

Response: The correct year is 1992.

Comment 71: Page A-10. It is unclear from the text whether the external dosimetry summation reports for solar pond workers in Table V show exposures only to plutonium or to gross alpha radiation produced by other radionuclides. Is plutonium the only radionuclide at the solar ponds?

Response: Thermoluminescent dosimeters (TLD) are used at Rocky Flats Plant. TLDs detect beta and gamma radiation.

Comment 72: Table V. This table does not show the mean, standard deviations or 95% UCLs for skin and hand exposures. It only shows the deep values.

Response: This is a standard report from the Rocky Flats Plant Dosometry Group.

APPENDIX C

Comment 73: A clear delineation of the samples taken from surface soil and from subsurface soil was never made in the VOC discussion. This needs to be done in order to determine the likely receptors that could be exposed to any chemicals present.

Response: The samples were taken from subsurface soil and pond sludges.

Comment 74: EPA's methodology for calculating PRGs which was used to estimate the concentrations of VOCs in soils associated with acceptable levels of risk or hazard explicitly states that site-specific information be used. How well do the default values listed in Table 2, Appendix C and used to calculate the "action level concentrations" shown in Table 1 reflect the conditions at Rocky Flats? For example, do Rocky Flats soils have an organic content close to 2%? What is the average soil moisture content at Rocky Flats? Why was an exposure interval, T, equivalent to 25 years used? If enough data is available to define the extent of contamination at this OU, the Division would prefer that the actual size of individual hot spots be used, instead of the default value of 45 m for the length of a side of the contaminated area.

How do the VOC levels found in the Phase I samples compare to the action levels calculated? This information needs to be reviewed and approved by the Division before DOE can go forward with the decision not to include inhalation of VOCs as an exposure pathway. In addition, VOCs emitted into basements could be a route of exposure for future office workers and residents on site. Therefore, workers are not the only population likely to be exposed to VOCs as indicated on page B-4, and the Division requests that inhalation of indoor VOCs be included for these two receptors as well as inhalation of outdoor VOCs for construction workers exposed to subsurface soil.

Response: This appendix was included as a preliminary screening tool. Exposure pathways of VOCs for a future on-site worker and future on-site resident have been included in the Final TM4.

SPECIFIC COMMENTS

Comment 1: Page 3-12 through Page 3-14, Section 3.5.1. The text details the health and safety programs in place at RFP to protect workers from exposure to chemical, physical, and biological hazards. However, this text is inappropriate for a risk assessment. The site has yet to be characterized and hazards have not been identified for OU4. Moreover, chemical concentrations and exposures cannot be determined at this time. This information is vital to enforcing regulations established by the Occupational Safety and Health Administration. Without this information workers cannot monitor or limit their exposures. Thus, occupational health hazards from exposure to contaminants will not become known until the risk assessment for OU4 is completed.

Rationale: Health and safety plans are not relevant in a risk assessment.

Response: The inclusion of information pertaining to health and safety programs currently conducted at RFP is not intended to suggest that a risk assessment will not be conducted for the current onsite Solar Ponds worker and a future potential construction worker. The reason for including health and safety information is to support the comparison of potential exposure-point concentrations with those in an industrial setting. These exposure scenarios should be adequate to characterize current exposure and future possible high short-term exposures to workers at the site.

Comment 2: Page 4-3, Last Paragraph. The text states "Dermal contact with soil will be assessed quantitatively only if results of OU4 Phase I sampling programs demonstrate the presence of organic chemicals of concern in surface soil samples at concentrations exceeding background levels." This approach is inappropriate for three reasons (EPA, 1989a). First, all chemicals of concern (COCs) should be evaluated for every appropriate pathway. Second, unlike inorganic chemicals which naturally occur, all organic chemicals are considered by EPA to be of anthropogenic origin. Thus, there are no background concentrations which organic compounds can be compared to. Third, if organic chemicals are detected in background samples, the background area selection will be invalidated because it indicates the area was affected by RFP activities. Dermal contact should be considered in the quantitative analysis.

Rationale: All COCs should be evaluated for all exposure pathways. Organic chemicals should be considered anthropogenic and cannot be eliminated based on comparison to background samples.

Response: DOE agrees that organic chemicals are considered anthropogenic and will be evaluated for all appropriate pathways.

quantified for a complete assessment of risk (EPA 1989a, 1986). RME estimates are available from the *Exposure Factors Handbook* (EPA, 1989b). Plant uptake of chemicals in the soil, as well as surface deposition of particulates, should be included in the assessment of fruit ingestion (Baes et al., 1984).

In addition, inhalation of VOCs from subsurface soils into basements should be considered as a pathway of exposure for future on-site residents. Elimination of this pathway from consideration at this time is premature.

Rationale: All potential exposure pathways should be addressed in the risk assessment.

Response: Ingestion of homegrown fruit will be addressed.

Comment 10: Page 5-3, Section 5.1.1 Exposure assumptions for an ecological worker are listed as 5 days/week for a 16 week field season. The Rocky Mountain Arsenal has done extensive research on this area. They interviewed ecological workers at three wildlife/ecological preserves and gathered information on exposure time, exposure duration, soil ingestion rates, etc. This information is available in the September 1992 Integrated Enlargement Assessment/Risk Characterization for the Rocky Mountain Arsenal. Attached to these comments is a summary sheet of the results which recommends an 8 hour/day, 242 days/year, 17 years/lifetime. EPA recommends that this information be used in the Rocky Flats exposure assessment.

Rationale: RME values and assumptions should be health-conservative.

Response: In developing exposure assumptions for a potential ecological researcher scenario, DOE has attempted to be conservative but reasonable. The assumptions used in this scenario were based on the concept of an academic researcher who would conduct relatively short-term but intensive investigations of specific area and for a specific purpose. The duration and frequency of field work was estimated based on input from various sources, including Dr. Ward Whicker of Colorado State University, who has conducted considerable research at RFP and elsewhere. The ecological evaluation performed as part of the Phase I RFI/RI for OU2 was also used as a reasonable model for a site-specific research program. Academic research includes a combination of field work, laboratory work, and office work; collecting samples or making observations at the site are typically not full-time efforts. This is in contrast to what DOE terms the "caretaker" scenarios, which would encompass a full-time RFP biologist whose work would cover the entire 10-square mile area. DOE believes that this type of outdoor worker would be more appropriately addressed by a sitewide risk assessment and, in any event, would be bounded by the onsite resident scenario.

chemical specific pharmacokinetic information which can be used to refine the estimate of toxicity, EPA suggests that this information be submitted to EPA's Reference Dose/Reference Concentration Workgroup. This information does not belong in the estimate of exposure.

Rationale: Use of a deposition factor should be supported by site-specific data. Intake from ingestion should be adjusted accordingly.

Response: It will be assumed that 75% of inhaled particulates are deposited and remain in the lungs.

Comment 13: Page 5-5, Second Indented Paragraph. The text proposes using a "fraction ingested from contaminated source" factor to modify soil ingestion based on the amount of time spent outdoors and the size of OU4 relative to the total area of RFP. The use of this fraction is inappropriate and could underestimate soil intake. The soil ingestion input parameters from RAGS (EPA, 1989a) or the *Exposure Factors Handbook* (EPA, 1989b) include ingestion of indoor dust, which should be considered to have contaminant concentrations equal to outdoor soils. A factor for fraction ingested should not be used in determining chronic daily intake from soil.

Rationale: Fractions reducing exposure estimates from soil are inappropriate for RME assumptions.

Response: Fractions will be based on estimated time of contact rather than relative area.

Comment 14: Page 5-5, Third Indented Paragraph. The text indicates that a matrix effect, indicating bioavailability of chemicals in soil, will be used in determining soil intake. Bioavailability factors are chemical-specific and dependent on the particular soil-chemical matrix in which the chemical is ingested. These factors are widely variable for each chemical. Unless sufficient information can be provided to substantiate chemical-specific bioavailability, this factor should be eliminated from the soil intake equation.

Rationale: Bioavailability factors vary widely and contribute uncertainty to the intake equations.

Response: The ability of soils to bind some compounds, including both organics and inorganics, can significantly reduce the availability of the compounds for dermal exposure. Chemical-specific information regarding adsorption on soil and its effect on availability to human receptors via the dermal pathway will be submitted to CDH and EPA for review and approval prior to inclusion in the revised technical memorandum.

Comment 15: Page 5-6, First Indented Paragraph. Using a 4-month harvesting season to reduce the intake of homegrown vegetables is inappropriate. The RME value for ingestion of vegetables is 80,000 milligrams per day (mg/day) (EPA, 1989b) based on a typical consumption of 200,000 mg/day and a proportion of 40 percent of vegetables being homegrown. The RME value should be used to determine contaminant intake through this pathway.

Rationale: RME values should be used to determine contaminant intake from homegrown vegetables.

Response: Ingestion of homegrown fruits and vegetables will be assumed to occur 350 days per year. Calculation errors have been corrected.

Comment 16: Page 5-6, Third Indented Paragraph. The use of matrix factor to account for bioavailability of contaminants deposited on the surface of homegrown produce is inappropriate. Particulates deposited on the surface of a plant are not covalently bound and should be assumed to be available for absorption in the gastrointestinal tract. Although it is possible that contaminants taken up by plants and incorporated into the structural plant parts may be less bioavailable than particulates on the surface of plants, very little information regarding this issue is available. Therefore, a reliable matrix factor cannot be estimated and should be eliminated from the intake equation, unless additional scientific information can be provided.

Rationale: The matrix factor is inappropriate for ingestion of contaminants from homegrown produce.

Response: The matrix factor will be deleted from the calculation. However, it should be clearly stated that contaminants deposited on the surface of vegetation are adsorbed to soil particles and not deposited as neat compounds. Consequently, matrix factors are applicable to this pathway of exposure.

Comment 17: Page 5-6, Section 5.1.5. The value used to represent RME exposed body surface area is not consistent with the value typically used for residential receptors. Residential receptors are not likely to wear long sleeves and long pants when gardening, particularly in the summer, in their yards and therefore would have more body surface area exposed than indicated. This body surface area value should be increased for both on- and off-site residential receptors. EPA's Dermal Exposure Assessment: Principles and Applications (EPA, 1992) provides more acceptable body surface area estimates.

Rationale: The body surface area value presented is not an RME estimate for residential receptors.

Comment 22: Appendices A, B, and C. Appendix A is a preliminary analysis of worker exposure to chemicals and radionuclides in the OU4 area. Appendix A is presented to "obtain a regulatory compliance perspective on current and potential future occupational risks." Appendices B and C present air monitoring data and PRGs for detected VOCs. These appendices should not be included in the risk assessment or this document. Occupational regulations and calculations of PRGs are irrelevant in a risk assessment. Occupational regulations are not considered in risk calculations and PRGs should not be calculated until risks are known. Typically, PRGs are presented in the feasibility study. These appendices should be removed.

Rationale: The appendices are inappropriate for a risk analysis.

Response: DOE understands that a Baseline Risk Assessment must be performed; and the inclusion of these appendices does not negate that obligation. However, since empirical exposure data exists for the Solar Ponds workers, DOE believes that it is appropriate to present the information to assist in the interpretation of the risk assessment.