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Department of Energy
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

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Mr. Steve M. Alexander
Perimeter Areas Section Manager
Nuclear Waste Program
State of Washington
Department of Ecology
1315 W. Fourth Avenue
Kennewick, Washington 99336-6018

Mr. Douglas R. Sherwood
Hanford Project Manager
U.S. Environmental Protection Agency
712 Swift Boulevard, Suite 5
Richland, Washington 99352

Dear Messrs. Alexander and Sherwood:

TRANSMITTAL OF THE LIMITED FIELD INVESTIGATION REPORT, DOE/RL-93-51, REVISION 0 AND THE QUALITATIVE RISK ASSESSMENT, WHC-SD-EN-RA-004, REVISION 0 FOR THE 100-HR-1 OPERABLE UNIT

Enclosed please find three copies each of the subject documents for your use. This constitutes final status of this document for public release. Also enclosed are responses to comments from the State of Washington Department of Ecology which were previously dispositioned. These comments are incorporated into Revision 0 of these documents.

If you have any questions, please contact Ms. Nancy A. Werdel, River Sites Remediation Division, at 376-5500.

Sincerely,

Steven H. Wisness
Hanford Project Manager

RSD:NAW

Enclosure

cc w/o encl:
D. Faulk, EPA
G. Eidam, BHI
S. Hajner, BHI
C. Hedel, BHI
D. Holland, Ecology
R. Stanley, Ecology

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DRAFT RESPONSES TO COMMENTS
November 22, 1993

QUALITATIVE RISK ASSESSMENT FOR THE 100-HR-1 SOURCE OPERABLE UNIT, HANFORD SITE, RICHLAND, WASHINGTON

Following are responses to comments by the Washington State Department of Ecology (Ecology) and United States Environmental Protection Agency (EPA) on the Qualitative Risk Assessment for the 100-HR-1 Source Operable Unit contained in a letter from Gary Freedman, Ecology, to Steven H. Wisness, RL, dated September 24, 1993.

General Comments

1. The 100-HR-1 QRA does not fit within the definition of a QRA established by the Hanford Past Practice Strategy (HPPS), which states, "A judgement not based solely on quantification, agreed to by the parties, based upon available site data regarding the threat posed by site contamination." The 100-HR-1 QRA is based on quantification, being qualitative only to the extent that the data used is scanty and questionable.

Comment Resolution: The QRA is based upon quantification for those waste sites for which sampling data are available. However, the QRA is qualitative in the sense that a limited number of exposure scenarios and pathways are evaluated to provide a bounding estimate of potential site risks. Additionally, the QRA evaluates risk at a number of waste sites for which no specific sampling data exists using historical process information or (where appropriate and possible) using analogous sites for which risk information is available.

2. The QRA is lengthy, and dense with information and analysis. While the sheer bulk of the document superficially indicates an excess of analysis, the substance of it falls short of the appropriate intent of the qualitative risk assessment. To find any particular bit of information was difficult, as data was scattered in various locations away from the text.

Comment Resolution: The first paragraph of Section 2.3 of the document will be revised to state: "As described in Section 1.1, the intent of the qualitative risk assessment is to provide information to be used in the LFI report to decide whether an interim remedial measure is necessary at each high-priority waste site. The results of the QRA are presented in the text and tables of Chapter 3 and summarized in the text and tables of Chapter 4." The text of this general comment does not specify what information was difficult to locate. The document format (Executive Summary, Introduction, Evaluation Overview, Qualitative Risk Assessment, and Summary and Conclusions) is standard and a Table of Contents and List of Acronyms are provided.

Supporting information, which may not be of interest to all readers, is provided in the Appendices.

3. Numbers cited in the text of the documents often did not exactly match numbers provided in the tables. Sometimes this may have been an effect of rounding, but even this should be done consistently between different parts of the documents.

Comment Resolution: The only numbers provided in the text of the human health evaluation are risk estimates which have one significant figure. These numbers have been checked and discrepancies between text and tables are not apparent. For the ecological evaluation, calculations are rounded to two significant figures. Standards for applying significant digits for radiation dose are documented in the dose estimation tables.

4. Although some information was presented in the Results Section of the Executive Summary as to what sites presented a human and ecological risk, a relative ranking of these sites was expected. From the information provided, is difficult for the risk manager to determine which site should have the initial priority for an IRM.

Comment Resolution: The relative ranking of each waste site is presented in section 3.(1-13).4 for that site, and summarized in section 4.2.2 and Tables 4-2 and 4-3 for all sites. For brevity, the relative rankings of all 13 high-priority waste sites were not included in the Executive Summary. Additional information regarding selection and prioritization of waste sites for an IRM is presented in the LFI.

5. The 0-6 feet soil depth ecological scenario is a reasonable approach. Its applicability needs to be described adequately, but was not, in the QRA documents. Although the document considers both the 0-15 feet and 0-6 feet ecological scenarios, the relevance of these scenarios are not mentioned in the Executive Summary. One problem may arise in extending this scenario to other operable units: The historical and LFI sampling data do not always include samples from 0-6 feet.

Comment Resolution: Gano and States (1982) state that the pocket mouse burrows to a depth of 6 ft. Evaluation of the 0-6 ft depth was selected to supplement the 0-15 ft scenario described in HSBRAM (1993) to provide a more realistic assessment of exposure of the pocket mouse to contaminants.

6. The ecological risk assessment takes into account fractional use by the pocket mouse. Fractional use is not considered in the human risk assessment; therefore, human risk corresponds directly to the concentrations of contaminants. A higher risk will be indicated for humans than for pocket mice. Since both the human and the pocket mouse are environmental receptors, there should be complementary assumptions for the human and ecological risk assessments concerning the size of the waste unit.

Comment Resolution: The human health risk assessment is performed as agreed upon by the Tri-Party Agreement managers. Because a similar evaluation is neither appropriate nor possible for the pocket mouse, fractional use of waste sites by the pocket mouse was considered. It is incorrect to presume that a higher risk will be indicated for humans than for pocket mice because the human health and environmental risk assessments are based upon entirely different assumptions.

7. Modeling the Biology of the Great Basin Pocket Mouse

Because of the importance of the Great Basin pocket mouse to the ecological QRA, the basic biological information presented in the QRA must be more extensive, especially if it is desired to make the risk assessment as ecologically realistic as possible. Comments relevant to this effort are provided below.

(a) None of the information presented (Pages D-4 and D-5) identifies documented home range sizes for this species, unless it is assumed the density data provide this information indirectly. Without information on territoriality (i.e., amount of overlap in home ranges, if any, between individuals), however, density information alone may not provide an accurate indication of home range size. Moreover, the effect of habitat conditions on home range size also needs to be considered. The study of O'Farrell (1975) provides information on home range size for the Great Basin pocket mouse. This study is a possible starting point for estimating the appropriate home range size considered in the conceptual model.

Comment Resolution: The parenthetical phrase "(The home range of the Great Basin pocket mouse varies from 508-4005 m^2 for parts of the Hanford Site [O'Farrell et al. 1975.])" will be added to the end of Section 2.3.2.1.3. However, additional points should be considered. As with any animal, population sizes vary from habitat to habitat (O'Farrell's study was on relatively undisturbed habitat on the ALE reserve, as opposed to the essentially vegetation-free waste sites in the 100 Area). The population size also varies considerably from year to year in response to food availability, and from season to season, i.e. low in late winter and high in fall. However, a more important point should be made. To attempt to quantify these factors for the QRA lends a false sense of accuracy to the result. Quantifying the factors does little for the stated purpose of the ecological QRA, which is to provide a relative ranking of waste sites for possible IRMs, and not to measure the actual ecological risk.

(b) Food uptake considerations should be more in line with what the animal actually eats. If the pocket mouse is predominately a seed eater then transfer coefficients should reflect contaminant uptake for that portion of the plant. Moreover, if there are seasonal changes in diet, then this data also should be incorporated into the model. French et al. (1974) provide information on diet composition for a related species of pocket mouse (long-tailed pocket mouse, Perognathus formosus).

Comment Resolution: As noted in the comment, the pocket mouse is generally a seed eater. However, information is not available to allocate radionuclides within plant compartments, especially for native plants. Therefore, available transfer coefficients were used which generally describe the transfer of contaminants from soil to plants. The available literature does not provide sufficient information to model specific uptake of contaminants from soil to plants to the pocket mouse. Also, see response to general comment 7(a).

(c) The activity patterns of the pocket mouse should be incorporated into the conceptual model as much as possible. If hibernation and estivation are incorporated into the model, however, this provides a strong reason to incorporate the effects of external dose, especially at sites such as the retention basins where the contamination is relatively shallow and radionuclides emitting high energy gammas (e.g., Cesium-137) are present. The information on external dose in (Poston and Soldat 1992) is for cottontail rabbits and deer and does not account for burrowing (dose was based on measurements from environmental TLDs placed three feet above the ground). There have been studies on Hanford that have placed dosimetry in pocket mice (Fitzner et al. 1979). These references should be checked both to gain perspective from information on actual exposures associated with waste sites and to evaluate possible information on exposure pathways. The QRA does not adequately justify its elimination of certain exposure pathways.

Comment Resolution: The QRA is intended to provide a relative ranking of waste sites for consideration of IRMs under the HPPS. It is not intended to evaluate all exposure pathways as would a baseline risk assessment.

(d) Certain points of the life cycle may be more susceptible to contaminant exposure than others. Thus, the conceptual model may need to incorporate this consideration into the toxicity assessment, if it has not done so already.

Comment Resolution: It is agreed that certain points of the life cycle may be more susceptible to contaminant exposure than others, as mentioned in O'Farrell et al. (1973). However, the exposure scenario is highly conservative and it is assumed that this condition represents a maximum exposure. In addition, see response to comment 7(a).

(e) There should be some discussion in the QRA as to whether exposure to the pocket mouse represents exposure to a maximally-exposed individual. If this is the case, then there also needs to be a qualitative discussion of what this exposure means at the population level and at higher trophic levels.

Comment Resolution: The pocket mouse was selected by the Tri-Party unit managers to represent the maximally exposed environmental individual because its home range approximates the areal extent of a waste site. Representatives of the EPA and Ecology requested that trophic levels higher than insects or mice not be examined in the QRA. Higher trophic levels are to be examined when a baseline risk assessment is performed. There is a general lack of

information concerning dose/response relationships at the population level of ecological organization. Higher trophic levels are discussed but not evaluated in this QRA, because this a "qualitative" rather than a "quantitative" risk assessment. Therefore, only one receptor (rather than several trophic levels) is used for evaluation of limited exposure scenarios.

8. If an individual site has EHQ values less than one, then the assessment should be rerun to consider the cumulative effect of adjacent sites. There is one caveat for this approach associated with the ecological QRA. The home range size of the pocket mouse still needs to be considered. The 100-B/C-1 QRA attempted to use the loggerhead shrike to integrate the effects of contaminant bio-accumulation over the entire operable unit. It seems that this effort was abandoned for the 100-HR-1 (and 100-DR-1) QRA(s) because the modeling scenario was unrealistic. Although some "realistic" method will be necessary for assessing cumulative risks at different trophic levels for a baseline risk assessment, I suggest use of the loggerhead shrike is inappropriate in the context of a QRA for another reason independent of modeling difficulties. The purpose of the QRA is to evaluate the risk posed by an individual waste site as one part of the decision process that determines whether an Interim Remedial Measure (IRM) is necessary (HSPPS). Because the loggerhead shrike scenario integrates across the entire operable unit (100-BC-1 OU), it does not enable an evaluation of the effect of an individual waste site.

Comment Resolution: As the next-to-last sentence in this comment points out, the purpose of the QRA is to evaluate the risk posed by an individual waste site as one part of the decision process that determines whether an IRM is necessary. The cumulative effect from individual waste sites is not part of the QRA. The home range of the pocket mouse is considered in the calculation of dose from a waste site. Use of the loggerhead shrike in the qualitative risk assessments has been discontinued.

9. Pathways other than those attributable to external exposure that present cancer risk levels greater than 10^{-4} and hazard quotients greater than 1 should be discussed in Section 4.

Comment Resolution: Table 4-3 and the text will be updated to identify pathways contributing risks greater than ICR = 1E-04 and/or HQ = 1. For the frequent-use scenario, pathways other than external exposure to radionuclides which present such estimated risks include soil ingestion (116-H-1, 116-H-7, 116-H-9, process effluent pipelines-sludge) and fugitive dust inhalation (116-H-7, 116-H-9). No pathways other than external exposure to radionuclides have estimated risks greater than ICR = 1E-04 and/or HQ = 1 for the occasional-use scenario. Table 4-3 identifies, for each exposure scenario, which waste sites have pathways contributing risks greater than ICR = 1E-06 and/or HQ = 1, and what type of contaminant these risks are associated with. The summary of the human health risk assessment presented in the text of Chapter 4 is limited primarily, for the sake of brevity, to the relative ranking of the high priority waste sites. Because external exposure to radionuclides is

identified as the pathway associated with the highest ICRs at most waste sites, this is noted in the text of Chapter 4 as well.

Specific Comments

10. **Deficiency:** Executive Summary (ES), Background Section, 2nd paragraph, last sentence:

The sentence implies that the Great Basin pocket mouse is a key part of the food chain involving currently listed threatened and/or endangered species (either federal or state) on Hanford. This is not accurate. They may be an important dietary component for a number of federal and state, candidate and monitor species, but that is not what is implied here.

Recommendation: The QRA needs to avoid motherhood statements that stretch the applicability of the risk assessment. The QRA should describe clearly, without exaggeration the placement of the pocket mouse within Hanford's terrestrial food webs and why it was chosen as an indicator species to assess waste site impacts to the environment.

Comment Resolution: The text will be changed on page ES-1, 2nd paragraph, last sentence, to read, "The pocket mouse is used because its home range approximates the size of the many waste sites, and these mice are a key part of the terrestrial food chain at the Hanford Site." However, the role of the pocket mouse within the Hanford terrestrial food web is not important in the QRA, since the pocket mouse is the receptor of choice to indicate the relative risk of a waste site.

11. **Deficiency:** ES, Background Section, 3rd paragraph, 2nd sentence:

The sentence implies that the maximum concentration for a contaminant, irrespective of the depth at which it was detected (from either historical or LFI data), was used in the risk assessment calculations. This is not accurate. Contaminant concentrations detected at greater than 15 feet were not considered in the calculations (see Page 2-5, Section 2.3.1.1).

Recommendation: The QRA should clarify the inconsistency.

Comment Resolution: The sentence will be changed to read, "The maximum concentration of each analyte detected above 15 ft at a waste site was selected from tabulated historical and LFI data for evaluation in the QRA." It should be noted that the data tables do indicate when maximum contaminant concentrations detected below 15 feet are greater than those concentrations detected above 15 feet.

12. **Comment:** ES, Results Section, paragraph 3:

There is a mixing of the use of the maximum contaminant concentration detected at a waste site (2nd sentence) with a later statement that only the maximum from the first 15 feet was considered (4th sentence).

Recommendation: The QRA should avoid misleading statements that imply to a reviewer that maximum concentrations, irrespective of depth, were considered.

Comment Resolution: The second sentence, paragraph 3 on page ES-2, will be revised to read, "In the case of 100-HR-1 terrestrial wildlife, the risk assessment assumed that the key receptor organism, the Great Basin Pocket Mouse, was a frequent site user and was exposed to the maximum concentration of soil contaminant to a depth of 15 ft in an individual waste site."

13. **Deficiency:** ES, Results Section, paragraph 4:

The last sentence does not indicate at which sites the NOEL was exceeded for which contaminants. There is no information provided about ecological benchmarks for non-radioactive contaminants. There is no indication, for those sites identified as causing a high risk, as to which scenario (0-6 feet, 0-15 feet, or both) causes the risk.

Recommendation: Indicate at which sites the NOEL was exceeded. Provide a brief statement about ecological benchmarks for non-radioactive contaminants. Define what is meant by an "ecological benchmark." Identify which scenario causes the risk.

Comment Resolution: Paragraph 4 on page ES-2 will be changed to read, "The ecological benchmark for radionuclides is a total internal dose of 1 rad/day. The organism dose that exceeded this benchmark was classified as high risk. Four sites, the process effluent pipelines (sludge) at the 0-6 ft depth, the 116-H-1 trench, the 116-H-2 trench and the 116-H-7 retention basin (the latter three at both the 0-6 and 0-15 ft depths), indicate potential ecological risks from strontium-90. For the non-radiological benchmark, the wildlife NOEL were exceeded by arsenic, lead, and zinc in the 116-H-7 Retention Basin for both the 0-6 depths and the 0-15 ft depths. The NOEL was exceeded by arsenic in the 116-H-1 Trench (0-15 ft) and by barium, manganese, and vanadium in the 116-H-9 crib (both the 0-6 and 0-15 ft depths). The evaluated receptor, the Great Basin pocket mouse, generally burrows to a maximum depth of 6 ft, and the 0-15 ft depth was used to meet the requirements of the Hanford Site Baseline Risk Assessment Methodology."

14. **Comment:** ES, Uncertainties Section, 1st paragraph, sentence 4:

The sentence describes uncertainties specific to the ecological risk assessment. Some additional uncertainties deserve mention with the understanding that uncertainties associated with the ecological QRA can be either conservative or non-conservative.

Recommendation: The QRA should indicate that uncertainties associated with the ecological QRA can be non-conservative as well as conservative.

On the conservative side of the ledger our lack of knowledge (or lack of use of available knowledge as the case may be) about pocket mouse activity and foraging patterns may cause an overestimate of the amount of contaminated food that is ingested. Conversely, the QRA considers on only one pathway of exposure (see comments to Appendix D). Moreover, there is a general lack of knowledge of the effects of specific contaminants on wildlife.

Comment Resolution: The entire uncertainties section of the Executive Summary will be rewritten as follows:

"Uncertainty exists in the results of the human health and environmental evaluations for the 100-HR-1 source operable unit because of uncertainties in the contaminant concentration data, in the assumptions of the exposure scenarios analyzed, and in the toxicity values for both human and ecological receptors. Where uncertainties exist, parameter estimates are generally biased in a conservative manner. Consequently, this QRA provides risk estimates which are biased toward the protection of human health and ecological integrity, considering the qualitative nature of the available data.

"Identification of contaminants and concentrations are based on a limited sampling program and historical data of unvalidated quality. It is unlikely that the available data fully characterize many of the waste sites. Maximum representative (rather than average) concentrations are used in the risk evaluation due to the limited number and quality of waste site sample data. Additional uncertainty is introduced by assuming that contaminants are uniformly distributed across the waste sites when it is known that the LFI and historical sampling programs were intended to take "snapshots" of likely "hot spots" suspected of being contaminated based upon process knowledge.

"The assumptions of the exposure scenarios and the risk evaluation itself lead to uncertainty in the application of the results, although the evaluation is meant to be an upper bound of potential risk. The two human health scenarios (frequent- and occasional-use) evaluated to provide estimates of hazard or risk do not currently occur in the 100-H Area. In the ecological risk evaluation no allowance is made for radioactive decay, bioavailability, or dilution effects.

"There are uncertainties associated with the toxicity values used in both the human health and ecological risk assessments. These values are often based on limited acute animal studies with the effects extrapolated to the lower chronic dose levels associated with environmental contamination. Additional uncertainty is introduced by applying these values to humans or to animal species other than those evaluated in the studies.

15. **Comment:** Section 2.1.2, paragraph 2, sentence 6:

Text states, "If upon review of the rejected data, the reason for rejection was due to administrative concerns and not because of other quality assurance/quality control issues, the rejected data are used in the QRA." If this means that the "R" qualifier was not removed from the data, then it would be impossible for the person validating to know which data was deemed usable and which was not, thereby possibly leading to incorrect assumptions about waste sites with "R" data.

Recommendation: Rejected data that was deemed usable should have the "R" qualifier removed. If it is found to have had an effect on data validation and waste site assumptions, affected waste site data should be reevaluated.

Comment Resolution: The "R" qualifier is placed on an LFI data point by the data validator prior to evaluation by the risk assessor. As stated in the text, if later evaluation of the data validation report by the risk assessor indicates that the reason for an "R" qualification is due solely to administrative concerns, then this data point is included for evaluation in the QRA. Data which had R qualifiers after data validation is included in the risk evaluation for the QRA so data which indicated contamination are not ignored for reasons which do not affect the quality of the data.

16. **Deficiency:** Section 2.2, paragraph 3, and Table 2-1:

As stated in the accompanying transmittal letter, based on the September 23 background meeting, the referenced background document will not be used for risk assessment determinations. Thus, there are two basic options available to determine background and to compare background to site data. The first is to determine some type of threshold value or point estimate for background and compare this value to the upper confidence level about the mean. The second compares distributions of background to distributions of site data.

The first option for evaluating background is more closely aligned with MTCA regulations. The MTCA cleanup regulations require that background values be represented by a single selected value. The regulations, WAC 173-340-708(c), (d), and (e), stipulate that the statistical method used to evaluate available data be appropriate for the statistical distribution of each hazardous substance. The lower tolerance limit may be used to compare a cleanup standard with background. That lower tolerance limit shall be based on coverage of 95% and a tolerance coefficient of 95% (this means that the background value shall be the *lower* 95% confidence limit around the 95th percentile of the background distribution). Other statistical methods may be used if approved by Ecology.

Ecology has determined that the approach required in MTCA regulations may not provide an appropriate method for evaluating background data, and has suggested other methods in the Washington State Department of Ecology Toxics Cleanup Program Statistical Guidance for Ecology Site Managers, August 1992. Location and number of samples may differ upon

whether natural and area background conditions are to be represented. At least 10 soil samples are required to determine natural background levels, and at least 20 samples are required to determine area background levels. Estimates of upper percentile values of the background distribution may be affected by small sample sizes.

Default procedures have been established by Ecology to determine a cleanup standard based on background data. The procedures are charted in Figure 12 of the MTCA statistical guidance document. It is assumed that the background distribution is lognormal unless rejected at $p < 0.05$. If not rejected, a best-fit lognormal distribution is estimated and a 90th percentile value is determined. The 50th percentile (median) value is also determined. The cleanup standard is determined based on whether the 90th percentile value is greater than 4 x the 50th percentile value. The lesser of either the 90th percentile or 4 x 50th percentile is then used as the cleanup standard. DOE-RL (1993b) has not established supporting information to justify the use of the 95/95 threshold using the *upper* confidence interval. The 95/95 is not the most appropriate threshold, as discussed in the MTCA Statistical Guidance.

The second option is to establish a background distribution for each constituent of concern or inorganic constituents as listed in the DOE-RL (1993b) Summary Table (page xi). The background distributions would be compared to distributions of compliance or site data to characterize or determine cleanup of various sites. The nonparametric test methods proposed by Gilbert and Simpson in Statistical Methods for Evaluating the Attainment of Cleanup Standard, Volume 3: Reference-Based Standards for Soils and Solid Media, 1992 are not dependent on any particular type of distribution or threshold value to determine of a site is contaminated or clean. The Wilcoxon Rank Sum and Quantile Tests and the Hot-Measurement Comparison may be sensitive to the type of sampling and number of samples analyzed. Bias can be eliminated or reduced by using similar methods to sample the reference and cleanup units and collecting an adequate number of samples. The advantage to this option is that no single background cleanup standard is required and the distributions and associated uncertainties of both the background data the compliance or cleanup data are utilized.

Recommendation: Do not use the conclusions of the draft background report, DOE-RL (1993b). Either a) calculate background as described above, or b) use the risk-based screening only, without the background screening, which would probably lead to substantially the same result.

Comment Resolution: The September 23 background meeting referenced in the comment has been superseded by an October 6, 1993, letter from P. S. Innis of the EPA and C. S. Cline of Ecology to S. H. Wisness of RL which gives specific instructions to make the background report "a generic soil background data report (with data set characteristics) that is appropriate for all end users." Because risk-based screening or screening against background will lead to substantially the same result it is not appropriate to redo this QRA. Future

QRAs will incorporate the guidance of the October 6, 1993, letter, as specified documents are developed.

The sensitivity of the overall risk ratings for waste units in the 100-HR-1 operable unit to the screening level for inorganic constituents was evaluated to assess the importance and urgency of reaching consensus on use of a particular statistic from the draft background report (DOE-RL 1993b) for background screening. The current background concentration used to screen inorganic constituents for consideration in a QRA is the 95% upper confidence limit on the 95th percentile of the lognormal distribution (95% UTL). As demonstrated in the following paragraphs, changing this screening statistic to the 90th percentile of the lognormal distribution has no effect upon the overall risk rating for any waste site.

The following tasks were performed to evaluate the effect of using the 90th percentile of the lognormal distribution for screening inorganic constituents at the 100-HR-1 operable unit:

1 - Sites that had data with overall risk ratings of Medium or Low under either exposure scenario were reviewed. The only site eliminated was the 116-H-7 Retention Basin, which was rated High in the frequent- and occasional-use scenarios. This site was eliminated because the overall risk would not be changed if more inorganic analytes were to be included in the risk characterization.

2 - Validated inorganic data (from data management file query) were compared against the 90th percentile data, as presented in Table 6-9a of the draft Hanford Site background report (DOE-RL 1993b), to check for inorganic which exceeded the 90th percentile value but not the 95% UTL value.

The following summarizes these exceedances:

a. 116-H-1 Trench:
No inorganic exceeded the 90th percentile value which did not also exceed the 95% UTL.

b. 116-H-2 Trench:
Nickel (24.4 mg/kg) was the only analyte which exceeded the 90th percentile value but not the 95% UTL. There would be no impact from adding nickel. Under the frequent- and occasional-use scenarios, nickel would have an HQ of approximately 0.01, and 0.001, respectively.

c. 116-H-3 French Drain:
No inorganic exceeded the 90th percentile value which did not also exceed the 95% UTL.

d. 116-H-9 Crib:
No inorganic exceeded the 90th percentile value which did not also exceed the 95% UTL.

Table 1 presents a comparison of the 90th percentile versus the 95% UTL values at the 100-HR-1 operable unit. It illustrates that, with exception of mercury and silver, 90th percentile inorganic values are at least 70% of the 95% UTL values. Table 2 provides a comparison of 90th percentile and 95% UTL values versus preliminary risk-based screening concentrations at the 100-HR-1 operable unit. This table indicates that the use of either background screening value will not affect exceedance of risk-based screening concentrations for any inorganic constituent.

17. **Comment**: Section 2.3.1.2

Three exposure scenarios are used in this QRA; frequent use under 1992 contaminant conditions, occasional use under 1992 contaminant conditions, and frequent use with radionuclides decayed to 2018. The HSBRAM, section C.2.2.1, states that "for 100 area QRA's, the residential and recreational scenarios will be evaluated for each site under current contaminant conditions." The exposure parameter section of this QRA, 2.3.1.2.3, uses the HSBRAM recreational and residential parameters. The HSBRAM does not provide for decaying radionuclides to the year 2018.

Recommendation: Do not rename the recreational and residential scenarios as occasional-use and frequent-use, respectively. Use the HSBRAM scenarios until the HSBRAM is amended. Do not decay radionuclides in disregard to the HSBRAM.

Comment Resolution: The occasional-use and frequent-use scenarios represent bounding estimates of human exposure. Calling the occasional-use and frequent-use scenarios "recreational" and "residential" caused reviewers to confuse the qualitative risk assessments with baseline risk assessments. Radionuclides are decayed to the year 2018 because this was the date at which remedial actions were intended to be completed in the Tri-Party Agreement. The HSBRAM (section 2.2.5.2) identifies that future scenarios will be evaluated at 2018 and 2118.

18. **Comment**: Section 2.3.1.2.1, paragraph 1:

The text states that "in accordance with the Tri-Party Agreement, the year 2018 is the earliest time in which the Federal Government could release portions of the Hanford Site for non-industrial uses." It is doubtful that the TPA precludes the Federal Government from using portions of the site for industrial uses before any particular date. The TPA merely provides that the cleanup will be completed by 2018.

Recommendation: Provide an appropriate justification for decaying radionuclides to the year 2018.

Comment Resolution: The Tri-Party Agreement states that remedial actions for all operable units will be completed by 2018. As discussed in the disposition to specific comment #17, 2018 is one of the dates identified for evaluation of future scenarios in baseline risk assessments. The last two sentences of the

first paragraph of section 2.3.1.2.1 in the QRA will be altered to state, "In accordance with the Tri-Party Agreement, the year 2018 is the date by which all remedial actions at the operable units are to be completed. This date is therefore chosen as a target date for evaluation of future baseline risks under a frequent-use scenario."

19. **Comment**: Section 2.3.1.2.1, paragraph 2:

The text seems to state that institutional controls are considered in establishing the occasional-use scenario. Institutional control is a remedial alternative. The risk assessment should be based on conditions prior to remediation.

Recommendation: Do not consider institutional controls in the occasional-use scenario. The current exposure is based on the assumption that institutional controls do not exist.

Comment Resolution: Institutional controls are not considered in the frequent- or occasional-use scenarios of the QRA that are used to establish the bounding risk estimates at the waste sites prior to remediation. The intent of Appendix F is to evaluate the potential risks associated with the external exposure pathway at the high-priority waste sites under an occasional-use scenario using exposure conditions representative of current site use. Because the exposure scenarios evaluated in the QRA are not representative of activities currently conducted at the waste sites, readers may misinterpret the risk estimates as indicative of an actual, current threat which may not exist under current site-use conditions. This evaluation of the external pathway, in addition to the evaluation of the frequent- and occasional-use scenarios without institutional controls, could be considered a "limited action" scenario (for a single pathway), as provided for in section 2.2.4 of the HSBRAM (DOE-RL 1993). Appendix F allows the reader to better assess the effects associated with external exposure to radionuclides upon the risk estimates if the actual depth profile of the radioactive contamination, rather than an assumption of uniform contamination, is used in the evaluation.

Sentences 1 and 2 of paragraph 2 in section 2.3.1.2.1 will be changed to read, "For the purpose of evaluating external exposure to radionuclides, an additional occasional-use exposure scenario is presented in Appendix F. This evaluation recognizes that contaminants that are located..." The last sentence of paragraph 2 in section 2.3.1.2.1 will be deleted.

20. **Comment**: Section 2.3.1.2.2:

No modeling of contaminant transport from the vadose zone to the groundwater was conducted for this QRA. The vadose zone is part of the source operable unit. It is efficient and effective to consider vadose zone transport along with the sources. The vadose zone data was collected through boreholes drilled through the sources. The cleanup of the sources through the IRM path of the HSPPS will include as much of the vadose zone as is necessary to protect the groundwater. It would

not be productive to include the vadose zone with the groundwater rather than the sources.

Recommendation: Include contaminant transport from the vadose zone to the groundwater in this source operable unit. See comment for section 2.3.3.

Comment Resolution: The HSBRAM (DOE-RL 1993) defines human exposure scenarios and pathways for use in a QRA. While ingestion of water is among the pathways cited for evaluation, the HSBRAM notes that, "Modeling of contaminant transport from one medium to another will generally be conducted as part of the comprehensive baseline risk assessment for a site, operable unit, aggregate area, or NPL site." Contaminants located in the upper 15 ft of soil are evaluated for human health risk via separate pathways, and are subject to remediation based on these evaluations. Modeling of migration to groundwater for contaminants above 15 ft is therefore generally unnecessary. For contaminants located below 15 ft, the authors suggest that any analysis of contaminant migration from the vadose zone to groundwater would be more appropriate within the LFI for this operable unit. The QRA is intended to be a qualitative analysis of risk for each waste site, supported by existing data. A qualitative discussion of potential impact to groundwater for each waste site is presented in sections 3.(1-12).6 and section 3.13.5, of the QRA.

21. **Comment:** Section 2.3.1.2.4, paragraph 4, sentence 1:

The text inaccurately interprets the WAC to require the assumption that a reasonable estimate of the depth of soil to which a human receptor may be exposed is 15 feet. WAC 173-340-740(6)(c) sets the point of compliance for soil cleanup levels based on direct human exposure. WAC 173-340-708, human health risk assessment procedures, while setting forth the concept of reasonable maximum exposure, does not mandate the depth of soil to which a person might be exposed. Neither HSBRAM, nor this QRA meets all the specific requirements and criteria of MTCA. It is therefore arbitrary to suggest that this one factor is mandated in this context. The QRA does not account for direct radiation exposure to a person situated at the 15 foot deep point of compliance of WAC 173-340-740(6)(c), as in a basement or within an excavation. Such a person would be exposed to soil below 15 feet deep.

Because the LFI resulted in limited information, it is plausible that concentrations situated at one depth at one horizontal coordinate may also be located at a shallower depth at another horizontal coordinate. If high levels of contamination are eventually left in the ground, at any depth, then some land use restrictions may have to be imposed. For example, well drilling may be prohibited. This is risk management. Ecology would like to be able to provide its risk managers with information on what risk is at what depth, without having to hunt through several tables. (Table 3-2a and F-3 are not enough because they do not characterize the risk.)

Recommendation: Do not base justification for delimiting soil exposure assessment to any specific depth on point of compliance. Include risk figures for soil below 15 feet. If DOE wants to do an additional calculation for less than 15 feet, then DOE may add a column to tables 3-2d, or Tables 4-2 and 4-3. DOE may instead create a whole new table comparing risk at different depths.

Comment Resolution: Evaluation of exposure to contaminants below 15 ft is beyond the scope which was agreed upon for the qualitative risk assessments. WAC 173-340-740(6)(c) states: "For soil cleanup levels based on human exposure via direct contact, the point of compliance shall be established in the soils throughout the site from the ground surface to fifteen feet below the ground surface. This represents a reasonable estimate of the depth of soil that could be excavated and distributed at the soil surface as a result of site development activities." A depth of 15 ft is a conservative estimate of the depth of soil to which an individual might be exposed under the scenarios evaluated in the QRA.

22. **Comment:** Section 2.3.1.2.4, paragraph 4, last sentence:

This allusion to institutional controls is inappropriate, because institutional controls are a remedial alternative rather than a baseline condition or land-use assumption.

Recommendation: Delete this sentence from the QRA.

Comment Resolution: The last sentence of the fourth paragraph of section 2.3.1.2.4 will be deleted because it is not directly relevant to the paragraph topic. See the resolution to specific comment #19 for additional information concerning references to institutional controls.

23. **Comment:** Section 2.3.1.3:

The method used to evaluate Carcinogenic Polycyclic Aromatic Hydrocarbons is not clear.

Recommendation: The method used to evaluate Carcinogenic Polycyclic Aromatic Hydrocarbons other than benzo(a)pyrene, either by using the benzo(a)pyrene toxicity factors or the benzo(a)pyrene toxicity equivalency factors, should be presented here.

Comment Resolution: As stated in section 2.3.1.3, bullet 5, surrogate toxicity factors for contaminants without specific toxicity factors are generally not used. EPA Region 10 does not consider it generally appropriate to use benzo(a)pyrene as a toxicity surrogate for other carcinogenic PAHs due to the fact that other PAHs are generally less potent carcinogens. Furthermore, EPA Region 10 does not have a position on the use of any toxicity equivalency factors for relating the toxicity of other carcinogenic PAHs to that of benzo(a)pyrene. The following sentence will be included in bullet 5 of section 2.3.1.3: "Because consensus on the appropriate manner of evaluating

carcinogenic PAHs other than benzo(a)pyrene has not been reached in EPA Region 10, these compounds are not quantitatively evaluated in the QRA."

24. **Deficiency:** Section 2.3.2.1.1, paragraph 2, last sentence:

The sentence states that all contaminants exceeding background are included in the risk assessment. This is not consistent with Fig. 2-4 (Page 2F-4) which implies that certain substances, such as aluminum [which can be toxic, especially to aquatic organisms (Devillers and Exbrayat 1992)], may have been eliminated from consideration even if their concentrations exceeded background (also see DOE-RL 1993, Section 2.1.4.3). Contaminants not of concern for humans may still be of concern for wildlife.

Recommendation: Contaminants should not be screened out based solely on their toxicity to humans. Each contaminant should also be assessed for its potential toxicity to plants, fish, and wildlife.

Comment Resolution: Screening of contaminants using human health criteria is used as a first cut in selection of contaminants of potential concern for the ecological risk assessment. Those constituents which may be dropped are then reviewed for consideration of ecological criteria. It is recognized that contaminants not of concern for the human health risk assessment may be of concern in the ecological risk assessment and the concentration of aluminum, in particular, is evaluated.

25. **Comment:** Section 2.3.2.1.1, paragraph 3, last sentence:

The sentence implies that no direct measures of biological uptake for contaminants of concern are available for the operable unit. Measures of uptake can be important for estimating transfer coefficients for contaminants between soil and biological media.

Recommendation: Contractors responsible for the 100 Areas have routinely taken environmental surveillance samples in the vicinity of the 100 Area waste units. The QRA should make use of the historical environmental surveillance data that are available for the operable unit. If the data are problematic in the sense that soil samples, for example, can not be correlated with vegetation samples to derive an estimated transfer coefficient, they should still be useful in discussing the qualitative nature of the risk assessment in general and the transfer coefficients in particular.

Comment Resolution: The fourth paragraph of Section 2.3.2.1.1 will be revised to read as follows:

"Components of the 100-HR-1 operable unit environment that may be affected by wastes at the site include parts of the food web shown in Figure 2.3. For this qualitative risk assessment, only one receptor (the Great Basin Pocket Mouse, a herbivore) was chosen for risk screening. This is in contrast to a baseline risk assessment where multiple receptors and their risks are determined from site-specific data. A listing of plants, animals, birds, and

reptiles found in proximity to the 100-HR-1 sites is available in Landeen et al. (1993). The reference also lists threatened and endangered plant and animal species native to Hanford. Information on 100-D area biotic sampling can be found in Schmidt et al (1993), Landeen et al. (1993), and Wintczak (1993). A summary table of measured biotic uptake of contaminants by plants near the 100-HR-1 waste sites is included in the Appendix (Table D-4) and can serve as potential verification data for the soil-based uptake model of radionuclides."

Landeen, D.S., M.R. Sackschewsky, and S.G. Weiss. 1993. 100 Areas CERCLA Ecological Investigations. WHC-EP-0620. Westinghouse Hanford Company, Richland, Washington.

Schmidt, J.W., A.R. Johnson, S.M. McKinney and C.J. Perkins. 1993 Westinghouse Hanford Company Operational Environmental Monitoring Annual Report, CY 1992. WHC-P-0573-1. Westinghouse Hanford Company, Richland, Washington.

Wintczak, T.M. 1993. Letter to R.D. Freeberg, DOE "Validated Data for the 100 Aggregate Area Biota Sampling. Correspondence No 9352382D, March 24, 1993. Westinghouse Hanford Company, Richland, Washington. Approximately 1000 pages."

Table D-4. Average Radionuclide Concentrations (pCi/g) Detected in 100-H Area Vegetation Samples from 1981 to 1992, as reported by Schmidt et al. (1993).

Year	Co-60	Sr-90	Cs-137	Pu-238	Pu-239/240
1981	6.8 E-01	NR	1.5 E-01	NR	NR
1982	NR	NR	NR	NR	NR
1983	1.3 E-01	NR	9.0 E-02	NR	NR
1984	1.8 E-01	2.0 E-00	1.3 E+01	2.0 E-04	1.7 E-03
1985	2.0 E-01	6.0 E-02	4.5 E-02	1.0 E-04	5.1 E-04
1986	2.2 E-01	5.3 E-01	1.3 E+00	1.3 E-04	4.4 E-05
1987	2.6 E-01	2.6 E-01	1.0 E-01	3.5 E-05	2.7 E-04
1988	9.0 E-01	3.9 E-01	1.5 E-01	2.0 E-04	1.5 E-04
1989	6.5 E-01	5.2 E-02	2.1 E-01	8.5 E-05	1.5 E-04
1990	<1.3 E-01	1.1 E-02	6.6 E-02	<1.4 E-04	3.0 E-04
1991	<2.8 E-02	5.7 E-02	3.0 E-02	4.5 E-05	5.7 E-04
1992	<2.0 E-02	6.7 E-02	<7.7 E-03	<1.5 E-06	<1.3 E-04

NR = Not Reported.

26. **Comment**: Section 2.3.2.1.1, 4th paragraph, last sentence:

Listing only mammals and sensitive bird species implies that these species are the only organisms of concern.

Recommendation: Justify this selective reporting of the species at risk.

Comment Resolution: The intent was not to imply that threatened and endangered species and mammals were the only species at risk but to provide the reader a perspective of the 100-Area. See the response to question 25. In order to be consistent, Table D-1 and D-2 will be removed from Appendix D. Additional information on 100-D area biota sampling and threatened and endangered species can be found in the Landeen et al. (1993) reference.

Landeen, D.S., M.R. Sackschewsky, and S.G. Weiss. 1993. 100 Areas CERCLA Ecological Investigations. WHC-EP-0620. Westinghouse Hanford Company. Richland, Washington.

27. **Deficiency:** Section 2.3.2.1.1, 5th paragraph, 4th sentence:

This sentence implies that radiation doses are weighted by the energy of the radiation (i.e., quality factors are applied); however, the last sentence of the paragraph uses the units rad/day. Rad is an un-weighted measure of radiation exposure. Also, throughout the document the QRA tends to mix the concepts of dose and dose rate. Rad/day is a dose rate, not a dose.

Recommendation: Weighted values of radiation exposure are usually associated with human exposure (the REM). The QRA needs to clarify how radiation doses were weighted for the purposes of the ecological QRA. Also, the QRA should strive to identify units of measures correctly; i.e., rad is a dose and rad/day is a dose rate.

Comment Resolution: On page 2-11, 5th paragraph of Section 2.3.2.1.1, the term "weighted" does not apply to radiation dose to animals and will be removed.

28. **Comment**: Section 2.3.2.1.2, sentence 1:

The sentence states that the assessment and measurement endpoint is the health and mortality, respectively of the Great Basin pocket mouse. Mortality of the pocket mouse is not an appropriate assessment endpoint.

Recommendation: Health and mortality of the pocket mouse should both be considered as measurement endpoints. We are using the pocket mouse as an indicator of the health of the entire operable unit ecosystem. Specific assessment endpoints have not been identified and agreed to by TPA participants. This should be done.

Comment Resolution: The first sentence in Section 2.3.2.1.2 will be corrected to read, "The measurement endpoints are the health and mortality of the Great Basin pocket mouse."

29. **Comment:** Section 2.3.2.2.1, 2nd and 4th paragraphs (also see Appendix D):

The discussion of home range size, waste site size, and their relationship to pocket mouse usage factors is confusing. It is difficult for a reader to equate statements such as: ". . . assumed that all of [its] life is spent within the site." (2nd paragraph, 2nd sentence) with ". . . assumed the receptor spends some fraction of [its] life in the site, [but] obtains all its food from the site and all consumed food is contaminated." (4th paragraph, 2nd sentence) and then understand the need for usage factors. If ingestion is the only pathway considered and all food is considered contaminated, why discuss and use a usage factor?

Recommendation: Incorporating usage factors into the conceptual model may be appropriate but not as indicated by the discussion in this section. Whatever approach is decided to be followed, i.e., use or do not use usage factors, the QRA needs to be clear about what is done.

Comment Resolution: The second sentence of the 4th paragraph will be changed to read, "It was assumed the receptor spends all of its life in the site..." On page D-7, the equation (8) variable FI will read, "FI = fraction ingested from contaminated source = 1".

30. **Comment:** Section 2.3.2.2.1, paragraph 4, last sentence:

The sentence states that a drinking water pathway was not considered because there is not a local source of water within the operable unit. Perhaps more relevant than the presence of a source of water is whether shrub-steppe rodents, such as the pocket mouse, will drink water when available.

Recommendation: The literature should be checked to determine whether Great Basin Pocket Mouse will make use of surface water when available. If they do not then the drinking water pathway can be eliminated independent of whether there are water sources available.

Comment Resolution: The 4th paragraph of Section 2.3.2.2.1, on page 2-13 will be revised to reflect available literature and indicate that the pocket mouse does not require water. The sentence will read, "Schmidt-Nielson (1948) and Kritzman (1974) state that this species does not need free water but occasionally eats green vegetation when available."

31. **Deficiency:** Section 2.3.2.2.1, 5th paragraph, last sentence:

The sentence states that example calculations are provided in Appendix D for calculating contaminant dose. Appendix D does not provide these example calculations.

Recommendation: Provide example calculations in Appendix D for radiological and hazardous chemical contaminants.

Comment Resolution: Example Calculation for Appendix D:

The internal dose rate calculation for the Great Basin Pocket Mouse is calculated for ingestion of plants growing in soil uniformily contaminated with 35 pCi/gm strontium-90. For this one radionuclide, the calculation can be described as:

$$R_c = [(B\ U\ f)/M] \qquad [1-e^{-\lambda T})/\lambda] \qquad [E]$$

Internal Dose Rate (R_c) = (Uptake Factors) (Decay Factors) (Absorbed Energy Rate)

Where
B = concentration in soil
U = plant uptake factor
f = mouse consumption rate
M = weight of mouse

Step 1. <u>Uptake Factors</u> - strontium-90

Uptake Factors = [(35E-9 Ci/kg)(19)(0.4)(0.3)(0.0327 kg/day)]/0.021 kg

= 1.2 E-07 Ci/day-kg

where
pCi to Ci conversion = 1 pCi/g = 1.0E-9 Ci/kg
B = 35 pCi/g soil = 35E-9 Ci/kg
U = plant uptake factor = 19 (Table D-3), and is the concentration per unit mass in the plant divided by the concentration per unit mass in the soil.
vegetation (wet) = 0.4 x [vegetation (dry)]
f = consumption by mouse = 0.0327 kg/day (from DOE 1992)
fraction of radionuclide initially retained in mouse = 0.3 (see Table 1, Baker and Soldat 1992)
weight of mouse (adult) = 0.021 kg

Step 2. <u>Decay Factors</u> - strontium-90

Decay factors $= (1-e^{-\lambda T})/\lambda = d^{-1}$

$= (1-e^{-((2.9E-03 + 6.5E-05)365)})/(2.9E-03 + 6.5E-05) = d^{-1}$

$= 222\ d^{-1}$

where

biological half-life = 236 d (Table 1, Baker and Soldat 1992)
loss rate/day = 0.693/biological half-life = 2.9E-03 day^{-1}
physical half-life = 29.1 yr times 365 day/yr = 10622 d
physical decay rate = 0.693/physical half-life = 6.5E-05 d^{-1}
effective decay constant (λ) = loss rate/day plus the physical decay rate/day
T = 365 days

Step 3. Absorbed Energy Rate - strontium-90

Absorbed Energy Rate = 1.14 MeV dis^{-1} x 5.1E4

= 58140 kg rad Ci^{-1} d^{-1}

where effective diameter of the mouse = 2 cm
effective absorbed energy = 1.14 MeV dis^{-1} for 2 cm mouse (see Table 2, Baker and Soldat 1992)
1 kg rad Ci^{-1} d^{-1} = (1 MeV dis^{-1})(3.7E10 dis s^{-1} Ci^{-1})(86,400 s d^{-1}) (2.602E-11 kg rad MeV^{-1})

= 5.1E04

Conclusion.

The Internal Dose Rate (rad/day)

= (Uptake Factors) (Decay Factors) (Absorbed Energy Rate)

= (1.2 E-07 Ci d^{-1} kg^{-1}) (222 d^{-1}) (58140 kg rad Ci^{-1} d^{-1})

= 1.6 rad/day

Reference:

DOE, 1992, Site-Wide Characterization Report, Fernald Environmental Management Project, FEMP-SWCR-3, U.S. Department of Energy, Fernald Field Office, Fernald, Ohio.

32. **Deficiency:** Section 2.3.2.2.2, 1st paragraph, 2nd sentence:

DOE Order 5400.1 should be 5400.5. Also, no DOE Orders are cited in the reference section (Section 5.0).

Recommendation: Identify the correct DOE Order. Update the reference section.

Comment Resolution: The second sentence in the first paragraph of section 2.3.2.2.2 will be corrected to read, "The only regulatory driver for radionuclides in the environment is DOE Order 5400.5, which requires exposure limits for aquatic organisms to be less than 1 rad/day." The corrected number of the DOE Order will also be provided in the references. Another sentence will be added to state, "The regulatory benchmark for terrestrial organisms has not been formally established. However, until a formal benchmark is established, hazard quotients for terrestrial ecological exposure are based on an exposure limit of 1 rad/day (NCRP 1991) for radionuclides and the NOEL dose for non-radionuclides."

33. **Comment**: Section 2.3.2.2.2, 1st sentence of 6th and 7th paragraphs:

The sentences imply that more than one species was assessed. The QRA focuses only on the pocket mouse. The wording might be a holdover from when risk to the loggerhead shrike also was assessed in the 100-BC-1 QRA (WHC 1993a).

Recommendation: Revise these passages to indicate that the pocket mouse was the only indicator species considered in this risk assessment.

Comment Resolution: The first sentence in Section 2.3.2.2.2, sixth paragraph, will be revised to read "To evaluate the toxicity of a chemical to the Great Basin pocket mouse, intake values for a given contaminant were compared with the NOEL or the LOEL." The first sentence in Section 2.3.2.2.2, seventh paragraph, will be revised to read, "Intake of contaminants by the Great Basin pocket mouse was estimated using intake parameters obtained from either published literature or derived from EPA formulas (EPA 1988)."

34. **Comment**: Section 2.3.2.3.1, paragraph 1:

A 1 rad/day benchmark is used in the QRA. One of the references for this benchmark is NCRP Report No. 109, *Effects of Ionizing Radiation on Aquatic Organisms*. The NCRP recommended a 1 rad/day chronic dose rate to the maximum exposed individual, which would be protective of populations. The NCRP also recommended a warning threshold of .25 rad/day, which would call for a more detailed evaluation of potential ecological consequences to the population.

Recommendation: Use a warning threshold, probably .25 rad/day.

Comment Resolution: A potential DOE radiological benchmark for terrestrial environments is currently being prepared by DOE-HQ. The use of a threshold will be either set by DOE-HQ or through the Interagency Risk Assessment Committee.

35. **Comment**: Section 2.3.2.3.1, paragraph 2:

While the risk assessment section of MTCA does not address environmental receptors, the cleanup standard sections do, e.g., cleanup levels may be based on concentrations which result in no adverse effects on the

protection and propagation of aquatic and terrestrial life (WAC 173-340-705(2)(b)). This is not a population based standard.

Recommendation: Consider effects at the individual level.

Comment Resolution: The requested evaluation is not appropriate to the scope agreed upon for the qualitative risk assessments.

36. **Deficiency:** Table 2-2:

The list of tabulated values is incomplete. Several other contaminants are present that could adversely affect wildlife; for example, aluminum, arsenic, and cadmium are present at some of the waste sites. Zinc is identified as having exceeded an NOEL for the 116-H-7 Retention Basin (Section 3.4.5 and Table 4-5) yet no NOEL value is provided in Table 2-2 for zinc. The QRA does not identify a basis for restricting the list of contaminants for which NOEL data are presented.

Recommendation: In general, a NOEL value, if available, should be provided for any non-radiological contaminant detected at the operable unit.

Comment Resolution: The screening process provides a list of contaminants above the Hanford background levels for inclusion in the ecological QRA. The detection (whether in historical or LFI data) of a non-radiological contaminant is the first step of the screening process. A particular contaminant may be eliminated from further consideration for a number of reasons. The rationale for any selection or elimination of a contaminant is shown in Table 3-1a, the Historical and LFI Data Summary for the 116-H-1 Trench. As footnoted in Table 3-1a, aluminum, calcium, iron, magnesium, potassium, and sodium are eliminated from consideration in the QRA as recommended in HSBRAM (DOE-RL 1993a). The NOEL table (Table 2-2., page 2T-2, Estimated Wildlife NOEL) presents contaminants which passed the screening criteria. It will be revised to include "Zinc = 0.02 mg/kg-day" which was inadvertently left out. It is recognized that analytes not of concern for the human health risk assessment may be of concern in the ecological risk assessment. Those constituents which fail the screening criteria are reviewed for consideration of ecological criteria.

37. **Deficiency:** Section 3.7.5, 1st sentence:

A soil concentration value is presented incorrectly as an indication of dose received from radionuclides.

Recommendation: Replace the soil concentration value with the appropriate dose rate value.

Comment Resolution: The paragraph in section 3.7.5, page 3-33, will be revised as follows: "The total dose to the Great Basin Pocket Mouse from maximum concentrations in the soil above 15 ft is 0.02 rad/day. The dose rate

is below the EHQ of 1 rad/day benchmark for this site, and no non-radiological contaminants exceeded their NOEL."

38. **Comment:** Section 3.10:

It is misleading to identify this facility as a retention basin. Retention basins were associated with reactor coolant effluent. The 116-H-6 facility was originally used as a sedimentation basin for the 100-H Area Water Filtration Treatment Facility (183-H). It was subsequently used as a solar evaporation basin that received 300 Area process-waste chemicals. We should not confuse its identity by calling it a retention basin.

Recommendation: Correctly identify the facility.

Comment Resolution: The 116-H-6 facility was named in accordance with the Hanford Site Waste Management Units Report (DOE/RL-88-30 1993).

39. **Comment:** Section 3, Tables

Tables that provide estimated dose data for the pocket mouse using the 0-6 feet soil depth scenario are identified as such; however, those for the 0-15 feet scenario are not identified on the table, and for the process effluent pipelines a table for the 0-15, scenario is not even provided.

Recommendation: Correctly identify the tables. Provide a table for the 0-15 feet scenario for the process effluent pipelines.

Comment Resolution: The tables will be corrected. For the process effluent pipeline no sample was taken below 5 ft. In this case, the only table should be for the 0-15 ft interval.
Table 3-1g. will be retitled: "Estimated Dose for the Great Basin Pocket Mouse at the 116-H-1 Trench (0-15 ft)".
Table 3-2e. will be retitled: "Estimated Dose for the Great Basin Pocket Mouse at the 116-H-2 Trench (0-15 ft)".
Table 3-3e. will be retitled: "Estimated Dose for the Great Basin Pocket Mouse at the 116-H-3 French Drain (0-15 ft)".
Table 3-4g. will be retitled: "Estimated Dose for the Great Basin Pocket Mouse at the 116-H-7 Retention Basin (0-15 ft)".
Table 3-5g. will be retitled: "Estimated Dose for the Great Basin Pocket Mouse at the 116-H-9 Crib (0-15 ft)".
Table 3-7e. will be retitled: "Estimated Dose for the Great Basin Pocket Mouse at the 116-H-7 Sludge Burial Trench (0-15 ft)".

40. **Deficiency:** Section 4.1.2, paragraph 3:

The risk characterizations are inappropriately lumped into risk categories. Not only is the risk category idea an over-simplification, but the categories themselves are miss-allocated.

Recommendation: Based on the goals and cleanup levels established under CERCLA and MTCA, the following risk categories would be appropriate in simplifying the risk characterization:

Low Risk = ICR < 1E-6
Medium Risk = 1E-6 < ICR < 1E-4
High Risk = 1E-4 < ICR

Comment Resolution: The qualitative risk characterization categories used in the QRA are arbitrary categories used to define relative risk levels associated with each waste site. "Very low", "low", "medium", and "high" risk categories were not intended as absolute pronouncements of risk but rather as rankings for the waste sites, in accordance with the objective of the QRA to prioritized waste sites for cleanup activities. EPA (NCP 1990) supports the concept of a risk range and defines the risk range of 10^{-4} to 10^{-6} as a "generally acceptable level" with 1E-06 as a "point of departure for establishing remediation goals" (40CFR300.340(e)(2). A paragraph defining the purpose and interpretation of the risk rankings will be included in section 2.3.1.4.1 and 4.1.2.

41. **Comment:** Section 4.1.2, last paragraph, last sentence:

The sentence inaccurately implies that the EHQ for radionuclides are based on the NOEL dose. NOEL doses are benchmarks for non-radionuclide contaminants.

Recommendation: Identify the NOEL as the applicable ecological benchmark for non-radionuclide contaminants.

Comment Resolution: The last sentence of Section 4.1.2 will be revised to read: "Hazard quotients for ecological exposure to radionuclides are based on an exposure limit of 1 rad/day (NCRP 1991) for radionuclides and a NOEL for non-radionuclides." Also, see answer to question 32.

42. **Comment:** Section 4.3:

Comments Nos. 26 and 27 apply to the Ecological Effects and Endpoint Selection subsections, respectively. Also, the last sentence of the Endpoint Selection subsection seems to have been written with the loggerhead shrike in mind.

Recommendation: Refer to Recommendations Nos. 26 and 27. Also, delete the last sentence of the Endpoint Selection subsection.

Comment Resolution: The Endpoint Section will be changed to read: "The measurement endpoints are the health and mortality of the Great Basin pocket mouse. Risk is evaluated for the pocket mouse based on a two-step accumulation model (soil-to-plant and plant-to-mouse). The dose to the pocket mouse was used to screen the level of risk of an individual waste site."

43. **Comment:** Section 4.3.1, paragraph 4:

The first sentence incorrectly states that all sites that had measurable Strontium-90 concentration exceeded a dose rate of 1 rad/day. The remainder of the paragraph implies that the 0-15 feet scenario drives the risk assessment results but is an unrealistic exposure scenario. The basis for this scenario may be open to question, but at least for the retention basin (116-H-7) the maximum concentrations (with the exception of zinc) were often found above six feet. Thus, though its reasoning is hypothetically true, this paragraph is somewhat misleading based on the actual results.

Recommendation: Rewrite the paragraph to reflect the actual results.

Comment Resolution: The fourth paragraph of Section 4.3.1 will be deleted. The results section 4.3.1 will be rewritten as follows:

"A qualitative ecological risk assessment was completed for the 100-HR-1 operable unit. Sites 116-H-1 Trench, 116-H-2 Trench, 116-H-7 Retention Basin, and the Process Effluent Pipelines (sludge) exceeded the EHQ of 1 rad/day. For sites that exceeded the EHQ, most of the dose is from strontium. The dose to the pocket mouse from radionuclides in the upper soil profile (0-6 ft) were at least as great as that of the total soil profile (0-15 ft). This suggests that the radionuclides (primarily strontium-90) are available within the rooting depth of plants and the burrowing depth of the pocket mice.

"For non-radiological constituents, site 116-H-1 Trench exceeded the wildlife NOEL for arsenic; however, the concentration used in the risk characterization is from the total 0-15 ft soil interval. The wildlife NOELs for arsenic, lead, and zinc are exceeded at 116-H-7 Retention Basin (both 0-6 and 0-15 ft scenarios). The 116-H-9 Crib (both 0-6 and 0-15 ft scenarios) exceeded the NOELs for barium, manganese, and vanadium."

44. **Comment:** Section 4.3.2, 5th paragraph, 3rd sentence:

The QRA makes the assumption that the seed concentration of contaminants is reduced compared to the rest of the plant but does not provide any reference to relevant studies.

Recommendation: The historical literature should be searched for information on the compartmentalization of contaminants in plants. If available, the information should then be evaluated for incorporation into the risk assessment model. It is preferable to eliminate uncertainties if they can be addressed by referring to published sources of information.

Comment Resolution: As noted in Section 4.3.2, 5th paragraph, 3rd sentence, the pocket mouse is generally a seed eater. However, information is not available to allocate radionuclides within plant compartments, especially for native plants. Therefore, available transfer coefficients were used which generally describe the transfer of contaminants from soil to plants. The

available literature does not provide sufficient information to model specific uptake of contaminants from soil to plants to the pocket mouse. Attempting to quantify this additional factor would do little to improve upon the stated purpose of the ecological QRA, which is to provide a relative ranking of waste sites for possible IRMs, and not to measure the actual ecological risk.

45. **Comment**: Tables 4-4 and 4-5:

There is no indication of whether the results apply to the 0-15 feet soil depth scenario, or to the 0-6 feet soil depth scenario, or to both.

Recommendation: Provide the scenario on which these results are based.

Comment Resolution: Tables 4-4 and 4-5 will be revised as follows:

Table 4-4. Environmental Hazard Quotients Summary for Radionuclides by Waste Site.

Waste Site	Soil Depth (feet)	Dose Rate Exceeds EHQ of 1 rad/day
116-H-1 Trench	0-6	yes
116-H-1 Trench	0-15	yes
116-H-2 Trench	0-6	yes
116-H-2 Trench	0-15	yes
116-H-3 Drain	0-6	no
116-H-3 Drain	0-15	no
116-H-7 Retention Basin	0-6	yes
116-H-7 Retention Basin	0-15	yes
116-H-9 Crib	0-6	no
116-H-9 Crib	0-15	no
Process Effluent Pipelines (Soil)	0-6	no
Process Effluent Pipelines (Sludge)	0-6	yes
116-H-7 Sludge Burial Trench	0-15	no

Table 4-5. Environmental Summary for Non-radiological Contaminants by Waste Site.

Contaminant	Soil Depth (feet)	Dose Rate Exceeds Wildlife NOEL
116-H-1 Trench	0-15	yes-arsenic
116-H-7 Retention Basin	0-6	yes-arsenic, lead, zinc
116-H-7 Retention Basin	0-15	yes-arsenic, lead, zinc
116-H-9 Crib	0-6	yes-barium, manganese, vanadium
116-H-9 Crib	0-15	yes-barium, manganese, vanadium

46. **Comment:** Appendix D, Plant Section, paragraph 1:

The section lacks a discussion of the assumptions made relative to the status of the vegetation in the QRA conceptual model. Currently, many of the waste sites are maintained free of vegetation by application of herbicides.

Recommendation: Besides describing the vegetation as it presently exists, there should be a description of the vegetation that is expected to be present upon the loss of institutional control. This is important because the ecological QRA assumes vegetation will be present when it determines its food intake parameters for the pocket mouse.

Comment Resolution: Presumption of what vegetation may be present at any time in the future is not possible without agreement on future land use. The QRA references documents where information describing existing Hanford Site vegetation can be found. Potential food intake by the pocket mouse is based upon assuming that vegetation which occurs on nearby naturally vegetated sites is also on waste sites.

47. **Comment:** Appendix D, Plants Section, paragraph 2:

Although it is not explicitly stated, the 0-6 feet ecological scenario is based partially on the rooting depths of vegetation expected to be present on the waste sites. Uptake of contaminants at depth by the root system of vegetation makes these contaminants potentially available to the rest of the food chain. The main reference cited by the QRA for plant rooting depths is Klepper et al. (1985). Because rooting depths (along with pocket mouse burrow depths) establish the basis for the limit of soil depth considered, they are a critical component of the conceptual model for the ecological risk assessment. The information in Klepper et al. must be critically evaluated and balanced against the information available in other publications. Rooting depths can be affected by such factors as soil type and evaporation/precipitation rates. Can the information in Klepper et al. be directly applied to the soil types and soil moisture conditions present on the 100 Area waste sites? At least one other study suggests significantly deeper rooting depths for big sagebrush. Moreover, some studies suggest that the mean root depth of big sagebrush is approximately four times the shoot height. Does this relationship hold for shrubs on Hanford? What about other deep-rooted plants? If we know the distribution of plant shoot heights, can we estimate the distribution of rooting depths at a site?

Recommendation: Because of the importance of the assumptions of rooting depth to an ecologically relevant QRA, all available information needs to be assessed in order to justify a particular soil-depth limit to the ecological scenario. It is probably not realistic to use maximum rooting depths. Instead, identifying the rooting depth above which a certain percentage (e.g., 90 %) of the root depths occur may be an acceptable approach. If root profiles are available, i.e., vertical and

horizontal distributions, this information might be considered for incorporation into the model as well.

Comment Resolution: The 6 ft level was selected to account for burrowing of pocket mice. According to Gano and States (1982), the maximum burrowing depth of the pocket mouse is 6 ft. It is intended that evaluating exposure conditions at both 0-6 ft and 0-15 ft will account for both biological interaction (e.g., burrowing activities and rooting depths at 0-6 ft) and requirements of the Hanford Site Baseline Risk Assessment Methodology (0-15 ft). The following sentence will be added to Appendix D, page D-4, the section entitled Mammals, the end of the third paragraph: "According to Gano and States (1992), the maximum burrowing depth of the pocket mouse is 6 ft."

48. **Comment:** Appendix D, Insect Section:

Insect abundance is described based on data from the Arid Lands Ecology Reserve. This habitat is potentially quite different from the 100 Areas.

Recommendation: Provide an appropriate level of description of the local ecology that is relevant to the purposes of the QRA. The current description is inconsistent.

Comment Resolution: In Appendix D, the Insects Section, the third sentence will be revised to read as follows: "The predominant taxa include ground-dwelling darkling beetles (family Tenebrionidae), and shrub-dwelling bugs (order Homoptera), grasshoppers (order Orthoptera), true bugs (order Hemiptera), and spiders (order Araneida) (Rogers 1979, ERDA 1975, Weiss and Mitchell 1992). The two latter references contain tables of insect species found on the entire Hanford Site."

ERDA 1975. Final Environmental Statement Waste Management Operations. ERDA-1538, Vol.1, Energy Research and Development Administration, Richland, Washington.

Weiss, S.G. and R.M. Mitchell. 1992. A Synthesis of Ecological Data from the 100-Areas of the Hanford Site. WHC-ET-0601. Westinghouse Hanford Company, Richland, Washington.

49. **Comment:** Appendix D, Reptile Section, last paragraph:

The sentence states that there are no state candidate species among the reptiles of Hanford. This is incorrect. The striped whipsnake (Masticophis taeniatus) is a state candidate species.

Recommendation: Identify the striped whipsnake as a state candidate species.

Comment Resolution: The last sentence in Appendix D, Reptile Section, will be revised to read: "The only herpetile with Federal or state classification is the striped whipsnake, a state candidate species."

50. **Comment:** Appendix D, Dose Calculations for Terrestrial Receptors Section:

The sentence states that radionuclide dose was calculated based on the computer code developed by Baker and Soldat (1992). The code and its key assumptions are not described. Also, it is not indicated whether the code has been validated.

Recommendation: The QRA should provide a description of the Baker and Soldat (1992) computer code and its assumptions. Also, the status of its validation should be indicated. If the code has yet to be validated, it should be.

Comment Resolution: The assumptions are stated in the reference, and the calculations are provided in the document Appendix. Another sentence will be added to the paragraph in Appendix D to read "The code has not been verified at this time, but planning is underway to verify it." Parameters not identified in Baker and Soldat (1992) will be provided in Appendix D, page D-7, for equation 8 ("Qv = ingestion rate (0.037 kg/day), FI = fraction ingested from contaminated source = 1, EF = exposure frequency (365 day/year), ED = exposure duration (1 year), and BW = body weight (0.021 kg)".

51. **Comment:** Appendix D, page D-7, last paragraph:

Soil ingestion and inhalation could be important for rodents because of their grooming, browsing, and burrowing behaviors.

Recommendation: Consider the soil ingested by the rodents as they groom, browse, and burrow.

Comment Resolution: What percentage soil ingestion and inhalation would contribute to the total contamination ingested by the pocket mouse is unknown. There are no known references for these factors and consideration of them is beyond the scope of the qualitative risk assessment. Because the qualitative ecological risk assessment is a screening procedure, adding new variables with additional uncertainty is of questionable value. To attempt to quantify these factors for the QRA lends a false sense of accuracy to the result. Quantifying the factors adds little to the stated purpose of the ecological QRA, which is to provide a relative ranking of waste sites for possible IRMs, and not to measure the actual ecological risk.

52. **Comment:** Appendix F, Table F-3, footnotes a and b:

Values are only presented for the 0-6 feet scenario.

Recommendation: As recommended in an earlier comments, risk should be characterized for depths greater than 15 feet for all pathways.

Comment Resolution: Footnotes a and b to Table F-3 refer to the Process Effluent Pipeline sludge data. Because the sludge is present within an existing enclosed structure (e.g., the pipeline itself) it is not possible to

evaluate external radiation risk levels without consideration of the additional radiation shielding afforded by the pipeline. The soil data associated with the Process Effluent Pipelines, as presented in Dorian and Richards (1978), only specified that the contamination was present above 15 ft depth. Footnote b informs the reader of this fact.

53. **Admin:** Section 3.5.5, 2nd paragraph:

Lead is identified as having exceeded the NOEL, but this should be vanadium (see the preceding paragraph and Tables 3-5g and 3-5h). Change lead to vanadium as the contaminant of concern.

Comment Resolution: The first paragraph of Section 3.5.5 will be revised to read: "The total dose rate to the Great Basin pocket mouse from radionuclides present in soil at the 116-H-9 crib is shown in Tables 3-5h and 3-5g for the soil intervals of 0-6 and 0-15 ft, respectively. The total dose rate (0.00023 rad/day) is below the EHQ of 1 rad/day for the Great Basin pocket mouse and includes both soil intervals. The calculated daily doses to the pocket mouse for barium, manganese, and vanadium (8.8, 67, and 0.19 mg/kg-day, respectively) are above the wildlife NOELs of 0.02, 0.01, and 0.07 mg/kg-day."

54. **Admin:** Appendix D, Dose Calculations for Terrestrial Receptors Section, equations:

To facilitate the use of these equations, provide a table of all the parameters used in them.

Comment Resolution: Inclusion of the requested information would not be appropriate to the scope agreed upon for the qualitative risk assessments. The requested parameters are available in the appendix of Baker and Soldat (1992).

55. **Admin:** Appendix D, Table D-3:

The references for Table D-3 (Soil-to-Plant Transfer Coefficients), though not in the list of references for Appendix D are in the section 5.0 references. Update these reference lists.

Comment Resolution: The references for Table D-3 (Soil-to-Plant Transfer Coefficients) are given in 5.0 REFERENCES (pages 5-1 to 5-4). The same references (Coughtrey et al. 1985, Whicker and Schultz 1982, Miller et al. 1977, Rouston and Cataldo 1978, DOE 1992) will be added to the reference section of Appendix D.

RESPONSES TO COMMENTS ON THE 100-HR-1 LFI REPORT FROM THE STATE OF WASHINGTON, DEPARTMENT OF ECOLOGY

GENERAL COMMENTS:

Comment 1

Tables of analysis results in this LFI should be revised to include a column which presents MTCA Method B concentrations for comparison to contaminant concentrations.

Response

The MTCA Method B levels are provided in Table 5-2 for each of the contaminants of potential concern. The text, for each site, indicates which contaminants of potential concern exceed the MTCA Method B level. The text will be modified as described below to add direction for the reader to see Table 5-2 for MTCA Method B cleanup levels.

Modification to Executive Summary, Investigation Results, 2nd paragraph:

Five sites were investigated by vadose zone boreholes: 116-H-1, 116-H-2, 116-H-3, 116-H-7, and 116-H-9. Radiological contamination is the primary concern, as confirmed through this study. Metals contamination was found at the 116-H-1 process effluent disposal trench and the 116-H-7 process effluent retention basin. The maximum concentrations of metals in the 116-H-1 samples were: As - 37.9 mg/kg, Cr - 29.6 mg/kg, and Pb - 187 mg/kg. The maximum concentrations of metals in the 116-H-7 samples were: As - 47 mg/kg and Pb - 540 mg/kg. ~~Concentrations of lead exceed the potential soil ARARs, which are Washington State Model Toxics Control Act (MTCA) cleanup regulation Method B concentrations.~~ Semi-volatile organic compounds were detected in concentrations below the potential soil ARARs, which are Washington State Model Toxics Control Act (MTCA) cleanup regulation Method B concentrations ~~the MTCA Method B guidelines~~. Volatile organic compounds, while detected, were generally low in concentration or likely laboratory contamination.

Modification to Section 1.4.1, 2nd paragraph:

Table 1-3 presents the 95th percentile of the data for a lognormal distribution and the 95 % confidence limit of the 95th percentile of the data distribution for inorganic analyses of Hanford Site soils (DOE-RL 1993b). The 95 % confidence limit of the 95th percentile of the data distribution, abbreviated as the 95% upper threshold limit (95% UTL), is identified by the Washington Administrative Code

(WAC), Model Toxics Control Act (MTCA) (WAC-173-340-708 [lld]), as one way to define threshold levels. The MTCA Method B concentrations for soil contaminants are listed in Section 5.0, Table 5-2. The 95% UTL values for inorganic constituents have been utilized in the 100-HR-1 QRA (WHC 1993a) to establish site potential contaminants of concern. An inorganic constituent at a site is considered a contaminant if the reported concentration exceeds the 95% UTL values. Because site-wide background levels for organic and radionuclide constituents have not been established (DOE-RL 1993b), all detected concentrations of these constituents were considered in the QRA as potential contaminants of concern.

SPECIFIC COMMENTS:

Comment 2

Comment: ES, Investigative Results Section, paragraph 2:

The sentence that begins, "Contaminant concentrations and locations ...," is confusing and seems contradictory to itself.

Recommendation: Revise the sentence to clarify what historical data is confirmed through the intrusive investigation and what data is not.

Response

The text will be revised as follows:

. . . Volatile organic compounds, while detected, were generally low in concentration or likely laboratory contamination. ~~Contaminant concentrations and locations determined through the intrusive investigation generally confirmed historical information such as documented in Dorian and Richards (1978) though the levels of contamination detected during the LFI were not consistent with the levels detected in the historical data.~~ The historical data (Dorian and Richards 1978), associated with the sites where LFI boreholes were drilled, was partially confirmed in that the majority of the contaminants presented in the historical data were also detected during the intrusive investigations. However, the detected concentrations of those contaminants were not consistent with the concentrations reported in the historical data. The concentrations reported in the historical data were generally one to two orders of magnitude higher than the concentrations detected during the recent intrusive investigations. The remaining high-priority sites in the 100-HR-1 Source Operable Unit were evaluated using data from analogous sites in the 100 Areas or historical data. No 100-HR-1 sites showed contamination that would warrant an expedited response action (ERA).

Comment 3

Comment: ES, Investigative Results Section, paragraph 2, sentence 6:

Text states that lead concentrations exceed Washington State Model Toxics Control Act (MTCA) cleanup regulation Method B levels. Since there are no MTCA Method B concentrations for lead, this is misleading.

Recommendation: Define the basis for lead cleanup guidelines more clearly.

Response

The sentence will be deleted since there are no MTCA Method B concentrations for lead.

Modification to Executive Summary, Investigation Results, 2nd paragraph:

Five sites were investigated by vadose zone boreholes: 116-H-1, 116-H-2, 116-H-3, 116-H-7, and 116-H-9. Radiological contamination is the primary concern, as confirmed through this study. Metals contamination was found at the 116-H-1 process effluent disposal trench and the 116-H-7 process effluent retention basin. The maximum concentrations of metals in the 116-H-1 samples were: As - 37.9 mg/kg, Cr - 29.6 mg/kg, and Pb - 187 mg/kg. The maximum concentrations of metals in the 116-H-7 samples were: As - 47 mg/kg and Pb - 540 mg/kg. ~~Concentrations of lead exceed the potential soil ARARs, which are Washington State Model Toxics Control Act (MTCA) cleanup regulation Method B concentrations.~~ Semi-volatile organic compounds were detected in concentrations below the potential soil ARARs, which are Washington State Model Toxics Control Act (MTCA) cleanup regulation Method B concentrations ~~the MTCA Method B guidelines~~. Volatile organic compounds, while detected, were generally low in concentration or likely laboratory contamination.

Comment 4

Comment: ES, IRM Recommendations Section, Bullet 5:

It is unrealistic to assume, especially for higher contaminant concentrations, that radionuclides with half-lives of greater than 5 years will be reduced to within acceptable levels by radioactive decay by the year 2018. Radionuclides such as Strontium-90, with half lives of around thirty years, will have only decayed by one half of their 1988 levels, which does not necessarily imply that their 2018 levels will be within acceptable limits.

Recommendation: Adopt a more realistic natural attenuation scenario using a shorter half-life as a basis.

Response

The bullet indicates that for sites where the excess risk is solely from radionuclides with half-lives of 30 years or less, that there may be the potential for reducing the levels of contamination at these sites, and consequently the risk, due simply to natural decay of the radionuclides. It is not suggested that sites with short half-life radionuclides will be considered naturally clean due to decay by the year 2018. However, it is possible that one half-life decay of a radionuclide will reduce the concentration of that radionuclide sufficiently to reduce the risk to an acceptable level.

Upon reviewing Table ES-2 it is observed that only sites 116-H-3 and 116-H-9 have the potential for natural attenuation by the year 2018. This potential does not, however, affect the outcome of the IRM candidacy for these two sites.

The text of the bullet will be slightly modified to clarify that the potential for natural attenuation will only be considered for sites where the excess risk is solely from external exposure from radionuclides with half-lives of 30 years or less.

Revised text of bullet:

- The potential for the contaminants at a site to be reduced by natural attenuation, e.g., radioactive decay by the year 2018, may be a consideration for sites where the excess risk is caused solely by external exposure from radionuclides with half lives of <30 years. This is not a consideration for sites where multiple exposure pathways drive the risk.

Comment 5

Comment: ES, IRM Recommendations Section, bullet 6 and paragraph following it:

This bullet provides recommendations for continued IRM candidacy. As written, it is unclear as to whether the sites presented in the paragraph following the bullet, as recommended solid waste burial grounds, are to maintain their IRM candidacy as is established in Table ES-2.

Recommendation: Include the 116-H-2 trench, 132-H-3 pumping station, 132-H-2 air filter building, 132-H-1 reactor exhaust stack, and the 116-H-4 pluto crib in bullet six as continued IRM candidates.

Response

Recommendation will be incorporated. Additional sites which are recommended as solid waste burial units will also be included in bullet 6. Bullet 6 will be rewritten as follows:

- ~~116-H-1 process effluent disposal trench, 116-H-7 process effluent retention basin, 116-H-5 process effluent outfall structure, and the process effluent pipeline sludge and soil.~~

- 116-H-1 process effluent disposal trench, 116-H-7 process effluent retention basin, 116-H-5 process effluent outfall structure, and the process effluent pipeline sludge and soil. Additionally, the 116-H-2 effluent disposal trench, 132-H-3 effluent pumping station, 132-H-2 exhaust air filter building, 132-H-1 reactor exhaust stack, and 116-H-4 pluto crib sites are recommended to continue to be IRM candidates and are recommended to be considered as solid waste burial grounds for future studies.

Comment 6

Comment: Section 1.0, paragraph 1, sentence 2:

This statement is incorrect. An LFI is required as per the HSPPS and Figure 1-2 of the 100-HR-1 LFI, when data are insufficient to formulate a conceptual model and perform a qualitative risk assessment.

Recommendation: State the correct reason for performing the LFI.

Response

The purpose of the LFI report is stated correctly -- to document whether or not sites are to be further considered for IRMs. The limited field investigation's purpose is to acquire additional site data, when existing site data is insufficient to formulate a conceptual site model or perform a qualitative risk assessment.

No change to the existing text.

Comment 7

Comment: Section 1.2, paragraph 7, bullet 2:

This bullet states, "Limited field sampling was sufficient for those high-priority sites where data are deemed insufficient to formulate the conceptual model and support the QRA." This is inconsistent with Table ES-2, footnote, which indicates that due to discrepancies between LFI and historical data for the 116-H-2 site, additional investigation may be necessary.

Recommendation: It should be clarified here that there is an exception to this statement in that additional investigation may be required for the 116-H-2 trench.

Response

The statement is correct as written within the context presented. The statement is an assumption made and agreed upon by DOE, EPA, and the State of Washington, Department of Ecology. It is not a statement of fact made by the author to indicate that the field sampling that was performed was adequate and the results of the sampling met all of the data objectives. The inconsistencies between the LFI data and the historical data for the 116-H-2 site are fully discussed in Chapter 3 and in the Conclusions (Chapter 5). Site 116-H-2 is not an exception to this statement.

Comment 8

Comment: Section 1.2, paragraph 7, bullet 3:

The Record of Decision (ROD) for this OU will include final remedy selection for low priority sites contained within this OU.

Recommendation: While this statement may apply to various waste sites throughout Hanford, it does not apply to this OU. This bullet should be deleted.

Response

The bullet is correct as stated. It is a quote from the 100-HR-1 RFI/CMS Work Plan (Section 1.1.2). A minor change will be made to the text of the paragraph before the bullets as shown:

Implementation of the HSPPS at the 100-HR-1 Source Operable Unit began with the development of the *RCRA Facility Investigation/Corrective Measures Study Work Plan for the 100-HR-1 Operable Unit* (DOE-RL 1992a). Through the work plan, the three parties assigned all known and suspected areas of contamination either a high- or low-priority, as listed in Table 1-2. Sites classified as high-priority pose a risk(s) through one or more pathways, any of which are sufficient to warrant a streamlined action via the IRM pathway. Low-priority sites do not pose enough risk to justify streamlining and are deferred to the final RFI. The three parties agreed that:

- none of the high-priority sites pose risks that would require an ERA;
- limited field sampling was sufficient for those high-priority sites where data are deemed insufficient to formulate the conceptual model and support the QRA; and
- certain remediation activities would be more efficient to implement at the 100 Area aggregate or Hanford Site scale than the operable unit scale.

Comment 9

Comment: Section 1.4.1:

See comment and recommendation No. 15 for the QRA of the 100-HR-1 OU. These comments apply to all areas of this LFI that reference this draft background document.

Comment 15 of QRA -- Text states, "If upon review of the rejected data, the reason for rejection was due to administrative concerns and not because of other quality assurance/quality control issues, the rejected data are used in the QRA." If this means that the "R" qualifier was not removed from the data, then it would be impossible for the person validating to know which data was deemed usable and which was not, thereby possibly leading to incorrect assumptions about waste sites with "R" data.

Recommendation from comment 15 of QRA -- Rejected data that was deemed usable should have the "R" qualifier removed. If it is found to have had an effect on data validation and waste site assumptions, affected waste site data should be reevaluated.

Response

The comment is unclear, please clarify. Section 1.4.1 does not make any reference to validated data with the "R" qualifier. It is assumed that the QRA comment being referenced is actually No. 16 which was also discussed in the cover letter associated with the comments.

QRA comment 16 discusses the usage of the Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes (DOE/RL-92-24, Rev. 1). It is my understanding that the background report can be used as part of the LFI report. The LFI presently references the draft version of this document. These references will be replaced throughout the text with the final version.

Revised text in Section 6.0:

U.S. Department of Energy, Richland Operations Office (DOE-RL), 1993a, "Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes," *DOE/RL-92-24*, Rev. 1, ~~draft,~~ U.S. Department of Energy, Richland, Washington.

Comment 10

Comment: Section 2.4.1, paragraph 2, sentence 3:

Text states " ... background levels were determined at the start of each shift, from ambient air, ... " It is not clear whether or not soil background was taken from this site investigation.

Recommendation: This sentence should clarify whether background was or was not taken for soil and air.

Response

The organic vapor monitor used to measure VOCs detects the concentration of VOCs in air. If a soil sample is tested for VOC content in the field, it is actually the air near the soil that is being analyzed by the monitor. Therefore, testing the ambient air (away from any suspected contaminated area) provides the required background concentration check.

Comment 11

Comment: Section 2.4.1 and 2.4.2:

The action level of volatile organic compounds (VOC) was set at 10 parts per million (ppm) above background for screening soil samples and cuttings from the vadose zone boreholes. On the other hand, the action level for VOC's was set at 5 ppm above background for screening liquid, sludge, and soil samples at low-priority sites.

Recommendation: Justification for using two different action levels should be provided.

Response

The action levels provided are from the associated descriptions of work (DOW) for the high- and low-priority sites. The basis for the selection of the action levels is not stated in the DOWs and is therefore not documented. No justification or solid explanation is available -- only conjecture -- as to why the action level changed.

Comment 12

Comment: Section 2.5.2.1:

The text states that the sampling technique was not documented for the water and sludge samples collected from the 1607-H-2 septic tank. Because the sampling technique was not documented, it is difficult to assess whether representative samples were collected during sampling.

Recommendation: The reason for not documenting the sampling techniques used in the field to show that representative samples and data were obtained should be

included. A discussion of the possible effect on the sampling results should also be presented.

Response

The original sample collection logs were investigated and following sampling information has been added to the text.

2.5.2.1 1607-H-2 Septic Tank. Five water and two sludge samples were collected from the intact 1607-H-2 septic tank. The septic tank has three man-holes aligned north to south. The five water samples were taken from the northern most man-hole using a dip pole with a 1 liter bottle on the end. The sludge samples were taken from the sludge at the bottom of the septic tank at the middle and southern most man-holes (samples B00ZM7 and B00ZM6, respectively). Sampling was performed using a large ladle on the end of an aluminum pole. ~~Because the sampling was performed before there was a requirement for a description of work, the sampling technique was not documented.~~

Comment 13

Comment: Table 2-1:

The estimated waste depths in this table are derived from the *Description of Work for the 100-HR-1 Source OU*, a document that is not available for utilization by the public. These numbers do not correspond to waste site depths presented in the *RCRA Facility Investigation/Correction Measures Study (RFI/CMS) for the 100-HR-1 Operable Unit*.

Recommendation: Use waste depths from the *RFI/CMS Work Plan for the 100-HR-1 OU* so that they can be referenced by the public.

Response

The *Description of Work for the 100-HR-1 Source OU* has been released to the public (My copy has a stamp indicating "Approval for Public Release" on November 14, 1991). The depths presented in the description of work are the accurate depths for the vadose zone boreholes and therefore referencing the depths from the RFI/CMS work plan would be incorrect. No change to Table 2-1.

Comment 14

Comment: Section 3.1.1, paragraph 3:

This paragraph addresses background. It gives the source for organic compound limits, but no references for radionuclide limits.

Recommendation: Provide the sources for radionuclide contamination limits in this paragraph.

Response

The paragraph will be reworded to:

Hanford sitewide background levels for organic and radionuclide analytes are not included in the Hanford Site background report (DOE-RL 1993a). Any detection of organic compound above the contract required quantitation limits is considered a contaminant of potential concern. Any detection of a radionuclide above the laboratory required detection limit (from Appendix A of the RFI/CMS work plan, DOE-RL 1992a) is considered a contaminant of potential concern.

Comment 15

Comment: Table 2-4:

Split soil samples collected at electrical facilities were analyzed at the same laboratory (Table 2-4). Different laboratories were used to analyze split soil samples collected at other facilities such as 116-H-1 and 1607-H-4 (Table 2-2 and 2-3).

Recommendation: The text should explain the reason for using the same laboratory for split sample analysis. If the split samples were intended to provide an independent check on the precision of the primary laboratory, then split samples from the electrical facilities did not fulfill that purpose.

Response

Table 2-4 is incorrect. The text has been reviewed and no changes to the text are required. The corrected version of the table is provided on the next page:

Table 2-46 Electrical Facilities - PCB Sample Collection Information

Location	Sample Number	Sample Type	Laboratory*	Date Sampled	Comments
105-H~~, 152 JIH~~	B018S5	Soil	DCHM	12/09/91	
151-H, South of South Large Pad ~~S EAST MAIN~~	B018S6	Soil	DCHM	12/09/91	
151-H, South of South Large Pad ~~SOUTH~~	B018S7	Soil	DCHM	12/09/91	Duplicate w/ B018S6
151-H, South of South Large Pad ~~S WEST COR~~	B018S8	Soil	S^3	12/09/91	Split w/ B018S6
151-H, South ~~S WEST COR~~	B018S9	Soil	DCHM	12/09/91	~~Duplicate of B018S8~~
151-H, Southwest ~~WEST~~	B018T0	Soil	DCHM	12/09/91	
151-H, ~~N EAST MAIN~~ West Center 151-H	B018T1	Soil	DCHM	12/09/91	
151-H, ~~N EAST MAIN~~ Between North Pylons	B018T2	Soil	DCHM	12/09/91	~~Split with B018T1~~

* DCHM = Data Chem Laboratories.
S^3 = Maxwell Laboratories, S-Cubed Division.

Comment 16

Comment: Section 3.2.4, paragraph 2:

Radionuclide and chemical analytical results from the LFI samples collected at analogous sites (116-DR-1, 116-DR-2, and 116-B-1) were compared to the results from the 116-H-1 site (Section 3.2.4)

Recommendation: To confirm the assumption that these sites are analogous, the geology, physical properties of soil, waste inventory, and volume of waste discharge should also be compared so that differences in contaminant concentrations, persistence, and migration can be determined.

Response

This is generally outside of the scope of this report. The 100-HR-1 LFI report is not an aggregate area report addressing all of the 100 Area facilities. To present descriptions of sites outside of the 100-HR-1 OU in the level of detail being requested would result in the mass duplication of reporting of site information. The draft LFI reports for the 100-DR-1 and 100-BC-1 OUs are referenced in the subject paragraph. If the reader wishes to find additional information on the geology, soil properties, and operational histories of sites within these other OUs, he may do so by reading these other LFI reports.

Section 2.0 will be modified to better define to the reader what is meant by "analogous site." The revised text and added table are presented below.

Data from an intrusive LFI investigations of analogous sites in the 100-DR-1 Source Operable Unit were applied to the LFI evaluation of the 116-H-5 outfall structure and to the 132-H-3 effluent pumping station. Each of the reactors and their support facilities in the 100 B/C, 100 H, and 100 D/DR Areas are similar in construction and use. An analogous site is a site associated with one of the other 100 Area reactors which has a similar process history, waste stream, and expected suite of contaminants to a site in the 100-HR-1. An analogous site does not necessarily have the same geology or contaminant concentrations. Table 2-1 presents 100 Area analogous sites.

Non-intrusive investigations of the other 100-HR-1 high-priority sites (116-H-7 sludge burial trench, 132-H-2 exhaust air filter building, 132-H-1 reactor exhaust stack, 116-H-4 pluto crib) relied on historical data such as that from past sampling and analysis (Dorian and Richards 1978) and process knowledge.

Table 2-1 100 Area Analogous Sites

Waste Site Description	100-B/C Area Site	100-D/DR Area Site	100-H Area Site
Process Effluent Disposal Trench	116-B-1	116-DR-1 116-DR-2	116-H-1
Fuel Storage Basin Trench	116-B-2	116-D-1a 116-D-1b	---
Dummy Decontamination French Drain	116-B-4	---	116-H-3
Process Effluent Retention Basin	116-B-11 116-C-5	116-D-7 116-DR-9	116-H-7
Reactor Confinement Seal Pit Drainage Crib	---	116-D-9	116-H-9
Process Effluent Outfall Structure	116-B-7 132-B-6 132-C-2	116-D-5 116-DR-5	116-H-5
Process Effluent Pipelines	Process Effluent Pipelines	Process Effluent Pipelines	Process Effluent Pipelines
Effluent Pumping Station	---	132-D-3	132-H-3
Exhaust Air Filter Building	132-B-4	117-D	132-H-2
Pluto Crib	116-B-3 116-C-2	116-D-2a	116-H-4
Gas Recirculation Building	132-B-5	115-D	---

Comment 17

Comment: Section 3.2.5:

Groundwater quality is assessed at the 116-H-1 site using data from up-gradient and down-gradient monitoring wells. The relative locations of these wells are not clear.

Recommendation: A location map for these monitoring wells should be provided in the report to show whether appropriate wells are used for groundwater assessment at the site. This comment applies to other sites where appropriate.

Response

A location map from the LFI report for the 100-HR-3 groundwater OU (Figure 1-4 of that report -- attached) will be added to this chapter and referenced in the text of the groundwater assessment sections.

Comment 18

Comment: Section 3.2.5:

The monitoring well data from many sites are used to conclude that the sites are currently impacting groundwater. These conclusions are provided without adequate support.

Recommendation: To support the conclusions, it should be indicated whether a driving force such as waste discharge or infiltration currently exists or whether contaminant transport modeling results were used.

Response

As stated in the Executive Summary and Section 1.1, there are no active facilities within the 100-HR-1 OU. No waste is discharged in the operable unit. Infiltration may be a driving force, however, the average annual precipitation and evapotranspiration are about equal. Waste sites near the Columbia River (e.g. within a couple of hundred meters) may be affected by changes in groundwater elevations of the uppermost unconfined aquifer which is known to fluctuate in response to changes in river stage, and reversals of groundwater gradient are known to occur.

No contaminants transport modeling was performed as part of the 100-HR-1 or 100-HR-3 LFIs or during the 100-HR-1 or 100-HR-3 QRAs. Contaminant transport modeling was not identified in the 100-HR-1 or 100-HR-3 Work Plans as an LFI task. The limited field investigations were not intended to characterize the operable units, as a result, data are not available to support contaminant transport modeling. The data available are sufficient to support the conclusions made.

The following paragraph in Section 1.1 has been modified as shown to assist the reader:

The cooling water treatment system included 16 settling basins, four of which were modified to store and treat liquid process wastes generated at the N Reactor fuel fabrication facilities. The resulting solar evaporation basins (116-H-6) received these wastes from 1973 through 1985 (WHC 1988a). Therefore, the solar evaporation basins are being handled under RCRA interim status guidelines (WHC 1988a) and will not be addressed further in this report. Currently there are no active facilities~~ or~~, operations, or waste/effluent discharges within the 100-HR-1 Source Operable Unit.

The footnote described below was added to the text of Chapter 3.0, page 3-1:

- concentrations of Sr-90 and Tc-99 and gross alpha levels in groundwater from monitoring wells near the high-priority sites are reviewed to assess the potential impact on groundwater in the groundwater uppermost unconfined aquifer. These data were obtained during the 100-HR-3 Operable Unit LFI.[1]

[1] There are currently no waste or effluent discharges in the operable unit. Infiltration may be a driving force for movement of contaminants from the vadose zone to the saturated zone, however, the average annual precipitation and evapotranspiration are about equal (DOE-RL 1992a). Waste sites near the Columbia River (e.g. within 300 m) may be affected by changes in groundwater elevations of the uppermost unconfined aquifer which is known to fluctuate in response to changes in river stage, and reversals of groundwater gradient are known to occur (DOE-RL 1992a). Contaminant transport modeling was not performed as part of the 100-HR-1 LFI or 100-HR-1 QRA. The data available are not sufficient to support such modeling, but are sufficient to support the conclusions made.

The same text was also added to Section 5.2.4 as shown below:

5.2.4 Current Impact on Groundwater

If LFI results indicate that a site is a current source of groundwater contamination or has a high probability of being a current contamination source, then the site is recommended to continue as an IRM candidate. The evaluation is based on review of monitoring well data from the 100-HR-3 Groundwater Operable Unit LFI (DOE-RL 1993d)~~, the analysis presented in the 100-HR-1 QRA (WHC 1993a),~~ and hydrogeological evaluation.

There are currently no waste or effluent discharges in the operable unit. Infiltration may be a driving force for movement of contaminants from the vadose zone to the saturated zone, however, the average annual precipitation and evapotranspiration are about equal (DOE-RL 1992a). Waste sites near the Columbia River (e.g. within 300 m) may be affected by changes in groundwater elevations of the uppermost unconfined aquifer which is known to fluctuate in response to changes in river stage, and reversals of groundwater gradient are known to occur (DOE-RL

1992a). Contaminant transport modeling was not performed as part of the 100-HR-1 LFI or 100-HR-1 QRA. The data available are not sufficient to support such modeling, but are sufficient to support the conclusions made.

Comment 19

Comment: Section 3.4.3, last paragraph:

The text concluded that no sampling was performed at the 116-B-4 dummy decontamination French drain as part of the 100-BC-1 LFI for comparison with the 116-H-3 dummy decontamination French drain.

Recommendation: Although no sampling was performed at the 116-B-4 drain as part of an LFI, historical data for the site could be compared with the data collected at the 116-H-3 drain to support the conclusions that the sites are indeed analogous.

Response

The subject paragraph will be modified as follows:

No sampling was performed at the analogous 116-B-4 dummy decontamination french drain site as part of an LFI making comparison of LFI data at the two sites impossible. The historical data for both sites (Dorian and Richards 1978) are comparable with a similar list of radionuclides detected at each site and similar concentrations. Based on the historical data, radionuclides detected at both sites were Cs-137, Co-60, Eu-152, Eu-154, Eu-155, Pu-239, and Sr-90.

Comment 20

Comment: Section 3.5.2.4:

A spectral gamma-ray log was not performed on the 116-H-7 borehole because the logging equipment could not be brought into the contaminated retention basin. Since the standing walls of the retention basin were demolished, the basin backfilled with soil, and the borehole was successfully drilled, the reason the logging equipment could not be brought to the site is unclear.

Recommendation: A specific reason for not performing spectral gamma-ray log should be stated.

Response

As stated in the text, the logging equipment could not be brought into the radiation contamination zone because of the possibility of contaminating the logging truck. Should the truck have become contaminated from the soil in the zone, it could not

leave the zone until it was decontaminated. Such a delay was considered unacceptable, since the logging truck was in constant use.

Comment 21

Comment: Section 3.5.4, last sentence:

Text states that there is an impact on groundwater through the 116-H-7 sludge burial trench. As indicated in the Executive Summary, IRM Decisions Section, bullet 3, "If LFI results indicate that a site is a current source of groundwater contamination then the site is recommended to continue as an IRM candidate."

Recommendation: According to the data included in this section, this waste site should be continued as an IRM candidate.

Response

The 116-H-7 sludge burial trench does not appear to be having an impact on the groundwater based on the results of the QRA. The trench was mistakenly added as a possible source of groundwater contamination based solely on its location relative to the monitoring wells. The historical data for this site does not suggest that it is having an impact on the area groundwater.

The subject paragraph will be changed as follows:

Monitoring well H4-11, constructed and sampled as part of the 100-HR-3 Groundwater Operable Unit LFI (DOE-RL 1993d), is located downgradient from the 116-H-7 retention basin and has elevated gross alpha levels (4.3 pCi/liter), as well as elevated levels of Tc-99 (36 pCi/liter), Sr-90 (26 pCi/liter), and Cr (90 μg/liter) relative to upgradient wells. Monitoring well H4-13, also located downgradient of the 116-H-7 retention basin and south of H4-11 has elevated levels of Sr-90 only (33 pCi/liter). ~~Monitoring well data indicate that there is a current impact to the groundwater though the 116-H-7 sludge burial trench and the process effluent pipelines may also be contributing contaminants.~~ Monitoring well data suggest that the 116-H-7 retention basin is having an impact on the groundwater, although the process effluent pipelines may also be contributing contaminants to the groundwater.

Comment 22

Comment: Section 3.6.2.1, Tables 1-3 and A-5:

Text states that there were no inorganic levels above the calculated 95% Upper Threshold Level (UTL). This is not true according to Tables 1-3 and A-5. There are in fact several inorganic substances that are above the 95% UTL.

Recommendation: Since substance that were found in concentrations less than the 95% were not considered in risk assessment of waste sites, this means that the 116-H-9 waste site was improperly evaluated, and therefore should be reevaluated in this LFI and QRA.

Response

The analytical results from sample B05WN8 in Table A-5, that indicates inorganic contaminants at concentrations above the 95% UTL, appear to be wrong. Upon reviewing the data in the data validation report for this sample, it was discovered that the concentrations for the majority of the inorganic constituents were approximately 10 times the concentrations for the other samples taken from the site. Upon further investigation, the mass of the inorganic metals found in the sample was calculated and found to be over 50% of the total mass of the sample. This mass does not include Silicon, Oxygen, Carbon, or Hydrogen; principle elements predominant in most minerals. The original laboratory data sheets were investigated and it was found that an error was made in the original reporting of the data. The data for this sample were found to be incorrect.

Table A-5 will now have a footnote indicating that the data is incorrect. That footnote will be expanded to indicate that during a review of the original laboratory data, the data were found to be in error and that the data is not used as part of the site evaluation. Additionally, this information will be included in the text of Section 3.6.2.1 to clarify the apparent inconsistency between the sample data and the conclusion for the site.

Modification to Section 3.6.2.1 is as follows:

3.6.2.1 Chemical Analysis. The laboratory analysis results from samples taken from the 116-H-9 vadose zone borehole did not indicate any inorganic levels above the 95 % UTL. (The analysis for one sample shows unrealistic levels of inorganic contaminants and was found to be in error. The inorganic data for this sample - B05WN8 - is not used for the evaluation of this site. See Table A-5 for further explanation.) There were no VOC, semi-volatile organic, or pesticide contaminants detected. The complete results of the chemical analyses for the samples taken from borehole 116-H-9 are presented in Table A-5, Appendix A.

Modification to footnote "a" in Table A-5 is as follows:

[a] Inorganic analysis results are suspect. The indicated levels of inorganic constituents is unrealistic for Sample B05WN8. The metal constituents for this soil sample add up to over 50% of the sample. This percentage does not include the major mineral elements of silicon, oxygen, carbon, and hydrogen. The levels appear to be approximately 10 times what would be expected for almost all of the inorganic constituents. Upon further investigation of the original laboratory records, it was

discovered that an error was made in reporting the results and these results are incorrect. The inorganic analytical results for this sample are not used in the LFI evaluation of this site.

Comment 23

Comment: Section 3.6.3, paragraph 1, sentence 3:

This passage assumes that the 116-H-9 waste site is clean, according to LFI and historical data. As stated in the previous comment, this is a false assumption.

Recommendation: Delete this sentence from the LFI.

Response

See the response to Comment S21 (22) above. The historical data for the site indicates that the site is clean.

Comment 24

Comment: Table 3-23b:

There is a partial listing of MTCA Method B cleanup concentrations listed in this table. There are no listings of this kind for an other potential Applicable, or Relevant and Appropriate Requirements (ARARs) presented here. There is no purpose in having a list of this kind in this table. Also WAC-173-340-740 does not provide specific sludge cleanup levels.

Recommendation: Delete the listing of MTCA Method B cleanup concentrations from the "Requirements" section of this table, and provide a summary of WAC-173-340-740 in the same manner as other potential ARARs listed.

Response

None of the other ARARs contain recommended cleanup levels for soils; therefore there is no information similar that can be listed for the other ARARs. Chemical- and location-specific ARARs are used in the LFI report as screening criteria for the evaluation of high-priority sites as IRM candidates. This use of ARARs is not intended to set cleanup standards for the high-priority sites.

Additionally, the levels in WAC-173-340-740 are for water (which is not applicable to this OU) and for soils. The "sludge" that is associated with several of the LFI sites was sludge when the 100-H Area was in operation. The material is now considered contaminated soil, not sludge.

The following change will be made to the text of Section 3.9, 5th paragraph:

Potential chemical- and location-specific ARARs are defined during the field investigation portion of the CERCLA process and refined in the feasibility study and proposed plan. Action-specific ARARs are generally defined during the phase I and II feasibility study and refined in detailed analysis and the proposed plan. Potential ARARs and TBCs in all categories are defined in the *100 Area Feasibility Study Phases 1 and 2* (DOE-RL 1992c). For purposes of this LFI, only the chemical- and location-specific ARARs are discussed. Chemical- and location-specific ARARs are used in the LFI report as screening criteria for the evaluation of high-priority sites as IRM candidates. This use of ARARs is not intended to set cleanup standards for the high-priority sites. Chemical- and location-specific ~~The~~ ARARs are presented in Tables 3-22 through 3-27.

Comment 25

Comment: Table 3-25, Block 4:

The remarks section states that B-reactor is either listed or eligible to be listed on this register. It is not clear if H-reactor is intended to be included on this list.

Recommendation: This list was probably indiscriminately transferred from the QRA for the 100-BC-1 OU. If this potential ARAR applies to H-reactor, then it should be stated here.

Response

H-Reactor is not on this register. The section of the table will be deleted since the National Historic Preservation Act is not an ARAR for the H-Area.

The revised Table 3-25 is shown on the next page:

Table 3-25

Description	Citation	A/ R&A*	Requirements	Remarks
Archaeological and Historical Preservation Act of 1974	16 U.S.C. 469	A	Requires action to recover and preserve artifacts in areas where activity may cause irreparable harm, loss, or destruction of significant artifacts.	Applicable when remedial action threatens significant scientific, prehistorical, historical, or archaeological data.
Endangered Species Act of 1973	16 U.S.C. 1531 et seq.		Prohibits federal agencies from jeopardizing threatened or endangered species or adversely modifying habitats essential to their survival.	
Fish and Wildlife Services List of Endangered and Threatened Wildlife and Plants	50 CFR Parts 17, 222, 225, 226, 227, 402, 424	A	Requires identification of activities that may affect listed species. Actions must not threaten the continued existence of a listed species or destroy critical habitat.	Requires consultation with the Fish and Wildlife Service to determine if threatened or endangered species could be impacted by activity.
Historic Sites, Buildings, and Antiquities Act	16 U.S.C. 461	A	Establishes requirements for preservation of historic sites, buildings, or objects of national significance. Undesirable impacts to such resources must be mitigated.	
~~**National Historic Preservation Act of 1966, as amended.**~~	~~16 U.S.C. 470 et seq.~~	~~A~~	~~Prohibits impacts on cultural resources. Where impacts are unavoidable, requires impact mitigation through design and data recovery.~~	~~Applicable to properties listed in the National Register of Historic Places, or eligible for such listing. B reactor is listed on the Register.~~
Wild and Scenic Rivers Act	16 U.S.C 1271	A	Prohibits federal agencies from recommending authorization of any water resource project that would have a direct and adverse effect on the values for which a river was designated as a wild and scenic river or included as a study area.	The Hanford Reach of the Columbia River is under study for inclusion as a wild and scenic river.

*NOTE: A = Applicable, R&A = Relevant and Appropriate

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Comment 26

Comment: Tables 4-2 and 4-3:

The potential for groundwater impact is qualified as either high, medium, or low.

Recommendation: The basis for these qualifications should also be stated.

Response

The basis for these qualifications is stated in Section 4.4.1, paragraph 3. A footnote to the table will indicate that the qualifications are explained in Section 4.4.1 of the text.

The revised Tables 4-2 and 4-3 are presented on the next pages:

Table 4-2 Human Health Data and Risk Assessment Summary (for sites where only process knowledge is available)

Site	Disposal Information	Suspected Risk-Driving Contaminants	Description and Notes	Qualitative Risk Rating*	Rationale for Rating	~~Potential Groundwater Impact~~[5]
116-H-5 outfall structure	Unknown volume of treated process effluent from the 116-H-7 retention basin between 1949 and 1965.	Co-60, Eu-152, Eu-154, As	Compartmented concrete box measuring 378 x 27 x 14 ft.	medium	116-D-5 outfall structure in the 100-DR-1 operable unit has a high risk estimate.	~~low~~
132-H-3 pump station	Pumped water from H reactor drains from 1949 to 1965. Sump water and sludge removed in 1987.	Co-60, Cs-134, Ra-226, Th-228, As, Hg	Demolished and buried in-situ in 1987. Backfilled with a minimum of 15 ft of clean fill.	low	Building rubble buried under 15 ft of fill.	~~unknown~~
116-H-6 retention basin	Received fuel fabrication wastes from the N reactor, treated wastes by solar evaporation. Received wastes through 1985.	uranium, P, thallium oxide, As, Hg, Sb, Be	Four concrete basins measuring 45 x 33 x 10 ft. Decommissioned in 1991.	medium	Possible effluent leakage; high volume of liquid waste received.	~~high~~
132-H-2 building	Filtered reactor exhaust air prior to emission using HEPA and halogen filters.	Co-60, Sr-90, Cs-137, Eu-152, Eu-154	59 x 39 x 35 ft. concrete building, 90% below ground. Demolished and buried in-situ in 1983 and covered with 3 ft of soil.	low	Building rubble buried under 3 ft. of fill; filters removed.	~~low~~
132-H-1 stack	Emitted filtered air from the 132-H-2 building. Documented radionuclide release in 1955.	Co-60, Sr-90, Cs-137, Eu-152	200 x 16 ft concrete stack, demolished in 1983 and covered with 3 ft of soil.	low	Building rubble buried under 3 ft of soil.	~~low~~
116-H-4 crib	Received low volumes of cooling water during periods of fuel element failure; discharged waste from fuel element failure.	(See 132-H-2 building evaluation)	4 x 4 x 2 ft crib used from 1950 to 1952. Excavated in 1960 to a depth of 30 ft for construction of 132-H-2 building on same site.	low (See 132-H-2 building evaluation)	Crib was in service only two years, has been excavated to a 30 ft depth.	~~low~~

* Rating is qualitative based on process information, analogous site information, and site-specific information such as size, potential contaminants, and location of contamination as indicated under rationale column. Additional discussion on the rating is provided for each site in the 100-HR-1 QRA (WHC 1993a).

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Table 4-3 Human Health Risk Assessment Summary (for sites where data are available).

Waste Site	Human Health Risk Assessment Summary					~~Potential Groundwater Impact[b]~~
	Frequent-Use Scenario			Occasional-Use Scenario		
	Qualitative Risk Estimation		Risk Driving Contaminant[a] (and pathway[c])	Qualitative Risk Estimation (1992)	Risk Driving Contaminant[a] (and pathway[c])	
	1992	2018				
Sites with LFI and historical data						
116-H-1 trench	high	high	R(O,I,E)[e]I(O,I) O(I)	medium	R (E), I(O)	~~high~~
116-H-2 trench	medium	medium	R(O,I,E)	low	R (E)	~~low~~
116-H-3 french drain	high	medium	R(O,I,E)	low	R[d] (E)	~~low~~
116-H-7 retention basin	high	high	R (O,I,E) I(O,I)	high	R (O,I,E) I(O)	~~high~~
116-H-9 crib	medium	medium	R(I,E)[e] I(O,I)	low	R(E) I	~~low~~
Sites with historical data only						
process effluent pipelines (soil)	low	low	R[dg](E)	very low	-	~~medium~~
process effluent pipelines (sludge)	high	high	R[g](O,I,E)	high	R[g](O,I,E)	~~medium~~
116-H-7 sludge burial trench	low	very low	R[dfg](E)	very low	-	~~low~~

- = Not applicable
[a] R = radionuclide, I = inorganic, O = organic contaminant
[b] ~~LFI and Historical Data are from the same medium (e.g., both from soil) or from different media (e.g., soil and sludge).~~
[c] O = oral, I = inhalation, E = external exposure pathways.
[d] Radionuclides contributing >1E-06 to the risk have half-lives of 30 years or less.
[e] Only the external exposure pathway has the risk driving contaminants for 2018.
[f] No risk driving contaminants present in 2018.
[g] Radionuclide concentrations analyzed and detected in upper 6 ft (2 m) did not exceed ICR of 1E-06 (see Appendix F in WHC 1993b).

Comment 27

Comment: Section 5.0

Several sites are recommended as IRM candidates. According to the IRM path, the process will proceed to selection of an IRM remedy, as determined through an LFI. This remedy selection may include a focused feasibility study (FFS), if needed (Figure 1-2); however, the report does not include a FFS.

Recommendation: Since this report does not contain enough information to select an IRM remedy, a FFS should be conducted.

Response

A FFS is out of the scope of this report. A FFS could be the next step along the IRM path, but an FFS would likely be a separate document.

Comment 28

Comment: Section 5.4, paragraph 2:

Text states, "The 1607-H-2 site had levels of heavy metals which greatly exceeded the 95% UTL values and MTCA Method B guidelines. Man-made radionuclides were also detected at the site. It is recommended that the priority rating of this site be reevaluated for this site." Also, most of the radionuclide sampling data at the 1607-H-2 site was rejected due to calibration error of analysis equipment (Section 3.8.1.2, and Table B-2 of the 100-HR-1 QRA), leaving only six radionuclides to be assessed for this site. This site was not evaluated in the QRA as a potential IRM candidate site because it was classified as a low-priority site.

Recommendation: Reclassify the 1607-H-2 site as high-priority, and perform a QRA. Provide recommendations as to whether this site should be remediated as an IRM. Reanalysis of radionuclide data may be necessary.

Response

The conclusions section of this LFI report recommends that the 1607-H-2 site be reclassified as a high-priority site. It is not within the scope of this LFI report to actually reclassify the site, only recommend its reclassification. If the site is reclassified by the unit managers, then a QRA will be performed and additional field data may be taken.

Administrative Comments

Comment 29

Executive Summary, Background Section, paragraph 4:

Change to: "The 100-HR-1 Source OU is one of two source OU's ..."

Response

Comment will be incorporated as indicated:

The 100-HR-1 Source Operable Unit is one of ~~three~~ two source operable units associated with the 100-H Area at the Hanford Site.

Comment 30

ES, IRM Recommendations Section, Bullet 2, last sentence:

Delete " ... and are conservative."

Response

Text is a direct quote from the 100 Area FS report. No change to the text.

Comment 31

Acronym List:

Replace the definition of EE/CA with "Engineering Evaluation/Cost Analysis"

Response

The acronym EE/CA is no longer used in text. It was removed from the text prior to issuance of Draft A of the document. The Acronym list was not updated at that time. The acronym list as since been updated.

Comment 32

Section 1.0, paragraph 3, sentence 7:

Delete " ... and is not intended to define current risk or baseline risk in a traditional sense."

Response

The text is correct as written; no change to the text.

Comment 33

Section 1.2, paragraph 2, sentence 1:

Delete " ... regardless of the regulatory agency lead (as defined in the Tri-Party Agreement)."

Response

The text is correct as written; no change to the text.

Comment 34

Section 1.2, last paragraph, sentence 1:

This LFI also included investigations at low-priority sites, as should be reflected in this sentence. Add " ... and low priority sites" to the end of this sentence.

Response

The text will be edited as indicated:

The 100-HR-1 LFI began the investigative phase of the RI for a select number of high- and low-priority sites.

Comment 35

Section 1.4.1:

Change the reference in the first paragraph (DOE 1993a) to DOE/RL (1993a). The reference made to HSBRAM (DOE/RL 1993b), should be changed to DOE/RL (1993a), *Hanford Site Background: Part I. Soil Background for Non-Radioactive Analytes*.

Response

The first paragraph reads as follows:

Results of the characterization of the natural chemical composition of Hanford Site soils is presented in *Hanford Site Background: Part I, Soil Background for Nonradioactive Analytes* (DOE-RL 1993a). The characterization included an analysis of physical properties and factors that might affect the natural soil chemical composition, as determined by regulatory protocols. Hanford Site soils have not been characterized to establish the natural concentrations of the following types of constituents: volatile organic compounds (VOC), semi-volatile organic compounds, pesticides and PCBs, and radionuclides.

The second paragraph had two references which were incorrect. They have been revised as follows:

Table 1-3 presents the 95th percentile of the data for a lognormal distribution and the 95 % confidence limit of the 95th percentile of the data distribution for inorganic analyses of Hanford Site soils (DOE-RL 1993~~b~~a).

An inorganic constituent at a site is considered a contaminant if the reported concentration exceeds the 95% UTL values. Because site-wide background levels for organic and radionuclide constituents have not been established (DOE-RL 1993~~b~~a), all detected concentrations of these constituents were considered in the QRA as potential contaminants of concern.

Comment 36

Section 1.1, paragraph 3, first sentence:

Delete the word "source" from the phrase " ... one of three *Source* Operable Units associated ... "

Response

The text has been modified as follows:

The 100-HR-1 Source Operable Unit is one of three ~~Source~~ Operable Units associated with the 100 H Area at the Hanford Site. Two of these units, 100-HR-1 and 100-HR-2, are source operable units composed of waste units. The groundwater/ surface-water operable unit is designated 100-HR-3 and includes the entire 100 H Area, the 100 D/DR Area, and the area in between.

Comment 37

Section 1.1, paragraph 9, sentence 4:

For the range of 2 to 6 feet/day, replace the corresponding metric values of 0.3 to 2.0 meters/day, with 0.6 to 2.0 meters/day.

Response

The text was modified as suggested:

Typical groundwater flow velocities in the uppermost aquifer (Ringold Formation) range from 2 to 6 ft/day (~~0.3~~ 0.6 to 2.0 m/day).

Comment 38

Table T-4g and T-4h:

Inorganics listed in these tables are presented in terms of radioactivity and radioactive dose rates (pCi/g and rad/day). These units are incorrect for these analytes. The units should be replaced with the correct ones (mg/kg and mg/kg-day).

Response

These tables do not appear to be part of the LFI report. Please clarify comment.

Additional Edits Made to the 100-HR-1 LFI Report -- Draft A

The following additional edits have been made to the 100-HR-1 LFI Report, Draft A. These edits are the result of review comments on the 100-DR-1 LFI and the 100-BC-1 LFI and from a Quality Assurance audit of the report.

Revision #1:

Add Table 2-1 (as attached) to make the 100-HR-1 LFI report consistent in structure with the 100-DR-1 LFI and the 100-BC-1 LFI. Also renumber the existing tables in Chapter 2.

Revision #2:

Chapter 4 -- All references to potential impact to the groundwater will be removed from this chapter as specified by DOE-RL in meeting notes dated Nov. 10, 1993. Tables 4-2 and 4-3 will be revised (see pages 23 and 24 of this comment response document). The paragraphs in Chapter 4 affected are presented below:

(1) Section 4.1.1, 1st paragraph

4.1.1 Approach

The QRA is conducted using the Hanford Site Baseline Risk Assessment Methodology (HSBRAM) (DOE-RL 1993b) as guidance and consists of:

- an evaluation of the data sources and/or process information;
- identification of maximum constituent concentrations, where data are available;
- a human health risk evaluation; and
- an ecological risk evaluation.~~; and~~
- ~~an analysis of potential impacts to groundwater.~~

Key factors that contribute to uncertainty throughout the risk assessment process are also identified.

(2) Section 4.4 -- All

~~**4.4 QUALITATIVE OVERVIEW OF POTENTIAL GROUNDWATER IMPACTS**~~

~~**4.4.1 Evaluation of Potential Groundwater Impacts**~~

~~The constituents present in sediments or soils associated with high priority waste sites in the 100 HR-1 Operable Unit have the potential to migrate through the vadose zone and into groundwater. The only constituents detected at significant levels in groundwater beneath the 100 HR-1 Operable Unit are gross beta, Cr, U, H-3, Sr-90, Tc-99 and nitrate.~~

~~The reactor cooling water effluent is the likely source of the radionuclides and Cr and is associated primarily with the 116-H-7 retention basin and 116-H-1 trench. Nitrate, as well as U and Tc-99, are associated with the 116-H-6 retention basin. Other radionuclides associated with the reactor cooling water have generally flushed to the river, decayed, or are sorbed to soils in the vadose zone.~~

~~Because of the high degree of uncertainty related to groundwater impacts, numerical risk estimates are not calculated. Instead, the potential for groundwater impacts is qualified as either high, medium, or low, as shown in Tables 4-2 and 4-3. "High" indicates that there is a significant possibility that groundwater is being impacted from the waste site. "Medium" indicates that it is possible, but not highly likely, that groundwater is being impacted from the waste site. "Low" indicates that there is a very small chance that groundwater is being impacted from the waste site. An "unknown" rating indicates that there is insufficient information available to assess the possibility of groundwater being impacted from the waste site.~~

~~**4.4.2 Uncertainties Associated with Evaluating Potential Groundwater Impacts**~~

~~Uncertainty exists in the evaluation of potential impact to groundwater for the following reasons:~~

- ~~Little contaminant data are available from vadose zone soils near the water table.~~
- ~~Little information exists regarding constituent solubilities, soil/water partitioning, and infiltration rates.~~
- ~~In general, the QRA is based on a limited data set. Actual sources responsible for observed groundwater contamination are difficult to identify.~~

(3) Section 5.2.4

5.2.4 Current Impact on Groundwater

If LFI results indicate that a site is a current source of groundwater contamination or has a high probability of being a current contamination source, then the site is recommended to continue as an IRM candidate. The evaluation is based on

review of monitoring well data from the 100-HR-3 Groundwater Operable Unit LFI (DOE-RL 1993d)~~, the analysis presented in the 100-HR-1 QRA (WHC-1993a),~~ and hydrogeological evaluation.

(4) Section 5.3.7

5.3.7 Process Effluent Pipelines - Sludge and Soil

The process effluent pipelines are recommended to continue as IRM candidates. Based on the sludge, the pipelines have a high human health risk and a ~~medium~~ probability of a current or future impact on groundwater. Because of the great linear extent of the process effluent pipelines across the 100-HR-1 Operable Unit, it is difficult to assess, from the existing monitoring wells, the current impact to groundwater posed by the process effluent pipelines. Because of the large volumes of effluent transported by the pipelines and their history of extensive leakage they are considered to be current sources of groundwater impact.

Table 2-2 LFI Investigation Activities for 100-HR-1 Operable Unit High-Priority Sites

Site	Name - Size	Comments	LFI Investigative Approach
116-H-1	Process Effluent Disposal Trench -- 91m x 30m x 4.6m deep	Received high activity effluent produced by ruptured fuel elements. Received sludge from 116-H-7 retention basin when 100-H Area was deactivated. Also received 90 kg of sodium dichromate.	B, C, F, G, H, P
116-H-2	Effluent Disposal Trench -- 84m x 30m x 1.8 m deep	Received decontamination wastes from the 132-H-3 effluent pumping station during reactor shutdown and standby periods. Received 600 kg of sodium dichromate.	B, C, F, G, H, R
116-H-3	Dummy Decontamination French Drain -- 0.9m diameter x 4.6m deep	Received wastes generated during decontamination of fuel-element spacers. Received 2000 kg of sodium dichromate, sodium oxalate, and sodium sulfamate.	B, C, F, G, H
116-H-7 Basin	Process Effluent Retention Basin -- 183m x 83m x 6m deep	Held cooling water effluent from H reactor for cooling/decay before release to the Columbia River, large leaks of effluent to the soil.	B, C, F, H
116-H-9	Confinement Seal Pit Drainage Crib -- 3m x 3m x 3m deep	Received 300,000 liters of waste from the 132-H-2 reactor exhaust air filter building seal pits.	B, C, F, G, H
116-H-5	Process Effluent Outfall Structure -- 115m x 8m x 4m	Discharged cooling water effluent to bottom center of Columbia River through effluent pipeline from sump or at shore using spillway.	AB, AC, AF, AG
Process Effluent Pipelines	Total Length approx. 610m, pipe diameter 152cm, buried 6m below surface	Transported reactor cooling water from reactors to retention basins, outfall structures, and 116-H-1 trench, leaked effluent to soil, contains contaminated sludge and scale.	H, T
116-H-7 Trench	Sludge Burial Trench -- unknown dimensions	Received sludge from the 116-H-7 process effluent retention basin.	H
132-H-3	Effluent Pumping Station -- Four concrete sumps with 300,000 liter capacity	Collected and pumped water from the H reactor drains, including the irradiated fuel storage drains, into the 116-H-7 process effluent retention basin. Water and sludge in sumps was removed before station was demolished in place and covered with 5m of fill.	H
132-H-2	Exhaust Air Filter Building -- 18m x 12m x 11m high	Contaminated building demolished in place, buried, covered with 5m fill. Building was built on the site of the demolished and removed 116-H-4 pluto crib.	H

Site	Name - Size	Comments	LFI Investigative Approach
132-H-1	Reactor Exhaust Stack -- 61m high x 5m diameter (now demolished)	Contaminated stack demolished in place, buried, covered with 1m fill.	H
116-H-4	Pluto Crib -- 1.2m x 1.2m x 0.6m deep	Received cooling water discharge contaminated by failed fuel elements. Received 1000 kg of sodium dichromate. Crib was excavated and the material was buried in the 118-H-5 burial ground. 132-H-2 exhaust air filter building was later built on the same site.	H

AB = Vadose zone borehole -- drilling, geologic logging, and sampling at an analogous site in the 100 Area
AC = Chemical and radionuclide information from analogous site in the 100 Area
AF = Field screening for radioactivity and volatile organic compounds at an analogous site in the 100 Area
AG = Borehole spectral gamma-ray geophysical log at an analogous site in the 100 Area
B = Vadose zone borehole -- drilling, geologic logging, and sampling
C = Chemical and radionuclide analysis of samples
F = Field screening for radioactivity and volatile organic compounds
G = Borehole spectral gamma-ray geophysical log
H = Analysis of historical data including prior sampling and radiological analysis
P = Physical properties analysis of samples
R = Ground penetrating radar to position boreholes
T = Radiological analysis using small remote controlled tracked vehicle

[7] From: Jennifer A Worden 2/6/95 3:24PM (542 bytes: 10 ln)
To: Anne W Sada
Subject: Poem
---------- Message Contents ----------

When people have light in themselves, it will shine out from them. Then we get to know each other as we walk together in the darkness, without needing to pass our hands over each other's faces, or to intrude into each other's hearts.

Just a little something I thought you could put up on your desk.

Jenni

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