Jefferson Proving Ground
Madison, Indiana

Final Decision Document Addendum
No Further Action

Sites 5 and 6

Prepared for
U.S. Army Corps of Engineers
Louisville District
Louisville, Kentucky

Total Environmental Restoration Contract
DACW27-97-D-0015 Task Order 1200

August 16, 2001

MONTGOMERY WATSON

MONTGOMERY WATSON
16 August 2001

Mr. Brooks Evens
U.S. Army Corps of Engineers
Louisville District
600 Martin Luther King Jr. Place
Attn: CELRL-ED-G-ER
Louisville, KY 40202-2230

Re: Final Decision Document Addendum, No Further Action, Sites 5/6 Jefferson Proving Ground, Madison, Indiana

Dear Mr. Evens:

Enclosed is a copy of the above-referenced Final Decision Document (DD) Addendum associated with Sites 5/6 at the Jefferson Proving Ground. This document was prepared under the Total Environmental Restoration Contract (TERC) Task Order 1200.

The Final DD Addendum has been modified to include in Appendix D the latest USEPA comments (dated June 19, 2001) and the responses to those comments. Those comments and responses are as follows:

1. The Army's dioxin/furan risk assessment calculations appear to provide an adequate response to General Comment No. 1 in U.S. EPA's March 28, 2001 review of the Decision Document Addendum and Risk Assessment (Appendix C) for the No Further Action (NFA) Sites 5 and 6. As recommended, the dioxin/furan risk assessment calculations have been incorporated into the Decision Document Addendum and/or Risk Assessment via Appendix D. No further response is needed.

   Response: Comment noted.

2. The Army has still not adequately addressed General Comment Nos. 2 and 3, or Specific Comment Nos. 1, 2 and 3 in U.S. EPA's March 28, 2001 review of the Risk Assessment (Appendix C) for NFA Sites 5 and 6. It is recommended that the information requested in these comments be incorporated into the Risk Assessment. Alternatively, an appendix should be added to the Decision Document Addendum to present the information.

   Response: The backup requested for all comments noted above (with the exception of Specific Comment 2) have been addressed by adding specific subappendices (see below) to Appendix C for the specific sections of the risk assessment that cover these issues.

   General Comment No. 2 – See Subappendix C2
   General Comment No. 3 – See Subappendix C2
   Specific Comment No. 1 – See Subappendix C2
   Specific Comment No. 3 – See Subappendix C3

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Subappendix C2 consists of a copy of Sections 5.1.4.4.4 and 5.1.4.5.5 from the Draft Phase II Remedial Investigation (RI). Subappendix C3 consists of a copy of Section 5.1.5.2.1 from the Draft Phase II RI.

Regarding specific comment 2: in a review of the development of the exposure point concentrations (EPCs) it was determined that for those compounds detected in soil the maximum concentrations were . used to represent the EPC. For this reason, the selection of chemicals of potential concern (COPCs) was conservative in nature and complied with the conditions stated in the comment that a chemical should be retained as a COPC if its concentration in any sample exceeds the Preliminary Remediation Goal (PRG).

3. U.S. EPA recommends that the Army replace the electronic version of our March 28, 2001 comment letter (see Appendix D) with the signed hard copy version that has U.S. EPA's letterhead on it.

   Response: The electronic version has been replaced with the original hard copy as requested.

Copies of this final DD Addendum are being distributed as indicated in the list at the end of this letter.

If you have any questions, please do not hesitate to call me at (608) 231-4747 ext. 243.

Sincerely,

MONTGOMERY WATSON

Leslie A. Busse

Leslie A. Busse
Task Order Manager

Enclosures: Final Decision Document Addendum, No Further Action, Sites 5/6

cc: Mr. Paul Cloud — U.S. Army Soldier, Biological and Chemical Command (1)
Mr. Kevin Herron — IDEM (3)
Ms Karen Mason-Smith — USEPA (3)
Mr. Ken Knouf – JPG (1)

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Appendix

ACRONYMS AND ABBREVIATIONS

COPC	Contaminants of Potential Concern
DD	Decision Document
JPG	Jefferson Proving Ground
NFA	No Further Action
PCP	Pentachlorophenol
PRG	Preliminary Remediation Goals
SVOC	Semi-Volatile Organic Compound
TERC	Total Environmental Restoration Contract
USACE	U.S. Army Corps of Engineers - Louisville District
USEPA	U.S. environmental Protection Agency
VOC	Volatile Organic Compound

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1.0 INTRODUCTION

This Decision Document (DD) Addendum has been prepared for the U. S. Army Corps of Engineers (USACE) under the Total Environmental Restoration Contract (TERC) DACW27-97-D-0015 Task Order 1200.

1.1 PURPOSE

This DD Addendum modifies the Final Decision Document, March 1999 (referenced below), to support No Further Action (NFA) for residential use of two sites at Jefferson Proving Ground (JPG). The two sites are Site 5 (Wood Storage Pile) and Site 6 (Wood Burning Area), located South of the Firing Line at JPG. This document is based on the findings of the following documents:

- *Technical Memorandum, No Further Remedial Action Is Planned at Sites 5 and 6, South of the Firing Line, Jefferson Proving Ground, Madison, Indiana* (Rust E&I, October 1998)

- *Final Decision Document for Site 5 – Wood Storage Pile and Site 6 – Wood Burning Area* (Rust E&I, March 1999).

The United States Environmental Protection Agency (USEPA) and Indiana Department of Environmental Management (IDEM) have reviewed this document. Their comments and the responses are included in Appendix D.

1.2 SCOPE

This DD Addendum summarizes the previously performed risk assessment for the future residential use scenario, whereas the March 1999 Final DD focused on the future industrial use scenario.

The scope of this DD Addendum includes the following:

- Section 1 Introduction – summarizes the purpose and scope of this DD Addendum.

- Section 2 Site Descriptions – includes a brief summary of location, use, and contaminants of potential concern (COPC) for Sites 5 and 6.

- Section 3 Risk Assessment – summarizes the risk assessment performed for the future residential scenario.

- Section 4 Conclusion – summarizes the support for NFA for Residential use of the sites.

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2.0 SITE DESCRIPTIONS

Sites 5 and 6 are located near the western side of the former airport at JPG on two abandoned airport runways (Appendix A).

The sites were generally used for wood storage. Stockpiles in Site 5 consisted of wood debris, plywood struts, boxes, pallets, and used crates. These stored wood items had been burned when the base was active. Site 6 was an open-waste pile receiving pentachlorophenol (PCP)-treated wood from 1975 through 1993. A portion of the PCP-treated wood was reportedly burned as a result of a lightning strike. PCP-contaminated wood at JPG was crushed and disposed of at an off-site facility. By the time the facility was closed in 1995, all stored wood/debris had been removed from the concrete runways at both sites. The most likely contaminant migration pathway is expected to be storm water runoff from the concrete surface to the soils adjacent to the runways. Any potential soil impacts are anticipated to be directly adjacent to the runway because of the flat topography.

During a Phase I RI, four surface-soil samples were collected in the area and tested for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), and dioxins/furans. Detectable concentrations of dioxins were present in the Phase I surface samples. In addition, SVOCs were detected, but these data were found to be suspect due to problems with the analytical method sensitivity. Consequently, three additional surface soil samples were collected during the Phase II RI and tested similarly. Detectable concentrations of dioxins and SVOCs were found.

Because dioxins/furans were detected, a comparison was made between site concentrations and their background sample concentrations to determine if the congeners detected at these sites are related to site activities or are consistent with anthropogenic background. These comparisons indicated that the concentrations of dioxins/furans in soil at Sites 5 and 6 are similar to the concentrations found in background soils at the facility. Therefore, the presence of dioxins/furans is more likely to be anthropogenic background than a consequence of site activities.

The tables included as Appendix B summarize the Phase I and II analytical results for the surface soil samples collected at Sites 5 and 6. No VOCs were detected in any of the samples from the two sites. None of the SVOCs detected exceeded regulatory health-based criteria. Although dioxins were detected in all samples, these congeners are consistent with background concentrations.

Each preliminary contaminant of potential concern (COPC) was screened against the Region IX Preliminary Remediation Goals (PRGs). Only dioxin/furans were retained as soil COPCs at Sites 5 and 6.

In addition, air COPCs from other sites at the JPG facility were evaluated for their potential impact on Sites 5 and 6. The air COPCs retained after comparison to Residential USEPA Region IX PRGs include: aluminum, chromium, silver, thallium, vanadium, and zinc. The air pathway was included based on potential migration of fugitive dust from the other site areas (agricultural fields) to Sites 5 and 6. The conditions at Sites 5 and 6 were not expected to generate fugitive dusts since it is paved and the soils adjacent to the site are vegetated.

3.0 RISK ASSESSMENT

A human health risk assessment was performed for Sites 5 and 6 and included in the October 1998 Technical Memorandum (included as Appendix C1). During the Phase I RI, it was determined that there were no ecological risks associated with Sites 5 and 6. The focus of this summary is on the human health risk assessment.

The risk human health assessment was performed for two future use scenarios, residential and industrial. The results of the industrial exposure scenario indicated that level of risk were well below deminimus risk levels. The risks associated with the residential scenario were within the USEPA's cancer risk range of 1E-06 and 1E-04, but not below the deminimus limit of 1E-06. The results of the residential scenario are summarized further below to put them into perspective.

The potential exposure pathways that were evaluated under the residential scenario are as follows:

- Inhalation of VOCs and fugitive particulates from other site sources.
- Dermal contact with site soil while gardening/playing outdoors.
- Ingestion of fresh home-grown fruits and vegetables grown in site soils.

Taken in combination, these three exposure pathways represent a conservative upper end estimate of the potential exposures residents may have to site soils and ambient air.

The risk associated with the first exposure pathway presented above (ambient air) were well below deminimus risk levels (i.e., hazard index of 1 or cancer risk of 1E-06), and so this exposure pathway would not pose a potential health concern to on-site residents.

The sole COPC that was detected in soil samples at Sites 5 and 6 for evaluation of the remaining two exposure pathways were dioxin/dibenzofurans. The SVOCs that were detected in a single surface soil sample were over an order of magnitude below USEPA Region IX health-based residential PRGs, and thus would not pose a health concern.

It should be noted that the dioxin/dibenzofurans concentrations at sites 5 and 6 are comparable to site-specific background concentrations. Risks associated with background levels of chemicals are sometimes excluded from consideration in a risk assessment, but for informational purposes (and as agreed to with regulatory anagencies) they were included in the Baseline Risk Assessment conducted for Sites 5 and 6. The overall cancer risks associated with incidental ingestion of soil and consumption of homegrown fruits and vegetables for future adults and children residents at Sites 5 and 6 are both 1E-05. This value is within USEPA's target risk range of 1E-06 to 1E-04, therefore no critical exposure pathways or COCs were identified for these receptors in the Baseline Risk Assessment.

The dioxin/dibenzofuran risks are considered representative of background conditions, therefore, the residual risk aside from the risks associated with dioxin/dibenzofuran would be below the deminimus cancer risk level of 1E-06.

It should be noted that the risks associated dioxin/dibenzofuran were based on the maximum concentration of these analytes detected in surface soil samples. It would be anticipated that if future residential development of the area occurred that resultant soil concentrations would likely be lower as surface soil and subsurface soil are mixed during site development. Also, the area that could have been potentially effected is quite limited based on the nature of site conditions. For example, the soil sample locations are located within close proximity to the concrete runway (i.e., less than 50ft), so areas affected would be smaller than the size of a normal residential lot. Additionally these risks estimates were based on reasonable maximum levels of exposure, meaning it was assumed that residents would live at a particular residence for 350 day per year for a 30 year duration, and ingested soil and consume homegrown produce over this entire period. Therefore, the risks presented in the Baseline Risk Assessment report represent a very conservative upper limit, which is unlikely to occur in the future even under a residential land use scenario.

Considering the results of the Baseline Risk Assessment, Sites 5 and 6 should not pose a health concern to residents living in residences built at Sites 5 and 6 above background conditions.

4.0 CONCLUSION

Sites 5 and 6 are recommended for No Further Action for residential use. The facts discussed in this DD Addendum are summarized as follows:

- Soil sample results indicate that SVOCs and dioxin/furans are present at the sites,
- A comparison of dioxin/furans concentrations against background concentrations indicates that these are consistent with anthropogenic background concentrations rather than the result of site-related activities.
- The SVOCs detected were below USEPA Region IX health-based residential PRGs.
- The affect of fugitive dust emissions from other JPG facility sites (i.e., specific agricultural fields) on Sites 5 and 6 were assessed and found to pose no health concern even under a residential land use scenario.
- Only dioxin/dibenzofurans were retained as COPC for soils at Sites 5 and 6. The results of the risk assessment indicated that the levels of potential risk for future residents were within the USEPA risk range of 1E-06 to 1E-04. In addition, and most importantly, the dioxin/dibenzofurans risks at Sites 5 and 6 are comparable to background levels of risk unrelated to site activities.
- During the Phase I RI, it was determined that there were no ecological risks associated with Sites 5 and 6.

Based on the sampling results and the risk assessment as summarized above, a No Further Action for residential use of Sites 5 and 6 is recommended.

APPENDIX A

LOCATION MAP – SITES 5 AND 6
(From Technical Memorandum, RUST E&I, October 1998)

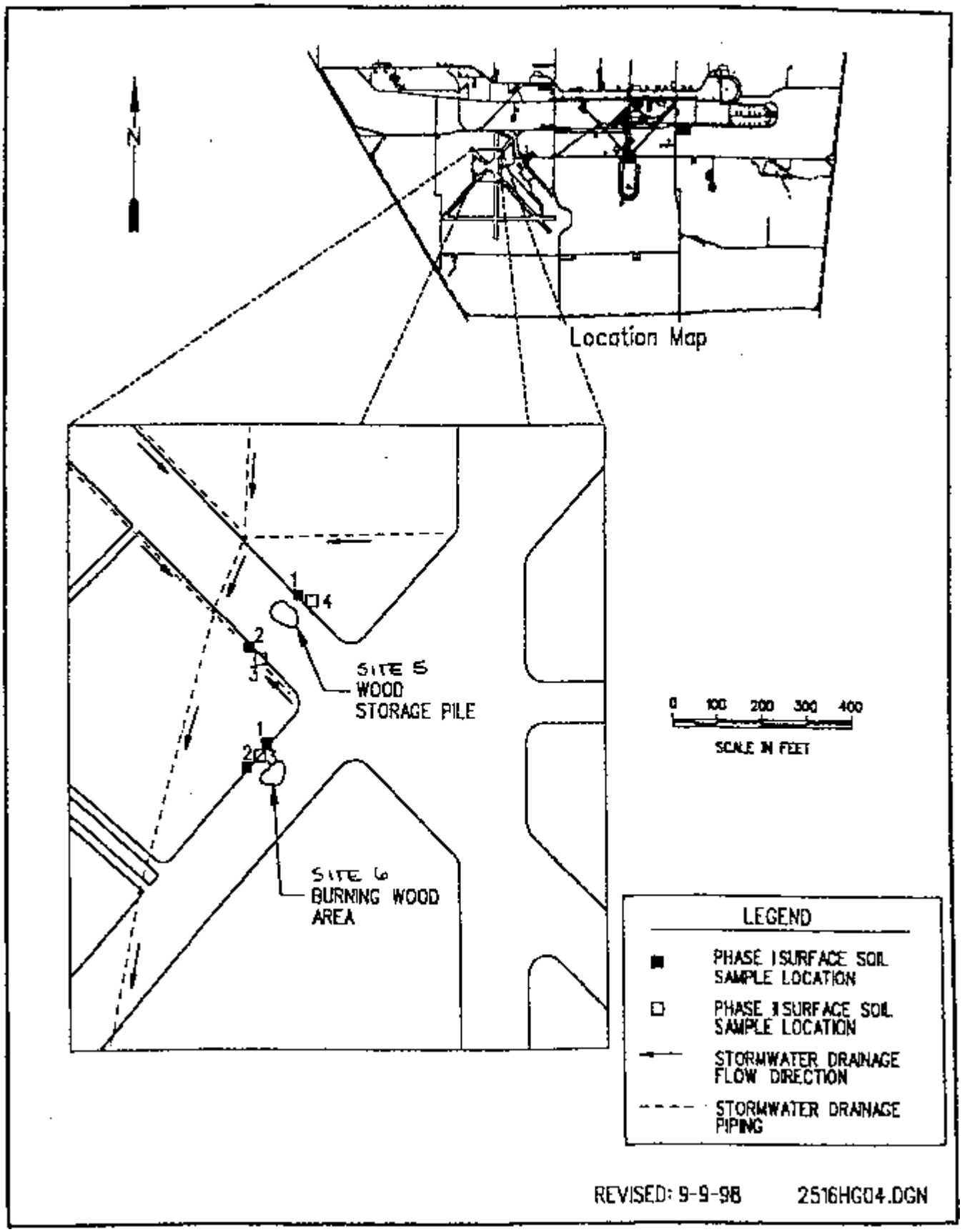

Figure 3-1. Location Map for Site 5 - Wood Storage Pile and Site 6 - Wood Burning Area

APPENDIX B

ANALYTICAL RESULTS
(From Technical Memorandum, RUST E&I, October 1998

Table 3-4. Analytical Results for Detected Contaminants from Phase I Surface Soil Samples at the Wood Storage Pile (Site 5) and Wood Burning Area (Site 6)

Sample ID	Contaminant	Concentration (µg/g)
WDP05SF001	Octachlorodibenzodioxin	0.0052
WDP05SF002	1,2,3,4,6,7,8-Heptachlorodiberzo-*p*-dioxin	0.0002
	Octachlorodibenzodioxin	0.0053
BWP06SF001	1,2,3,4,6,7,8-Heptachloradibenzo-*p*-dioxin	0.00064
	1,2,3,6,7,8-Hexachlorodibenzo-*p*-dioxin	0.000033
	Octachiorodiberzodioxin	0.010
	Octachlorodibenzofuran	0.000210
BWP06SF002		
	1,2,3,4,6,7,5-Heptachloradibenza-*p*-dioxin	0.000092
	Octachlorodibenzodioxin	0.0061

Table 3-5. Analytical Results for Phase II Samples from the Wood Storage Pile (Site 5) and Wood Burning Area (Sigte 6)

Analyte / Sample ID	WDP05SF003 (µg/g)	WDP05SF004 (µg/g)	BWP06SF003 (µg/g)	BWP06SF003 Dup (µg/g)
2,3,4,6,7,8-Hexachlorodibenzofuran	LT 0.00000362	0.00000291	0.00000442	0.00000767
2,3,4,7,8-Pentachlorodibenzofuran	0.00000124	0.00000102	0.00000106	0.00000197
1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin	0.00032800	0.00025900	0.00043400	0.00077500
1,2,3,4,6,7,8-Heptachlorodibenzofuran	0.00005140	0.00003620	0.00008170	0.00014500
1,2,3,6,7,8-Hexachlorodibenzo-*p*-dioxin	0.00001320	0.00001120	0.00001610	0.00002750
1,2,3,6,7,8-Hexachlorodibenzofuran	0.00000650	LT 0.00000204	0.00000257	0.00001280
1,2,3,4,7,8,9-Heptachlorodibenzofuran	LT 0.00000282	0.00000323	0.00000474	0.00001000
1,2,3,7,8,9-Hexachlorodibenzo-*p*-dioxin	0.00001420	0.00001040	0.00001390	0.00002380
1,2,3,7,8,9-Hexachlorodibenzofuran	LT 0.00000049	0.00000041	0.00000065	LT 0.00000080
1,2,3,4,7,8-Hexachlorodibenzo-*p*-dioxin	0.00000450	0.00000399	0.00000447	0.00000840
1,2,3,4,7,8-Hexachlorodibenzofuran	0.00000335	LT 0.00000346	0.00000302	LT 0.00000519
1,2,3,7,8-Pentachlorodibenzo-*p*-dioxin	0.00000344	0.00000254	0.00000350 U	0.00000592
1,2,3,7,8-Penachlorodibenzofuran	0.00000141	0.00000112	0.00000166	0.00000304
Octachlorodibenzodioxin	0.00809000	0.00832000	0.01150000	0.01570000
Octachlorodibenzofuran	0.00015100	0.00009380	0.00040200	0.00072600
2,3,7,8-Tetrachlorodibenzo-*p*-dioxin	LT 0.00000061	0.00000027	0.00000043	0.00000064
2,3,7,8-Tetrachlorodibenzo furan	LT 0.00000149	LT 0.00000204	LT 0.00000103	0.00000147
Fluoranthene	0.0506	LT 0.67	LT 0.67	LT 0.67
Phenanthrene	0.0303	LT 0.67	LT 0.67	LT 0.67
Pyrene	0.0632	LT 0.67	LT 0.67	LT 0.67
Di-n-butyl phthalate	LT 0.67	LT 0.67	LT 0.67	0.0876

Note.- Subsequent EcoChem data qualifier "U" result in a nondetect for 1,2,3,7,8-pentachlorodibenzo-*p*-dioxin (BWP06SF003).

APPENDIX C

DRAFT RI RISK INFORMATION

C1 Human Health Risk Assessment

C2 Section 5.1.4.4.4 Adequacy of Analytical Methods and Quantitation Limits and Section 5.14.5.5 Screening with Region IX Preliminary Remediation Goals

C3 Exposure Point Concentrations — Section 5.1.5.2.1 Outdoor Air

Appendix C1

Human Health Risk Assessment
(From Technical Memorandum, RUST E&I, October 1998)

3.6 HUMAN HEALTH RISK ASSESSMENT

3.6.1 Summary of Approach

The approach used in conducting the human health risk assessment (HERA) for Sites 5 and 6 is consistent with the methods suggested by the USEPA in *Risk Assessment Guidance for Superfund (RAGS), Volume I, Human Health Evaluation Manual (PART A)* (USEPA 1989a) and subsequent updates/guidance, including Exposure Factors Handbook (USEPA 1995a); a memorandum entitled "Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors" (USEPA 1991); *Guidance for Data Useability in Risk Assessment* (Part A; USEPA 1992a); and *Supplemental Guidance to RAGS*: "Calculating the Concentration Term" (USEPA 1992b).

The objective of this risk assessment, like any other, is not to calculate actual risks to real people but rather to estimate *potential* risks to human health. Scientists and behavioralists currently cannot predict exactly how sensitive a person's body might be to a specific chemical or how much exposure they might receive in the future. However, upper bounds of these. characteristics have been established and are used in risk assessment today for estimating potential risk to humans. In keeping with current USEPA guidance, reasonable maximum exposure (RME) conditions were assumed in the land use scenarios and for the receptors evaluated in this assessment. The RME represents the *highest* exposure that is reasonably expected to occur at the site. Likewise, chemical toxicity toward humans is believed to be overstated in the criteria development procedures used by USEPA. Thus, this overall approach to the risk assessment ensures that any real risks presented by the contaminants at these sites should be less than those estimated in the risk assessment.

The HHRA approach follows project-specific recommendations (i.e., those that are applicable to risk assessment), as specified in written review comments prepared by the State of Indiana, the USAEC, and USEPA Region V on the *Final Draft RI Report for Jefferson Proving Ground, South of the Firing Line* (Rust 1994). The HHRA approach also follows recommendations from USEPA Region V comments on the *Draft Technical Memorandum for No Further Action, Sites 5 and 6 (July 1998).* The following sections summarize the results of the human health risk assessment for Sites 5 and 6 in the Phase II RI.

3.6.2 Selection of the Chemicals of Potential Concern for Sites 5 and 6

The objective of this step is to identify media-specific chemicals of potential concern (COPCs) at these sites that could pose potentially signficant risks to human health. The general steps followed include elimination of quality control data or data affected by quality controlsamples, evaluation of data usability, and background screening, which have all been discussed in previous sections. The additional steps include evaluation for hot spots, evaluation of frequency of detection, nutrient screening, and screening with Region IX PRGs (USEPA 1998a). These latter steps are described on a medium-specific basis for Sites 5 and 6 in the following sections.

3.6.2.1 *Surface Soil*

3.6.2.1.1 ***Data Grouping***. For the purposes of the risk assessment, the analytical data for seven dioxinlfuran samples collected at Site 5 and Site 6 in both Phase I and Phase II were grouped together. No obvious hot spots of contamination were evident. Likewise, the analytical data for the three SVOC samples in Phase II were grouped together.

3.6.2.1.2 ***Frequency of Detection.*** Chemicals that are infrequently detected may be sampling or analytical artifacts unrelated to site operations. Such chemicals may be eliminated from the quantitative risk assessment if there is no reason to believe that the chemical may be present (USEPA 1989a). Evaluation of frequency of detection was not undertaken at these sites because of too few samples (a chemical could be eliminated only if it was detected in five percent or fewer samples).

3.6.2.1.3 ***Nutrient Screening.*** Surface soil samples at this site were not analyzed for inorganic constituents. Therefore, no nutrient screening was required.

3.6.2.1.4. ***Summary of Preliminary COPCs.*** Table 3-6 summarizes the frequency of detection, range of detected values, range of reporting limits, arithmetic mean, 95 % upper confidence limit (UCL) of the mean, and the exposure point concentration (EPC) for each preliminary COPC in soil at Sites 5 and 6. The EPC was either the UCL value of the chemical or its highest detected concentration, whichever was lowest.

3.6.2.1.5 ***Region IX Preliminary Remediation Goal Screening.*** The EPC for each preliminary soil COPC was lastly compared to its chemical-specific Region IX residential soil PRG (USEPA 1998a; Table 3-7). One-tenth of the PRG was used for noncarcinogens; the 1×10^{-6} PRGs were used for carcinogens. A chemical was retained and carried through the risk assessment as a final COPC only if the EPC exceeded its PRG. As a result of the screening, only dioxins/furans were retained as COPCs in surface soil at Sites 5 and 6.

3.6.2.2 *Air*

3.6.2.2.1 ***Summary of Preliminary COPCs.*** Ambient air concentrations, to which future receptors at these sites might be exposed, were estimated using air emission/dispersion modeling. Appendix D presents the air dispersion modeling methodology. In the site-specific conceptual model, discussed below, Sites 5 and 6 were evaluated under two future site-specific scenarios: as residential sites and as industrial sites.

Table 3-6. Soil Erposure Point Concentrations of Preliminary Chemicals of Potential Concern, Site 5 - Wood Storage Pile and Site 6 - Wood Burning Area

Chemical	Frequency of Detection[a]	Range of Detected Values (µg/g)	Range of Reporting Limits (µg/g)	Arithmetic Mean Concentration (µg/g)	95% UCL Concentration (µg/g)	Exposure Point Concentration[b] (µg/g)
Surface Soil						
Di-n-butyl phthalate	1/3	0.088	0.670	0.253	87.4	0.088
Fluoranthene	1/3	0.051	0.670	0.240	19,101	0.051
Phenanthrene	1/3	0.030	0.670	0.233	2.4E+07	0.030
Pyrene	1/3	0.063	0.670	0.244	2,207	0.063
2,3,7,8-TCDD equivalents	7/7	5.20E-06 - 3.24E-05	NA[c]	1.54E-05	3.55E-05	3.24E-05

[a]Number of samples in which the analyte was detected/total number of samples analyzed.
[b]The 95% UCL (upper confidence limit of the mean) or the maximum detected value, whichever is lower (USEPA 1989a).
[c]Not applicable.

Table 3-7. Selection of Chemicals of Potential Concern in Soil Based on USEPA Region IX's Preliminary Remediation Goals Site 5 - Wood Storage Pile and Site 6 - Wood Burning Area

Chemical	USEPA Region IX PRG Screen		
	Residential PRG (µg/g)	Exposure Point Conc. (µg/g)[(b)]	Retained as Soil COPC?
Surface Soil			
Di-n-butyl phthalate	550	0.088	No
Fluoranthene	200	0.051	No
Phenanthrene	150[(a)]	0.030	No
Pyrene	150	0.063	No
2,3,7,8-TCDD equivalents	3.8E-06	3.24E-05	**YES**

Note.—PRGs were taken directly from the Region IX PRG table (USEPA 1998a) except as noted in the footnotes. Values for noncarcinogens are 1/10 of the Region IX PRG.

[a]Value for pyrene.

[b]From Table 3-6

In the future industrial land use scenario for the facility, all contaminated sites, including Sites 5 and 6, were assumed to be industrial, except for five sites, which were designated agricultural sites only (see Appendix D). Each site with particulate-bound COPCs in surface soil (metals, SVOCs, and dioxins/furans) and/or volatile COPCs in surface/subsurface soil was assumed to contribute to the air concentrations at all of the sites. In the future residential scenario for the facility, all sites were assumed to be residential except for the five sites designated agricultural. It was assumed that particulate and VOC emissions from the strictly residential sites would be negligible because the home sites would be covered with dense vegetation (lawns) and pavement. Therefore, under the residential scenario, only the five agricultural sites south of the firing line contribute to the air concentrations at all of the sites. The list of preliminary air COPCs is therefore the same for every site for a given scenario, but the concentrations of the COPCs vary. Table 3-8 presents the estimated ambient air concentrations at Sites 5 and 6 under the future residential and industrial scenarios, respectively. These concentrations are also documented in Appendix D, Air Emissions and Dispersion Modeling, Table D-6 (future residential scenario) and Table D-4 (future industrial scenario).

3.6.2.2.2 ***Region IX Preliminary Remediation Goal Screening.*** The exposure point concentrations for each, preliminary air COPC at Sites 5 and 6 in the future residential scenario and the future industrial scenario were compared to chemical-specific Region IX ambient air PRGs (USEPA 1998a; Table 3-8). One-tenth of the PRG was used for noncarcinogens; the 1×10^{-6} values were used for carcinogens. The exception was lead, for which the full PRG was used. As a result of the screening, aluminum, chromium, silver, thallium, vanadium, and zinc are retained as COPCs in air for future on-site residents. For future on-site workers, aluminum, chromium, silver, thallium, vanadium, and zinc were retained. It should be noted that the sources for all of these air COPCs are not Site 5 or Site 6.

3.6.3 Exposure Assessment

3.6.3.1 *Site Conceptual Model*

Once the COPCs are selected, these data along with other project data such as regional land uses, etc., are used to finalize site conceptual models. A health risk assessment conceptual model for a site schematically describes the relationship between the source materials and the potentially impacted human receptor populations. It details the various known and/or potentially contaminated environmental media at a site and then describes the various exposure pathways by which human populations may come into contact with the site chemicals in these media.

There are no people who specifically work at or currently frequent sites 5 and 6. There are, however, several types of individuals who could potentially be affected by the existing contamination at the facility. These are current trespassers to JPG, off-facility (nearby) rural residents, and future hunters. In each case, these individuals would most likely be impacted

Table 3-8. Selection of Chemicals of Potential Concern in Air Based on USEPA Region IX's Preliminary Remediation Goals, Site S - Wood Storage Pile and Site 6 - Wood Burning Area

Chemical	USEPA Region IX PRG Screen		
	Ambient Air PRG (µg/m^3)	**Exposure Point Conc. (µ/m^3)**	**Retained as Air COPC?**
Residential Scenario			
Aluminum	—[(a)]	2.77E-02	**YES**
Arsenic	4.5E-04	1.46E-05	No
Barium	5.2E-02	2.36E-05	No
Beryllium	8.0E-04	1.14E-06	No
Cadmium	1.1E-03	4.59E-08	No
Chromium	2.3E-05	3.84E-05	**YES**
Lead	1.5E+00[(b)]	3.40E-06	No
Manganese	5.1E-03	1.96E-03	No
Silver	—	8.10E-05	**YES**
Thallium	—	5.15E-06	**YES**
Vanadium	—	7.33E-06	**YES**
Zinc	—	2.34E-06	**YES**
Dioxins/Furans	4.5E-08	2.02E-13	No
Benzo(a)anthracene	2.2E-02	4.22E-09	No
Benzo(a)pyrene	2.2E-03	8.96E-09	No
Benzo(b)fluoranthene	2.2E-02	1.66E-08	No
DDE	2.0E-02	2.48E-09	No
Dibenz(a,h)anthracene	2.2E-03	4.96E-10	No
Dieldrin	4.2E-04	—	No
Indeno(1,2,3-cd)pyrene	2.2E-02	2.50E-09	No
1,1-Dichloroethylene	3.8E-02	3.03E-09	No
Chlorobenzene	2.1E+00	5.49E-05	No

Table 3-8. Selection of Chemicals of Potential Concern in Air Based on USEPA Region IX's Preliminary Remediation Goals, Site S - Wood Storage Pile and Site 6 - Wood Burning Area (continued)

Chemical	USEPA Region IX PRG Screen		
	Ambient Air PRG (µg/m^3)	Exposure Point Conc. (µg/m^3)	Retained as Air COPC?
Industrial Scenario			
Aluminum.	—	3.11E-02	**YES**
Arsenic	4.5E-04	1.65E-05	No
Barium	5.2E-02	2.42E-05	No
Beryllium	8.0E-04	1.83E-06	No
Cadmium	1.1E-03	1.59E-06	No
Chromium	2.3E-05	7.21E-05	**YES**
Lead	1.5E+00[(b)]	3.40E-06	No
Manganese	5.1E-03	2.16E-03	No
Silver	—	8.10E-05	**YES**
Thallium	—	5.15E-06	**YES**
Vanadium	—	3.88E-05	**YES**
Zinc	—	1.68E-03	**YES**
Dioxins/Furans	4.5E-08	5.08E-09	No
Benzo(a)anthracene	2.2E-02	4.22E-09	No
Benzo(a)pyrene	2.2E-03	9.05E-09	No
Benzo(b)fluoranthene	2.2E-02	1.66E-08	No
DDE	2.0E-02	2.48E-09	No
Dibenz(a,h)anthracene	2.2E-03	4.96E-10	No
Dieldrin	4.2E-04	3.69E-09	No
Indeno(1,2,3-cd)pyrene	2.2E-02	2.48E-09	No
1,1-Dichloroethylene	3.8E-02	3.03E-09	No
Chlorobenzene	2.1E+00	5.49E-05	No

Note.–PRGs were taken directly from the Region IX PRG table (USEPA 1998a). Values for noncarcinogens are 1/10 of the Region IX PRG.

[a]Not applicable.

[b]Federal ambient air quality criterion for lead.

simultaneously by multiple sites rather than by single units. Because of this, these current receptor populations were addressed separately on a facility-wide, cumulative basis rather than by specific sites during the Phase II RI.

Therefore, the site-specific exposure scenarios forwarded for Sites 5 and 6 in this memorandum only address future land use development. Sites 5 and 6 had two potential future land uses forwarded for their evaluation:

- Residential
- Industrial/commercial

Residential Use

Under the future residential land use scenario, both of these sites are assumed to be developed for residential purposes, with the supposition that a family would build a house directly on or within either of these areas of potential concern.

With respect to a risk assessment analysis, resident populations were assumed to consist of both adults and children. Each individual would be expected to come in contact with site contaminants via the following pathways at Sites 5 and 6:

- Inhalation of VOCs and fugitive particulates from other site sources
- Dermal contact with site soil while gardening/playing outdoors
- Incidental ingestion of site soil while gardening/playing outdoors
- Ingestion of fresh home-grown fruits and vegetables grown in site soils

On-site Worker

Industrial land use is also considered to be a plausible future option for these sites at JPG. On-site industrial workers (adult males and females) are assumed to be individuals who could be exposed directly to contaminated media through the following pathways at Sites 5 and 6:

- Inhalation of VOCs and fugitive particulates from other site sources
- Incidental ingestion of site soil while working outdoors
- Dermal contact with site soil while working outdoors

3.6.3.2 *Exposure Point Concentrations*

3.6.3.2.1 ***Air.*** The estimated ambient air concentrations of COPCs at these sites for the future on-site residents and the future on-site workers are presented in Table 3-8. The methodology used to derive the site-specific air concentrations is described in Appendix D, Air Emissions and Dispersion Modeling.

3.6.3.2.2 ***Soil.*** The concentrations of dioxins/furans, the only COPC in surface soil at these sites, are presented in Table 3-6. No subsurface soil samples were collected at Sites 5 and 6.

3.6.3.2.3 ***Fruits and Vegetables.*** Chemical contamination of fresh home-grown garden produce can arise from chemical uptake from contaminated soil. Fruit and vegetable accumulation of dioxins/furans detected in soil were calculated for the following vegetables (for the future on-site residents) :

- Potatoes
- Tomatoes
- Lettuce
- Carrots
- Beans/peas

Root Uptake by Root Vegetables

Root uptake of chemical contaminants in potatoes and carrots was calculated as follows (USEPA 1994a,b):

$$CVR = \frac{CS - RCF - VG}{K_d} \qquad \text{(Equation 3-2)}$$

where

CVR = contaminant level in root vegetables via root uptake from soil (mg/kg - fresh wt)
RCF = ratio of concentration in roots to concentration in soil pore water (L/kg; chemical-specific)
VG = below ground vegetable correction factor (unitless) = 0.01
K_d = soil-water partition coefficient (L/kg; chemical-specific)
CS = contaminant level in soil (mg/kg)

The RCF for dioxins/furans was calculated using the following equation (USEPA 1995b):

$$Log\ RCF = (0.77)\ (Log\ K_{ow}) - 1.52 \qquad \text{(Equation 3-3)}$$

A log K_{ow} value for dioxins/furans of 6.64 was taken from Montgomery and Welkom (1990). For organic chemicals, $K_d = K_{oc} \cdot f_{oc}$ (f_{oc} = fraction of organic carbon in soil). A site-specific f_{oc} of 0.007 was used in the risk assessment; this value is the average f_{oc}, for 54 surface soil samples collected at the facility in October 1997. A K_{oc} value of 4.57E+06 for dioxins/furans was also taken from Montgomery and Welkom (1990); the site-specific K_d for dioxins/furans is therefore 3.20E+04. Using the above equations, an RCF of 3.92E+03 was calculated for dioxins; the resulting concentration in root vegetables is 3.97E-08 mg/kg (see Appendix C).

Root Uptake by Above-Ground Vegetables

Root uptake of chemical contaminants in above-ground vegetation was calculated as follows:

$$CYR = RUF \times CS \times DWF \qquad \text{(Equation 3-4)}$$

where

CVR = contaminant level in above-ground vegetation via root uptake (mg/kg - fresh weight)
RUF = root uptake factor (kg/kg dry weight)
CS = contaminant level in soil (mg/kg)
DWF = dry-to-wet weight conversion factor (unitless) of 0.06 (tomatoes); 0.05 (lettuce); and 0.18 (beans) (Wenck 1983; Wiersma *et al*. 1986); contaminant levels in above-ground fruits and vegetables consumed by humans are expressed on a wet-weight basis.

An RUF value of 5.62E-03 was calculated for dioxins/furans using the following equation (Travis and Arms 1988):

$$\log RUF = 1.588 - (0.578 \times \log K_{ow}) \qquad \text{(Equation 3-5)}$$

The resulting fresh-weight concentrations in above-ground fruits/vegetables are: tomatoes - 1.09E-08 mg/kg; lettuce - 9.11E-09 mg/kg; and beans - 3.28E-08 mg/kg (see Appendix C).

3.6.3.3 *Exposure Dose Algorithms*

In the exposure assessment step of a risk assessment, the contaminant concentrations of the COPCs at a site are translated into RME doses for the various human receptor(s). This translation of environmental contamination levels into human doses of the COPCs is made by using variations of the standard exposure assessment equation (USEPA 1989a):

$$I = \frac{C \times CR \times EF \times ED}{BW \times AT} \qquad \text{(Equation 3-6)}$$

where

I = intake, the amount of chemical at the exchange boundary (mg chemical/kg body weight-day)
C = exposure point concentration; the concentration of a contaminant at the location on the site where receptor contact is made (e.g., mg/kg soil)

CR = contact rate, the amount of contaminated medium contacted per unit time or event (e.g., kg/day)
EF = exposure frequency (describes how often exposure occurs [days/year])
ED = exposure duration (describes how long the exposure period is [years])
BW = body weight (the average body weight of the receptor over the exposure period [kg])
AT = averaging time (time period over which exposure is averaged [days]).

Thus, each individual's chemical exposure dose is dependent upon:

- Concentration of the chemical in an environmental medium at the point of exposure;
- Extent of contact that the individual has with that medium;
- How often the individual comes into contact with that contaminated medium;
- How long the exposure occurs; and
- Body weight of the receptor.

The exposure point concentrations of COPCs at Sites 5 and 6 for each receptor population were derived as described (above) in Section 3.6.3.2. This section details the assumptions related to how each receptor's exposure was envisioned to occur. The assumptions are consistent with the HHRA Work Plan for this facility that was submitted to and accepted by the USEPA Region V (Rust, 1997b). Specific details of the exposure equations that were used for this assessment, as well as the assumed value of each input parameter, are provided in the remainder of this section.

3.6.3.3.1 ***Inhalation of Contaminated Air.*** The potential exists for fugitive dust to be generated at these and other sites and for it to disperse in the ambient air. In addition, VOCs in contaminated soil may also be released into the ambient air. Thus, inhalation of airborne contaminants (VOCs and particulates) is a potential route of exposure for any individual within the air dispersion impact zone of a site. This potential impact zone is defined on the basis of air dispersion modeling, as described in Appendix D. This pathway is applicable to the following receptors at Sites 5 and 6: future on-site residents and workers.

The equation used for calculating human exposure doses of COPCs due to inhalation of volatile and dust-bound contaminants is provided in Table 3-9, along with the values of the exposure variables used for each receptor. The values for the exposure variables are explained in further detail below.

Contaminant Concentrations in Ambient Air (CAA) at Sites 5 and 6

These values are the projected cumulative annual average ambient air levels at Sites 5 and 6 of each VOC and particulate-bound COPCs from the facility. These values represent the direct output of the air dispersion modeling, as described in Appendix D. As noted previously, however, none of the air COPCs at Sites 5 and 6 originate from these two sites; the air COPCs all originate from other sites at this facility.

Table 3-9. Variable Values for Inhalation of Vapor Phase and Particulate-Bound Chemicals

Equation:

$$\text{Inhalation Dose (mg\kg-day)} = \frac{CAA \times IR_A \times ET \times EF \times ED}{BW \times AT}$$

where

CAA = Contaminant level in air (mg/m^3)
IR_A = Inhalation rate (m^3/hour)
ET = Exposure time (hours/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time (days)

Exposure variables:

	IR_A	ET	EF	ED	BW	AT	
	(m^3/hr)	(hr/d)	(d/yr)	(yr)	(kg)	(days)	
						Cancer	Noncancer
FUTURE SCENARIOS							
On-site workers	0.83	8	180	25	70	25,550	9,125
On-site residents							
Adults	0.83	24	252	30	70	25,550	10,950
Children	0.67	24	252	6	15	25,550	2,190

Inhalation Rate (IR_A)

The average inhalation rate of a receptor is dependent upon his/her age (or size), sex, and activity level. The inhalation rate used for the future on-site resident adults and future workers was 0.83 M^3/hour (standard default factor; USEPA 1991). For the future on-site children, a value of 0.67 M^3/hour was used (USEPA 1995a).

Exposure Time (ET)

The exposure time is the period of each day that the person is assumed to be present in the impact zone of a site. For future on-site residents (adults and children), it was conservatively assumed that exposure to potential site-related air contaminants occurs 24 hours per day. The future on-site worker was assumed to have an exposure period of 8 hours per day.

Exposure Frequency (EF)

The exposure frequency is the number of days per year that an individual comes into contact with a contaminated environmental medium. The average monthly low temperature in southern Indiana is less than freezing (32 °F) for 3 months of the year. Generation of fugitive dust and volatile emissions would be expected to be essentially nonexistent during these three winter months. Therefore, future residents (adults and children) were assumed to be exposed to contaminants in ambient air 252 days per year (7 days per week, 4 weeks per month, 9 months per year). Future on-site workers were assumed to be exposed 180 days per year (5 days per week, 4 weeks per month, 9 months per year).

Exposure Duration (ED)

The exposure duration is the number of years that an individual comes into contact with the contaminated environmental medium. Future on-site adult residents were assumed to live in the area for 30 years (90th percentile for time spent at one residence; USEPA 1989a). Children were assumed to be exposed for 6 years (ages 1 through 6). Future workers were assumed to work 25 years (USEPA 1991).

Body Weight (BW)

The body weight term in the equation in Table 3-9 refers to the average weight of the receptor during the period of time that his/her exposure to site contaminants occurs. For purposes of this assessment, the values suggested by the USEPA (1991) were used: 70 kg for adults and 15 kg for children.

Averaging Time (AT)

The averaging time is the time interval (in days) over which the health criterion is applicable. For cancer effects, this term is fixed at 25,550 days (70 years x 365 days/year) (USEPA 1989a). For noncancer effects, this term is the number of years a receptor is exposed

(exposure duration) multiplied by 365 days/year (USEPA 1989a). For adult residents this value is 10,950 days (30 years x 365 days). For children, this value is 2,190 days (6 years x 365 days/year). For future on-site workers, the value is 9,125 days (25 years x 365 days/year).

3.6.3.3.2 ***Incidental Ingestion of Contaminated On-Site Soil.*** Mouthing behavior (children) and incidental ingestion of soil with residential or work-related activities may expose human receptors to contaminated on-site soil via the oral route of exposure. The equation used to calculate the human exposure dose due to incidental ingestion of contaminated soil is presented in Table 3-10. The assumed values for the exposure parameters are also listed in this table. This pathway was assumed to be complete for all future on-site receptors. Details of the derivation of the values not previously described are presented below.

Contaminant Concentration in Soil (CS)

The exposure point concentrations of the dioxins/furans in surface soil at Sites 5 and 6 for this exposure pathway were described in Section 3.6.3.2.

Ingestion Rate (IR_S)

A future adult worker at these sites was assumed to consume 50 mg of soil per day. This is the value recommended for a receptor in a commercial/industrial setting (USEPA 1991). Soil consumption rates of 100 mg/day and 200 mg/day were used for the future adult residents and children, respectively (USEPA 1989a).

Exposure Frequency (EF)

It was assumed that direct contact with soil would be negligible during the three winter months. Therefore, the exposure frequencies for the receptors were the same as for exposure to ambient air, with the exception of future on-site residents. Since the soil ingestion rates for these receptors are daily-averages, which already take into account seasonal differences in exposures, the exposure frequency of these receptors was assumed to be 350 days per year, a value that allows for 2 weeks per year away from the area (e.g., vacation).

3.6.3.3.3 ***Dermal Contact With Contaminated Soil.*** The chemicals in contaminated soil also may be absorbed into a receptor's body through dermal contact. Exposure depends on a variety of factors, including exposure time, skin surface area, types of activities, and hygienic practices. Thus, the estimates for these factors are highly variable. The equation that was used to calculate chemical doses due to dermal contact with contaminated soil is presented in Table 3-11, along with the assumed values for the exposure parameters. This pathway is

Table 3-10. Variable Values for Ingestion of Chemicals in Soil

Equation:

$$\text{Soil Ingestion Dose (mg/kg-day)} = \frac{CS \times IR_S \times CF \times EF \times ED}{BW \times AT}$$

where

CS = Contaminant level in soil (mg/kg)
IR_S = Ingestion rate (mg soil/day)
CF = Conversion factor (10^{-6} kg/mg)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time (days)

Exposure variables:

	IR_A	EF	ED	BW	AT	
	(mg/d)	(d/yr)	(yr)	(kg)	(days)	
					Cancer	Noncancer
FUTURE SCENARIOS						
On-site workers	50	180	25	70	25,550	9,125
On-site residents						
Adults	100	350	30	70	25,550	10,950
Children	200	350	6	15	25,550	2,190

Table 3-11. Variable Values for Dermal Contact with Chemicals in Soil

Equation:

$$\text{Soil Dermal Contact Dose (mg/kg-day)} = \frac{CS \times CF \times SA \times AF \times EF \times ED \times ABS}{BW \times AT}$$

where

CS = Contaminant level in soil (mg/kg)
CF = Conversion factor (10^{-6} kg/mg)
SA = Skin surface area available for contact (cm^2 /event)
EF = Soil-to-skin adherence factor = 0.2 mg/cm^2
EF = Exposure frequency (events/year)
ED = Exposure duration (years)
ABS = Dermal absorption factor (chemical-specific)
BW = Body weight (kg)
AT = Averaging time (days)

Exposure variables:

	SA	EF	ED	BW	AT	
	(cm^2/event)	(events/yr)	(yr)	(kg)	(days)	
					Cancer	Noncancer
FUTURE SCENARIOS						
On-site workers	2,490	180	25	70	25,550	9,125
On-site residents						
Adults	5,800	252	30	70	25,550	10,950
Children	3,580	252	6	15	25,550	2,190

relevant for all future on-site receptors at Sites 5 and 6. Details of the derivation of the values not previously described are presented below.

Exposure Frequency (EF)

Exposure frequencies for all receptors were the same as for exposure to ambient air, since dermal exposure would only be expected to be significant during the warmer 9 months of the year: future residents—252 days/year and future on-site workers—180 days/year.

Skin Surface Area Available for Contact (SA)

The value used in the equation for the surface area of the adult workers' skin available for contact with soil was 2,490 cm^2/event, which corresponds to the maximum surface area of the hands and forearms measured in men (USEPA 1989c). The value used for future on-site adult residents was 5,800 cm^2 (USEPA 1992c). For future resident children, a value of 3,580 cm^2 (total surface area of arms, hands, legs, and feet; USEPA 1985) was used.

Adherence Factor of Soil to Skin (AF)

A soil adherence factor of 0.2 mg/cm^2 was used (USEPA 1992d).

Dermal Absorption Factor (ABS)

The absorption factor accounts for the desorption of the chemical from the soil matrix and the absorption of the chemical across the skin. For this assessment, the USEPA Region V recommended dermal absorption factor for dioxins/furans was used: 0.05 (for OC < 10 %; OC = organic carbon content of soil; the site-specific OC is 0.7 %)

3.6.3.3.4 ***Ingestion of Contaminated Fruits and Vegetables.*** Consumption of contaminated home-grown fruits and vegetables may be a source of chemical exposure for future on-site residents. The equation used to calculate human exposure dose due to ingestion of contaminated fruits and vegetables is provided in Table 3-12, with the values for the exposure parameters. Details of the derivation of the values not previously described are provided below.

Concentration in Fruits/Vegetables (CV_i)

The calculation of the concentrations of dioxins/furans in home-grown fruits and vegetables which were used in this risk assessment is discussed in Section 3.6.3.2.3.

Consumption Rate for Fruits/Vegetables ($CONV_i$)

The consumption rates for adults and children are provided in Table 3-13. These are 95th percentile values as determined by Pao and others (1982).

Table 3-12. Variable Values for Ingestion of Chemicals in Garden Fruits/Vegetables

Equation:

$$\text{Fruit/Vegetable Ingestion Dose (mg/kg-day)} = \sum_{i=1}^{5} \frac{(CV_i \times CONV_i) \times CF \times FR_v \times EF \times ED}{BW \times AT}$$

where

CV_i = Contaminant level in fruit/vegetable 'I' (mg/kg)
$CONV_i$ = Consumption rate for fruit/vegetable 'I' (g/day)

	Potatoes	Tomatoes	Carrots	Beans/Peas	Lettuce
Adult	209	133	130	181	66
Child	123	67	85	104	29

CF = Conversion factor (10^{-3} kg/g)
FR_v = Fraction of fruit/vegetables that is homegrown = 0.4 (unitless)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time (days)

Exposure variables:

	EF	ED	BW	AT	
	(days/yr)	(yr)	(kg)	(days)	
				Cancer	Noncancer
FUTURE SCENARIOS					
On-site residents					
Adults	350	30	70	25,550	10,950
Children	350	6	15	25,550	2,190

Fraction of Fruit/Vegetables that is Homegrown (FR_V)

A most conservative value for this parameter is 0.40 (USEPA 1989a).

Exposure Frequency (EF)

The vegetable consumption rates provided in Table 3-12 have been averaged over an entire year. Therefore, the exposure frequency for fruitivegetable ingestion for future on-site residents was 350 days/year, allowing for 2 weeks per year away from home.

3.6.4 Toxicity Assessment

The toxicity assessment is the step in the risk assessment process in which the relationship between the dose of a chemical received and the incidence of adverse health effects in an exposed population is characterized. This characterization utilizes current available scientific (toxicological) knowledge on each COPC, as well as governmental policies in order to (1) characterize the nature and strength of the evidence of causation of chemical-induced health effects and (2) quantitatively estimate the incidence of health effects in an exposed population as a function of chemical dose when sufficient evidence exists. Toxicity assessments are critical components in risk assessments because they allow the calculated exposure doses of the various receptor populations (from the Exposure Dose Algorithms) to be translated into potential health risks.

3.6.4.1 *Noncarcinogenic Chemicals of Potential Concern*

Noncarcinogenic health effects may occur in an individual upon exposure to a dose of a chemical above its toxicological threshold. The reference dose (RfD) of a chemical is the toxicity value currently proposed by the USEPA to represent this threshold for regulatory purposes. RfDs are reported as chemical intake (mg/kg-day). Also used to quantify noncarcinogenic effects are reference concentrations (RfCs), which are reported as concentrations of chemicals in air (mg/m^3). RfCs are defined by the USEPA as estimates of daily exposure levels for the entire human population, including sensitive subpopulations, that are likely to be without appreciable deleterious effects.

There is no chronic oral RfD for dioxins/furans, the only COPCs in soil at Sites 5 and 6. For the COPCs in air, conversion of toxicity values from RfCs (concentration) to RfDs (dose) was employed for the toxicity assessments utilized in this risk assessment. The inhalation pathway was evaluated in terms of dose (i.e., RfDs) in order to provide consistency with the otherexposure routes addressed and to allow for a project-specific exposure assessment (to accommodate receptor-specific adjustments in physiological and behavioral assumptions of the various human populations). Chronic RfCs were used to evaluate exposures to both adults and children.

The primary source of the inhalation toxicity values was IRIS (USEPA 1998b). If a value was unavailable in IRIS, HEAST (US EPA 1997) was utilized. If a toxicity value was not available from IRIS or HEAST, provisional criteria were obtained from other sources, such as the National Center for Environmental Assessment (NCEA). For any remaining chemicals (i.e., for those lacking inhalation toxicity values), Rust E&I evaluated the development of inhalation criteria from oral toxicity values. Table 3-13 summarizes the chronic inhalation RfDs used in the risk assessment for Sites 5 and 6.

3.6.4.2 *Carcinogenic Chemicals of Potential Concern*

To estimate the lifetime (assumed to be 70 years) probability of human receptors contracting cancer as a result of their exposure to known or suspected carcinogens of potential concern in the project database, exposure doses were multiplied by USEPA carcinogen slope factors. Oral slope factors (SFs) were used for ingestion exposure pathways. Inhalation SFs, either published by USEPA or derived from published inhalation unit risks (URs), were used for the inhalation exposure pathway. SFs/URs are derived under the regulatory policy that assumes that a threshold for carcinogenicity does not exist. SFs represent the estimated risk of cancer per unit of exposure dose. URs represent the estimated risk of cancer per unit of exposure (air) concentration.

SFs/URs represent plausible upper-bound estimates of the probability of a carcinogenic response per unit of chemical exposure continuously over a lifetime. They are usually derived from the upper 95th percent confidence limit of an extrapolated slope of the dose-response curve for a chemical in an animal carcinogenicity study. The SF is expressed as the reciprocal of mg of chemical intake per kg of body weight per day [$(mg/kg\text{-}day)^{-1}$]. The UR is expressed as the reciprocal of chemical concentration in air [$(\mu g/m^3)^{-1}$]).

The SFs/URs are used in risk assessments to estimate an upper-bound lifetime probability of an individual developing cancer as a result of his/her exposure to a particular dose/concentration of a potential carcinogen. SFs/URs are accompanied by their weight-of-evidence classification to indicate the strength of evidence that the chemical may be a human carcinogen (USEPA 1989a).

Carcinogenic risk was quantified in only those exposure pathways involving the routes of exposure for which the chemical is known or suspected to be carcinogenic. In addition, conversion of toxicity values from URs (concentration) to SFs (dose) was employed for the toxicity assessments. The inhalation pathway was evaluated in terms of dose (i.e., SFs) in order to provide consistency with the other exposure routes addressed and to allow for a project-specific exposure assessment (to accommodate receptor-specific adjustments in physiological and behavioral assumptions of the various human populations).

Table 3-13. Chronic Inhalation Toxicity Values - Noncarcinogenic Effects

COPC	Chronic RfC (mg/M^3)	Chronic RfD[a] (mg/kg-d)	Confidence Level	Critical Effect	Uncertainty Modifying Factor	Source
Aluminum	5.0E-03	1.4E-03	Medium	Cognitive and psychomotor impairment	300/1	NCEA[b]
Chromium (VI)	NA[c]	1.0E-030[d]	Low	No effects reported	500/1	IRIS[e]
Silver	NA	5.0E-03[f]	Low	Argyria	3/1	IRIS
Thallium	NA	8.0E-05[f]	Low	No adverse effects	3,000/1	IRIS
Vanadium	NA	7.0E-03[f]	NR[g]	None reported	100/NR	HEAST[b]
Zinc	NA	3.0E-01[d,i]	Medium	Decrease in erythrocyte superoxide dismutase concentration	3/1	IRIS

[a]The inhalation RfD was calculated from the reported RfC (reference concentration):

$$\text{Inhalation RfD} = \frac{20\ m^3/d \times \text{RfC}\ (mg/m^3)}{70\ kg}$$

[b]National Center for Environmental Assessment; NCEA values are provisional.
[c]Not available.
[d]Value extrapolated from oral RfD using oral and inhalation absorption factors:

$$\text{Inhalation RfD} = \frac{\text{oral absorption factor}}{\text{inhalation absorption factor}} \times \text{Oral RfD}$$

For Cr VI: oral RfD = 5.0E-03 mg/kg-day; oral abs = 0.05; inhalation abs = 0.25 (Owen 1990).
For Zn: oral RfD = 3E-02 mg/kg-day; oral abs = 0.5 (Owen 1990).
[e]Integrated Risk Information System.
[f]No inhalation or oral absorption factors could be located for this chemical: the oral RfD was used as the inhalation RfD.
[g]Not reported.
[h]Health Effects Assessment Sununary Tables.
[i]Adult value only. As suggested in IRIS, an oral RfD for children was calculated from the recommended total daily intake of zinc for preadolescent children (10 mg/day; NRC, 1989). The value of 10 mg/day was divided by the child's body weight of 15 kg to derive a zinc oral RfD for children of 6.6E-01 mg/kg-d.

IRIS (USEPA 1998b) and HEAST (USEPA 1997) were the sources for each SF/UR. Tables 3-14 and 3-15, respectively, present the oral and inhalation SFs used in the risk assessment.

3.6.5 Risk Characterization

Risk/hazard characterization is the last step in the risk assessment process. In this step, the potential incidence of human cancer risks and the potential noncarcinogenic health hazards were estimated for Sites 5 and 6. These health- indices were calculated by integrating the exposure assessment and the toxicity assessment databases. To characterize potential noncarcinogenic hazards, comparisons were made between the receptor-specific exposure doses and the appropriate toxicity criteria (chronic RfDs). To quantify potential carcinogenic risks, receptor-specific exposure doses were multiplied by the applicable toxicity criteria (SFs). Each of these numerical expressions of risk are then accompanied by explanatory text interpreting the results.

3.6.5.1 *Potential Chronic Health Hazards*

By convention, the average daily exposure doses to human receptors over the specific time-frame of exposure are used for calculation of noncarcinogenic health hazards (USEPA 1989a). The noncarcinogenic daily exposure doses calculated in the exposure assessment were used to calculate hazard quotients (HQs) for each of the COPCs for each receptor. The HQ was determined from the receptor-specific and pathway-specific exposure doses (calculated in the Exposure Assessment) using the following equation:

$$HQ = \frac{\textit{Calculated Exposure Dose (mg/kg-day)}}{\textit{RfD (mg/kg-day)}} \qquad \text{(Equation 3-7)}$$

The HQ approach assumes that there is a level of exposure to a chemical (e.g., RfD) at which it is unlikely for even sensitive individuals in a population to experience adverse health effects. Therefore, if the HQ for a given substance is less than or equal to 1.0, the calculated receptor-specific exposure dose is less than or equal to the chemical's regulatory threshold dose, indicating that the chemical concentration in that site medium will probably not produce a noncarcinogenic health hazard to the receptor population. A ratio greater than 1.0 indicates the *potential* for adverse health effects in the modeled population, but not necessarily that they would occur (due principally to the fact that the RfDs are calculated in such a highly conservative fashion).

When multiple noncarcinogenic chemical substances are evaluated in a medium and/or when a receptor's exposure is to multiple environmental media, a summation of all of the appropriate chemical-specific HQs for a receptor is made (USEPA 1986). The result of this summation process is a receptor-specific screening hazard index (HI). The same interpretation of this

Table 3-14. Oral Toxicity Values - Carcinogenic Effects

Chemical	Oral Slope Factor $(mg/kg\text{-}d)^{-1}$	Weight of Evidence[a]	Cancer Type/Target Organ/Species	Source
,3,7,8-TCDD	1.5E+05	B2	Tumors/respiratory system/rat	HEAST[b]

[a]The Weight-of-Evidence Classification B2 = Probable human carcinogen. sufficient evidence in animals & inadequate data humans.
[b]Health Effects Assessment Summary Tables.

Table 3-15. Inhalation Toxicity Values - Carcinogenic Effects

Chemical	Inhalation Unit Risk $(\mu g/M^3)^{-1}$	Inhalation Slope Factor[a] $(mg/kg\text{-}d)^{-1}$	Weight of Evidence[b]	Cancer Type/Target Organ/Species	Source
			Inorganics		
Aluminum	ND[c]	ND	ND	ND	
Chromium (VI)	1.2E-02	4.1E+ 01	A	Carcinoma/lung/human	IRIS[d]
Silver	ND	ND	D	ND	IRIS
Thallium	ND	ND	D	ND	IRIS
Vanadium	ND	ND	ND	ND	
Zinc	ND	ND	D	ND	IRIS

[a]The inhalation slope factor was convened directly from the published inhalation unit risk:

$$SF = \frac{70\ kg \times UNIT\ RISK\ (\mu g/m^3)^{-1}}{20\ m^3/d \times 1.0E\text{-}03\ mg/\mu g}$$

[b]The Weight-of-Evidence Classifications are: A = Human carcinogen; D = Not classifiable as to human carcinogenicity.
[c]No Data.
[d]Integrated Risk Information System.

resulting HI, as described above for the HQ, is then used to characterize the overall potential for the site to induce noncarcinogenic toxic effects in the receptor population.

Those COPCs that exceed an HQ of 1.0 are identified as contaminants of concern (COCs). COCs represent the primary contributors to the potential noncancer hazard for the receptor-specific exposure pathway under evaluation.

Noncarcinogenic health hazards are documented in Appendix C for all of the COPCs for each future receptor at Sites 5 and 6. Table 3-16 provides a summary of these noncarcinogenic hazards. For all of the receptors evaluated, the total HI is less than 1.0, indicating that these receptors are not likely to experience adverse noncancer health effects as a result of exposure to chemicals in soil and air at these sites.

3.6.5.2 *Potential Excess Lifetime Cancer Risks*

A 70-year lifetime is used by convention to calculate lifetime-equivalent exposure doses to human receptors for the carcinogenic risk calculations (USEPA 1989a). In this assessment, the receptor-specific exposure doses derived for each direct and indirect exposure pathway (e.g., exposure to chemicals in soil, air, and vegetables) were translated into cancer risks. The cancer risks were determined from the pathway-specific exposure doses (calculated in the Exposure Dose Algorithms) and the oral SFs using the following equation:

$$\textit{Excess Lifetime Cancer Risk} = 1 - \exp(-D \times SF) \qquad \text{(Equation 3-8)}$$

where

D = Pathway-specific exposure dose (mg/kg-d)
SF = Chemical-specific slope factor $[(mg/kg\text{-}d)^{-1}]$

Equation 3-8, which is referred to as the one-hit equation, is valid at both low (< 1E-02) and high risk levels (USEPA 1989a).

To assess the simultaneous exposure of a receptor population to multiple carcinogens from multiple exposure routes, all of the cancer risks calculated for a receptor population were summed (USEPA 1986). Each overall receptor cancer risk is then compared to USEPA's target risk range (1E-06 to 1E-04). To put the overall cancer risks calculated for each receptor population into perspective, the risk management criterion of 1.0E-04 was used. If this criterion is exceeded for a site, any chemical that individually was associated with a risk level greater than 1.0E-05 was identified as a COC. COCs represent the primary contributors to the potential cancer risk for the receptor-specific exposure pathway under evaluation. If the total cancer risk for a receptor from all exposure pathways is less than 1.0E-04, then it is concluded that the sites do not pose a significant risk to that receptor and no COCs are identified.

Table 3-16. Surnrnaty of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 5 - Wood Storage Pile and Site 6 - Wood Burning Area

Exposure Pathway	Pathway-Specific Cancer Risk	Carcinogenic Chemicals of Concern	Pathway-specific Hazard Index	Noncarcinogenic Chemicals of Concern
Future On-site Resident Adult				
Incidental ingestion of soil	2.85E-06		NA	
Dermal contact with soil	1.19E-06		NA	
Ingestion of home-grown fruits/vegetables	7.53E-06		NA	
Inhalation of VOCs and fugitive dusts	1.33E-07		0.0039	
Total	1.17E-05	None	0.0039	None
Future On-site Resident Child				
Incidental ingestion of soil	5.33E-06		NA	
Dermal contact with soil	6.86E-07		NA	
Ingestion of home-grown fruits/vegetables	4.15E-06		NA	
Inhalation of VOCs and fugitive dusts	9.99E-08		0.0147	
Total	1.03E-05	None	0.0147	None

Table 3-16. Stunnlary of Receptor-Specific Carcinogenic Risks and Noncarcinogenic Hazards
Site 5 - Wood Storage Pile and Site. 6 - Wood Burning Area (continued)

Exposure Pathway		Pathway-specific Cancer Risk	Carcinogenic Chemicals of Concern	Pathway-Specific Hazard Index	Noncarcinogenic Chemicals of Concern
Future On-site Worker					
Incidental ingestion of soil		6.11E-07		NA	
Dermal contact with soil		3.04E-07		NA	
Inhalation of VOCs and fugitive dusts		4.94E-08		0.0010	
	Total	9.64E-07	None	0.0010	None

NA = Not applicable.

The cancer risk calculations are documented in Appendix C for all of the COPCs for each future receptor at Sites 5 and 6. Table 3-16 provides a summary of these carcinogenic risks.

The overall cancer risks calculated for the future adults and children living at Sites 5 and 6 are 1.2E-05 and 1.0E-05, respectively. Since these cancer risks are within USEPA's target risk range of 1.0E-06 to 1.0E-04, no critical exposure pathways or COCs are identified for these receptors.

The overall cancer risk calculated for the future workers at Sites 5 and 6 is 9.6E-07. Since this estimated cancer risk is below USEPA's de *minimis* risk level of 1.0E-06, no critical exposure pathways or COCs are identified for future workers.

3.6.6 Uncertainty/Sensitivity Analysis

The numerical risks/hazards that are calculated for Sites 5 and 6 represent *conditional* estimates of risk based on various simplifying assumptions concerning contaminant exposure and toxicity. These estimates of risk/hazard are derived using a series of conservative procedures that address contaminant concentrations at the site, their fate in the environment, how someone currently or in the future might be exposed to these contaminants, and the toxicity of each chemical toward humans. The uncertainty analysis specifies, when appropriate, the critical assumptions made for the site so that the site-specific results can be interpreted in a proper context by risk managers.

To assist the risk managers in this project, a qualitative uncertainty analysis has been performed. The qualitative uncertainty analysis (1) itemizes the major areas of uncertainty in the site-specific risk assessment and (2) demonstrates that the assessment overall has been conservatively performed (i.e., that the potential risks/hazards at the site have not likely been underestimated, but may have been significantly overestimated).

The qualitative uncertainty analysis for this site is presented in Table 3-17. Based on this analysis, it can be concluded that this risk assessment is conservative. Some of the major, calculated uncertainties in this study that are most influential to the risks/hazards include:

- Assumptions regarding receptors' exposure time (24 hours/day) and exposure frequency (350 days/year)
- Assumptions regarding receptors' food-chain ingestion rates (95th percentile of U.S. population)
- Maximum soil concentrations used

3.6.7 ECOLOGICAL RISK ASSESSMENT

Based on protocols established in the PERA (Rust E&I 1997c), there were no ecological risks determined for Sites 5 and 6. As a result, no further ecological risk analysis has been undertaken.

Table 3-17. Qualitative Uncertainty Analysis Site 5 - Wood Storage Pile and Site 6 - Wood Burning Area

Key Assumption/ Input Parameter	Selected Value	Potential for: Underestimation	Potential for: Overestimation	Comments
A. Human Behavior				
Future receptors' exposure duration	30 years	Medium	Medium	National upper-bound time (90th percentile) at one residence
Future receptors' exposure frequency	350 days/year	Medium	Medium	High-end value
Future receptors' exposure time	24 hours/day	Low	High	Maximum possible value
Future receptors' foodchain ingestion rates	NA	Low	High	Nearly impossible for an average weight receptor to ingest daily the 95th percentile U.S. population consumption amounts
Exclusion of certain exposure pathways in the quantitative analysis	NA	Low	Low	Pathways eliminated are those that have low possibility of contributing risk to these receptors
B. Chemical Fate/Transport in the Environment				
Calculation of exposure point concentration of COC/foodchain modeling	NA	Low	High	Conservative assumptions and input parameters
Use of air dispersion modeling to predict air concentrations	NA	Low	High	Conservative assumptions and input parameters

Table 3-17. Qualitative Uncertainty Analysis Site 5 - Wood Storage Pile and Site 6 - Wood Burning Area (continued)

Key Assumption/ Input Parameter	Selected Value	Potential for: Underestimation	Potential for: Overestimation	Comments
C. Chemical Toxicity				
Assumption that USEPA reference doses truly represent toxicological thresholds	NA	Low	High	High degree of conservativeness utilized by USEPA in deriving RfDs from toxicological literature
Assumption that USEPA carcinogenic slope factors truly represent dose-response phenomena	NA	Low-moderate	Moderate-high	Use of linearized, multi-stage mathematical model to predict cancer incidence at low exposure levels is USEPA policy; not currently supported by scientific data
Assumption of risk/hazard additivity	NA	Moderate	Moderate	Summation of chemical-specific risks/hazards may over- or under-predict risks/hazards to receptors
Screening out of certain contaminants based on USEPA criteria	NA	Low	Low	Only chemicals present in concentrations less than Region IX criteria eliminated

4.0 CONCLUSIONS AND RECOMMENDATIONS

Based on this analysis, the two sites addressed within this memorandum (Sites 5 and 6) have been recommended for No Further Action under the RI/FS being conducted at JPG. This section summarizes the rationale for this decision.

Surface soil sample results from the Wood-Storage Pile (Site 5) and Wood-Burning Area (Site 6) indicate that SVOCs and dioxins/furans are present. A review of the dioxins/furans against background concentrations indicates that these contaminants are consistent with anthropogenic levels and may represent background contamination rather than site-related contamination. The SVOCs are at low concentrations, below their respective USEPA Region IX PRGs. Only dioxins/furans were retained as COPCs in site soils for the human health risk assessment. In addition, COPCs from other sites at this facility were evaluated.

The results of the human health risk assessment indicate that no risks or hazards for the future on-site worker exceed the USEPA risk management criteria. Additionally, no risks or hazards to the hypothetical future resident exceed risk management criteria. During the Phase I RI, it was determined that there were no ecological risks associated with Sites 5 and 6.

Based on the human health and ecological risk assessment results, a No Further Action decision is appropriate for both sites summarized in this memorandum. This technical memorandum supports a decision to remove Sites 5 and 6 from the RI/FS at JPG.

Appendix C2

Section 5.1.4.4.4 Adequacy of Analytical Methods and Quantitation Limits and Section 5.1.4.5.5 Screening with Region IX Preliminary Remediation Goals (Taken From Draft Phase II Remedial Investigation, August 1998 RUST)

A complete review of the Phase II sample documentation was conducted by EcoChem prior to this assessment. Their conclusions on the data set are provided in the risk assessment for each site and in Appendix P.

5.1.4.4.3 ***Completeness and Relevance of Data Sources.*** The Phase I and Phase II RI comprise the databases for quantitative use in this health risk assessment. Below are specific instances where either Phase I or Phase II data were not incorporated:

- Due to data quality issues with some SVOC compounds in the Phase I data, resampling was conducted for these analytes at specific sites at JPG. In these instances, the Phase II soil data for the problematic SVOC compounds were substituted for previous Phase I data.

- At some sites (e.g., the Red Lead Disposal Area) remediation activities have occurred and portions of these sites are considered closed. Data from the remediated areas were not considered in the site-specific risk assessments.

- Phase I groundwater data were not used in the risk assessment

EcoChem completed a review of the Phase I data for completeness and representativeness (Appendix P). Their evaluation determined that volatile organics, pesticides, explosives, semivolatiile organics, and metals were all analyzed using a broad spectrum analysis, which included the USEPA's target analyte list and organic chemicals pertinent to military installations. Field screening procedures were used as a guide in selecting sampling locations.

5.1.4.4.4 ***Adequacy of Analytical Methods and Quantitation limits.*** Appropriate analytical methods are those that have detection limits that meet risk assessment requirements for COPCs and have sufficient QC measures to quantitate chemical identification and measurement. Appropriate analytical methods also minimize the probability of false negative results; that is, non-detection of an analyte when it truly is present at potentially significant concentrations.

All Phase I samples were analyzed using USAEC-certified methods or USEPA methods. Only USEPA methods were used to conduct the Phase II Analyses. An analytical problem was identified during the initial Phase I DQA with the USAEC SVOC methods (LM25, soil; UM25, water). The potential existed for some analyte concentrations above the CRL to go undetected. To address this data gap, sites previously sampled for SVOCs were resampled in the Phase II investigation, and the samples were analyzed for SVOCs using USEPA SW846 methods.

All analytical data used quantitatively in the risk assessment have undergone a Modified USEPA Level III validation effort. An additional 20 percent have undergone an extensive EPA Level IV/V validation. USEPA data qualifiers assigned during this process were incorporated into the electronic database and used to assess the level of certainty/uncertainty of the analytical results in the risk assessment on a site-by-site basis.

A comparison of Region V DQLs was also made in the risk assessment to all project CRLs/MDLs for those chemicals that were analyzed for but not detected in various environmental media. This comparison was made to detennine if any chemical of potential concern may have been missed due to an elevated analytical reporting limit. These DQLs are derived exclusively from the Region IX Preliminary Remediation Goals and are health based (USEPA 1995b; 1996c). Since DQL values are provided for soil and groundwater, but not surface water and sediment, surface water CRLs/MDLs were compared to drinking water DQLs, and sediment CRLs/MDLs were compared to soil DQLs. A discussion is provided in each site-specific risk assessment for this evaluation.

To determine if an elevated non-detect value for a given chemical warranted discussion in the site-specific risk assessments, three main criteria were used. First, the elevated non-detect value had to substantially exceed the DQL. Second, for locations/wells that had multiple sampling events, the elevated non-detect value(s) did not warrant discussion if at least half of the other events exhibited an acceptable CRL. Third, for sites with multiple sampled locations/wells, the elevated non-detect value(s) did not warrant discussion if at least half of the other sampled locations/wells exhibited an acceptable CRL. Other criteria were also used, such as the relative likelihood for any given chemical type to be found at the site or location/well.

5.1.4.4.5 ***Quality and Completeness of Data Validation.*** An initial DQA was performed by EcoChem on approximately 10 percent of the Phase I analytical data. The assessment followed USAEC's PAM-11-41 (USATHAMA 1990) and USEPA's Functional Guidelines (USEPA 1988a; USEPA 1988b; USEPA 1991b) as described previously in Section 3.4.2. Results of this analysis were used to help determine data quality issues and data gaps, which were subsequently addressed in the Phase II RI,

In addition to this initial DQA, 100 percent of the analytical data (Phase I and Phase II) has undergone a Modified Level III validation effort by EcoChem using a Data Quality Screening Tool (DQST) or equivalent manual screening method as previously described in Section 3.4.2.

This DQST identifies “critical lots” (i.e., lots with 5 percent or more of the QC points outside of the acceptance criteria). Since the presence of these outliers indicates that some external event (e.g., matrix interferences, poor analytical technique, etc.) has affected the data quality, these critical lots undergo an in-depth USEPA Level IV/V validation effort performed by EcoChem. EcoChem then assigns USEPA data qualifiers, which were incorporated into the electronic database for use in the risk assessment. A detailed description of the DQA and flowchart illustrating the DQST process is included in the JPG Facility-Wide QA Project Plan (Rust 1996b).

Additional components of the data review for the risk assessment are described below.

Table 5-8. Nutrient Screening Values

Nutrient	RDA[a] (mg/kg-d)[b]	Nutrient Screening Value (ppm)	
		Soil	Groundwater
Calcium	14	1,000,000	510
Magnesium	5.7	1,000,000	200
Iron	0.26	70,000	9.4
Potassium	0.57	150,000	20
Sodium	20[c]	1,000,000	730

[a]U.S. recommended daily allowance (USEPA 1994b).
[b]Milligrams per kilogram per day.
[c]See text.

5.1.4.5.5 ***Screening with Region IX Preliminary Remediation Goals.*** For each site-specific risk assessment, a table of summary statistics for each medium and data grouping is provided that describes the preliminary COPCs at each area of concern (i.e., those chemicals judged to be contaminants at each site). These tables include frequency of detection, range ofdetections, range of CRLs, arithmetic mean concentration, the 95 percent upper confidence limit (UCL) of the mean, and the selected exposure point concentration (EPC) for each preliminary COPC.

Preliminary COPCs for sediment, surface water, groundwater, and site soil data sets were then screened by comparing their exposure point concentrations to EPA Region IX preliminary remediation goals (PRG) to obtain the final list of COPCs for each site (USEPA 1996c).

Soil

Before the final screening step of each site's soil databases was conducted, an analysis was undertaken to determine if hot spots of contamination in soil exist, which would warrant a separate evaluation. The process involved reviewing contaminant distribution across the site, the distance separating the various sample locations, and the size of the site with respect to a hypothetical 0.5-acre residential lot. The rationale underlying the hot spot analysis is described in detail for each site.

As mentioned in Section 5.1.4.3.1, two data sets for soil were evaluated separately: (1) data for organic chemicals and inorganic chemicals detected in surface soil above background or above nutrient levels and (2) surface soil data combined with subsurface soil data (down to 10 feet bgs) for all organic chemicals and inorganic chemicals detected above background or above nutrient levels. This approach for soil data was used to accommodate the exposure scenarios selected in the conceptual site models (presented in Section 5.1.4.6).

A soil EPC was calculated for each soil data grouping at each site. This exposure point concentration was the maximum detected value or the 95 % UCL of the mean, whichever was lower, for each contaminant (USEPA 1989b). One-half of the CRL was used for nondetects.in this analysis. Each chemical-specific EPC was then compared to the appropriate Region IX residential soil PRG. These PRGs assume the following exposure pathways: ingestion, inhalation of particulates, inhalation of volatiles, and dermal absorption. One-tenth of the value was used for most noncarcinogens. The exceptions were lead and organic chemicals for which the PRG is based on saturation limits or maximum limits; for these chemicals the full PRG was used. The 1 x 10^{-6} PRGs were used for carcinogens. If the EPC exceeded the PRG, the chemical was retained and carried through the risk assessment as a COPC for soil. At the request of USEPA Region V, all chemicals at each site that were screened out in this analysis are presented in an appendix (Appendix X), along with an order-of-magnitude estimate of their collective potential health risks. The order-of-magnitude cancer risk and noncancer hazard estimates for these eliminated chemicals were calculated as follows, as described in the Region IX guidance (USEPA 199c) (the full PRG was used for noncarcinogens for this calculation). The order-of-magnitude noncancer hazard index estimates do not include chemicals with PRGs based on saturation limits or maximum limits.

$$\textit{Order -of Magnitude Cancer Risk} = \left[\left(\frac{EPC_x}{PRG_x}\right) + \left(\frac{EPC_y}{PRG_y}\right) + \left(\frac{EPC_z}{PRG_z}\right)\right] \times 10^{-6} \qquad \text{(Equation 5-1)}$$

$$\textit{Order-of Magnitude Hazard Index} = \left[\left(\frac{EPC_x}{PRG_x}\right) + \left(\frac{EPC_y}{PRG_y}\right) + \left(\frac{EPC_z}{PRG_z}\right)\right] \qquad \text{(Equation 5-2)}$$

Air

For all chemicals in soil that were carried through the risk assessment (i.e., those that exceeded the soil PRG), air concentrations were modeled, if appropriate for the site, as described in Appendix R. The modeled air concentrations were compared to the Region IX ambient air PRGs (USEPA 1996c). One-tenth of the value was used for noncarcinogens. If the modeled air concentration exceeded the PRG, the chemical was retained and carried through the risk assessment as a COPC in air. All chemicals at a site that did not exceed the PRG are presented in Appendix X. The order-of-magnitude cancer risk and noncancer hazard for these eliminated chemicals were calculated as described above for soil COPCs.

Groundwater

An on-site groundwater EPC was calculated for each preliminary COPC at each site, as described above for soil. Each chemical-specific EPC was compared to the appropriate Region IX tap water PRG (USEPA 1996c). These PRGs assume the following exposure pathways: ingestion from drinking and inhalation of volatiles. One-tenth of the value was used for

Appendix C3

Exposure Point Concentrations – Section 5.1.5.2.1 Outdoor Air

5.1.5.1 *Environmental Fate Analysis*

Groundwater transport modeling of site contaminants to off-site receptor points and air dispersion modeling of site contaminants on- and off-site were conducted for the risk assessment since some of the receptor populations (e.g., off-facility residents) are located distant from the JPG sites.

5.1.5.1.1 ***Air Emission/Dispersion Modeling.*** The volatilization of VOCs from soil into ambient (outdoor) air and the dispersion of fugitive dusts (metals, SVOCs, and explosives) are potential complete exposure pathways for current off-facility residents, current on facility tenant employees/residents and trespassers, and for future off-facility residents, on-site residents, hunters, and workers. Details of the air emissions/dispersion modeling are discussed in Appendix R.

5.1.5.1.2 ***Saturated Zone Transport Modeling.*** For human health risk assessment purposes, groundwater exposure was evaluated under the future land use scenarios. These evaluations were based on potential groundwater usage (such as drinking and/or showering) by nearby off-facility residents who could in the future live downgradient (west-southwest) of JPG and by future on-site receptors (residents and workers addressed under site-specific evaluations). To address the potential for JPG to present risks through the off-facility migration pathway (i.e., as a facility-wide assessment), a conservative screening-level analytical modeling approach was used to predict contaminant transport in groundwater and establish exposure point concentrations distant to the sites. Modeling was used to evaluate the groundwater fate of only those contaminants currently detected in site monitoring wells. Appendix S documents the saturated zone transport modeling methodology.

5.1.5.2 *Exposure Point Concentrations*

The human receptors selected for inclusion in this risk assessment were assumed to be exposed simultaneously to site contaminants from multiple media and through a number of exposure routes. The derivation of the exposure point concentrations of the COPCs in these relevant environmental media at the JPG sites is summarized below. Statistical procedures used to derive the exposure point concentrations (USEPA 1992f; Gilbert 1987) were described previously (Section 5.1.4.1). In general, the 95 percent UCL of the arithmetic mean of sample concentrations within each data set or the highest detected concentration in the data set, whichever was lower, was designated as the media- and chemical-specific exposure point concentration (USEPA 1989b).

5.1.5.2.1 ***Outdoor Air.*** Air dispersion modeling results were used to obtain particulate-bound chemical concentrations, as well as volatile chemical concentrations, in ambient air at each receptor exposure point location, as described in Appendix R.

The maximum cumulative annual average off-facility ambient air concentrations of dust-bound contaminants and VOCs, representing all potential/applicable on-site source areas, was used as the exposure point concentrations with respect to the nearby current (off-facility) residential receptors. The receptor exposure point location was determined by the modeling outputs; that is, the locations of the maximum off-facility air dispersion isopleths for particulates and VOCs. These current residential receptors were assumed to live at the point(s) of maximum off-facility air concentrations where a residence is (or could be) located.

The maximum cumulative annual average on-facility ambient air concentrations of dust-bound contaminants and VOCs in the region of where current tenant resident/employees are located were used as the exposure point concentrations for these current receptors. The receptor exposure point location was determined by the modeling outputs, as grid points closest to the existing inhabited buildings.

The exposure point concentrations for the future on-site workers and future on-site residents were the maximum on-site annual average air concentrations (of dust-bound contaminants and VOCs), based on the combined contribution of all sites to each of the other sites. The receptor exposure point locations were determined by the modeling outputs (i.e., the locations of the maximum site specific air dispersion isopleths for particulates and VOCs). These future on site receptors were assumed to live or work at the points of maximum on-site air concentrations where a residence or industry could be located at each site.

Facility-wide Concentrations

The term "facility-wide" refers to the entire facility south of the Firing Line. For estimating facility-wide exposure of the current trespasser and the future hunter to contaminants in ambient air, the on-site annual average air concentrations (of dust-bound contaminants and VOCs) were averaged over the entire facility south of the Firing Line (see Appendix R).

5.1.5.2.2 ***Surface Soil.*** The surface soil data (0 to 2 feet bgs) for surface soil COPCs were grouped on a site-specific basis. Further sub-grouping of the data was based on the nature and extent of contamination (i.e., hot spots). The 95 percent UCL of the arithmetic mean of the concentration for each analyte in each final data grouping or its highest detected concentration, whichever was lower, was used as the site-specific surface soil exposure concentration for the future on-site worker or as the input concentration for estimating soil uptake by agricultural crops. (The soil exposure point concentrations for the future on-site resident are discussed in Section 5.1.5.2.3.)

APPENDIX D

RESPONSES TO USEPA AND IDEM COMMENTS

RESPONSE TO

USEPA TECHNICAL REVIEW OF
DECISION DOCUMENT ADDENDUM
NO FURTHER ACTION SITES 5 AND 6
(RECEIVED JANUARY 19, 2001)
JEFFERSON PROVING GROUND
MADISON, INDIANA

The Decision Document Addendum, No Further Action - Sites 5 and 6, dated October 2000 (Decision Document Addendum) was submitted to U.S. EPA to support a No Further Action (NFA) proposal for future residential use at Sites 5 and 6. A March 1999 Final Decision Document was previously submitted by the Army and its contractor to support an NFA determination for future industrial use. The Decision Document Addendum and Technical Memorandum for No Further Remedial Action Is Planned at Sites 5 and 6 (NFRAP Tech Memo) were both reviewed to determine if the information provided supports the NFA proposal for a future residential use scenario.

Decision Document Addendum

1. **Section 2.0, Site Descriptions:** This paragraph states that *"because the concrete near the sites is in good condition, migration vertically through the concrete to the soils beneath the concrete would not be expected. . . ."* During U.S. EPA's most recent visit to the concrete runway at the Old Airfield, we observed that the condition of the concrete runway at the Old Airfield is in very bad condition. The concrete runway has weathered into loose gravel and rebars are sticking up all over the place. Please make a note of this poor concrete condition in the Decision Document Addendum.

   Response: Comment will be incorporated as requested.

NFRAP Tech Memo

1. **Section 3.6.2.2.1, Summary of Preliminary COPCs, Page 3-28:** It is not agreed that lawns will eliminate volatile organic compound (VOC) extrusion from subsurface impacts nor is it agreed that lawns will eliminate wind suspension of contaminants entrained on dust particles. While the presence of a lawn is likely to have little influence on VOC emissions from the subsurface, this issue is irrelevant based on the fact that no VOCs have been identified as COPCs at these sites (although it is noted that no subsurface soil samples were collected at Sites 5 and 6). Particulate emissions from Sites 5 and 6, however, are worthy of consideration. Vegetation such as residential lawns will lower potential particulate suspension, however it will not preclude it. Revise the Decision Document Addendum to address the inhalation of particulates from Sites 5 and 6 for residents and industrial worker exposures.

Response: It should be noted that in the past, USEPA has not commented on this issue to our knowledge. IDEM has commented on this issue to RUST and it was resolved by RUST with the following comment response:

"Although we agree with the commentator that flower gardens, small construction projects, etc., would generate some dust on occasion, the activities typically involve small areas and short time periods. The flower and vegetable gardens are generally kept damp through watering, which minimizes dust emissions. The amount of dust generated annually is therefore expected to be relatively small compared to that generated from the larger agricultural areas, which were modeled for the residential scenarios. The discussion of this issue will be expanded in the site conceptual model." The IDEM said that this response was acceptable.

It would be suggested that this information be incorporated into the revised Decision Document. In addition, the Decision Document Addendum could be revised to address the inhalation of particulates from Sites 5 and. 6 for residential exposure quantitatively, but this does not seem warranted if more supporting information is provided describing why the particulate exposure pathway would not be significant.

It should be noted that in the risk assessment conducted for Sites 5 and 6, inhalation of particulates were evaluated for the industrial worker exposure scenario. If it is still considered mandatory that inhalation risk be quantified, we could use the modeled air results from the industrial scenario, if applicable, along with residential exposure assumptions to evaluate whether chemicals detected at Sites 5 and 6 would pose a inhalation exposure concern. If the modeled air results for the industrial worker scenario do not appear applicable, then the default particulate emission factor (PEF) in Risk Assessment Guidance for Superfund (RAGS) Part B could be used to evaluate wind erosion from residential sites.

2. **Section 3.6.3.1, Site Conceptual Model, Pages 3-28 through 3-31:** Although the risk assessment addresses current exposures in a cursory fashion in this section, it is not clear whether any potential populations currently have access to Sites 5 and 6 (e.g., maintenance or security personnel, trespassers). An assessment of receptors such as these, associated with exposures to multiple sites, is not presented within this risk assessment. Trespasser exposures should be addressed based on access to Sites 5 and 6. Alternatively, the risk assessment could state and demonstrate the position that risk or hazard attributable to future potential receptor populations will tend to overestimate exposures as compared with those associated with current populations. Therefore, remedial decisions predicated on the basis of potential future contact is expected to be protective of continuing current exposures. In order for this option to be viable, JPG should revise the Decision Document Addendum to demonstrate that contaminant levels indicative of potential acute affects are not present at the site and that remedial decisions will be made within a timely fashion, suitable to the reuse goals.

Response: This comment does not appear to be applicable to the Decision Document Addendum. The Decision Document Addendum is addressing residential exposure, which is considered a more conservative exposure scenario then the other exposure scenarios (i.e., maintenance or security personnel, trespassers) listed above.

Also, to address this comment in the original document, if this is what is being request, we would need further clarification. It is not understood why acute effects would have to be considered. There are not toxicity values available to evaluate acute health effects. This is not normally evaluated in a risk assessment.

It should be noted that Rust did evaluate current trespassers in the risk assessment. The risk assessment for current facility-wide trespassers is found in Section 28 of the RI. These trespassers were assumed to have access to all of the facility, so a facility-wide exposure point concentration was calculated for each site-specific COPC in surface soil. All surface soil COPCs were eliminated in the soil PRG screen. The trespassers were also assumed to be exposed to particulate and VOC emissions from all of the sites, as well as to surface water and sediment at several surface water bodies. The total cancer risk to this receptor was 2.2E-06 and the total HI was 0.1.

3. **Section 3.6.3.1, Conceptual Site Model, Page 3-31:** Both residential and industrial receptor contact should consider inhalation of particulate emissions from Sites 5 and 6 and should not limit this route of exposure to other site areas. Residents will be engaged in home maintenance and play, and industrial workers could be involved with intrusive activities in these areas, all activities based on close contact with soil (dermal exposures are considered). In the absence of consideration of inhalation of dioxin-associated particulate emissions, the risk assessment may be considered incomplete. Revise the Decision Document Addendum to consider inhalation of particulate emissions from Sites 5 and 6 in the assessment of receptors contact.

   Response: See response to No. 1.

TECHNICAL REVIEW OF
DECISION DOCUMENT ADDENDUM - APPENDIX C (RISK ASSESSMENT)
NO FURTHER ACTION SITES 5 AND 6

JEFFERSON PROVING GROUND
MADISON, INDIANA

The Decision Document Addendum, No Further Action - Sites 5 and 6 (Decision Document Addendum) was submitted to U.S. EPA to support a No Further Action (NFA) proposal for future residential use at Sites 5 and 6. A March 1999 Final Decision Document was previously submitted to support an NFA determination for future industrial use. Appendix C of the Decision Document Addendum is a Human Health Risk Assessment (Risk Assessment) that Jefferson Proving Ground (JPG) has used to support the proposal for future residential use at Sites 5 and 6. The Risk Assessment was reviewed to determine if the information provided supports the NFA proposal for a future residential use scenario.

GENERAL COMMENTS

1. Where appropriate, JPG should refrain from non-standard risk assessment verbiage. Use of phrasing such as, "calculate actual risks to real people" and "nearly impossible for an average weight receptor" are not appropriate for use in a risk assessment conducted under the auspices of U.S. EPA. The Risk Assessment should be an impartial assessment of risk, free from predetermination, and use of these types of phrases tends to remove the required impartiality. Regarding the first example quote presented above, a risk assessment is designed to provide risk managers with an upper bound estimate on the potential or probability for risks to be incurred by current or future receptor populations. Regarding the second quote, use of the terms "unlikely" or "highly unlikely" are preferred, rather than "nearly impossible". In a third example, the last sentence in the second paragraph of Appendix C, Section 3.6.1 tends to indicate a predetermination of overestimation of risks - this in not appropriate for an introduction. This assessment should be limited to the uncertainty or risk characterization sections. In addition, this sentence should be phrased such that the approach employed tends to indicate that risks are unlikely to be underestimated, rather than a flat statement that the approach ensures that any real risks are overestimated. Revise the Risk Assessment to use impartial language, free from predetermination.

   Response: The language in the original risk assessment will be revised when the document is updated in the future. However, the comment does not appear to have direct bearing on the Decision Document Addendum submitted. The statements used above were not used in developing the Decision Document Addendum.

2. The Risk Assessment fails to address treatment of non-detect results in development of the Contaminants of Potential Concern (COPC) list or for use in development of

exposure point concentrations (EPC). Revise the Risk Assessment to explain how non-detected results were treated in developing these factors.

Response: Section 3.4.1.3 of the NFRAP Tech states that the Contract Reporting Limits (CRLs) (actually the Sample Quantitation Limits (SQLs)) were compared to the USEPA Region V Data Quality Limits (DQLs) for chemicals not detected in environmental media at Sites 5 and 6 and no exceedances of significance were identified. Section 3.6.2.1.5 of the NFRAP Tech Memo describes how COPCs were selected by comparison of the exposure point concentration (either the maximum detected value or the 95% UCL, whichever was lower) to the Region IX PRGs (1/10 of the PRG for noncarcinogens).

Section 5.1.4.5.5 of the RI describes how non-detects (SQLs) were used to calculate 95% UCLs. One-half of the SQL was used for non-detects.

3. The risk assessment fails to address consideration of sample quantitation limits (SQLs) or other quantitation limits in developing a COPC list and in addressing non-detect results. Revise the Risk Assessment to address these considerations.

   Response: See Response to No. 2

4. To the greatest extent possible JPG should strive to present environmental media concentrations in standard risk assessment units. Soil/sediment concentrations should be presented in mg/kg, not ug/g. This eliminates potential for confusion and speeds screening and comparisons to health-based criteria.

   Response: The units in the original risk assessment will be revised when the document is updated in the future. However, the comment does not appear to have direct bearing on the Decision Document Addendum submitted.

SPECIFIC COMMENTS

1. **Section 3.6.2.1.4, Summary of Preliminary COPCs, Page 3-25:** This section and Table 3-6 fail to address potential issues associated with elevated detection limits, or report detection limits themselves and the influences these levels have on development of a COPC list and resultant EPCs. Revise the Risk Assessment to address these issues.

   Response: See response to General Comment No 2 and 3 above.

2. **Section 3.6.2.1.5, Region IX Preliminary Remediation Goal Screening, Page 3-25:** This section indicates that a chemical was only retained as a COPC if its EPC (based on the lower of the maximum detected concentration or the 95% Upper Confidence Limit [UCL]) exceeded its corresponding PRG. In development of a COPC list for

use in a risk assessment conducted under the auspices of U.S. EPA, all contaminants detected at a concentration exceeding the most appropriate health based criteria are identified as site COPCs. Comparison of the EPC to these health-base criteria can be used to further refine the COPC list in terms of which COPCs are recommended for quantitative evaluation in the risk assessment. Revise the Risk Assessment such that all chemicals which exceed the screening criteria remain site COPCs to ensure that these contaminants are not lost within the regulatory review process and ensure that other considerations are met (e.g., potential presence of a hotspot).

Response: USEPA agreed with the use of the Region IX PRGs for screening for COPCs. All chemicals with EPCs that exceeded the PRGs were retained as COPCs.We are not aware of other health-based criteria that would be more appropriate for soils. The process used for screening appears appropriate.

3. **Table 3-8, Pages 3-29 to 3-30:** The text does not explain how these ambient air exposure point concentrations were developed. Revise the Risk Assessment to explain how these concentrations were developed.

   Response: See response to Comment 1 under NFRAP Tech Memo.

4. **Section 3.6.3.3.3, Dermal Contact with Contaminated Soil, Page 3-40:** The value presented by JPG for surface area of an adult worker's skin available for contact with soil is 2,490 cm^2/event. Due to the fact that Appendix C does not present a reference section, this value from U.S. EPA, 1989c cannot be verified. Currently, U.S. EPA uses an estimate of 3,300 cm^2/event for an industrial worker's skin contact area. This value is used in the technical background document for the Region IX PRGs used within the Risk Assessment (Appendix C). This value is based on the average of the 50^{th} percentiles for males and females over the ages of 18 and may be reproduced from Tables 6-2 and 6-3 from the 1997 version of U.S. EPA's Exposure Factors Handbook. Revise the Risk Assessment to use 3,300 cm^2/event for the surface area of an adult worker's skin available for contact with soil.

   The value used to estimate a child's skin contact area appears to overestimate the current value used by U.S. EPA, however this value may be used within the Risk Assessment.

   Response: The exposure factors in the original risk assessment will be revisited when the document is updated in the future. However, the comment does not appear to have direct bearing on the Decision Document Addendum submitted. The comment is on worker exposure assumptions and not residential exposure assumptions.

5. **Table 3-13, Page 3-44:** The text within the Risk Assessment does not effectively address the fact that JPG has adjusted toxicity criteria based on absorption when

employing route to route extrapolation. Adjustments of this type to U.S. EPA promulgated toxicity criteria are not considered correct. JPG should employ strict route to route extrapolation when attempting to use toxicity criteria predicated on one exposure route for use in assessing exposure via a second route. JPG should not make any adjustment based on absorption potential. Uncertainties associated with this methodology should be evaluated within the uncertainty section of the Risk Assessment. This is especially true when extrapolating from the oral to inhalation routes for heavy metals, where considerable uncertainty is associated with potential for these molecules to be absorbed from lung alveoli by the bloodstream. Revise the Risk Assessment to eliminate adjustments base on absorption potential, as discussed above.

Response: This is the first time this issue has been raised. The Work Plan indicated that RUST would extrapolate toxicity values, but did not specify that it would base the extrapolation on relative absorption. Only a few metals are affected, as absorption information was not found for most chemicals. The extrapolation in the original risk assessment will be revisited when the document is updated in the future. However, the comment does not appear to have significant implications for the previously calculated risk estimates.

6. **Section 3.6.5.2, Potential Excess Lifetime Cancer Risks, Page 3-47:** This section indicates that only contaminants contributing risks in excess of 10^{-5} may be considered Contaminants of Concern (COCs) where the total site risk exceeds the upper bound threshold of 10^{-4} as specified in the National Oil and Hazardous. Substances Contingency Plan (NCP). U.S. EPA does not agree with this statement. The intimation here by JPG is that remedial action will only be predicated on the need to address COCs. Total risk estimated for a site with the 10^{-6} to 10^{-4} range may or may not require remedial action or additional investigation. For sites that fall within this risk range, decisions must be made regarding the acceptability of residual risks allowed to remain *in situ.* This determination is predicated on the inherent conservatism or degree of uncertainty associated with the risk assessment. Under its definition of COCs, JPG is attempting to make a predetermination regarding an acceptable level of risk which may be allowed to remain in place.

   Revise Section 3.6.5.2 and Table 3-16 of the Risk Assessment to clearly indicate whether dioxins have contributed to risks in excess of 10^{-5} . This information needs to be clearly presented so that U.S. EPA can adequately assess the risk management decisions proposed by JPG.

   Response: The language in the original risk assessment will be revisited when the document is updated in the future. However, the comment does not appear to have direct bearing on the Decision Document Addendum submitted.

It can be noted that the inhalation risks presented in Table 3-16 for the residents are not related to Sites 5 and 6. The total risk for the adult associated with dioxins in soil is 1.16E-05 and the total risk to the child attributable to dioxins is 1.02E-05.

MWK/LAB
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RESPONSES TO IDEM COMMENTS

DECISION DOCUMENT ADDENDUM
NO FURTHER ACTION SITES 5 AND 6

JEFFERSON PROVING GROUND
MADISON, INDIANA.

As you are no doubt aware, IDEM deferred Risk Assessment specific comments to EPA. So here are the only comments IDEM has on the Sites 5 and 6 Decision Document Addendum for JPG.

Page 2-1, 2.0 Site Descriptions, second paragraph, sentence 6: IDEM staff does not agree with the assessment of the condition of the concrete runways. The condition of the runways has deteriorated greatly over the years of inactivity and lack of adequate or proper maintenance. Also, concrete is not considered as an impervious barrier. This statement should be removed or corrected to indicate that contamination could possibly exist under the concrete. It should also be noted that the concrete itself may contain contamination due to its deteriorated condition which could allow contaminant migration into it.

Response: The condition of the concrete will be corrected. However, when the concrete pad was in use it was likely in much better condition and provided an effective barrier to vertical migration of contamination. The pads were used to store wood or burn wood, and so the residual ash would not be expected to migrate through concrete before being disposed of.

Page 3-2, 3.0 Risk Assessment, second paragraph, sentences 5 and 6: IDEM suggests the Army select some less conservative inputs for the Baseline Risk Assessment and determine what they feel would be more reasonable risk exposure levels. Obviously, the less conservative inputs would need justifications. More simplistically put would be to show us with real numbers rather than imply with unsupported statements.

Response: The statements in the paragraph mentioned were provided to qualitatively put the risks into perspective. The estimated risks are below deminimus values (not considering the dioxin risks that were comparable to background), and so further refinement of the risk characterization by considering more reasonable exposure conditions did not appear necessary.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

REPLY TO THE ATTENTION OF:

SRF-5J

March 28, 2001

Mr. Paul Cloud
U.S. Army Soldier and Biological Chemical Command
ATTN: AMSSB-OET
5183 Blackhawk Road
Aberdeen Proving Ground, MD 21010-5424

Subject: Evaluation of the U.S. Army's February 9, 2001 Responses to U.S. EPA's January 11, 2001 Technical Review Comments for the Decision Document Addendum and Appendix C (Risk Assessment), No Further Action Sites 5 and 6 at Jefferson Proving Ground in Madison, Indiana

Dear Mr. Cloud:

The United States Environmental Protection Agency, Region 5 (U.S. EPA)and its contractor (TechLaw Inc.) has reviewed the U.S. Army's February 9, 2001 Responses to U.S. EPA's Technical Review of the Decision Document Addendum and Appendix C (Risk Assessment), No Further Action Sites 5 and 6 (Dated October 2000), for the Jefferson Proving Ground (JPG) site in Madison, Indiana. For your convenience, this letter is being E-mailed, faxed and mailed to you to expedite your receipt of our comments.

Overall, most of the responses appear to be adequate and do not require that the Army significantly modify the risk assessment. The modifications which have been requested will serve to improve the overall clarity and transparency of the document. Comments related to Section 3.6.2.2.1 and 3.6.3.1 of the No Further Remedial Action Planned (NFRAP) Tech Memo, however, require that the Army incorporate into the risk assessment an assessment of the risk associated with exposure to dioxins/dibenzofurans for the inhalation of particulates. Although this assessment is not expected to change the overall level of risk associated with the site, it will eliminate an important data gap in the risk assessment. Also, please note that U.S. EPA and TechLaw has not provided an evaluation of the Army's response to the Indiana Department of Environmental Management's (IDEM) comments.

Please contact me at (312) 886-6150, if you have any questions about TechLaw's evaluations of the Army's responses.

Sincerely,

Karen L. Mason-Smith

Karen L. Mason-Smith
Remedial Project Manager

Enclosure

cc: M. DeRosa, TechLaw Inc.
K. Herron, IDEM
L. Busse
B. Evens

EVALUATION OF THE U.S. ARMY'S FEBRUARY 9, 2001 RESPONSES TO U.S. EPA'S TECHNICAL REVIEW OF DECISION DOCUMENT ADDENDUM AND APPENDIX C (RISK ASSESSMENT), NO FURTHER ACTION SITES 5 AND 6

JEFFERSON PROVING GROUND
MADISON, INDIANA

Submitted to:

Ms. Karen Mason-Smith
Work Assignment Manager
U.S. Environmental Protection Agency
Region 5 SRF-5J
77 W. Jackson
Chicago, Illinois 60604

Submitted by:

TechLaw, Inc.
20 North Wacker Drive
Suite 1260
Chicago, Illinois 60606

U.S. EPA Work Assignment No.	**05-05ZZ-03**
Contract No.	**68-W6-0063**
U.S. EPA WAM	**Karen Mason-Smith**
Telephone No.	**312/886-6150**
Tech.Law WAM	**Michael DeRosa**
Telephone No.	**312/345-8915**

EVALUATION OF THE U.S. ARMY'S FEBRUARY 9, 2001 RESPONSES TO U.S. EPA'S TECHNICAL REVIEW OF DECISION DOCUMENT ADDENDUM AND APPENDIX C (RISK ASSESSMENT), NO FURTHER ACTION SITES 5 AND 6

JEFFERSON PROVING GROUND
MADISON, INDIANA

Decision Document Addendum

1. **Section 2.0, Site Description:** The response appears to be adequate.

NFRAP Tech Memo

1. **Section 3.6.2.2.1, Summary of Preliminary COPCs, Page 3-28:** The response does not appear to adequately address the comment. The Decision Document Addendum should be revised to address the inhalation of particulates from Sites 5 and 6 for residents and industrial worker exposures for all constituents of potential concern (COPCs) including dioxin/dibenzofurans. With respect to deriving an inhalation exposure point concentration, Jefferson Proving Ground (JPG). must provide sufficient information to adequately support the values used (i.e., the methodology and assumptions used to derive the exposure point concentrations must be clearly stated in the Decision Document Addendum).

2. **Section 3.6.3.1, Site Conceptual Model, Pages 3-28 through 3-31:** The response appears to be adequate.

3. **Section 3.6.3.1, Conceptual Site Model, Page 3-31:** The response does not appear to adequately address the comment. In the presentation of results, it is not clear what risk is attributed to dioxins/dibenzofurans exposure versus metals. The Decision Document Addendum should be revised to address the inhalation of particulates from Sites 5 and 6-for residents and industrial worker exposures for all COPCs including dioxin/dibenzofurans. In addition, JPG must provide sufficient information to adequately support any values used (i.e., the methodology and assumptions used to derive the exposure point concentrations must be clearly stated in the Decision Document Addendum).

APPENDIX C - RISK ASSESSMENT

GENERAL COMMENTS

1. The response appears to be adequate.

2. The response appears to be partially adequate. Through revision of the document, JPG

should state in a transparently clear manner that all sample quantitation limits (SQLs) were sufficiently sensitive to note a contaminant exceedence in comparison to Region IX Preliminary Remediation Goals (PRGs). Further, the document still needs to describe how contaminants which were reported as non-detect in every analysis were treated. Of particular interest is the potential for contaminants reported as non-detect in every sample to be associated with an elevated SQL in comparison to the most relevant PRG. In this case, the contaminant would remain a site COPC and would need to be evaluated qualitatively with regard to potential presence and potential to elicit health effects. This qualitative evaluation can be advanced in the uncertainty section of the document. Possible considerations with regard to presence include documented historical use or storage at the facility or potential breakdown product of a known site-related contaminant. A quantitative evaluation is not necessary for these COPCs (if any).

3. The response appears to be partially adequate. Please see response to General Comment No. 2, above.

4. The response appears to be adequate.

SPECIFIC COMMENTS

1. **Section 3.6.2.1.4, Summary of Preliminary COPCs, Page 3-25:** Please see the response to General Comment No. 2, above.

2. **Section 3.6.2.1.5, Region IX Preliminary Remediation Goal Screening, Page 3-25:** The response appears to be partially adequate. Although chemical constituents with exposure point concentrations (EPCs) that exceed the PRG may be excluded from further evaluation in risk calculations, constituents detected at concentrations that exceed the PRG in any single sample and those that were undetected, but the SQL exceeded the PRG, should be retained on the list of COPCs.

3. **Table 3-8, Pages 3-29 to 3-30:** The response appears to be partially adequate. A discussion on how ambient air exposure point concentrations were developed should be included for completeness.

4. **Section 3.6.3.3.3, Dermal Contact with Contaminated Soil, Page 3-40:** The response appears adequate.

5. **Table 3-13, Page 3-44:** The response appears adequate.

6. **Section 3.6.5.2, Potential Excess Lifetime Cancer Risks, Page 3-47:** The response appears adequate.

RESPONSE TO

USEPA EVALUATION OF THE ARMY'S RESPONSE TO TECHNICAL REVIEW OF DECISION DOCUMENT ADDENDUM NO FURTHER ACTION SITES 5 AND 6
(RECEIVED MARCH, 2001)
JEFFERSON PROVING GROUND
MADISON, INDIANA

Inhalation Risk Evaluation for Sites 5 and 6

Montgomery Watson was tasked with calculating the risk associated with the soil inhalation exposure pathway at Sites 5 and 6. Based on the screening against USEPA Region 9 residential preliminary remediation goals (PRGs) for soil that was included in the human health risk assessment for Sites 5 and 6, the only contaminant that was retained as a chemical of potential concern (COPC) in soil was 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD). Consequently, potential risk associated with inhalation of soil containing TCDD was calculated.

The following equations were used to calculate exposure to 2,3,7,8-TCDD due to inhalation of contaminated soil:

$$(1)\quad \text{Inhalation Dose (mg/kg-day)} = \frac{CAA \times IR_A \times ET \times EF \times ED}{BW \times AT}$$

Where:

CAA = Contaminant level in air (mg/m^3)
IRA = Inhalation rate (m^3/hour)
ET = Exposure Time (hours/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time (days)

$$(2)\quad CAA = (\text{Contaminant level in soil}) \times 1/PEF$$

Where:

PEF = Particulate emission factor (m^3/kg)

CAA was calculated using the maximum detected level of 2,3,7,8-TCDD (3.24×10^{-5} ug/g) at Sites 5 and 6 as stated in Table 3-7 of the human health risk assessment. The default value for the PEF (1.32×10^{9} m^3/kg) was taken from the USEPA Soil Screening Guidance. All other exposure parameter values were taken from the human health risk assessment.

Inhalation doses of 2,3,7,8-TCDD were calculated for adult and child receptors. The calculated doses are 2.07×10^{-15} mg/kg-day for adults and 1.56×10^{-15} mg/kg-day for children. Refer to Table 1 for a summary of these calculations.

Excess lifetime cancer risk associated with these exposures was calculated using the following formula:

$$\text{Excess Lifetime Cancer Risk} = D \times SF$$

Where:

D = Pathway-specific exposure dose (mg/kg-day)
SF = Chemical-specific slope factor (1/mg/kg-day)

A slope factor for 2,3,7,8-TCDD was not available in USEPA's Integrated Risk Information System (IRIS). Consequently, a slope factor of 1.5×10^{5} from the Health Effects Assessment Summary Tables (HEAST) as listed on the USEPA Region 9 web page was utilized to calculate risk.

The following excess lifetime cancer risks were calculated:

Adults	3.10×10^{-10}
Children	2.34×10^{-10}

These risk levels are well below the *de minimis* cancer risk of 1×10^{-6}, and this does not change the conclusion of the decision document.

Table 1 - Risk Associated with Soil Inhalation Exposure Pathway for 2,3,7,8-TCDD										
Receptor	**CAA**	**IR_A**	**ET**	**EF**	**ED**	**BW**	**AT**	**Inhalation Dose (mg/kg-day)**	**Slope Factor**	**Excess Lifetime Cancer Risk**
Adult	2.45E-14	0.83	24	252	30	70	25550	2.07E-15	1.5E+05	3.10E-10
Child	2.45E-14	0.67	24	252	6	15	25550	1.56E-15	1.5E+05	2.34E-10
Legend										
CAA = Contaminant level in air (mg/m^3)										
IR_A = Inhalation rate (m^3/hour)										
ET = Exposure time (hours/day)										
EF = Exposure frequency (days/year)										
ED = Exposure duration (years)										
BW = Body weight (kg)										
AT = Averaging time (days)										
Notes										
CAA = (Contaminant level in soil) x 1/PEF										
Contaminant level in soil = Soil exposure point concentration (EPC) = 3.24×10^{-5} ug/g										
(value from Table 3-7 in Appendix C of Decision Document Addendum)										
Particulate emission factor (PEF) = 1.32×10^9 m^3/kg										
(default value from USEPA Soil Screening Guidance: Technical Background Document EPA/540/R95/128)										
Parameters IR_A, ET, EF, ED, BW, and AT are values used in Appendix C of Decision Document Addendum										
Slope factor is HEAST value as listed on USEPA Region 9 web page (no slope factor available in IRIS)										
JCF/MWK										
WAD1 -SERVER1\Main\jobs\1351\200\04\JPG TCDD Inhalation Risk.xls										
1351200.040102										

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

REPLY TO THE ATTENTION OF

SRF-5J

June 19, 2001

Mr. Paul Cloud (ATTN: AMSSB-OET)
U.S. Army Soldier and Biological Chemical Command
5183 Blackhawk Road
Aberdeen Proving Ground, MD 21010-5424

Subject: Evaluation of the U.S. Army's Dioxin/Furan Risk Assessment Calculations for the Decision Document Addendum and Appendix C (Risk Assessment), No Further Action at Sites 5 and 6; Jefferson Proving Ground; Madison, Indiana

Dear Mr. Cloud:

The United States Environmental Protection Agency Region 5 (U.S. EPA) has reviewed the *U.S. Army's (Army) Dioxin/Furan Risk Assessment Calculations for the Decision Document Addendum and Appendix C (Risk Assessment), No Further Action at Sites 5 and 6 for the Jefferson Proving Ground (JPG) site in Madison, Indiana, dated May 2001*. This letter documents our evaluation of the subject Decision Document.

U.S. EPA and its technical consultant (TechLaw Inc.) reviewed the subject document based on U.S. EPA's original comments dated March 28, 2001. Our review indicates that the Army's dioxin/furan risk assessment calculations provide an adequate response to General Comment No. 1 from U.S. EPA's March 28, 2001 comments. As indicated in that comment letter, the issue identified in General Comment No. 1 appeared to be the most significant of the issues presented in that review. However, our March 28, 2001 comment letter also identified less significant issues relating to: the Army's procedures for addressing sample quantitation limits (SQLs); the selection process for chemicals of potential concern (COPCs); and, the need to provide a better description regarding the development of ambient air exposure point concentrations. These issues, which were presented in General Comment Nos. 2 and 3, as well as Specific Comment Nos. 1, 2 and 3 of U.S. EPA's March 28, 2001 letter, have not been addressed by the Army.

During the April 25, 2001 JPG Base Realignment and Closure Team (BCT) meeting held at JPG, Indiana, U.S. EPA provided an oral concurrence with the Army technical consultant's (Montgomery Watson) dioxin/furan risk assessment calculations and requested that Montgomery Watson include those calculations into the subject Decision Document via the appendix. U.S.

EPA's comments are as follows:

1. The Army's dioxin/furan risk assessment calculations appear to provide an adequate response to General Comment No. 1 in U.S. EPA's March 28, 2001 review of the Decision Document Addendum and Risk Assessment (Appendix C) for No Further Action (NFA) Sites 5 and 6. As recommended, the dioxin/furan risk assessment calculations have been incorporated into the Decision Document Addendum and/or Risk Assessment via Appendix D. No further response is needed.

2. The Army has still not adequately addressed General Comment Nos. 2 and 3, or Specific Comment Nos. 1, 2 and 3 in U.S. EPA's March 28, 2001 review of the Risk Assessment (Appendix C) for NFA Sites 5 and 6. It is recommended that the information requested in these comments be incorporated into the Risk Assessment. Alternatively, an appendix should be added to the Decision Document Addendum to present this information.

3. U.S. EPA recommends that the Army replace the electronic version of our March 28, 2001 comment letter (see Appendix D) with the signed hard copy version that has U.S. EPA's letterhead on it.

Please call me at (312) 886-6150, if you have any questions or need additional information regarding our comments.

Sincerely,

Karen L. Mason-Smith

Karen L. Mason-Smith
Remedial Project Manager
Superfund Division

cc: M. DeRosa, TechLaw Inc.
K. Herron, IDEM
B. Evens, ACOE-Louisville
L. Busse, Montgomery Watson

RESPONSE TO

**USEPA JUNE 19, 2001 EVALUATION OF
THE U.S. ARMY'S DIOXIN/FURAN RISK ASSESSMENT CALCULATIONS FOR
DECISION DOCUMENT ADDENDUM AND APPENDIX C (RISK ASSESSMENT),
NO FURTHER ACTION SITES 5 AND 6
JEFFERSON PROVING GROUND
MADISON, INDIANA**

EPA's Comments

1. The Army's dioxin/furan risk assessment calculations appear to provide an adequate response to General Comment No. 1 in U.S. EPA's March 28, 2001 review of the Decision Document Addendum and Risk Assessment (Appendix C) for the No Further Action (NFA) Sites 5 and 6. As recommended, the dioxin/furan risk assessment calculations have been incorporated into the Decision Document Addendum and/or Risk Assessment via Appendix D. No further response is needed.

   Response: Comment noted.

2. The Army has still not adequately addressed General Comment Nos. 2 and 3, or Specific Comment Nos. 1, 2 and 3 in U.S. EPA's March 28, 2001 review of the Risk Assessment (Appendix C) for NFA Sites 5 and 6. It is recommended that the information requested in these comments be incorporated into the Risk Assessment. Alternatively, an appendix should be added to the Decision Document Addendum to present the information.

   Response: The backup requested for all comments noted above (with the exception of Specific Comment 2) have been addressed by adding specific subappendices (see below) to appendix C for the specific sections of the risk assessment that cover these issues.

   General Comment No. 2 – See Subappendix C2
   General Comment No. 3 – See Subappendix C2
   Specific Comment No. 1 – See Subappendix C2
   Specific Comment No. 3 – See Subappendix C3

   Subappendix C2 consists of a copy of Sections 5.1.4.4.4 and 5.1.4.5.5 from the Draft Phase II Remedial Investigation (RI). Subappendix C3 consists of a copy of Section 5.1.5.2.1 from the Draft Phase II RI.

   Regarding specific comment 2: in a review of the development of the exposure point concentrations (EPCs) it was determined that for those compounds detected in soil the maximum concentrations were used to represent the EPC. For this reason, the selection of chemicals of potential concern (COPCs) was conservative in nature and complied with the conditions stated in the comment that a chemical should be retained

as a COPC if its concentration in any sample exceeds the Preliminary Remediation Goal (PRG).

3. U.S. EPA recommends that the Army replace the electronic version of our March 28, 2001 comment letter (see Appendix D) with the signed hard copy version that has U.S. EPA's letterhead on it.

Response: The electronic version has been replaced with the original hard copy as requested.

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