



START

Confederated Tribes and Bands
of the Yakima Indian Nation

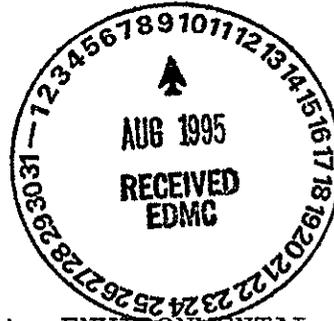
9513360.1869 0041777 018628

Established by the
Treaty of June 9, 1855

July 27, 1995

Mr. Thomas P. Grumbly, Assistant Secretary
Environmental Management Program
Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585

Mr. John Wagoner, Manager
Richland Field Office
Department of Energy
P.O. Box 550 A7-50
Richland, WA 99352



Dear Mr. Grumbly and Mr. Wagoner:

Subject: HANFORD REMEDIAL ACTION (HRA) ENVIRONMENTAL IMPACT STATEMENT (EIS) IMPLEMENTATION PLAN (DOE/RL-93-66); REQUESTED MODIFICATIONS AND ADDITIONS--

The subject DOE/RL document of June 1995, approved by Mr. Grumbly's memorandum of June 9, 1995, is a plan to establish future land-use objectives to provide design bases for the DOE to determine cost-effective, technically-sound remediation strategy for the Hanford Site. Many Yakama Nation letters to DOE have pertained to the scope and alternatives to be considered, as well as the decision process, associated with the subject EIS. One letter to Mr. Grumbly (ATTACHMENT A) is particularly relevant to the subject Implementation Plan.

REQUESTED MODIFICATION AND ADDITIONS--

1. Section 6.0, "Anticipated Environmental Reviews and Consultations," should be expanded to include reference to the Treaty of 1855 between the Yakama Indian Nation and the United States in Table 6-1 under the column "Legislation", with the corresponding agency being the Yakama Nation. The heading of this part of Table 6-1 should be modified to cover "Legislation and Treaties". This comment is consistent with our comment made in our letter of January 20, 1995, see ATTACHMENT B, concerning consultation and cooperation on this EIS and its Record of Decision (ROD) and is requested to resolve the earlier comment.

2. Reference to our letter, ATTACHMENT B, and its attachments should be made in a revised Implementation Plan for the subject EIS. We consider this is necessary to assure entities preparing the EIS are aware of our previous input and use it as a base for preparing alternative evaluations and other sections of the EIS. Appendix C of the subject Implementation Plan, "Proposed Annotated Outline for the Draft Hanford Remedial Action Environmental Impact

Statement" should be expanded to reference bases for each section of the outline, including pertinent Yakama Nation letters and comments. For example, in a manner similar to the way the Hanford Future Site Uses Working Group report is referenced in the outline at Section 3.1, Yakama letters should be referenced at appropriate sections throughout the outline.

We consider the establishment of such bases important in the consultation and cooperation process. Yakama Nation ER/WM staff (F. R. Cook) should be contacted for detailed references to Yakama Nation letters in this regard. We will work with DOE staff and contractors preparing the EIS as part of our cooperative agreement with DOE to assure comprehensive, valid design bases for alternative evaluations and other decision evaluation processes.

We consider such involvement necessary to assure an holistic consideration of alternatives reflecting Yakama Nation cultural values and rights reserved by the Treaty of 1855. This request is consistent with comment 2. of our letter to Mr. Grumbly, ATTACHMENT A.

3. The appropriate consideration of cumulative impacts identified in other NEPA documents, briefly discussed in section 1.3 of the subject Implementation Plan, is extremely important to assure the ROD is considered and not unfounded. To this end we request that the Annotated Outline specifically identify the subsidiary EIS's and Environmental Assessments being considered and the systems management required to accomplish valid evaluations of these impacts.

Our concerns with cumulative long-term impacts, especially those related to Yakama Nation values and rights associated with usage of the land and water (surface and ground) affected by the remediation and waste disposal actions in the vicinity, should be addressed in the Outline. Our comments in ATTACHMENT C, concerning risk assessments, are directly pertinent to the evaluation of these cumulative impacts. This letter is an example of letters that should be referenced as a base in the Annotated Outline. This comment also reflects comment 2. of our letter to Mr. Grumbly, ATTACHMENT A.

4. Implementation of DOE's Indian Policy should be specified in the subject Implementation Plan.

5. The Energy Reorganization Act addresses disposal of high-level radioactive wastes that are subject to the regulation of the Nuclear Regulatory Commission (NRC). This legislation should be specified in Table 6-1 with the NRC being identified as the responsible Agency in the Table.

The NRC is also responsible for the U.S. Ecology Company's low-level radioactive waste facility at Hanford. DOE also owns the land at the Site. Chemical Wastes in the site will likely require remediation. Thus, its environmental impacts should be considered

as part of the cumulative impacts considered in the EIS. The NRC should be considered a cooperating agency with respect to the determination of the cumulative impacts in this regard.

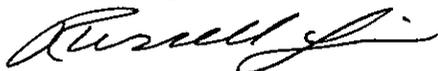
Impacts from the Siemens Fuel Manufacturing plant at Richland, a licensee of the NRC, should also be considered in the EIS. Contamination of the ground water by past operations of the plant has already occurred and adds impacts that should be considered. The remediation of the contaminated ground water, some of which has spread to the DOE lands, should be considered in the EIS. NRC is the cognizant Federal entity that is responsible for NEPA evaluations of these impacts.

5. Table 6-1 does not clearly identify issues associated with ground water. The table should be revised to specifically address ground water under the column "Subject Area".

6. Table 6-1 should be modified to specifically identify "Religious Sites" in the column "Subject Area." Protection of burial grounds should be considered in the scope of the subject EIS. Comment 5A of ATTACHMENT A, our letter to Mr. Grumbly, should be noted in this regard.

7. In Table 6-1 the Subject Area "Siting and Planning" should include the Yakama Nation along with other governmental entities.

Sincerely,



Russell Jim, Manager
Environmental Restoration/Waste Management Program
Yakama Indian Nation

cc: K. Clarke, DOE/RL
L. McClain, DOE/RL
M. Riveland, WA Ecol.
C. Clarke, U.S. EPA Reg. 10
T. O'Toole, DOE/EH
Washington Gov. M. Lowry
U. S. Senator P. Murray
DNFSB
D. Sherwood, EPA, Richland

ATTACHMENTS A, B, AND C

RL Commitment Control

JUL 28 1995

Richland Operations Office



Confederated Tribes and Bands
of the Yakima Indian Nation

Established by the
Treaty of June 9, 1855

December 15, 1994

Mr. Thomas P. Grumbly, Assistant Secretary
Environmental Management Program
Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585

Subject: ENVIRONMENT MANAGEMENT 1995 (2ND DRAFT); COMMENTS ON--

Dear Mr. Grumbly:

Thank you for the opportunity to comment on the Environmental Management's report to Congress for the up-coming year. Our comments are as follows:

1. USE OF EXISTING FACILITIES--In the section on "Environmental Regulations" we consider that the issue of using existing facilities for waste management, including volume reduction, chemical treatment and stabilization, rather than decommissioning the facilities because of regulatory non-compliance should be addressed. For example, the use of the PUREX facility at Hanford for processing various radioactive wastes should be considered because of its potential for saving large sums of money and expediting the tank waste remediation efforts. However, current RCRA regulations would prohibit the use of PUREX for processing, since it does not provide 100% double isolation of hazardous materials. It is recommended that such issues be discussed under the heading of "Waste Management" to alert Congress to the conflict between certain regulatory requirements and cost effective cleanup.

1a. COMPLIANCE AGREEMENTS NOT COST EFFECTIVE--The requirement to meet compliance agreement actions and yet be cost effective may be incompatible objectives. Thus, assumption 1.13 of the "Baseline Environmental Management Report" (BEMR), referenced at page 4 issue Box, should be modified to add the constraint that meeting compliance agreements must be cost effective as well as technically feasible. The legal requirements to be cost effective specified in the Federal Facilities Compliance Act (FFCA) should be noted in this regard in the subject report.

1b. WASTE MANAGEMENT--We note that the Federal Facilities Compliance Act is a primary driver for development of site treatment plans for DOE mixed waste. Such treatment plans must comply with State requirements for treatment and storage of mixed waste. They must also comply with Yakama Nation Treaty Rights. These potentially conflicting requirements should be properly balanced as is suggested above for the implementation of the PUREX facility in ER/WM work.

2. NEPA IMPLEMENTATION--We would propose that the report be modified to add a discussion of efforts to effectively balance all impacts associated with Environmental Management's actions via the NEPA process and to make note of the fact that RCRA and CERCLA decision making process is insufficient when it comes to balancing impacts on cultural and religious values and values associated with Treaty Rights. We consider that these impacts are best addressed under the NEPA process. This perspective should be included in the subject report at the discussion of Environmental Management Programmatic Impact Statement at page 4 in support of the Secretary's initiative this year to fully and effectively implement NEPA.

3. INDIAN POLICY IMPLEMENTATION--A discussion of the establishment of the DOE's Indian Policy should be included in the report. Implementation of the policy should also be reported and problems identified. In particular requirements for "consultation" should be described and emphasis made of the objective of reaching mutually agreeable actions as a result of consultation, thereby assuring issues are resolved, Indian values upheld and rights protected. Effective consultation at Hanford between the Yakama Nation and the DOE have yet to be realized in all areas. Improvement of the interactions with the Tribes should be an objective identified for 1995, with audits planned for evaluating compliance with the Secretary's Indian Policy.

In addition, in the second paragraph at page 5 of the subject report an explanation should be provided for the meaning of "Indian Tribal lands". A description of environmental restoration activities necessary to allow for full exercise of Yakama Nation Treaty rights at Hanford should be provided. In this regard the discussion at page 14 should clarify how the Tri-Party Agreement signed on May 15, 1989 will ensure compliance with Yakama Nation Treaty rights at Hanford.

4. GROUND WATER PROTECTION--On page 15 under the discussion of "Hanford Performance Targets for 1995" it states that,

"Treatment and disposal facilities are scheduled to begin operations in 1995 for some liquid effluent streams in two areas on-site. This will end the discharging of untreated liquids into the ground"

This comment suggests that the ground water will be protected hence forth. However, plans for the treatment facilities require that contaminated water continue to be discharged to the ground water. (Tritiated water is the primary contaminant.) Such injuries to the ground water will continue to exist into the distant future. We consider the continued contamination of the ground water is unsatisfactory. This issue should be reported.

5. PROTECTION OF RELIGIOUS SITES--During 1994 actions were taken to protect Indian burial grounds along the Columbia River north of Richland. The actions involved relocating the site of the Environmental Molecular Science Laboratory (EMSL) to avoid disruption of the burial ground. This significant action to protect the religious site should be noted in the report in connection with the discussion of the EMSL on page 16.

5A. PROTECTION OF BURIAL GROUNDS--At page 15 of the subject report it is noted that Hanford will implement a new environmental restoration strategy to accelerate remediation of ground water sites along the Columbia River. The Yakama Nation agrees with the focus of attention on the Columbia River, however, we have not agreed with the means of remediation that involves potential disruption of burial grounds along the River through the use of sheet metal pilings. The current planning does not employ minimally disruptive technology, such as the cryogenic techniques discussed in comment 7 below.

We request that the discussion at page 15 reflect concerns with protection of religious sites, for example, burial grounds, and commit to acting in consultation with the Yakama Nation to assure that actions affecting potential religious sites are agreed upon by the Yakama Nation.

6. LAND USE PLANNING--At page 15 there is a discussion of the Environmental Restoration Disposal Facility. Currently, the planning for this facility requires institutional controls forever to assure protection of the ground water and future residents using the Site. We consider that this is a significant design shortcoming and may result in significant modification of the opening date of 1996 reported on page 16. The report should identify that the significant issue of land use at Hanford in the time frame 100 years or more in the future and that assumptions about institutional controls in performance assessments are not resolved. We recommend that actions to plan for eventual loss of institutional controls and, hence, unrestricted usage should be addressed in this section. This same issue applies to other areas at Hanford at the 300 area and 200 areas where restricted use scenarios are being assumed to extend into the distant future without consideration of the loss of institutional controls.

7. CRYOGENIC TECHNOLOGY DEVELOPMENT--The discussion on technology development missed discussion of a key development at Oak Ridge and Hanford involving cryogenic barrier developments. The freezing of soils at Oak Ridge with effective isolation of liquid contaminants and application of this technology at Hanford in a trial run scheduled for early next year should be reported. Not only did the freezing operation at Oak Ridge demonstrate the barrier function, it also indicated an added benefit of separating soluble wastes from water during the crystallization process. Both functions can be profitably employed at Hanford and other places. The Yakama

Nation endorses the cryogenic technique because of its low impact to the environment and culturally significant sites, for example, burial grounds along the Columbia River at Hanford.

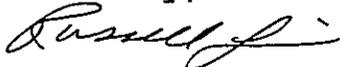
8. PROTECTION OF TREATY RIGHTS--Yakama Nation Treaty rights are affected by DOE mixed waste treatment planning and implementation, because such plans will determine the amount of waste treated on-site, the amount of waste disposed of on-site, the final waste form of treated wastes, as well as, transportation configurations. Each of these decisions will impact Yakama Nation Treaty rights. Therefore, DOE must explain in the "WASTE MANAGEMENT" section of the report how it will ensure that site treatment plans, or in the case of Hanford, the Hanford Federal Facility Agreement and Consent Order, will fully incorporate Yakama Nation rights and otherwise provide for the process necessary for consultation.

DOE should explain whether or not "working closely" with Indian Nations fulfills the requirements of its trust responsibility and the DOE American Indian Policy.

DOE states that environmental regulation compliance accounts for almost 80% of the EM budget request for 1995. However, environmental regulation compliance as stated does not consider environmental cleanup and restoration necessary to comply with Indian Nation Treaty rights. At page 2, "ENVIRONMENTAL REGULATIONS", should explicitly describe planning and process requirements for compliance with Treaties, which are of higher legal status than compliance agreements or agreement milestones.

9. INTEGRATION OF ACTIVITIES--An explanation should be provided for when and how DOE will integrate environmental restoration and decontamination & decommissioning wastes into its mixed waste treatment plans, as well as, incorporation of cost estimates for environmental restoration work in planning and budget documents.

Sincerely,



Russell Jim, Manager
Environmental Restoration/Waste Management Program
Yakama Indian Nation

cc: J. Wagoner, DOE/RL
K. Clarke, DOE/RL
M. Riveland, WA Ecol.
G. Emison, U.S. EPA Reg. 10
T. Grumbly, DOE/EM
T. O'toole, DOE/EH
Washington Gov. M. Lowry
U. S. Senator P. Murray
DNFSB



Confederated Tribes and Bands
of the Yakama Indian Nation

018628
Established by the
Treaty of June 9, 1855

February 6, 1995

Mr. John Wagoner, Manager
Richland Field Office
Department of Energy
P.O. Box 550 A7-50
Richland, WA 99352

Dear Mr. Wagoner:

Subject: HANFORD REMEDIAL ACTION (HRA) DRAFT ENVIRONMENTAL IMPACT STATEMENT (DEIS); COMMENTS ON LETTER FROM DOE/RL (McCLAIN) REGARDING PUBLIC MEETING--

The subject DOE/RL letter of January 19, 1995, received on January 25, 1995, requested comments on a proposed public meeting to hear public comments on the subject DEIS.

As you know, our relationship with the United States is on a government-to-government basis. We consider participation in public meetings as the mode of conducting this relationship is inappropriate. We would hope to have meaningful consultation and cooperation (C&C) on this the key decision (ROD) associated with the subject impact evaluation. In particular, our recent letters regarding the management of waste and recyclable materials created from the remedial actions are pertinent to our concerns and consideration of alternative actions. Also our recent letter regarding the methodology for evaluation of risks at Hanford remaining or created by the remedial actions are pertinent to the scope and content of the subject DEIS.

We recommend that a meeting be scheduled to accomplish the C&C suggested, following our review of the DEIS. We request that four copies be forwarded us to allow this review. The objective of the meeting should be to reach agreement on alternatives to be assessed, including alternatives that do not require restricted uses at remediated areas or waste disposal sites for more than 100 years following the completion of remediation. (Our recent letter regarding the ERDF discusses these criteria in more detail.)

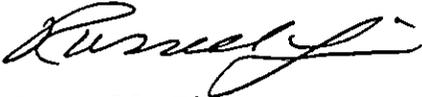
We consider that direct linkage to research and development (R&D) actions to create capabilities to remediate, treat and/or recycle materials should be an integral part of any alternative being considered, when such R&D effort is necessary.

In this regard the DEIS should also be tied to DOE/RL system design efforts, with appropriate design criteria, specification of

cultural values and the necessary validation of design procedures being developed to accomplish impact evaluations and actual remediation actions.

We consider that the first half of April, 1995 should be targeted for the C&C suggested herein. Please contact Mr. Cook of my staff (509-946-0101) for the logistical planning of this meeting.

Sincerely,



Russell Jim, Manager
Environmental Restoration/Waste Management Program
Yakama Indian Nation

cc: K. Clarke, DOE/RL
L. McClain, DOE/RL
M. Riveland, WA Ecol.
C. Clarke, U.S. EPA Reg. 10
T. Grumbly, DOE/EM
T. O'Toole, DOE/EH
Washington Gov. M. Lowry
U. S. Senator P. Murray
DNFSB
D. Sherwood, EPA, Richland

018628

Established by the
Treaty of June 9, 1855Confederated Tribes and Bands
of the Yakima Indian Nation

January 4, 1995

Mr. John Wagoner, Manager
Richland Field Office
Department of Energy
P.O. Box 550 A7-50
Richland, WA 99352

Dear Mr. Wagoner:

Subject: DRAFT HANFORD SITE RISK ASSESSMENT METHODOLOGY (HSRAM);
COMMENTS ON--

This letter provides a review of the Draft Hanford Site Risk Assessment Methodology (HSRAM) document proposed for use during Hanford cleanup activities. The overall objective of this evaluation is to provide recommendations regarding the adequacy of HSRAM in addressing potential impacts to long-term human and ecological health, and cultural and religious resources of the Yakama Nation.

The HSRAM is an important document because it will be used regularly as a tool in the decision process when defining Department of Energy (DOE) remediation and restoration actions at Hanford. Risk calculation procedures and assumptions stipulated in HSRAM will be the basis for soil, air and water cleanup goals and cleanup standards at Hanford. Accordingly, it is imperative that these risks-based cleanup goals and standards be protective of future Yakama Nation cultural and religious uses of impacted lands, since use of the lands and water is expected to occur, consistent with the assurances of the Treaty of 1855, which recognizes a religious culture, including a mode of subsistence that relies on the land, the water and other biological resources.

Impacts on the Yakama Nation cultural and religious values and resources have not been adequately addressed in the current version of the HSRAM document. Since HSRAM is considered to be a living document by DOE, the Yakama Nation has the following recommendations for modification of the document in future revisions:

- 1) *Develop Native American Exposure Scenario*
- 2) *Independently Review Validity of Radionuclide Risk Assessment Assumptions and Procedures*
- 3) *Develop Successive Generation Risk Assessment Procedures*

4) Develop Ecological Evaluation Procedure Based on Background Conditions

5) Develop Pre-1943 Background Soil and Water Cleanup Standard Baseline

6) Perform Objective Re-evaluation of the Qualitative Risk Assessment

The following paragraphs describe the above recommendations in more detail. In addition, specific, detailed comments on the HSRAM listed by page are included as ATTACHMENT A to this letter.

1) Develop Native American Exposure Scenario

There is no specific exposure scenario in the HSRAM which adequately addresses protection of Yakama Nation cultural and religious resources and other future site uses. A Native American exposure scenario must be included in the HSRAM which specifically addresses cultural, religious and unrestricted future site use concerns of the Yakama Nation. The Yakama Nation must approve of the scenario.

On page 31 of the HSRAM document, a "Native American" scenario is discussed as a possibility, but no further information is provided regarding how soon it will be developed, who are the participants in its development, and if the scenario will definitely be incorporated into the HSRAM. There are four exposure scenarios involving a range of activities from industrial to residential property uses that are described in detail in the document, particularly in Appendix A. The Yakama Nation recommends that a Native American exposure scenario be developed and propagated through the risk assessment process in the same level of detail as the four exposure scenarios already present in the document.

The exposure scenario should include all Yakama Nation contamination exposure concerns regarding agricultural, cultural and religious land uses including hunting/fishing, collection of medicinal herbs and native plants, non-Indian farming, unrestricted land use and/or development, aqua culture, and religious uses. Specific exposure routes, pathways and receptors will need to be identified and potential intake rates and related parameter assumptions modified for Yakama Nation citizen activities. This exposure scenario should be the model for any land areas that may be accessed by the Yakama Nation now or in the future. Such access should be assumed for all areas at approximately 130 years hence (100 years past closure of disposal areas or completion of remediation activities.)

2) Review Radionuclide Risk Assessment Procedures

Radiological risk characterization procedures described in the HSRAM may not adequately assess potential human health risks to the Yakama Nation or any future land users. After reviewing the human

health evaluation methodology, the Yakama Nation concludes that a more thorough review of assumptions and justifications of procedures used in assessment of risks from radionuclides is required. Some examples of concerns raised by the HSRAM regarding radionuclide risk assessment include the following:

HSRAM states (p. 28 and 29) that "soil contaminated by photo-emitters (gamma) is the only exposure media that should be routinely evaluated for the external exposure pathway." As partial justification for this approach, the document states that a cover of uncontaminated soils may act as a shield to radiation exposure.

This approach to exposure assessment of radionuclides is not conservative and does not account for unrestrictive site use and actually presumes a corrective action. Standard risk assessment procedures require that exposure risks from soil contaminants be evaluated regardless of depth of occurrence of contamination. The shielding argument also does not address potential leaching and completion of the groundwater exposure pathway.

HSRAM cites (p.42) as appropriate EPA (1989a) risk assessment protocols which exclude acute toxicity of radionuclides from consideration stating that levels of radioactive contaminants are not high enough at superfund sites for them to be a concern.

The Yakama Nation believes that exposure to high level wastes in underground storage tanks at Hanford could be characterized as acutely toxic and that Hanford is not a typical superfund site.

The HSRAM document cites (p. 42) recent references on radioactive toxicity which state that limiting exposure to reduce cancer risks also limits genetically significant exposure. Accordingly, HSRAM stipulates only significant cancer-risk from radioactive components need be considered.

Selection of cancer-risk as the limiting parameter for radioactive exposures avoids assessment of risk due to mutagenic, teratogenic or lifetime shortening effects.

The HSRAM document states (p. 43) that radionuclide slope factors used in the toxicity assessment may be biased and are highly dependent upon the chemical form of the radionuclide. The document also indicates that slope factors are calculated for single default lung class and that non carcinogenic effects for radionuclides need not be addressed unless chemical toxicity is suspected (p. 49).

These statements indicate that there is a high degree of uncertainty in the toxicity assessment of radionuclides. More rigorous scientific justification needs to be provided in the HSRAM document to support the current default assumptions for radionuclide toxicity. The uncertainty analysis in the toxicity assessment and the risk characterization sections should be more quantitative. Error propagation and/or sensitivity analysis to

determine which risk assessment parameters affect overall risk the most is warranted.

Based on these examples, the Yakama Nation recommends third party, independent, scientific review of radionuclide risk characterization procedures and assumptions developed by DOE, the EPA, the National Council on Radiation Protection (NCRP) and the National Research Council (NRC). Members of the review group should include at least two scientific reviewers acceptable to the Yakama Nation.

The validity of these procedures and assumptions must be evaluated with respect to Hanford cleanup issues and the Yakama Nation future site use concerns or concerns developed under the Native American exposure scenario. At a minimum, the Yakama Nation recommends that the documents listed under Radionuclides in ATTACHMENT B be reviewed in more detail by the independent review group.

3) Develop Successive Generation Risk Assessment Procedures

Risk characterization procedures must be developed to estimate health risks beyond lifetime or partial lifetime exposures to the individual. These are the only HSRAM exposure scenarios used in all intake rate calculations. Additive impacts of mixed chemicals or effects to succeeding generations, and overall risks to the population are not addressed.

Overall exposure to the population (or subsets of the population), genetic effects and/or other health effects which may be propagated through several generations must be quantitatively estimated. HSRAM must provide acceptable, scientifically defensible procedures for such calculations. The Yakama Nation recommends that such risks be evaluated quantitatively through statistics including simple multiplicative or additive probability calculations or other cumulative risk probability curve estimation techniques. The Yakama Nation must approve of the calculation procedures developed.

4) Develop Ecological Evaluation Procedures based on Background Contamination

The Yakama Nation considers that an alternate procedure for evaluation of ecological risks be developed which allows comparison of risks to background levels for soil and water contamination.

The HSRAM ecological evaluation methodology is overly complex. Problem formulation and evaluations are susceptible to multiple or conflicting assumptions and/or interpretations. The alternate procedure proposed by the Yakama Nation is one that would use background cleanup standards developed for soil and water contamination. Bio-accumulation of contaminants in biota should be assessed and compared to normal or non-impacted communities. Any impacts above background would require corrective action. The Yakama Nation should concur with the "background" ecological evaluation methodology developed.

5) Develop Pre-1943 Background Soil and Water Cleanup Standards

The Yakama Nation requests that all determinations of background soil and water contamination be based on pre-1943 site conditions and/or conditions that pre-date acquisition of Yakama Nation lands by the federal government. Such conditions should be estimated if data is not available.

Screening of anthropogenic sources of contamination (e.g. radio-nuclides, organic contaminants) against background concentrations is not acceptable, because such contaminants should have been absent from the environment before Hanford operations.

In addition, determination of background concentrations should be based on collection of adequate and representative sample numbers, unbiased sampling locations, all appropriate analytical testing parameters, best available analytical method detection limits, or valid estimates. Industry standard quality assurance and quality control procedures should be invoked for validation of data whether it is estimated or measured. The Yakama Nation must approve of all background concentration estimation procedures developed or implemented by DOE.

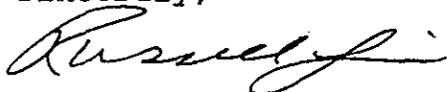
6) Perform Objective Re-evaluation of Qualitative Risk Assessment (QRA)

The QRA is described in HSRAM as a decision tool for implementation of interim remedial measures (IRM) on operable units where there is insufficient data to conduct a full risk assessment. While the HSRAM stipulates that the QRA is not to be used as a substitute for a full risk assessment, the Yakama Nation is concerned that once an IRM is implemented, an independent and objective full risk assessment of cleanup alternatives may not be performed.

Accordingly, the Yakama Nation requests that an objective review be conducted by an unbiased third party of any subsequent full risk assessments prepared for an IRM site. In addition, specific time-frames for reevaluation of the QRA should be stipulated so that the review is performed well in advance of development of final cleanup alternatives. This will allow modification of cleanup plans at any early planning stage. The Yakama Nation must approve of all QRAs and final risk assessments prepared by DOE. Clear schedules for development of final cleanup plans should be identified in the appropriate schedules and included as milestones in project control documents.

As described earlier, detailed, page-by-page comments regarding the HSRAM are provided as an attachment. The points addressed above reflect Yakama Nation's primary concerns/requirements and other broad issues associated with the HSRAM document which have not been resolved by the DOE. We recommend that a workshop be scheduled to further review questions regarding this letter and to resolve potential disagreements.

Sincerely,



Russell Jim, Manager
Environmental Restoration/Waste Management Program
Yakama Indian Nation

Attachments

cc: K. Clarke, DOE/RL
J. Mecca, DOE/RL
M. Riveland, WA Ecol.
C. Clarke, U.S. EPA Reg. 10
D. Sherwood, EPA Richland
T. Grumbly, DOE/EM
T. O'Toole, DOE/EH
Washington Gov. M. Lowry
U. S. Senator P. Murray
DNFSB

ATTACHMENT A: HSRAM Comments listed by section and page

The attached page comments follow the format and content of the HSRAM document, first addressing the section on Data Evaluation and Contaminant Identification followed by a review of the Human Health Evaluation Methodology, Ecological Evaluation Methodology and Qualitative Risk Assessment Methodology. Comments on the Human Health Evaluation Methodology (Chapter 3) address the Yakama Nation exposure scenarios and radionuclide risk characterization issues separately.

Data Evaluation and Contaminant Identification (Chapter 2)

p.12: The document states that background conditions do not refer to pristine or pre-industrial conditions because they no longer exist, and that background reports are available for non-radioactive analytes for soil (DOE-RL 1993a) and groundwater (DOE-RL 1992b).

Comment: Background conditions should consider pre-1943 site conditions since this is the time that Hanford production activities began in earnest. The referenced documents should be reviewed and background concentrations corrected for anthropogenic contributions made after 1943.

p.13: The document states that 95% upper tolerance limits (UTL's) should be calculated for each parameter and contaminant concentrations compared to it. Exceedence of the 95% UTL would then warrant further evaluation of the contaminant as a potential chemical of concern.

Comment: The Yakama Nation recommends that statistical procedures be used (Gilbert, 1987) to determine if the distribution of background concentrations has been adequately defined prior to calculation of 95% UTL's. Low sample numbers and high matrix or sampler variability can yield estimates of the 95% UTL which are biased to a high concentration. Under such circumstances, contaminants of concern might be screened from further consideration since they do not exceed an artificially high background concentration.

p.15: The document states that when background data consists entirely of non-detect values (censored data) and multiple detection limits have been used in the analyses, one half of the value of the highest sample quantitation limit (SQL) should be used as the surrogate background screening concentration.

Comment: The Yakama Nation recommends that the lowest SQL be used as a surrogate instead since this would be more conservative and rigorous in evaluation of background chemicals.

Human Health Evaluation Methodology (Chapter 3)

Comments Relating to the Yakama Nation Exposure Scenario

p.29: The document indicates that biota primary exposure pathways do not consider ingestion of agricultural/farm raised fish or native herbs and plants. However, Appendix A-6 does address potential ingestion of native plants under a recreational scenario but no exposure parameters are presented in accompanying tables.

Comment: The Yakama Nation recommends that these pathways be included and/or addressed in detail in a Yakama Nation exposure scenario.

p.30: The document excludes the dermal absorption exposure route associated with immersion/submersion of an individual in contaminated water or soil. It's exclusion is based on the short-term duration of such an exposure and low dermal permeability of most contaminants potentially. Tritium exposure is qualified as a potential exception to the low dermal permeability exclusion.

Comment: The justification given for exclusion of the dermal exposure route may not adequately consider such exposures during fishing or fish aquaculture activities characteristic of a Yakama Nation exposure scenario.

p.33: The document recommends using 95% upper confidence limits (UCL) as concentration inputs for the exposure assessment in all cases, even if the maximum detected concentration is higher than the UCL. The document does not specify, if a log-normal underlying probability distribution will be used as the default assumption nor is a specific procedure provided for determination of the 95% UCL.

Comment: The Yakama Nation recommends using the higher of the two (95% UCL or the maximum observed concentration) as this will be more conservative and protective. This is the intent of the baseline risk assessment. The Yakama Nation recommends analyzing the underlying probability distribution of the contaminant concentrations and using Land's method of 95% UCL estimation if the log-normal probability distribution is indicated (Land, 1971, 1975; Gilbert, 1987).

p.34: The document indicates that models for bio-accumulation of contaminants in the food-web and ingestion by humans are not currently well defined and may require site-specific development.

Comment: The Yakama Nation requests that empirical data regarding environmental monitoring of Hanford species (Jaquish & Bryce, 1990) be used either directly or in model calibration. Extrapolation from other studies should be used carefully with uncertainties thoroughly explained and quantified where possible.

p.35: The document indicates that future scenario time frames for baseline risk assessments at Hanford should be the years 2018 (~25 yr) and 2118 (~125 yr).

Comment: These time frames for assessment of potential future site uses may not address Yakama Nation non-restrictive site use plans for 500 year time frames. The Yakama Nation recommends that the Yakama Nation exposure scenario evaluate such multi-generational, long-term potential future site use plans. The uncertainties in the future site use scenarios should be evaluated quantitatively through probability theory.

p.36/37 and Appendix D: The document specifies only lifetime or partial lifetime exposure scenarios for all intake rate calculations. Multiple generations, additive impacts or effects to succeeding generations or overall risks to the population are not addressed.

Comment: The Yakama Nation recommends that such risks be evaluated quantitatively through statistics including simple multiplicative or additive probability calculations or other cumulative risk probability curve estimation techniques.

p.39: The document indicates that a companion document for HSRAM that provides general and numerical toxicity information for Hanford-specific contaminants is forthcoming.

Comment: The Yakama Nation recommends that this reference be obtained and reviewed as part of development of the Yakama Nation exposure scenario.

p.41 and Appendix D: The document indicates that the bench-mark for chronic exposures of non-carcinogenic effects is a reference dose (RfD) which considers only one lifetime (30 years). Such a bench-mark does not address mutagenic and/or other effects of chemicals propagated through generations, although the document indicates that RfD's are being developed to evaluate specific critical effects (such as developmental problems etc.).

Comment: The Yakama Nation recommends that additional information on the development of RfD's for specific critical effects and/or mutagenic or teratogenic effects be evaluated in the context of Yakama Nation long-term concerns to successive generations.

p.42 and Appendix D: The document indicates that carcinogenic effects are calculated for lifetime or partial lifetime cancer risks only. Mutagenic and/or other effects of chemicals propagated through generations are not considered in the estimation procedures provided.

Comment: The Yakama Nation recommends that additional information be obtained through a literature search to assess long-term or genetic effects associated with carcinogenic exposure to chemicals.

p. 45: The document indicates that ranges of health effects are not considered in evaluation of toxicity assessment uncertainty.

Comment: The Yakama Nation recommends that additive and/or multiple risks from exposures of chemical mixtures be assessed in the uncertainty evaluation, or preferably in the overall risk characterization summary. A sensitivity analysis of parameters used in risk calculations should be performed to determine which variable or parameters control overall site risk. Risk distribution curves or other stochastic risk assessment approaches (e.g. p. 50) warrant further evaluation, especially if risk estimates exhibit high uncertainty/low confidence.

Comments Related to Radionuclide Risk Characterization

p.4: The HSRAM document indicates that radiation protection standards proposed by DOE (Order 5400.5) are acceptable. The standards are based on a radiation dose limit to individuals and an "as low as reasonably achievable (ALARA)" principle. According to the NCRP (1993), an ALARA principle is applicable for a lower limit of fatal lifetime health risk of $1E-05$.

Comment: The Yakama Nation recommends that the scientific justification for these radiation exposure standards be examined. A lifetime risk approach does not account for successive generation or mutagenic effects possible past a single lifetime.

p.19: The document describes considerations in assessment of radionuclides in the risk-based screening process. While no specific screening criteria is stipulated, the document proposes elimination of certain exposure routes based on known properties of radionuclides.

Comment: The Yakama Nation recommends that the screening procedure for radionuclides be specifically defined and scientifically justified. Preliminary screening of radionuclides should not be based on risk-specific concentrations, but rather on detectable concentrations or conservative estimated concentrations based on knowledge of past operations.

p.28/29: The document states that "soil contaminated by photo-emitters (gamma) is the only exposure media that should be routinely evaluated for the external exposure pathway." As partial justification for this approach, the document states that a cover of uncontaminated soils may act as a shield to radiation exposure (Kocher & Sjoreen, 1985).

Comment: This approach to exposure assessment of radionuclides is not conservative and does not account for unrestrictive site use and actually presumes a corrective action. Standard risk assessment procedures call for use of maximum or 95% UCL concentrations in assessment of exposure risks for soil contaminants regardless of depth of occurrence of contamination. The shielding argument also does not address potential leaching and

completion of the groundwater exposure pathway. The Yakama Nation recommends that the scientific justification for this approach be examined, and a more conservative approach be adopted for radionuclide soil exposures.

p.30: The document states that dermal uptake is a secondary exposure pathway and should not be regularly considered in a risk assessment, since dermal exposure of radionuclides is considered less significant than air inhalation. The document further states that tritium generally has high dermal permeability and therefore may warrant closer evaluation. Other radioactive exposure pathways excluded from regular consideration are: ingestion of particulate contaminants, inhalation of small (sub-micron) particulates, air immersion, and external exposure due to immersion/submersion in soil, sediment or water

Comment: Sufficient justification for exclusion of these exposure pathways from regular consideration in the risk assessment process has not been provided. The Yakama Nation recommends that the importance of these exposure pathways be evaluated further and/or that more rigorous scientific justification be provided for their regular exclusion. In particular, the high dermal permeability of tritium and the probable Yakama Nation fishing and aqua-cultural activities and the inhalation of small radioactive particulates should be addressed.

p.30 and 38: The document describes the use of dose-rate conversion factors (DRFs) which are combined with an estimation of exposure duration to calculate committed effective doses due to radioactive media. The only current sources of DRFs are the DOE (1988b) and EPA (1988b). In addition, all doses are converted to cancer risk by multiplication of the dose by a cancer incidence risk factor ($6.2 \times 10^{-4}/\text{rem}$, EPA, 1989e). A dose reduction factor of 0.8 (EPA 1991c) is also proposed in the radionuclide calculation procedure.

Comment: The calculations of radioactive doses and risks rely on numerous conversion factors and assumptions justified or developed in other documents. A third party, scientific review of the results of these documents and an assessment of the applicability of the findings for the Hanford site and Yakama Nation future site uses is recommended. Assessment of risk from radionuclides based solely on cancer risk does not address mutagenic, teratogenic or potential developmental effects. Cancer risks also address only lifetime or partial lifetime risks to individuals. This approach does not address Yakama Nation long-term, multi-generational and population risks.

p.42: The document describes radiation effects as either stochastic or non-stochastic (acute toxicity). Stochastic effects are a function of dose such that there is no threshold dose below or above which an effect definitely occurs or does not occur. Examples of stochastic effects are carcinogenesis, mutagenesis,

teratogenesis, and life shortening. In contrast, non-stochastic (acute) effects are characterized by a threshold dose.

The document also cites EPA (1989a) risk assessment protocol for superfund sites indicating that acute toxicity need not be considered since levels of radioactive contaminants are not high enough at superfund sites for it to be concern.

The document also cites recent references on radioactive toxicity (NRC 1990, EPA 1989e, EPA 1989a) which state that limiting exposure to reduce cancer risks also limits genetically significant exposure. Accordingly, HSRAM stipulates only significant cancer-risks from radioactive components need be considered.

Comments: The Yakama Nation believes that exposure to high level wastes in underground storage tanks at Hanford could be characterized as acutely toxic and that Hanford is not a typical superfund site. Accordingly, acute toxicity effects should not be removed from consideration in the baseline risk assessment process. The Yakama Nation also recommends that the documents cited as references in support of selection of cancer-risk as the limiting parameter for radioactive exposures be carefully reviewed. Assessment of risk due to mutagenic, teratogenic or lifetime shortening warrants further consideration.

p.43, 49: The document states that radionuclide slope factors used in the toxicity assessment may be biased and are highly dependent upon the chemical form of the radionuclide. The document also indicates that slope factors are calculated for single default lung class and that non carcinogenic effects for radionuclides need not be addressed unless chemical toxicity is suspected (p. 49).

Comment: These statements indicate that there is a high degree of uncertainty in the toxicity assessment of radionuclides. As a result, the Yakama Nation recommends that a more detailed literature search or evaluation of current data be performed of radionuclide carcinogenic and non-carcinogenic health effects. At a minimum, more rigorous scientific justification needs to be provided in the HSRAM document to support the current default assumptions for radionuclide toxicity. Alternatively, the risk assessment procedures should require a detailed toxicity assessment before defining cleanup goals associated with radionuclide contaminants. The uncertainty analysis in the toxicity assessment and the risk characterization sections should be more quantitative. The Yakama Nation recommends some error propagation and/or sensitivity analysis to determine which risk assessment parameters affect overall risk the most.

Ecological Evaluation Methodology (Chapter 4)

p.56: The document indicates that screening of chemicals of concern in the ecological assessment can be performed in conjunction with the human health screening process.

Comment: The Yakama Nation recommends that the procedures be kept separate since assumptions used in back-calculating screening concentrations for human health may have little or no relevance to screening concentrations which cause risk to ecosystems.

p.56: The document only defines two operable units: source operable units (cribs, soils, trenches, etc.) and groundwater operable units (i.e. contaminated groundwater).

Comment: The Yakama Nation recommends that impacted or potentially impacted areas away from source and groundwater operable units be defined. This will allow formulation of exposure scenarios which are not automatically restricted to currently known or obviously impacted areas.

p.58: The document only considers critical and/or sensitive habitats (defined by 50 CFR 424.02 (d)) as those potentially at risk. Critical habitats are physical or biological features essential to conservation of species, or habitats which may require special management considerations or protection. The document states that such habitats are better indicators of ecological risk.

Comment: The Yakama Nation recommends consideration of other potentially more common or robust habitats for evaluation of ecosystem risks. Such a habitat may allow selection of an indicator species for which a more conservative endpoint than mortality can be considered or measured. The DNR and WDO criteria (p. 65) of selection of other species that are not endangered or threatened, but considered sensitive or of interest may be a more conservative approach.

p.69 and 72: The document indicates that there is no consensus among DOE, EPA, or Ecology on ecological endpoints. DOE selected endpoints have been as follows: health of selected receptors/organisms (assessment endpoints); and individual mortality (measurement endpoints). The document also states that ecological risk should only be measured at or near operable units.

Comment: The Yakama Nation recommends a more conservative and potentially sensitive measurement endpoint than mortality. Suggestions include: distribution/abundance of a species, age/size/class of species/populations/communities, and biodiversity.

The Yakama Nation recommends definition of operable units which are broader in area or coverage than current proposed operable units. Assessment of ecological risks near or simply within operable units may limit evaluation of actual impacts. Potential exposures which are dependent on ecological receptors contact with a waste site may underestimate the amount of contact with the contaminated media, particularly if it has spread from the immediate vicinity of the operable unit.

p.76: The document states that the analysis phase of the ecological risk evaluation does not include assessment of physical effects to the ecosystem.

Comments: Such an evaluation approach ignores potential on-site activities associated with remediation which could impact surrounding ecosystems or species. Activities such as trucking, excavation and construction of treatment systems could have significant physical impact and cause disruption of ecosystem habitat.

p.76: The statements of minimized contaminant transport from 100 & 200 areas assumes continued "as is" usage and does not account for potential future Yakama Nation site uses.

Comment: The Yakama Nation recommends future, non-restrictive site use be considered in the problem formulation phase of the ecological risk evaluation. In general, the ecological evaluation methodology did not consider or allow for future site use contingencies. If the current conditions of Hanford ecosystems are the baseline model against which ecological risks will be measured, significant changes or development of a biota background assessment methodology is warranted.

p.78: The document states that the primary exposure pathways for ecological receptors is ingestion, drinking water and external exposure. The importance of the drinking water pathway has not yet been evaluated for its effect on receptor contamination.

Comment: Too few exposure routes are listed for the obvious complexity of an ecological risk evaluation. For example, it is unclear if the external exposure route includes immersion/submersion of receptors in soils and water. It is not clear if a fish receptor ingests water or is simply submersed in water. A clear distinction between drinking water consumption and water ingestion is also not stated. Thorough identification and assessment of the significance of the exposure routes should be a mandatory step the ecological risk evaluation process.

p.79, 81, 82: The document lists several bench-mark concentrations for evaluation of relevant effects to ecosystem receptors including: 1 rad/day (DOE order 5400.5), 0.1 rad/day (IAEA, 1992) and various Ecology surface & groundwater criteria.

Comment: The Yakama Nation recommends that the scientific justification for these bench-mark chemical concentrations to be evaluated more carefully. For example, Ecology cleanup standards appear to be risk-based numbers derived for human health concerns. These may not be appropriate bench-mark concentrations for ecosystems and primary animal consumers. The Yakama Nation also recommends against using non-conservative concentrations such as the concentration at which 50% of the organisms die (LC_{50}).

Qualitative Risk Assessment (Chapter 5)

p.88: The document stipulates that the Qualitative Risk Assessment (QRA) will primarily be used as a decision tool to perform Interim Remedial Measures (IRM) and where site-specific data is very limited.

Comment: The Yakama Nation is concerned that once an IRM is implemented, an independent and objective full risk assessment of cleanup alternatives may not be performed. Accordingly, the Yakama Nation recommends that an objective review be conducted by an unbiased third party of any subsequent full risk assessments prepared for an IRM site. In addition, specific time-frames for reevaluation of the QRA should be stipulated so that the review is performed well in advance of development of final cleanup alternatives.

p.90: The document states that contaminants below 15 feet will not be considered for identification or characterization of soil contaminants for possible excavation remediation scenarios. Such soil will only be considered for groundwater contamination.

Comment: The Yakama Nation recommends that this restriction on soil risk assessment be dropped. Potential deeper excavations to 20-22 feet below grade are easily achievable with a backhoe. Also drilling activities and stepped excavations could result in exposure of such deeper soils.

p.91: The document states that certain riparian-specific areas may have background concentrations of metals which are elevated above other background areas.

Comment: While it is true that organic-rich soils present in riparian-specific areas tend to be a sink for metals, the Yakama Nation recommends careful statistical analysis to show elevated "background" in such areas is not due to fallout or concentration from impacted areas.

p.91: The document states that maximum observed concentration will automatically be selected as the estimator of exposure point concentrations and that radioactive decay corrections must be made for radionuclide contaminants.

Comment: The Yakama Nation recommends that a 95% UCL also be considered when assessing exposure point concentrations. Limited sample concentration data sets are often characterized by high variability and uncertainty. The 95% UCL accounts for such uncertainty and may yield a more conservative exposure point concentration.

The Yakama Nation recommends against radioactive decay corrections of contaminant concentrations in the QRA process since the data are likely to be limited and uncertain. With the high degree of uncertainty in the data and the distribution of contaminants, the

Qualitative Risk Assessment (Chapter 5)

p.88: The document stipulates that the Qualitative Risk Assessment (QRA) will primarily be used as a decision tool to perform Interim Remedial Measures (IRM) and where site-specific data is very limited.

Comment: The Yakama Nation is concerned that once an IRM is implemented, an independent and objective full risk assessment of cleanup alternatives may not be performed. Accordingly, the Yakama Nation recommends that an objective review be conducted by an unbiased third party of any subsequent full risk assessments prepared for an IRM site. In addition, specific time-frames for reevaluation of the QRA should be stipulated so that the review is performed well in advance of development of final cleanup alternatives.

p.90: The document states that contaminants below 15 feet will not be considered for identification or characterization of soil contaminants for possible excavation remediation scenarios. Such soil will only be considered for groundwater contamination.

Comment: The Yakama Nation recommends that this restriction on soil risk assessment be dropped. Potential deeper excavations to 20-22 feet below grade are easily achievable with a backhoe. Also drilling activities and stepped excavations could result in exposure of such deeper soils.

p.91: The document states that certain riparian-specific areas may have background concentrations of metals which are elevated above other background areas.

Comment: While it is true that organic-rich soils present in riparian-specific areas tend to be a sink for metals, the Yakama Nation recommends careful statistical analysis to show elevated "background" in such areas is not due to fallout or concentration from impacted areas.

p.91: The document states that maximum observed concentration will automatically be selected as the estimator of exposure point concentrations and that radioactive decay corrections must be made for radionuclide contaminants.

Comment: The Yakama Nation recommends that a 95% UCL also be considered when assessing exposure point concentrations. Limited sample concentration data sets are often characterized by high variability and uncertainty. The 95% UCL accounts for such uncertainty and may yield a more conservative exposure point concentration.

The Yakama Nation recommends against radioactive decay corrections of contaminant concentrations in the QRA process since the data are likely to be limited and uncertain. With the high degree of uncertainty in the data and the distribution of contaminants, the

precision implied of performing a decay correction seems meaningless. A more conservative approach would be to use the concentration without correction.

p.91: The document states that the QRA will only address "frequent-use" and "occasional-use" exposure scenarios. In addition, the document recommends against modelling groundwater fate and transport of contaminants to exposure points.

Comment: The Yakama Nation recommends that the Native American exposure scenario (to be developed) be used as the model for the QRA "frequent-use" exposure scenario. This scenario is likely to be more conservative and therefore protective when considering IRMs.

The Yakama Nation recommends against any fate and transport modeling (not just groundwater) in the QRA to estimate exposure risks. Such modeling typically dilutes directly measured contaminant concentrations and is not conservative enough for the scope of a QRA. Maximum observed concentrations or 95% UCL are most appropriate for the QRA.

p.96-97: The document states that generic endpoints defined by DOE (Order 5400.5 for radionuclides) and national water quality criteria will be used in evaluating ecosystem risks. The source operable unit measurement endpoint is proposed as the dose to the Great Basin pocket mouse. For groundwater the measurement endpoint is radiological dose to riparian and aquatic organisms.

Comment: The Yakama Nation recommends definition of operable units which are broader in area or coverage than simply source and groundwater operable units. Assessment of ecological risks near or simply within operable units may limit evaluation of actual impacts. Potential exposures which are dependent on ecological receptors contact with a waste site may underestimate the amount of contact with the contaminated media, particularly if it has spread from the immediate vicinity of the operable unit. In addition, the Yakama Nation recommends that thorough documentation or scientific justification be provided for selection of the Great Basin pocket mouse as the sole indicator species for qualitative ecological risk assessment for source operable units.

018628

ATTACHMENT B: Radionuclide Reference List

DOE/RL-91-45, Revision 3, Appendix E of HSRAM.

Baes, C.F., R.D. Sharp, A.L. Sjoreen, and R.W. Shor. 1984. Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides Through Agriculture, ORNL-5786, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Baker, D.A., and J.K. Soldat. 1992. Methods for Estimating Doses to Organisms from Radioactive Materials Released into the Aquatic Environment, PNL-8150, Pacific Northwest Laboratory, Richland, Washington.

DOE Order 5400.5.

DOE. 1988b. External Dose-Rate Conversion Factors for Calculation of Dose to The Public, DOE/EH-0070, U.S. Department of Energy, Washington, D.C.

DOE-RL. 1994a. Risk Evaluation of Remedial Alternative for the Hanford Site, DOE/RL-93-54, Decisional Draft, U.S. Department of Energy, Richland, Washington.

Dorian, J.J., and V.R. Richards. 1978. Radiological Characterization of the Retired 100 Areas, UNI-946, United Nuclear Industries, Richland, Washington.

EPA. 1994. Health Effects Assessment Summary Tables: Annual Update. FY-1994, EPA 540-R-94-020, March 1994, U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, D.C.

EPA. 1991a. Standard Default Exposure Factors, OSWER Directive 9285.9-03, U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1991c. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual, Part B: Development of Risk-Based Remediation Goals; Review Draft, OSWER 9285.7-01B, U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1989a. Risk Assessment Guidance for Superfund: Volume 1, Human Health Evaluation Manual, Part A; Interim Final, EPA/540/1-89/002, U.S. Environmental Protection Agency, Washington, D.C.

EPA. 1989e. Risk Assessment Methodology: Environmental Impact Statement for NESHAPS Radionuclides. Volume I: Background Information Document, EPA/520/1-89/005, U.S. Environmental Protection Agency, Office of Radiation Programs, Washington, D.C.

EPA. 1988b. Limiting Values of Radionuclide Intakes and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion, EPA-520/1-88-020, U.S. Environmental Protection Agency, Office of Radiation Programs, Washington, D.C.

International Atomic Energy Agency. 1992. Effects of Ionizing Radiation on Plants and Animals at Levels Implied by Current Radiation Protection Standards, Technical Report Series, No. 332, Vienna, Austria.

Kocher, D.C., and A.L. Sjoreen. 1985. "Dose-Rate Conversion Factors for External Exposure to Photon Emitters in Soil," *Health Physics*, Vol. 48, pp. 193-205.

Napier, B.A., D.L. Peloquin, D.L. Strenge, and J.V. Ramsdell. 1988. GENII - The Hanford Environmental Radiation Dosimetry Software System, PNL-6584, Pacific Northwest Laboratory, Richland, Washington.

NCRP. 1993. Limitation of Exposure to Ionizing Radiation, *NCRP Report No. 116*, National Council on Radiation Protection and Measurements, Bethesda, MD.

NCRP. 1991. Effect of Ionizing Radiation on Aquatic Organisms, *NCRP Report No. 109*, National Council on Radiation Protection and Measurements, Bethesda, MD.

NRC. 1990. Health Effects of Exposure to Low Levels of Ionizing Radiation (BEIR V), National Research Council, National Academy Press, Washington, D.C.

Ophel, I.L., M. Hoppenheit, R. Ichikawa, A.G. Kalimor, S. Kobayashi, Y. Nishiwaki, and M. Saki. 1976. Effects of Ionizing Radiation on Aquatic Organisms and Ecosystems, *IAEA Technical Report No. 172*, International Atomic Energy Agency, Vienna, Austria.

Rose, K.S.B. 1992. "Lower Limits of Radiosensitivity in Organisms, Excluding Man," *Journal of Environmental Radioactivity*, Vol. 15, pp. 113-133.

General Reference List

Gilbert, Richard O. 1987. Statistical Methods for Environmental pollution Monitoring. Van Nostrand Reinhold.

Land, C.E. 1971. Confidence intervals for linear functions of the normal mean and variance, *Annals of Mathematical Statistics* 42:1187-1205.

Land, C.E. 1975. Tables of confidence limits for linear functions of the normal mean and variance, in *Selected Tables in Mathematical Statistics*, vol. III. American Mathematical Society, Providence, R.I., pp. 385-419.