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DEPARTMENT OF ECOLOGY

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CORRESPONDENCE CONTROL

July 15, 1992

Mr. Eric Goller
U.S. Department of Energy
P.O. Box 550
Richland, WA 99352

Dear Mr. Goller:

Re: Columbia River Impact Evaluation Plan, Draft A (M-30-02)

The Washington Department of Ecology has reviewed the Columbia River Impact Evaluation Plan, Draft A, DOE/RL-92-28, May, 1992. A copy of our comments are enclosed with this letter.

Ecology would like a determination of whether discharges to the River pose a threat to human health or the environment. Documentation of the methods and data used to conduct the impact evaluation is not sufficient to evaluate many conclusions of the study. Many basic assumptions limit applicability of the Plan. Limitation of the effort to the 100-Area is inappropriate. While review of this report has been informative, it does not yet provide the basis for determining impacts.

Ecology will work with USDOE and USEPA to develop a study that will satisfy our mandate to protect public health and the environment. Please respond within 30 days, by August 14, with written comment dispositions, after which we will be available to discuss any outstanding issues.

Sincerely,

Steven F. Cross

Steven F. Cross
CERCLA Unit
Nuclear and Mixed Waste Management

SC:jw
Enclosure

cc. L. Albin, DOH
P. Day, USEPA
L. Gadbois, USEPA
L. Goldstein, Ecology
D. Jansen, Ecology
J. Sprecher, B&C
D. Teel, Ecology
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Washington Department of Ecology Comments
on the
Columbia River Impact Evaluation Plan
Draft A, DOE/RL-92-28

1992 July 15

1. Section 1.1, second paragraph on page 2

Deficiency: The text states that " the study extends upstream a sufficient distance to provide appropriate background information for evaluating impacts." Background levels for radioactive contaminants have not been determined.

Recommendation: Replace the word "background" with "reference.

2. Section 1.2, bottom paragraph of page 2

Deficiency: The text states that "the scope of this document includes the review of relevant existing data and collection programs," that "only existing, publicly-available information was used," and that "other publicly available information that was not referenced." The Washington Department of Health and the Washington Public Power Supply System conduct routine environmental monitoring programs which include the Hanford Reach. The USEPA routinely monitors surface water upstream of the 100-Areas and downstream at the Richland drinking water intake. Columbia River supplies drinking water to some parts of the 100-Area.

Recommendation: The Plan should include a review of these programs and data.

3. Section 2.2.1, last paragraph on Page 11
Figures 2-3 and 2-4
Appendix B

Deficiency: The plume configurations shown on Figures 2-3 and 2-4 are not the same as those delineated in the respective operable units in Appendix B.

Recommendation: Explain or correct the difference in the plume configurations.

4. Section 2.2.1, page 15
Section 4.1.1, page 53
Appendix B, page B-1

Deficiency: The selection of contaminants of concern to this study is referred from this section to a method described in section 2.2, which in turn refers to specifics in Appendix B, which finally references several reports. There is no tabulation of the different values from the various studies compared to the two criteria. The two criteria used to determine contaminants of concern are drinking-water standards and MTCA groundwater standards. Background is not a criteria.

Recommendation: Tabulate the contaminant levels in the various studies against the criteria of drinking water standards, MTCA, and background. The tabulation should indicate the origin of the data. This would belong in an appendix. Ecology will evaluate whether the list of contaminants of concern for this study is complete when this information is provided.

5. Section 2.2.1, last paragraph on page 11

Deficiency: The text states that five radioactive and two chemical contaminants are found in groundwater associated with 100 area operations. Several metals, nonmetallic ions, volatile organics and radionuclides are known to be elevated in 100-HR-3 groundwater. Also several radionuclides are presently discharged in liquid effluents discharged to the Columbia River and to ground disposal facilities in the 100 Area.

Recommendation: Include in the list of chemicals of potential concern the list of contaminants known to be elevated in 100-HR-3 groundwater listed on Table 3-21, RCRA Facility Investigation/Corrective Measures Study Work Plan for the 100-HR-3 operable unit, Hanford Site, Draft C, DOE/RL-88-36 and the liquid effluents discharge listed on Tables 2-2 and 2-3 of the Plan.

6. Section 2.2.1, first paragraph on page 15

Deficiency:

Selection of chemicals of concern was based on human health using drinking water standards. This approach has two limitations. (1) Not all chemicals have drinking water standards, and (2) many chemicals are more toxic to environmental receptors than to human receptors and are therefore not considered.

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The selection of potential chemical stressors in the environmental toxicity assessment is based on ground water regulations that were developed to protect human health, not environmental health. Thus, the screening procedure for selection of potential chemical stressors, an essential part of the Columbia River Impact Evaluation Plan, is flawed. For example, Cushing (1979) studied the simple phytoplankton/caddis-fly larvae/whitefish food chain. He found that the concentrations of five elements (K, Br, Hg, Rb, and Se) either remained constant or increased though the food web.

Recommendation:

Use all chemicals detected in the data set selected for this evaluation that were identified at concentrations above the upstream reference concentrations in the Columbia River. A table should be included which lists all chemicals identified in each media grouping, eg, seep samples, the frequency of detection, average and range of concentrations. Any statistical comparison should be fully documented.

The criteria for the selection of potential chemical stressors should be expanded to include environmental receptors. Potential chemical stressors such as ^{65}Zn, ^{103}Ru, ^{144}Ce, ^{54}Mn, ^{46}Sc, $^{95}Zr/^{95}Nb$, and other radiological contaminants should be screened in a systematic way. Past ecological studies should be evaluated to determine which elements could significantly affect the ecology of the river.

7. <u>Section 2.2.1, first paragraph on Page 15 and Appendix B</u>

Deficiency: Only one year of groundwater monitoring data, Evans et al. 1990, was used to identify groundwater contaminants. Yet several years of monitoring data exist, sometimes with higher concentration of contamination.

Recommendation: Use at least five years of groundwater monitoring data or justify, based on a presentation of previous data, why the one data set is representative.

8. <u>Section 2.2.1, Table 2-1, page 17</u>
<u>Appendix B, Section B.2.1.</u>

Deficiency: The table lists contaminant of potential concern, source concentration, and flow rate. The text does not explain how the contaminant of concern were identified for each plume, how the source concentration was determined or the calculation for the flow rate.

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Recommendation: State the rational for selecting these contaminants of potential concern and explain why the other contaminants present in the 100-area groundwater were not listed. Show how the source concentration were calculated showing a range of contaminate concentration for each area plume. Present a table showing now the flow rate was calculated.

9. Section 2.2.1.1, third paragraph on page 15

Deficiency: Chromium has also been detected in monitoring wells located in the 600 Area above MCLs, including wells 699-83-47, 699-96-49 and 699-97-43.

Recommendation: List concentrations of contaminants of concern, for all wells in the 100 Area, include location, data for at least five years of monitoring and range and average for each year.

10. Section 2.2.1.2, page 18

Deficiency: The total effective half-life of each radioactive contaminant of concern is not listed. Total effective half life (calculated from the biological and radiological half lives) is a better indicator of removal rate than either the individual physical or biological half life.

Recommendation: The total effective half life of each radioactive contaminant of concern should be listed in addition to the respective physical decay.

11. Section 2.2.2.1., second bullet top of page 25

Deficiency: There is insufficient documentation of the statistics used to determine that only downstream tritium concentrations are greater than upstream concentrations. Inspection of Table 2-4 indicates that ^{60}Co, ^{99}Tc, and for the last four years NO_3 concentrations are also higher.

Recommendations: Document the statistics used to determine that contaminants are or are not significantly different.

12. Section 2.2.2.1, third paragraph on page 19

Deficiency: There is not enough discussion of the developments in analytical techniques.

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Recommendation: Be more specific about when the changes were made, and the quality of results from early work. What analyses are now possible, but were prevented by lack of technique?

13. Section 2.2.2.1, page 19-20
Table 2-4, page 24

Deficiency: The sources of data in this table are not provided. There is no explanation of why data for many constituents is missing in every year except 1989.

Recommendation: Reference the data sources. Include missing data or explain why data is not included

14. Section 2.2.2.1, first full paragraph on page 20

Deficiency: The text states that sone data were reported as negative numbers "due to correction for background levels."

Recommendation: "Background" needs definition. Background radiation levels are not typically subtracted from analytical results. Machine background (electronic noise or cosmic radiation levels) are subtracted. Clarify whether this was the counting background or the background measured at a reference station.

15. Section 2.2.2.1, last paragraph on page 20

Deficiency: Upstream concentrations trend downward since the period of reactor shutdowns, although reactor operations should not have affected upstream levels.

Recommendation: Explain why upstream concentrations trend downward over time.

16. Section 2.2.2.1, second point at top of page 25

Deficiency: The text states that except for ^{3}H, downstream contaminant levels are not different from upstream levels. This statement contradicts the 1990 PNL report, which describes an increase in ^{129}I.

Recommendation: Include this reference in the Plan.

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17. Section 2.2.2.1, last sentence of top paragraph on page 25

Deficiency: The text states that sources in addition to the 100 Area have contributed tritium impacts to the River.

Recommendation: Because this statement is true, health evaluations need to be done on a cumulative effect. Revise the Plan to include all the contribution of all radionuclides to the river pathway. Delete "possibly" and "at this time."

18. Section 2.2.2.1, last four paragraphs of section, pages 25-26

Deficiency: The conclusions from previous studies are presented without evaluation as to the adequacy and validity of the studies. For example, two studies, Robeck (1954) and Dirkes (1990) are quoted as references on the lack of impact of the site on the environmental receptors and Columbia River. Adequate support for these statements is not provided. Statements in Robeck that there was no apparent immediate effect on aquatic populations, and that chemical constituents were well below the maximum permissible concentrations at the time, are not applicable without a re-evaluation of these criteria under current and future conditions.

Recommendation: Re-evaluate the applicability of these criteria under current and future conditions. Replace "Outside of the areas . . . ." with the actual conclusion in Dirkes, page 37, that "localized areas of impact were observed within the river near the discharge zone with radionuclide concentrations above the DWS."

19. Section 2.2.2.2., fourth paragraph on page 26

Deficiency: Section states that the down-river sampling demonstrated that the effects of groundwater discharges on river water quality were very small or negligible. This logic does not comply with the intent of the State of Washington Model Toxics Control Act that defines a point of compliance that does not include dilution. WAC-173-340-730(6)(b) states:

> "Where hazardous substances are released to the surface water as a result of groundwater flows, no dilution zone shall be allowed to demonstrate compliance with surface water cleanup levels. See WAC-173-340-720(6)(d) for additional requirements."

WAC-173-340-730(6)(d) states:

> "At sites where the affected groundwater flows into nearby surface water, the cleanup level may be based on protection of the surface water. At these sites, the department may approve a conditional point of compliance that is located within the surface water as close as technically possible to the

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point or points where groundwater flows into the surface water. Conditional points of compliance may be approved only if the following requirements are met:

(i) Use of a dilution zone under WAC 173-201-035 to demonstrate compliance with surface water cleanup levels shall not be allowed;

(ii) Groundwater discharges shall be provided with all known available and reasonable methods of treatment prior to release into surface waters;

(iii) Groundwater discharges shall not result in violations of sediment quality values published in Chapter 173-204 WAC; and

(iv) Groundwater monitoring shall be performed to estimate contaminant flux rates and to address potential bioaccumulation problems resulting from surface water concentrations below method detection limits.

Recommendation: Follow the intent of the Model Toxics Control Act section relating to the discharge of contaminated groundwater into surfaces water by explaining in the Plan how WAC 173-340-730 Surface water Cleanup Standards will be used.

20. Section 2.2.3, page 26, first paragraph of section

Deficiency: The text states that concentrations "were significantly higher in sediments collected at McNary Dam compared to sediments collected upstream of the Priest Rapids Dam . . . ."

Recommendation: Explain whether the sediments collected were at the same relative depth using similar protocols.

21. Section 2.2.3, page 27, Table 2-5

Deficiency: No error term was included. Author names are incorrect. No detection limits are given.

Recommendation: Include error term whenever reporting radioactivity results. Include the uncertainty for each measurement. The authors are Jaquish and Bryce. Include the laboratory's detection limits.

22. Section 2.2.3, first full paragraph of page 27

Deficiency: The statement that the presence of metals in the sediments are attributed to mining activities references Sampling and Analysis of 100 Area Springs, DOE/RL-92-12. No reference to the statement was found in that report.

Recommendation: Cite the section and page in the report where the statement is made that presence of metals in samples are attributed to mining activities.

23. Section 2.2.3, first full paragraph of page 27

Deficiency: The text states that some constituents were higher in sediments collected along the 100 Area than "derived background concentrations." There is no explanation or definition of this term. The term "reference concentration" may be a more appropriate denomination of study-specific comparative concentrations.

Recommendation: Explain the appropriate term and include the data used to make the determination.

24. Section 2.2.3, first full paragraph on page 28

Deficiency: The text applies the concept of dilution to River sediment. The statement is made that the continued influx of uncontaminated sediment will result in further dilution of radioactivity in sediment. The influx of uncontaminated sediment will only cover, and will not dilute the contaminated sediment. The contaminated sediment will remain in place until the next erosion cycle. Since the sediment behind McNary Dam is not mixing, dilution is not occurring. Also, the conclusion that the surface sediment contaminant levels are "low" is quantitatively unsupported.

Recommendation:

Delete the last sentence. Do not refer to dilution of sediment. Change "low" to "lower" in the second to the last sentence.

The idea of surface sediments needs definition. Clarify the depth of the surface sediments and source term for these radionuclides. Describe what is meant by "relatively" uncontaminated. Is this a reference to natural products in the sediments? How is global fallout from weapons testing accounted for in the assessment?

25. Section 2.2.4, first partial paragraph on page 30

Deficiency: The text states that "fish are mobile within the Hanford Reach and the opportunistic sampling methods used by the Environmental Monitoring Program may be insufficient to detect impacts. Analyses of fish samples by the Washington Department of Health and the Washington Public Power Supply System would support measurements made by the Hanford Site Environmental Program.

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Recommendation: Explain how sampling should be conducted to assess these impacts.

26. Section 2.2.4, p. 30, second to the last paragraph

Deficiency: Cushing (1979) also found that the concentrations of four potential chemical stressors (Br, Hg, Rb, and Se) remained constant though the food web.

Recommendation: Include information about Br, Hg, Rb, and Se in the summary of Cushing (1979).

27. Section 2.2.3, last paragraph on page 26

Deficiency: Concentrations of ^{238}Pu increased from 0.0002 Pci/L at the Priest Rapids Dam to 0.004 pCi/L at the Hanford Slough. The concentration of ^{152}Eu measured at the McNary Dam is the highest of all of the radionuclides measured, 0.774 pCi/L, but a comparison with upstream ^{152}Eu concentrations can not be made since no measurements were made of ^{152}Eu concentrations at the upstream sample points.

Recommendation: List ^{238}Pu with the concentrations significantly higher in sediments in the Hanford Reach, or state why not included in list. State that ^{152}Eu was not sampled upstream of the McNary Dam.

28. Section 2.2.4, last paragraph, p.30.

Deficiency:

The conclusions are not supported by the evidence. For example, the conclusion in this paragraph states:

> "Past and present ecological monitoring appear to indicate, however, that there are no impacts on the Hanford Reach that can be solely attributed to 100 Area operations."

Is it possible to find evidence that an ecological impact would be derived solely from one source?

The evidence given to support conclusions is ambiguous. The Plan states that

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"numerous studies have reported on radioactive contaminants in wildlife that could be attributed to Site operations . . . ."

And, in fact, "non-radioactive contaminants in the Hanford Reach are not as widely studied . . . as radioactive contamination." The Plan quotes several studies that show no impact, but whose "sampling methods . . . may be insufficient to detect impacts." The Plan attributes radionuclide concentrations found in Canada geese muscle tissue to "worldwide fallout."

There is too little scientific evidence to make definitive conclusions. The real question this document should be answering is what kind of data would be needed to detect an ecological impact (i.e., ecological endpoint).

Recommendation: Eliminate conclusions that are not supported by the evidence. Because of the paucity of the data, there should be no conclusions concerning the ecological impact of the Hanford 100 Area. Instead, the authors should identify data gaps and likely ecological endpoints for proper assessment of the 100 Area impacts.

29. Section 2.2.4, bottom paragraphs on page 29, and the top paragraph on page 30

Deficiency: Statement is made that no difference could be found in fish samples collected upstream and downstream on the site. But Jaquish and Mitchell (1988) found that differences in fish collected in 1987 from the 100-D Area and fish collected upstream from the Hanford Site boundary.

White Fish	Location	^{60}Co	^{90}Sr	^{137}Cs
Muscle	Upstream 100-D	0.006 0.011	0.001 0.001	0.016 0.022
Carcass	Upstream 100-D	-- --	0.018 0.024	-- --

Concentration in pCi/g net weight

Recommendation: Change the statement to explain that fish samples collected on the site contained higher concentrations of radionuclides.

30. Section 2.2.4, fourth paragraph on page 4

Deficiency: There are no citations for the assertions in this paragraph.

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Recommendation: Provide appropriate references for the assertions in this paragraph.

31. Section 2.2.4, first full paragraph on page 30

Deficiency:

A) The speculation that goose eggshell ^{90}Sr levels may be attributed to worldwide fallout is not supported by Rickard, W.H. & K.R. Price, 1990, *Strontium-90 in Canada Goose Eggshells and Reed Canary Grass* (PNL-SA-16110). That study stated that "the eggshell data suggested to us that a source of ^{90}Sr in addition to worldwide fallout was available to the geese nesting on Plow Island." The study also stated that "a relationship seems to exist between the releases of ^{90}Sr to the Columbia River, ^{90}Sr concentrations measured in reed canary grass, and ^{90}Sr measured in goose eggshells from Plow Island."

B) While the first sentence is supported by Jaquish and Bryce (1990), page 4.33, the next two are not.

C) The mallard duck were collected from near the 100-N Area. The statement is made that radionuclide concentrations found in geese muscle tissue are similar to those expected from worldwide fallout, yet in the same paragraph we are told that radionuclides were not detected in mallard duck tissue.

Recommendation:

A) Replace the third sentence with

"Rickard and Price (1989) concluded that a source of ^{90}Sr in addition to worldwide fallout was available to the geese nesting on Plow Island, and that a relationship seems to exist between the releases of ^{90}Sr to the Columbia River, ^{90}Sr concentrations measured in reed canary grass, and ^{90}Sr measured in goose eggshells from Plow Island."

B) Reference the specific page that supports the second and third sentences.

C) In the last sentence, change "along the Hanford Reach" to "near the 100-N Area." Explain why radionuclides from worldwide fallout are found in geese tissue but are not found in duck tissue.

32. Section 3.1.1, Figure 3-1, page 32

Comment: Use the term "River Water" or Surface Water" consistently in the text and table.

33. Section 3.1.1, third paragraph, page 33

Deficiency: The text states that human access to the 100 Area is limited by institutional controls. At the present time river access to the springs, the river bank up to the high water mark, and the groundwater/river mixing zone is not restricted.

Recommendation: Change the text to reflect that river access to springs is not limited.

34. Section 3.1.2, page 33, second paragraph of section

Deficiency: The text states that recent analyses "do not show differences between sampling points that are upstream and downstream of the Site." This statement contradicts the 1990 PNL report regarding ^{90}Sr in alfalfa.

Recommendation: Include this impact in the plan.

35. Section 3.1.2, fifth paragraph, page 33

Deficiency: The statement is made that recent water-quality analyses of the River do not show differences between sampling points that are upstream and downstream of the site. Yet Table 2-4 of this Plan NO_3, ^{3}H, ^{60}Co, and ^{99}Tc are elevated in samples collected at the Richland pump house.

Recommendation: State that several chemical constituents are elevated in samples collected downstream from the Hanford site.

36. Section 3.1.2, fourth paragraph on page 33 and Figure 3-1

Deficiency: Several pathways are not shown:

- River water to crop to cattle to human
- River water to food crops to terrestrial animals
- Seeps directly to humans and aquatic/riparian life.

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Recommendation: Add the above to Figure 3-1.

37. Section 3.1.3, second sentence of last paragraph on page 33

Deficiency: Although the second clause of the sentence states that a consensus methodology for river sediment contamination evaluation does not exist at this time, the third clause states that there is no evidence of significant ecological impacts associated with contaminated sediment. If there is no evaluation methodology, how can the significance of the ecological impacts associated with the contaminated sediments be measured?

Recommendation: Explain how the ecological impacts of the contaminated sediments can be evaluated.

38. Section 3.1.4, p. 34, first paragraph of section

Deficiency: This section, Biotic Pathways, does not describe biotic pathways in adequate detail. The introductory paragraph states that

> "it is known that contaminants associated with past Site operations are migrating from soil/ground-water sources through the surface water to aquatic biota. Biotic pathways of contaminant transport in the Hanford Reach ecosystem are difficult to evaluate due to ecosystem complexity, but are based to a large degree on the food chain."

The quoted passage is vague, simplistic, and too general to be of any use. Ecosystems are, without exception, complex systems that include food webs.

Recommendation: Eliminate this paragraph. Describe what is known about biotic pathways in the Hanford Reach ecosystem and reference all conclusions.

39. Section 3.1.4, p. 34, second and third paragraphs

Deficiency: The inclusion of human and environmental receptors is confusing and does not lead to a convincing analysis. Most of the section describing Biotic Pathways is concerned with human exposure. The second and third paragraphs are concerned with human ingestion of possibly contaminated biota. The relevant set of environmental pathways for human exposure versus environmental exposure will be different. For example, quantifying the transfer of contaminants to biota is essential in the environmental evaluation, but not as important in the human risk assessment.

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Recommendation: Separate potential pathways of contaminant migration for humans and environmental receptors. For example:

3.1 Potential Pathways of Contaminant Migration
- 3.1.1 Human Receptors
  - 3.1.1.1 Ground Water Pathways
  - 3.1.1.2 Surface Water Pathways
  - 3.1.1.3 Sediment Pathways
  - 3.1.1.4 Biotic Pathways
- 3.1.2 Environmental Receptors
  - 3.1.2.1 Ground Water Pathways
  - 3.1.2.2 Surface Water Pathways
  - 3.1.2.3 Sediment Pathways
  - 3.1.2.4 Biotic Pathways

40. Section 3.1.4, second full paragraph on page 34

Deficiency: Human ingestion of fish is chosen as the most significant biotic pathway. There is no rationale stated why this pathway was picked over the other biotic pathways.

Recommendation: Explain why this pathway was chosen, and why other pathways were eliminated.

41. Section 3.1.4, third full paragraph on page 34

Deficiency: The text states that contaminant exposures to non-aquatic habitats do not appear to be a significant concern from the perspective of the environmental evaluation. One example is given, the bald eagle, but an evaluation is not made of State and Federal threatened and endangered species.

Recomendation: Evaluate State and Federal threatened and endangered species.

42. Section 3.1.4, p. 34, fourth paragraph of section

Deficiency: Besides human exposure, this section seems to be concerned only with non-aquatic sensitive habitats or non-aquatic critical habitat. The attempt to show a cause and effect relationship between the 100 Area contaminants and top carnivores would require more data.

Recommendation: Further studies should concentrate on lower trophic levels in the food web.

43. Section 3.2, last paragraph, page 34

Deficiency: Given the discussion in this section that there is assumed to be no decay of radionuclides, and no retardation or transformation of any contaminants, then why is there in Appendix B, Section B.1.3, *Soil/Water Partitioning Coefficients and Decay Coefficients for Groundwater Contaminants*, and Table B-1 *Decay Half-Lives and Partitioning Coefficients for Hanford Contaminants*. Fate regarding radioactive decay is known, and should be included in the evaluation. Ignoring this principle yields an unnecessarily conservative model.

Recommendation: Explain why this discussion is present in Appendix B, given the statements in Section 3.2.

44. Section 3.3

Deficiency: Exposure concentrations derived from models are used inappropriately in two cases.

First, in accordance with the Model Toxics Control Act, it is not appropriate to use diluted concentrations to determine environmental impacts. Since diluted concentrations can not be used to determine groundwater and surface water cleanup standards we think that the point of compliance should also be used as the point of exposure for the environmental assessment. Also, EPA guidance recommends use of actual data whenever possible. Assessment of the concentrations fully mixed into the Columbia River does not consider that toxic effects could be occurring in the near shore environment at the point of release of groundwater. This area may be an important habitat for organisms below fish on the food chain.

Second, there are data on the concentrations of contaminants in wildlife and terrestrial plants. These data should be used to evaluate impacts to human and environmental receptors..

Recommendation: For environmental receptors, use the maximum concentration of the chemicals detected in any groundwater, seep, or near shore sample. For human and environmental receptors, use actual data on the concentration of contaminants in wildlife and terrestrial plants. Also, we recommend that modeled concentrations be compared to real data at the Richland water intake.

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45. Section 3.3, page 35

Deficiency: The text states that empirical data provide the basis for evaluating the current impact associated with site operation in the 100-Area, and that modeled contaminant levels are the basis for estimating potential impacts to the Reach by past 100 Area operations. This distinction is not clear. The data used in Chapter 4.0, Impact Evaluation, is all modeled data. It is not apparent that empirical data is used at all.

Recommendation: Clarify the different uses of empirical and predicted contaminant levels. Explain why empirical data is not used in Chapter 4.0.

46. Section 3.3.1, fourth paragraph of page 35
Section 3.3.2.1, second full paragraph of page 39

Comment: References to Table 2-2 should be to Table 2-1.

47. Section 3.3.2.1, page 41, Table 3-1

Comment: The unit for tritium at 100 K-1 should be pCi/l.

48. Section 3.3.2

Deficiency: Certain data and calculations are scattered throughout the report or embedded implicitly within other tables.

Recommendation: Provide a summary table with the contaminants of concern across the top, and the following down the side:

concentration upriver
average concentration from the model
concentration at Richland intake from the model
Richland minus upriver concentrations
average minus upriver concentrations
bioconcentration factor
fish concentration
AWQC/SAWQC

49. Section 3.3.2.1, Table 3-1.

Deficiency: The note at the bottom of Table 3-1 references flux measurements in Appendix B. Flux measurements could not be found in Appendix B.

Recommendation: Place flux measurements in a table in Appendix B. Show the data used to make the calculation.

50. Section 3.3.2.1, second paragraph page 36

Deficiency: A vertical line source is one of the model assumptions. Much of the groundwater flows through the fluvial Hanford Formation. The lower portion of the Hanford Formation may be in channels and other erosional features that are cut into the Ringold Formation. If these channels are filled with higher permeable Hanford Formation deposits, then they may act as preferred pathways for groundwater movement in the unconfined aquifer. If this happens then a point source would be more valid than using a vertical line source.

Recommendation: Use point source in the model, rather than the vertical line source assumption.

51. Sections 3.3.2.2 and .3, page 42 and 50

Deficiency: The text states that the model results are "order of magnitude" estimates. This means that, on an average basis, model results may be a factor of 10 to 100 time too high or low than actual conditions. The text does not indicate that any model validation was conducted. The only indication that predicted was compared to actual is the 1990 ^{90}Sr levels. This single comparison is not sufficient to verify the model. Ecology can not rely on the model without validation. The figures predict contaminant concentrations in the River through the use of a model. The report does not attempt to correlate the predicted levels with empirical levels easily available in existing data.

Recommendation: Validate the model. Test the validity of the predicted concentrations with empirical data available from existing sources.

52. Section 3.3.2.3, pages 42 *et seq.*

Deficiency: The concentration axis in several of the figures is too stretched out, reducing the resolution of the graphs. The benefits of filling the axis with the data

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points outweighs the visual impact of placing the SAWQC data point on the graph of River concentrations.

Recommendation: Reduce the maximum concentrations on the axis of figure 3-6 to 0.01, figure 3-7 to 10000, figure 3-8 to 0.1, figure 3-9 to 1, figure 3-10 to 10, and figure 3-11 to 10.

53. Section 3.3.3, page 50, first paragraph of section
Table 3-2, page 51

Deficiency:

The Plan calculates radionuclide concentrations in fish by applying a bioaccumulation factor to the estimated radionuclide concentration in water. The calculation does not account for bioaccumulation from sediments to bottom feeding fish, resuspension of contaminated sediments or bioaccumulation of benthic or other organisms that are food sources for small fish. The report does not attempt to correlate the predicted levels with empirical levels easily available in the annual Hanford Site environmental reports published by PNL.

While the estimated concentration of ^{90}Sr in fish was .03 pCi/L, actual bass carcass concentration was 0.049 pCi/L (Jaquish and Mitchell). The BCF method also estimated ^{137}Cs of .006 pCi/L, although actual whitefish muscle was .022 pCi/L, and bass muscle was .044 pCi/L.

The estimated ^{137}Cs concentration in fish is three times lower than the Washington Department of Health Laboratory LLD for ^{137}Cs in this media. This presents a problem in trying to use sampling data to verify their calculations. The highest ^{137}Cs concentration found in fish in 1990 was 0.053 pCi/gram by PNL in the 100-D Area. Table 3-2 estimates the ^{137}Cs concentration at 0.006 pCi/gram. the highest ^{60}Co concentration found in fish was 0.059 pCi/gram/ The ^{60}Co would probably present a greater health risk from ingestion than ^{137}Cs.

The summary of contaminant concentrations and subsequent impact assessment in fish do not include the entire carcass. Some cultural groups would include whole fish in their diets.

Recommendation:

Test the validity of the predicted fish concentration values with empirical data available from existing sources. Actual contaminant concentrations in fish should be

used to determine biological transport, until a better understanding of contaminant specific bioconcentration factors are made.

The summary of contaminant concentration and subsequent impact assessment in fish should include the entire carcass, not just flesh.

54. Section 4.1.1.1, page 53, second paragraph of section

Deficiency: There is no reference for the U background.

Recommendation: Provide a reference for U background.

55. Section 4.1.1.1, last sentence of last paragraph of page 53

Deficiency: The principle of NCP 430(e)(2)(i)(A)(2) is mischaracterized. That section states that "the 10^{-6} level shall be used as the point of departure for determining remediation goals for alternatives when ARARs are not available . . . ."

Recommendation: Change "10^{-4}" to "10^{-6}."

56. Section 4.1.2.1, fourth paragraph on page 55.

Deficiency: Given that children will sit in boats for miles, hike up riverbanks, and will play at the edge of rivers as much or more than adults, the elimination of children from the recreational scenario seems invalid.

Recommendation: Include children in the recreational scenario.

57. Section 4.1.2.2. last paragraph page 55.

Deficiency: The following pathway is not included quantitatively in potential exposure pathways for residential receptors

- Ingestion of beef and milk from cattle eating river irrigated crops.

Recommendation: Include this pathway in the quantitative evaluation.

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58. Section 4.1.2.2, first paragraph page 56

Deficiency: the following pathways are not included quantitatively in potential exposure pathways for recreational receptors

- Ingestion of spring water
- Ingestion of waterfowl or game eating aquatic flora and river-irrigated crops.

Recommendation: Include these pathways in the quantitative evaluation. Also, there are actual data on the concentration of chemicals in wildlife and these data should be used to assess the risk to humans.

59. Section 4.1.2.1, page 55, first sentence of section

Deficiency:

The Plan only describes two land-use scenarios, residential and recreational, both of which are based on current site conditions. This will limit the utility of the results of the impact analysis. Consideration of alternate future land uses would provide useful information to decision-makers involved in evaluation of site-use alternatives and remedial action alternatives.

Potential human receptor populations have been identified based on current and probable near future use of the Hanford Reach. This severely limits the utility of any conclusions that the Impact Evaluation may reach. Current and near-term site conditions are dependant and premised on comprehensive institutional controls.

Section 1.2 points out that "significant adverse impact" is defined (consistent with the NCP) as a potential threat to human health or the environment in the absence of remedial action. Since institutional control is a type of remedial action, this study does not reach a conclusion relevant to significant adverse impacts. *I.e.*, it does not evaluate potential threats, and it does not evaluate threats in the absence of institutional controls.

The *Description/Justification and Impact of Change for Change Request Package for Hanford Past-Practice Milestones Change Control Form Number M-12-90-4* (May 13, 1991) clarifies the purpose of this Plan. It states (pg. 7) that the river impact study under M-30-01 and -04 would provide data on which to begin the 100-Area combined risk assessment proposed under M-30-02. It also states (pg. 9) that information from the M-30-00 study will be used to support a cumulative risk

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assessment for the 100-Area, in terms of the Columbia River as a route of exposure. Based on the assumption that the cumulative 100-Area risk assessment will consider future land uses (See the HSBRAM), this contributory effort should also look ahead.

Current exposure has been studied on an ongoing basis, as presented in the annual environmental reports published by PNL. This current effort will not make a significant new contribution to our understanding of the site without considering future impacts.

Recommendation: Consider exposure pathways that would arise from alternative future site uses. This means that there may need to be quantitative evaluation of more populations and exposure pathways. The relevant populations and pathways can be agreed to after the need to look ahead is established.

60. Section 4.1.2.2, second and fourth paragraphs of page 56

Deficiency:

There is no justification provided for addressing certain pathways only qualitatively, rather than quantitatively. Quantification of Sr, for example, is suggested by its importance mentioned on page 67.

The qualitative discussions of two human health pathways and three environmental pathways are said to be provided in section 4.1.5. Section 4.1.5 is titled "Uncertainty Analysis," and is under the human health evaluation section. The discussion in the ninth paragraph of section 4.1.5 is cursory, and addresses only one pathway, the ingestion of River irrigated plants.

Recommendation: Justify use of qualitative analysis. If justifiable, the two human health qualitative discussions should be under their own headings under section 4.1, and the three environmental qualitative headings should be under their own headings under section 4.2.

61. Section 4.1.2.3, page 58, first paragraph of *Summary . . . Residential Scenario*

Comment: The text states that "since upstream and downstream concentrations of U are identical, the intake value for this radionuclide is zero." By accounting for background, the tritium concentration is reduced by roughly half and ^{137}Cs is reduced by a factor of four. The Washington Department of Health has a mandate to establish statewide baseline environmental radiation levels. Other agencies currently conducting environmental radiation programs are summarizing data from their

reference stations to assist in the definition of background. The Plan neglects reference concentrations, and only calculates the risk from 100 Area activities. Elevated radionuclide concentrations upriver may have come from Hanford air emissions or resulted from global fallout.

62. Section 4.1.2.3, second to last paragraph of page 58

Deficiency: The text states that contaminant concentrations in fish were calculated from River concentrations (after the subtraction of upstream concentrations). The paragraph does not indicate reference for these calculations, why empirical measurements were not used, or whether these calculations are provided in the Plan.

Recommendation: Provide the reference for these calculations. Explain why empirical measurements were not used. State where these calculations (and the underlying assumptions, such as bioconcentration factors) are provided in the Plan.

63. Section 4.1.2.3, Table 4-2, page 57

Deficiency: For recreational water ingestion pathway, the ingestion rate is given as one liter per day, and the exposure frequency as one day per year. Footnote b indicates that this is a site-specific assumption. No support for these assumptions is provided. Recreational users of the River may drink more than one liter of River water per day, and engage in recreation for more than one day per year.

Recommendation: Provide cogent support for these assumptions.

64. Section 4.1.2.3, Table 4-3

Comment: The parameters and methods used to determine the calculated risks are not present. These include the method used to calculate the body burden, the biological half-life of strontium and uranium, the origin of dose conversion factors, any computer codes used in the calculation, and the origin of the risk factors. Without this information, it is impossible to verify the calculated results. Units of time are not listed in Table 4-3 for the column "intake (pCi)", nor are they reported in the text.

65. Section 4.1.3.1, page 61, first paragraph of section

Comment: The text states that the toxicity values for carcinogens are based on the concept that there is always a response to any exposure to a carcinogenic chemical. he dose effect from exposure to very low concentrations of radionuclides is not known. No threshold is the most conservative as compared to other models. This conservatism should be acknowledged.

66. Section 4.1.5, third paragraph of section on page 66

Deficiency: The magnitude of the contaminant radioactive decay and chemical degradation could be quantified, at least within bounds. Because groundwater transit-time from the sources to the springs is relatively longer than transit-time from the springs to the Richland well-field intake, decay may be relatively unimportant. Furthermore, the five radionuclides of concern have half-lives considerably longer than River transit-time.

Recommendation: In a separate paragraph, explain the extent of radioactive decay and chemical degradation.

67. Section 4.1.5, last paragraph of section on page 68

Deficiency: The subject of section 4.1.5 is uncertainty analysis. This paragraph compares estimates of risk associated with the gamma emissions from the 1301-N liquid waste disposal facility to risk associated with the residential water and fish ingestion pathways. This comparison is not relevant to uncertainty analysis.

Recommendation: Remove this paragraph.

68. Section 4.1.6, first paragraph of page 68

Deficiency: The text states that the seven contaminants "possibly" resulted from activities at the 100 Area. The last paragraph on page 11 states that the seven contaminants are associated with 100 Area operations.

Recommendation: Delete the word "possibly."

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69. Section 4.2, page 69, second paragraph

Deficiency: This paragraph seeks to justify averaged concentrations for all environmental receptors. The rational for averaging applies only to a limited number of free-swimming and non-bottom feeding fish. It does not apply to all environmental receptors however. For example; bottom feeders would be exposed to contaminated sediments, organisms lower on the food chain are not mobile over the entire Reach, the range of some mobile organisms is local (such as the N-Area beaver), and some animals may feed on organisms in localized areas of relatively high contamination concentration. An organism may be irradiated externally by radionuclides in any or all of the air, water, soil (sediments), and vegetation. An organism may be irradiated internally by radionuclides accumulating within the body by inhalation, or by direct absorption through gills or the integument in aquatic organisms, and by ingestion of food and water. The relative significance of internal and external sources can be markedly altered by the size and behavior of the organisms. NCRP Report No. 109.

Recommendation: Develop a method to determine impact in zones closer to the points of discharge, considering the sensitivities of different types of organisms.

70. Section 4.2, p. 69, second paragraph

Deficiency: The ground water/surface water dilution modeling is not appropriate for ecological assessment. The text states that

> "for the purpose of this assessment, exposure point concentrations are calculated by averaging the contaminant concentration...over the length of the Hanford Reach. This reasonable because environmental receptors are unlikely to remain in the area of the peak contaminant concentration, and their mobility will, in effect, provide receptors with a spatially averaged exposure."

Many, if not most, organisms in the Hanford Reach, such as macrophytes and macroinvertebrates, are not mobile. The assumption of mobility is essential to the use of a dilution model for environmental evaluation. The assumption of mobility is incorrect. Therefore, the surface water model should not be used in the environmental evaluation.

Recommendation: Actual contaminant concentrations in sediment, ground water, springs, and seeps should be used in the exposure analysis of the environmental evaluation. The seeps should be though of as point sources that may impact the sediment, water, and biota of a mixing zone, much as is done with Washington State guidelines on NPDES permits. The Hanford seeps should be studied with no less vigor than an instance when an industry requests permission to release effluent into a

water body, and the State requires that dilution be demonstrated by a field test, by testing chronic and acute toxicity of aquatic organisms, and by analyzing the sediment for likely contaminants. In addition, the potential uptake of contaminants by macrophytes should be examined.

71. Section 4.2, second paragraph, page 69

Deficiency: In accordance with Model Toxics Control Act, it is not appropriate to use diluted concentrations to determine environmental impacts. Also, EPA guidance recommends use of actual data whenever possible. Assessment of the concentrations fully mixed into the Columbia River does not consider that toxic effects could be occurring in the near shore environment at the point of release of groundwater. This area may be an important habitat for organisms below fish on the food chain.

Recommendation: For environmental receptors, use the maximum concentration of the chemicals detected in any groundwater, seep or near shore sample.

72. Section 4.2.1, page 70, Table 4-6

Deficiency: The table lists water quality criteria for Hanford Reach contaminants. Criterion are set at the 1/10 the LOAEL values. This factor is not referenced.

Recommendation: Reference this.

73. Section 4.2.2, p. 70, first paragraph

Deficiency: The concepts of Environmental Hazard Quotient (EHQ) and Environmental Hazard Index (EHI) are referenced to RAGS: Volume II (EPA 1989) and WAC 173-340-708(12). These concepts are not presented in either reference.

Recommendation: If the concepts of EHQ and EHI are to be used, use a correct reference.

74. Section 4.2.1, second paragraph of page 70

Deficiency: The dicta of Gerber *et al.* (1989) is mischaracterized. The topic of the article is risk to man, and environmental toxicity is only mentioned in the introductory paragraph. The article states that 1) ^{99}Tc is much less toxic than the gamma-emitting actinides, 2) its radiological toxicity might be less than its chemical toxicity, 3) it

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spreads more readily in the environment than many other long-lived radionuclides, 4) little is known about its toxicity except for plants, and 5) it appears to be rather toxic to plants.

Recommendation: Revise conclusions so that they are supported by cogent references.

75. Section 4.2.3, p. 73, first paragraph

Comment: The text states that "the results of the above environmental impact assessment should be regarded as semiquantitative, at best." There was no quantitative analysis. The analysis should be regarded as qualitative, at best. The environmental impact characterization is fatally flawed. The data gaps are numerous.

76. Section 4.2.3, page 73, third paragraph

Deficiency: For the environmental evaluation, the assumption of ground water and surface water mixing cannot be classified as conservative. The conservative assumption would be to treat the ground water seeps as point sources.

Recommendation: Either state that the use of the mixing models is not a conservative assumptions, or more correctly, do not use the dilution model presented for the environmental evaluation.

77. Section 5.1, fourth paragraph third bullet on page 75

Deficiency: While most contaminants show little significant difference in river water quality several contaminants appear to be significant.

Recommendation: The contaminants that are significant should be named and addressed and appropriate statistical justification provided.

78. Section 5.2.2, page 79, first paragraph of section

Deficiency: The Plan focuses only on the 100 Area.

Recommendation: The scope of Plan should be extended to the entire Hanford Reach.

79. Section 5.2.2.1.1, fourth paragraph on page 81

Deficiency: The statement that near-shore surface water samples show that concentrations of anticipated contaminants of concern are generally below analytical detection limits is not supported by the data. Several contaminants of concern were detected including ^{3}H, ^{60}Co, ^{90}Sr, and ^{99}Tc.

Recommendation: Provide a more quantitative discussion of this information; eg., the percentage of the times the contaminants were detected.

80. Section 5.2.2.1.1., *Activity 1A-4 -- Cr Speciation*, page 82

Deficiency: The last sentence of the first paragraph of this activity description states that

> "investigation of the speciation of Cr in the various environmental media could possibly show that the impact potential attributable to Cr is either far less or non-existent."

The electron transfer reaction between Cr(III) and Cr(VI) is kinetically limited. Conclusions drawn from geochemical speciation modeling may be incorrect. In any case, it will be extremely difficult to convincingly model the Cr(III)-Cr(VI) couple in heterogeneous media such as soils and sediments.

Recommendation: Information in addition to pH, Eh, TOC, and DO will be required such as mineralogy, surface charge, and colloidal content of the heterogeneous media.

81. Section 5.2.3, page 85

Deficiency: The importance of the possible harmful effects of high pollutant concentrations in the sediment are underemphasized, though the text states that

> "subsurface seeps and springs would represent a potential exposure point to Site contaminants for aquatic organisms, especially those that might burrow or dig into sediments,"

(pg. 33) and that

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"concentrations of ^{60}Co, ^{90}Sr, ^{137}Cs, ^{154}Eu, and $^{239,240}Pu$ were significantly higher in sediments collected at McNary Dam compared to sediments collected upstream of the Priest Rapids Dam"

(pg. 27). The text also states that

"river sediments represent a potential pathway for contaminant migration from river water to certain biotic components. Although river sediments are known to be contaminated, a consensus methodology does not exist at this time that allows for an evaluation, and there is no evidence of past or present significant ecological impacts associated with contaminated sediments. Thus, impacts due to river sediments will not be evaluated further in this report. Data collection activities needed to fill this data gap are discussed in Section 5.2."

(pgs. 33-34). However, while a river sediment monitoring program (Activity 3-1) is proposed, no biological sampling is proposed.

Recommendation: Include sampling of benthic organisms, and ecological toxicity tests with river sediment sampling monitoring.

82. Section B.2.1, second paragraph page B-8

Deficiency: The hydraulic conductivity value appears to be low given the variability in hydraulic conductivity for the unconfined aquifer. Studies indicate the aquifer is heterogeneous, especially in the 100-H area.

Recommendation: Revaluate the model's total pumping rate given the high hydraulic conductivities in the 100-H area.

83. Section B.2.2, fourth paragraph on page B-8

Deficiency: Wells placed near the middle and bottom of the unconfined aquifer contain contamination, indicating that the contaminated aquifer thickness is greater than 30 feet. The deeper wells include 199-H3-26 screened 60 feet below the water table and 199-H4-126 screened 40 feet below the water table.

Recommendation: Model aquifer thickness using wells with deeper screen intervals to determine true contaminated aquifer thickness.

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84. Section B.2.2, pages B-8 through B-18

Deficiency: Plume configuration and concentration levels are underestimated if sources other than Evans (1990) are used.

Recommendation: Evaluate concentrations and plume configuration in all wells in the 100 Area for a five year interval. Table all concentrations by year showing average and range of concentrations, provide maps of showing all well locations.

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