Confederated Tribes and Bands of the Yakama Nation

Established by the Treaty of June 9, 1855

March 19, 2010

David A. Brockman, Manager
Richland Operations Office
U.S. Department of Energy
P.O. Box 550
Richland, Washington 99352

Mary Beth Burandt, Document Manager
Office of River Protection
U.S. Department of Energy
Post Office Box 1178
Richland, WA 99352
TC&WMEIS@saic.com

Dear Mr. Brockman and Ms. Burandt:

Thank you for the opportunity to comment on the Draft Tank Closure and Waste Management Environmental Impact Statement (Draft TC & WM EIS) for the Hanford Site, Richland, Washington (DOE/EIS-0391-D) prepared by the U.S. Department of Energy (USDOE). This letter, including the attachments, summarizes and transmits the Yakama Nation's comments and concerns regarding the alternatives presented in the Draft TC & WM EIS.

The Yakama Nation's vision for the cleanup and closure of the Hanford Site includes the following objectives:

1. Compliance with Yakama Nation Treaty Rights, including full access to cultural resources by the Yakama Nation and its members within its ceded land and aboriginal territory, including on the Hanford Site.
2. Protection of the health of Yakama Nation tribal members and the environment in the following ways:
   - The Hanford Site and all its resources (including, but not limited to, the Columbia River, the islands in the Columbia River, other surface waters, geologic resources, groundwater, air, and biological resources including plants, fish, and wildlife) are safe for all exposure scenarios and tribal uses.
   - The cleanup actions must achieve cleanup goals that are protective based on the exposure parameters and lifestyle described in the Yakama Nation exposure scenario[1].

[1] Yakama Nation Exposure Scenario for Hanford Site Risk Assessment, Richland, Washington, prepared for the Yakama Nation ERWM Program by RIDOLFI Inc., September 2007.

- The cleanup actions must be protective of all ecological resources that have been or may be affected by Hanford releases and activities.

3. Cleanup actions must comply with all applicable or relevant and appropriate federal and state regulatory requirements.
4. Cleanup actions must be compatible with clean closure of the tanks. For example, cleanup actions such as grouting of the tanks, which would preclude clean closure, should not be implemented.
5. Cleanup actions are complete and permanent and must not rely on long-term stewardship and institutional controls to address long-lived radionuclide contamination at the Hanford site. Long-term stewardship and institutional controls will not be effective for wastes that remain dangerous for hundreds or thousands of years.
6. The Draft TC & WM EIS clearly shows that importing wastes from off-site would result in drinking water standards being exceeded. USDOE should abandon plans to resume importation of wastes from off-site.
7. The Draft TC & WM EIS also clearly shows that risks associated with contamination in the vadose zone and groundwater will exceed protective levels for thousands of years. USDOE should indicate what kinds of concurrent actions it intends to take in regard to groundwater and the vadose zone to ensure that the cleanup of the site reduces risks to levels that are protective of Tribal subsistence uses without relying on long-term stewardship and permanent institutional controls.

The description of alternatives provided in the Draft TC & WM EIS does not present overall alternatives in a straightforward way that allows for the direct comparison of the various alternatives and their impacts, and does not provide a clear basis for choice among the numerous combinations of options. We respectfully request that you revise the EIS to identify preferred alternatives that meet the cleanup objectives described above and address the attached specific comments, and that a revised EIS be circulated for public review and comment.

Sincerely,

Harry Smiskin

Harry Smiskin, Chairman, Yakama Tribal Council

cc/enc: Moses Squeochs, General Council Chairman
Donald Isadore, Jr., Yakama Tribal Council
Warren Spencer, Jr., Yakama Tribal Council
Lavina Washines, Yakama Tribal Council
Sam Jim, Sr., Yakama Tribal Council
Phil Rigdon, YN DNR Deputy Director
Russell Jim, Manager, ER/WM Program

Attachment 1

Yakama Nation ERWM Program General Comments on the *Draft Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington* (USDOE/EIS-0391).

This Attachment 1 presents the Yakama Nation Environmental Restoration and Waste Management (ERWM) Program's general comments on the U.S. Department of Energy's (USDOE) Draft Tank Closure and Waste Management Environmental Impact Statement (hereinafter referred to as "the EIS") for the Hanford Site, Richland, Washington. The general comments presented here summarize the major issues and concerns identified by ERWM on behalf of the Yakama Nation. Attachment 2 presents targeted comments keyed to specific sections or pages in the EIS. Attachment 3 provides additional detailed information prepared by the Institute for Energy and Environmental Research (IEER, 2010).

ERWM finds that all of the proposed alternatives are deficient in numerous ways. Primarily, none of the alternatives would achieve compliance with environmental regulations or important criteria such as the drinking water standards. It is our position that key elements of the EIS should be reanalyzed and reevaluated in a substantially revised EIS that meets the criteria identified by the Yakama Nation in its letter to the USDOE dated March 12, 2010, to which this document is an attachment. Those criteria are expanded upon below.

Overview: The EIS Is Deficient in Numerous Ways

Insufficient Detail, Poor Organization

Overall, the EIS is difficult to follow and does not provide adequate information for evaluating environmental impacts and risks to human health and ecological resources. The EIS is incomplete and inconsistent in many respects. For instance, the reader is directed to numerous other reports for the parameters and concentrations used as inputs in groundwater modeling, air emissions modeling, and risk analysis equations. This makes it impossible to construct a coherent technical picture of the analysis underlying the alternatives in the EIS. Also lacking is a clear explanation of the process for screening contaminants of potential concern and the rationale for determining receptors of concern and exposure pathways. The USDOE should provide this information in a concise and consistent format throughout the EIS and its appendices.

In addition, the EIS does not facilitate straightforward comparison of the environmental and health impacts of each alternative. Instead, a number of alternatives are grouped together as "preferred," although their impacts could differ widely and some of this grouping is not technically appropriate. Further, some alternatives seem to be preferred for reasons unrelated to environmental or compliance considerations. For example, the USDOE appears to have rejected Alternative 6B based on a policy aversion to treating all tank waste as high-level waste, even though it is currently defined as such under the Nuclear Waste Policy Act of 1982.

The USDOE should present each alternative as a comprehensible set of actions for tank waste management, including tank waste storage, retrieval, treatment, and closure, plus the associated impacts of low-level waste and mixed waste streams generated in the process. For all alternatives, future post-remediation impacts should be clearly presented in tables and graphs showing the future variation over time of concentrations of all major contaminants and the evolution of compliance with applicable or relevant and appropriate requirements (ARARs).[1]

Unacceptable Environmental Consequences

Most important, all of the alternatives fail to meet drinking water standards for groundwater—even the standards for single radionuclides—even when institutional controls are assumed to be in effect inside the core zone.

A revised EIS should present at least one alternative that meets all applicable drinking water standards for groundwater within the core zone without the need for institutional controls following cleanup actions for both tank farm and non-tank-farm 200 Areas.

The preferred alternative of landfill closure for the single-shell tank system would result in chemical and radiological groundwater contamination that would persist at concentrations above federal and state standards for the entire 10,000-year analysis period presented in the EIS. Selecting this preferred alternative would result in adverse environmental impacts to groundwater of sufficient magnitude and duration that they would be unacceptable from the standpoint of public health or welfare and environmental quality.

A revised EIS should include clean closure as the preferred alternative.

Cumulative Impacts

The cumulative impacts of the proposed actions, in combination with other past, present, and reasonably foreseeable future actions, would be environmentally unacceptable, and mitigation measures necessary to meet federal and state laws and regulations and to protect human health and the environment are not included in any of the proposed alternatives.

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[1] Additional detailed information provided in Attachment 3.

A revised EIS should include mitigation measures that address these issues.

The EIS Does Not Comply with Yakama Nation Treaty Rights

The Yakama Nation holds treaty-reserved rights to resources on and affected by the Hanford Site. It is the responsibility of both the Yakama Nation and the federal government to ensure that those resources are protected and maintained for current and future generations. Through its *American Indian Policy* (USDOE, 2006), the USDOE indicates that the most important doctrine arising from the relationship between the federal government and tribal governments is "the trust responsibility of the United States to protect tribal sovereignty and self-determination, tribal lands, assets, resources, and treaty and other federally recognized and reserved rights." Further, the USDOE indicates that it "will pursue actions that uphold treaty and other federally recognized and reserved rights of the Indian nations and peoples…and will, to the extent of its authority, protect and promote these treaty and trust resources and resource interests." Unfortunately, this policy is not reflected in the EIS. Not only does the EIS fail to adequately consider the impacts of the proposed actions on the Yakama Nation's treaty-reserved rights and resources, it actively denies that many of those rights exist.

All statements included in the EIS that convey the USDOE's "beliefs" or "positions" regarding the extent of tribal treaty rights, including repeated statements that it is the USDOE's position that Hanford is not "open and unclaimed land," should be removed from this document. All potential impacts to treaty-reserved rights and resources should be thoroughly evaluated and considered in a revised EIS, and the preferred alternative should be consistent with the USDOE's American Indian Policy, with the federal trust responsibility, and with the terms of the Treaty of 1855.

The EIS Does Not Adequately Identify or Protect Yakama Nation Cultural Resources

There is no issue of greater importance to the Yakama Nation than protection of, and respect for, its treaty-reserved rights. The Hanford Site lies within the ceded area of the Confederated Tribes and Bands of the Yakama Nation. Within this ceded area, the Yakama Nation retains the rights to natural and cultural resources, including areas of ancestral use, archaeological sites, and burial grounds. These resources are sacred and sensitive to the Yakama Nation, and they must be managed to preserve, protect, and perpetuate the resources that are inseparable from its way of life.

Only the Yakama Nation can determine what is significant to its people or, in the words of the USDOE, the "American Indian Interest." Many cultural and geographic features within the site are of significant cultural value to the Yakama Nation. The USDOE cannot speak on its behalf by assigning an arbitrary value to these resources. As an example, we point to the statement that "culturally important geographic features include Rattlesnake Mountain, Gable Mountain, Gable

Butte, Coyote Rapids and the White Bluffs portion of the Columbia River" (Section 3.2.8.3.1). In fact, the entire Columbia River is culturally significant to the Yakama Nation, as are many other features within the site that the USDOE has entirely failed to identify. Such a simple example makes clear that these determinations can and should be made only by the people of the Yakama Nation.

Further, the "American Indian Interest" sections of the EIS are significantly deficient because of failures to address the loss of tribal cultural activities and resources.

The Yakama Nation cannot be separated from its natural and cultural resources. It is therefore incumbent on the USDOE to present a clear and definitive plan for restoring both the resources and the Yakama Nation's access to them to a state that will allow the people of the Yakama Nation to continue their way of life without concern for their safety or health.

The EIS Must Comply with Federal and State Environmental Laws

National Environmental Policy Act (NEPA)

Issues related to compliance with NEPA requirements are discussed in the following sections. We believe that significant revisions will be required to adequately address these issues.

Alternatives Analysis

The Council on Environmental Quality (CEQ) regulations (40 CFR 1500-1508) for implementing NEPA state that the analysis of alternatives is "the heart of the environmental impact statement" and should "present the environmental impacts of the proposal and the alternatives in comparative form, thus sharply defining the issues and providing a clear basis for choice among options by the decision maker and the public."

The presentation of alternatives in Chapter 2 of the EIS does not allow for direct comparison of the alternatives and their impacts and does not provide a clear basis for choice among the numerous combinations of options.

A revised EIS that complies with NEPA regulations and allows for direct comparison of the alternatives as a basis for decision making should be prepared.

Reasonable Alternatives

The CEQ regulations for implementing NEPA require that an EIS "rigorously explore and objectively evaluate all reasonable alternatives." Among other things, this means that reasonable alternatives should meet the purpose of and need for the proposal. One of the purposes of the EIS is "to treat the waste and close the single-shell tank…system in a manner that complies with

Federal and applicable Washington State laws and USDOE directives to protect human health and the environment." It is the position of the Yakama Nation that none of the proposed alternatives complies with federal and state laws or is protective of human health and the environment.

A revised EIS should present alternatives that meet the definition of reasonable by better addressing the purpose and need of the proposed action.

Compliance with Other Laws

The CEQ regulations for implementing NEPA require that an EIS "shall state how alternatives considered in it and decisions based on it will or will not achieve the requirements of…other environmental laws and policies." The EIS does not adequately discuss how the alternatives considered will or will not comply with other federal or state environmental laws or policies, including among others the federal Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Resource Conservation and Recovery Act, Nuclear Waste Policy Act, and Atomic Energy Act and Washington State's Model Toxics Control Act (MTCA). While most environmental permitting and cleanup decisions based on those environmental laws will be made by regulatory agencies other than the USDOE, the decisions made by the USDOE in a NEPA Record of Decision (ROD) for this EIS should not prejudice or limit the ability of other environmental regulators to independently carry out their responsibilities for cleanup and closure.

A revised EIS should provide sufficient information to support informed decisions by environmental regulators, including clearly stating whether actions proposed in the EIS will or will not comply with federal and state environmental laws.

Other Environmental Regulations

CERCLA/MTCA Integration

When evaluating the extent to which various alternatives considered in the EIS comply with CERCLA requirements, the USDOE should also comply with the requirements of MTCA. Section 120(a)(4) of CERCLA states that "State laws concerning removal and remedial action, including State laws regarding enforcement, shall apply to removal and remedial action at facilities owned or operated by a department, agency, or instrumentality of the United States." Based on this provision, MTCA requirements are legally applicable to CERCLA cleanups at federal facilities in Washington State, including the Hanford Site.

While the USDOE's practice has been to apply MTCA risk requirements only to non-radiological contaminants, MTCA defines radionuclides as hazardous substances. Although

MTCA does not include cleanup levels for individually named radionuclides[2], it clearly states that "radionuclides are hazardous substances under the act." [Washington Administrative Code (WAC) 173-340-200]. Radionuclides are carcinogens, and MTCA defines the maximum allowable incremental cancer risk level for individual carcinogens as $1x10^{-6}$. It defines the maximum allowable incremental lifetime cancer risk level for multiple carcinogens and multiple exposure pathways as $1x10^{-5}$.

MTCA's inclusion of both chemicals and radionuclides in assessing cancer risks is consistent with U.S. Environmental Protection Agency (USEPA) guidance on establishing cleanup levels for CERCLA sites with radioactive contamination (USEPA, 1997). That guidance states that:

- The USEPA uses a consistent methodology for assessing cancer risks at CERCLA sites no matter the type of contamination.
- The USEPA classifies radionuclides as known carcinogens.
- Cancer risks for radionuclides should generally be estimated using the slope factor approach.
- Cancer risks from radiological and non-radiological contaminants should be summed to provide risk estimates for persons exposed to both types of carcinogenic contaminants.
- The USEPA is aware of "no technical, policy, or legal rationale for treating radiation risks differently from other risks addressed under CERCLA."

Based on the requirements of MTCA and CERCLA regulations the radiological and non-radiological cancer risks should be combined and compared to the standard that Washington State has determined is protective of human health. This standard has an upper limit of lifetime risk for carcinogens of $1x10^{-5}$.

Radiation Protection Standards and ARARs[3]

The EIS uses 100 millirem (mrem) per year whole body total effective dose equivalent as the reference value for its health protection dose calculations. This appears to be at odds with USDOE Order 5400.1, which requires program plans to meet drinking water standards. Further, this reference value is inappropriate because it yields a lifetime fatal cancer risk of 1 in 238, which is far higher than the upper bound CERCLA risk level of 1 in 10,000 or the MTCA upper

[2] MTCA includes groundwater cleanup levels for radium and for gross alpha and gross beta particle activity.
[3] Additional detailed information provided in Attachment 3.

bound risk level of 1 in 100,000. In addition, CERCLA indicates that when considering many radionuclides and hazardous materials, a $1x10^{-6}$ risk level should be used as a starting point.

The EIS states that the remediation of the "non-tank-farm 200 Areas is being addressed under CERCLA." However, it does not reconcile how risk levels at least two orders of magnitude greater for radionuclides alone are compatible with a CERCLA cleanup for the non-tank-farm 200 Areas or how the tank farm cleanup can be made compatible with CERCLA when no alternative in the EIS meets those requirements.

The CERCLA framework indicates that the USDOE should use a $1x10^{-6}$ lifetime cancer incidence risk for individual chemicals and radionuclides, as required by law. The lifetime cancer risk level should not exceed $1x10^{-5}$, an upper bound value required by MTCA when multiple carcinogens are present.

Tank Closure and Waste Management Options Must Be Compatible with Clean Closure[4]

Tank Storage and Waste Retrieval Alternatives

The technologies for retrieving waste from the tanks are complex and pose a variety of technological risks. The assumption made in the EIS that the amount of residual radionuclides is proportional to residual volume does not take into account the technical history of the tanks, specifically the effects of waste neutralization. Residuals of strontium-90, plutonium, and several other radionuclides are likely to be far greater than assumed while residual cesium-137 may be far less.

At least 99 percent of the waste volume should be removed. Approaches that could create more hazardous wastes and increase the risk of new tank leaks and tank corrosion should be deemphasized or avoided. Residual radionuclide amounts should be carefully characterized. No actions should be taken that would make waste retrieval beyond 99 percent impossible. This precludes alternatives such as grouting. (Grouting would also make clean closure by tank removal, part of Alternative 6B for instance, impossible.) Yakama Nation does not support the construction of new double-shell tanks (DSTs).

Waste Treatment

Certain core elements of the waste treatment plant (WTP)—notably, pretreatment of the waste and glass melters—are common to all alternatives[5]. A common mode failure is therefore

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[4] Additional detailed information provided in Attachment 3.
[5] In this discussion, the term "all alternatives" excludes the no-action alternative.

possible. In this context, the concerns of Defense Nuclear Facilities Safety Board (DNFSB, 2009) regarding accidental criticalities, build up of explosive gases, non-uniform settling of particles, and possible failure of pulse jet mixers are especially worrisome. Further, the present design of the WTP does not include provisions for incorporation of technetium-99 (Tc-99) or iodine-129 (I-29) into immobilized high-level waste (IHLW). On-site disposal of much or most of these radionuclides would likely eventually violate drinking water standards. Finally, the results in Appendix Q and Appendix U for Tc-99 and I-129 water contamination are inconsistent; this indicates that at least one set of calculations is incorrect; it may be that both are incorrect.

The revised EIS should include provisions for the full implementation of the DNFSB's recommendations. There should be no onsite disposal of immobilized low-activity waste (ILAW) or any treatment option such as bulk vitrification or stone casting that would result in any tank waste being disposed of onsite. All tank waste should be immobilized either as IHLW or ILAW. The approach in Option 2B for two high-level waste and six low-activity waste melters would meet this goal. Treatment should include alternatives for incorporating almost all Tc-99 (as in Alternative 2B) and iodine-129 (not presently in any alternative) in IHLW. The calculations for Tc-99 and I-129 need to be carefully checked for consistency, quite apart from issues associated with the validity and accuracy of the models.

Treatment of the Cesium and Strontium Capsules

All alternatives include vitrifying the cesium and strontium in the capsules with IHLW.

The cesium and strontium capsules should be moved into dry storage and a wider range of alternatives to treatment in the WTP should be considered.

Tank and Tank Farm Closure

The tanks are likely to have large residual source terms for radionuclides such as strontium-90 and plutonium-239/240, even in the case of 99 percent volume retrieval. Grouting the tanks or simply abandoning the tanks after a period of surveillance (the year 2193 is suggested in Alternative 2A) would be inappropriate.

The "Option Case" for Alternative B, including removal soil and ancillary equipment and clean closure of six cribs and trenches, is broadly acceptable for tank closure, provided that on-site secondary waste disposal meets the overall lifetime cancer risk criterion of $1x10^{-5}$ ***as an upper limit for multiple carcinogens in all other wastes to be disposed of on site. Additionally, clean closure of the DSTs and associated ancillary equipment should be considered in a revised EIS.***

Waste Management and Disposal

The waste in the Hanford tanks is high-level waste by law and cannot be disposed of as transuranic waste. All tank waste should be converted into IHLW or ILAW. Adequate provision must be made for on-site storage of all IHLW, because there is no high-level waste repository on the horizon. ILAW waste should be managed as high-level waste when stored on site (as proposed in Alternative 6B) and disposed in a deep geologic repository off site as Greater than Class C (GTCC) waste; the latter is not currently part of any alternative. There should be no shallow land disposal of GTCC waste at any site, including the Hanford Site.

Waste Importation

The USDOE's source terms for radionuclides in imported waste are incomplete and speculative. Nonetheless, they still indicate that the majority of I-129 and Tc-99 impacts on groundwater would derive from waste imported from off site. Other major source terms are the wastes generated as a result of remediation elsewhere on the Hanford Site, such as the 100 and 300 Areas, and disposed of in the Environmental Restoration Disposal Facility (ERDF). As with imported wastes, some ERDF source terms would by themselves cause exceedances of drinking standards in groundwater.

There should be no import of off-site wastes onto the Hanford Site. It will eventually be essential to clean-close the ERDF as one in a series of steps to fully remediate the site. Plans for doing so should be part of the CERCLA process for the Central Plateau.

Central Plateau Cleanup

None of the tank farm closure alternatives meets CERCLA and MTCA requirements. Further, the EIS does not address an intensive cleanup of the non-tank-farm 200 Areas in compliance with CERCLA (including drinking water standards).

A plan that addresses the removal of the contamination in the non-tank-farm 200 Areas is an essential complement to a preferred alternative that will meet all ARARs, including drinking water standards for groundwater, and allow use of the Hanford Site without institutional controls after remediation is complete.

A revised EIS should contain an alternative in which the tank farm cleanup occurs in an overall context of meeting CERCLA requirements, including drinking water standards, for all parts of the Central Plateau and the rest of the Hanford Site.

Reliance on Institutional Controls for Thousands of Years is Unrealistic[6]

The EIS closure strategy places unwarranted reliance on the use of institutional controls and long-term stewardship. As the National Research Council (NRC) Board on Radioactive Waste Management has stated (NRC, 2000):

> The committee believes that the working assumption of USDOE planners must be that many contamination isolation barriers and stewardship measures at sites where wastes are left in place will eventually fail, and that much of our current knowledge of the long-term behavior of wastes in environmental media may eventually be proven wrong. Planning and implementation at these sites must proceed in ways that are cognizant of this potential fallibility and uncertainty.

Rather than adopt the stance that some areas such as the Central Plateau will be irretrievably sacrificed (either through institutional controls or to severe and extensive contamination or both), it would be prudent to focus on cleaning up the site to a standard that will allow for future unrestricted access and be fully protective of human health and the environment. In fact, the USDOE did just this in the 2003 Tank Closure EIS Notice of Intent, which included clean closure alternatives that "supported future use on an unrestricted basis and that did not require post-closure care" [68 Federal Register 1052].

We support incorporation of a clean closure alternative into a revised EIS.

The EIS appears to assume institutional control for 10,000 years. No government on Earth, let alone a government department, has existed for anything close to that time. The NRC, in reviewing USDOE cleanup plans, has explicitly advised the USDOE on this point in the past and said that "DOE's intended reliance on long-term stewardship is at this point problematic" (NRC, 2000). The EIS does not address the risk of technical failure over such long periods.

The USDOE should not rely on institutional controls significantly beyond the cleanup period. A reasonable approach is to assume institutional controls for the duration of the cleanup required by a given alternative, with complete release thereafter. Such an approach is consistent with the advice of the NRC, with historical and technical realities, and, assuming a thorough cleanup, with the unrestricted exercise of treaty rights by the Yakama Nation.

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[6] Additional detailed information provided in Attachment 3.

Barriers are not Designed to Last for Thousands of Years[7]

The EIS closure strategy places unwarranted reliance on the use of barriers as a primary component. As quoted above, this is also a concern of the NRC Board on Radioactive Waste Management.

Available evidence suggests that there is no verified barrier design that can ensure proper functionality over the period during which the covered wastes will remain dangerous without extensive monitoring, maintenance, and periodic replacement. Furthermore, while a properly functioning barrier may protect against surface infiltration, by design such a barrier does not mitigate lateral subsurface flow, which would reach and mobilize remaining contamination.

We oppose the USDOE's proposal to leave large volumes of leaked, spilled, and intentionally discharged tank wastes in place and cover it with a barrier.

Vadose Zone Modeling Is Deficient

The model used in the EIS has deficiencies that require additional attention, of which the most significant is the persistent reduction in uncertainty as modeled results are passed from the source to vadose and ultimately to groundwater models. These uncertainties directly affect risks and impacts predicted for the site and should be carefully accounted for throughout the model, as well as presented with the modeled results to provide context. Values entered for waste source geometry should be explicitly identified and compared with characterization data. Model sensitivity analysis should incorporate distribution coefficients and discuss the additional uncertainty introduced by assigning a singular assumed value for this parameter, since it is known to change with environmental variables.

In addition, the revised EIS should include:

- A detailed description of the constituent solubility limited release model.
- Results for and discussion of sensitivity analyses performed for all other chemical and constituent distribution coefficients in addition to I-129.
- Discussion of the selection process used to assign the distribution coefficient to plutonium in contaminated soil of 150 ml/g (Table M-10). This value does not reflect the more conservative values measured by Delegard and Barney (1983) that are still used today (PNNL-13895). Many Delegard's measured values are significantly lower than the value selected for the EIS model indicating more rapid movement in the subsurface.

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[7] Additional detailed information provided in Attachment 3.

- Additional justification for the discrepancy between the chemical constituents addressed in the source release models and vadose zone transport models.

Uncertainties should be carried forward into the groundwater model and presented with modeled results in a revised EIS. As listed above, other revisions should be made in performance of the modeling and in discussion of modeled results.

The Vadose Zone Must Be Remediated

Contamination within the vadose zone continues to provide a source term for groundwater contamination. Previous remedial actions at the Hanford Site have frequently been limited to identified process waste facilities (e.g., cribs and trenches) and restricted to usually less than 20 feet below the ground surface. To support groundwater remediation efforts, the vadose zone must also be appropriately addressed. While the USDOE has pursued some experimental technologies, the best approach uses mature and proven methods that permanently remove contamination. We do not favor *in situ* methods for vadose zone remediation for the following reasons:

- *In situ* methods frequently require contact with a reducing agent or other catalyst to reduce contaminant mobility. It is difficult to ensure an appropriate time for the reaction between the two species.

- Placement of the treatment chemical and verification of its delivery to the zone of contamination cannot be ensured.

- The permanence of many *in situ* methods has not been proven; long-term monitoring is required.

- Changes in subsurface aqueous chemistry or geochemistry cannot be accurately predicted or accounted for, necessitating a more experimental approach than may be appropriate for field-scale remediation.

Future remedial actions in the vadose zone should address the full extent of contamination, both inside and outside of waste structures. Additional characterization data should be gathered to minimize uncertainty in the selection and design of the remedial actions.

Groundwater Modeling Is Deficient

The groundwater model used in the EIS has deficiencies that require attention:

- Model uncertainty is not adequately addressed. Modeled results are frequently reported with a level of precision that cannot be fully justified.

- The model does not account for the many subsurface heterogeneities at the Hanford Site or interactions between geologic strata[8], which can result in significant model error that may be difficult to quantify or left unquantified.

- Even within individual geologic units, hydraulic parameters can vary over orders of magnitude (Shannon & Wilson, 2009), which the model does not address. Rather, each geologic unit is assigned a single set of hydraulic parameters assumed to apply throughout each layer.

- Source terms are frequently defined using broad but unjustified or incorrect assumptions. An example is the unrealistic assumption that tank waste residual radionuclides and residual volume are directly proportional. There could be significant ramifications for the modeled results if estimated source terms do not accurately reflect site conditions.

- Long-term predictions for contaminant fate and transport are based on speculative underlying assumptions about climate and site conditions (for instance, future rainfall) that cannot be verified. The natural variability in several of these parameters adds to the uncertainty, but is not directly addressed in the modeled results.

In addition, significant discrepancies in solutions to the Base and Sensitivity (referred to as the Alternate) cases result from relatively small differences in input parameters. An example is illustrated in Table 1, which shows that a small change in the top-of-basalt surface results in significant change in hydraulic conductivity (affecting groundwater flow patterns, travel times, and simulated contaminant concentrations).

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[8] The USDOE has previously provided hydraulic conductivity values for the Ringold Gravels as low as less than 1 meter per day (PNNL-17439, 2008) and for Hanford Gravels as high as more than 2,000 meters per day (PNNL-16435, 2007).

Table 1. Comparison of calibrated hydraulic conductivity values (in meters per day) for the Base and Alternate models.*

Parameter	Base Case	Alternate Case	Difference
Hanford mud	0.171	0.481	181%
Hanford silt	6.8	21.8	221%
Hanford sand	123.6	30.4	-75%
Hanford gravel	156	222.1	42%
Ringold sand	3.57	0.83	-77%
Ringold gravel	19.2	18.7	-3%
Ringold mud	1.514	1.958	29%
Ringold silt	1.51	0.77	-49%
Plio-Pleistocene sand	96.8	84.2	-13%
Plio-Pleistocene silt	5.81	6.87	18%
Cold Creek sand	99.13	39.4	-60%
Cold Creek gravel	62.7	5.6	-91%
Highly conductive Hanford gravel	3982	4331	9%

***The change in hydraulic conductivity for each unit that results from a small adjustment in the top-of-basalt surface by approximately 3 meters. Data taken from Tables L-20 and L-24 of USDOE/EIS-0391.**

Although they appear modest when compared with natural variability in hydraulic conductivity, these differences significantly influence the model because of the large area modeled and the assumption made in the modeling that each stratigraphic layer is homogeneous.

The USDOE's decision to promote model stability by fixing boundary inflows is also a concern, especially because this is one of the parameters to which the model is more sensitive. Additional information is needed to justify the value of 49 million cubic meters annually, which is more than twice any input value used recently by others (Pacific Northwest National Laboratory [PNNL]-11801, 1997; PNNL-13447, 2001; PNNL-13623, 2001; PNNL-14753, 2006).

Selection of the Base case result over the Alternate case result is insufficiently justified. The Alternate case fits the measured head data better than the Base case, and so is more defensible based on the data. In its singular application to one-time, point-source releases of Tc-99 in the year 2100, modeled results for the Alternate case indicate significantly greater concentrations of technetium at the Columbia River than in the Base case. This difference justifies further effort to determine which model provides the most reasonable and conservative evaluation of future site conditions.

There is considerable specific and cumulative uncertainty associated with many of the model parameters, including source terms, boundary inflow, geologic parameters, and interactions as well as more general variables such as site topography and annual precipitation. However, the uncertainty has not been explicitly recognized and incorporated into the model or the dose and risk calculations. Together, the factors demonstrate that the degree of precision presented in the EIS is not currently justified.

These deficiencies are also noted by the USDOE itself in its Quality Assurance Follow Up to the EIS (USDOE, 2008), which states that:

The evaluation was "limited by insufficient documentation in many areas including model development, input/output process controls, and modeling uncertainties" (p. 4).

There are omissions in the quality assurance materials such as "…the appendices containing details of the groundwater modeling" and "a number of yet-to-be-developed SAIC calculations and analyses packages" are lacking (p. 7).

A revised EIS should address the following points:

- ***Concentrations, doses, risks, and hazard quotients should be calculated with the Alternate case model as well as the Base case model.***
- ***Appendix L should include specific information regarding water balances and boundary inflows, which should be compared to previously modeled results for the Hanford Site. Any differences should be justified or resolved.***
- ***Boundary inflows either should be estimated as part of model calibration or used to develop alternate models, similar to the approach used to develop the alternate model for the cutoff elevation in the Gable Gap area.***
- ***Approaches for combining uncertainties and risks associated with multiple alternate models (e.g., Meyer et al., 2007) should be used to combine predictions of the Alternate and Base models.***
- ***The USDOE's quality assurance team should review all appendices, calculations, and analyses that were not available for its October 2008 review. The team should be provided with public comments on the EIS for use in this review.***

Groundwater Remediation Must Be Integrated with Remediation of the Vadose Zone

The USDOE acknowledges that groundwater at the Hanford Site interacts directly with the Columbia River. During high flows, the river recharges groundwater in the banks of the channel. During low flows, groundwater seeps into the channel to support baseflow. Groundwater at the Hanford Site must be protected against further contamination and restored to the highest beneficial use possible, whether as drinking water or to support aquatic life in the Columbia River, a significant cultural resource for the Yakama Nation.

Groundwater remediation is unlikely to be successful in the absence of protection against future contamination. For this reason, groundwater remediation should be closely tied to remediation of the overlying vadose zone. Previous attempts using an *in situ* approach have suffered in part because contamination of groundwater is ongoing, not static. Additional concerns regarding *in situ* approaches include:

- The target zone is deep in the subsurface and placement of remedial agents is uncertain and unverifiable.
- Many *in situ* precipitates have not proven stable and permanent.[9]
- All *in situ* approaches require ongoing monitoring and often maintenance. Plans and funding for these actions have not been provided.
- The time periods over which monitoring and maintenance would be required surpass even the most extensive institutional memory on record.

The Yakama Nation supports a more conventional and mature approach to remediating subsurface contamination that will permanently remove contamination and does not require long-term monitoring or maintenance.

Human Health Must Be Protected Under All Exposure Scenarios and Tribal Uses

The human health risk analysis does not adequately address potential risks to the Yakama Nation.

Short-Term Risk Analysis

The short-term risk analysis in Appendix K is inadequate because it does not evaluate an appropriate Native American Indian scenario.

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[9] Most notably, *in situ* treatments that attempted to produce autunite in the 300 Area (PNNL-17480, 2008).

Members of the Yakama Nation are much more dependent on natural resources for their way of life than are members of the general public. What's more, they pursue their way of life within the areas evaluated in the short-term analysis:

- 50-mile radius of the site: The Yakama Reservation is located 20 miles west of the Hanford Site.
- Maximally exposed individual: The Yakama people hunt and fish in and along the Columbia River, just outside of the boundary representing the "maximally exposed individual."
- Site workers: Staff of the Yakama Nation evaluate on-site cultural resources as part of investigation activities.

In its evaluation of short-term risks, the EIS does not consider exposure to contaminants from ingestion of wild plants, game, and fish, all of which are consumed by members of the Yakama Nation for medical, nutritional, and cultural reasons, potentially resulting in disproportionate impacts to this highly exposed population. The EIS also does not consider exposure to contaminated water, which could occur via drinking and inhalation during traditional sweat-lodge ceremonies. The inhalation, soil contact and/or ingestion, and food ingestion exposure rates used to represent the general population and on-site workers for the short-term risk analysis are too low to reflect a traditional tribal member engaged in hunting, fishing, plant gathering, and other cultural activities.

A revised EIS should evaluate an Native American Indian scenario for short-term risks under each alternative to reflect the lifestyle and exposure rates described in the Yakama Nation Exposure Scenario (Ridolfi, 2007), which was provided to the USDOE in 2007.

Long-Term Risk Analysis

The long-term risk analysis in Appendix Q is inadequate because the American Indian scenarios—American Indian resident farmer and American Indian hunter-gatherer—do not fully represent the Yakama Nation. Pathways presented in the EIS appropriately included exposure to radionuclide and chemical contamination from inhalation of fugitive dust; ingestion of soil, water, fish, meat, and plants; and participation in a sweat lodge, however, some exposure scenarios were incomplete. The resident farmer was assumed to consume domestic meat, milk, and garden plants and either groundwater or surface water; however, an evaluation of both water sources would be more complete. The hunter-gatherer was evaluated based on exposure to both groundwater and surface water and was assumed to consume game and wild plants. However, the hunter-gatherer lifestyle does not preclude the consumption of domestic products (e.g., meat, milk, garden plants).

The exposure parameters in the American Indian scenarios are generally too low to represent a a Yakama Nation lifestyle as described in the Yakama Nation Exposure Scenario (Ridolfi, 2007). For example, the inhalation, soil contact and/or ingestion, and food ingestion rates and fraction of time spent outdoors do not reflect a subsistence lifestyle that includes active hunting, fishing, and gathering of wild plants and cultural activities such as ceremonies performed on dirt floors. The Yakama people consume more meat and plants than the general population. They also consume much more fish from local sources, including the Columbia River, as a primary part of their diet.

Comparison of Yakama, USDOE, and EIS Exposure Parameters

Prior to release of the EIS, the USDOE developed a tribal scenario in which some exposure parameters for the Yakama Nation and the Confederated Tribes of the Umatilla Indian Reservation[10] were merged and proposed for use in Hanford Site risk assessment. Table 2 compares the USDOE-developed exposure parameters with Yakama Nation parameters documented in Ridolfi (2007) as well as with those used in Appendix K and Appendix Q of the EIS. The table illustrates that generally lower rates are assumed in the EIS than were developed by either the Yakama Nation or the USDOE; in particular, the fish consumption rate used in the long-term risk assessment is about one-third of the Yakama Nation subsistence rate.

Table 2. Native American Indian adult exposure parameters.

Exposure Parameter	Unit	Yakama Nation[a]	USDOE Pre-EIS White Paper[b]	USDOE EIS Short Term[c]	USDOE EIS Long Term[d]
Inhalation rate	m^3/hr	1.08	1.08	0.83	0.96
Soil ingestion rate	mg/day	200	400	120	120
Water ingestion rate	L/day	4(1)	4(1)	--	2
Fish consumption rate	g/day	519	620	--	170
Meat consumption rate	g/day	704	125	508	422
Plant consumption rate	g/day	1,417	1,350	836	1,082(2)
Milk ingestion rate	L/day	1.2	--	--	0.6

[10] Developed using frequency and duration assumptions not agreed to or accepted by the Yakama Nation and Umatilla Indians.

Notes:

[a] Yakama Nation Exposure Scenario (Ridolfi, 2007)

[b] U.S. Department of Energy Tribal Scenario (USDOE, 2009)

[c] The EIS, Appendix K

[d] The EIS, Appendix Q

Includes water consumption during sweat lodge use

Includes grain consumption

m^3/hr = cubic meters per hour; mg/day = milligrams per day; L/day = liters per day; g/day = grams per day

Yakama Nation Exposure Scenario Chronology

To fully understand our objection to exposure parameters used in the EIS, it is important to understand how the Yakama Nation Exposure Scenario was developed. The process began with a facilitated meeting on January 18, 2006, that was attended by representatives of the Yakama Nation, the USDOE, and the USEPA. The purpose of the meeting was to discuss the technical work necessary to improve the risk assessment process for the Hanford Site. At this meeting, the parties agreed on the need for an exposure scenario that reflected the unique pathways and risks to the Yakama people and resources. Subsequently, a scope of work was developed for the Yakama Nation and approved by the USDOE in 2006. The majority of the work, including literature research and interviews with Yakama members, was conducted in 2007. The Yakama Nation Exposure Scenario was completed on September 7, 2007, and submitted to the USDOE for use in the Hanford Site risk assessment.

On November 14, 2007, the USDOE Office of River Protection posed questions about the scenario to the Yakama Nation, which responded with further clarification on December 11, 2007. At about the same time, the USEPA Office of Environmental Assessment submitted comments on the Yakama Nation Exposure Scenario in a memorandum dated January 3, 2008.

In a submittal dated December 19, 2007, the USDOE's subcontractor, Neptune and Company, Inc., presented an approach for applying the scenario to the risk assessment process. This approach, which was provided to the Yakama Nation on January 16, 2008, included exposure assumptions not identified in the scenario but recommended by the USEPA. The Yakama Nation agreed to these assumptions and has since been anticipating application of the scenario in Hanford Site risk assessments.

The USDOE has failed to apply the Yakama Nation Exposure Scenario in any of its risk evaluations and analyses, including the EIS. The Yakama Nation Exposure Scenario should be applied in a revised EIS.

Cumulative Risk

A comprehensive cumulative risk assessment should consider exposures to both chemical and radiological contaminants (which are present in all Hanford Site media, including the vadose zone), taking into account the sum of all contaminant exposures. In addition, a cumulative risk assessment should evaluate all possible pathways, including such pathways as drinking water wells drilled by individuals for their own use.

Contaminant Selection

Potential exposure to radiological and hazardous chemical contaminants was evaluated for both the short- and long-term human health risk analyses presented in the EIS. Appendices D, K, and Q refer to an initial inventory of 46 radionuclides that was screened to arrive at a final set of constituents retained for detailed analysis. The complete inventory list is not presented in the EIS, and the EIS does not provide a thorough description of the screening process used to retain the final set.

As stated in the EIS, radioactive inventories were also not adjusted to account for differences in the duration of each alternative; the justification for this is that radioactive decay over time will only reduce the radioactivity. To the contrary, however, some radionuclide concentrations will actually increase over time (e.g., the decay of plutonium-241 will lead to an increase in its daughter product, americium-241, until equilibrium is reached). Another limitation occurred in the evaluation of direct intrusion into residual contamination, in which hazardous chemicals were not evaluated because of an assumed limited exposure time. In addition, the drinking water pathway was not evaluated.

Human Health Risk Analysis Results

The results of the short-term human health risk analysis in the EIS indicate that the average project impact for a full-time worker with a 40-year exposure period is at least 10 times the USEPA's maximum acceptable lifetime cancer risk of $1x10^{-4}$ for every alternative.[11]

The analysis results demonstrate that no proposed alternative is adequately protective of worker health.

[11] In the short-term risk analysis, only latent cancer fatality rates (as opposed to cancer risk incidence) were presented for the general population and maximally exposed individual.

Every alternative also shows a long-term radiological risk above the maximum cancer risk level in at least one location (core zone boundary, river nearshore, and barriers), with the core zone boundary showing unacceptable cancer risks under all alternatives.

For the drinking water well user, all tank closure alternatives for B Barrier, T Barrier, and the core zone boundary exceed the 10 mrem per year criteria used in the EIS. Further, doses to an American Indian "intruder" engaged in residential agriculture following well drilling at the tank farms exceed the USDOE dose guideline of 500 mrem per year in at least one tank farm for every alternative. The EIS acknowledges these exceedances, but does not discuss how this issue might influence decision making or alternative selection.

No alternative presented in the EIS is adequately protective in the long term for groundwater use. Other alternatives must be considered in a revised EIS.

Ecological Resources Must Be Protected Under All Exposure Scenarios and Tribal Uses

None of the tank closure alternatives presented in the EIS is protective of ecological resources. Each alternative or combination of alternatives shows an unacceptable risk to aquatic biota, including salmonids exposed to hexavalent chromium via groundwater discharging to the Columbia River at the nearshore area. Each also shows unacceptable risk to terrestrial resources exposed to contaminants such as mercury, xylene, and formaldehyde via air deposition. And, although the EIS has a 10,000-year horizon, it does not address how conditions at the site will more than likely change over time as a result of climate change, dam alterations, or river channel migration.

Although the EIS concludes that a few ecological resources will be impacted by unacceptable risks, even this evaluation is inadequate. Many integral elements of the ecosystem are not included in the impacts evaluation and risk analyses. In addition, impacts to numerous receptors are not evaluated, nor are all exposure pathways. For example, the only exposure pathway evaluated for terrestrial receptors is air releases; the exposure pathway via ingestion of plants and invertebrate and vertebrate prey by salmonids is not evaluated; and plants are not included as riparian or aquatic receptors.

A revised EIS must take into consideration all relevant ecological receptors and exposure pathways.

Aquatic Resources

The EIS excludes the Columbia River from evaluation (excepting a small portion of nearshore habitat), despite the fact that the Columbia River and the Hanford Reach provide habitat for a wide range of aquatic and terrestrial species.[12] Both the National Oceanic and Atmospheric Administration (NOAA) Fisheries Service and the U.S. Fish and Wildlife Service (USFWS) have designated critical habitat for salmonid species throughout the Columbia River basin, which includes the Hanford Reach.[13]

The EIS assumes that exposure of ecological resources to contaminated groundwater is inconsequential because there are few seeps along the river and discharges occur under water or flow through the riparian zone for only 16.6 feet. This assumption is subjective and provides inadequate basis for discounting the risks to aquatic resources. During the fall, seasonal water levels in the river are at their lowest; as a result, undiluted contaminated groundwater discharging from the seeps is more accessible to ecological resources (Fabre, 2007). Additionally, seeps in the nearshore area are not the only points where contaminated groundwater discharges to the river. Preliminary results from a recent study (Tiller et al., 2009) show hexavalent chromium concentrations in excess of USEPA water quality criteria at several groundwater upwelling locations in the Hanford Reach.

The Columbia River, the Hanford Reach, and their biological resources must be considered in a revised EIS because these resources will be affected by the discharge of contaminated groundwater for the foreseeable future.

Terrestrial Resources

The only exposure pathway evaluated for terrestrial species is air deposition. However, as acknowledged in the EIS, plants and animals are routinely observed in the upland portions of the Hanford Site. Numerous springs, vernal pools, and ponds in the upland habitats provide an important source of water for terrestrial animals. The EIS states that mammals and waterfowl have been observed using ponds and upland aquatic habitats in the core zone. The EIS also

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[12] The riverbanks along the Hanford Reach are vegetated with riparian plant species typical of Columbia Basin shrub-steppe ecosystems as well as introduced species. The riparian and upland portions of the Hanford Reach are used by numerous plants, insects, mollusks, amphibians, reptiles, birds, and mammals. The Hanford Reach, part of a National Monument, is characterized by diverse riverine habitats consisting of cobble substrates, riffles, deep pools, backwater sloughs, islands, and gravel bars. The Hanford Reach provides spawning, rearing, and migratory habitat for salmonids and other fish species, including white sturgeon. Critical spawning and rearing habitat for fall Chinook salmon is also found in the Hanford Reach (USFWS, 2008).

[13] Critical habitat has been designated for upper and mid-Columbia River steelhead, upper Columbia River Chinook, and bull trout (NOAA, 2010; USFWS, 2010).

states that dense blooms of watercress (an aquatic plant) occur in springs in the upland area and that these springs support aquatic insect populations in greater numbers than do mountain streams. This information supports the need for consideration of these habitats and their associated receptors.

A revised EIS must evaluate groundwater as an exposure pathway for terrestrial resources. Additionally, the assumption that institutional controls will preclude plants and animals from entering the upland terrestrial habitat in the core zone for 10,000 years is inadequate to provide for the protection of ecological resources.

Fast Flux Test Facility

The EIS also presents alternatives for the Fast Flux Test Facility (FFTF). The Yakama Nation supports implementation of Alternative 3 using the Idaho Options for treatment of bulk sodium and remote handled special components (RH-SCs). We support disposal of the RH-SCs at the Nevada Test Site as presented in the EIS. Based on estimates provided by the USDOE, the difference in cost between Alternative 3 and Alternative 2, the USDOE's preferred alternative, is less than 3 percent. However, implementation of Alternative 3 would result in significant improvement of the 400 Area's end state. As part of Alternative 3, the USDOE should remove subgrade concrete and other rubble from the site before backfilling with clean material to leave as little residual contamination in place as possible.

FFTF operations have not yet resulted in the type of extensive and severe environmental contamination pervasive throughout much of the Hanford Site. Implementing Alternative 2 would be a significant step away from appropriate closure of the site. The Yakama Nation does not support Alternative 2 for the following reasons:

- Entombment (i.e., grouting waste in place) makes future remedial actions difficult if not impossible.

- Entombment of waste will ultimately lead to heavy contamination of an area that is not now as severely impacted as other portions of the Hanford Site.

- Alternative 2 relies on institutional controls and barriers to temporarily prevent contamination from mobilizing and migrating into the environment. However, the EIS acknowledges that this contamination will ultimately be released into the environment.

- Constructing a new sodium reaction facility (i.e., exercising the Hanford Reuse Option for bulk sodium) will commit significant resources to building, operating, and then destroying a facility that is redundant of a nearly identical existing facility at the Idaho National Laboratory.

Implementing Alternative 3 with both Idaho Options would meet the USDOE's vision of responsibly shrinking the Hanford footprint by not leaving residual contamination in place. The USDOE acknowledges that preferred Alternative 2 will ultimately lead to the release of significant contamination into the environment, resulting in further impacts to human health and the environment. Given that Alternative 3 with both Idaho Options results in minimal future impacts to the environment, it is supported by the Yakama Nation with the stipulations stated above.

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Attachment 2
Hanford Tank Closure and Waste Management EIS
Yakama ERWM Program Targeted Comment Compilation
March 12, 2010

Comment ID No.	Section	Subsection	Page	Figure, Map or Table Number	Comment
1	General				Remediation approaches that leave pipes, valves and other high level waste-handling equipment in place are incompatible with the Nuclear Waste Policy Act, which requires high level waste to be disposed in a deep geologic repository. The removal of the facilities and equipment that have handled high level waste and have residuals in them needs to be evaluated in a revised EIS.
2	General				Please address the fact that USDOE's preferred alternatives do not include removing source material that could result in groundwater being restored to a usable condition in a reasonable time frame.
3	General				Cleanups based on a specific risk level which is derived from known contamination at the site cannot be implemented effectively at many areas because there is too much uncertainty or unknowns regarding the site (e.g., wastes and contaminated media are not sufficiently characterized to make informed decisions). Provide a plan to resolve these data gaps.
4	General				Disposing of wastes from other USDOE sites at Hanford will adversely affect the environment and significantly increase site-related risks, particularly with respect to groundwater as a source of drinking water. This is particularly significant for disposal of off-site wastes containing I-129 and Tc-99. At least one Alternative should be provided that excludes the import of off-site waste and meets all drinking standards and aquatic life criteria.
5	General				Provide justification that the two points of compliance included in the EIS (core-zone boundary and the Columbia River) are sufficient, and address the possible need for evaluation at other locations on the site.
6	General				Please address the fact that there is a significant amount of variability in the time series graphs of the groundwater modeling results presented in the EIS and the affects this may have on the reliability of results.
7	General				The document cites compliance with potentially applicable regulatory requirements. Clarify that all actions will comply with all ARARs.
8	General				State Environmental Protection Act (SEPA) requirements may not have been met under this NEPA action. Clarify how SEPA requirements will be met where they are found to apply.
9	General				Clarify and define the term selective clean closure.
10	General				Clarify how failure of institutional controls will impact the projected risk evaluation.
11	General				Permitting of a new solid-liquid separations facility will require SEPA coverage. Clarify how this EIS would be adequate to meet the needs of the SEPA checklist for this facility.
12	General				Clarify whether air emissions from steam reforming facilities are included in the risk evaluation.

Comment ID No.	Section	Subsection	Page	Figure, Map or Table Number	Comment
13	General				Explain how risks and impacts will be calculated and included for temporary storage of high-level waste (HLW) on the Hanford site, define the timetable for storage and include this in the risk and impact calculations.
14	General				Provide the site conceptual hydrogeologic model for review including specific assumptions used in the model, such as data selection, qualification and justification.
15	General				Provide a more detailed explanation of how transuranic (TRU) waste can/will be stored on site until it can be shipped to Waste Isolation Pilot Plant. Include the location and specifications of the TRU Waste Interim Storage Facility in particular.
16	General				Bulk vitrification test demonstrations have shown it is not suitable for low-activity waste (LAW) that contains Tc-99. Revise the alternatives to exclude the use of this technology.
17	General				Address the need for plans to conduct a thorough characterization in every tank farm where a leak or release has occurred to identify the contaminants. Explain how plans will be developed for removing residual contamination, sampling and analysis of residual waste, radiological assessment of the structural steel of the tanks, assessment of risk to human health and the environment from future releases of radiation due to tank degradation.
18	General				Include plans for sampling waste transfer lines between facilities and evaluating residual waste solidified in place. Leaving these lines in place threatens the vadose zone and groundwater in the future as contaminants are remobilized. As such, a work plan for vadose zone remediation should be developed.
19	General				Revisit the alternatives for removing tanks which overlay known areas of contamination and provide a more detailed analysis of the feasibility of removing all single-shell tanks (SST). Include an estimate of the time to completion for full removal and identify sources for clean fill material.
20	General				The EIS states the Resource Conservation and Recovery Act (RCRA) barrier can last 500 years before needing maintenance, and the Hanford barrier can last 1,000 years. However, the National Research Council has noted that existing test results cannot be reliably extrapolated out to these lengths of time (National Research Council, 2000). Provide justification for these predictions including any assumed maintenance and monitoring activities which will be conducted.
21	General				Include plans to conduct sampling and analysis of residual waste that will be left in the tanks, including radiological assessment of the structural steel.
22	General				Provide a cost analysis for long-term institutional controls. Include in the comparison the cost of future remediation as a result of residual waste mobilization versus the cost of clean closure in present day dollars.

Comment ID No.	Section	Subsection	Page	Figure, Map or Table Number	Comment
23	General				Reliance on process records and institutional knowledge cannot substitute for appropriate site characterization data. Reliance on historic records and process knowledge frequently does not identify all contamination. Provide a plan for conducting comprehensive site characterization in each alternative.
24	General				Provide a comprehensive suite of parameters that ensure proper characterization of extent of contamination.
25	Section 2	2.3.3.2.2	2-44		Provide the details of the remote handled special components (RH-SCs) storage facility within Hanford, including location, dimensions, shielding and emergency systems, beyond the site near the sodium storage facility (page 2-110). These specifics are not addressed in the Environmental Assessment of Sodium Residuals Reaction/Removal (USDOE/EA-1547F).
26	Section 2	2.3.3.3.2	2-47		The Idaho National Labs (INL) Sodium Processing Facility (SPF) has day tanks that are 2,570 liters each (page E-202). The proposed day tanks for the Hanford Sodium Reaction Facility (SRF) are significantly larger than INL's SPF (16,300 liters each - page 2-46). The estimate for 7,600 liters per day of 50% weight sodium hydroxide solution is justified for SPF based on past operating experience at INL (E-209), but appears to be applied to the proposed Hanford facility as well (2-47) without proper justification or accounting for the fact that the new facility tanks are approximately 6 times larger than the existing facility's. Justify these differences and address the operational and facility lifespan consequences as part of the Hanford SRF Option.
27	Section 2	2.3.3.3.2	2-47		Address in detail the transfer of the caustic sodium hydroxide solution produced at the Hanford SRF to the Waste Treatment Plant (WTP). According to the Hanford Site Sodium Disposition Evaluation Report (HNF-33211 R0), the WTP's Pretreatment facility will be equipped with an exterior flanged pipe connection for routing from truck deliveries to the site. This should be included as part of the EIS.
28	Section 2	2.5.3	2-105	2-3, 2-6	Both tables incorrectly indicate that Alterative 3 will include onsite disposal of the reactor vessel and depleted uranium shield in the reactor containment building (RCB). Revise the tables presented with Alternative 3 to be consistent with the text of the EIS.
29	Section 2	2.5.3.1	2-107		Provide more detail regarding the specific waste to be left within the subgrade portion of the RCB in this description. In particular, explain the final disposition of the reactor vessel and depleted uranium shielding, and estimate the amount of internal piping which would be treated in place and left on site. While facility disposition (p. 2-109) notes the reactor vessel remains in place with Alternative 2, this is not revisited in detail. Address disposal of depleted uranium shielding in particular within the text and correct the tables on pages 2-105 and 2-135, which incorrectly specify Alternative 3 for its onsite disposition.

Comment ID No.	Section	Subsection	Page	Figure, Map or Table Number	Comment
30	Section 2	2.5.3.2	2-109		No mention of institutional controls other than the surface barrier is made regarding facility disposition in Alternative 2. Identify additional institutional controls beyond the landfill barrier and specific post-closure security and maintenance activities (if any).
31	Section 2	2.5.3.2	2-110		Bulk sodium is described as being stored in solid form in Section 2.3.3.3, whereas this section describes all Fast Flux Test Facility (FFTF) sodium to be in liquid form. Resolve this inconsistency, and correct the rest of the text.
32	Section 2	2.7.2	2-135	Table 2-6	Table 2-6 indicates on site disposal of the reactor vessel and attached depleted uranium shield for Alternative 3: Removal. Resolve this inconsistency in the text of the EIS. Include more detail and subcategories for post-closure care and administrative/institutional controls which will be implemented. The information currently provided for these categories are too broad and vague to be properly evaluated.
33	Section 2	2.7.4	2-142		Appendix E (E-193) estimates that complete processing of all available bulk sodium currently stored at the FFTF and 200-West will produce less than 40% of the total sodium hydroxide solution needed for the WTP pretreatment process. Justify the statement that there is some uncertainty as to whether all of the caustic solution would be used, and provide further explanation.
34	Section 2	2.9.2.1	2-230	2-24, 2-25	Include the radioactively contaminated bulk sodium as a contaminants of potential concern (COPC) under Alternative 1. The large inventory of bulk sodium would be left on-site and available for environmental release.
35	Section 3	3.2.5.1.1	3-28		There is inadequate documentation and citation of original sources in this discussion (Figure 3-9 for example). Provide references to original source documents for all materials including figures which are cited from other sources. Perform a thorough check for all references throughout the EIS.
36	Section 3	3.2.5.2	3-37		Format this section to follow the same basic organization and nomenclature as the previous sections. Include basic physical and hydrogeologic information and data used to prepare the models. Revise the EIS so that separate sections are consistent and complementary to one another.
37	Section 3	3.2.5.4	3-38		Format this section to follow the same basic organization and nomenclature as the previous sections. Include basic physical and hydrogeologic information and data used to prepare the models. Revise the EIS so that separate sections are consistent and complementary to one another.
38	Section 3	3.2.6.2.1 & 3.2.6.2.4	3-46 & 3-48		Provide the reader with useful, accurate, and documented information on vadose zone conditions and properties (e.g., bedding and other heterogeneities) in this Section.

Comment ID No.	Section	Subsection	Page	Figure, Map or Table Number	Comment
39	Section 3	3.2.6.3.1	3-49		In this Section a water table map, geologic cross-section with superimposed water table, and a paragraph description of the suprabasalt aquifer system are provided, but no conceptual groundwater model is discussed. Aquifer property information useful to the analysis is not provided. Revise this section to include the conceptual hydro model, and provide the basic data and information useful for the numerical modeling in the appendices.
40	Section 5	5.2.1.1.2	5-373		Consider COPC concentrations driving risk/hazards for water from a well which is drilled directly through the FFTF Barrier near or through the entombed waste as well as at the edge of the barrier. Such a scenario is highly plausible over the course of the 10,000-year period of analysis in which most, if not all, institutional controls should be expected to fail.
41	Section 5	5.2.1.2	5-379		For Alternative 2, provide a spatial distribution of groundwater tritium concentrations at the time of peak concentration.
42	Appendix D	D.1.4	D-24		Include all recorded tank leaks in this section, specifically address tank overflow events and other unplanned releases. For example, the overflow event at tank T-101, which was probably as large or larger than the T-106 leak.
43	Appendix D	D.1.5	D 24-27		Revisit and revise the Section that describes the past practice of disposal to cribs and trenches and correct factual errors to more accurately estimate the magnitude of materials disposed in this manner.
44	Appendix D	D.1.5	D-24		Clarify that discharge to ponds was frequently contaminated. In particular explain that the original ditch leading to T- Pond was abandoned and covered because of very high surface radioactivity.
45	Appendix D	D.1.5	D-24	Table D-28	Reconcile the low radionuclide contents reported in Table D-28 with the history of discharges to the T cribs and tile fields that included large quantities of tank supernatant overflow at the end of tank cascades.
46	Appendix D	D.1.5	D-26	Table D-28	Correct errors and omissions in the grouping on this page (including that 216-T-23 should be listed with T and not TY, TY should include 216-T-27, the 216-T-19 crib and tile field located at the south end of TY should be included. T-19 received approximately 455 million liters of evaporator condensate containing very high concentrations of tritium and I-129).
47	Appendix D	D.2.1.6	D-110	Table D-28	This section identifies 37,694 kilograms of depleted uranium as part of the hazardous materials inventory which is not in the bulk sodium residuals. Clarify whether this uranium comprises the depleted uranium shielding which is part of the reactor vessel, or if it is in addition to it. Specifically address the disposal of the depleted uranium shielding within each action alternative, and reconcile inconsistencies between the EIS text and Appendices regarding depleted uranium disposition.
48	Appendix D	D.2.3.3	E-191		Provide a detailed description of the "monitoring program" which would be established under Alternative 3. Include details of any institutional controls and future land use plans.

Comment ID No.	Section	Subsection	Page	Figure, Map or Table Number	Comment
49	Appendix D	D.2.4	D-115		Itemize the ancillary buildings and their internal equipment and components which will be left onsite as part of this action alternative description.
50	Appendix D	D.2.4.2	D-116		Indicate specifically what is expected to be included as part of the uncontaminated material classification. Identify process components specifically included or excluded from this group.
51	Appendix D	D.2.4.2.9	E-199		Provide estimates of operating emissions which will be produced during conversion of bulk sodium to sodium hydroxide at the Hanford SRF, including estimates of radionuclides included in the exhaust and the volume of exhaust expected to pass through the filtration system.
52	Appendix D	D.2.4.3.8.8	E-207		Provide operating records for the Idaho National Labs SPF.
53	Appendix D	D.2.4.4	D-116		The text incorrectly states that demolition waste handling would be the same between Alternatives 2 and 3. One of the major differences between the Alternatives is the disposition of demolition and radioactively contaminated waste onsite inside the RCB and adjacent building foundations in Alternative 2 while Alternative 3 calls for the removal of all this waste to an integrated disposal facility (IDF). Clarify this text throughout the document and provide additional descriptive detail.
54	Appendix D	D.2.4.4.1	E-210		The text of this section is inconsistent with the flow charts provided in Figures 2-65 and 2-68, both of which exclude disposal of Hanford treated RH-SCs at the Nevada Test Site (NTS). Explain this discrepancy specifically (that is, why Hanford treated RH-SCs cannot be sent to NTS).
55	Appendix D	D.2.4.4.2.8	E-218		It is not clear that the irradiated and contaminated metal components which will be delivered to the induction melter in the RH-SC processing facility will meet the typical induction melter requirements such as charge materials be of known composition and clean of oxidation products. Include specific text explaining how these challenges will be met.
56	Appendix D	D.2.4.4.2.8	E-219	E-48	Provide dimensions for the induction melter on Figure E-48.
57	Appendix D	D.2.4.5	D-117		Provide a detailed description of the planned post-closure care program planned for the site; including any barriers not already mentioned, fencing, access restrictions or other institutional controls as well as funding available to maintain these facilities.
58	Appendix K	K.1.1.1	K-2		The details provided in the example (i.e., half-lives and emissions) are only accurate for the U-238 decay chain. The example should specify the isotope of uranium in order to be accurate and complete.
59	Appendix K	K.1.1.3	K-7		The rationale for multiplying the health risk factor by 2 for individual doses > 20 rem was not discussed. Indicate how this factor was selected (research, arbitrarily selected for a more conservative estimate of cancer risk, etc.)

Comment ID No.	Section	Subsection	Page	Figure, Map or Table Number	Comment
60	Appendix K	K.1.2.4	K-8		Occupational exposure to chemicals must be maintained within OSHA permissible exposure limits [29 CFR 1910]. The American Conference of Governmental Industrial Hygienists threshold limit values are recommendations or guidelines rather than regulatory requirements, and should not be used.
61	Appendix K	K.1.2.6	K-9		The exposure assessment assumes air is the only medium and inhalation is the only exposure pathway for a chemical impact assessment. This assumes any incident will result only in an air release. Address chemical incidents that may result in a release to soil or water (such as a liquid spill) and potential exposure via dermal contact or ingestion.
62	Appendix K	K.2	K-11		Human receptors for radiological exposure include: 1) a member of the general population within 50 miles of the site, 2) a maximally exposed individual (MEI) hypothetical member of the public located just outside the site boundary (with the highest yield impacts), and 3) an MEI onsite worker at specific locations. None of these scenarios includes Native Americans, who are considered a exposure population unique from the general public or site workers, and may be exposed to releases during normal operations and accidents during cleanup actions. Also, the onsite MEI only considers workers at the Columbia Generating Station and Laser Interferometer Gravitational-Wave Observatory. Consider and include exposure scenarios for workers at US Ecology, ERDF, or other waste management areas; and include an exposure scenario for Native Americans.
63	Appendix K	K.2.1.1.1	K-11/13	Figure K-1	When first introducing the off-site MEI (as shown on the figure), indicate how the off-site MEI locations were determined from the assumed emission sources.
64	Appendix K	K.2.1.1.1	K-13	Figure K-1	Include the onsite MEI locations.
65	Appendix K	K.2.1.1.1.1	K-14		Regarding the internal dose, also account for wild plants, game, and fish, which are harvested by Native Americans, as well as, water used during traditional sweats, via ingestion, inhalation, and dermal contact. Any of these activities may be practiced by Native Americans within 50 miles of the site and in the hypothetical off-site MEI locations during normal operations and accidents. Consider utilizing the GENII computer code ENV module, which has the capacity to calculate exposure based on multiple media sources and pathways, or address reasons for not utilizing this module.

Comment ID No.	Section	Subsection	Page	Figure, Map or Table Number	Comment
66	Appendix K	K.2.1.1.3.1	K-16		Justify the reasoning that, in this section, a 30-foot height was assumed for evaluating meteorological data to model transport of releases from the Supplemental Treatment Technology Site-East and West (vs. a 200-foot stack emission from the WTP) to an off-site MEI. This is inconsistent, however, with Section K.2.1.1.1.1 that states that the emission would be assumed to be at ground level (resulting in a reduced dispersal, and a more highly concentrated plume) for these supplemental treatment sites. Revise the document to be consistent where necessary.
67	Appendix K	K.2.1.1.3.3	K-23	Table K-5	The footnote to this table states that "food consumption rates represent the portion of the diet consisting of contaminated food." Explain how this portion is calculated, consider a worst case scenario where 100% of the diet is contaminated for a MEI. Include fish consumption since off-site MEI locations are along the Columbia River.
68	Appendix K	K.2.1.1.3.3	K-23	Table K-5	Provide parameter inputs to reflect a traditional tribal member as presented in the tribal lifestyle described in the Yakama Nation Exposure Scenario provided to USDOE in 2007 (Ridolfi, 2007). Correct the assumption that the MEI would be exposed only 50% of the time (i.e., provide a 100% scenario) because it is unlikely that individuals spend half of their time elsewhere.
69	Appendix K	K.2.1.1.3.3	K-24		The MEI was assumed to consume a larger portion of their diet from fruits & vegetables grown in a family garden. Native Americans with a traditional tribal lifestyle would ingest wild foods and medicines (plant, fish, and animal origins) hunted or harvested from locations closer to the source term than the location of a residential garden.
70	Appendix K	K.2.1.1.3.4	K-24		Provide the source and location of the screening analysis that was conducted for each Alternative to identify key radionuclides that would be released during normal operations. For example, explain how neptunium-237 and thorium-232 (which are site contaminants and which were included in the detailed analysis in Appendix Q) were eliminated.
71	Appendix K	K.2.1.1.3.4	K-25		The Best-Basis Inventories include radionuclide estimates for 46 radionuclides. Appendix K indicates a total of 14 radionuclides were included in the air pathway dose analysis. Appendix K should identify the complete list of 46 radionuclides, and a thorough description of the criteria used to eliminate radionuclides from the detailed analysis.
72	Appendix K	K.2.1.1.4	K-33		For the radionuclide analysis, radioactive inventories should be adjusted to account for differences in the duration of the alternatives. Radioactive decay over time would reduce the radioactivity of each radionuclide. Both plutonium (Pu)-241 and its daughter, americium (Am)-241, are included in the air pathway dose analysis. The half-life of Pu-241 (14.4 years) is significantly shorter than that of Am-241 (432.7 years) resulting in an increase in the Am-241 concentration until equilibrium conditions are reached.

Comment ID No.	Section	Subsection	Page	Figure, Map or Table Number	Comment
73	Appendix K	K.2.1.2.1	K-48		In the assessment of doses to radiation workers, dose was calculated based on a 2,080-hour work year. In the case of the noninvolved workers, dose was calculated based on a 2,000-hour work year. These exposure durations are inconsistent and should be resolved.
74	Appendix K	K.2.1.2.1	K-49	Table K-48	The average project impact for a full-time worker with a 40-year exposure period is at least 10 times the maximum acceptable increased lifetime cancer risk for every Alternative. Provide incidence rates as well, and compare to an acceptable risk level for each Alternative being proposed including the No Action Alternative.
75	Appendix K	K.2.2.1.1	K-57		For the FFTF decommissioning Alternatives, ground-level radiological emissions were assumed, and the statement was made that "this conservative assumption resulted in overestimation of the impacts." Indicate whether a sensitivity analysis was done to determine if a more dispersed plume would impact a larger population.
76	Appendix K	K.2.2.1.4	K-64		Impacts under FFTF Alternative 1 (No Action) are not evaluated here because they are considered part of the "Hanford Baseline." Revise to evaluate impacts under every Alternative, including No Action.
77	Appendix K	K.3.9.1	K-127	Table K-102	It is insufficient to evaluate only those chemicals used in the waste treatment process (vitrification plant) and supporting operations to determine chemical impacts from an accident, and not include those contained within the process streams or process byproducts. Although the quantities may not be as great, these additional chemicals may be extremely hazardous; there is no way of knowing from Table K1-102 what chemicals are not considered here. Identify and evaluate the chemicals contained within process streams or process byproducts to determine chemical impacts from an accident.
78	Appendix K	K.3.9.3.1	K-137	Table K-106	Provide the criteria used to condense the list of 400 hazardous materials to 24 that could potentially result in significant impacts on workers and clearly explain the process for eliminating chemicals. Provide the elimination criteria and explain the screening evaluations which were performed for all chemicals.
79	Appendix K	K.4	K-153		Justify the use of industrial safety impact rates only between 2001 and 2006. This "recent history" provides a low-end estimate of recordable cases and fatality rates (2 per 200,000) that may not be reflective of actual incident rates. This is particularly true as construction activities (private industry total recordable rate of 6.7 per 200,000) will likely increase with the implementation of Alternatives. As such, the occupational safety impacts calculated for each of the Alternatives may currently be underestimated.
80	Appendix L	L.1	L-1		Define and use consistent geologic terminology. Distinguish the difference in the EIS analysis between silt, mud and clay. Specific information should include grain size information and geochemistry as appropriate.

Comment ID No.	Section	Subsection	Page	Figure, Map or Table Number	Comment
81	Appendix L	L.2	L-3		The USDOE notes: "In the Gable Gap area near Gable Mountain and Gable Butte, the elevation of the basalt/suprabasalt sediment interface is uncertain." There are more than 800 boring logs which reach the top of basalt in the Hanford site (page L-19). The USDOE should provide the specific data (e.g., well logs) which were used, along with measurement uncertainty which was assigned, to better estimate the elevation of the basalt/suprabasalt sediment interface. Discuss the sensitivity of the model to basalt elevation and explain how uncertainty in determining this surface is carried forward to model results.
82	Appendix L	L.2	L-4		"For the purpose of this regional-scale model, the water balance in the unconfined aquifer beneath Hanford is assumed to have remained relatively constant since 1940, except for anthropogenic recharges resulting primarily from operations at Hanford." Provide data and discussion of how pumping at Hanford impacted the water balance in the unconfined aquifer. Data should note whether pumping has increased or decreased over the years. Also, explain the impacts of the basalt aquifer pumping and alluvial recharge associated with irrigated farming in Cold Creek Valley.
83	Appendix L	L.4.1	L-7		Provide the slice maps (e.g., elevation layers) in the report that show how elevation layers vary across the model domain.
84	Appendix L	L.4.1.2	L-8		"The model domain is divided into a 200- by 200-meter (656- by 656-foot) horizontal grid, with a "fringe" of partial cells on the northern, eastern, and southern sides." Provide justification for these grid dimensions.
85	Appendix L	L.4.2	L-11		Near the northern boundary of the 200-East Area a series of erosional windows through the Elephant Mountain Member of the Saddle Mountains Basalt are known to occur. While for many areas within the model the basalt may be accurately modeled as a no-flow boundary, this area needs to be addressed in detail. Provide discussion of how erosional unconformities are handled in the model, and where they are included (if at all).
86	Appendix L	L.4.2.2	L-13		"The EIS MODFLOW groundwater flow model sets streambed thickness at 2 meters (6.6 feet) and conductivity at 0.0004 meters (0.0013 feet) per second." Provide specific justification for these values, including any site data which was used in their determination.
87	Appendix L	L.4.2.5	L-15	Figure L-4	Identify all layers which contain, and the corresponding position of the mountain front recharge zone. Explain if it only occurs at Earth's surface, or if it is represented in subsurface as well.
88	Appendix L	L.4.3.2	L-18		Provide the criteria used to interpret the logs, and identify geologic units. Explain the interpretation process and why previous subsurface interpretations were not used.
89	Appendix L	L.4.3.2.1	L-19		Explain why the top of basalt was remapped. A number of highly credible top of basalt maps and grid models have been generated previously. Provide well data used in the remapping process.

Comment ID No.	Section	Subsection	Page	Figure, Map or Table Number	Comment
90	Appendix L	L.4.3.2.2	L-23		Provide justification for the subsurface model provided, and the reason for not employing a more traditional method for building the geologic framework for the model such as using structure contour surface maps.
91	Appendix L	L.4.3.2.2	L-24		"Remove incongruities due to extrapolation from borehole out to edge of transect (seam)." This is an unavoidable artifact of extensive extrapolation from limited data. Provide a description of the process used to resolve these discrepancies between transects.
92	Appendix L	L.5.2	L-26		"Anthropogenic inputs are applied in 1-year stress periods beginning in 1944." Include an explanation of stress periods here.
93	Appendix L	L.5.3	L-26		"Outer iterations vary the preconditioned matrix of hydrogeologic parameters of the flow system, e.g., transmissivity, saturated thickness, in an approach toward the solution. Inner iterations continue until the user-defined maximum number of inner iterations has been executed or the final convergence criteria are met." Provide a brief explanation of the convergence criteria, and how closely they must be met with this text.
94	Appendix L	L.7.2.3	L-32	Table L-13	The model needs to be revised so that the highly conductive Hanford gravel and activated basalt are encoded within the preliminary calibration.
95	Appendix L	L.7.2.4	L-32		The hydraulic conductivity values used might generally be low, especially for the coarser units. It should be noted that most Hanford Site aquifer tests have been done in 4-inch wells, completed in approximately 8-inch borings. Given other observations made about gravelly deposits in the region, it is likely that the wells are too small to pump hard enough to adequately stress the aquifer. Please discuss the limitations of the data sources and quality used in this section.
96	Appendix L	L.10	L-63	Figures L-49 & L-82	The x-axis in these graphs are reported as observed head. If this is observed data it should be noted as such; however, this does not seem sensible since the time plotted reaches 2015.
97	Appendix L	L.10.2.3	L-93		The path line analysis appears to have generated some results that do not seem to make sense. All of the maps show particle traces that parallel water level contours, rather than traversing across them. The maps certainly suggest that either the tracks or the water table maps are incorrect. Reconcile this error and provide an explanation of the mechanics for constructing path lines.
98	Appendix M				The release models described in Appendix M include parameters that describe assumptions related to the geometry of waste sources. List and describe all parameters included in the release models and provide the values assigned to them and their associated uncertainty.

Comment ID No.	Section	Subsection	Page	Figure, Map or Table Number	Comment
99	Appendix M				The uncertainties in the distribution coefficients and their effects on uncertainties in release rates are at least as significant as the effects of the variables that were included in the sensitivity analysis. Revise the sensitivity analyses for the release models to consider the effects of uncertainties in distribution coefficients. Revise the range of values used in these sensitivity analyses to be consistent with published ranges.
100	Appendix M				The uncertainties that are identified through the release model sensitivity analyses are not carried forward into subsequent modeling or analyses. This ultimately translates into uncertainty in the vadose zone transport model and into uncertainties in the groundwater flow models. These uncertainties ultimately translate into uncertainties in risks and impacts. Revise to carry forward the uncertainties identified in the sensitivity analyses into subsequent modeling and analyses.
101	Appendix M				Five models for simulating releases from solid sources are described in Appendix M. The scenarios for which the models are used are described for four of the release models. Applications for the fifth release model (constituent solubility limited release) are not described. Describe the applications of the constituent solubility limited release model, remove the fifth model from the appendix if it is not used to describe releases.
102	Appendix M	M.2.2.5	M-12	Equation M-28	The equation presented to describe releases for the constituent solubility limited release model (Equation M-28, page M-12) appears to be in error. The listed equation gives the release rate per unit area (grams/year/square meter). Review the equation and determine if an area term on the right side of the equation is necessary to give the release rate in grams per year.
103	Appendix M	M.3	M 13 - M14	Table M-2	Please model more variable scenarios, update infiltration rates to reflect current conditions (rather than falling back on 3.5 millimeters per year, which is apparently a value arrived at for undisturbed Hanford desert). Account for global warming or climate change as needed to provide a more appropriate long-term model. Discuss uncertainty associated with model results.
104	Appendix M	M.5.2.4	M-90	Figure M-109	The label for the vertical axis in Figure M-109 (page M-90) is incorrect. The graph shows the cumulative release of Tc-99 in curies. Correct the label for the vertical axis in Figure M-109 (page M-90).
105	Appendix N				A large number of bar charts showing the mass of chemical and radiological constituents that reach the water table are included in Appendix N. Because of the logarithmic scales used on these charts, they do not provide an accurate accounting of mass. Provide mass balances in tabular form to compare the releases to the vadose zone (from Appendix M) with the releases to the aquifer (from Appendix N); discuss any discrepancies.

Comment ID No.	Section	Subsection	Page	Figure, Map or Table Number	Comment
106	Appendix N				The sensitivity analyses considers I-129 distribution coefficients in the range of 0 to 0.2 milliliters per gram. Sensitivities to distribution coefficients for other chemical and radiological constituents are not included. Revise the sensitivity analysis to consider the effects of uncertainties in distribution coefficients for additional radiological and chemical constituents use a range of values in these sensitivity analyses that is consistent with published ranges.
107	Appendix N				The uncertainties that are identified through the release model sensitivity analyses are not included in the vadose zone models. The uncertainties in the vadose zone transport model are carried forward into the groundwater flow models. These uncertainties ultimately translate to evaluation of risks and impacts. Revise to carry forward the uncertainties identified in the sensitivity analyses into subsequent modeling and analyses.
108	Appendix N				The vadose zone transport simulations are conducted for a subset of the radiological and chemical constituents released from the sources. The number of radiological and chemical constituents included in the vadose zone transport models is smaller than the number used in the source release models. Provide the rationale and selection criteria applied when deciding which constituents to include and which to exclude from the release models.
109	Appendix N	N.1.1.2	N-2		The parameters presented do not appear to be consistent with 3D analysis that is presumably performed by STOMP. It is additionally unclear if release and receiving areas between models are consistent. Provide additional detail regarding the parameters used and the selection of boundary conditions.
110	Appendix N	N.1.2	N 2 - 8		Revise models to utilize actual measured precipitation and infiltration rates, rather than averaging unusual large-scale events or large areas of geologic strata.
111	Appendix N	N.1.2	N-10	Figure N-8	Clarify the apparent relationship shown in the figure between BY Cribs contamination and Tc-99 contamination at the Tank Farms in 200-West. It does not seem plausible that the BY Cribs is responsible for Tc-99 contamination at the Tank Farms in 200-West.
112	Appendix N	N.1.2	N-3		"In an initial step, values of vadose zone parameters were determined for the 16 soil types by matching moisture content profiles predicted using the Van Genuchten relationship to moisture content profiles measured in 140 undisturbed vadose zone boreholes." Explain the uncertainty involved in the Van Genuchten determination of vadose material hydraulic properties (i.e., hydraulic conductivity) and how this uncertainty is carried through to the modeled result.
113	Appendix N	N.1.2	N-9	Figure N-7	Clarify the meaning of the isolated lobe on the contour map, located to the northeast and whether it is related to the BY Crib plume or contamination from Gable Mountain Pond or some other source.

Comment ID No.	Section	Subsection	Page	Figure, Map or Table Number	Comment
114	Appendix N	N.2.1.2	N-51	Figure N-80	The label for the vertical axis in Figure N-80 (page N-51) is incorrect. The graph shows release of chemical constituents in kilograms. Correct the label for the vertical axis in Figure N-80 (page N-51).
115	Appendix N	N.3.2	N-91		"The case evaluated in this section, discharge of a volume of liquid to the vadose zone, is comparable to a past leak at a tank farm, with aqueous discharge ranging from 4 cubic meters (1,057 gallons) to 400 cubic meters (105,700 gallons). This range corresponds to current estimates of volumes of past leaks (Hanlon 2003) and reflects the degree of uncertainty in estimates of leak volumes that is related to difficulty in measurement of volume of material in large underground tanks." The Hanlon (2003) document does not adequately describe how the tank leakage estimates were determined. Provide additional information on how the leaked volumes and total activities were estimated. Include in this information the uncertainty associated with the estimate.
116	Appendix O	O.2.3	O-6		"The dispersivity increases linearly with distance from the source location up to a specified threshold." Explain how the threshold was determined or selected.
117	Appendix O	O.3.1	O-33	Table O-6 & O-9	Review and reconcile the results of the fate and transport modeling, since they do not seem to make sense. For example, COPC concentrations related to releases from cribs and trenches are shown for Alternative 1 (Table O-6) and Alternative 2A (Table O-9). The model output results are different for events that happen in the past. This suggest the model is not stable enough to reliably replicate past events. It is implausible that analysis for future closure scenarios will therefore be appropriately representative.
118	Appendix O	O.6.1.2	O-18		"These results suggest that regional-scale contaminant plumes (i.e., areas of groundwater contaminated above benchmark values) from the EIS cumulative analysis sources in the 200-East Area are somewhat different for the Base and Alternate Case flow fields." Explain the reason for the discrepancy between the Base and Alternate cases, include information on the plume's sensitivity to parameters which were changed.
119	Appendix O	O.6.3	O-19		"These values resulted in retardation factors (R) of approximately 1 and 3 for the bulk density (2.6 grams per cubic centimeter) and porosity (0.25) assumed for the unconfined aquifer." Provide the uncertainty associated with the assumed bulk density and porosity when used in calculating the retardation factors. Provide a comparison with measured values for these parameters and describe the uncertainty introduced by using assumed values.
120	Appendix O	O.6.4	O-104		"It is uncertain whether peak concentrations of U-238 were captured during this standard analysis period of 10,000 years." Provide an explanation as to why it cannot be determined whether peak concentrations have passed. Include discussion of why the U-238 concentration does not appear to diminish significantly over time at the core zone boundary.

Comment ID No.	Section	Subsection	Page	Figure, Map or Table Number	Comment
121	Appendix O	O.6.4	O-105		Indicate whether the modified STOMP analysis results listed on this page are from Base or Alternate case scenarios.
122	Appendix Q				The dose guidelines for the evaluation of groundwater, surface water, and intruder scenarios should be summarized in a single location for ease of interpretation of results.
123	Appendix Q				To allow for comparison, revise the graphs in this chapter to be consistent or comparable in type (logarithmic versus linear) and range for each alternative.
124	Appendix Q	Q.2	Q-2	Table Q-1	Americium is listed as one of the radionuclides selected for detailed analysis in Table Q-1. Pu-241 is not listed as one of the plutonium isotopes in the table. Contributions from the decay of Pu-241 will increase the Am-241 concentration over time. Clarify whether the increase in Am-241 from the decay of Pu-241 is considered in the analysis.
125	Appendix Q	Q.2.2.2	Q-15		Include all exposure pathways that are applicable to each individual. Do not assume exposure pathways are mutually exclusive (e.g., the American Indian hunter-gatherer and the resident farmer are each potentially exposed to radiological and chemical contamination via both groundwater and surface water, etc.).
126	Appendix Q	Q.2.3	Q-18		Include both radiologic and chemical exposure (short- and long-term).
127	Appendix Q	Q.2.3.2.3	Q-18 & Q-22		It is stated that the drinking water pathway is not assessed because it involves transport through the vadose zone to groundwater, which would occur in the future after short-lived radionuclides have decayed. This fails to address extensive contamination with long-lived radionuclides that continue to decay for thousands to millions of years. Revise to address short-term exposures to high concentrations via the drinking water pathway in the intruder scenario, where well water is used immediately after the well is drilled and provide a short-term impact analysis.
128	Appendix Q	Q.2.4.2	Q-26	Table Q-9	Include the parameter inputs provided in the Yakama Nation Exposure Scenario to adequately reflect time spent outdoors on site by a traditional tribal member. (Ridolfi 2007)
129	Appendix Q	Q.2.4.2	Q-28		Revise the section to include the fish consumption rate, that is representative of a tribal diet, as shown in the Yakama Nation Exposure Scenario. (Ridolfi 2007)

Comment ID No.	Section	Subsection	Page	Figure, Map or Table Number	Comment
130	Appendix Q	Q.3	Q-32	Tables Q-16 & Q-17	Table Q-16, *Summary of Radiological Dose at Year of Peak Dose for Drinking-Water Well User (millirem per year)* , provides the dose for the year of peak dose and the calendar year of the peak dose. Table Q-17, *Summary of Radiological Risk at Year of Peak Radiological Risk for Drinking-Water Well User (unitless)* , provides the radiological risk for the year of peak radiological risk and the calendar year of the peak radiological risk. The year of peak radiological risk should not precede the year of the peak dose or peak concentration. For example, for U Barrier, Scenario 2A, the year of peak dose is calendar year 11,763 while the year of peak radiological risk is calendar year 2096. This discrepancy should be addressed in the text of the EIS.
131	Appendix Q	Q.3	Q-32	Table Q-16	All tank closure alternatives for B Barrier, T Barrier, and the Core Zone Boundary for the Drinking-Water Well User exceed the 10 millirem per year criteria. There is no acceptable Alternative proposed. A revised EIS should provide at least one Alternative which meets the stated criteria.
132	Appendix Q	Q.3.1.1	Q-33	Table Q-17	Every Alternative proposed shows a radiological risk above the maximum acceptable increased lifetime cancer risk level (3×10^{-4} per EPA) in at least one location (core zone boundary, river near shore, and at barriers); the core zone boundary, in particular, shows unacceptable cancer risks from every alternative and should be reconsidered. Provide an Alternative that is adequately protective of human health and against cancer risk in the long term and meets legal requirements.
133	Appendix Q	Q.3.1.1.8	Q-236	Table Q-209	Table Q-209, Doses to an American Indian Engaged in Residential Agriculture Following Well Drilling at the Tank Farms, indicates multiple situations in which the USDOE Intruder dose guideline of 500 millirem is exceeded. The text mentions that some of these situations exceed the guideline, but it does not discuss how this issue might influence decision-making. This discussion should be included in a revised EIS.
134	Appendix U				Revise the estimates for dose and risk for the "American Indian Resident Farmer" to include all the pathways relevant to the Yakama lifestyle.
135	Appendix U	U.1.3	U-5	Figure U-1	Appendix U does not explain the incidental increases in tritium concentration after calendar year 2240. The concentration of tritium is expected to decrease over time as a result of radioactive decay. Provide an explanation for this discrepancy.
136	Appendix U	U.1.3	U-6	Figure U-3	Appendix U should explain the increases in Sr-90 after calendar year 2690. The concentration of Sr-90 is expected to decrease over time as a result of radioactive decay.
137	Summary				Clarify how risks under the Alternatives presented can address cumulative impact analyses accurately without an overall Hanford Site Baseline Risk Assessment.

Comment ID No.	Section	Subsection	Page	Figure, Map or Table Number	Comment
138	Summary				Please identify the six sets of cribs and trenches (ditches) that are contiguous to the SST. Indicate whether any of these would be permitted treatment, storage, and disposal units or RCRA past practice units.
139	Summary				WAC 173-303-610 dangerous waste regulations require clean closure first be attempted before a decision is made to close as a landfill. Washington State regulations also require corrective action be performed for leaks and spills. Revise the EIS to provide at least one Alternative that meets this requirement.
140	Summary				Clarify the impacts to effluent treatment facility as a result of WTP operation in terms of additional waste and ability to treat the waste delivered appropriately.
141	Summary	S.1.2.1	S-5		It is stated on S-5 that the disposal pathway for both failed and spent melters will require further evaluation than presented in this document. If a separate EIS is expected to be required this should be stated. Provide additional detail regarding how the failed and spend melters will be addressed.
142	Summary	S.2.1.3	S-23		Please provide an easily understood comparison of the WTP configuration changes between Alternatives as well as the design elements common to all Alternatives.
143	Summary	S.2.1.5	S-27	Table S-1	Clarify whether or not an additional facility would be constructed and if it was included in the cumulative impacts assessment.
144	Summary	S.2.3.3	S-31	Table S-4	Please provide rationale for choosing only 100 years of post closure care.
145	Summary	S.3.1.3	S-36		Regarding tank waste transfers, recirculation of sluicing liquids back to the tanks could create characterization problems for WTP waste streams. This issue should be addressed in detail.
146	Summary	S.4.1.2	S-50		Regarding the statement, “Although the following technologies were ultimately not considered reasonable for detailed analysis in this EIS, that does not preclude their future consideration as potentially viable approaches for retrieving waste from the SSTs,” please clarify under what circumstances these technologies would be considered, and whether another EIS would be performed to address their impacts.
147	Summary	S.5.1	S-53		Please clarify whether combined impact analyses were performed for noise or facility accidents to meet NEPA requirements.
148	Summary	S.5.4.1	S-93		USDOE’s preferred Alternative for tank closure includes landfill closure which does not address past leaks. USDOE acknowledges that past leaks are major contributors to long-term groundwater impacts. These impacts should be addressed.

Comment ID No.	Section	Subsection	Page	Figure, Map or Table Number	Comment
149	Summary	S.5.4.3	S-100	Table S-8, S-9	EIS Tables S-8 and S-9 demonstrate that the Alternatives presented are not expected to meet drinking water standards if waste from other USDOE sites is disposed at Hanford. In both Alternatives 2 and 3 shown in Table S-8, the calculations assume that imported waste would be disposed in an IDF. Table S-9 indicates that almost the entire impact on groundwater in the IDF would come from imported waste. This is reiterated when Alternative 2 is compared with Alternative 3 in Table S-9, which assumes no imported waste is disposed in an IDF. In the no imported waste case, the drinking water standard is met for Tc-99 and exceeded for I-129. In the case of imported waste, the drinking water standard for Tc-99 is exceeded by more than 20 times for and more than 170 times for I-129. Please address this issue in greater detail and revise the EIS to include at least one alternative which is expected to meet drinking water standards. Disposal of imported waste in an IDF should be excluded from all Alternatives.

Burke, T.M. 2007. *Hanford Site Sodium Disposition Evaluation Report* (HNF-33211). Prepared for the U.S. Department of Energy Assistant Secretary for Environmental Management by Flour Hanford Inc, May.

National Research Council (NRC). Board of Radioactive Waste Management, Commission on Geosciences, Environment, and Resources, 2000. *Long-Term Institutional Management of U.S. Department of Energy Legacy Waste Sites.* Washington, DC: National Academy Press, pages 3-5.

RIDOLFI Inc. (Ridolfi), 2007. *Yakama Nation Exposure Scenario for Hanford Site Risk Assessment, Richland, Washington*. Prepared for the Yakama Nation ERWM Program. September.

U.S. Department of Energy (USDOE). 2006. *Environmental Assessment, Sodium Residuals Reaction/Removal and Other Deactivation Work Activities, Fast Flux Test Facility Project, Hanford Site, Richland, Washington*. March.

Hanlon, B.M. 2003. *Waste Tank Summary Report for Month Ending December 31, 2002* (HNF-EP-0182). Rev. 177, CH2M HILL Hanford Group, Inc., Richland, Washington. February.

INSTITUTE FOR ENERGY AND
ENVIRONMENTAL RESEARCH

6935 Laurel Avenue, Suite 201
Takoma Park, MD 20912

Phone: (301) 270-5500
FAX: (301) 270-3029
e-mail: ieer@ieer.org
http://www.ieer.org

Attachment 3

Detailed Comments on *Draft Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington* (*TC & WM EIS*) (DOE/EIS-0391), EIS October 2009

Arjun Makhijani, Ph.D.

prepared by the Institute for Energy and Environmental Research

March 18, 2010

The following comments on the *Draft Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington*[1] were prepared by the Institute for Energy and Environmental Research to feed into overall comments being submitted by the Environmental Restoration and Waste Management program of the Yakama Nation.

A. Institutional Controls

The DOE appears to assume institutional control for 10,000 years – the entire period of assessment of impacts in the TC&WM EIS. Indeed, it states explicitly that consequences of its onsite impact calculations are "hypothetical" because it does not expect to lose control of it:

> Consistent with DOE guidance (DOE Guide 453.1-1), the potential consequences of loss of administrative or institutional control are considered by estimation of impacts on onsite receptors. Because DOE does not anticipate loss of control of the site, these onsite receptors are considered hypothetical and are applied to develop estimates for past and future periods of time. [2]

[1] United States Department of Energy. *Draft Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington* (*TC & WM EIS*) (DOE/EIS-0391), October 2009. Hereafter TC&WM EIS 2009.
[2] TC&WM EIS 2009, Vol. 2, p. Q-31.

There are a number of problems with the DOE assumption that the onsite exposure cases are just hypothetical because it will retain institutional control for 10,000 years. No government, not to speak of a government department has lasted anything close to that time. The DOE assumption does not even take into account the history of the site for the last 1,000 years let alone a period ten times that. Various Indian tribes have used the site freely, including for subsistence hunting, fishing, and gathering for both food and medicines; wars have taken place at or near the site; and subsequent to those wars, a complex and evolving pattern of use prevailed until the site was taken over for plutonium production during World War II.

Compliance with treaty requirements, historical facts, as well as technical reality demand that the baseline assumption in evaluating and comparing alternatives and compliance with laws and regulations should be that institutional controls will not last a few decades beyond the time that the site is declared cleaned up. The National Research Council, in reviewing DOE cleanup plans, has explicitly advised the DOE on this point in the past. Specifically, in a report on long-term management it stated:

> The Committee on Remediation of Buried and Tank Wastes finds that much regarding DOE's intended reliance on long-term stewardship is at this point problematic….
>
> […]
>
> Other things being equal, **contaminant reduction is preferred to contaminant isolation and imposition of stewardship measures whose risk of failure is high.**
>
> […]
>
> *The committee believes that the working assumption of DOE planners must be that many contamination isolation barriers and stewardship measures at sites where wastes are left in place will eventually fail, and that much of our current knowledge of the long-term behavior of wastes in environmental media may eventually be proven wrong. Planning and implementation at these sites must proceed in ways that are cognizant of this potential fallibility and uncertainty.*[3]

Given that so many of the major geologic features of the area are on the order of 10,000 years old, the baseline assumption for contamination isolation measures, such as caps and barriers, should also be that their risk of failure is high. And, as noted above, the assumption of long-term institutional control is not compatible with either local or global historical reality. In view of that, the DOE should discard the assumption of institutional controls significantly beyond the cleanup period for its analysis of the alternatives, and for its choice of the preferred alternatives.

A reasonable plan would be to assume institutional control for the duration of cleanup required by the alternative under consideration, with a free release after that. Such an approach would be consonant with the advice of the National Research Council and with historical and technical

[3] National Research Council, Board on Radioactive Waste Management, Commission on Geosciences, Environment, and Resources, *Long-Term Institutional Management of U.S. Department of Energy Legacy Waste Sites,* Washington, DC: National Academy Press, 2000, on the Web at http://www.nap.edu/catalog.php?record_id=9949, pp. 3-5. Original italics; bold added.

realities. With the proviso of thorough cleanup (see below), it is also the only assumption that is consonant with the unrestricted exercise of treaty rights by the Yakama Nation.

We note here that in the past, the DOE had included such an alternative in the tank waste EIS Notice of Intent of 2003:

> *Closure*: Clean closure reflects minimal residual waste in tanks and ancillary equipment, and contaminated soils remediated in place and/or removed from the tank system to be treated and disposed of in accordance with RCRA requirements. As operations are completed, all SST system storage, treatment, and disposal facilities at the Hanford Site would be closed. ***Waste storage and disposal facilities would be closed in a manner that supported future use on an unrestricted basis and that did not require post-closure care***.[4]

Recommendations: The DOE should discard the assumption of institutional controls significantly beyond the cleanup period for its analysis of the alternatives, and for its choice of the preferred alternatives. A reasonable plan would be to assume institutional control for the duration of cleanup required by the alternative under consideration, with a free release after that. Such an approach would be consonant with the advice of the National Research Council, with historical and technical realities. With the proviso of thorough cleanup (see below), it is also the only assumption that is consonant with the unrestricted exercise of treaty rights by the Yakama Nation.

B. Range of alternatives considered

The TC&WM EIS does not present overall alternatives whose environmental and health impacts could be compared in a straightforward way. Instead, the DOE has used a confusing approach in which a number of alternatives, with impacts that could differ widely, are grouped together as "preferred." The DOE has summarized its preferences as follows:

> Eleven alternatives for potential tank closure actions are evaluated in this draft EIS. These alternatives cover tank waste retrieval and treatment, as well as closure of the SSTs. DOE does not have specific preferred alternatives for retrieval or treatment of the tank waste, but has identified a range of preferred retrieval and treatment options. For retrieval, DOE prefers Tank Closure alternatives that would retrieve at least 99 percent of the tank waste. All Tank Closure alternatives would do this, with the exception of Alternative 1 (No Action) and Alternative 5. For treatment, DOE prefers Tank Closure Alternatives 2A, 2B, 3A, 3B, 3C, 4, and 5 because they would allow separation and segregation of the tank waste for management and disposition as LLW and HLW, according to the risks posed. In contrast, DOE does not prefer Tank Closure Alternatives 6A, 6B, or 6C because they would treat all tank waste as HLW. For closure of the SSTs, DOE prefers landfill closure, as provided under Tank Closure Alternatives 2B, 3A, 3B, 3C, 5, and 6C, for the reasons described in Section S.5.4.1. The Tank Closure alternatives that capture each of DOE's preferred retrieval, treatment, and closure options

[4] TC&WM EIS 2009, Vol. 2, p. A-18, which is part of the 2003 "Notice of Intent to Prepare and Environmental Impact Statement for Retrieval, Treatment, and Disposal of Tank Waste and Closure of Single-Shell Tanks at the Hanford Site, Richland, WA." The NOI starts on p. A-14. Emphasis added.

> are Alternatives 2B, 3A, 3B, and 3C. For storage, DOE prefers Alternatives 2A, 2B, 3A, 3B, 3C, 4, and 5. These alternatives assume shipment of IHLW [Immobilized High-Level Waste] canisters for disposal off site.[5]

However, it is not technically appropriate, for instance, to lump Alternatives 2B and 3B together for treatment, even though they are similar in many respects. This is because Alternative 2B would vitrify all low-activity waste, which allows for the possibility of offsite disposal, while Alternative 3B has a stone-casting of some radioactive waste as part of its treatment process. Further, even the onsite disposal impacts of the stone casting and vitrified low-activity waste would be different, so that they are not equivalent from a health and environmental point of view. Indeed, Alternative 2B, which the DOE "prefers," is closest with respect to waste management and environmental impacts to Alternative 6B, which the DOE explicitly rejects. The DOE's rejection of Alternative 6B (as well as Alternatives 6A and 6C) in the passage quoted above is not based on process or environmental or health considerations. Rather, it appears to be based on a policy aversion to treating all tank waste as high-level waste, even though it is currently defined as such under the Nuclear Waste Policy Act of 1982.

Further, none of the alternatives come close to meeting drinking water standards for groundwater, even for single radionuclides, even when institutional control is assumed to be in effect inside the core zone. The overall problem, when all radionuclides are taken into account, as they are required to be under the EPA regulations, is even worse. For instance, groundwater concentrations of either technetium-99 or iodine-129 or both exceed the drinking water limits individually at the core zone boundary in all cases. When the restriction that the sum of the ratios of estimated concentrations to maximum contaminant levels (MCLs) is applied, the problem is even worse. These are very severe in many cases, as is evident from the estimates of future contamination in Appendix U.

Further, even though this is a tank closure EIS, the closure of the double shell tanks (DSTs) is not even considered. Only Single Shell Tank (SST) closure alternatives are presented. It is reasonable to assume, as the DOE has done, that the DSTs will be closed after the SSTs, since the former are needed for retrieval of SST waste and transfer operations to the Waste Treatment Plant (WTP). However, this does not provide a sufficient rationale to defer the problem of considering DST closure to a later date. This balkanized approach prevents an integrated assessment of health and environmental impacts related to decommissioning of the high-level waste tank farms, which should be the central objective of this EIS.

The DOE should present each alternative as a comprehensive and comprehensible set of actions from tank waste management for tank waste storage, retrieval, treatment, and closure, plus the associated impacts of low-level waste and mixed waste streams generated in the process. In this context, it is important to note that the peak year concentrations, doses, and risks presented in Appendix U for the three alternatives combined with non-tank-farm 200 Areas source terms are essentially useless for the purpose of estimating the overall impact of cleanup or even to allow a determination of what actions the DOE might be planning for the non-tank-farm 200 Areas vadose zone clean up. This is because most of the peak year radiological impacts are in the past – even though there were no resident farmers drinking groundwater and using it for irrigation on

[5] TC&WM EIS 2009, p. S-118.

the site in the years of estimated peak impact (for the most part during the 1950s to the 1990s). Even so, the portion of Appendix U that shows the non-tank-farm impacts and other parts of the TC&WM EIS where various tank farm impacts are estimated make it clear that even after DOE has completed what it calls "reasonably foreseeable" actions, Hanford will remain contaminated far beyond drinking water standards outside of the core zone for thousands of years.

There should be at least one alternative in the Final EIS in which all applicable drinking water standards are met for groundwater within the core zone without institutional controls at the completion of foreseeable cleanup actions. Since the DOE does not appear to include a set of actions that would lead to such a result, it seems clear that the list of actions would need to be expanded, especially to clean up the contamination from past practices in the non-tank-farm 200 Areas, or contracted, as for instance, in the case of the plan to import waste.

Further, for all alternatives, future post-remediation impacts should be clearly presented in tables and graphs showing the future variation over time concentrations of all major contaminants, as well as the individual future peak for each contaminant beyond the completion of cleanup activities at the site. This is important, since a part of what makes the TC&WM EIS difficult or impossible to interpret in terms of Applicable or Relevant and Appropriate Requirements (ARARs) is that peak concentrations are shown in the past or within the cleanup period, when the scenarios such as the one for a resident farmer (whether native American or not) are not meaningful.[6]

Recommendations: The DOE should present each alternative as a comprehensible set of actions from tank waste management for tank waste storage, retrieval, treatment, and closure, plus the associated impacts of low-level waste and mixed waste streams generated in the process. There should be at least one alternative in the Final EIS in which all applicable drinking water standards are met for groundwater within the core zone without institutional controls at the completion of cleanup actions both for tank farm and non-tank farm 200 Areas. For all alternatives, future post-remediation impacts should be clearly presented in tables and graphs showing the future variation over time concentrations of all major contaminants and the evolution of compliance with ARARs.

C. Radiation Protection Standards and ARARs

The DOE has used a reference value of 100 millirem (mrem) per year whole body total effective dose equivalent (TEDE) as the reference value to its health protection dose calculations. For population dose the DOE uses a so-called "background" exposure value:

> The significance of dose impacts is evaluated by comparison against the 100-millirem-per-year all-exposure-modes standard specified for protection of the public and the environment in DOE Order 5400.5. Population doses are compared with total effective dose equivalents from background sources of 365 millirem per year for a member of the population of the United States (NCRP 1987).[7]

[6] TC&WM EIS 2009, Vol. 2, Appendix U. See for instance, Table U-2 and Figures U-1 to U-48.
[7] TC&WM EIS 2009, Vol. 2, p. Q-238.

This approach is problematic for a number of reasons. To take the issue of "background sources" first. The amount includes about 200 millirem per year of radon dose, almost all of which is due to indoor radon. While radon occurs naturally, its outdoor concentrations are, on average, considerably lower than indoor ones. This is because indoor radon concentrations are mainly an artifact of building construction. Radon concentrations indoors can be lowered to close to outdoor levels with appropriate construction and control technology. Indoor radon should not be considered a part of natural background radiation. This position has ample scientific justification, as is evident in the positions of various scientific advisory bodies. An extensive discussion with references is provided in a 2005 IEER publication, a part of which is quoted below:

> As noted by the National Research Council in 1999
>
> > Many human activities – such as mining and milling of ores, extraction of petroleum products, use of groundwater for domestic purposes, and **living in houses** – alter the natural background of radiation either by moving naturally occurring radionuclides from inaccessible locations to locations where humans are present or by concentrating the radionuclides in the exposure environment.
>
> The National Research Council considered indoor radon to be a "technologically enhanced naturally occurring radionuclide [TENORM]." The treatment of other TENORM from a radiation protection standpoint is thus illustrative in the present context. For example, playground equipment and fences contaminated with TENORM waste from the oil industry containing radium has been found at a number of locations in Mississippi and Louisiana.[8]

A background level at sea level of 100 mrem per year is a reasonable reference value to use for background, when such a reference is appropriate, as for instance when comparing radiation to other natural hazards. Such a comparison is neither relevant nor appropriate in the present case, even though 100 millirem per year is the same as the annual exposure limit for the public in DOE Order 5400.5.

Clean up of a site is subject not only to DOE Order 5400.5 but to a complex set of standards, especially when both radionuclides and hazardous chemicals are present and the site has been put on the National Priorities List (a "CERCLA site") by the EPA, as is the case with Hanford. It is simply inappropriate for the DOE to take a posture that CERCLA strictures, which include compliance with ARARs, such as drinking water limits, are not relevant to overall health impact assessment. One of the most important relevant requirements is the set of maximum contaminant levels in EPA's drinking water standards for radionuclides and chemicals. Technetium-99 and iodine-129 are fission products that are important long-lived radionuclides with half-lives of 213,000 years and 15.7 million years, respectively. A drinking-water dose

[8] Arjun Makhijani and Brice Smith, *Comments on the U.S. Environmental Protection Agency's Proposed Rule for the Public Health and Environmental Radiation Protection Standards for Yucca Mountain, Nevada*, Institute for Energy and Environmental Research, Takoma Park, Maryland, November 21, 2005, Section Two. On the web at http://www.ieer.org/comments/waste/yuccaepa.pdf. References may be found in this publication. The emphasis in the National Research Council quote was added by the authors of the IEER paper.

limit of 4 millirem per year Total Effective Dose Equivalent (TEDE) or to any internal organ applies to these two radionuclides and all other beta-particle emitting man-made radionuclides, except strontium-90 and tritium, for which MCLs are specified. If more than one such radionuclide is present the sum of the doses must not exceed 4 millirem.[9] Yet, though the appropriate dose limit corresponding to drinking water standards is 4 millirem per year (TEDE or internal organ dose), DOE uses 100 mrem per year TEDE in Appendix Q to measure impacts from these two radionuclides. In fact, the TC&WM EIS only calculates TEDE[10] and does not calculate organ doses as required by drinking water regulations. In this context it is important to note that the iodine-129 dose to the thyroid, which is not calculated in the TC&WM EIS, is about 20 times larger than the internal committed effective dose equivalent.

Even more important, the 100 millirem per year TEDE in DOE Order 5400.5 is entirely inappropriate in a CERCLA context. CERCLA cleanup requires that the lifetime cancer incidence risk from residual radioactive and chemical contaminants be in the range 10^{-4} to 10^{-6}. The CERCLA regulation states:

> (*2*) For known or suspected carcinogens, acceptable exposure levels are generally concentration levels that represent an excess **upper bound lifetime cancer risk** to an individual of between 10^{-4} and 10^{-6} using information on the relationship between dose and response. **The 10^{-6} risk level shall be used as the point of departure** for determining remediation goals for alternatives when ARARs are not available or are not sufficiently protective because of the presence of multiple contaminants at a site or multiple pathways of exposure…[11]

Using the DOE's selected value of fatal cancer risk of 6 deaths per 10,000 person rem,[12] a 100 millirem per year dose over 70 years creates a lifetime risk of dying from cancer of 1 in 238. This is 42 times higher than the highest allowable risk under CERCLA and 4,200 times higher than the lowest CERCLA risk level of 10^{-6}. If one uses cancer incidence risk (rather than fatal cancer risk) the disparities are even greater.

Hanford has vast quantities of radionuclides and hazardous chemicals whose interactions are not well understood; their combined effect on the human body and ecosystems is largely unknown. Indeed, the importance of such interactions is only now beginning to be appreciated. And until recently, it was normal to assume that a radiation protection framework that limited cancer among human beings would also be satisfactory for protection of other species, and by extension, of ecosystems. Given these realities, if there is any site to which the 10^{-6} risk level "shall be used

[9] Drinking water standards for photon and beta-emitters, except strontium-90 and tritium, are not specified as MCLs but as a dose limit of 4 millirem per year TEDE or 4 millirem to the most exposed organ. See 40 CFR 141.66(d)(1).
[10] Appendix H states: "***All*** radiological impacts are calculated in terms of the committed dose received by the exposed populations and its associated health effects. The calculated radiation dose is the total effective dose equivalent (10 CFR 20), the sum of the effective dose equivalent from external radiation exposure and the 50-year committed effective dose equivalent from internal radiation exposure." (TC&WM EIS 2009, Vol. 2, p. H-2) Emphasis added. The ratio of iodine-129 doses is for adults. It was calculated from EPA's Federal Guidance Report 13, CD, published in 2002.
[11] 40 CFR 300.430(e)(2)(i)(A)(*2*), which is a part of the Remedial Investigation and Feasibility Study portion of the National Oil and Hazardous Substances Pollution Contingency Plan, specified at 40 CFR 300. Emphasis added.
[12] TC&WM EIS 2009, Vol. 2, p. K-7.

as the point of departure," it should be Hanford. A 10^{-6} lifetime fatal cancer risk would mean an average exposure of about 0.024 millirem per year – about 4,200 times lower than the DOE's reference value of 100 millirem per year. For a lifetime cancer incidence risk for women, this value would be reduced to about 0.014 millirem per year.

DOE's analysis in Appendix Q is geared to the inappropriate reference value of 100 millirem per year that is two to four orders of magnitude than the CERCLA risk range of 10^{-4} to 10^{-6}. DOE Order 5400.5 has very little real relevance for a CERCLA site. A Record of Decision that is based on this limit would allow serious violations of the CERCLA risk limits as well as drinking water ARARs for radionuclides and chemicals. The CERCLA risk range and the drinking water standards should be central considerations.

DOE has stated in the Draft EIS that the remediation of the "non-tank-farm 200 Areas is being addressed under CERCLA, which will also satisfy substantive RCRA and Hazardous Waste Management Act corrective action requirements."[13] But the document provides no clue as to how an EIS Record of Decision that is based on risk levels that are at least two orders of magnitude higher for radionuclides alone would be made compatible with a CERCLA cleanup for the non-tank-farm 200 Areas. It would be completely unacceptable if an ROD under the EIS that had lax cleanup criteria, resulting in part from an inappropriate radiation dose limit, were to be used later as a rationale for failing to make a major effort to remediate the non-tank-farm part of the 200 Areas vadose zone. DOE's use of 100 millirem per year as the reference value for assessing the health impacts of alternatives also appears to be at odds with the requirements of DOE Order 5400.1, which is its order for general environmental protection at its facilities, which states in part:

> SPECIAL PROGRAM PLANNING REQUIREMENTS. In addition to other program requirements and documentation required in this Order, each Head of Field Organization shall prepare a separate plan of sufficient scope and detail to reflect program significance, as appropriate, for each of the following activities.
>
> a. A Groundwater Protection Management Program that includes for each site, the following: (1) documentation of the groundwater regime with respect to quantity and quality; (2) design and implementation of a groundwater monitoring program to support resource management and comply with applicable environmental laws and regulations; (3) **a management program for groundwater protection and remediation, including specific Safe Drinking Water Act (SDWA), Resource Conservation and Recovery Act (RCRA) and CERCLA actions**; (4) a summary and identification of areas that may be contaminated with hazardous substances; (5) strategies for controlling sources of these contaminants; (6) a remedial action program that is part of the site CERCLA program required by DOE 5400.4; (7) decontamination and decommissioning and other remedial programs contained in DOE directives. Plans, permits, and other technical documents such as those associated with compliance with the SDWA, RCRA, and CERCLA may be used in whole or in part to satisfy this requirement. This plan shall be completed no later

[13] TC&WM EIS 2009, Vol. 1, pp. 1-13 and 1-14.

than 18 months after the effective date of this Order. The plan shall be reviewed annually and updated every 3 years.[14]

The matter is further complicated by the well-known presence at Hanford of vast amounts of hazardous chemicals, ranging from heavy metals, such as chromium, to organic pollutants, such as carbon tetrachloride and TCE. These substances are covered by the RCRA as well as the counterpart Washington State law known as the Model Toxics Control Act (MTCA). The latter specifies lifetime cancer risk limits of 10^{-6} for individual carcinogens and 10^{-5} for all hazardous substances combined. MTCA includes radionuclides in its definition of hazardous materials.[15]

In view of the fact that Hanford has a large number of chemical and radioactive contaminants the CERCLA framework quoted above indicates that the DOE should use a 10^{-6} lifetime cancer incidence risk for individual chemicals and radionuclides as required by law. This will mean the maximum contaminant levels for evaluating TC&WM EIS alternatives for groundwater and surface water that are much more stringent than drinking water standards. Under this approach the limits for some of the prominent radionuclides are shown in Table 1.

Table 1: Drinking Water Limits Corresponding to a 10^{-6} Lifetime Cancer Incidence Risk Level for Some Man-Made Radionuclides

Radionuclide	**picocuries per/liter**
Americium-241	0.19
Cesium-137	0.64
Iodine-129	0.13
Plutonium239/240	0.15
Strontium-90	0.35
Technetium-99	7.1
Tritium	400

Notes: 1. Values have been calculated using the lifetime morbidity risk coefficients in Federal Guidance Report 13, published by the Environmental Protection Agency in 1999; the CD containing the risk and dose coefficients was published in 2002.
2. All values are rounded as indicated.

Similarly, carcinogenic chemicals may be assessed by MCLs that use a 10^{-6} risk factor for individual contaminants.

Overall, the above restrictions mean that individual radionuclide and chemical concentrations should be such that they not exceed 10^{-6} lifetime risk levels after clean up is completed.

There is also the question of restrictions relating to multiple contaminants. In this case, the sum of ratios of the concentrations of all radionuclides and carcinogenic chemicals present to their

[14] DOE Order 5400.1, *General Environmental Protection Program*, p. III-2, changed on 6-29-1990, on the web at https://www.directives.doe.gov/directives/archive-directives/5400.01-BOrder-c1, viewed on February 14, 2010, emphasis added.

[15] . The risk level for individual carcinogens could be increased to 10^{-5} under Modified Method C for cleanup, but the overall risk level in case of multiple carcinogens also has to be maintained at 10^{-5}. *Washington Administrative Code*, "Model Toxics Control Act--Cleanup," Chapter 173-340 WAC, Update of 10/12/07, on the web at http://www.ecy.wa.gov/pubs/wac173340.pdf, p. 18 and pp. 94-96

MCLs derived from a 10^{-5} cancer incidence risk level should be less than one. This would make the result compliant with MTCA and the combined chemical risk would be in the middle of the CERCLA risk range.

This risk value should be evaluated over time, since the peaks of individual chemical and radionuclide concentrations can be expected to differ due to a variety of factors such as varying K_d's and different half-lives.[16] The peak value of the risk should be less than 10^{-5} for unrestricted use of the site after cleanup is completed.

Recommendations: In view of the fact that Hanford has a large number of chemical and radioactive contaminants the CERCLA framework quoted above indicates that the DOE should use a 10^{-6} lifetime cancer incidence risk for individual chemicals and radionuclides as required by law. For all carcinogens, the cancer incidence risk level should not exceed 10^{-5}, an upper bound value required by MTCA when there is more than one carcinogen.

D. Tank Storage and Waste Retrieval Alternatives

The alternatives that require building new double shell tanks are unrealistic and could cause a variety of problems and delays. They should be ruled out. DOE's Alternative 2B for waste storage appears to be the best one available. No new DSTs would be built, but four new below-grade storage and waste conditioning facilities, called Waste Receiver Facilities, would be built.

The technologies for retrieval of waste from the tanks in order to deliver it to the Waste Treatment Plant are complex and pose a variety of technological risks. For instance, sluicing of waste requires the addition of vast amounts of water under pressure – it is projected to increase the volume of the retrieved solid waste by a factor of four.[17] Sluicing and use of chemicals could also cause corrosion and cracking. This is noted in the TC&WM EIS:

> Stress-corrosion cracking and pitting/crevice corrosion are the failure mechanisms most applicable to the SSTs that have leaked in the past. The rate at which these modes of corrosion may have progressed in nonleaking SSTs is unknown. However, the general condition and age of the SSTs suggest that new SST leaks could occur during retrieval actions that involve additions of liquid to the tanks (DOE 2003c).[18]

As another example, chemical removal to achieve a 99.9 percent volume removal level could create more hazardous wastes and potentially aggravate residual contamination on the site. Corrosive chemicals could also increase the risk of new tank leaks. The TC&WM EIS identifies this as the only approach to achieving a retrieval of 99.9 percent of the waste volume.

In view of the risks of adding chemicals and of sluicing in the SSTs, it appears to us that the use of vacuum-based retrieval, complemented by the in-tank vehicle, which is a mobile retrieval

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[16] K_d is the ratio of the concentration of a contaminant in the soil to that in the water. A low K_d means a higher water contamination for a given soil concentration and vice versa.
[17] TC&WM EIS 2009, Vol. 2, p. D-28, where the DOE states: "Current analysis projects that three volumes of sluicing liquid would remove one volume of SST solids".
[18] TC&WM EIS 2009, Vol. 2, p. E-28.

system, should be the preferred options to retrieve 99 percent of the waste in the tanks. These methods should especially be preferred in tanks that have leaked or are suspected of having leaked. Further development of these methods to achieve greater than 99 percent retrieval is desirable. Sluicing (or modified sluicing) can be used to increase the proportion of recovered waste beyond 99 percent or as necessary to achieve the 99 percent target if it cannot be achieved with a combination of vacuum-based and in-tank vehicle mobile system retrieval.

We are in agreement with the TC&WM EIS approach that the SST waste transfer infrastructure not be used for tank waste transfer. Rather, as noted below, this SST infrastructure, which contains residual high-level waste, should be removed and stored as HLW (see below).

The goal should be to retrieve at least 99 percent of the waste volume and as much beyond that as possible without further compromising the integrity of the SSTs or inducing leaks in the inner shell of the DSTs. This is because the remaining one percent of the waste volume would still likely contain a huge amount of residual radioactivity.

The characterization of residual radioactivity in the TC&WM EIS ignores the technical history of the tanks and the non-uniform nature of distribution of radionuclides in the waste. While a highly accurate estimate of residual radioactivity by radionuclide would not be possible at the present time and will depend to some extent on retrieval technology, a much better set of estimates based on the history of the tank farm should be possible.

Appendix D shows DOE assumptions regarding residuals in the tanks. The simple, but highly unrealistic, assumption used is that the proportion of radioactivity of each radionuclide removed will be the same as the proportion of the volume removed. The assumption is applied to every volume removal option considered – 90 percent, 99 percent, and 99.9 percent. So for instance, residual strontium-90 at 99 percent retrieval is assumed to be 505,000 curies, since the source term in the tanks is estimated at 50.5 million curies.[19] Similarly, the cesium source term in the tanks is estimated at 45.9 million curies; the residual source term after 99 percent removal is estimated at 459,000 curies – and so on for all radionuclides listed in the tables.

This is not a reasonable way to estimate residual radioactivity or the impacts of various options of tank closure. For instance, we know that the acidic wastes from the reprocessing canyons were neutralized prior to storage in the SSTs and DSTs. This process tends to separate out various radionuclides into different parts of the waste. Specifically, the actinides, including plutonium and uranium, would tend to go to the bottom sludge layer, while strontium-90 also tends to go to the sludge layer with the actinides. In contrast, the cesium remains preferentially in solution after neutralization. Evaporation of the solution and the crystallization process subsequent to evaporation would tend to concentrate cesium-137 in the salts.

Other chemical processes at Hanford, such as addition of ferrocyanides, addition of solvents and organic complexants, inter-tank waste transfers, and processing of some wastes in the 1950s to extract uranium, have further complicated the picture. While this makes it difficult to estimate

[19] SST and DST residuals are separately estimated. They have been added here. The data cited here are from Tables D-4 and D-5 for the SST and DST source terms and Tables D-16 and D-17 for the residuals. See TC&WM EIS 2009, Vol. 2, Appendix D.

the effect of removal of a certain waste volume on residual radioactivity, a best estimate would start with the well known effects of waste neutralization, which has occurred in all cases. The sludge layer that forms at the bottom of the tanks after waste neutralization is a small proportion of the volume and contains almost all the actinides as well as strontium-90. It is also reasonable to assume that sluicing and vacuum removal technologies would tend to mobilize the more easily removed liquids and salts, while the encrusted portions of the sludges would be preferentially retained in the tanks as residuals.

These considerations indicate that the residual plutonium, uranium, neptunium, and strontium-90 in the tanks could well be an order of magnitude higher than estimated in Appendix D of the TC&WM EIS. At the same time, the residual cesium-137 and tritium would be far lower than estimated. This means that residual strontium-90 could be in the millions of curies even with 99 percent waste volume removal. As for plutonium, residuals could be well over 100 kilograms, while residual uranium could be well over 100 metric tons.[20]

These considerations point to the need for two items in a preferred option for tank closure:

a. Waste residues must be carefully characterized by radionuclide and hazardous chemical, especially in the final stages of tank waste removal. The use of the in-tank mobile unit could be particularly useful in this regard. Appropriate research and development to enhance the capabilities of this or some other in-tank mobile vehicle should be initiated so that residual tank wastes can be accurately characterized.
b. No actions should be planned or taken that would make waste retrieval beyond 99 percent impossible. This rules out alternatives for closing tanks in place that would make clean closure by tank removal (which is part of Alternative 6B, for instance) impossible.

Recommendations: At least 99 percent of the waste volume should be removed. Approaches that risk creating more hazardous wastes and increase the risk of new tank leaks and tank corrosion should be de-emphasized or not used. Residual radionuclide amounts should be carefully characterized. No actions should be planned or taken that would make waste retrieval beyond 99 percent impossible. This rules out alternatives, such as grouting, for closing tanks in place that would make clean closure by tank removal (which is part of Alternative 6B, for instance) impossible. No new DSTs should be built.

E. Waste treatment

The success of the Waste Treatment Plant is the most critical element to the ability to remove waste from the SSTs and prepare it for long-term management. Certain core elements of the WTP – pretreatment of the waste, at least two high-level waste melters, at least two low activity waste melters, are common to all alternatives except the no-action alternative and Alternative 6A. The robust and reliable functioning of the WTP is central to the success of the purposes of

[20] Natural uranium isotopic composition has been assumed in this calculation, since natural uranium or uranium of very low enrichment were the main types of uranium fuel used at Hanford.

the TC&WM EIS. The WTP is under construction and, according to the TC&WM EIS, is 40 percent complete.[21]

Alternative 6A would treat all tank waste as high-level waste and require five high-level waste melters. It is also unclear whether the very diverse waste types that would constitute the melter feed could be successfully processed as borosilicate glass. Further, under this alternative, high-level waste processing would continue for 145 years. The WTP would have to be replaced. New DSTs would have to be built. The technical uncertainties would be compounded by the logistical and budgetary uncertainties. Risks of SST leaks and tank failures over such a long period would increase. For these reasons, we support pretreatment of the waste and completion of treatment expeditiously.

1. *Safety*

However, the course towards successful pretreatment is unclear at present. In a November report (issued just a few weeks after the TC&WM EIS), the Defense Nuclear Facilities Safety Board raised serious performance and safety concerns about the pulse jet mixers that are a critical part of the pretreatment process in the WTP.[22]

The three safety issues identified were:

a. Inadvertent criticality due to preferential separation and settling of particles with "high concentrations of fissile materials (e.g. uranium or plutonium)" creating a sediment layer at the bottom of the pretreatment vessel due in part to "underpowered pulse jet mixers";
b. Release of flammable gas generated in bottom sediments by radiolysis under certain conditions;
c. Lack of demonstration of a sufficient level of reliability of the pulse jet mixer for the one million to ten million cycles and the problem that "insufficient reliability can ultimately lead to failure of structural components in process vessels…."[23]

The report noted that the DOE contactor, Bechtel National, Incorporated (BNI) "has not conducted nor does it plan to conduct any long-term test to demonstrate the reliability of a fully prototypic mixing system…."[24]

The problem is further complicated by the reality that the solution to the problems identified by the DOE would, according to the Vice-Chairman of the DNFSB, require the "deployment of new mixing, sampling, and separation systems. The result would be new design basis requirements

[21] TC&WM EIS 2009, Summary, p. S-36.
[22] Memorandum from A. Poloski to T.J. Dwyer, *Subject: Inadequate Mixing, Waste Treatment and Immobilization Plant*, Defense Nuclear Facilities Safety Board Staff Issue Report, November 11, 2009, with a cover letter dated January 10, 2010 from Vice-Chairman of the DNFSB, John E. Mansfield, to Inés Triay, Assistant Secretary of Environmental Management, Department of Energy. On the Web at http://www.dnfsb.gov/pub_docs/staff_issue_reports/hanford/sir_20100106_hd.pdf. Memorandum cited hereafter as DNFSB 2009; cover letter cited hereafter as DNFSB 2010.
[23] DNFSB 2009, p. 2.
[24] DNFSB 2009, p. 2.

for particle size and density for WTP that must be consistent with the actual performance of the newly deployed systems."[25]

This is a rather alarming state of affairs when so much construction of the WTP has already been completed. Addressing the problems identified by the DNFSB, redesign as necessary, and full testing are essential, since pretreatment is central to the separation of high-level tank waste into high activity and low activity waste streams that would then be vitrified in separate melters into Immobilized High-Level Waste (IHLW) and Immobilized Low Activity Waste (ILAW). The present course – no long-term reliability test – is very risky, especially as the DOE does not appear to have a viable back up plan.

The Final EIS should include provisions for the full implementation of the DNFSB's recommendations. It should also include urgent development of backup technologies for pretreatment that are compatible with vitrification either as IHLW and ILAW of the all the waste in the waste steams created from such pretreatment. As noted below, we are opposed to onsite disposal of ILAW and to any treatment option, such as bulk vitrification or stone casting, that would result in any tank waste being disposed of onsite. A back up approach could be explored would be to expand Alternative 6A to include more high-level waste melters, some possibly with phosphate glass, so that additional DSTs and replacement of the WTP would not be required and processing would be completed within about 25 years of the start of the WTP, as now envisioned for Alternatives 2B, 6B, and others. Any option that extends the emptying of the tanks and vitrifying those wastes beyond 2043 would be unacceptable. There have already been far too many delays.

2. *Technetium-99 removal*

As presently designed, the WTP does not include removal of technetium-99 so that it can be vitrified in the HLW waste stream. The TC&WM EIS makes contradictory statements about Tc-99 removal and its environmental impacts. In the summary it states:

> Tank Closure Alternative 2B includes technetium-99 removal in the WTP, a pretreatment activity that separates technetium-99 and sends it for immobilization into IHLW glass. By contrast, Tank Closure Alterative 2A assumes no technetium-99 removal in the WTP; therefore, most of the technetium-99 is immobilized in ILAW glass and disposed of onsite in an IDF. **The analysis indicates that ILAW glass with or without technetium-99 has similar potential short-term and long-term impacts. The analysis further indicates that removal of technetium-99 and disposal of it offsite as IHLW glass provides little reduction in the concentrations of technetium-99 at either the Core Zone Boundary or the Columbia River nearshore.** This is because the rate of release of technetium-99 from ILAW glass is small when compared to the rate of release of technetium-99 from other sources such as ETF [Effluent Treatment Facility]-generated secondary wastes and tank closure secondary wastes.[26]

However, Volume 1 of the TC&WM EIS states:

[25] DNFSB 2010.
[26] TC&WM EIS 2009, Summary, p. S-91. Emphasis added.

> Another assumption detailed in Appendix D of this *TC & WM EIS* is partitioning of technetium-99 in IHLW, ILAW, and supplemental treatment primary waste forms. Without technetium-99 removal as a pretreatment step in WTP, the analysis assumes that roughly 97 to 98 percent of the technetium-99 from treated tank waste would be captured in ILAW or supplemental treatment waste products, 1 to 2 percent would be captured in secondary waste forms, and less than 1 percent would be captured in IHLW.… However, under Tank Closure Alternative 2B, where technetium-99 removal would be incorporated as a pretreatment step in WTP, 97.5 percent of technetium-99 is expected to be captured in IHLW and only 1 percent in ILAW.… Similar to iodine-129 above, **technetium-99 is a conservative tracer with a long half-life (211,000 years) and is projected to exceed benchmark concentrations. Potential mitigation measures that could be considered include technetium-99 removal as a pretreatment option in the WTP.** Also, the development of more robust, longer-performing waste forms, particularly for supplemental treatment technologies and grouted secondary waste, could be pursued.[27]

The analysis in the TC&WM EIS indicates that while other sources of Tc-99 contribute most of the contamination, Tc-99 from the tanks themselves would constitute a sufficient source term to cause an exceedance of the reference drinking water limit of 900 picocuries per liter that DOE has used. Specifically, the difference in peak groundwater concentration of Tc-99 at the boundary of the core zone between Alternative 2A, which does not include Tc-99 removal, and in Alternative 2B, which does, is 1,900 picocuries per liter.[28] Hence, while the total concentrations in both cases are over 25,000 picocuries per liter, the situation calls for reducing other sources rather than adding a source that by itself would cause a violation of the drinking water limit. As we shall see the main other source of Tc-99 within the actions specified in the TC&WM EIS is offsite waste, which is easily controlled by not bringing it to Hanford.

Tc-99 removal technology exists. Some alternatives included in the TC&WM EIS include its incorporation. It should be incorporated into the WTP design and construction as specified in Alternative 2B.

3. *Iodine-129 capture*

The TC&WM EIS does not include any alternative for incorporating iodine-129 in the HLW waste stream. Iodine is volatile and would have to be captured by secondary recovery. According to the TC&WM EIS:

> One of the assumptions of the *TC & WM EIS* analysis is that approximately 20 percent of iodine-129 would be captured in primary waste forms (e.g., ILAW, bulk vitrification, or steam reforming waste forms), with the balance due to volatization recovered in secondary waste forms. The only exception would be under Tank Closure Alternatives 3B, 4, and 5, where cast stone would capture a higher percentage of iodine-129 due to the nonthermal nature of this treatment technology**.** **Iodine-129,** as mentioned above, is one of the conservative tracers with a half-life of approximately 17 million years and **is**

[27] TC&WM EIS 2009, Vol. 1, p. 7-16. Emphasis added. Grouting or any onsite disposal of Tc-99 from the tanks is inappropriate, since the half-life of Tc-99 is much longer than the timeframe of major geologic disruption in the region, making shallow land burial of such radionuclides inappropriate (see below).
[28] This difference is calculated from Tables Q-59 and Q-80.

projected to exceed benchmark concentrations. As such, reasonable mitigation measures could be considered that would recycle secondary waste streams into the primary waste stream feeds within the WTP to increase iodine-129 capture in ILAW and bulk vitrification, which are considered more stable waste forms than those associated with secondary waste. The current WTP design supports the ability to recycle. For example, one method would involve the recycling of iodine within the WTP by capturing it in the submerged bed scrubber and returning it to pretreatment. This recycling could theoretically concentrate the iodine in the feed stream, which, in turn, could put more iodine in a specific volume of glass product. Also, the development of more robust, longer-performing waste forms, particularly with regard to cast stone, steam reforming, and grouted secondary waste, could be pursued.[29]

The current plan to dispose of iodine-129 in a secondary waste stream in the Effluent Treatment Facility (ETF) is clearly unsatisfactory. The TC&WM EIS analysis shows that the annual flux of iodine-129 at the water table is orders of magnitude greater in case of ETF disposal compared to incorporation in ILAW glass that is disposed of on site. The figure below, reproduced from Appendix N of the EIS, shows that iodine-129 contamination of the groundwater would exceed that from ILAW by two orders of magnitude even when the majority of the iodine-129 (70 percent) is incorporated in the ILAW.

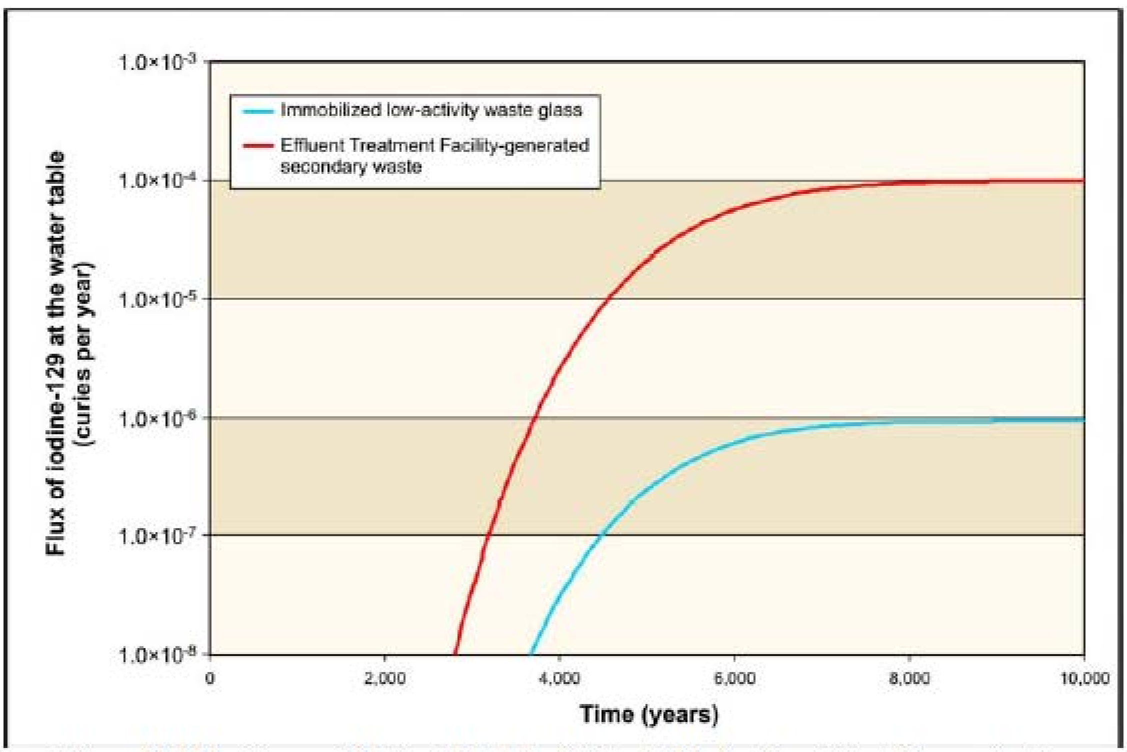

Figure N–155. Fluxes of Iodine-129 at the Water Table for Two Waste Forms for the 70 Percent Partition to Immobilized Low-Activity Waste Glass Case

Source: TC&WM EIS, Vol. 2, p. N-108.

[29] TC&WM EIS 2009, Vol. 1, p. 7-16. Emphasis added.

Appendix E notes that submerged bed scrubbers will be part of the offgas treatment of both the HLW and LAW melters. It is unclear why the iodine-129 rich scrubber solution cannot be recycled to the HLW waste stream for incorporation into IHLW rather than into ILAW. This is important since under most options, the DOE plans to dispose of ILAW on site. Under Option 6B, the DOE states that ILAW would be managed as HLW and stored on site, but no disposal path is specified. This option should logically include disposal of ILAW glass in a deep geologic repository since it treats ILAW as high-level waste for storage purposes.

The bottom line is that iodine-129 should be recovered an incorporated into glass that will be disposed of in a deep geologic repository. It would be preferable to incorporate this into IHLW and the Final EIS should contain at least one such alternative.

4. *Internal inconsistencies in I-129 and Tc-99 contamination estimates*

Appendix Q provides details of the results of DOE's calculations regarding the impacts of various alternative actions taken under the TC&WM EIS at various points in the Hanford Site. It also provides the year of peak impact. Appendix U does the same for the combined impacts of actions taken under the TC&WM EIS and other sources of contamination not covered under the TC&WM EIS. Specifically, Appendix U includes the contamination due to the non-tank-farm 200 Areas contamination.

The results in Appendix Q and Appendix U are inconsistent and the inconsistency indicates that at least one set of calculations is incorrect; it may be that both are incorrect.

Specifically, the concentration from TC&WM EIS and non-TC&WM EIS actions should be equal to or greater than that attributable to TC&WM EIS actions alone. This is not the case. For instance, Appendix Q, Table Q-80 states that the technetium-99 contamination at the core zone boundary in the year of peak dose under Alternative 2B (and other comparable alternatives) would be 25,900 picocuries per liter in the year 2050. Appendix U states that under Alternative Combination 2 (of which Alternative 2B is a part) the Tc-99 concentration at the core zone boundary at the time of peak dose would be 1,780 picocuries per liter, or more than an order of magnitude lower. Further, it states that the year of peak impact was in the past – 1997.[30]

How can the impact from all sources be less than the impact from some sources? How can there be a greater concentration on Tc-99 from some activities in the future when Appendix U states that a smaller concentration from all activities has already occurred in the past?

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[30] The Tc-99 concentrations are from Table Q-80 and Table U-9. The values in these tables are given in curies per cubic meter. These have been converted here to picocuries per liter (by multiplying curies per cubic meter by a factor of 10^9) for consistency and comparability with the usual method of stating drinking water MCLs. See TC&WM EIS 2009, Vol. 2, p. Q-98 and p. U-62.

The same problem is found in these two tables in regard to iodine-129. The respective concentrations at the core zone boundary are 30 picocuries per liter in Table Q-80 (in 2050) and only 8.79 picocuries per liter in Table U-9 (in 1997).

A careful consistency check as well a check on the validity of the source terms and models that underlie these calculations is needed, quite apart from issues associated with the validity and accuracy of the models.

Recommendations: The Final EIS should include provisions for the full implementation of the DNFSB's recommendations. There should be no onsite disposal of ILAW and or resort to any treatment option such as bulk vitrification or stone casting that would result in any tank waste being disposed of onsite. All tank waste should be immobilized either as ILHLW or ILAW. The approach in Option 2B for two HLW and six ILAW melters would meet this goal. Treatment should include alternatives for incorporating almost all Tc-99 (as in Alternative 2B) and iodine-129 (not presently in any alternative) in IHLW. The calculations for Tc-99 and I-129 need to be carefully checked for consistency, quite apart from issues associated with the validity and accuracy of the models.

F. **Treatment of the Cesium and Strontium Capsules**

While the DOE is formally deferring the question of the final disposition of the cesium and strontium capsules, which constitute the most concentrated large source of radioactivity in the DOE complex, the TC&WM EIS discussed the treatment of these capsules. However, only one alternative to the no action alternative is presented. This is unacceptable for the two largest source terms and by far the most concentrated source terms of radioactivity on site.

The course of action that is common to all alternatives other than "no action" is that DOE would "[r]etrieve cesium and strontium capsules from the WESF [Waste Encapsulation and Storage Facility] for de-encapsulation at the Cesium and Strontium Capsule Processing Facility and treatment in the WTP."[31]

It would be safer to remove the cesium and strontium capsules into dry storage and consider a wider range of alternatives to treatment in the WTP. Mixing tens of millions of curies of strontium-90 and cesium-137 into IHLW would greatly increase the heat load and external radiation associated with IHLW. This may be problematic for repository disposal, since heat loading is a primary determinant of space requirements. The number of containers of IHLW will be very large. Increasing the heat loading in these containers could increase the costs of disposal considerably. It would be prudent, especially in a context when no repository site has yet been selected and Yucca Mountain is off the table, to consider a variety of immobilization options for the cesium and strontium now in the capsules. The immobilization of the cesium and strontium in the capsules presents an opportunity to develop more durable waste forms and this should be pursued in parallel to treatment of tank waste in the WTP.

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[31] TC&WM EIS 2009, Summary, p. S-23.

Finally, a timeline is needed for completion of cesium and strontium immobilization. It should be completed no later than the immobilization of tank waste.

Recommendations: It would be safer to remove the cesium and strontium capsules into dry storage and consider a wider range of alternatives to treatment in the WTP.

G. Tank and Tank Farm Closure

As discussed above, tanks are likely to have very large residual source terms for radionuclides like strontium-90 and plutonium-239/240 even in the case of 99 percent volume retrieval. Grouting the tanks or simply abandoning the tanks after a certain period of surveillance (the year 2193 is suggested in Alternative 2A) would be inappropriate. Alternatives 6A and 6B propose clean closure, including removal of tanks, and removal of ancillary equipment and some contaminated soil as follows:

> **Alternatives 6A and 6B.** Clean-close all 200-East and 200-West Area SST farms following deactivation by removing all tanks, associated ancillary equipment, and contaminated soil to a depth of 3 meters (10 feet) directly beneath the tank base. Package these materials as HLW for storage on site. Excavate deep soils, where necessary, to remove contamination within the soil column, and treat these soils in the PPF [Preprocessing Facility] to make them acceptable for disposal on site. Process the resulting liquid waste stream in the PPF and dispose of it on site in an IDF [Integrated Disposal Facility]. Dispose of the washed soils in the RPPDF [River Protection Project Disposal Facility]. Cover the cribs and trenches (ditches) associated with the tank farms with a landfill barrier (Base Cases) or clean-close them (Option Cases).[32]

This is broadly acceptable with some provisos. Treating soil as high-level waste and storing it as such is technically and legally sound. But making soils "acceptable for disposal on site" after treatment needs to be defined. As noted above, this acceptability must be in the framework of an overall risk criterion from all residual radioactivity and carcinogenic chemicals not exceeding 10^{-5}. None of the existing plans for cleanup of the Hanford Site meet this criterion. A second proviso is that excavation of the soil may need to be carried out around the tanks and the depth of excavation below them beneath may need to be more or less than 3 meters, depending on the tank and the extent and type of leaks. Rather than a fixed depth, the excavation extent and depth should be determined by sampling and characterization as the tanks and ancillary pipes and other equipment are decommissioned and dismantled. Third, clean closure of the DSTs and associated ancillary equipment should be made part of the TC&WM EIS.

The "Option Case" for Alternative 6B includes clean closure of six cribs and trenches. While this would increase short-term impacts, such as demand for workforce and resources, it would greatly decrease long-term impacts, as noted in the TC&WM EIS:

> Cribs and trenches are major contributors to potential long-term groundwater impacts for all Tank Closure alternatives due to their early discharges in the 1950s and 1960s. As shown in Figure 2–127, for Tank Closure Alternative 1 (no landfill closure of the cribs and trenches), Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C (landfill closure of the

[32] TC&WM EIS 2009, Summary, p. S-26.

> cribs and trenches), and Tank Closure 6B, Option Case (clean closure of the cribs and trenches), estimates of human health impacts (radiological risk to the drinking-water well user) correlate with the closure options. For example, Tank Closure Alternative 1 and Tank Closure Alternatives 2B, 3A, 3B, 3C, and 6C have similar radiological risk to the drinking-water well user at the Core Zone Boundary throughout the period of analysis, because the contaminants have already reached the vadose zone or groundwater and, therefore, there is minimal benefit to the addition of a landfill closure barrier. By contrast, results for Tank Closure Alternative 6B, Option Case, indicate that clean closure of the cribs and trenches significantly reduces radiological risk to the drinking-water well user at the Core Zone Boundary after calendar year 7000. The variability in lifetime radiological risk represented in Figure 2–127 is attributable primarily to the release of multiple constituents at differing times and rates from 35 sources comprising these sets of cribs and trenches and secondarily from variability in prediction of concentration inherent in the method applied (i.e., particle tracking) for simulation of transport of contaminants in the unconfined aquifer.[33]

For the issue of unrestricted access and of treaty rights, it is clear that clean closure of cribs and trenches would be preferable.

Recommendations: Alternative 6B is broadly acceptable for tank closure, including removal of soil and ancillary equipment, with some proviso, including ensuring that onsite secondary waste disposal meets the overall risk criterion of 10^{-5} as an upper limit in the context of all other wastes to be disposed of onsite. Clean closure of the DSTs and associated ancillary equipment should be made part of the TC&WM EIS. The “Option Case” for Alternative 6B includes clean closure of six cribs and trenches. This should be pursued. While this would increase short-term impacts, such as demand for workforce and resources, it would greatly decrease long-term impacts, as noted in the TC&WM EIS.

H. Waste Disposal

The TC&WM EIS is even more complex in its consideration of waste management approaches and has a bewildering array of possibilities (a fact that is recognized within the document). Apart from the various wastes generated as part of the tanks closure process, there are wastes from other areas of Hanford, offsite wastes, and a variety of waste disposal sites discussed in the TC&WM EIS. We will take up the question of IHLW, ILAW, and Greater than Class C waste first and then discuss low-level wastes and mixed low level waste issues.

1. *Immobilized High-Level Waste and Immobilized Low-Activity Waste*

In the absence of a high-level waste repository or even an active program to find and develop one, Hanford must make provision for storage of all the high-level waste. Further, ILAW waste should be managed as high-level waste when stored on site. This is provided for in Alternative 6B. The Final EIS should specify the options. One suitable option to examine would be to dispose of the vitrified ILAW as Greater than Class C waste along with any Greater than Class C waste generated during Hanford remediation. We are opposed to shallow land disposal of

[33] TC&WM EIS 2009, Vol. 1, p. 2-290.

GTCC waste at any site, including Hanford. Construction of a GTCC disposal site at Hanford is one of the alternatives being considered in the GTCC EIS being prepared by DOE.[34] Besides being inappropriate for GTCC, such a site would add to the burdens of contamination on the site instead of reducing it.

In view of the lack of an active program for a deep geologic repository, considerable storage will be needed for IHLW and also for ILAW (the latter under Alternative 6B). The TC&WM EIS anticipates this:

> The IHLW Shipping/Transfer Facility would be constructed concurrently to support IHLW glass canister shipments. Construction of additional storage modules is included under each of the *TC & WM EIS* alternatives to provide storage capacity for IHLW glass produced in the WTP. In the case of Tank Closure Alternatives 6A, 6B, and 6C, all of the waste would be managed as IHLW glass, and appropriate storage facilities are considered for IHLW glass, ILAW glass, and waste from closure of the tank farms.
>
> **E.1.2.1.3.1 Assumptions and Uncertainties**
>
> Due to uncertainties regarding the timing for shipment of IHLW glass canisters off site and the capacity for receiving all waste managed as HLW (Tank Closure Alternatives 6A, 6B, and 6C), it was assumed that onsite storage facilities would be required for all IHLW glass.[35]

This is a sound approach. Additional waste storage buildings should be part of the Final EIS preferred alternative consistent with 6B streams from IHLW and ILAW.

We are also in agreement that HLW melters taken out of service should be treated as high-level waste and that disposal onsite should be ruled out.[36]

2. Low-Level Waste and Mixed Low-Level Waste

It is useful to enunciate a principle for onsite disposal of waste. In general radionuclides disposed of on site should be short-lived, defined as those with half-lives of less than ten years. We understand that sharp segregation of waste into short and long-lived components is often impossible. Given this problem, the general principle should be that the total source terms for residual long-lived radionuclides should be such that the restrictions discussed in Section C (above) are maintained in the post-remediation phase.

We have already discussed the need for immobilizing technetium-99 and iodine-129 retrieved from the tanks into wastes that will not be disposed of at Hanford, though small fractions may wind up mixed with rubble and very dilute low-level wastes. These should be minimized. Even one percent of the tank source term for Tc-99 would be about 300 curies. One percent of the iodine-129 source term would be about half a curie, which is a larger source term than the Tc-99

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[34] TC&WM EIS 2009, Vol. 2, p. S-15.
[35] TC&WM EIS 2009, Vol. 2, p. E-14.
[36] TC&WM EIS 2009, Vol. 2, p. E-172.

one given that the drinking water MCL for iodine-129 is almost three orders of magnitude lower than that of Tc-99.

Remediation of other parts of the Hanford Site, such as the 100 and 300 Areas, which are along the Columbia River, is proceeding with the wastes being disposed of in the Environmental Restoration Disposal Facility (ERDF). ERDF is a lined disposal facility with provision for leachate collection. We recognize that waste disposal in ERDF is a concomitant of the way cleanup of the 100 and 300 Areas has been organized. But we also note that the DOE itself has projected a very substantial exceedance of the drinking water limits under EDRF, and by extension at the core zone boundary, since ERDF abuts the southern end of the core zone. Table 2 below is taken from a DOE publication related to ERDF.

Table 2. Potential Groundwater Contaminants at the ERDF

Constituents	Maximum detected soil concentration	Predicted groundwater concentration	Travel time to ERDF boundary
Radionuclides	**picocuries per gram**	**picocuries per liter**	**Years**
Carbon-14	640	1.3×10^6	520
Technetium-99	1.1	2.3×10^3	520
Total uranium	20034	1.1×10^3	520
Uranium-233/234	2100	5.3×10^2	520
Uranium-235	638.4	2.3×10^1	520
Uranium-238	9143	4.9×10^2	520

Source: United States Department of Energy. *Remedial Investigation and Feasibility Study Report for the Environmental Restoration Disposal Facility*. DOE/RL 93-99 rev.1. Richland, WA: DOE Richland Operations Office, October 1994. On the Web at http://www5.hanford.gov/pdw/fsd/AR/FSD0001/FSD0047/D196061256/D196061256_58632036_76907_802.pdf. Table 4-10 (pp. 4T-10c to 4T-10d)

The estimated future peak concentration of carbon-14 is more than two orders of magnitude greater than the drinking water MCL (calculated from the 4 millirem per year dose limit). The technetium-99 concentration would be more than a factor of two greater than the MCL. Total uranium would be about 50 times more than the drinking water limit.

We are not commenting here on the use of ERDF for ongoing remediation efforts, notably in the River Corridor. However, we note that it will be impossible to meet cleanup criteria if EDRF is just capped. It will be essential to clean close ERDF as part of the series of steps to fully remediate Hanford. Plans for doing so should be part of the CERCLA process for the Central Plateau.

The low-level wastes that will be generated as part of the tank waste remediation process are proposed to be disposed on in various ways on site. Aside from the no action alternative, the TC&WM EIS proposes the use of one or two integrated disposal facilities (IDF East and IDF West). IDF West would have a small capacity relative to IDF East and there appears to be no real purpose to building both of them. The DOE has noted this. IDF West should be eliminated from the set of alternatives, since it needlessly complicates an already complex picture in terms of potential alternatives. Besides, the analysis in the TC&WM EIS indicates that groundwater pollution would be greater under IDF West compared to IDF East for the same source term.[37]

However, the main source term at the IDF is not Hanford origin waste, but offsite waste:

> For iodine-129 and technetium-99, release to the vadose zone is dominated by waste management sources, in particular by offsite waste disposed of in IDF-East. Offsite waste accounts for over 93 percent of the total release to the vadose zone for iodine-129 and over 83 percent of the total release to the vadose zone for technetium-99.[38]

It defeats the purpose of remediation if offsite wastes contribute to the majority of the contamination for thousands of years and drinking water standards are violated for thousands of years as a result of offsite wastes. Import of wastes into Hanford can be controlled by the DOE in that it can manage the wastes otherwise. We recommend that the Final EIS have an alternative that does not include offsite wastes containing long-lived radionuclides. This alternative should also limit the Hanford long-lived radionuclide source term so that it complies with the restrictions in Section C above.

The DOE has estimated impacts of offsite wastes based only on the source terms that DOE could somehow calculate. However, these estimates contain large and unquantified uncertainties. The TC&WM EIS notes:

> Estimates of potential, future offsite generated LLW and MLLW volumes requiring disposal in DOE regional disposal facilities are comprised primarily of waste generated in **cleanup and decommissioning projects, rather than legacy waste. Much of this work is yet to be planned. Therefore, there are significant uncertainties in waste volume projections because waste is yet to be generated, and little characteristic information is available as previously discussed. This is a change from the situation during the early years of the EM program when most MLLW was in storage awaiting treatment and disposition.**
>
> **In addition to uncertainties in waste volume, the newly collected LLW and MLLW waste data did not include radionuclide or hazardous chemical data needed for EIS modeling. EM has not collected radionuclide and hazardous constituent information since the 1990's, when data was collected to support the Federal Facilities Task Force and the WMPEIS development.** Documented information on radionuclides is found in the *Low-Level Waste Capacity Report*, Revision 2, produced in 2000. This document continues to serve as a source for waste characteristics.
>
> It is difficult to predict the radionuclide and hazardous chemical composition of waste projected in the future, particularly from cleanup programs, because the waste does not exist until the cleanup work progresses. Forecasts are based on best available characterization of the site or facility, the technology selected for cleanup, and the work plans. For this reason, the forecast waste characteristics data in most instances relies on representative information from similar waste streams recently sent to disposal. Actual LLW and MLLW disposal profiles were requested from waste managers and several

[37] TC&WM EIS 2009, Summary. See Tables S-8 and S-9 on pages 100 and 101, respectively.
[38] TC&WM EIS 2009, Vol. 1, p. 5-1197.

> were judged to have the necessary data for modeling and be suitable for projected waste streams.[39]

Many of the source terms are inappropriately estimated. Some do not appear to be "similar waste streams" as claimed. For instance, the Rocky Flats waste composition has been used for estimation at Savannah River Site and West Valley source terms. However, the latter sites have reprocessing plants; SRS also has reactors. Rocky Flats was a facility whose main purpose was to produce plutonium pits and it did not have reprocessing facilities with large amounts of fission products and did not have reactors. As another example, in several cases – Oak Ridge, Savannah River Site, and Idaho National Laboratory– exactly the same volume of mixed low-level waste was estimated. This is completely unrealistic. If the DOE does not have even moderately reliable information, the resultant environmental impact analysis will be meaningless.

One conclusion from the above is that the offsite source term radiological impacts could be much larger than estimated in the TC&WM EIS. The DOE has made no effort to bound these impacts.

The problem with chemicals is even worse, since the large majority of source terms is not reported. And the unreported source terms are ignored in the impact analysis.[40]

One must conclude that the offsite impacts may be seriously underestimated both in regard to chemicals and radionuclides, including long-lived radionuclides. This reinforces our conclusion that offsite wastes should continue to be banned from the Hanford Site.

3. *Other issues relating to waste*

The TC&WM EIS discusses the possibility of using phosphate glass as follows:

> It has been proposed that the use of a phosphate glass formula for Hanford waste vitrification would have some advantages over the current baseline borosilicate glass. Hanford tank waste has some chemical constituents that are troublesome to incorporate into the base program ILAW and IHLW borosilicate glasses. The low solubility of sulfate in silicate glasses limits the concentration of sodium oxide in the ILAW glass. Without the sulfate problem, an increase in waste loading would be possible for ILAW glass. **Sulfate incorporation and chemical durability have been demonstrated in the laboratory for phosphate glasses formulated for Hanford ILAW. Similarly, for IHLW glass, the chromium solubility limits the waste loading in the baseline borosilicate glass. High chromium content may be incorporated by adding phosphate to the waste feed and operating at 1,200 to 1,250 °C (2,190 to 2,280 °F).** Increased waste loading can be accommodated, and the lower viscosity of the resulting melt allows a shorter residence time in the melter. These factors offer the potential for improved IHLW glass throughput at the WTP. This option was not considered for evaluation in this *TC & WM EIS* because the phosphate glass formula has not been proven to be compatible with production-scale melters, and the resulting product glass

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[39] TC&WM EIS 2009, Vol. 2, pp. D-127 and D-128.
[40] TC&WM EIS 2009, Vol. 2, table D-82.

> has not been shown to meet the waste acceptance technical requirements for DOE's Civilian Radioactive Waste Management System (DOE 2007). [41]

Given that Yucca Mountain is no longer being considered as a repository, the phosphate glass melter approach should be seriously reevaluated as a complement to the borosilicate glass.

Recommendations: There should be no import of offsite wastes into Hanford. It will eventually be essential to clean close ERDF as part of the series of steps to fully remediate Hanford. Plans for doing so should be part of the CERCLA process for the Central Plateau.

I. Central Plateau Cleanup

The data and analyses in Appendix U of the TC&WM EIS show that an intensive cleanup of the non-tank-farm 200 Areas will be needed if the Central Plateau, and hence the Hanford Site, are to be restored to anywhere near environmentally acceptable conditions. For instance, the TC&WM EIS estimates that the Columbia River nearshore concentration of plutonium-239/240 will be 4250 picocuries per liter – 283 times the drinking water limit were only plutonium present – in the year 2953, more than 800 years from the present. The charts and maps in Section U-1 of Appendix U show several radioactive and hazardous chemical pollutants that are estimated to exceed ARARs for hundreds or even thousands of years.

A plan that addresses the removal of the contamination in the non-tank 200 Areas is an essential complement to a preferred alternative for the TC&WM EIS that will allow the use of the Hanford Site without institutional controls after remediation is complete. At present none of the tank farm closure options meet CERCLA and MTCA requirements. The final TC&WM EIS should contain an option in which the tank farm cleanup activities are set in an overall context of meeting CERCLA requirements for all parts of the Central Plateau and the rest of the Hanford Site.

Recommendations: A plan that addresses the removal of the contamination in the non-tank 200 Areas is an essential complement to a preferred alternative for the TC&WM EIS that will meet all ARARs, including drinking water standards for groundwater and allow the use of the Hanford Site without institutional controls after remediation is complete is essential. The final TC&WM EIS should contain an option in which the tank farm cleanup activities are set in an overall context of meeting CERCLA requirements, including drinking water MCLs, for all parts of the Central Plateau and the rest of the Hanford Site.

[41] TC&WM EIS 2009, Vol. 2, p. E-171.