DOE/EIS-0391

Final Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington

Volume 3, Book 1
Section 1: Overview
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Cover Sheet

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Title: *Final Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington* (*TC & WM EIS*) (DOE/EIS-0391)

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Abstract: The Hanford Site (Hanford), located in southeastern Washington State along the Columbia River, is approximately 1,518 square kilometers (586 square miles) in size. Hanford's mission from the early 1940s to approximately 1989 included defense-related nuclear research, development, and weapons production activities. These activities created a wide variety of chemical and radioactive wastes. Hanford's mission now is focused on the cleanup of those wastes and ultimate closure of Hanford. To this end, several types of radioactive waste are being managed at Hanford: (1) high-level radioactive waste (HLW) as defined in DOE Manual 435.1-1; (2) transuranic (TRU) waste, which is waste containing alpha-particle-emitting radionuclides with atomic numbers greater than uranium (92) and half-lives greater than 20 years in concentrations greater than 100 nanocuries per gram of waste; (3) low-level radioactive waste (LLW), which is radioactive waste that is neither HLW nor TRU waste; and (4) mixed low-level radioactive waste (MLLW), which is LLW containing hazardous constituents as defined under the Resource Conservation and Recovery Act (RCRA) of 1976 (42 U.S.C 6901 et seq.). Thus, this environmental impact statement (EIS) analyzes the following three key areas:

1. **Retrieval, treatment, and disposal of waste from 149 single-shell tanks (SSTs) and 28 double-shell tanks (DSTs) and closure of the SST system.** In this *TC & WM EIS*, DOE proposes to retrieve and treat waste from 177 underground tanks and ancillary equipment and dispose of this waste in compliance with applicable regulatory requirements. At present, DOE is constructing a Waste Treatment and Immobilization Plant (WTP) in the 200-East Area of Hanford. The WTP would separate waste stored in Hanford's underground tanks into HLW and low-activity waste (LAW) fractions. HLW would be treated in the WTP and stored at Hanford until disposition decisions are made and implemented. LAW would be treated in the WTP and disposed of as LLW at Hanford as decided in DOE's Record of Decision (ROD) issued in 1997 (62 FR 8693), pursuant to the *Tank Waste Remediation System, Hanford Site, Richland, Washington, Final Environmental Impact Statement* (DOE/EIS-0189, August 1996). DOE

proposes to provide additional treatment capacity for the tank LAW that can supplement the planned WTP capacity in fulfillment of DOE's obligations under the Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement). DOE would dispose of immobilized LAW and Hanford's (and other DOE sites') LLW and MLLW in lined trenches on site. These trenches would be closed in accordance with applicable regulatory requirements.

2. **Final decontamination and decommissioning of the Fast Flux Test Facility (FFTF), a nuclear test reactor.** DOE proposes to determine the final end state for the aboveground, belowground, and ancillary support structures.

3. **Disposal of Hanford's waste and other DOE sites' LLW and MLLW.** DOE needs to decide where to locate onsite disposal facilities for Hanford's waste and other DOE sites' LLW and MLLW. DOE committed in the ROD (69 FR 39449) for the *Final Hanford Site Solid (Radioactive and Hazardous) Waste Program Environmental Impact Statement, Richland, Washington* (DOE/EIS-0286F, January 2004) that LLW would be disposed of in lined trenches. Specifically, DOE proposes to dispose of the waste in either the existing Integrated Disposal Facility (IDF) in the 200-East Area (IDF-East) or the proposed 200-West Area IDF (IDF-West).

DOE released the *Draft TC & WM EIS* in October 2009 (74 FR 56194) for review and comment by other Federal agencies, states, American Indian tribal governments, local governments, and the public. The comment period was 185 days, from October 30, 2009, to May 3, 2010.

In accordance with Council on Environmental Quality (CEQ) regulations (40 CFR 1502.9(c)) and DOE regulations (10 CFR 1021.314(c)), DOE prepared a supplement analysis (SA) of the *Draft TC & WM EIS* (*Supplement Analysis of the "Draft Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington"* [DOE/EIS-0391-SA-01, February 2012]). DOE prepared an SA to evaluate updated, modified, or expanded information developed subsequent to publication of the *Draft TC & WM EIS* to determine whether a supplement to the draft EIS or a new draft EIS was warranted. Fourteen topic areas were reviewed. Revisions include changes to contaminant inventories, corrections to estimates, updates to characterization data, and new information that was not available at the time of publication of the *Draft TC & WM EIS*. The modified inventories do not change the key environmental findings presented in the draft EIS. They do not present significant new circumstances or information relevant to environmental concerns and bearing on the proposed action(s) and their impacts. Changes to some of the parameters used in the alternatives analysis do not significantly affect the potential environmental impacts of the alternatives on an absolute or relative basis, whether the changes are considered individually or collectively. These are not substantial changes in the proposed action(s) that are relevant to environmental concerns. DOE concluded, based on analyses in the SA, that the updated, modified, or expanded information developed subsequent to the *Draft TC & WM EIS* does not constitute significant new circumstances or information relevant to environmental concerns and bearing on the proposed actions(s) in the *Draft TC & WM EIS* or their impacts. Therefore, DOE determined that a supplement to the *Draft TC & WM EIS* or a new *Draft TC & WM EIS* was not required.

DOE posted the *Supplement Analysis of the "Draft Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington"* on the DOE NEPA website, http://energy.gov/nepa/office-nepa-policy-and-compliance, on February 8, 2012, and on the *TC & WM EIS* website, http://www.hanford.gov/index.cfm?page=1117&, on February 9, 2012, and the SA was provided on February 14, 2012, to the DOE public reading room at 2770 University Drive, Room 101L, Richland, Washington 99352. The SA is also provided here as Appendix X of this final EIS for convenience only.

In preparing this *Final TC & WM EIS*, DOE considered all comments received on the draft EIS and revised this final EIS, as appropriate. DOE has clarified and/or revised its Preferred Alternatives for the three program areas as presented in this *TC & WM EIS*, as follows:

Tank Closure

Eleven alternatives for potential tank closure actions are evaluated in this final EIS. These alternatives cover tank waste retrieval and treatment, as well as closure of the SSTs. DOE has identified the following Preferred Alternatives: 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 except Alternatives 1 (No Action) and 5. For closure of the SSTs, DOE prefers landfill closure; this could include implementation of corrective/mitigation actions as described in the Summary of this EIS, Section S.5.5.1, and Chapter 2, Section 2.10.1, which may require soil removal or treatment of the vadose zone. Decisions on the extent of soil removal or treatment, if needed, will be made on a tank farm– or waste management area–basis through the RCRA closure permitting process. These landfill closure considerations would apply to Tank Closure Alternatives 2B, 3A, 3B, 3C, 5, and 6C. DOE does not prefer alternatives that include removal of the tanks as evaluated in Tank Closure Alternatives 4, 6A, and 6B. As described in the Summary of this EIS, Section S.5.5.1, and Chapter 2, Section 2.10.1, DOE believes that removal of the tank structures is technically infeasible and, due to both the depth of the contamination and the technical issues associated with removal of the tank structures, that it presents significant uncertainty in terms of worker exposure risk and waste generation volume.

DOE does not have a preferred alternative regarding supplemental treatment for LAW; DOE believes it beneficial to study further the potential cost, safety, and environmental performance of supplemental treatment technologies. Nevertheless, DOE is committed to meeting its obligations under the TPA regarding supplemental LAW treatment. When DOE is ready to identify its preferred alternative regarding supplemental treatment for LAW, this action will be subject to NEPA review as appropriate. DOE will provide a notice of its preferred alternative in the *Federal Register* at least 30 days before issuing a ROD. For the actions related to tank waste retrieval, treatment and closure, DOE prefers Tank Closure Alternative 2B, without removing technetium in the Pretreatment Facility.

Although DOE previously expressed its preference that no Hanford tank waste would be shipped to the Waste Isolation Pilot Plant (WIPP) (74 FR 67189), DOE now prefers to consider the option to retrieve, treat, and package waste that may be properly and legally designated as mixed transuranic (TRU) waste from specific tanks for disposal at WIPP, as analyzed in Tank Closure Alternatives 3A, 3B, 3C, 4, and 5. Initiating retrieval of tank waste identified as mixed TRU waste would be contingent on DOE's obtaining the applicable disposal and other necessary permits and ensuring that the WIPP Waste Acceptance Criteria and all other applicable regulatory requirements have been met. Retrieval of tank waste identified as mixed TRU waste would commence only after DOE had issued a *Federal Register* notice of its preferred alternative and a ROD.

FFTF Decommissioning

There are three FFTF Decommissioning alternatives from which the Preferred Alternative was identified: (1) No Action, (2) Entombment, and (3) Removal. DOE's Preferred Alternative for FFTF Decommissioning is Alternative 2: Entombment, which would remove all above-grade structures, including the reactor building. Below-grade structures, the reactor vessel, piping, and other components would remain in place and be filled with grout to immobilize the remaining radioactive and hazardous constituents. Waste generated from these activities would be disposed of in an IDF, and an engineered modified RCRA Subtitle C barrier would be constructed over the filled area. The remote-handled special components would be processed at Idaho National Laboratory and returned to Hanford. Bulk sodium inventories would be processed at Hanford for use in the WTP.

Waste Management

Three Waste Management alternatives were identified for the proposed actions: (1) Alternative 1: No Action, under which all onsite LLW and MLLW would be treated and disposed of in the existing lined Low-Level Radioactive Waste Burial Ground 218-W-5 trenches and no offsite waste would be accepted; (2) Alternative 2, which would continue treatment of onsite LLW and MLLW in expanded, existing facilities and dispose of onsite and previously treated, offsite LLW and MLLW in a single IDF (IDF-East); and (3) Alternative 3, which also would continue treatment of onsite LLW and MLLW in expanded, existing facilities, but would dispose of onsite and previously treated offsite LLW and MLLW in two IDFs (IDF-East and IDF-West). DOE's Preferred Alternative for waste management is Alternative 2, disposal of onsite LLW and MLLW streams in a single IDF (IDF-East). Disposal of SST closure waste that is not highly contaminated, such as rubble, soils, and ancillary equipment, in the proposed River Protection Project Disposal Facility (RPPDF) is also included under this alternative. After completion of disposal activities, IDF-East and the proposed RPPDF would be landfill-closed under an engineered modified RCRA Subtitle C barrier. The final EIS analyses show that, even when mitigation is applied to certain offsite waste streams (e.g., removal of most of the iodine-129), some environmental impacts of small quantities of iodine-129 would still occur and, therefore, limitations for that constituent should apply regardless of the alternative selected.

DOE will continue to defer the importation of offsite waste to Hanford, at least until the WTP is operational, subject to appropriate NEPA review and consistent with its previous Preferred Alternative for waste management (74 FR 67189). The limitations and exemptions defined in DOE's January 6, 2006, Settlement Agreement with the State of Washington (as amended on June 5, 2008) regarding *State of Washington v. Bodman* (Civil No. 2:03-cv-05018-AAM), signed by DOE, Ecology, the Washington State Attorney General's Office, and the U.S. Department of Justice, will remain in place.

This *Final TC & WM EIS* contains revisions and new information based in part on comments received on the *Draft TC & WM EIS*. Sidebars in the margins indicate the locations of these revisions and new information. Minor editorial changes are not marked. Volume 3 contains the comments received on the draft EIS and DOE's responses to the comments. DOE will use the analysis presented in this final EIS, as well as other information, in preparing one or more RODs. DOE will issue a ROD no sooner than 30 days after EPA publishes a Notice of Availability of this *Final TC & WM EIS* in the *Federal Register*.

Final Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington (Final TC & WM EIS)

Washington State Department of Ecology (Ecology) Foreword

Summary

Ecology believes that the U.S. Department of Energy (DOE) and its contractor have prepared a *Final TC & WM EIS* that presents many important issues for discussion. Ecology's involvement in the production of this *TC & WM EIS* shows that this document has benefited from quality reviews and quality assurance procedures. In addition, this document benefited from public comments, and important additions were made in regard to mitigation measures and sensitivity studies.

The single best thing this document does is to clearly indicate the severity of the environmental impacts (both current and future) associated with the waste at the Hanford Site (Hanford), and, as such, DOE and its environmental impact statement (EIS) contractor should be commended for their factual representation.

The information in this document will help shed light on many key decisions that remain to be made about Hanford cleanup. To Ecology, the results of this EIS clearly indicate that some basic tenets concerning future Hanford cleanup are needed to reduce the impacts. They include the following:

- Waste from the tanks needs to be removed to the maximum extent possible. It is not the shell of the tanks or the act of landfill closing that increases the environmental impacts, it is the extent of retrieval from the tanks and the amount of vadose zone remediation.

- Glass is the only acceptable waste form for immobilized low-activity waste (ILAW) that is going to be disposed of at Hanford. This is true for the low-activity waste (LAW) treated through the existing LAW Vitrification Facility and for the LAW treated in the additional supplemental LAW treatment facility. This *TC & WM EIS* shows that all other waste forms are not protective of the groundwater and Columbia River.

- Groundwater pump-and-treat systems will have to continue to treat the groundwater beneath the Central Plateau for a long time after the tank waste has been retrieved and treated.

- A new emphasis should be placed on remediating problematic soil contamination in and beneath the tank farms and in other Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) waste sites in the Central Plateau to limit further groundwater impacts; this would include development of vadose zone remediation methods.

- Hanford's existing waste burden exceeds the capacity of the natural and engineered environment to attenuate it. Therefore, poorly performing waste forms and offsite waste should be eliminated as waste management options.

- As DOE and Ecology have indicated consistently throughout the *TC & WM EIS* development process, certain secondary waste from the Waste Treatment Plant (WTP) must be treated and immobilized to a greater extent to protect groundwater. The performance criteria for secondary waste must be improved beyond a grouted waste form.

- Hanford should embrace the use of a Central Plateau cumulative risk tool to ensure that all individual remediation decisions are protective in aggregate.

Ecology expects DOE to consider our input through this foreword, as well as through our comments made during the public comment process. Ecology worked with DOE with the intent of helping to produce a final EIS that fully informs future decision making. Ecology will continue to work with DOE as it develops the National Environmental Policy Act (NEPA) Record of Decision (ROD) and the important mitigation action plan. As defined in our cooperating agency Memorandum of Understanding (MOU), Ecology expects to be fully involved in the preparation of the ROD.

I. Introduction

Ecology has been a cooperating agency with DOE since 2002 in the production of both the *Draft* and this *Final TC & WM EIS*, as well as a coauthor in the preceding *Tank Waste Remediation System, Hanford Site, Richland, Washington, Final Environmental Impact Statement* (*TWRS EIS*). DOE prepared this EIS to meet the requirements of NEPA. In addition, Ecology has reviewed this EIS to ensure important sections can be adopted to satisfy the requirements of the State Environmental Policy Act (SEPA) to support our permitting processes. The information in this EIS will help inform Ecology and others about critical future cleanup decisions impacting Hanford's closure. When Ecology makes decisions through its permitting process, Ecology will look to this *Final TC & WM EIS* and, if appropriate, adopt portions. Ecology will use the information to develop mitigating permit conditions.

Ecology provided comments regarding the *Draft TC & WM EIS* to document areas of agreement or concern with this EIS and to assist the public in their review. Public and regulator input on the *Draft TC & WM EIS* were critical for the completion of an acceptable *Final TC & WM EIS*.

In this *Final TC & WM EIS*, Ecology issued a revised foreword to comment on the EIS key findings, DOE's Preferred Alternatives, and disposition of Ecology's comments on the *Draft TC & WM EIS*. Ecology has also issued this revised foreword to discuss Ecology's position on certain issues and future needed mitigation actions.

II. Ecology's Role as a Cooperating Agency

Ecology has been a cooperating agency in the preparation of this EIS. A state agency may be a cooperating agency on a Federal EIS when the agency has jurisdiction by law over, or specialized expertise concerning, a major Federal action under evaluation in the EIS.

As a cooperating agency, Ecology did not coauthor or direct the production of this EIS. Ecology did have access to certain data and information as this document was being prepared by DOE and its contractor. Our roles and responsibilities in this process were defined in an MOU between Ecology and DOE.

DOE retained responsibility for making final decisions in the preparation of this *Final TC & WM EIS*, as well as for determining the Preferred Alternatives presented in this EIS. However, Ecology's participation as a cooperating agency enabled us to help formulate the alternatives presented in this *TC & WM EIS*.

Ecology's involvement as a cooperating agency—and the current scope of this *Final TC & WM EIS*—is grounded in a series of events.

On November 8, 2002, DOE asked Ecology to be a cooperating agency on the "Environmental Impact Statement for Retrieval, Treatment, and Disposal of Tank Waste and Closure of Single-Shell Tanks at the Hanford Site, Richland, Washington," known as the "Tank Closure EIS." On November 27, 2002, Ecology formally agreed. The March 25, 2003, MOU outlines the respective agency roles and responsibilities.

While the "Tank Closure EIS" was being developed, another DOE EIS, the *Draft Hanford Site Solid (Radioactive and Hazardous) Waste Program Environmental Impact Statement, Richland, Washington (HSW EIS)*, was in the review stage. Among other matters, the *HSW EIS* examined the impacts of disposal at Hanford of certain volumes of radioactive waste and mixed radioactive and hazardous waste, including waste generated from beyond Hanford.

In March 2003, Ecology filed a lawsuit in the U.S. District Court seeking to prevent the importation and storage of certain offsite transuranic (TRU) and mixed TRU wastes that DOE had decided to send to Hanford prior to issuance of the *Final HSW EIS*. Ecology and intervening plaintiffs obtained a preliminary injunction against these shipments.

In January 2004, DOE issued the *Final HSW EIS*. Based on the *Final HSW EIS*, DOE amended a ROD that directed offsite radioactive and hazardous wastes to Hanford (within certain volume limits) for disposal and/or storage. In response, Ecology amended its lawsuit to challenge the adequacy of the *HSW EIS* analysis.

In May 2005, the U.S. District Court expanded the existing preliminary injunction to enjoin a broader class of waste and to grant Ecology a discovery period to further explore issues with the *HSW EIS*.

In January 2006, DOE and Ecology signed a Settlement Agreement, ending litigation on the *HSW EIS* and addressing concerns found in the *HSW EIS* quality assurance review during the discovery period. The Settlement Agreement called for expanding the scope of the "Tank Closure EIS" to provide a single, integrated set of analyses of (1) tank closure impacts considered in the "Tank Closure EIS" and (2) the disposal of all waste types considered in the *Final HSW EIS*. The Settlement Agreement also called for an integrated cumulative impacts analysis.

Under the Settlement Agreement, the "Tank Closure EIS" was renamed this *TC & WM EIS*. Ecology's existing MOU with DOE was revised along with the Settlement Agreement so that Ecology remained a cooperating agency on the expanded *TC & WM EIS*.

The Settlement Agreement defined specific tasks to address concerns Ecology had with the *HSW EIS*. DOE has now revised information and implemented quality assurance measures used in this *TC & WM EIS* related to the solid-waste portion of the analysis. Ecology and its contractors have performed discrete quality assurance reviews of that information to help confirm that the quality assurance processes of DOE's EIS contractor have been followed.

Based on Ecology's involvement throughout the years of EIS development, we believe that positive changes have been made to address data quality shortcomings in the *HSW EIS*. These specifically relate to the following:

- The data used in analyzing impacts on groundwater
- The integration of analyses of all waste types that DOE may dispose of at Hanford
- The adequacy of the cumulative impacts analysis

Ecology reviewed the *Draft TC & WM EIS* and this *Final TC & WM EIS*. In our reviews, we confirmed that the terms of the Settlement Agreement have been addressed to our satisfaction.

III. Regulatory Relationships and SEPA

Now that this *TC & WM EIS* has been finalized, Ecology will proceed with approving regulatory actions required to complete the Hanford cleanup. These include actions under the (1) Hanford Federal Facility Agreement and Consent Order, also known as the Tri-Party Agreement (TPA), and (2) *State of Washington v. Chu* (Civil No. 2:08-cv-05085-FVS) Consent Decree, as well as actions that require state permits or modifications to existing permits, such as the Hanford Dangerous Waste Sitewide Permit. This

permit regulates hazardous waste treatment, storage, and disposal activity at Hanford, including actions such as tank closure and supplemental treatment for tank waste.

Ecology must comply with SEPA when undertaking permitting actions. It is Ecology's sense that this *Final TC & WM EIS* will be suitable for adoption in whole or in part to satisfy SEPA. It is Ecology's plan to adopt in part portions of this *Final TC & WM EIS* when needed for individual permitting actions.

In addition, Ecology will have a substantial role in establishing standards and methods for the cleanup of contaminated soil and groundwater at Hanford, including areas that are regulated under hazardous waste corrective action authority and/or under CERCLA through a CERCLA ROD. Information developed in this EIS will thus be useful in other applications for the cleanup of Hanford.

IV. DOE's Responses to Ecology's Comments on the *Draft TC & WM EIS*

Ecology submitted comments on the *Draft TC & WM EIS* with a cover letter from Jane Hedges, Program Manager of Ecology's Nuclear Waste Program. These comments were discussed in detail with DOE and the EIS contractor. Many of our comments resulted in changes and additions in this *Final TC & WM EIS*. All of our comments were resolved to our satisfaction. Our comments and DOE's responses to those comments can be seen in the Comment-Response Document, Section 3.1, at Commentor No. 498.

V. Preferred Alternatives

This *Final TC & WM EIS* considers three sets of actions: tank waste treatment and tank farm closure, Fast Flux Test Facility (FFTF) decommissioning, and waste management. The Preferred Alternatives are summarized in this section. DOE's Preferred Alternative decisions with which Ecology disagrees are discussed in this section under Area of Disagreement; those Ecology generally agrees with are discussed in the subsequent section VI of this foreword.

The Preferred Alternatives for the three sets of actions can be summarized as follows:

<u>Tank Waste Treatment and Tank Farm Closure:</u>

- Retrieval of at least 99 percent of the waste from each tank.
- Landfill closure of the tank farms.
- Possible soil removal or treatment of the vadose zone.
- DOE chose to not identify a preferred alternative for supplemental treatment needed to treat that portion of LAW that the WTP, as currently designed, does not have the capacity to treat in a reasonable timeframe.

<u>FFTF Decommissioning:</u>

- All above-grade structures, including the reactor building, would be removed.
- Below-grade structures, the reactor vessel, piping, and other components would remain in place and be filled with grout to immobilize the remaining radioactive and hazardous constituents (FFTF Decommissioning Alternative 2: Entombment).
- Waste generated from these activities would be disposed of in an Integrated Disposal Facility (IDF), and an engineered modified Resource Conservation and Recovery Act (RCRA) Subtitle C barrier would be placed on top.
- Bulk sodium inventories would be processed at Hanford.

Waste Management:

- Onsite low-level radioactive waste (LLW) and mixed low-level radioactive waste (MLLW) streams would be disposed of in a single 200-East Area IDF (IDF-East) under a modified RCRA Subtitle C barrier.

- Single-shell tank (SST) closure waste that is not highly contaminated would be disposed of in the River Protection Project Disposal Facility (RPPDF) under a modified RCRA Subtitle C barrier.

- This final EIS shows that, even when mitigation is applied to offsite waste, environmental impacts would still occur. DOE is deferring the decision on the importation of offsite waste at Hanford, at least until the WTP is operational, subject to appropriate NEPA review. The limitations and exemptions defined in DOE's January 6, 2006, Settlement Agreement with the State of Washington (as amended on June 5, 2008), signed by DOE, Ecology, the Washington State Attorney General's Office, and the U.S. Department of Justice, regarding *State of Washington v. Bodman* (Civil No. 2:03-cv-05018-AAM) will remain in place.

Area of Disagreement:

Ecology agrees with a majority of the Preferred Alternative choices made in this *Final TC & WM EIS*, except for DOE's decision to omit a preferred supplemental treatment alternative from this *Final TC & WM EIS*. This omission leaves this EIS incomplete. This omission is not supported by (and is contrary to) the analysis in this *TC & WM EIS*, which clearly supports a second LAW vitrification alternative as the only environmentally protective option for supplemental treatment. Further, the cost comparisons in this EIS show that all the various options are cost neutral, so any assumptions about potential cost savings in choosing other treatment options are invalid.

As a cooperating agency on this *TC & WM EIS*, Ecology encourages DOE to select a preferred alternative in the ROD that includes a supplemental treatment decision. Ecology prefers an alternative that is similar to Tank Closure Alternative 2B or, at the very least, Alternative 2A. It is essential that ILAW to be disposed of above groundwater and upstream from the Columbia River be vitrified to ensure the water and future users will be protected from the tank waste constituents.

Alternative 2B is consistent with the TPA and the *State of Washington v. Chu* Consent Decree. Also, Alternative 2B does not extend the mission as far as Alternative 2A. Alternatives 2A and 2B both support the retrieval of waste from all the tanks, treatment of all that waste, and a defined end of mission.

Ecology is concerned that, by choosing vague language in this *Final TC & WM EIS* concerning supplemental treatment, DOE is bringing into question its previous commitments about when and if all of the waste will be removed from the SSTs and when and if all the tank waste will be treated. This puts into question the end of mission for tank waste treatment. Because such an undefined scenario was not analyzed in any of the alternatives in this *TC & WM EIS*, related impacts are not visible to decision makers or the public. There are several milestone dates that were critical components of the Consent Decree settlement that resolved the *State of Washington v. Chu* lawsuit. We believe DOE's failure to identify a preferred alternative in this *Final TC & WM EIS* will jeopardize compliance with these dates.

DOE has invested 10 years and $85 million, and Ecology has provided significant effort in cooperating agency review and consultation in producing this *TC & WM EIS*. Ecology expects that investment should result in a *Final TC & WM EIS* that supports making a supplemental treatment decision. We are especially concerned because the *Draft TC & WM EIS* identified no data gaps and gave no indication of DOE's intent to delay a decision on supplemental treatment. Further, no analysis in the *Preliminary Final TC & WM EIS* reviewed by Ecology identified gaps in the supplemental treatment data, nor did the analysis support a delay in making a supplemental treatment decision. No public comment received on the *Draft TC & WM EIS* encouraged DOE to delay selecting a preferred alternative.

If DOE does not select a preferred alternative for supplemental tank waste treatment, we request that it identify the following:

- The data it is using to make this decision and where is it documented in this *TC & WM EIS*.
- Any data gaps in this *TC & WM EIS* and how those gaps will be addressed in the future.
- Additional data it is analyzing to aid it in making the decision.
- The NEPA documentation DOE will use to analyze and support supplemental waste treatment selection. Will it be an additional EIS? How will DOE reconcile the timing of future NEPA documentation and TPA supplemental treatment milestones?

VI. Ecology Insights on Alternatives Considered, EIS Key Findings, and Needed Mitigation Measures

This *Final TC & WM EIS* considers 17 alternatives. Ecology's insights, technical perspectives, and legal and policy perspectives are provided below. Areas of agreement with DOE and points of concern are noted.

SST Waste Retrieval and Tank Farm Closure

Ecology believes that DOE has presented an appropriate range of alternatives for evaluating tank waste retrieval and tank closure impacts. However, based on the hazardous waste tank closure standards of the "Dangerous Waste Regulations" (WAC 173-303-610(2)) and the TPA requirements, Ecology supports only alternatives that involve tank waste retrieval to the maximum extent possible or 99 percent, whichever is greater, from each of the 149 SSTs. An acceptable performance assessment is essential in establishing a clear understanding of the risks and benefits of this retrieval goal. This assessment will be an important part of any specific tank farm closure plan permitting actions.

The analysis in this final EIS, including the new mitigation section, shows that the two most important factors in tank farm closure are (1) maximizing tank waste retrieval and (2) vadose zone remediation of specifically identified hot spots of contamination. Specific vadose zone mitigation will be addressed in specific tank farm closure plan permitting actions.

While DOE has identified the Preferred Alternative for tank closure as including landfill closure, it is important to point out that the specific details of how a tank farm will be closed will be identified in each tank farm closure plan permit. These closure plans will be subject to public comment and agency response before landfill decisions can be implemented.

High-Level Radioactive Waste Disposal

High-level radioactive waste (HLW) associated with the tank waste includes, but may not be limited to, immobilized high-level radioactive waste (IHLW) and HLW melters (both retired and failed). It has been DOE's longstanding plan to store these wastes at Hanford and then ship them off site and dispose of them in a deep geologic repository. The idea was that the nature of the geology would isolate the waste and protect humans from exposure to these very long-lived, lethal radionuclides. The Nuclear Waste Policy Act (NWPA) indicates that these waste streams require permanent isolation. By contrast, the ILAW glass, and perhaps other waste streams, may not require deep geologic disposal due to the level of pretreatment resulting in radionuclide removal and the degree of immobilization provided for in the ILAW glass.

However, the final decision on HLW disposal has recently become an issue with significant uncertainty. This *Final TC & WM EIS* contains the following statement:

> The Secretary of Energy has determined that a Yucca Mountain repository is not a workable option for permanent disposal of spent nuclear fuel (SNF) and HLW. However, DOE remains committed to meeting its obligations to manage and ultimately dispose of these materials. The Administration has convened the Blue Ribbon Commission on America's Nuclear Future (BRC) to conduct a comprehensive review of policies for managing the back end of the nuclear fuel cycle, including all alternatives for the storage, processing, and disposal of SNF and HLW. The BRC's final recommendations will form the basis of a new solution to managing and disposing of SNF and HLW.

The State of Washington asserts that there is only one legal process in place for developing a geologic repository, which is provided by the NWPA. Under the NWPA, only Congress can take Yucca Mountain off the table. The convening of the BRC to examine alternatives to Yucca Mountain and recommend possible amendments to the NWPA cannot substitute for a process already provided by law. Legally, Yucca Mountain is still the location for the deep geologic repository.

The NWPA requires permanent isolation of these most difficult waste streams. Leaving these wastes stored at Hanford indefinitely is not a legal option or an acceptable option to the State of Washington.

Ecology is concerned about the glass standards and canister requirements for the IHLW. These standards were developed based on what was acceptable for Yucca Mountain. Now that Yucca Mountain is no longer DOE's assumed disposal location, Ecology is concerned about what standards for glass and canisters will be utilized by the WTP. Ecology insists that DOE implement the most conservative approach in these two areas to guarantee that the glass and canister configurations adopted at the WTP will be acceptable at the future deep geologic repository.

In addition, Ecology maintains that DOE should build and operate adequate interim storage capacity for the IHLW and the HLW melters in a manner that does not slow down the treatment of tank waste.

This *Final TC & WM EIS* assumes that the used (both retired and failed) HLW melters are HLW and, therefore, should be disposed of in a deep geologic repository. This EIS also assumes that the used HLW melters will stay on site before shipment to such a repository. DOE has not requested, and Ecology has not accepted, long-term interim storage of used HLW melters at Hanford.

The final disposal of these melters should be in a deep geologic repository. This EIS evaluates only storage of the HLW melters and not the disposal pathway. The disposal pathway for the used melters (both retired and failed) will require further evaluation than is presented in this *Final TC & WM EIS*. Ecology and DOE will need to reach a mutual understanding and agreement on the regulatory framework for disposal.

Pretreatment of Tank Waste

This *Final TC & WM EIS* includes numerous alternatives that pretreat tank waste to separate the high-activity components and direct them to an HLW stream. The HLW stream will be vitrified, resulting in a glass waste product that will be sent to a deep geologic repository. However, this final EIS has one alternative (not the Preferred Alternative) that provides no pretreatment for some portion of the waste in the 200-West Area.

As a legal and policy issue, Ecology does not agree with alternatives that do not require pretreatment of the tank waste. Such alternatives do not meet the intent of the NWPA to remove as many of the fission products and radionuclides as possible to concentrate them in the HLW stream. For this reason, Ecology requests that DOE rule out any alternative that does not pretreat tank waste.

TRU Tank Waste

This *Final TC & WM EIS* considers the option of treating waste from specific tanks as mixed TRU waste and sending it to the Waste Isolation Pilot Plant (WIPP). This final EIS also considers WTP processing of the waste from these specific tanks.

Ecology is concerned by DOE's current approach to the potential mixed TRU tank waste. Prior to public comment on the *Draft TC & WM EIS*, DOE issued a statement in the Federal Register (74 FR 67189) that indicated that it was no longer considering sending Hanford tank waste to WIPP:

> DOE is now expressing its preference that no Hanford tank wastes would be shipped to WIPP. These wastes would be retrieved and treated in the Waste Treatment Plant (WTP) being constructed at Hanford. The State of Washington Department of Ecology (Ecology), a cooperating agency on the EIS, has revised its Foreword to the Draft EIS in response to this modification to the preferred alternative for tank waste.

For this reason, Ecology did not comment on this approach during public comment, and no public meeting was held in New Mexico.

However, this *Final TC & WM EIS* reversed this course and is now supporting the idea of some tank waste being classified as TRU waste and being packaged for disposal at WIPP. Ecology has concerns that there may be significant public concern regarding this path forward that has not been given the opportunity to be voiced, particularly since the public meetings in New Mexico were canceled.

Ecology has legal and technical concerns with any tank waste being classified as mixed TRU waste at this time. DOE must provide peer-reviewed data and a strong, defensible, technically and legally detailed justification for the designation of any tank waste as mixed TRU waste, rather than as HLW. DOE must also complete the WIPP certification process and assure Ecology that there is a viable disposal pathway (i.e., permit approval from the State of New Mexico and the U.S. Environmental Protection Agency) before Ecology will modify the Hanford Sitewide Permit to allow tank waste to be treated as mixed TRU waste. Further, Ecology is concerned with the cost benefit viability of an approach that sends a relatively minor amount of tank waste to WIPP, given the cost it would take to secure the disposal path, and to construct and operate the drying facility for the TRU tank waste.

Supplemental Treatment

In this *Final TC & WM EIS*, DOE considers additions to the treatment processes that the WTP would use; specifically, technologies to supplement the WTP's treatment of LAW. Because the WTP as currently designed does not have the capacity to treat the entire volume of LAW in a reasonable timeframe, additional LAW treatment capacity is needed. In section V of this foreword, we describe DOE's approach to delay the decision on supplemental treatment and describe Ecology's significant concern over that approach. In this section, we provide further information on our concerns.

Ecology is stating that this EIS and ROD should make a decision on supplemental treatment; that the only viable choice is the second LAW Vitrification Facility; and that to delay the decision in this EIS will endanger future tank waste milestones and commitments.

<u>Vitrification Options:</u>

Ecology agrees that evaluation of additional LAW vitrification treatment capacity as part of the scope of this EIS was needed. An additional supplemental LAW treatment system is necessary to treat all the tank waste in a reasonable amount of time. Ecology fully supports the *Final TC & WM EIS* alternative that assumes a second LAW Vitrification Facility would provide additional waste processing. Building a second LAW Vitrification Facility has consistently been Ecology's and DOE's baseline approach.

Ecology is supportive of a second LAW Vitrification Facility as the Preferred Alternative in the ROD for the following reasons:

- LAW vitrification is a mature technology that is ready to be implemented with no further testing.
- LAW vitrification produces a well-understood waste form that is extremely protective of the environment (the bulk vitrification waste form is not as protective and the waste form performance data show that cast stone and steam reforming are the least protective forms).

Ecology's measuring stick for a successful supplemental treatment technology has always been whether it is "as good as glass" (from the WTP).

Bulk vitrification is a type of vitrification; however, data from the last bulk vitrification experimental testing indicate waste form performance and technology implementation issues. There has been a lack of significant progress on advancing a bulk vitrification test facility for actual waste. The environmental results from the waste form performance presented in this *Final TC & WM EIS* indicate that LAW vitrification is superior to bulk vitrification. A recently published DOE report indicates that a second LAW Vitrification Facility would be preferable.

Cast Stone and Steam Reforming Options:

Ecology is not supportive of alternatives that consider supplemental treatment methods that are not vitrification. This issue was addressed during the *State of Washington v. Chu* settlement negotiations and resolved with a series of target milestones, to become enforceable after the 2015 TPA negotiations on supplemental treatment, which dictate the schedule for a "Supplemental Treatment Vitrification Facility" (see TPA Milestones M-62-31-T01 through M-62-34-T01 and Milestone M-62-45). Specifically related to the cast stone (grout) and steam reforming alternatives, Ecology has waste form performance and technical concerns. From a technical standpoint, the waste treatment processes of steam reforming and cast stone would not provide adequate primary-waste forms for disposal of tank waste in onsite landfills. This has been the subject of a previous DOE down-select process, in which Ecology and other participants rated these treatment technologies as low in performance. This final EIS shows that the waste form performance of both cast stone and steam reforming would be inadequate. These alternatives do not merit any further review.

Specifically related to the steam reforming alternative, Ecology has technical concerns about the *Draft* and *Final TC & WM EIS* assumptions regarding contaminant partitioning and its effects on waste form performance. Additionally, recent testing (2009 to 2011) on steam reforming development has shown that the technology readiness is very low, the mass balance cannot be closed, cost savings assumptions have evaporated, and waste performance is still undetermined. In addition, there have been operational off-normal events in 2012 in an Idaho steam reforming plant that raise many operations and safety questions. DOE should not include steam reforming as part of the Preferred Alternative and no further studies are warranted.

Washington State is particularly concerned with the recent re-emergence of cast stone or grout as the favored choice for treating LAW. Because this re-emergence coincides with the vague-language change about a preferred alternative for supplemental treatment in this *TC & WM EIS*, Ecology would like to recap the important history of grouting tank waste at Hanford.

For the past two decades, the citizens of the Northwest have vigorously opposed grouting LAW. Their concerns included waste form performance and the increased waste volume (twice as much as ILAW glass) that would create increased disposal needs and associated costs.

Important information on grout and cast stone waste form performance history includes the following:

- The Hanford Waste Task Force, a stakeholder advisory group, concluded that "grout doesn't adequately protect public, workers, and environment" and that "reduction of waste volume was an issue for grout" because grout increases final-waste-form volume significantly. (*Final Report of the Hanford Waste Task Force, Appendix F*, 1993.)

- DOE's 1995 waste form performance assessment resulted in identification of three constituents that would ultimately violate drinking water standards if grout is used. The three constituents (nitrate, iodine-129, and technetium-99) violated drinking water standards before and after the 10,000-year analysis timeframe. (*Performance Assessment of Grouted Double Shell Tank Waste Disposal at Hanford*, 1995, WHC-SD-WM-EE-004 Rev. 1.)

- The 2003–2006 supplemental treatment down-select showed that cast stone would not be appropriate for LAW treatment because it would significantly impact the groundwater, i.e., above drinking water standards, and would not be "as good as glass." Roy Schepens, Office of River Protection Manager, defined the term "as good as glass" in his letter to Mike Wilson, Ecology (June 12, 2003), as follows:

  > The waste form resulting from treatment must meet the same qualifications of those imposed for the expected glass form produced by the Waste Treatment Plant (WTP). We expect all waste forms produced from any supplemental technology to: (1) perform over the specified time period as well as, or better than WTP vitrified waste; (2) be equally protective of the environment as WTP glass; (3) meet LDR [land disposal restrictions] requirements for hazardous waste constituents; (4) meet or exceed all appropriate performance requirements for glass, including those identified in the WTP contract, Immobilized Low Activity Waste (ILAW) Interface Control Documents, and ILAW Performance Assessment.

- The 2009 *Draft* and 2011 *Preliminary Final TC & WM EIS* indicated that the environmental performance of the grouted waste form would not meet required standards and that grout actually performed the worst of all the supplemental treatment options considered.

- In 2012, the U.S. Nuclear Regulatory Commission (NRC) issued a report, *Technical Evaluation Report for the Revised Performance Assessment for the Saltstone Disposal Facility at the Savannah River Site, South Carolina*, exposing issues related to long-term performance of the resulting waste form.

Based on this history and the results of this *Final TC & WM EIS*, no further consideration of grout or cast stone is warranted.

Cost Comparisons:

We believe that credible cost comparisons have been made in a number of documents and that all current data, including that in this EIS, do not demonstrate marked cost reductions, nor have our experiences with other technologies (bulk vitrification) at Hanford demonstrated significant cost reductions. The cost information is included in the following:

- In the mid-1990s, recognizing the broad-based public concern about grout and the potential for LAW vitrification at costs that appeared similar to those for grout on a grand scale, Washington State opted for vitrification when negotiating a new set of milestones for tank waste treatment. In return, Washington agreed to DOE's desire to delay construction of the Hanford Waste Vitrification Plant [the treatment plant prior to the WTP] for budgetary reasons and other DOE sites competing for the same resources.

- DOE's 2003 report, *Assessment of Low-Activity Waste (LAW) Treatment and Disposal Scenarios for the River Protection Project (RPP)*, did not show a favorable grout waste treatment cost estimate.

- DOE's 2007 report, *Hanford River Protection Project Low Activity Waste Treatment: A Business Case Evaluation*, examined the cost and viability of implementing cast stone, bulk vitrification, and steam reforming waste treatment. The report stated that "cost differences between Business Cases 2 through 7 are unlikely to be the major factor in selecting a supplemental LAW technology."

  In the report, all the technologies were cost neutral when compared to each other and to ILAW glass. The report went on to comment on the added time and cost that would be required to bring the supplemental technologies up to the technology readiness level of ILAW glass.

- The 2009 *Draft* and 2011 *Preliminary Final TC & WM EIS*, which have gone through extensive DOE and external review, indicate that the costs are relatively equivalent for ILAW glass and grouted LAW approaches.

Summary of Important History of Tank Waste Treatment:

This summary provides select relevant history on issues related to Hanford tank waste treatment that should be considered before the *TC & WM EIS* decision on supplemental treatment is finalized in the ROD.

- The 1996 *TWRS EIS*, which Ecology coauthored with DOE, resulted in a ROD that committed to some important actions, including the following:

  – Treating all of the tank waste

  – Pretreating and separating the tank waste so that some of the tank HLW can be disposed of in a near-surface landfill, while the remainder is disposed of in a deep geologic repository

  – Vitrifying the pretreated LAW portion prior to near-surface disposal and vitrifying the HLW portion for deep geologic disposal

  – Removing all of the retrievable waste out of the tanks

  Because the *TWRS EIS* ROD will be superseded by the *TC & WM EIS* ROD, it is important to the State of Washington that DOE stand by its commitments to these actions.

- In 1997, NRC issued a determination that a portion of Hanford tank waste could be considered waste incidental to reprocessing and, therefore, could be disposed of in a near-surface landfill. The tank waste treatment system for 177 tanks included the following:

  – Solids leaching, complexant destruction, liquid–solids separation, and cesium ion exchange to separate tank waste into HLW and incidental waste fractions

  – Vitrification (glass) for treatment and disposal of the incidental waste fraction

  NRC stated that the determination of the proposed LAW fraction as incidental waste is a provisional agreement. If the Hanford tank waste is not managed using a program comparable to the technical basis analyzed in the reference letter, NRC must revisit the waste determination (Paperiello [1997], NRC, to J. Kinzer, DOE). Changing the methods of pretreatment, the

near-surface disposal location, or the form of treatment for LAW from vitrification to something new would invalidate the incidental waste determination, and a new analysis would be necessary.

- Between 2003 and 2006, Washington State agreed to allow DOE to consider alternative supplemental treatment approaches as long as they performed "as good as glass." DOE stated that its goal was to identify alternative approaches that were faster and cheaper, but still performed just as well as glass. This effort examined many different technologies; however, in the end, no viable approaches have been identified.

- In the Consent Decree settlement that resolved *State of Washington v. Chu*, Civil No. 2:08-cv-05085-FVS, we agreed to the following:

  – A delay in the end of tank waste treatment from 2028 to no later than 2047
  – A delay in final waste removal from SSTs from 2018 to no later than 2040
  – A schedule for supplemental treatment to be online by 2022

  As outlined above, the State of Washington asserts that the milestones resulting from these negotiations dictate that supplemental treatment be some form of vitrification.

Secondary Waste from Tank Waste Treatment

This *Final TC & WM EIS* evaluates the impacts of disposing of secondary waste that would result from tank waste treatment. Ecology agrees with DOE that secondary waste from the WTP and from supplemental treatment operations will need additional mitigation before disposal. This assumption is not reflected in (and, in fact, is contradicted by) the current DOE baseline, which does not identify additional mitigation.

The new mitigation section in this final EIS outlines the requirement for treatment standards for the secondary waste. This was an important addition to this EIS. Chapter 7, Section 7.5.2.8, and Appendix M, Section M.5.7.5, discuss a number of options for improving grout performance for secondary waste. At an infiltration rate of 3.5 millimeters per year, lowering the diffusivity for grout by two orders of magnitude (i.e., from 1×10^{-10} to 1×10^{-12} square centimeters per second) would decrease the contribution of Effluent Treatment Facility–generated secondary waste by a factor of 100, thus deleting this waste from the list of dominant contributors to risk.

DOE has not determined what the secondary-waste treatment would be, but DOE and its contractor are evaluating various treatment options. These treatment options should meet at least the performance standard (1×10^{-12} square centimeters per second) identified in this final EIS. This will have to be refined and verified through the risk budget tool mitigation measures required in the IDF permit.

Tank Waste Treatment Flowsheet

In preparing this *Final TC & WM EIS*, some assumptions were made about highly technical issues, such as the tank waste treatment flowsheet, which is a representation of how much of which constituent would end up in which waste form and in what amount.

Certain constituents, such as technetium-99 and iodine-129, are significant risk drivers because they are mobile in the environment and have long half-lives. This final EIS assumes that 20 percent of the iodine-129 from the tank waste would end up in vitrified glass and 80 percent in the grouted secondary waste. The same assumption was made for bulk vitrification glass and the WTP LAW Vitrification Facility waste glass.

Based on review of the *Final TC & WM EIS* contaminant flowsheets for the WTP and bulk vitrification, Ecology has technical concerns with this approach. The design configuration for the WTP indicates that

iodine-129 recycles past the melter multiple times, which leads to a higher retention in the glass and less in the secondary waste. Therefore, Ecology believes the retention rate of iodine-129 in the ILAW glass may be higher than that in the bulk vitrification glass. However, Ecology is aware that there is uncertainty in the actual glass retention results.

Through our cooperating agency interactions, DOE agreed to run a sensitivity analysis to show the information under a different approach. The sensitivity analysis in this *Final TC & WM EIS* shows that if recycling of iodine-129 is as effective as the WTP flowsheets indicate, then the WTP with a Bulk Vitrification Facility alternative would place 80 percent of iodine-129 in secondary waste (a less robust waste form). This can be compared to an alternative that includes a second LAW Vitrification Facility in addition to the WTP, which would place 30 percent of the iodine-129 in secondary waste. This 50 percent difference in capture reinforces Ecology's opinion that choosing Tank Closure Alternative 2B, which would use the WTP and a second LAW Vitrification Facility, would be most protective from a tank waste treatment perspective. This is one more reason that Ecology is supportive of Alternative 2B as the Preferred Alternative.

One key treatment mitigation identified in this final EIS is that both WTP and supplemental treatment must include recycle of key contaminants through the melter systems to maximize the retention of these constituents into the most robust waste forms.

Waste Release

This *Final TC & WM EIS* models contaminant releases from several different types of final waste forms, including the following:

- ILAW glass
- LAW melters (retired and failed)
- Waste in bulk vitrification boxes
- Steam reformed waste
- Grouted LAW from tank waste
- Grouted secondary waste
- Waste left in waste sites
- Grouted waste in the bottom of tanks
- Waste buried directly in landfills
- Waste that has been macroencapsulate

Ecology understands the methods and formulas used for the waste form release calculations (for all waste types). After reviewing the analysis approaches and contaminant release results for the waste forms identified above, Ecology agrees with most of the approaches used. The one area where Ecology has concerns is the steam reforming waste form release rates. Based on the limited test data available, the results in this final EIS may overestimate the contaminant retention in the steam reforming waste form.

Offsite Waste

DOE is decades behind its legal schedule in retrieving tank waste from the SSTs and years behind its legal schedule in completing construction of the WTP. DOE has not even begun treating Hanford's 207 million liters (54.6 million gallons) of tank waste.

Ecology is concerned about DOE maintaining its legal schedule for contact-handled TRU waste shipments for disposal at WIPP. Additionally, it is essential that DOE proceed with planning and development of a remote-handled TRU waste facility.

Large areas of Hanford's soil and groundwater are contaminated, and many of these areas will likely remain contaminated for generations to come, even after final cleanup remedies have been instituted.

In light of the current issues associated with a deep geologic disposal facility and DOE's attempt to terminate the Yucca Mountain program, it is unclear when close to 60 percent of the nation's HLW and more than 90 percent of the nation's defense-related SNF will leave the state of Washington.

Washington State is aware that, under DOE's plans, more curies of radioactivity would leave Hanford (in the form of vitrified HLW and processed TRU waste) than would be added to Hanford through proposed offsite-waste disposal. However, based on the current lack of waste movement from Hanford, the current state of Hanford's cleanup, and the analysis in this *Final TC & WM EIS*, Washington objects to the disposal at Hanford of additional wastes that have been generated from beyond Hanford.

As the *Draft* and *Final TC & WM EIS*s show, disposal at Hanford of the proposed offsite waste would significantly increase groundwater impacts to beyond acceptable levels. Such disposal would add to the risk term at Hanford today, at a time when progress on reducing the bulk of Hanford's existing risk term has yet to be realized. DOE should take a conservative approach to ensure that the impact of proposed offsite-waste disposal, when added to other existing Hanford risks, does not result in exceeding the "reasonable expectation" standard of DOE's own performance objectives (DOE Manual 435.1-1, Section IV.P(1)) and of other environmental standards (e.g., drinking water standards). The additional analysis in this *Final TC & WM EIS*, including the mitigation section, clearly indicates that eliminating offsite-waste disposal at Hanford is the only environmentally appropriate action.

Washington State supports a "no offsite-waste disposal" alternative as the Preferred Alternative in this *Final TC & WM EIS*, to be adopted in a ROD. DOE should forgo offsite-waste disposal at Hanford (subject to the exceptions in the current *State of Washington v. Bodman* Settlement Agreement).

Waste Disposal Location Alternatives

Ecology agrees with DOE that a preferred alternative utilizing IDF-East appears better for long-term disposal of waste than locating the IDF in the 200-West Area (IDF-West) because of the faster rate of groundwater flow in the 200-East Area.

Climate Change

Additional qualitative discussion of the potential effects of climate change on human health, erosion, water resources, air quality, ecological resources, and environmental justice has been added to Chapter 6 of this final EIS. Additional discussion of the types of regional climate change that could be expected has also been added to Chapter 6, Section 6.5.2, Global Climate Change. Appendix V has also been expanded. In the *Draft TC & WM EIS*, Appendix V focused on the potential impacts of a rising water table from a proposed Black Rock Reservoir. Following the retraction of this proposal, the focus of Appendix V was changed to analysis of potential impacts of infiltration increases resulting from climate change under three different scenarios.

Vadose Zone Modeling

This *Final TC & WM EIS* uses the STOMP [Subsurface Transport Over Multiple Phases] modeling code for vadose zone modeling. Based on its current review, Ecology believes that the Hanford parameters used with this code are adequate for the purposes served by this EIS. Ecology notes that the *TC & WM EIS* STOMP modeling code parameters are based on a regional scale and may need to be adjusted for site-specific closure decisions or other Hanford assessments. Use of STOMP in other assessments requires careful technical review and consideration of site-specific parameters. Ecology supports the process that DOE used for the Waste Management Area C performance assessment workshops in determining appropriate site-specific parameters. These workshops included a broad level of participation with other agencies, tribal nations, and stakeholders.

Risk Assessment and Cumulative Impacts

This *Final TC & WM EIS* evaluates risk under the alternatives and in the cumulative impact analyses. The risk assessment modeling presented in this final EIS should not be interpreted as a Hanford sitewide comprehensive human health and ecological risk assessment, applied to the river corridor or other specific

Hanford areas. Specific Hanford areas will require unique site parameters that are applicable to that area's specific use.

This *Final TC & WM EIS* presents an evaluation of the cumulative environmental impacts of treatment and disposal of wastes at Hanford. The cumulative impact analyses allow DOE to consider the impacts of all cleanup actions it has taken or plans to take at Hanford.

Cumulative Risk Evaluation Tool

This *Final TC & WM EIS* indicates that Hanford's Central Plateau remediation is going to be a difficult balancing of the risks from many contamination sources. This final EIS also points out the need to make cleanup and mitigation decisions with the cumulative impacts in mind and not in isolation. It is clear from reading this EIS that contamination source remediation across the Central Plateau will have to be gauged against a tool that evaluates cumulative risks as they are determined. Another DOE document, *Status of Hanford Site Risk Assessment Integration, FY2005* (DOE/RL-2005-37), stated that the groundwater and the Columbia River are natural accumulation points for impacts from multiple sources. A comprehensive risk assessment capability is necessary to address the cumulative impacts on these resources. The proposed acceptable risk left in an individual site will have to be evaluated against such a cumulative evaluation tool prior to making final decisions. For this and other reasons, a significantly detailed mitigation action plan is required by this NEPA process. From the standpoint of SEPA, the plan will have to point to requirements in the TPA to drive the required mitigation actions and their integration. Ecology will work with DOE to incorporate new TPA requirements to accomplish the following:

- Comprehensively and transparently transfer the working files, vadose zone and groundwater modeling framework, and quality assurance and quality control requirements to the appropriate site contractor and responsible DOE agent to serve as the basis for all future modeling.

- Develop a work plan for continuing this modeling for the purpose of making overall Central Plateau risk decisions and site-specific remedial decisions.

- Identify a gap analysis to highlight areas that are currently not being addressed by a risk evaluation.

- Develop a Central Plateau cumulative risk evaluation tool.

- Develop site-specific risk assessments that are integrated with the Central Plateau cumulative risk evaluation tool.

Without these requirements and implementation of such future risk evaluation tools, future Hanford remediation has the potential to be random at best and not protective, as well as, in some places, to re-contaminate groundwater and vadose zone areas that have been remediated.

VII. Noteworthy Areas of Agreement

Ecology and DOE have discussed and reached agreement on the following significant issues and parameters for the purposes of this *Final TC & WM EIS*:

- Tank waste must be retrieved from tanks and immobilized.

- Secondary waste will need to be mitigated in waste forms that are more protective than grout to provide adequate protection.

- The best location for the IDF is in the 200-East Area.

- Waste from the tanks needs to be removed to the maximum extent possible.
- In many cases, vadose zone contamination under the tank farms will have to be mitigated to be protective of the groundwater and the Columbia River.
- Remediation of problematic soil contamination in the Central Plateau will be needed to limit further groundwater impacts; this would include development of vadose zone remediation methods.
- Eliminating or limiting offsite waste disposal at Hanford is the only legitimate approach.
- The manner in which DOE presents groundwater data and information (i.e., with graphics).
- The quality assurance requirements that DOE and Ecology identified in the *State of Washington v. Bodman* Settlement Agreement.
- The *Technical Guidance Document for Tank Closure Environmental Impact Statement Vadose Zone and Groundwater Revised Analyses* agreement, which focused on parameters shown to be important in groundwater analysis.
- The location of calculation points for contaminant concentrations in groundwater.
- The use of tank farm closure descriptions and alternatives analysis.
- The use of tank waste treatment descriptions and alternatives analysis.
- Inclusion of the US Ecology Commercial LLW Radioactive Waste Disposal Site and the cocooned reactors transported to the Central Plateau in the comprehensive cumulative impacts assessment.
- Overall modeling approaches for vadose zone and groundwater.
- The use of modeling assumptions for the double-shell tanks.
- Alternatives assumptions about how processes would treat existing wastes and generate other wastes during treatment processes, and how DOE would dispose of all of the wastes.
- The methods for evaluating and using waste inventory data.
- Release mechanisms for contaminants from various waste forms.
- An alternative in this *Final TC & WM EIS* that evaluates the impacts of treating and disposing of all tank waste and residue to meet the RCRA/Hazardous Waste Management Act HLW treatment standard of vitrification.
- The inventory assumptions used for the pre-1970 burial grounds.

Ecology's agreement on these issues and parameters is specifically for the purposes of this *Final TC & WM EIS* and is based on Ecology's current knowledge and best professional judgment.

Final Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington (Final TC & WM EIS)

U.S. Environmental Protection Agency (EPA), Region 10 Foreword

After receiving the EPA comments on the *Draft TC & WM EIS*, the U.S. Department of Energy (DOE) wrote to the EPA, inviting the EPA to be a cooperating agency in the development of this *Final TC & WM EIS*. The two agencies signed a memorandum of understanding (MOU) in April 2011 to formalize the EPA's involvement as a cooperating agency and to define each agency's roles and responsibilities in the preparation of this final EIS. Prior to entering into the MOU, the EPA participated in two meetings organized by DOE, in April and October of 2010, to discuss the EPA's comments on the draft EIS and DOE's preliminary plans to address them.

The EPA was not involved in the development of the preliminary final EIS beyond the April and October 2010 meetings. When preliminary final EIS documents were released for review in August 2011, the limited timeframes for review necessitated our focused review on DOE's draft responses to the EPA's draft EIS comments and issues that the EPA considered important to address in this final EIS. This Foreword, therefore, reflects only a limited review of the preliminary and draft final EIS documents. Based on our limited review, the EPA has the following concerns regarding this *Final TC & WM EIS*:

Tank Closure and Waste Management

The EPA notes that the results of analyses of all Tank Closure alternatives in the preliminary and draft final EISs, including DOE's Preferred Alternative for tank closure, Tank Closure Alternative 2B, predict sustained release of contaminants to the environment, particularly to the vadose zone and to groundwater within the EIS analysis area. While we recognize the technical challenges associated with analyzing and addressing this problem, and that there are multiple sources of contaminants over time, we remain concerned about the potential impacts of sustained contaminant release to the vadose zone in the study area and migration to groundwater. We understand that the models used in this EIS to analyze impacts were developed in a process that included peer review. However, present and future users of the models should be aware of any limitations of the models, and assumptions employed in these analyses. We agree with statements in the preliminary and draft final EISs stating that, "these models are complex and rely on assumptions that are subject to a large degree of uncertainty…." At present, we collectively do not have enough information to accurately predict how various contaminants migrate through soils and groundwater, nor when peak groundwater impacts will occur. However, the best site-specific data should be incorporated into the assumptions, especially when the models are being used to inform site-specific decisions.

The EPA will continue to coordinate with DOE and the Washington State Department of Ecology (Ecology) to address contamination issues through our relevant authorities under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); Resource Conservation and Recovery Act (RCRA); and Hanford Federal Facility Agreement and Consent Order, also known as the Tri-Party Agreement (TPA). The TPA currently identifies groundwater in the study area as an operable unit, which will be addressed under CERCLA.

The EPA's comments on the preliminary final EIS addressed the relationship of this EIS to permitting requirements of Ecology's authorized dangerous waste program. We appreciate the changes made to this final EIS in response. The EPA believes that this EIS can serve as a set of bounding analyses reasonably expected to reflect the environmental performance requirements that Ecology may

establish through the permitting process. In this context, the EPA would support an approach to tank closure that includes landfill and clean closure components analyzed in this EIS. The EPA will continue to work closely with Ecology in support of that agency's authorized dangerous waste permitting program.

Secondary- and Offsite-Waste Disposal

This final EIS indicates that disposal of secondary and offsite waste on site at Hanford would continue to show significant impacts of the release of technetium-99 into the vadose zone and groundwater. To prevent additional contamination of the vadose zone and groundwater from such disposal, DOE will need to establish waste acceptance criteria and appropriate treatment technologies to reduce or immobilize contaminants in the wastes, primarily technetium-99 and iodine-129. For example, the steam reforming waste performance is still associated with a high degree of uncertainty, suggesting that steam reforming technology remains immature and requires more improvements. Similarly, iodine-129 is very volatile and cannot be easily converted to immobilized low-activity waste glass.

Next Steps

The EPA's role and responsibilities as a cooperating agency in the development of this final EIS are distinct from its obligations under the National Environmental Policy Act (NEPA) and Section 309 of the Clean Air Act, which require the EPA to review and comment in writing on the environmental impacts of major Federal actions, including actions that are the subject of draft and final EISs under NEPA. The EPA intends to carry out this independent authority in a review of the publicly released version of this final EIS. In addition, the EPA's role as a cooperating agency is separate from, and not intended to duplicate or replace the EPA's regulatory roles, including those under RCRA, CERCLA, and the TPA. We will continue to carry out these responsibilities in coordination with other agencies as appropriate.

Final Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington (Final TC & WM EIS)

U.S. Department of Energy (DOE) Foreword

DOE appreciates the efforts of the Washington State Department of Ecology (Ecology) and the U.S. Environmental Protection Agency (EPA), Region 10, which participated as cooperating agencies in the preparation of this *TC & WM EIS*. Although each had different roles as cooperating agencies, their involvement improved the quality of the National Environmental Policy Act (NEPA) process for this environmental impact statement (EIS).

Ecology began participating in the EIS development as a cooperating agency in 2002 and reconfirmed their participation in 2006 after signing the January 6, 2006, Settlement Agreement (*State of Washington v. Bodman*, Civil No. 2:03-cv-05018-AAM) (subsequently amended on June 5, 2008) ending litigation on the January 2004 *Final Hanford Site Solid (Radioactive and Hazardous) Waste Program Environmental Impact Statement, Richland, Washington*. Ecology's participation as a cooperating agency was important, among other things, to ensure that this *TC & WM EIS* meets Washington State Environmental Policy Act (SEPA) requirements. As a result of the 2006 Settlement Agreement, Ecology accepted additional responsibilities under a concurrent revised Memorandum of Understanding (MOU) to conduct quality assurance reviews of the groundwater and other technical analyses. Ecology also independently ran the models used in this EIS and verified DOE's results. Ecology's role as a cooperating agency supporting SEPA requirements is different from its role under the Hanford Federal Facility Agreement and Consent Order (also known as the Tri-Party Agreement [TPA]) or its role in implementing Washington State's Hazardous Waste Program at the Hanford Site. More-detailed information on Ecology's role can be found in the cooperating agency agreements in Appendix C, Section C.1.1, of this *Final TC & WM EIS*.

DOE appreciates Ecology's support in the development of this EIS and its participation in all the scoping meetings, public hearings on the *Draft TC & WM EIS*, and stakeholder interactions, as well as its support of the EIS schedule. This EIS is needed to support NEPA and SEPA decisions related to the TPA and 2010 Consent Decree (*State of Washington v. Chu*, Civil No. 2:08-cv-05085-FVS) milestone commitments. DOE also appreciates the efforts made by Ecology to understand the inventory, input assumptions, modeling results, and uncertainty analyses and to conduct the quality assurance reviews, contribute to analysis development, assist in presentation of analyses, and participate jointly in public involvement activities. Ecology has expressed both substantial areas of agreement and some areas of disagreement with DOE's Preferred Alternative selections in its foreword to this *Final TC & WM EIS*, consistent with the opportunity afforded to them under the provisions of the *TC & WM EIS* MOU between Ecology and DOE. For its part, DOE understands the state's perspective and will continue to work with them on the path forward at the Hanford Site.

Ecology's comments on the draft EIS can be found in the Comment-Response Document (CRD) (Volume 3 of this final EIS), Section 3, commentor number 498. Ecology and DOE have identified the need for additional secondary-waste-form development (see Chapter 7, Section 7.5.2.8, and Appendix M, Section M.5.7.5). Ecology has also focused on closure of the single-shell tanks; specifically, in Waste Management Area C. More-detailed information on Ecology's permitting process in relation to the NEPA actions can be found in Section 7.1.

DOE invited EPA to be a cooperating agency in 2002 and to participate in model development in 2006 after the January 6, 2006, Settlement Agreement was signed. EPA was not able to participate as a cooperating agency until 2010. Information on EPA's role as a cooperating agency can be found in Appendix C, Section C.1.2.

EPA's comments on the draft EIS as part of their responsibility under Section 309 of the Clean Air Act and DOE's responses can be found in the CRD, Section 3, commentor number 509, of this final EIS. DOE has made changes to this final EIS as a result of EPA's specific comments. EPA's foreword to this EIS indicates a limited timeframe for review of this final EIS. DOE appreciates EPA's focus on DOE's responses to their comments on the draft EIS.

EPA expressed concern regarding the impacts of sustained releases under Tank Closure Alternative 2B. To address this concern, DOE has added information regarding Alternative 2B to Chapter 5, Section 5.1.1.3.4, showing the potential impacts when discharges from the CERCLA [Comprehensive Environmental Response, Compensation, and Liability Act] cribs and trenches (ditches) are excluded. This was done to more clearly show the impacts of the proposed actions separate from the impacts attributed to the adjacent CERCLA cribs and trenches (ditches). For example, Figure 5–87 shows the hydrogen-3 (tritium) results under Tank Closure Alternative 2B, Case 3 (Case 3 excludes cribs and trenches [ditches]), indicating that the tritium concentrations peak two to four orders of magnitude below the benchmark in this case, which highlights that the primary concentration of tritium originates from discharges to cribs and trenches (ditches). In addition, the CRD, Section 2.7, discusses impacts of alternatives based on whether a proposed action being evaluated has occurred, and how mitigation strategies and environmental compliance vary based on those factors.

EPA had comments regarding the EIS modeling that was developed as an outcome of the 2006 Settlement Agreement. DOE believes that its detailed responses to EPA's comments on this specific issue address this EPA concern. EPA also expressed concern about DOE's disclosure of uncertainty relative to future use of the model. DOE believes that discussion of uncertainty, comparison of model results to field data, and disclosure of data and model limitations are important aspects of the analysis presented in this final EIS, as required under NEPA. More-specific discussion on this point can be found in the CRD, Section 2.4. In addition, the groundwater model development process was reviewed by a Technical Review Group (TRG). The TRG was formed to evaluate conversion of the groundwater model from previous models used on site (see the Summary, Section S.1.4.1, and Chapter 1, Section 1.6.1.2). For more information, the report titled *MODFLOW Flow-Field Development: Technical Review Group Process and Results Report*, dated November 2007, can be found on the *TC & WM EIS* website at http://www.hanford.gov/index.cfm?page =1117&.

Comment-Response Document Guide

This Comment-Response Document (CRD) volume of this *Final Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington (Final TC & WM EIS)* consists of the following four sections:

- **Section 1 – Overview of the Public Comment Process**

  This section describes the organization of this CRD and how to navigate the document, the *Draft TC & WM EIS* public comment process; the draft environmental impact statement (EIS) hearing format; and the role of the cooperating agencies in the CRD development.

- **Section 2 – Topics of Interest**

  This section presents topics of interest identified from the public comments received on the *Draft TC & WM EIS* and the U.S. Department of Energy's (DOE's) response to each topic.

- **Section 3 – Public Comments and DOE Responses**

  This section presents a side-by-side display of the comments received by DOE during the public comment period on the *Draft TC & WM EIS* and DOE's response to each comment. The comments were obtained at eight public hearings on the draft EIS and via telephone, fax, email, and U.S. mail.

- **Section 4 – References**

  This section contains the references cited in this CRD.

To Find a Specific Comment and DOE Response

Refer to the "List of Commentors" immediately following the Table of Contents. This list is organized alphabetically by commentor name and shows the corresponding page number(s) where commentors can find their comment(s). Public officials, organizations, and interest groups appear first on the list, followed by individuals. Email campaign signatories are listed last in the "List of Commentors."

Several identical comment documents were submitted twice (sometimes three times) via multiple transmission methods (e.g., identical comment documents from several of the tribes were submitted via email and U.S. mail). To maintain administrative record traceability of receipt, each comment document DOE received (regardless of duplication) was identified with a specific identification number in chronologic order. A comprehensive discussion of the comment receipt process is included in Section 1.2.

DOE has made a good faith effort to interpret the spelling of names that were either handwritten on comment forms or letters or transcribed from oral statements made during public hearings.

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Fifty-four (54) anonymous individuals photographed one of two posters submitted as comments on the *Draft TC & WM EIS.*

ACRONYMS, ABBREVIATIONS, AND CONVERSION CHARTS

List of Acronyms, Abbreviations, and Conversions

2020 Vision	*2020 Vision for WTP Project Transition to Operations*
ALARA	as low as is reasonably achievable
ARAR	applicable or relevant and appropriate requirement
BBI	Best-Basis Inventory
BEIR	Biological Effects of Ionizing Radiation
BOF	balance of facilities
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
COPC	constituent of potential concern
CRD	Comment-Response Document
CTUIR	Confederated Tribes of the Umatilla Indian Reservation
DNFSB	Defense Nuclear Facilities Safety Board
DOE	U.S. Department of Energy
DOJ	U.S. Department of Justice
DOT	U.S. Department of Transportation
DST	double-shell tank
EBR-II	Experimental Breeder Reactor II
Ecology	Washington State Department of Ecology
EIS	environmental impact statement
EM	Office of Environmental Management
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
ETF	Effluent Treatment Facility
FBSR	fluidized-bed steam reforming
Fermi	Enrico Fermi Nuclear Generating Station
FFTF	Fast Flux Test Facility
FR	*Federal Register*
Gable Gap	Gable Mountain–Gable Butte Gap
GENII	Hanford Environmental Radiation Dosimetry Software System (Generation II)
GHB	Generalized Head Boundary
GNEP PEIS	*Global Nuclear Energy Partnership Programmatic Environmental Impact Statement*
GTCC	greater-than-Class C
GTCC EIS	*Environmental Impact Statement for the Disposal of Greater-Than-Class C (GTCC) Low-Level Radioactive Waste and GTCC-Like Waste*
HAB	Hanford Advisory Board
Hanford	Hanford Site
Hanford Comprehensive Land-Use Plan EIS	*Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement*
HLM	Historic Leak Model
HLW	high-level radioactive waste

HSW EIS	*Final Hanford Site Solid (Radioactive and Hazardous) Waste Program Environmental Impact Statement, Richland, Washington*
ICRP	International Commission on Radiological Protection
IDF	Integrated Disposal Facility
IHLW	immobilized high-level radioactive waste
ILAW	immobilized low-activity waste
INL	Idaho National Laboratory
INTEC	Idaho Nuclear Technology and Engineering Center
LAW	low-activity waste
LCF	latent cancer fatality
LIGO	Laser Interferometer Gravitational-Wave Observatory
LLBG	low-level radioactive waste burial ground
LLW	low-level radioactive waste
MCL	maximum contaminant level
MEI	maximally exposed individual
MLLW	mixed low-level radioactive waste
MOA	Memorandum of Agreement
MODFLOW	modular three-dimensional finite-difference groundwater flow model
MODPATH	MODFLOW particle-tracking postprocessing package
MOU	Memorandum of Understanding
MRS	mobile retrieval system
MTCA	Model Toxics Control Act
NEPA	National Environmental Policy Act
NIOSH	National Institute for Occupational Safety and Health
NI PEIS	*Programmatic Environmental Impact Statement for Accomplishing Expanded Civilian Nuclear Energy Research and Development and Isotope Production Missions in the United States, Including the Role of the Fast Flux Test Facility (Nuclear Infrastructure PEIS)*
NMFS	National Marine Fisheries Service
NNSS	Nevada National Security Site
NOI	Notice of Intent
NRC	U.S. Nuclear Regulatory Commission
NTSF	National Transportation Stakeholders Forum
ORP	Office of River Protection
OSHA	Occupational Safety and Health Administration
PCB	polychlorinated biphenyl
PM_n	particulate matter with an aerodynamic diameter less than or equal to *n* micrometers
PUREX	Plutonium-Uranium Extraction
R&D	research and development
RCB	Reactor Containment Building
RCRA	Resource Conservation and Recovery Act
RCW	*Revised Code of Washington*
REDOX	Reduction-Oxidation
rem	roentgen equivalent man
RESRAD	RESidual RADioactivity
RH	remote-handled

RH-SC	remote-handled special component
RL	Richland Operations Office
ROD	Record of Decision
RPP	River Protection Project
RPPDF	River Protection Project Disposal Facility
SA	supplement analysis
SEIS	supplemental environmental impact statement
SEPA	State Environmental Policy Act
SHPO	State Historic Preservation Officer
SIM	Hanford Soil Inventory Model
SNF	spent nuclear fuel
SPF	Sodium Processing Facility
SST	single-shell tank
STOMP	Subsurface Transport Over Multiple Phases
SWITS	Hanford Solid Waste Information Tracking System
TC & WM EIS	*Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington*
Technical Guidance Document	*Technical Guidance Document for Tank Closure Environmental Impact Statement Vadose Zone and Groundwater Revised Analyses*
TPA	Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement)
TRAGIS	Transportation Routing Analysis Geographic Information System
TRU	Transuranic
TWRS EIS	*Tank Waste Remediation System, Hanford Site, Richland, Washington, Final Environmental Impact Statement*
U.S.C.	*United States Code*
US Ecology	U.S. Ecology Commercial Low-Level Radioactive Waste Disposal Site
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VBR	vacuum-based retrieval
WAC	*Washington Administrative Code*
WIDS	Waste Information Data System
WIPP	Waste Isolation Pilot Plant
WM PEIS	*Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste*
WRF	waste receiver facility
WTP	Waste Treatment Plant
Yucca Mountain EIS	*Final Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada*

Measurement Units

The principal measurement units used in this *Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington (TC & WM EIS)* are SI units (the abbreviation for the *Système international d'unités*). The SI system is an expanded version of the metric system that was accepted as the legal standard by the International Organization for Standardization. In this system, most units are made up of combinations of seven basic units, of which length in meters, mass in kilograms, and volume in liters are of most importance in this *TC & WM EIS*. Exceptions are radiological units that use the English system (e.g., rem, millirem).

Scientific (Exponential) Notation

Numbers that are very small or very large are often expressed in scientific, or exponential, notation as a matter of convenience. For example, the number 0.000034 may be expressed as 3.4×10^{-5} or 3.4E-05, and 65,000 may be expressed as 6.5×10^{4} or 6.5E+04. In this *TC & WM EIS*, numerical values that are less than 0.001 or greater than 9,999 are generally expressed in scientific notation, i.e., 1.0×10^{-3} and 9.9×10^{3}, respectively.

Multiples or submultiples of the basic units are also used. A partial list of prefixes that denote multiples and submultiples follows, with the equivalent multiplier values expressed in scientific notation.

Prefix	Symbol	Multiplier	
atto	a	0.000 000 000 000 000 001	1×10^{-18}
femto	f	0.000 000 000 000 001	1×10^{-15}
pico	p	0.000 000 000 001	1×10^{-12}
nano	n	0.000 000 001	1×10^{-9}
micro	μ	0.000 001	1×10^{-6}
milli	m	0.001	1×10^{-3}
centi	c	0.01	1×10^{-2}
deci	d	0.1	1×10^{-1}
deca	da	10	1×10^{1}
hecto	h	100	1×10^{2}
kilo	k	1,000	1×10^{3}
mega	M	1,000,000	1×10^{6}
giga	G	1,000,000,000	1×10^{9}
tera	T	1,000,000,000,000	1×10^{12}
peta	P	1,000,000,000,000,000	1×10^{15}
exa	E	1,000,000,000,000,000,000	1×10^{18}

The following symbols are occasionally used in conjunction with numerical expressions:

$<$ less than
$\leq$ less than or equal to
$>$ greater than
$\geq$ greater than or equal to

Conversions

English to Metric			Metric to English		
Multiply	**by**	**To get**	**Multiply**	**by**	**To get**
Area			**Area**		
square inches	6.4516	square centimeters	square centimeters	0.155	square inches
square feet	0.092903	square meters	square meters	10.7639	square feet
square yards	0.8361	square meters	square meters	1.196	square yards
acres	0.40469	hectares	hectares	2.471	acres
square miles	2.58999	square kilometers	square kilometers	0.3861	square miles
Length			**Length**		
inches	2.54	centimeters	centimeters	0.3937	inches
feet	30.48	centimeters	centimeters	0.0328	feet
feet	0.3048	meters	meters	3.281	feet
yards	0.9144	meters	meters	1.0936	yards
miles	1.60934	kilometers	kilometers	0.6214	miles
Temperature			**Temperature**		
degrees Fahrenheit	Subtract 32, then multiply by 0.55556	degrees Celsius	degrees Celsius	Multiply by 1.8, then add 32	degrees Fahrenheit
Volume			**Volume**		
fluid ounces	29.574	milliliters	milliliters	0.0338	fluid ounces
gallons	3.7854	liters	liters	0.26417	gallons
cubic feet	0.028317	cubic meters	cubic meters	35.315	cubic feet
cubic yards	0.76455	cubic meters	cubic meters	1.308	cubic yards
Weight			**Weight**		
ounces	28.3495	grams	grams	0.03527	ounces
pounds	0.4536	kilograms	kilograms	2.2046	pounds
short tons	0.90718	metric tons	metric tons	1.1023	short tons

Note: The use of the SI system of units as the principal system of measurement in this *TC & WM EIS*, combined with the use of significant figures or rounding when presenting numerical data, may cause some conversions to appear to be incorrect throughout this environmental impact statement (EIS). This is generally more common when the original value was in English units and was subsequently converted to the SI system for presentation in this EIS. The rounding error may be more noticeable when the corresponding measurement units in the English and SI systems are not relatively comparable in magnitude (e.g., feet and meters). For example, for the "2.9-million-liter (758,000-gallon) capacity" values presented in Chapter 2, Section 2.2.1.1, the original value of 758,000 gallons was converted to 2,869,000 liters (rounded to 2.9 million liters). However, converting 2.9 million liters to gallons yields 766,000 gallons, which is different from the original value. In another example, for the values "22 by 29 meters (72 by 94 feet)" presented in Section 2.3.3.2.2, the original value of 94 feet was converted to 28.6 meters (rounded to 29 meters). Converting 29 meters to feet yields 95 feet, which is slightly different from the original value of 94 feet. In this *TC & WM EIS*, the original value in English units is preserved, whereas, in many instances, the SI unit is actually the converted number.