UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
SOLID WASTE AND
EMERGENCY RESPONSE

June 26, 2012

MEMORANDUM

SUBJECT: National Remedy Review Board Recommendations for the 100-K, 200-UP-1, and 300 Areas of the Hanford Superfund Site

FROM: Amy R. Legare, Chair
National Remedy Review Board

TO: Daniel D. Opalski, Director
Office of Environmental Cleanup
U.S. EPA Region 10

Purpose

The National Remedy Review Board (the Board) has completed its review of the proposed cleanup action for the 100-K, 200-UP-1, and 300 Areas of the Hanford Superfund Site ("Hanford Site"), in Richland, Washington. This memorandum documents the Board's advisory recommendations.

Context for Board Review

The Administrator established the Board as one of the October 1995 Superfund Administrative Reforms to help control response costs and promote consistent and cost-effective remedy decisions. The Board furthers these goals by providing a cross-regional, management-level, "real time" review of high cost proposed response actions prior to their being issued for public comment. The Board reviews all proposed cleanup actions that exceed its cost-based review criteria.

The Board review is intended to help control remedy costs and to promote both consistent and cost-effective decisions. Consistent with CERCLA and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), in addition to being protective, all remedies are to be cost-effective. The Board considers the nature of the Site; risks posed by the Site; regional, state, tribal and potentially responsible party (PRP) opinions on proposed actions; the quality and reasonableness of the cost estimates; and any other relevant factors or program guidance in making our advisory recommendations. The overall goal of the review is to ensure sound decision making consistent with current law, regulations, and guidance.

Generally, the Board makes the advisory recommendations to the appropriate regional division director. Then, the region will include these recommendations in the administrative record for the site, typically before it issues the proposed cleanup plan for public comment. While the region is expected to give the Board's recommendations substantial weight, other important factors, such as subsequent public comment or technical analyses of response options, may influence the region's final remedy decision. The Board expects the regional division director to respond in writing to its recommendations within a reasonable period of time, noting in particular how the recommendations influenced the proposed cleanup decision, including any effect on the estimated cost of the action. Although the Board's recommendations are to be given substantial weight, the Board does not change the Agency's current delegations or alter the public's role in site decisions; the region has the final decision-making authority.

Overview of the Proposed Actions

100-K Area – The 100-K area is located adjacent to the Columbia River in the northern portion of the Hanford Site in what is referred to as the River Corridor. The 100-K Area is subdivided into three operable units (OUs) to address cleanup of the soil and groundwater contamination: the 100-KR-1 and 100-KR-2 source (soil) OUs, which encompass liquid waste disposal sites, burial grounds, and soil waste sites; and the 100-KR-4 groundwater OU, which addresses groundwater contamination underlying 100-K. The contaminants of concern (COCs) in the vadose zone include radionuclides, metals, inorganic anions, semivolatile organics and polychlorinated biphenyls (PCBs). The primary groundwater contaminant is hexavalent chromium (Cr(VI)). Other contaminants in groundwater include carbon-14, strontium-90, tritium, total chromium, nitrate and trichloroethene.

Interim actions have remediated 16 waste sites to unrestricted standards through remove, treat (if necessary) and dispose (at Hanford's Environmental Restoration Disposal Facility). Another 50 sites are scheduled to be remediated under the interim action record of decision (ROD) by the time the ROD associated with this review is signed. Interim actions have also been performed to remediate groundwater. Three groundwater treatment systems have been installed and operational since 1997. The original KR system was designed to capture a Cr(VI) plume and prevent discharge to the Columbia River. The KW and KX systems became operational in 2007 and 2009, respectively, to provide additional containment. These three systems have treated over 8.3 billion liter (2.2 billion gallon) of groundwater by removing 576 kilogram (1,269 pounds) of Cr(VI) through the end of 2010. These interim remedial actions provide protection to the Columbia River and mitigate threats to human health, groundwater and ecological receptors.

EPA's preferred alternative is Alternative 3 (remove, treat, dispose (RTD) and Expanded Groundwater Treatment), which expands on the current interim actions. Alternative 3 uses a strategy of RTD almost exclusively for waste sites to rapidly achieve cleanup requirements with the greatest degree of certainty, as well as expanded pump-and-treat for groundwater. This remedy also includes temporary surface barriers for waste sites near the reactors. Once the reactors are removed, the waste site would be addressed using RTD if COCs are still present at concentrations above cleanup levels. Institutional controls (ICs) would be applied as necessary to extend or expand existing land use (land disturbance, excavation and irrigation restrictions). Warning notices and entry restrictions would be maintained.

200-UP-1 Area - The central portion of the Hanford Site, referred to as the Central Plateau, is an area designated as an industrial-land use area. The Central Plateau consists of four groundwater OUs divided

into the 200 West and 200 East areas. The 200-UP-1 Groundwater OU is the southernmost of two groundwater OUs that underlie the 200 West Area. The 200-UP-1 Groundwater OU extends to the south-southeast of the 200 West Area across the Hanford Site.

The groundwater contamination in the 200-UP-1 OU has resulted largely from operations and disposal process liquid waste associated with plutonium recovery processes. The facilities and areas that are associated with these operations are the U Plant (Uranium Recovery Plant), S Plant (Reduction-Oxidation [REDOX] Plant), the 241-S-SX Single-Shell Tank (SST) Farm, and the 241-U Tank Farm Waste Management Areas (WMAs). Liquid wastes generated by the U Plant and S Plant operations were routinely discharged to the ground through engineered discharge structures and surface impoundments including cribs, French drains, reverse wells, ditches and ponds. A number of SSTs in the 241-S, SX Tank Farm (WMA S-SX), and 241-U Tank Farm (WMA U) have leaked and are suspected or known contributors to vadose zone soil contamination. These represent the 200-UP-1 OU groundwater contaminant sources. The primary COCs are carbon tetrachloride, nitrate, uranium, and hexavalent chromium. The remaining COCs are iodine-129, technetium-99 and tritium.

EPA's preferred alternative is Alternative 3, which would take approximately 35 years of active remediation through pump-and-treat. This remedy proposes active restoration through pump-and-treat for technetium-99, uranium, carbon tetrachloride, and total chromium. It also makes use of naturally occurring attenuation processes for tritium, the diffuse parts of the nitrate plume and the remaining portions of the carbon tetrachloride plume. It should be noted that highly concentrated areas of the nitrate plume located near the uranium plume will be extracted and treated. The treatment facility where contaminated groundwater will be remediated is currently designed to operate for 25 years. It is reasonable to believe that the facility can be updated to operate for the additional 10 years of pumping required for this remedy.

300 Area - 300-FF-1 and 300-FF-2 are OUs of waste sites in the southeast portion of the Hanford Site, covering about 56-square miles. 300-FF-5 is the groundwater OU beneath 300-FF-1 and -2. About 1/2 square mile is proposed for cleanup to industrial standards and the rest to residential standards. Groundwater is proposed for cleanup to drinking water standards.

300-FF-1 contains large liquid waste disposal sites. 300-FF-2 waste sites are solid waste and minor liquid waste disposal sites. Both operable units are sites contaminated with radionuclides and chemicals. 300-FF-5 groundwater beneath these areas is contaminated with radionuclides and chemicals. A main mission in the 300 Area was machining uranium fuel rods for use in the reactors. Uranium bearing waste was the primary waste discharged in the 300 Area. In addition there were a wide variety of other laboratory and research and development buildings, activities and subsequent waste disposed in the 300 Area.

The EPA's preferred alternative is RTD for the source waste sites for both surface use and groundwater protection, except for sites with only uranium below 15 feet that could leach to groundwater at concentrations above groundwater standards. That deep uranium will be immobilized with *in-situ* treatment to protect groundwater. The existing interim ROD for 300-FF-2 and -5 is proposed to be replaced with this ROD. The existing ROD for 300-FF-1 is proposed to be amended to add *in-situ* uranium treatment.

National Remedy Review Board Advisory Recommendations

The Board reviewed the information packages describing these proposals and discussed related issues with management and staff of EPA's Region 10 Hanford Project Office (Dennis Faulk, Emerald Laija, Larry Gadbois, and Christopher Guzzetti); numerous representatives of the Yakama Nation; representatives of the Confederate Tribes of the Umatilla Indian Reservation; and representatives of the Washington State Department of Ecology and Oregon Department of Energy on March 27-29, 2012. Based on this review and discussion the Board offers the following comments:

Recommendations Common to All Three Areas:

Human Health Risk

The Board package indicates that potential risks from groundwater were estimated using a 90th percentile value to represent the exposure point concentration (EPC). EPA guidance exists on how to calculate EPCs when calculating risk (OSWER Directive No. 9285.6-10, December 2002, *Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites*), which recommends the use of an upper-bound estimate of the mean; or, if this upper-bound cannot be calculated due to data paucity or limitations, the guidance defaults to the maximum detected concentration. It is this statistical representation of the data set that should be used as the EPC when estimating cancer risks and non-cancer hazards at a site. EPA's risk assessment guidance recommends that the reasonable maximum exposure estimates the maximum exposure reasonably anticipated at a site. This estimation involves using upper-bound values for the exposure parameters (such as contact rate, frequency, and duration) with an estimate of the average concentration that is not likely to underestimate the average concentration. For these areas, the Region identified EPCs using a 90th percentile concentration, which does not follow either recommendation for an EPC nor does it follow the guidance by using an upper-bound estimate of the concentration. The Board recommends that the decision documents fully explain how the cleanup approach at these areas (including those where contamination is above MCLs) is consistent with EPA guidance (e.g., achieving groundwater cleanup levels throughout the plume [as measured in each well]; see OSWER Directive 9283.1-33, June 2009, *Summary of Key Existing EPA CERCLA Policies for Groundwater Restoration*), and, if it is not consistent, what the reason for deviating from EPA guidance is and how the approach would still result in a remedial action that is protective of human health and the environment. In addition, the decision documents also should include an uncertainty discussion explaining why the approach being taken at these areas does not result in an overestimate or underestimate of the likely true risk.

Applicable or Relevant and Appropriate Requirements

The Board did not have sufficient information to evaluate the role of the Washington Model Toxics Control Act (MTCA) for these areas and whether MTCA Method B is an applicable or relevant and appropriate requirement (ARAR) for these areas. However, it may be appropriate to use it as a "to-be-considered" guidance in developing soil cleanup levels. To the extent MTCA might be considered as an ARAR, the Board notes that the stringent cleanup levels identified by the State of Washington may not be achievable with current technology. The Board recommends that the Region, DOE, and the State work together in evaluating the appropriate role of MTCA in designing a remedial action that will protect human health and the environment. In addition, the Board recommends that the proposed plan and decision documents explain how the cleanup adequately meets the National Historic Preservation

Act consultation process, including, for example, the specific and concrete steps for how cleanup in the cultural areas will proceed in a manner that prevents disturbances (e.g., specific soil sampling designs to protect artifacts), including associated costs.

Cost

In the package presented to the Board, no detailed costs were provided for any of the alternatives; therefore, the Board could not determine if EPA guidance was followed when determining the costs. The lack of detailed cost information also prevented the Board from evaluating cost effectiveness during its review. Also, since there is a 20-year history of remedial/removal actions at the Hanford facility, there should be unit costs that are easily available from actual expenditures for similar completed actions. The Board recommends that detailed unit costs be provided for all the alternatives in the decision documents, using OSWER Directive No. 9355.0-75, July 2000, *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study.*

Terminology

In the documents and presentation to the Board there was inconsistent use of terminology in reference to "chromium:" in some instances, the term appeared to apply to both hexavalent and trivalent chromium but in other instances, only to hexavalent chromium. Clear terminology is especially critical when discussing risks associated with trivalent chromium, which is an essential dietary nutrient, and hexavalent chromium (a chemical EPA has recently identified with oral carcinogenic potential acting through a mutagenic mode of action). The Board recommends that the decision documents clearly define the terms "chromium" and "hexavalent chromium" for remedy selection purposes at these areas and use them consistently.

Policy and Guidance

The Board notes that CERCLA Section 120(a)(2) of CERCLA states that "No department, agency, or instrumentality of the United States may adopt or utilize any such guidelines, rules, regulations, or criteria which are inconsistent with the guidelines, rules, regulations, and criteria established by the Administrator under this Act." Future decision documents should fully explain any such use of non-EPA guidance (e.g., RESRAD, lack of lines of evidence to support monitored natural attenuation, use of something other than 90-99 percent reduction in toxicity per the NCP), why it is appropriate for these areas, and how it will ensure protectiveness of human health and the environment consistent with CERCLA and the NCP.

100-K Area Recommendations:

Institutional Controls

The package presented to the Board indicated that ICs will play an important role for the 100-K Area. The Board recommends that the proposed plan and other decision documents clearly explain in sufficient detail which specific ICs would be needed to ensure protectiveness of human health, upon what authority they would be based and how they would be enforced over the long-term.

Human Health Risk

The Region indicated that a quantitative baseline human health risk (BHHRA) had been completed in the early 1990s. Since that time, several interim actions and removal actions have been implemented to remediate specific areas of contamination. The Board recommends that the Region update or develop an addendum to the BHHRA to confirm current 100-K Area conditions are associated with unacceptable risks. This update should also address significant changes in toxicity values, or exposure pathways or scenarios that may have changed since the time of the original BHHRA. Additionally, the Board recommends that risk from specific exposure scenarios, such as exposures unique to culturally or archaeologically sensitive areas, be characterized in this revision or addendum.

The Board notes that in some areas of the package, the soil cleanup levels are at times based on residential land use at $1 \times 10^{-4}$and at other times, on rural residential land use at 1×10^{-4}. "Rural residential land use" is not defined by EPA in CERCLA risk assessment guidance. Rather, EPA used this term used during a draft proposed rulemaking under the Atomic Energy Act. A similar risk assessment scenario in EPA's preliminary remediation goal (PRG) for radionuclides calculator (OSWER Directive No. 9355.01-83A, February 2002, *Radionuclide Preliminary Remediation Goals for Superfund*) used to be called "Agricultural," but now it is referred to as "Farmer." The soil- based cleanup numbers used in the BHHRA seem to differ from the PRG residential or farmer scenarios. The Board recommends that the Region provide documentation of the risk assessment performed per EPA guidance; otherwise, justify the reason for deviating from EPA guidance.

Ecological Risk

The Board notes that within the presented package, it was stated that there was an ecological risk from both hexavalent chromium and carbon-14. Through communication with the Region, it is clear that the preferred alternative remedy addresses these ecological risks. Since there is a substantial interest in the ecological risks at the 100-K Area, the Board commends the Region for highlighting the ecological risks from hexavalent chromium and carbon-14. The Board recommends that the Region clearly communicate in the decision document how the preferred alternative remediates these risks.

Principal Threat Waste

The package states there are no principal threat wastes (PTW) as part of the 100-K Area action, But also states that a majority the 165 individual waste sites have not been characterized. The importance of PTW identification was recently the subject of the Region 4 Regional Administrator's decision in the Department of Energy (DOE) Paducah dispute. The identification and treatment of PTW at the Hanford Site (e.g., for Cr(VI) in soils found at concentrations several orders of magnitude above the cleanup level of 2 mg/kg) should be consistent with CERCLA, the NCP and EPA guidance (i.e., OSWER Directive No. 9380.3-06FS , November 1991, *A Guide to Principal Threat and Low Level Threat Wastes*). The Board recommends that the Region thoroughly investigate the individual waste sites and address PTW if discovered.

Remedial Action Objectives

The remedial action objective (RAO) 2 included in the package states: "RAO 2. Prevent unacceptable risk to human health and ecological exposure to surface water containing contaminant concentrations

above federal and state standards and risk-based thresholds." The Board recognizes the importance of the Columbia River as a resource and agrees that ongoing monitoring of river impacts from the Hanford Site should be performed, either as a part of this remedy or other actions at the Site. However, the package did not provide clear enough information indicating that the 100-K Area impacts surface water to the extent that an RAO is called for and a subsequent remedial action is needed to mitigate these impacts. The Board recommends that the decision documents explain more clearly how the 100-K Area contaminants are in fact impacting surface water in the Columbia River in a manner that results in unacceptable human health or ecological risks and how the preferred alternative will address these risks.

Remedy Performance

The Board notes that under Alternative #3, temporary surface barriers are proposed for those contaminated areas that will not be addressed until the reactors are removed sometime within the next 75 years. The Washington State Department of Ecology raised concerns regarding the scope and timing of the final action for the reactor and adjacent contaminated materials. The Board recommends that the upcoming decision documents present a detailed schedule for completion of the reactor removals, and in the event removal does not occur, a contingency to address the remaining contamination.

As explained in the package, the groundwater conditions are alternating between high flow rates through the 100-K Area toward the river and into the river at low flow river stage, and frequent pulsed reversed groundwater gradients at high river stage that flush from the vadose zone inland and up into the shallow groundwater. Due to the high yield porous aquifer and river interaction with the groundwater, conventional pump-and-treat may be impractical (i.e., not cost-effective) to control groundwater contaminant migration. The Board recommends that the Region request that the Department of Energy (DOE) evaluate the practicality and cost-effectiveness of physical containment (e.g., installing a slurry wall and/or grout curtain) around the chromium source areas to enhance the effectiveness of the groundwater pumping containment action so as to make it practical/cost-effective.

Monitored Natural Attenuation

Based on the information provided in the package, the mechanism for the groundwater COCs to reach drinking water standards was not fully explained. The Board recommends that future decision documents provide additional supporting evidence for monitored natural attenuation (MNA) consistent with Agency guidance. (OSWER Directive No. 9200.4-17P, April 1999, *Use Of Monitored Natural Attenuation At Superfund, RCRA Corrective Action, And Underground Storage Tank Sites;* EPA/600/R-07/139, October 2007, *Monitored Natural Attenuation of Inorganic Contaminants in Ground Water Volume 1 - Technical Basis for Assessments*; EPA/600/R-07/140, October 2007, *Monitored Natural Attenuation of Inorganic Contaminants in Ground Water Volume 2 - Assessment for Non-Radionuclides;* EPA/600/R-10/093, September 2010, *Monitored Natural Attenuation of Inorganic Contaminants in Ground Water Volume 3 - Assessment for Radionuclides*.) The decision documents should identify mechanisms of natural attenuation for all contaminants for which MNA is being selected (nitrates, tritium and carbon tetrachloride). These mechanisms, which may be different under different conditions, should be identified for the range of hydrologic and geochemical settings encountered in the 100-K Area. This information includes determining the organic transformation products, radionuclide isotopes and daughters; and identifying the immobilization processes and rates that may be present or become present in both the vadose zone and groundwater environments.

Cost

The Board notes there are available technologies for treating groundwater with Cr(VI) in addition to pump-and-treat (e.g., *in-situ* chemical reduction using calcium polysulfide, ferrous iron or zero valent iron). The Board recommends that the Region evaluate cost estimates for different treatment technologies that are based on unit volume or mass of soil and groundwater to be treated. The Board also recommends that the Region include in the decision documents a better justification as to why pump-and-treat is the best approach to be taken to treat Cr(VI) in the 100-K Area.

Stakeholders

During the presentation to the Board, a number of issues related to tribal consultation, exposure scenarios in the risk assessment process and cleanup levels were discussed. Resolution of some of these issues appears to involve federal trustee responsibilities and treaty rights, as well as environmental justice considerations. The Board recommends that the Region continue to work with the Tribes and DOE to ensure that the cultural areas are appropriately addressed consistent with legal requirements and EPA guidance and policy positions (*EPA Policy on Consultation and Coordination with Indian Tribes,* May 4, 2011). For example, the Board recommends that the proposed plan and other decision documents provide a clear description of "protocols (e.g., tribal archeology) and procedures" regarding cleanup in the cultural areas, and how capping and ICs would be used (if at all) to help ensure protection of human health. If protocols and procedures have not been agreed to by the time a proposed plan is published, the Board recommends that the Region consider addressing the cultural areas as a separate operable unit.

200-UP-1 Area Recommendations:

Human Health Risk

The summary of the baseline risk assessment presented in Section 6.1 of the Board package appears to be a residual risk assessment, rather than a true baseline risk assessment. For example, Table 6-2 presents risks/hazards that appear to be simple ratios of exposure point concentrations to state standards and criteria, instead of estimating exposure point concentrations and running those concentrations through risk scenarios to estimate the potential risks now and in the future if no remedial action is implemented. The Board recommends the Region conduct a BHHRA consistent with EPA CERCLA guidance (i.e., EPA/540/1-89/002, December 1989, *Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual)* that identifies risk-driving chemicals, and exposure pathways and media of concern. This information will be helpful to identify and support remedial action objectives for this area.

Remedy Performance

The package provided to the Board presented three active groundwater pump-and-treat alternatives with three estimated remediation time periods. The different time periods were related to the degree that contaminants would be addressed with both chromium and nitrate lengthening the remediation periods. The Region described the action as a final remedy for the groundwater except for iodine for which no effective treatment technology exists. The proposed action would hydraulically contain iodine contamination and be considered an interim remedy. The Board notes that the remediation timeframes

for all alternatives assume that the contaminant source is eliminated. However, vadose zone contamination still exists. The issue is further complicated by the fact that the State agency is responsible for the vadose zone remediation and that there has not been a cleanup schedule identified. Since the contaminant source is not being addressed and will continue to migrate into the groundwater, the Board believes that the entire groundwater action should be an interim remedy. The Board recommends that the Region reconsider its designation of the proposed groundwater action as final and also include more discussion of the iodine technology development issue, along with associated costs, in the proposed plan and other decision documents. In addition, the Board encourages the State and DOE to work quickly to identify remedies for the vadose zone in order to ensure that groundwater cleanup goals can be achieved throughout the plume.

Based on information presented to the Board, it appears that the primary risk driver in the groundwater cleanup action is carbon tetrachloride (CCl_4) and, therefore, effective source control to reduce groundwater loadings will save cost and time in the groundwater cleanup action. The existing CCl_4 soil vapor extraction system was installed in 1992. The Board recommends that the Region consider re-evaluating and potentially optimizing the system to maximize CCl_4 removal (e.g., more vapor extraction wells, use of inlet air wells, rebound cycling, weatherization and preheating for year-round operation and other engineering solutions).

Monitored Natural Attenuation

Based on the information provided in the package, the Board believes that MNA has not been evaluated to the degree necessary to consider it an appropriate remedy for the 200-UP-1 Area. The Board recommends that future decision documents provide supporting evidence for MNA consistent with Agency guidance. (OSWER Directive No. 9200.4-17P, April 1999; EPA/600/R-07/139, October 2007, *Monitored Natural Attenuation of Inorganic Contaminants in Ground Water Volume 1 - Technical Basis for Assessments*; EPA/600/R-07/140, October 2007, *Monitored Natural Attenuation of Inorganic Contaminants in Ground Water Volume 2 - Assessment for Non-Radionuclides;* EPA/600/R-10/093, September 2010, *Monitored Natural Attenuation of Inorganic Contaminants in Ground Water Volume 3 - Assessment for Radionuclides*.) The decision documents should identify mechanisms of natural attenuation for all contaminants for which MNA is being selected (nitrates, tritium and carbon tetrachloride). These mechanisms, which may be different under different conditions, should be identified for the range of hydrologic and geochemical settings encountered at the Site. This information includes determining the organic transformation products, radionuclide isotopes and daughters, identifying the immobilization processes and rates that may be present or become present in both the vadose zone and groundwater environments.

Furthermore, contaminated plumes that are unstable or expanding are not candidates for MNA (OSWER Directive No. 9200.4-17P, April 1999). The Board recommends that the decision documents include a discussion of plume stability and biotic and abiotic degradation rates for the plumes for which MNA is being proposed. The degradation rates can be compared to values in the literature. Because the sediments in this area contain low organic matter and groundwater is mostly oxic, natural attenuation via biological degradation for both nitrate and CCl_4 may be limited.

In addition, the package (page 83 and table 8-1) provides information on the preferred alternative with a given MNA timeline for tritium remediation of 25 years. Also, the package (page 60) indicates that initial concentrations for tritium are in the range of 200,000 to 2,000,000 picoCurie per liter. The time to

reach tritium remediation goals using decay alone would be in the neighborhood of 41 to 82 years using this initial concentration range. The Board recommends the Region clarify the role of radioactive decay and any additional attenuation mechanisms to meet the remediation goal of 25 years for the tritium groundwater plume per the 200-UP-1 Area package.

Cost

Alternatives 2, 3, and 4 appear to be all the same pump-and-treat remedies with minor variations. Also, based on the estimated time to meet the RAO to return the groundwater to a beneficial use, all three alternatives will require 125 years. Alternative 2 appears to be the most cost-effective remedy based on the nine criteria presented in the package to the Board. However, Alternative 3 is the Region's preference. Therefore, the Board recommends that the Region better explain their preference for Alternative 3 in the decision documents.

In the presentation to the Board, the Region indicated that the cost estimates provided in the package may not include some major maintenance efforts that will be required at the end of the design life of some equipment, and that some economy of scale will be lost when the 200-ZP-1 pump-and-treat remedy is completed. The Board recommends that the Region revisit the cost estimates for the three alternatives and ensure the cost estimates are complete per OSWER Directive No. 9355.0-75, July 2000, *A Guide to Developing and Documenting Cost Estimate During the Feasibility Study*.

300 Area Recommendations:

Remedial Action Objectives

The RAO 2 included in the package states: "RAO 2. Prevent unacceptable risk to human health and ecological exposure to surface water containing contaminant concentrations above federal and state standards and risk-based thresholds." The Board recognizes the importance of the Columbia River as a resource and agrees that ongoing monitoring of river impacts from the Hanford Site should be performed, either as a part of this remedy or other actions at the Site. However, the package did not provide clear information indicating that the Site impacts surface water to the extent that an RAO is called for and a subsequent remedial action is needed to mitigate these impacts. The Board recommends that the decision documents explain how Site contaminants are in fact impacting surface water in the Columbia River in a manner that results in unacceptable human health or ecological risks. The administrative record should contain data and information showing that the RAO is appropriate and can be measured to ensure the remedial action and clean-up goals have been achieved. If there is insufficient information to demonstrate an unacceptable current or future impact on surface water, the Board recommends that this RAO should be modified or dropped, and the vadose zone cleanup levels should not be based on protection of surface water.

The review package states that groundwater was evaluated as a potential drinking water source. Proposed cleanup levels for groundwater were provided yet there was no RAO for restoring groundwater. To the extent the groundwater is found to be a potential drinking water aquifer, the Board recommends that the decision documents clearly state that the groundwater RAO in the Hanford and Ringold Formations is to restore the aquifer to drinking water standards. If the Ringold Formation is not considered a drinking water aquifer (see recommendation below), then the RAO and performance standards should not be included in future decision documents.

Remedy Performance

The package provided to the Board for the 300 Area presented three active remedial action alternatives that varied only in the manner in which deeper uranium contamination is addressed. The remedy preferred by the Region (Alternative 3) includes *in-situ* uranium sequestration (phosphate precipitation) in the vadose zone and at depths below 15 feet in all areas with vadose zone uranium that could impact groundwater above maximum contaminant levels (MCLs). Under the preferred alternative, the *in-situ* phosphate treatment would be implemented in a phased manner and its effectiveness would be evaluated during implementation. The Board notes that the effectiveness of this technology has not been demonstrated on a pilot or full scale at this or other sites. As described in the package, treatment success is defined as a 50 percent reduction in leaching; the incremental cost of this treatment would be $113 million. Alternative 4 would physically remove the deep uranium contamination to the top of the water table at low river stage; this may be up to a depth of up to 45 feet (depending on the river stage). The incremental cost of doing this would be $255 million. Based on their comments, the states of Oregon and Washington prefer the RTD approach because of concerns about the effectiveness of the *in-situ* uranium sequestration process.

Given the uncertainties about the *in-situ* treatment process, the Board recommends that: 1) additional information be developed to sufficiently support selection of this vadose zone treatment approach, especially considering the hydraulic conditions in this area of the Hanford facility, and 2) the decision documents establish clear benchmarks for defining success (including timeframes) if Alternative 3 is selected. This approach would help ensure that all stakeholders have a common understanding of what is expected and would help avoid the potential for disputes and delays in remedy implementation. The Board also recommends consideration of a contingency remedy (e.g., Alternative 4), which could be included in the decision documents in case initial treatment efforts (pilot or full scale) prove to be ineffective. Including a contingency remedy at this time could avoid the need to amend the ROD in the future. The Board recognizes the importance of a timelier cleanup of the area given its close proximity to the river.

With regard to Alternative 3's treatment success being defined as a 50 percent reduction in leaching, the Board notes that CERCLA contains a preference for treatment to the maximum extent practicable, and that the NCP preamble provides a guideline for effective treatment as a 90 to 99 percent reduction in concentration. The Board recommends that the decision documents explain how a 50 percent success rate is consistent with the statutory and NCP provisions regarding treatment.

The information presented to the Board for the preferred alternative indicated that soil physical characterization would take place in the subsurface before the preferred alternative uranium sequestration (phosphate precipitation) takes place. However, it would be important to determine how the preferred alternative affects the subsurface soil particles after uranium sequestration. Given the 300 Area's river flux velocity of 50 feet/day, phosphate treated uranium particles may be mobilized for enhanced transport in flux water to the river. The Board recommends that physical and chemical analyses be performed to determine if enhanced transport of phosphate treated uranium particles (colloids) may reduce the effectiveness of the proposed remedy.

As explained in the package, the groundwater conditions are alternating high flow rates through the Site area toward the river and into the river at low flow river stage, and frequent pulsed reversed groundwater

gradients at high river stage that flush from the vadose zone inland and up into the shallow groundwater. Due to the high yield porous aquifer and river interaction with the groundwater, conventional pump-and-treat may be impractical (i.e., not cost-effective) to control groundwater contaminant migration. The Board recommends that the Region request DOE to evaluate the practicality and cost-effectiveness of physical containment (e.g., installing a slurry wall and/or grout curtain) around the 300 Area industrial complex to enhance the effectiveness of the groundwater pumping containment action so as to make it practical/cost-effective.

Based on the package presented to the Board, groundwater trichloroethene (TCE) and cis- 1,2-dichloroethene concentrations, along with uranium, are above MCLs in the upper Ringold Formation, yet their treatment is not addressed and there is no proposed remedy for these contaminants in this formation. In addition, it is asserted that the Ringold Formation is not a drinking water aquifer as discussed in EPA guidance (OSWER Directive No. 9283.1-33, June 2009, *Summary of Key Existing EPA CERCLA Policies for Groundwater Restoration*, EPA/440/6-86-007, November 1986, *Guidelines for Ground-Water Classification Under the [1984] EPA Ground-water Protection Strategy, Final Draft*). The Board recommends that the decision documents explain the basis for the groundwater classification in this Area and how the remedy selection approach for TCE contamination daylighting in the river above MCLs in the finer grained interval is consistent with CERCLA, as well as the NCP (e.g., expectations) and Agency guidance on restoration of groundwater to its beneficial use.

Monitored Natural Attenuation

In the package presented to the Board, the preferred remedy for the tritium plume would be an MNA approach. During the presentation, the Region clarified that the tritium plume is actually expanding yet the tritium is undergoing decay. The package indicates (page 6) that the tritium MCL (20,000 pCi/L) will be achieved in 17 years with MNA. The tritium concentration in the plume is reported to be 50 times the MCL (1,000,000 pCi/L) in the package (page 5). However, the time to achieve the tritium MCL via radioactive decay (primary attenuation mechanism) is approximately 69 years when calculated from the initial concentration given in the package. The Board recommends that the Region clarify the role of radioactive decay and any additional attenuation mechanisms to meet the RAO goal of 17 years for the tritium ground water plume as per the package. The Board notes that existing EPA guidance on MNA states that a plume should be stable and that all mechanisms be clearly identified to be appropriately considered as an MNA remedy. The Board recommends that the proposed plan and other decision documents provide lines of evidence explaining how the proposed approach would be effective and consistent with OSWER Directive No. 9200.4-17P, April 1999 and the ORD technical background document, *Monitored Natural Attenuation of Inorganic Contaminants in Ground Water, Volume III - Tritium,* EPA/600/R-10/093) September 2010.

The Board Chair received a March 26, 2012, letter from DOE in which the Department provided its perspective on the cleanup options for the 300 Area. DOE expressed a belief that natural attenuation continues to be a viable approach to address the uranium plume in the 300 Area. The letter advocates identification of natural attenuation as a contingent remedy to be implemented if a performance benchmark (50 percent reduction in labile uranium) for the uranium treatment is not achieved. Neither the package, the March 26th letter, nor the presentation to the Board, gave any indication DOE has demonstrated the existence of lines of evidence, as discussed in the above referenced EPA guidance, to justify an MNA remedy. The Board does not support selection of MNA as a remedy or contingent remedy unless such lines of evidence exist. The Board further notes that no basis for the suggested 50%

reduction performance benchmark is given, and that the relationship between percent reduction in labile uranium and achievement of numeric cleanup goals in soil and groundwater is unclear. The Board recommends that the decision documents clearly reflect EPA's approach which uses achievement of numeric cleanup levels to judge the ultimate success of remediation.

Stakeholders

During the presentation to the Board, a number of issues related to tribal consultation, exposure scenarios in the risk assessment process, and cleanup levels were discussed. Resolution of some of these issues appears to involve federal trustee responsibilities and treaty rights, as well as environmental justice considerations. The Board recommends that the Region continue to work with the Tribes and DOE to ensure that the cultural areas are appropriately addressed consistent with legal requirements and EPA guidance and policy positions (e.g., *EPA Policy on Consultation and Coordination with Indian Tribes,* May 4, 2011). For example, the Board recommends that the proposed plan and other decision documents provide a clear description of "protocols (e.g., tribal archeology) and procedures" regarding cleanup in the cultural areas, and how capping and ICs would be used (if at all) to help ensure protection of human health. If "protocols and procedures" have not been agreed to by the time a proposed plan is published, the Board recommends that the Region consider addressing the cultural areas as a separate operable unit.

Off-Site Plume

In the presentation to the Board, it was stated that the nitrate groundwater contamination in and around the 300 Area is not associated with activities from the 300 Area. The Board notes that the Region also indicated that up-gradient nitrate groundwater contamination is coming from the west (i.e., the 200 Area) and southwest (i.e., the irrigated agriculture fields and some industry). This would suggest that the agriculture-related nitrate is not site related but may affect the groundwater restoration objective for the 300 Area. The Board recommends that the Region further evaluate whether CERCLA authority should be used to address this plume as part of the remedial action to be selected, and if so, which alternatives (including engineering controls, ICs and/or other response actions) might be needed to address the off-site agriculture nitrate groundwater contamination that could affect the 300 Area cleanup.

Conclusion

We commend the Region's collaborative efforts in working with the Board and stakeholder groups at this site. We request that a draft response to these recommendations be included with the draft proposed plan when it is forwarded to Headquarters. This memo will be posted to the Board's website (http://www.epa.gov/superfund/programs/nrrb) within 30 calendar days of my signature. Once your response is final and made part of the Site's administrative record your response will also be posted on the Board's website.

Thank you for your support and the support of your managers and staff in preparing for this review. Please call me at (703) 347-0124 should you have any questions.

cc: J. Woolford (OSRTI)
P. Anderson (OSRTI)
E. Gilberg (OSRE)
R. Cheatham (FFRRO)
D. Ammon (OSRTI)
D. Cooper (OSRTI)
NRRB members