

ENVIRONMENTAL REMEDIATION DECISION-MAKING FOR BEAR CREEK VALLEY AT THE U.S. DEPARTMENT OF ENERGY OAK RIDGE RESERVATION IS FACILITATED UNDER A WATERSHED APPROACH

D. G. Adler¹, P. D. Moss², S. R. Pack², K. P. Catlett¹, C. S. Haase³, S. P. Kucera³. ¹U.S. Department of Energy, Oak Ridge, TN, ²Science Applications International Corporation, Oak Ridge, TN, ³Bechtel Jacobs Company, LLC, Oak Ridge, TN.

ABSTRACT

Managing environmental releases within Bear Creek Valley at the U.S. Department of Energy's Oak Ridge Reservation in Oak Ridge is being facilitated through a watershed management approach. Under this approach, all sources of environmental contamination within the Bear Creek watershed are evaluated concurrently. Then comprehensive remedial alternatives for eliminating or otherwise controlling these contaminant sources are developed to meet watershed-based remedial action objectives. The Bear Creek watershed is a 2800-acre area where groundwater is confined by two ridges and the surface water and groundwater systems are interconnected through a common exit pathway. The eastern third containing numerous disposal areas previously used for waste management by the Oak Ridge Y-12 Plant. Addressing Bear Creek Valley as a watershed is premised on the fact that the multiple disposal areas are releasing contaminants into common groundwater and surface water exit pathways. The watershed approach allows for an evaluation of these releases collectively and development of remediation strategies that address their cumulative impact. Once the remediation strategies are defined a single decision can be made that identifies the most effective set of remedial actions. The benefits of this strategy include: 1) environmental remediation objectives for the entire Bear Creek Valley are established to be consistent with all legal requirements; 2) releases from the individual disposal areas are evaluated within the context of overall watershed contamination challenges, allowing prioritization of cleanup activities, a coordinated technical approach, and allocation of limited cleanup resources; and 3) a significant reduction in documentation costs and schedule associated with remedy selection. Under the watershed approach, multiple potential remediation objectives, ranging from full restoration of the entire valley to achieve conditions compatible with unrestricted future development to simply maintaining existing conditions in the valley were evaluated in a feasibility study. From this range of objectives, a decision regarding the best remediation strategy was determined for Bear Creek Valley. This decision defines a clear, consistent vision for use of the valley at the conclusion of cleanup activities, is protective of human health and the environment, complies with applicable or relevant and appropriate requirements, is cost-effective, and has broad public support.

INTRODUCTION AND BACKGROUND

Bear Creek Valley is located within the Department of Energy Oak Ridge Reservation, which is located in east Tennessee northwest of Knoxville. The valley extends from the eastern end of the Oak Ridge Y-12 Plant to the Clinch River, a distance of approximately 16 km (10 miles). The Bear Creek Valley is an operationally and hydrologically complex site. There are multiple individual waste units within the valley that contain various types of hazardous and radioactive wastes derived from the Y-12 Plant. Groundwater is contaminated throughout the eastern 5 km (3 miles) of the valley; individual plumes from separate sources have commingled to produce the seemingly continuous contamination of groundwater with multiple contaminants (figure 1).

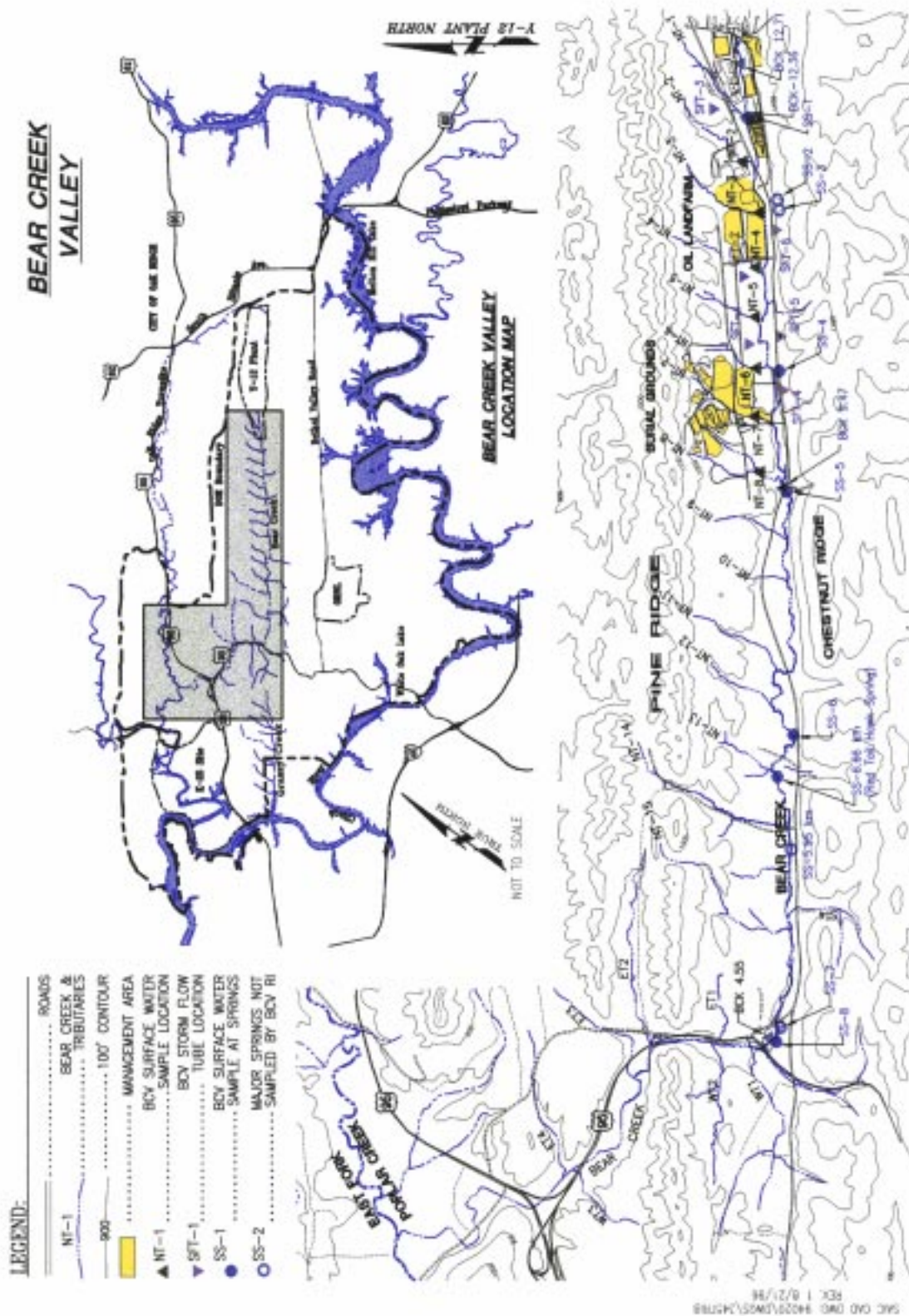


Figure 1. Location Map for Bear Creek Valley showing the main physical features and location of waste units.

During the operation of the Y-12 Plant since the 1940s, hazardous and radioactive materials were disposed of at the various sites in BCV. Considerable volumes of solid hazardous and radioactive materials, particularly uranium, are in trenches located at the Bear Creek Burial Grounds and also at the Boneyard/Burnyard. Hazardous liquids are known to have been disposed of at S-3 Ponds, Oil Landfarm, Hazardous Chemicals Disposal Area and Bear Creek Burial Grounds.

Until 1992, prior to the formulation of the Federal Facilities Agreement, remedial investigation and remedial actions on the Oak Ridge Reservation were carried out under the RCRA. The Oak Ridge Reservation is now listed on the National Priorities List, and investigations and actions in Bear Creek Valley are required to comply with CERCLA.

The original strategy for remedial investigation in Bear Creek Valley separated studies of the groundwater and surface water from studies of the sources by assigning waste areas as source operational units, and hydrogeologic regimes that are common to more than one source operable unit as integrator operational units. This strategy was adopted in response to the complexity of the waste sites in the valley and the realization that groundwater plumes in Bear Creek represent commingled contamination from multiple sources. The approach was designed to “shut off” source areas from the environment prior to remediating contaminant plumes in groundwater and surface water. This would result in more immediate attention (removal action and/or Records of Decision) for the source operational units while an investigation continued into the integrator operational units. The unforeseen shortfalls of this approach were a regulatory perceived lack (or delay) of action on groundwater contamination in Bear Creek Valley and poor site-wide integration that would gain optimum cost-effectiveness of remedial actions. Under this strategy the 20 waste sites in Bear Creek Valley would have been prioritized for investigation and remediation based on the known content of the disposal areas. The Bear Creek Burial Grounds, containing 40 million pounds of uranium and uranium contaminated wastes would be the obvious starting point.

In 1994, DOE adopted the Watershed Approach to remediation of facilities on the Oak Ridge Reservation. Under this management strategy we recognized that while the Bear Creek Burial Grounds contain the most contamination, another site, the Boneyard/Burnyard is responsible for the most offsite contamination, followed by the S-3 Site. Now, we plan to remediate these two sites as a priority and the most expensive site to remediate, the Bear Creek Burial Grounds falls lower in priority.

The Watershed Approach adopted by the Oak Ridge Federal Facility Agreement parties, and has as its objectives:

- prioritization of remedial action decisions;
- expeditious implementation of highest priority actions, and
- increased cost effectiveness of remedial action by setting watershed Remedial Action Objectives based on an integrated, valley wide, future land use plan.

Consistent with the Watershed Approach the environmental media and waste sites in Bear Creek Valley were combined into a single Characterization Area encompassing the entire Bear Creek Watershed. The benefits of this approach include:

- reduced site investigation phase, with reliance on historical data as the basis for remedial action decisions and a single Remedial Investigation/Feasibility Study for the watershed rather than for individual sites;
- development of consistent Remedial Goal Options across the multiple source units;
- an increased focus on development of an integrated prioritization of focused, integrated remedial actions, and
- reduction in cost and schedule for the Remedial Investigation/Feasibility Study, Record of Decision process.

Accordingly, the Bear Creek Valley Remedial Investigation documented and interpreted the results of numerous historical field characterization efforts conducted in Bear Creek Valley prior to 1994 as well as three limited Remedial Investigation field projects covering specific portions of the watershed in 1994 and 1995. This interpretation provided a comprehensive evaluation of the conditions at and risks associated with all of the wastes sites, associated floodplains, and groundwater in the valley.

Data. Inherent in the accelerated watershed approach is the heavy reliance on historical data to form the basis of the Remedial Investigation. For Bear Creek Valley, a significant historical data set existed; thus minimal effort was spent by the watershed team in gathering additional extent of contamination information. While this approach greatly reduced the schedule and cost of the Remedial Investigation, it does result in higher levels of uncertainty in the evaluation results. The likelihood of important data gaps in the Bear Creek Valley Remedial Investigation was minimized by adherence to the Data Quality Objective process during the planning phase, and by proactive uncertainty management during the data collection and evaluation phases. Additionally, data gaps were reviewed from a valley-wide perspective to determine whether the uncertainty they posed prevented the feasibility study from identifying the most likely remedial alternatives for the valley.

Uncertainty. Although uncertainty cannot be eliminated, it was managed such that decisions and actions identified for Bear Creek Valley could accommodate the likely impacts of that uncertainty. Uncertainties were managed during the feasibility study and in the Proposed Plan by using contingency actions. If likely bounds can be estimated for uncertainty, then reasonable contingent actions can be evaluated that will accommodate possible variances in the site conceptual model or presumed technology effectiveness. Where uncertainty was too great to be managed by contingent actions, it was deemed unacceptable and additional focused studies were used. The resulting feasibility study accommodated the identified uncertainties through selection of contingent actions that allow for flexibility within the remedy selection.

Future land use. Risk managers typically have made future land-use decisions in the Proposed Plan stage of the CERCLA process through selection of an alternative, with or without institutional controls. The Bear Creek Valley Remedial Investigation/Feasibility Study evaluated multiple future land-use scenarios in the valley and potential future risk receptors so the risk managers could compare the risk reduction, technical feasibility, and cost associated with the



Prioritization. One of the goals of characterizing the conditions in Bear Creek Valley from a valley-wide perspective was to identify which waste units were priority units with respect to risk reduction. It is the goal of the program to first address the sites contributing highest current risk and with the greatest potential for reduction of risk. Sites contributing least current risks and potential future risks will be addressed second. To support this prioritization effort, the remedial investigation developed a valley-wide framework that could be used to evaluate alternatives and on which decisions could be based. A data evaluation method was devised that calculated a relative risk value for each source or source area in the watershed. This method is referred to as the integration point assessment. The integration assessment was designed to rank off-site risks associated with various sources by using contaminant fluxes from the sources as a basis for the ranking. In addition this model was used to estimate the reduction of risk to off-site receptors resulting from remedial actions taken in the valley. The integration point is a point where

contaminant releases from multiple sources come together. For the Bear Creek Valley watershed, the integration point is Bear Creek kilometer 9.47 located where Zones 3 and 2 interface.

Conclusions of the integration assessment. Contaminated shallow groundwater at waste areas discharges to nearby tributaries of Bear Creek which subsequently discharge into Bear Creek. As a result, contamination of select surface water bodies is occurring and will likely continue into the future. The principal contaminants moving along these pathways include uranium, nitrate and various volatile organic compounds. Interconnectivity of groundwater and surface water causes additional groundwater contamination from contaminated surface water downgradient of the disposal areas. The Boneyard/Burnyard and the S-3 Site contribute approximately 90% to downstream contaminant migration. From a valley-wide perspective the Bear Creek Burial Grounds, containing the largest quantity of uranium, are contributing little to the current offsite risk due to the stable nature of the waste and the existence of a leachate collection and treatment system (figure 3).

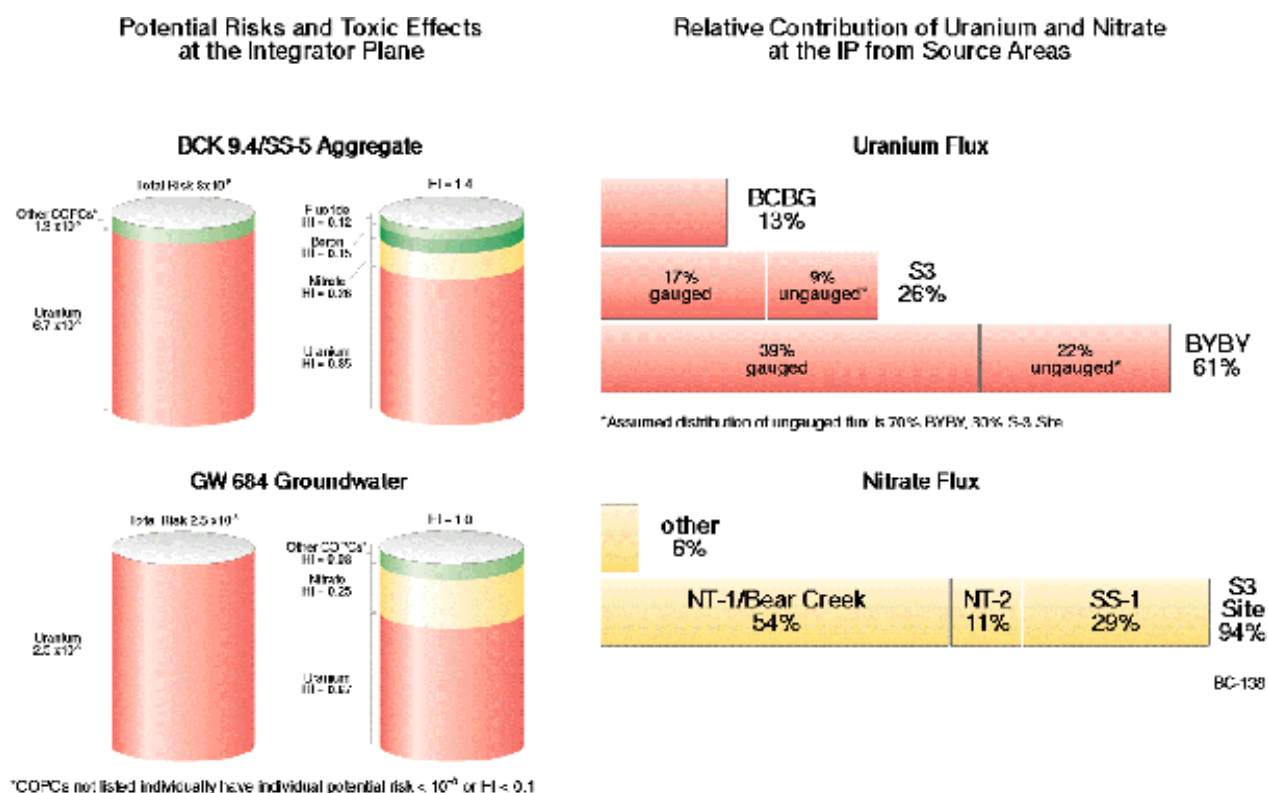


Figure 3. Potential Risks and Hazards at the Integrator Point and relative magnitude for the sources of nitrate and uranium.

Conclusions of the Feasibility Study. An extensive analysis of remediation approaches for Bear Creek Valley was conducted and documented in the feasibility study. These ranged from full remediation of the entire valley to simply maintaining existing conditions in the valley.

Remedial alternatives evaluated generally include combinations of migration control and source control approaches. The feasibility study concluded that several intermediate remediation options are available which would yield full remediation of surface water, partial remediation of groundwater, and partial remediation of surface land areas. Full remediation would be prohibitively expensive with cost estimates in excess of \$1 billion. But because of our approach we can state with confidence that full remediation is not necessary to eliminate offsite contamination. Additionally, much of the valley can be remediated to a condition compatible with unrestricted future use through implementation of moderately expensive alternatives. However, Zone 3 would require continued use restrictions and monitoring.

Watershed goals and selected remedy. The proposed plan established remedial goals for the watershed. They are 1) to achieve ambient water quality criteria in all waters of the state, 2) improve groundwater quality in Zone 2 consistent with eventually achieving conditions compatible with unrestricted use, and maintain clean groundwater and surface water in Zone 1, and 3) reduce risk from direct contact to create conditions compatible with future industrial use of Zone 3.

The selected remedy supports these goals by addressing the highest priority sites in the watershed, the S-3 Site and the Boneyard/Burnyard. Shallow contaminated groundwater is intercepted at the S-3 Site prior to discharge into Bear Creek or its tributaries which will allow us to achieve ambient water quality criteria and will support the goal of improved groundwater conditions downgradient due to the interconnectivity of Bear Creek and groundwater. Source material in contact with groundwater will be removed from Boneyard/Burnyard and remaining waste will be hydraulically isolated and capped to support the goal of improved groundwater conditions and reduced risk of direct contact. Remedial decisions for the lower priority Bear Creek Burial Grounds are deferred due to the unwillingness of regulators to agree at this time to leave this waste in place even though risk is minimal. A decision will be made on the Bear Creek Burial Grounds after other remedial actions are in place and their impacts can be assessed.

Conclusions. Had the waste areas in Bear Creek Valley continued to be addressed on a single operational unit basis, it is highly possible that the Boneyard/Burnyard would have remained a low priority site and the Bear Creek Burial Grounds would have remained the high priority site. This approach was found to be flawed in that the risk from the Boneyard/Burnyard was found to be significant using a valley-wide assessment. The primary benefits of combining the environmental media and waste sites in Bear Creek Valley into a single Characterization Area encompassing the entire Bear Creek Watershed include:

- reduced site investigation phase, with reliance on historical data as the basis for remedial action decisions;
- development of consistent Remedial Goal Options across the multiple source units; reduction in cost and schedule for the Remedial Investigation/Feasibility Study, Record of Decision process, and
- prioritized remedial actions resulting in significant cost savings and ultimately improved risk reduction.