POSSIBLE IMPACTS ON DOE ORDER 435.1 COMPLIANCE FOR A LLW FACILITY WITHIN A LARGER CERCLA SITE

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ABSTRACT

Meeting the performance assessment (PA) and composite analysis (CA) objectives for a waste management facility subject to DOE Order 435.1 requirements and physically located in an area undergoing CERCLA remedial action can be greatly influenced by the CERCLA process. The CERCLA process tends to reduce the uncertainty and conservatism in the selection of such things as public receptor location and exposure scenarios, exposure conditions for the inadvertent intruder scenario, and type of waste disposal unit cover required.

As an illustration, the development of the PA and CA for the Interim Waste Management Facility (IWMF) and the Tumulus I and II facilities in Solid Waste Storage Area 6 (SWSA 6) of U.S. Department of Energy's (DOE's) Oak Ridge Reservation is discussed. Those facilities are aboveground, engineered units for long-term environmental isolation of low-level radioactive waste (LLW), received operations wastes since the late 1980s, and are subject to compliance with the performance objectives and provisions of DOE Order 435.1, "Radioactive Waste Management." Remediation of other below ground LLW sources in SWSA 6 and other sources in the Melton Valley watershed, which contains SWSA 6, however, is being concurrently assessed in a separate CERCLA process. The CERCLA assessment also addresses sources migrating from the adjacent, connected Bethel Valley watershed. The remedial action provisions and requirements developed for the CERCLA site are discussed relative to the PA and CA for the IWMF and Tumulus I and II under DOE Order 435.1. Details of how the CERCLA process can impact the PA/CA analysis are presented. Specific findings are described in the following two paragraphs.

Land use planning under CERCLA provides a well defined public receptor location and exposure scenario, which at this site eliminates the consideration of the hypothetical

public use of a groundwater well located just outside the 100 m buffer zone surrounding the facilities. This reduces potential doses by placing the receptor beyond 100 m from the source and diluting any contaminants in surface water before they reach the receptor.

Integration of doses due to other (CERCLA) sources at the public receptor location facilitates the CA analysis. Also institutional controls, which include perpetual maintenance and surveillance (M&S) and periodic 5-year reviews of CERCLA actions where contaminants are not all removed, enables using a less robust cover design for the IWMF, Tumulus I, and Tumulus II, since M&S activities will control site degradation by natural phenomena.

The purpose of this paper is to illustrate the influence of proximate CERCLA sites on the PA and CA, and not necessarily to provide a detailed description of the PA and CA themselves.

INTRODUCTION

At U.S. Department of Energy (DOE) sites, it is not uncommon to find low-level radioactive waste (LLW) disposal facilities that are surrounded by sites being remediated under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). In order to obtain a disposal authorization statement that is necessary for continued operation, active DOE LLW disposal facilities are required under DOE Order 435.1 to have a reviewed and accepted performance assessment (PA) and composite analysis (CA). The CA demonstrates the cumulative effect of the LLW disposal facility and any other DOE sources of radionuclides in the environment that could mix with releases from the disposal facility.

This paper demonstrates how the requirements of CERCLA and DOE Order 435.1 can be coordinated and how the presence of the disposal facility within a CERCLA-controlled area can modify some of the requirements of the PA and CA. The paper uses as an example the preparation of a revised PA for the aboveground disposal units at Solid Waste Storage Area (SWSA) 6 on the Oak Ridge Reservation (ORR). However, the principles illustrated may apply to LLW sites at other DOE sites as well. At the present time the three aboveground disposal units, the fully loaded and inactive units designated Tumulus I and Tumulus II and the partially filled Interim Waste Management Facility (IWMF) that may receive waste in the future, are the only disposal units in SWSA 6 that are controlled by DOE Order 435.1. All other disposal units in the SWSA, regardless of when they received waste, are being managed under CERCLA as a result of an exemption (1). Figure 1 shows the general location of SWSA 6 on the ORR relative to the Oak Ridge National Laboratory (ORNL), where the LLW disposed of in SWSA 6 was generated, and the other major plant sites (K-25, now designated as the East Tennessee Technology Park, and Y-12). Waste disposal units in SWSA 6 are depicted in Figure 2, including the aboveground IWMF and Tumulus I and II disposal units. It is expected that all of SWSA 6 except the IWMF, Tumulus I, and Tumulus II will be managed under CERCLA.

DOE Order 435.1 (hereafter called "the Order") places specific requirements on LLW disposal facilities. In order to obtain a disposal authorization it must be demonstrated in a PA

that projected annual doses to a representative member of the public from all pathways and from the air pathway alone meet the performance objectives of 25 mrem/yr and 10 mrem/yr, respectively. Another performance objective in the Order places limits on radon fluxes from the disposal facility or radon concentrations at the facility boundary. Performance measures in the Order limit the projected doses that hypothetical inadvertent intruders into the disposal facility may receive. In determining projected doses to intruders, institutional controls are generally assumed to keep intruders off the facility for 100 years. The Order also requires that a CA be approved that demonstrates that the projected total annual dose from all sources meets certain limits and, in some circumstances, explores options for reducing that dose. The PA performance objectives and measures, and the limits for the CA, must be met at any time up to 1,000 years after disposal facility closure.

CERCLA remediation, on the other hand, requires that if contamination is left in place after the selected remedy is applied the projected lifetime incremental cancer risk to a member of the public from that contamination be no more than 10^{-6} to 10^{-4}. The ability to control future land use is a major consideration in selecting remediation methods under CERCLA when residual contamination is left on the site. Also, remediation under CERCLA requires that the selected remedial action be reviewed no less frequently than every five years until any contaminants remaining on the site reach levels that allow unrestricted exposure and unlimited use of the site.

The PA and CA on which this paper is based are both revisions of an earlier pair of a PA and a CA that was developed for SWSA 6 (2,3). The most recent PA and CA made extensive use of the information generated in the 1994 versions. The 1994 PA and CA modeled migration of contaminants through the vadose zone to the groundwater and eventually to surface water in White Oak Lake. They also relied on limited analyses of migration of contaminants through covers over the disposal units into the atmosphere. Projected doses to hypothetical public receptors were calculated from direct radiation, use of groundwater and surface water, consumption of contaminated food, and inhalation of gaseous contaminant releases. Projected doses to hypothetical inadvertent intruders were calculated from ingestion of food and soil, inhalation, and direct radiation.

This paper discusses the interaction between CERCLA and DOE Order 435.1 with regard to three important aspects of the PA and CA: treatment of intruders, point of compliance for doses to the public, and use of CERCLA cleanup goals in the CA.

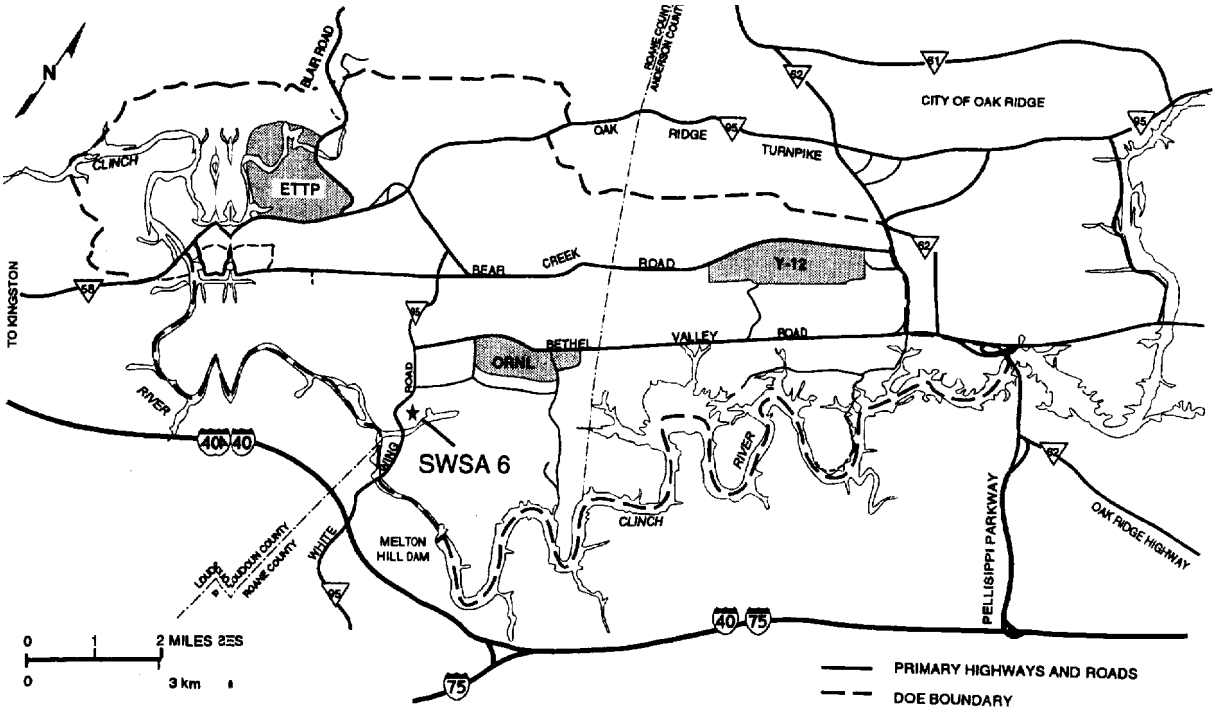

Fig. 1. Location map for SWSA 6, ORNL and other major plant sites within the ORR.

INTRUDER ANALYSIS

The Order requires that the PA assess the impacts on hypothetical inadvertent intruders and establish that they will not exceed performance measures of 100 mrem/yr for chronic intrusion and 500 mrem for any acute (relatively short-term) exposure. The Order also indicates that such intrusion can be assumed to occur any time after 100 years after closure of the facility.

CERCLA, on the other hand, requires that the selected remedy be reviewed at least every 5 years until the site can be released for unlimited use. It also requires maintenance and institutional control of the site. (DOE Order 5400.5 places a similar requirement for control at DOE sites independent of CERCLA.) Using a strict interpretation of CERCLA it could then be construed that there is no need for intruder analyses in the PA because institutional control of the CERCLA areas surrounding the facility that is controlled by the Order will be maintained for all practical purposes forever. Of course if the site is only visited once every 5 years there is a clear opportunity for at least acute intruder exposures to occur.

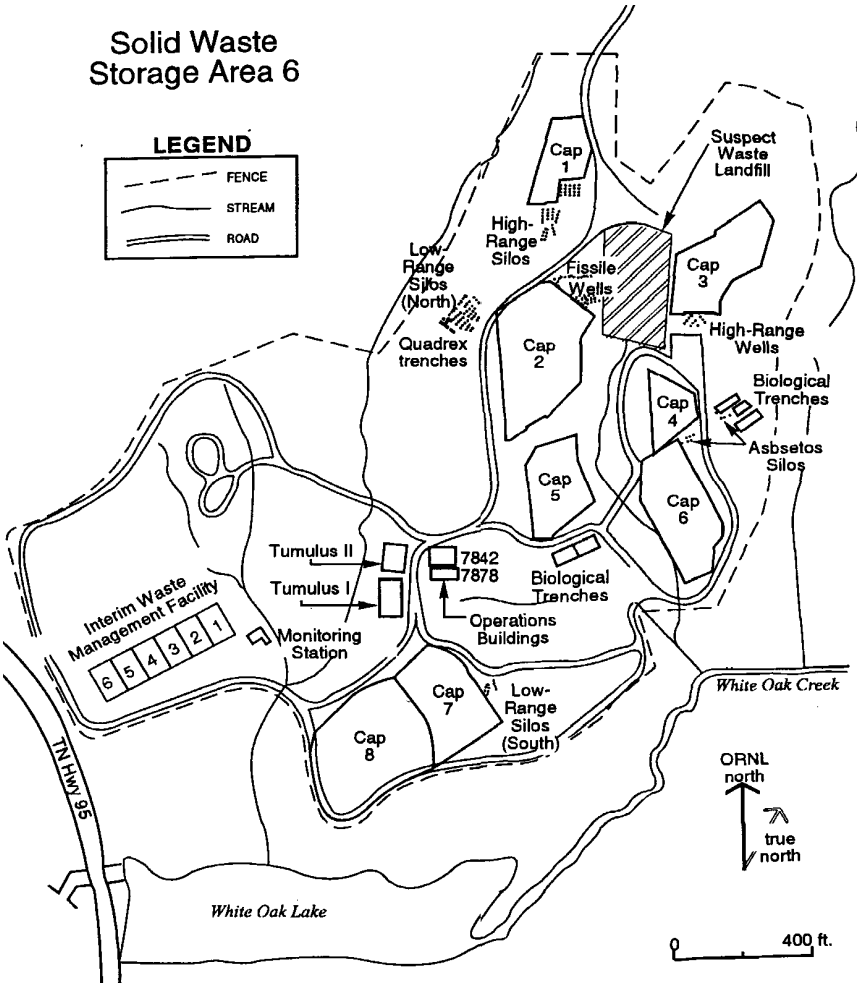

Fig. 2. IWMF and Tumulus I and II aboveground and other belowground waste units in SWSA 6

In the latest PA for the aboveground disposal units in SWSA 6 it was decided to conservatively analyze both acute and chronic intruder scenarios. In fact, the radionuclide concentration limits for the IWMF that were derived in the PA, which will be used in determining waste acceptance criteria for that disposal unit, were all determined by the analysis of chronic intruder scenarios. Since lapses in constant vigilance are potentially possible, as noted in the preceding paragraph, it was felt that the acute scenarios could not be ignored. Also, in the limiting case where the site may only be visited once every 5 years the limit on annual dose corresponding to the performance measure for the chronic intruder (100 mrem/yr) could result in a 500 mrem dose before the chronic intruder is forced to leave the site.

The degree of conservatism associated with retaining the intruder analyses in the PA, even though the LLW disposal facility will be controlled for much more than 100 years because it is surrounded by a CERCLA site, depends in part on the CERCLA remedy. For SWSA 6, the details of that remedy have not been determined. In the revised PA it is

assumed that, as a minimum, the covers over the remediated waste areas remaining on the CERCLA site will be inspected periodically and any unsatisfactory conditions will be corrected. A natural extension of that process, given the close proximity of the aboveground disposal units analyzed in the PA and the CERCLA site, is that significant degradation of the covers over the disposal units that are the subject of the PA would also be noted and repaired, and such actions would be included in the closure plan for those aboveground disposal units. For the Environmental Management Waste Management Facility (EMWMF) at ORR, which will be used to dispose of large volumes of CERCLA generated waste from the Reservation, there are plans to accumulate a fund for periodic maintenance of the site, including mowing, for periods well beyond 100 years. Similar care might be anticipated for some CERCLA sites at ORR.

POINT OF COMPLIANCE

The Order indicates that the point of compliance (POC) for the performance objectives that limit doses to the public should be the point of highest projected dose or concentration of radionuclides beyond a 100 meter buffer zone surrounding the disposed waste. It allows a larger or smaller buffer zone to be assumed in the PA if adequate justification is provided.

If an LLW disposal facility subject to the Order is surrounded by a CERCLA site or immediately adjacent to such a site, the same requirement for revisiting the selected remedy until the CERCLA site can be released for unrestricted use that is described in the preceding section of the paper can lead to a POC for the PA that is significantly farther from the disposal facility than 100 meters. Figure 3 shows other disposal sites in the Melton Valley watershed, which contains the SWSA 6 site, that are being remediated under the CERCLA process. For the revised PA for the aboveground disposal units at SWSA 6, the fact that those disposal units are surrounded by a CERCLA site results in a POC for water pathways that is the more distant White Oak Creek, specifically White Oak Dam at the western end of White Oak Lake. The Record of Decision (ROD) for the Melton Valley where SWSA 6 is located designates SWSA 6 as a waste management area within which access to groundwater will be denied for as long as the CERCLA site is controlled. The choice of WOD eliminates the possibility of a well near the waste disposal units.

The consequence of moving the POC for the water pathways from a well to the creek at the dam is a significant dilution of contaminant concentrations after the groundwater downgradient from the aboveground disposal facilities flows into White Oak Creek and White Oak Lake, relative to concentrations in groundwater removed from a well 100 meters from the disposal units. Consequently, the projected doses from the water pathway from the two inactive aboveground disposal units are very small and the contaminant concentration limits for waste placed in the IWMF that are imposed by the water pathway dose analysis are very high. In fact, the concentration limits are equal to the specific activities of all of the nuclides analyzed. Moving the point of compliance out to a distance greater than 100 meters can also reduce the projected dose from the air pathway.

The effect on the POC used in the PA of being surrounded by a CERCLA site may not be as dramatic for other LLW disposal facilities as it is for the aboveground disposal units in SWSA 6. However, it still may result in moving the compliance point farther from the waste, and causing projected doses to be lower and contaminant limits in the waste to be higher. Of course the magnitudes of those effects will depend on the details of the site and the selected CERCLA remedy, as the SWSA 6 example shows.

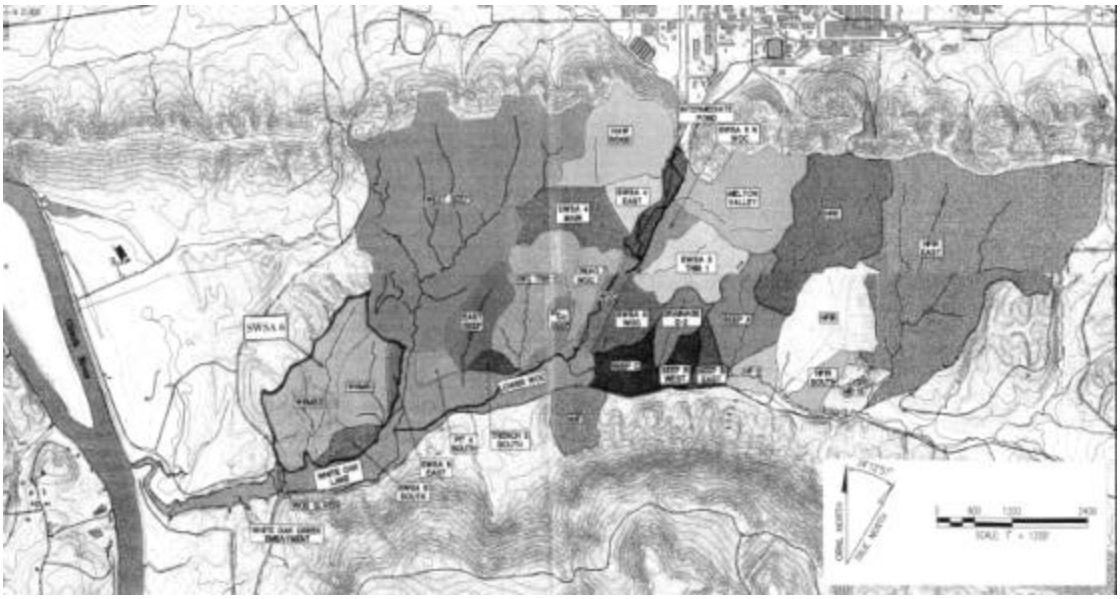

Fig.3.Waste disposal units in the Melton Valley watershed being remediated under the CERCLA process.

USE OF CERCLA CLEANUP GOALS IN THE CA

As noted above, the Order requires that a CA be prepared as a companion document to the PA. The CA must analyze the potential cumulative impacts to a hypothetical future member of the public from the LLW disposal facility and all other DOE-related sources of radionuclides that could mix with projected releases from the disposal facility. The following discussion assumes that CERCLA risk assessments have already been performed for the selected remedy and that the CERCLA process for the CERCLA sources that must be included in the CA has reached or passed the signing of a ROD. In that case use of the CERCLA-generated information in the CA, as opposed to doing separate calculations of the effects of the CERCLA sites, would be most cost-effective. It would also avoid having two separate (and possibly inconsistent) sets of calculations of radionuclide release and migration for the same sources.

Typically, CERCLA sets goals for remediation that are stated in terms of risk, not dose. For example, the risk goal may be to remediate the CERCLA site (exclusive of the imbedded or adjacent LLW disposal facility subject to the Order's requirements) sufficiently to assure that the incremental lifetime cancer risk from the CERCLA site will not exceed 10^{-4}

at any reasonable time in the future. The CA requirements, however, are stated in terms of dose, not risk. The risk limit must be converted to a dose, in order to represent the potential contribution of the CERCLA site to the total dose from all sources of radionuclides that contribute to the dose to the designated receptor in the CA. This can only be done accurately if the mix of radionuclides from the CERCLA sources at the CA POC is known; equal risks from different radionuclides can translate into different doses.

Two other factors complicate the conversion of the CERCLA remediation goal to a dose that is useful for the CA. The risk goal may not be used entirely for risks from radioactive contaminants, the only contaminants of interest in the CA. Also, the point at which the risk goal is to be achieved (the POC for the CERCLA remediation) may not be the same as the POC for the CA. The first factor may not complicate the use of the CERCLA cleanup goal as long as the fraction of that goal attributable to radionuclides is known; if the fraction is not known, it can conservatively be assumed to be unity. The second factor may cause considerable difficulty, to the point of having to explicitly model releases from the CERCLA sites in the CA.

Several choices are available for converting the CERCLA remediation goal to a dose projection. They include:

- Using a representative risk-to-dose conversion, such as 7.6×10^{-4}/rem (4).

- Assuming a mix of radionuclides from the CERCLA site reaching the CA POC and developing a single risk-to-dose conversion factor for some assumed combination of those nuclides. Then that conversion factor is used to relate the remedial action risk goal to the peak contribution of the CERCLA-remediated sources of radionuclides to dose at the POC.

- If the CERCLA feasibility study (FS) provides information about the contributions of individual radionuclides to projected risks, converting those risks to dose on a nuclide-by-nuclide basis to determine the contribution of the CERCLA sources to the peak dose at the POC.

For the CA for the aboveground disposal units at SWSA 6, the corresponding CERCLA analyses focused on only three radionuclides--ones that are presently being found in significant quantities in White Oak Creek at the POC (see Refs. 5 and 6). Those nuclides are ^{3}H, ^{90}Sr, ^{137}Cs. The FS listed remedies for sharply reducing the releases of those nuclides from the CERCLA sources in the Melton Valley watershed, and in Bethel Valley. Other radionuclides, that are not now appearing in the surface water in White Oak Creek may also be contained by the preferred remedy prescribed in the Proposed Plan and the ROD for the Melton Valley watershed. However, extensive monitoring of that water far into the future is planned and, if other nuclides are measured in concentrations that indicate that the risk goal of the cleanup may not be met, additional measures to contain those nuclides will be taken at the CERCLA sites.

Radionuclides other than those addressed in detail as part of the Melton Valley CERCLA process might be observed in White Oak Creek in significant concentrations in the future. If that happens, the CA that is a companion document to the PA for the aboveground disposal units in SWSA 6 will have to be revised as part of the CA Maintenance Plan. For the present the projected peak dose from the CERCLA-remediated sources considered in the CA is based on the three nuclides named above. The third method of converting risk to dose listed above was used in the CA.

White Oak Dam was also chosen to demonstrate compliance with the dose limits for the CA. Because of the high degree of dilution in the waters of White Oak Creek and White Oak Lake, the aboveground disposal units contribute negligible dose from the water pathway. CERCLA sites contribute about 10 mrem/yr. Conversely, proximity of the aboveground disposal units to WOD causes them to dominate the air pathway dose in the CA, providing almost all of the up to 10 mrem/yr conservatively estimated for that pathway. Together, all DOE sources are projected to contribute less than the 30 mrem/yr dose constraint prescribed for CAs.

SUMMARY

This paper discusses several interactions between the requirements of DOE Order 435.1 and CERCLA that can occur when a DOE LLW disposal facility is surrounded by a CERCLA site that will be remediated while leaving some contaminants in place. Similar considerations may apply if the CERCLA site is adjacent to, but not entirely surrounding the disposal facility. The interactions were illustrated using the current draft PA and CA for the aboveground disposal units in SWSA 6 at the ORR. Every combination of LLW disposal facility and CERCLA site can result in different interactions, so the developers of the PA and CA will have to look closely at the details of their own situation to determine what the effect of a nearby CERCLA site will be. The process of preparing the CA is clearly simpler if a ROD for the CERCLA site has been signed, as is the case for the illustration provided.

REFERENCES

(1) "Disposal Authorization for Selected Oak Ridge Reservation Solid Waste Management Area 6 Low-Level Waste Disposal Facility Facilities: Tumulus I, Tumulus II, and Interim Waste Management Facility," U.S. Department of Energy. Memorandum from James J. Fiore, Office of Environmental Restoration Environmental Management and Mark W. Frei, Office of Waste Management Environmental Management, to G. Leah Dever, Manager, Oak Ridge Operations (1999)

(2) "Performance Assessment for Continuing and Future Operations at Solid Waste Storage Area 6," ORNL-6783/R1, Oak Ridge National Laboratory, Oak Ridge, TN (1997)

(3) "Composite Analysis for Solid Waste Storage Area 6," ORNL-6929, Oak Ridge National Laboratory, TN (1997)

(4) "Estimating Radiogenic Cancer Risks," EPA 402-R-93-076. Washington, DC, U.S. Environmental Protection Agency (1994)

(5) "Record of Decision for Interim Actions for the Melton Valley Watershed at the Oak Ridge National Laboratory, Oak Ridge, Tennessee," DOE/OR/-1-1826, U.S. Department of Energy, TN (2000)

(6) "Feasibility Study for Melton Valley Watershed at Oak Ridge National Laboratory, Oak Ridge, Tennessee," DOE/OR/01-1629, U.S. Department of Energy, TN (1998)