July 23, 2006

Chief, Rules Review and Directives Branch
U.S. Nuclear Regulatory Commission
Mail Stop T6-D59
Washington, DC 20555-0001

RE: Draft NUREG-1854

Dear Sir/Madam:

The West Valley Citizen Task Force (CTF) has studied NRC's draft Standard Review Plan for U.S. Department of Energy (DOE) Waste Determinations (Draft NUREG-1854). We recognize that the Nuclear Regulatory Commission (NRC) may find it useful to have a more uniform application of principles in conducting waste determination activities at the many DOE defense sites across the country, and we are therefore providing a variety of comments on NUREG-1854, ranging from fully constructive comments to expressions of our concern about the underlying process of waste reclassification.

With regard to waste reclassification, the CTF is concerned particularly with "waste incidental to reprocessing" ("WIR") determinations by which certain wastes from the reprocessing of spent nuclear fuel "can be considered low-level waste and managed accordingly." (p. iii) As stated by NRC, the NUREG-1854 draft report applies to four sites, including the West Valley [NY] and Hanford [WA] sites. We disagree. The guidance given in the draft report cannot be applied legally to make WIR determinations for waste at the West Valley site; existing law does not allow it.

Our first few comments are provided below, and additional detailed comments are listed in the attachment sent with this letter.

APPLICATION OF LAW. The draft report (p. xiii) cites the National Defense Authorization Act for Fiscal Year 2005 (NDAA) as the legal authority for conducting WIR determinations in South Carolina and Idaho. Such legal authority does not exist, however, in other states such as Washington and New York where the Hanford and West Valley sites are located.

OUR PREVIOUS DISAPPROVAL. The draft report (pp. xvii-xviii, xix, xx, 1-9, and 2-3) cites NRC's prior announcement, made in 2002 in its *Final Policy Statement for the Decommissioning Criteria for the West Valley Demonstration Project*, that WIR determinations can be applied to waste management activities at the West Valley site, including the West Valley Demonstration Project. We supplied written testimony on the draft for that policy (SECY-98-251) on December 22, 1998, followed by oral testimony to the Commission (given January, 1999, in Rockville, MD). In our written comments we expressed serious misgivings about the legality of using the WIR reclassification at West Valley. We questioned whether the proposed criteria might be a

"means of allowing DOE to reclassify the HLW (high-level waste) collected from tank residue and decontamination of the process building and vitrification facility as LLW (low-level waste)." We expressed concern that NRC was providing DOE with "de facto authority to dispose of their wastes onsite at the eventual expense of New York." We reiterate our objection now with even more certainty.

EXECUTIVE VS. CONGRESSIONAL POWERS. It appears that any use of WIR determinations to reclassify waste at the West Valley site would violate the Nuclear Waste Policy Act. If applied to DOE activities at the West Valley Demonstration Project, WIR determinations would also violate that act as well. In both of these laws, Congress created waste classification systems that define high-level waste in a way that cannot be overruled by an executive agency such as NRC. Therefore, NRC can not authorize or participate in WIR determinations that are inconsistent with the waste classifications defined by Congress. In addition, NRC suggests in the draft report (p. xix) that DOE Order 435.1 may authorize WIR determinations on waste sent offsite from the West Valley site. With the possible exception of wastes sent offsite to South Carolina or Idaho, we disagree. NRC's suggestion is defective for the same general reason given above: Congress created waste classification systems that define high-level waste in a way that cannot be overruled by an executive agency such as DOE. NRC is mistaken in thinking that DOE can authorize or participate in WIR determinations that are inconsistent with the waste classifications defined by Congress.

SELECTIVE USE OF REGULATORY PROTECTION. The draft report describes the use of the performance objectives of NRC's 10 CFR Part 61 regulations, Subpart C, as important criteria in any WIR determination. However, it should be noted that the 10 CFR 61 regulations were intended to be protective *when used in their entirety.* The same degree of protectiveness cannot be achieved when portions of the 10 CFR Part 61 regulations are used selectively, without complying with the full set of requirements. As stated in the draft report, p. xv, WIR determinations "typically use the performance objectives of 10 CFR Part 61, Subpart C, as a criterion that must be met (see Section 2); references to other parts of the regulations in 10 CFR Part 61 (i.e., other than Subpart C) are included only to provide information and guidance as they relate to the staff reviews." Such selective use of 10 CFR Part 61 does not provide adequate protection.

EXTREME WEATHER EVENTS. A frequent theme in our more detailed comments (attached) is that NRC needs to ensure that any analysis of site stability and site suitability will incorporate the increased frequency of extreme weather events that has been occurring as a result of climate change. Extreme weather events, especially intense storms that produce locally heavy rainfall, will have a major effect on erosion, infiltration, and other processes that negatively affect waste containment at disposal sites.

GOOD BASIS FOR REVIEW. Despite our serious concern that WIR determinations cannot be conducted legally at most sites, we recognize that the draft report contains a very extensive and generally good set of review criteria for near-surface waste disposal. We remain concerned that

NRC may not have the authority to regulate or enforce in the various areas covered by its review, yet we commend NRC for the thoroughness of the review process set forth in the draft report. Most of our attached comments deal constructively with that review process.

We appreciate this opportunity to comment on the NUREG-1854 draft report.

Sincerely,

Additional detailed comments of the West Valley Citizen Task Force, dated July 23, 2006,
on
NUREG-1854, draft *Standard Review Plan for Activities Related to U.S. Department of Energy Waste Determinations*, issued May 2006.

1. In Chapter 1, NRC requires a good level of detail for detailed technical reviews, as outlined on pages 1-1 through 1-9. Required information includes, for example, summaries of performance assessments, intruder analyses, exposure pathways, and dominant radionuclides (p. 1-2); descriptions of relevant physical and chemical forms of radionuclides, design features in relation to performance objectives, design criteria in relation to natural events and processes, information on past waste management practices, and information on previous waste releases (p. 1-3); information on the human population distribution and also on local biological characteristics such as plants or burrowing animals that could compromise waste containment (p. 1-4); assessments of land use, ground and surface waters, and natural resources (p. 1-5); descriptions of surface and subsurface geology, including geomorphology, erosion processes, structural geology and the potential for seismic events, slope stability, etc. (p. 1-6); descriptions of hydrologic features, zones, and parameters (pp. 1-6 to 1-7); information on radiological status of the site, including past releases and plume movement (pp. 1-7 to 1-8); and evaluation of prior waste determinations, including source terms and inventories, performance assessments and dose modeling calculations, etc. (p. 1-9).

2. In Chapter 1, section 1.1.3.3 on meteorology and climatology needs to require consideration of future effects from carbon emissions. Both this section (p. 1-5) and the review procedures on p. 4-19 need to require assessment of the ongoing climate change that is caused or aggravated by human activities, especially the increased frequency or severity of extreme weather events that are a recognized consequence of rising concentrations of greenhouse gases in the atmosphere. Erosion at the West Valley site is particularly sensitive to extreme precipitation events. Such events are not only linked to the cyclical processes and orbital patterns mentioned on p. 4-19; they are also aggravated by human effects on climate. The draft report needs to ensure that these human climatic effects are taken into consideration, especially since these effects can be expected to continue (and become more severe) for decades into the future as atmospheric carbon dioxide concentrations continue to rise. Note that an increased frequency and severity of extreme weather events means not only more high-precipitation events but also more prolonged droughts. The combination of these two effects produces a concern that is illustrated on p. 4-19, where NRC refers to the importance of "short duration, large magnitude events, especially when discrete high-permeability pathways that can transmit large amounts of infiltration are present in the near-surface (e.g., desiccation cracks in a clay soil)." This concern applies directly to the West Valley site where such infiltration aggravates slumping and accelerates erosion. The link to human-induced climate changes must be made.

3. In Chapter 2, in relation to the possible substitution of "comparable" safety requirements for the performance objectives of 10 CFR Part 61, Subpart C, NRC makes a good point that "strong justification for using alternative safety requirements would be required, unless it can be

determined that the proposed alternative safety requirements are more stringent than those of 10 CFR Part 61, Subpart C." (p. 2-6)

4. In Chapter 2, page 2-7, NRC states that its staff uses 25 mrem total effective dose equivalent (TEDE) in place of the dose limits specified in 10 CFR 61.41. This NRC practice cannot be assumed in all cases to be as protective as 10 CFR 61.41 (depending, for example, on the concentration of radioactive iodine in a given quantity of waste). NRC would need to show on a case-by-case basis that its proposed alternative safety requirement (25 mrem TEDE) is as protective as the legally binding requirement in 10 CFR Part 61, Subpart C.

5. In Chapter 2, page 2-8, NRC correctly emphasizes the importance of site stability, as required by 10 CFR 61.44. In particular, NRC makes a good point that the effects of site instabilities identified in its review must be adequately modeled or bounded by performance assessments and intruder analyses. Site instability effects would include, for example, erosion effects at the West Valley site.

6. In Chapter 3, p. 3-1, NRC states that, "Analyses to support NRC license modification or termination at West Valley will be performed independently of the waste determination process..." This statement may create a potential concern for NYSERDA at the West Valley site, in the event that NRC might decide not apply the same criteria to DOE's waste determination activities as to NYSERDA's license termination activities.

7. In Chapter 3, pages 3-5 to 3-10, NRC focuses on "highly radioactive" radionuclides and states that these radionuclides "are defined in terms of the risks they pose to various receptors..." NRC should ensure that long-lived mobile isotopes such as Tc-99 and I-129 are included in this category of "highly radioactive" radionuclides. In any case, NRC must ensure that adequate protection from long-lived mobile isotopes is achieved.

8. In Chapter 3, p. 3-6, NRC makes a good point that "it is particularly important that the reviewer evaluate the potential uncertainties in predicted receptor doses" and recommends that, in identifying uncertainties, "the reviewer should consider the results of independent performance assessment and inadvertent intruder analyses." Additional good points include the review procedures specified in section 3.2.2, pages 3-6 to 3-7. The meaning of "independent" in the above sentence is apparently illustrated on p. 4-10, where NRC suggests that it may be necessary in certain circumstances for the reviewer "to perform independent analysis of the disposal system."

9. In Chapter 3, p. 3-8, NRC makes a good point that information about available technologies for radionuclide removal may be found in reports from other DOE sites as well as reports from third parties such as National Academy of Sciences or Defense Nuclear Facilities Safety Board. NRC cites specific examples of such reports on p. 3-10.

10. In Chapter 3, pages 3-9 to 3-13, NRC properly emphasizes the need to ensure that radionuclide removal is not stopped prematurely. On page 3-16, NRC makes a good point that

the risk to workers should not be accepted uncritically as a reason for stopping the removal of radionuclides. NRC indicates that additional protective measures for reducing worker risk would need to be evaluated, in the event that radiological risks to workers are cited by DOE as a reason why additional radionuclide removal is impractical.

11. In Chapter 3, pages 3-17 to 3-23, NRC discusses concentration averaging, wherein residual radioactive waste is mixing with nonradioactive material for the purpose of waste stabilization. NRC describes concentration averaging practices that it considers appropriate and other such practices that it considers inappropriate. On page 3-18, NRC lists several principles that are intended "to prevent arbitrary or incorrect classification of materials that may result in near-surface disposal of materials that are not suitable for near-surface disposal." On page 3-19, NRC indicates that "mixing with excessive amounts of stabilizing materials solely to reduce the waste concentrations to alter waste classification should not be performed. In most cases, the ratio of the unstabilized to stabilized radionuclide concentrations would not be significantly greater than a factor of 10 for waste classification purposes." We are concerned that such tenfold dilution is too large a dilution factor to be protective (a lower factor would be better) but otherwise recognize that these NRC statements establish limits on the practice of concentration averaging.

12. In Chapter 3, pages 3-20 to 3-21, we are concerned about an example provided by NRC that is roughly analogous to the type of concentration averaging that DOE might try to apply to HLW tank 8D-2 at the West Valley site. In this example, NRC would allow a twentyfold dilution (waste concentrations "would be reduced by a factor of 20 for estimating waste classification"), assuming a 0.1-cm-thick layer of residual waste that is not easily removed from a 1-cm-thick tank wall and is then covered by a 1-cm-thick layer of stabilizing grout. NRC would allow the 2-cm combined thickness of the tank wall and grout to serve as "dilution" for the 0.1-cm residual waste layer (hence the dilution factor of 20), even though the residual waste layer would not be physically mixed with either the tank wall or the grout. This is unprotective for two reasons. First, a dilution factor as large as 10 or 20 should not be allowed in general; it is not sufficiently protective for near-surface disposal. Second, neither the tank wall nor the grout would serve any real purpose of stabilization in this West-Valley-type example. After the steel tank wall rusts through, it will no longer exist as a barrier to radionuclide migration. It will be replaced by particles of rust (primarily iron oxides) though which water can migrate. The grout, located on the other side of the residual waste layer, will be essentially irrelevant when radionuclides start to migrate and leach toward the bed of rust. Since the grout is *not* assumed to be physically mixed with the residual waste, it cannot stabilize radionuclides that are migrating *away from* the grout.

13. In Chapter 3, p. 3-21, in the context of 10 CFR 61.58, NRC makes a good point that, "When performing the intruder calculations, it is not appropriate to calculate an average dose factoring in the likelihood of the occurrence of the scenario. The likelihood of the intruder scenario occurring is already represented in the higher limit (e.g., 500 mrem/yr) applied for inadvertent intruder regulatory analysis."

14. In Chapter 3, in section 3.5.1.2 on pages 3-22 to 3-23, we are concerned that NRC may allow near-surface disposal of "wastes that do not meet the Class C concentration requirements" through a consultation process with DOE. NRC needs to recognize that some proposed WIR determinations may produce unacceptable options for waste disposal, in which case NRC would need to deny the WIR determination in accordance with its own rules. Consultation cannot be viewed as a universal last resort that would justify unacceptable WIR determinations.

15. In Chapter 4, pages 4-1 to 4-49, NRC reviews performance assessments and their many components, with emphasis on proper methods, assumptions, and review procedures.

16. In Chapter 4, p. 4-4, NRC makes good points about institutional controls and the need to limit reliance on such controls. In general, the concern is that human societies may be unwilling or unable to maintain institutional controls for the thousands of years during which certain radionuclides remain hazardous. The underlying regulatory philosophy, as noted by NRC, is based on "the relatively large uncertainty associated with predicting societal systems."

17. In Chapter 4, including p. 4-10 and also sections 4.4 and 4.5 on pages 4-39 through 4-43, NRC makes good points about data uncertainty and indicates that appropriate review procedures should be used "to ensure that DOE has captured the variability in data and provided an assessment of uncertainty due to the incomplete knowledge of the natural system, engineered system, or [waste] inventory." NRC endorses either probabilistic or deterministic analysis but would require that deterministic analysis be supported by the use of sensitivity analyses and be bounded by the selection of conservative values. Conceptually, we recognize that either type of approach (probabilistic or deterministic) is reasonable, yet we remain concerned that deterministic analyses can be abused or biased by exaggerated claims of "conservative" values. A primary benefit of probabilistic analysis is that the range of uncertainty for each value is clearly stated and is then carried through the performance assessment in an explicit and formal manner. A deterministic analysis does not carry the uncertainty through the performance assessment, but, instead, uses some degree of "worst-case" or "conservative" values as its starting-point. This is susceptible to abuse, especially when values are claimed to be "conservative" but are far from worst-case values, or when agencies justify the use of certain unconservative values by claiming that other values in the same calculation are overly conservative. In such cases, given the complexity of the calculations, the final degree of conservatism in a deterministic analysis is hard to decipher. For these reasons, NRC must either require probabilistic analysis or ensure full compliance (not just lip service) with its safeguards for deterministic analysis, consisting of appropriate sensitivity analyses and adequately conservative values. Again, where NRC expresses a preference on p. 4-40 for a mixture of deterministic and probabilistic methods, the agency must ensure that any supporting claims (e.g., that a parameter is "well constrained" or "of little significance") can be adequately verified.

18. In Chapter 4, in section 4.2.1 on pp. 4-11 to 4-12, NRC makes a good points about the need for consistency and for transparent, traceable documentation.

19. In Chapter 1, section 4.3.1 on climate and infiltration needs to include human-induced climate change, especially in section 4.3.1.1.3 on p. 4-17. Overall, section 4.3.1 needs to require review and assessment of the increased frequency and severity of extreme weather events that are a recognized consequence of rising atmospheric concentrations of greenhouse gases from human activities. Such extreme weather events may increase infiltration and unsaturated zone flow, which affect engineered barriers and waste disposal facility performance (see p. 4-16). Additional effects, including the undercutting of slope toes and water infiltration that lubricates and causes downslope failure of slump blocks, should also be included in the required review. Note that an increased frequency and severity of extreme weather events means not only more high-precipitation events but also more prolonged droughts. The combination of these two effects produces a concern that is illustrated on p. 4-19, where NRC refers to the importance of "short duration, large magnitude events, especially when discrete high-permeability pathways that can transmit large amounts of infiltration are present in the near-surface (e.g., desiccation cracks in a clay soil)." This concern applies directly to the West Valley site where infiltration aggravates slumping and accelerates erosion. The link between slumping and human-induced climate change must be recognized and fully incorporated into the review requirements.

20. In Chapter 4, in section 4.3.2 on engineered barriers, NRC makes good points about the need to show clearly a) the timeframe over which an engineered barrier would serve its intended function, b) assumptions about barrier integrity and degradation, c) effects of biointrusion such as root penetration and burrowing animals, d) interactions among incompatible materials that may be adjacent to or incorporated into the barrier, e) uncertainty about long-term performance of the barrier, f) adequacy of the modeling of barrier performance, and g) analysis of impacts if a barrier does not achieve its design goals.

21. In Chapter 4, in section 4.3.3 on source term and near-field release of radionuclides, NRC makes good points about the importance of understanding the quantities and distribution of radionuclides in a given disposal unit and how those radionuclides may escape into the environment, and also about the importance of careful review of the underlying assumptions, data, and models. NRC notes on pages 4-27 to 4-28 that the wasteform, its degradation mechanisms, and chemical environment must be taken into account. Gaseous and other releases of radionuclides must be adequately analyzed, as indicated on pages 4-29 to 4-30. Uncertainties and assumptions in the source term and release mechanisms must be acknowledged and included in the various analyses.

22. In Chapter 4, in section 4.3.4 on radionuclide transport, NRC makes good points about the need to understand and appropriately analyze the air, water, and biotic pathways by which any released radionuclides may travel away from the disposal unit. On pages 4-32 to 4-36, in relation to probable maximum floods, other surface water processes, and transport in the saturated zone, NRC needs to ensure that the effects of human-induced climate change (including the effects of extreme weather events on maximum flood areas, groundwater recharge processes, and water table fluctuation) are taken into account.

23. In Chapter 4, in section 4.3.4 on radionuclide transport, NRC makes good points on pages 4-33 to 4-34 about the importance of analyzing a) groundwater chemistry and possible reactions with radionuclides, b) the partitioning of radionuclides between groundwater and geologic media, c) the potential for colloid-facilitated transport of radionuclides, d) and the potential for radionuclide transport on sediments carried by surface water.

24. In Chapter 4, in section 4.3.4 on radionuclide transport, NRC makes a pair of good points about erosion and climatology but needs to ensure that these points are considered in combination with each other. The points are very relevant to the West Valley site. On page 4-34, NRC emphasizes the need to "ensure that the potential for erosion and exhumation of wasteforms is considered for those areas where site characteristics (e.g., gullies, steep terrain)indicate that erosion is a significant process." In the next paragraph on the same page, NRC indicates that the "climatology...that may affect radionuclide transport" must be adequately described. As already described in our comments above, climatology must include the changes in extreme weather events that are occurring as a result of human-induced climate change. These climatological changes will have a very significant effect on the rate of erosion (and will increase the exposure and exhumation of wasteforms by erosion) at sites such as West Valley where erosion is already a serious problem due to gullies, steep terrain, slumping, etc.

25. In Chapter 4, in section 4.3.4 on radionuclide transport, NRC indicates on p. 4-34 that DOE must provide "an adequate description of groundwater flow directions and velocities (horizontal and vertical) for each potentially affected aquifer." This is a good point but should explicitly require description and documentation of a) any manmade connections between potentially affected aquifers, b) the effect of such connections (or demonstrated absence of such an effect) on groundwater flow directions and velocities, and c) the effect of such connections (or demonstrated absence of such an effect) on the transport of radionuclides into aquifers that would not otherwise be affected. Two examples of manmade connections between potentially affected aquifers would be 1) any test wells or borings that are either uncased or susceptible to leakage along the outside surface of the casing and 2) pilings such as the pilings that were driven in the 1960s to support the West Valley process building, some of which were mechanically repositioned in a way that may have created open pathways for water flow between two otherwise separated waterbearing zones.

26. In Chapter 4, in section 4.3.4 on radionuclide transport, NRC makes a good point on p. 4-36 that the modeling of any hydrological units as aquitards must be "consistent with information about the spatial variability of the unit and the presence of any fast pathways through the unit." NRC provides two examples but should also specifically consider a) the likely presence of undetected sand lenses (either isolated or interconnected sand lenses) in glacial aquitards, and the associated question of whether such lenses can and should be detected and characterized by modern hydrogeophysical methods or must otherwise must be treated as an explicit uncertainty, and b) the likely presence of open joints and fractures in near-surface glacial aquitards, combined with the likely presence of "incipient" joints at greater depth in those same aquitards (as has been studied at the West Valley site), and the associated question of determining the depth threshold at which such joints do *not* act as fast pathways for radionuclide transport.

27. In Chapter 4, in section 4.3.4 on radionuclide transport, NRC correctly emphasizes the importance of characterizing the hydrologic and geochemical properties of the groundwater system through which radionuclide transport may occur. NRC should also require adequate characterization of the effects of any past, present, or future plumes of organic solvents that may be, or may have been, mixed with the groundwater. Any such characterization should include a) how the presence of organic solvents in combination with groundwater may affect flow and transport rates, sorption properties, etc., and b) whether and how any *past* plume of organic solvent has modified the surface properties of the geologic media through which groundwater is flowing, thereby affecting present and future sorption and partitioning, even if the past plume of organic solvent is now gone.

28. In Chapter 4, in section 4.3.5 on biosphere characteristics and dose assessments, NRC makes a good point that selected exposure pathways must be both reasonably complete and consistent with regional practices of human populations in the vicinity of the disposal site. NRC also emphasizes that any use of default parameters must be justified.

29. In Chapter 4, in section 4.4 on computational models and computer codes, NRC makes good points about the need for quality assurance testing of computer codes. A related point, as noted on p. 4-41, is that computer codes must account properly for radionuclide decay and ingrowth and must assign appropriate properties to daughter radionuclides.

30. In Chapter 4, in sections 4.4 and 4.5 on computational models, computer codes, uncertainty analysis, and sensitivity analysis, NRC discusses the question of probabilistic vs. deterministic modeling methods. This NRC discussion has already been addressed in part by our comments above. For all cases where a deterministic analysis is performed, NRC needs to ensure that its review procedures (in sections 4.4.2, 4.5.1, and 4.5.2) deal adequately with the issues we raised above. In particular, such review needs to take a good, hard look at whether deterministic performance assessments (and underlying assumptions) are adequately conservative to account for uncertainty. In cases where unconservative or marginally conservative parameters are being justified by claims that other parameters are "overly conservative," the reviewer must ensure that the logic is clear and/or require a probabilistic assessment that to show that the approach is valid. Similarly, in dealing with "a dynamic system that responds nonlinearly to the independent variables" or when "there are numerous inputs (e.g., data or models) that are uncertain" (p. 4-42), the reviewer would need to evaluate any deterministic model with a very critical eye. Critical evaluation is also needed for sensitivity analyses. Assumptions that support sensitivity analyses require close attention; they cannot be taken at face value.

31. In Chapter 4, in section 4.5 on uncertainty/sensitivity analysis, NRC makes good points that a) appropriate combinations of parameters must be used in sensitivity analyses to capture the interdependence of key parameters and b) realistic parameter distribution ranges must be used in probabilistic analyses to avoid "risk dilution."

32. In Chapter 4, in section 4.6 on evaluation of model results, NRC makes good points about the modeling of barriers and about the importance of reviewing intermediate model results as

part of the assessment of barrier performance. In section 4.6.1.4, NRC needs to ensure on a case-by-case basis that 25 mrem/yr TEDE achieves compliance with the requirements of 10 CFR 61.41, including its separate limit of 75 mrem/yr to the thyroid.

33. In Chapter 5, dealing with inadvertent intrusion onto a closed site after institutional controls are no longer effective, NRC provides a helpful explanation on p. 5-2 that "Future human behavior cannot be accurately predicted over hundreds to thousands of years. To address this uncertainty, hypothetical intruder scenarios are designed to bound the exposure to the intruder, while avoiding speculation about future human activities." NRC provides several plausible intruder scenarios (intruder-resident, intruder-agriculture, intruder-recreational hunting/fishing, intruder-driller, intruder-construction, etc.) and identifies exposure pathways such as contact with contaminated drill cuttings from an onsite well, ingestion of well water, ingestion of vegetables grown onsite, etc.

34. In Chapter 5, on page 5-5, NRC makes a good point that DOE must not use the probability of an intrusion to reduce the potential consequences estimated in an intruder analysis. As explained by NRC on p. 3-21, "The likelihood of the intruder scenario occurring is already represented in the higher limit (e.g., 500 mrem/yr) applied for inadvertent intruder regulatory analysis."

35. In Chapter 6, dealing with worker protection, NRC describes the necessary application of radiation protection programs and dose limits, including attention to ALARA (As Low As Reasonably Achievable) requirements.

36. In Chapter 7, dealing with site stability, waste stability, and facility stability, NRC makes many good points about the need to characterize a disposal site, including "the potential for erosion, flooding, seismicity, and other disruptive processes" as well as the stability of the waste itself and the engineered features of the disposal facility. NRC correctly notes the relevance of 10 CFR 61.44, which states that the disposal facility must be sited, designed, used, operated, and closed to achieve long-term stability of the disposal site and to eliminate, to the extent practicable, the need for ongoing active maintenance of the disposal site following closure. NRC specifically indicates that the types of technical review described in 10 CFR 61.13(d) should be conducted (involving erosion, mass wasting, slope failure, etc.) and notes the relevance of the siting considerations described in 10 CFR 61.50 (these identify processes that may affect long-term site stability, not only for new sites but also for existing sites). NRC outlines important areas of review, including flooding, ponding, water-table fluctuation, surface geologic processes, seismicity, effects of plant roots and burrowing animals, etc. For all these areas of review, NRC needs to ensure that the analysis of site stability will incorporate changes in extreme weather events that are occurring as a result of human-induced climate change. An increased frequency of extreme precipitation events will aggravate any existing effects of flooding, ponding, water-table fluctuation, and surface geologic processes such as erosion, mass wasting, slumping, and landsliding. Effects of water-table fluctuation, erosion, mass wasting, slumping, and landsliding may be exacerbated by extreme precipitation that enters subsurface pathways created by plant roots and burrowing animals. Seismic events may in turn trigger slope failures, especially when extreme weather events have already undercut the toes of steep

slopes and/or increased the pore pressure and lubrication that will enhance the detachment of slump blocks. Thus, for its various review areas, NRC needs to ensure that the reviews incorporate the increased frequency of extreme weather events from human-induced climate change.