Confederated Tribes and Bands
of the Yakama Nation

Established by the
Treaty of June 9, 1855

October 11, 2011

Mr. Timothy A. Frazier
Designated Federal Officer
Blue Ribbon Commission on America's Nuclear Future
U.S. Department of Energy
1000 Independence Ave., SW
Washington, DC 20585

Subject: Comments on the July 29, 2011, *Draft Report to the Secretary of Energy,* of the Blue Ribbon Commission on America's Nuclear Future (BRC)

Dear Mr. Frazier:

The Yakama Nation Environmental Restoration Waste Management (ERWM) Program appreciates the opportunity to review and provide comments on the BRC's *Draft Report to the Secretary of Energy.* Please find attached our comments, prepared on behalf of the Yakama Nation by the Institute for Energy and Environmental Research (IEER).

The Confederated Tribes and Bands of the Yakama Nation is a federally recognized sovereign pursuant of the Treaty of June 9, 1855 made with the United States of America (12 Stat. 951). The U.S. Department of Energy's Hanford site was developed on land ceded by the Yakama Nation under the 1855 Treaty with the United States. The Yakama Nation retains reserved rights to this land under the Treaty.

If you have any questions, please contact me at (509) 945-6741 or Arjun Makhijani of IEER at (301) 270-5500.

Sincerely,

Russell Jim
Yakama Nation
ERWM Program Manager

Enclosure
cc: Mary Woollen, BRC Outreach Coordinator

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Comments on the July 29, 2011, *Draft Report to the Secretary of Energy*, of the Blue Ribbon Commission on America's Nuclear Future (BRC)

Prepared by the Institute for Energy and Environmental Research (IEER) on behalf of the Yakama Nation

30 September 2011

The following are the comments of the Yakama Nation on the *Draft Report to the Secretary of Energy*, of the Blue Ribbon Commission on America's Nuclear Future (hereafter Draft Report), published on July 29, 2011, for public comment.[1] We are providing comments in the expectation that they will be taken into account in the final report of the BRC. Page numbers in parentheses refer to the Draft Report.

Main recommendations for changes/additions to the Draft Report

The final report should

- Recommend abandonment of the co-mingling policy for commercial spent nuclear fuel and defense high-level waste.
- Recommend a dedicated repository for defense high-level waste as well as a number of other kinds of waste like GTCC and GTCC-like waste, reactor graphite blocks, and depleted uranium from enrichment plants that would cause severe environmental harm if disposed of in shallow land burial but that do not have a high thermal source term that is characteristic of spent nuclear fuel.
- Look more closely at the ways in which the Nuclear Regulatory Commission is using the process for revising waste classification to relax radiation protection regulations and whether is it doing sound science in the process.

[1] Blue Ribbon Commission 2011

- Recommend that safety and radiation protection standards in the future be at least as protective as those for the present generation, including drinking water standards and EPA's 40 CFR 190 as presently written.
- Recommend radiation protection standards take into account tribal life and culture and follow Executive Order 13045 on the protection of children from environmental risks.
- Include a period of exclusively science-based work prior to any consent-based and science-based siting process.
- Include a provision for stopping characterization after site selection should there be sufficient data that a site is unsuitable (as there was at Hanford as early as 1983).
- Make the recommendation for a tribal role in standard setting that is stronger and broader and include a recommendation that a revised Nuclear Waste Policy Act (NWPA) allow for stricter state, tribal, and local safety standards if they give their consent for characterization.
- Recommend dry Hardened On-Site Storage of spent fuel aged more than five years and low density storage in pools of the rest. This should be independent of whether a consolidated storage facility is recommended or not.
- Explicitly exclude the DOE from the siting process for a consolidated storage facility, if such a facility continues to be recommended, and also exclude DOE sites as consolidated storage sites.
- Recommend direct disposal, without reprocessing, of spent fuel from U.S. light water reactors.

Additional details on these recommendations are provided below, as are the Yakama Nation's points of agreement with the BRC Draft Report.

A. Need for a repository or repositories

One of the key recommendations of the Draft Report is that "***United States must proceed promptly to develop one or more permanent deep geological facilities for the safe disposal of spent fuel and high-level nuclear waste."*** (p. 30) We are in agreement that development of a geologic repository for spent fuel and high-level waste, including defense high-level waste, is essential. The Draft Report notes that current policy, based on a decision in the 1980s, assumes that defense and commercial waste will be disposed of in the same repository. We do not understand why the BRC has referred the matter of co-mingling of defense high-level waste for further study to the Disposal Subcommittee. (p. 93) This 1980s policy, based on the assumption of a repository being available in 1998, is clearly obsolete.

Defense high-level waste is not as thermally hot as commercial spent fuel, which currently has more than 30 times as much radioactivity as defense high-level waste. Moreover, there are other reasons to consider a separate geologic disposal path for some classes of waste beyond the possibility that it would expedite the disposal of defense high-level waste.[2]

Specifically, the Draft Report should have paid more attention to the Greater than Class C (GTCC) waste and "GTCC-Like" waste that the DOE is now considering in an Environmental Impact Statement process. These wastes are not suitable for shallow land disposal, but rather should also be disposed of in a deep

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[2] TRU wastes buried at DOE sites before 1970 are being excavated at the Idaho National Laboratory. They are being sent to WIPP. We expect that this will also be the case for similar buried TRU wastes at Hanford and other sites for which WIPP is the legally appropriate destination. The discussion in this section relates to all types of waste, other than commercial high-level waste and spent fuel that should be disposed of in a deep geologic repository.

geologic repository. This is, in any case, the default option under existing low-level waste regulations (at 10 CFR 61) of the Nuclear Regulatory Commission (NRC), unless a special permit is granted to do otherwise. We are attaching the comments on the Draft GTCC EIS that the Yakama Nation submitted to the DOE in June 2011 as an integral part of these comments.[3] Our evaluation shows that shallow land burial of such wastes is inappropriate and would grossly violate existing norms of radiation protection. It also indicates that the DOE continues to do performance assessments that have significant scientific deficiencies.

The BRC report notes that the current classification system is not risk-based and provides depleted uranium (DU) from enrichment plants as a prime example.(p. 110) It also notes that the NRC staff has found that shallow-land DU disposal is unsuitable at "some sites." (p. 110). However, the BRC should have looked more closely at the analysis of the NRC staff, which made untenable assumptions for the shallow dry sites where it concluded that shallow land burial of large amounts of DU may meet low-level waste performance standards under 10 CFR 61. For instance, the entire exercise of assuming that performance of shallow land burial could be assessed for a million years was described at the NRC-sponsored workshop as "silly" or as "silliness," (including by the principal author of the NRC staff paper!) though it was also noted that these were possibly not the most appropriate terms in a regulatory context.[4] The NRC staff also made the entirely implausible assumption there would be no erosion for one million years. Moreover, while the NRC staff report declared that the low-level waste performance standards would be met under some circumstances, it did not actually calculate organ doses as required by the performance standards.[5]

Depleted uranium is clearly like transuranic waste in its radiological characteristics. This is evident when one compares the specific activity of the long-lived alpha-emitting radionuclides to the 100 nanocuries per gram lower limit that defines TRU waste. The main differences between DU and TRU waste are that (i) the specific activity of DU increases with time, (ii) the risks from radium-226 and radon-222 decay products become very substantial if the DU waste is ever exposed, and (iii) DU is also chemically toxic due to the large mass involved. Apart from nomenclature (uranium is, literally, not "transuranic" by the etymology of the word "transuranic") uranium should, from a risk point of view, be in the same category as TRU waste – slated for deep geologic disposal. As the National Research Council has noted:

> The alpha activity of DU is 200 to 300 nanocuries per gram. Geological disposal is required for transuranic waste with alpha activity above 100 nanocuries per gram. If uranium were a transuranic element, it would require disposal in the Waste Isolation Pilot Plant [WIPP], based on its radioactivity. The chemical toxicity of this very large amount of uranium would certainly become a problem as well.[6]

For instance, the peak doses (occurring between 9,000 and less than 20,000 years) using various medium to low rainfall conditions and medium to low erosion rates would exceed existing standards in all cases by more than 1,000 times.[7] Moreover, making very long-term calculations for shallow burial

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[3] See Attachment 3 of the attached comments on the GTCC EIS comments of the Yakama Nation. (Yakama Nation 2011)

[4] Makhijani 2009, p. 8. References to NRC materials and transcripts are provided there.

[5] NRC 2008, p. 5, and Makhijani 2009

[6] NAS-NRC 2003 p. 64

[7] Makhijani and Smith 2004 Table 5 (p. 24). See also Makhijani and Smith 2005 p. 16, where a series of calculations show how the dose goes to zero at a certain time when the erosion rate is reduced greatly. But note that even in

requires factoring in ice ages and other phenomena that can and have profoundly reshaped the surface. Generic calculations such as the ones done by the NRC are scientifically inappropriate and its conclusion that shallow land burial of large amounts of DU could in some cases result in satisfactory performance does not have a sound scientific basis.

We were surprised to see in the Draft Report (i) an endorsement of the NRC process of revising waste classification without qualification (p. 111) and (ii) an assumption in estimating waste volumes in Table 3 (p. 119) that DU would be disposed of in shallow land facilities (Footnote 223, p. 153) without any serious scientific scrutiny of the underlying NRC documents, meeting transcripts, or modeling assumptions. We are not against making a more rational waste classification, of course. But the manner in which the NRC is proceeding is at several levels neither compatible with sound science nor maintaining radiation protection levels. That the BRC has endorsed this process without comment on these problem aspects is not a very reassuring start for the science-based process that the BRC recommends. The BRC should discard the assumption of shallow land burial of DU and recommend geologic disposal for it. It should also modify the waste estimates in Table 3 accordingly. Since DU does not have a significant thermal source term, the constraints on the repository need not be nearly as stringent as for commercial spent fuel.

The Yakama Nation's comments on the Draft GTCC EIS also note that there are several other categories of waste that should go into a deep geologic repository because shallow land disposal would gravely compromise existing health and environmental standards, violate Yakama Nation treaty rights, and unreasonably require institutional control for the indefinite future. Even the DOE estimates that Hanford groundwater would be polluted hundreds of times above present standards under current cleanup assumptions. For instance, the graphite moderator blocks from World War II and early Cold War era Hanford reactors have the potential for greater carbon-14 emissions than would be allowed if commercial spent fuel were to be disposed of under the EPA's geologic disposal rule at 40 CFR 191 (which applies to all repositories except Yucca Mountain). The DOE itself projects that groundwater pollution from carbon-14 alone would exceed the drinking water standard by about 650 times in about 520 years in the future.[8] When the groundwater impact of other long-lived radionuclides at Hanford, like technetium-99, plutonium-239, or iodine-129, are taken into account the outlook becomes even more adverse. This is completely unacceptable to the Yakama Nation, since it abrogates certain treaty rights; it should also be completely unacceptable to the BRC since it violates all reasonable norms of radiation protection.

While the BRC has acknowledged that the present waste classification system is not risk-based, it has not properly evaluated whether the current NRC processes are going to take it in that direction or whether they are turning it into an exercise to relax radiation protection rules, such as abandonment of organ dose considerations in doing performance assessments. Specifically, as part of the process for considering unique waste streams, including depleted uranium from enrichment plants, the NRC published three documents in May 2011. These documents propose a huge relaxation of radiation protection standards. For instance, they would amend 10 CFR 61 to omit organ doses. This would mean an order or magnitude or more relaxation of concentrations for certain radionuclides, like strontium-90,

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the case of the 0.1 mm/yr erosion rate when the dose at 100,000 years is very low, the dose would dramatically increase after 123,000 years. The dose can only be made negligible if the waste cover is assumed to remain intact essentially forever.

[8] Yakama Nation 2011 Attachment 3, p. 14 (pdf p. 55)

and also implicitly permit much greater violations of drinking water rules.[9] The BRC should take note of these facts and recommend that radiation protection standards be maintained at least at present levels while the process of rationalizing waste classification is being carried out. A relaxation of radiation protection norms, as now proposed, would be completely unacceptable to us and we hope it is completely unacceptable to the BRC.

It is important to note that present low-level waste standards consider only concentrations of waste in the classification system. This has led to some of the problems we face today. For instance, the problem of disposal of depleted uranium arises mainly because of the huge amounts involved. Were there only a few kilograms here and there, there would not be a big issue. At over half a million tons, it is a huge problem both because of the high alpha specific activity and the total number of curies. Practical waste classification and disposal standards should not only limit concentrations of long-lived radionuclides in waste streams to be disposed of in low-level waste facilities, they should also limit total amounts. Deep geologic disposal should be required if the total amounts or concentrations are above the limits. This will prevent dilution from being used as a wholesale approach to disposal of wastes in shallow land burial facilities at the lowest possible cost. This is now being contemplated by the NRC.[10]

Moreover, it is not enough to consider classification of individual waste streams. The contamination of the soil, groundwater, and plant and animal resources at the specific sites where it will be disposed of needs to be considered in cases where the sites already bear a heavy burden of contamination. It is clear that there are many waste streams at Hanford, including buried transuranic wastes, graphite moderator blocks, and low activity glass that will be produced from high-level wastes that would result in violation of groundwater protection standards. These waste, like depleted uranium, need to be disposed of in a deep geologic repository. It would be cheaper and faster for these kinds of wastes to have their own designated repository, where defense high-level waste can also be disposed of.

These facts clearly point to a conclusion that a separate repository process would be beneficial for defense high-level waste and a significant number of other waste streams that would greatly damage the environment if they were to be disposed of in shallow land facilities or simply left as buried wastes on DOE sites like Hanford. Such a repository would likely save money and be less complicated and difficult to site than a co-mingled repository. We are available to provide more details on waste streams that should be included in addition to the analysis in Attachment 3 of the Yakama Nation's comments on the Greater-than-Class-C Draft EIS published by the DOE.

We stress that a separate repository for defense high-level waste and certain other wastes would still have to meet the same siting rules and performance standards as a commercial spent fuel and high-level waste repository. But it would be less difficult to do so due to the lack of a large thermal source term and the far lower total amount of radioactivity. The main urgent problems of waste at the major defense sites are to stabilize wastes and to put them in forms suitable for repository disposal. This is the case, for instance, with high-level wastes in tanks at Hanford and the Savannah River Site. There is time to follow the process with integrity to set up a defense high-level and other waste deep geologic repository and to do it right.

[9] Makhijani 2011
[10] NRC 2010

B. Standards

We support the BRC's recommendation that there should be generic regulations that all sites should meet before they can be deemed acceptable.(p. vii) This will improve public confidence, compared to the special standard that was sought to be set for Yucca Mountain. But a generic standard is far from enough. Specifically, we believe that the BRC should clearly and unequivocally recommend that management of wastes should meet criteria for health protection for future generations, no matter how far into the future, similar to those we use to protect ourselves today.

We understand that it may be technically difficult to evaluate doses over long periods of time up to estimated peak dose which may extend out to hundreds of thousands of years for high-level waste and spent fuel. But technical difficulty of waste management and disposal cannot now be a case for a lax policy. There is no moral case for protecting ourselves better than we propose to protect future generations.

Specifically, we believe that the BRC should specify that future generations should be protected to a standard at least as stringent as the protections we provide ourselves. Two limits are particularly important:

- The existing limits for radionuclides in drinking water, specified in 40 CFR 141.66.
- Dose limits for fuel cycle facilities, specified in 40 CFR 190.10(a), including the organ dose limits specified there.

We are opposed to a time limit on performance. The standard can and should be more frank and clear about the uncertainties involved in estimating doses so far into the future, and it should take them into account. It can adopt methods for long-term evaluation that recognize those uncertainties. We explicitly disagree with the Draft Report's recommendation that "[r]egulatory standards and requirements for compliance demonstrations (including the required level of confidence in the demonstration or "standard of proof") should not go beyond what is scientifically possible and reasonable."(p. 102) If we know enough geology to estimate what happened hundreds of millions of years ago (with uncertainties), we should be able to at least go out into the future with uncertainties for a small fraction of that time, such as one million years with some confidence. If this is deemed infeasible, how can the very concept of geologic disposal be deemed technically feasible? The inability of present-day science to do a "reasonable" million-year calculation should not be an occasion to abandon the concept of setting a limit on peak dose. Rather, it should be an occasion to call for improving the science. Rockets in 1961 could not take people to the moon. But that did not prevent the country from setting a goal of getting there in a decade. Why should there be a less ambitious attitude for protecting future generations from the wastes we are generating today? And we have more than ten years to do it!

Our suggestion that dose be assessed to the time of peak dose is identical to the recommendation of prior National Research Council studies in 1983 and again in 1995.[11] In fact the 1983 geologic isolation report of the National Research Council explicitly criticized the EPA for proposing a 10,000 year time limit.[12] A deep geologic repository is not going to materialize anytime soon. It is worth the time and effort to do the science right and to create the methods if they are at present inadequate. This connects

[11] NAS-NRC 1983 and NAS-NRC 1995
[12] NAS-NRC 1983 Section 8.5.8 (pp. 226-228) and p. 236

with our recommendation of an initial period of science-based work only, prior to any siting effort (see Section C below).

Further, we do not understand why the BRC discussed public health protection criteria for a deep geologic repository but failed to note the severe problems of waste at Hanford and other DOE sites that threaten health, potentially to a far greater degree than current estimates of impacts of properly sited and constructed geologic repositories. This is an issue both of equity and of tribal rights (since so many DOE facilities are on land involving tribal rights). It is all the more important to include this issue because DOE proposes to dispose of a vast radionuclide inventory on Hanford's Central Plateau in addition to the radionuclides that have already been disposed of there.

Finally, in all cases, compliance should consider gender and age as well as the special diet and customs of tribes that might result in higher radiation exposures than "Reference Man." It would be in violation of the Executive Order 13045 on "Protection of Children from Environmental Health Risks and Safety Risks" to have a standard that does not specifically address the higher risks faced by children. It orders executive branch departments and agencies to "make it a *high priority to identify* and assess environmental health risks and safety risks that may disproportionately affect children" and "ensure that its policies, programs, activities, and standards address *disproportionate risks to children* that result from environmental health risks or safety risks." [13] The Yakama Nation recommends strongly that the BRC recommend compliance with Executive Order 13045 as part of developing a safety standard for geologic repositories.

C. Science-based and consent-based processes for site selection

We agree with the Draft Report's recommendation that the siting process should be science-based and consent-based.(p. xv) The Draft Report considers lessons learned at length mainly from the failure of the consent aspects of the siting under the Nuclear Waste Policy Act. But there is far less attention to the scientific failures related to NWPA implementation and the lessons to be learned from them.

For instance, a paper prepared by Dr. Donald E. White, a member of the 1983 National Academies of Sciences (NAS) panel on geologic isolation (and one of the most eminent geologists in the United States) concluded that it would be very difficult to safely mine a repository at Hanford:

> Construction of the repository at very high in-situ temperatures, estimated by Rockwell to be 57^{o}C, but possibly considerably higher. Refrigeration on a scale seldom if ever attempted in world mining may be necessary. The costs in time, money, energy, and lives of men are likely to be very high.
>
> Even if each of the above is individually tractable, all in combination may be intolerable. More satisfactory alternatives probably can be found elsewhere.[14]

This 1983 assessment clearly indicated that it would likely be very unsafe to create a deep repository at Hanford and also very expensive. Despite this fact, the DOE went ahead and named Hanford as one of its top three sites in 1986.

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[13] Executive Order 13045, 1997 (emphasis added)
[14] White 1983. The quote is on p. 23 (p. 111 of the pdf).

In view of the above, we especially appreciate that the BRC has recommended that the new entity that would manage wastes would be subject to the same rules and regulations of the Mine Safety and Health Administration as a private corporation.(p. 78) However, no private corporation has handled commercial spent fuel or built mines in which a large thermal source term would be added in the course of work in the mine. The thermal source term of TRU waste going to WIPP is tiny compared to commercial spent fuel. It would be important to at least add a caution that rules for protecting workers may have to be considerably strengthened in light of some of the unique aspects of the work with commercial spent fuel and high-level waste. A formal review and a license by the Mine Safety and Health Administration should be required as part of the process of selecting a site and licensing a repository.

Similarly, the failure of the scientific process at key points in the Yucca Mountain site evaluation needs more analysis and comment. How did an oxidizing environment with metal canisters at a seismically active site with a geologic medium that was estimated by the DOE itself to have little value in retarding waste come to be selected as the only site? Why did the DOE not alert Congress and the public to the results of the 1983 National Research Council report (commissioned by the DOE itself) that due to lack of surface water for large scale dilution, the radiation doses from Yucca Mountain could be very high – far above any conceivable radiation safety limit?[15] If the next process is going to be more scientifically sound than the one we have had so far, it is imperative that the BRC examine the scientific flaws in the site selection process so that they can be avoided in the future.

The BRC needs to analyze this experience and make its recommendations for a science-based repository program in light of the lessons that should be learned.

The BRC should also explicitly recommend that a large science-based component should precede the consent-based part that applies to only the site selection. The main reason for our recommendation is that the safety of geologic disposal is not about the site alone. Rather, it is the combination of the site, the engineered barriers in relation to the site, and the sealing of the repository during closure that provides the performance. For instance, a geologically attractive site may be difficult to seal in a manner that would assure the reestablishment of pre-existing hydrogeologic conditions for a long period. We believe that far more study prior to the start of a site selection process is needed.

Specifically, the BRC should recommend a research process which considers the following three elements ***in combination***: host rock types, engineered barriers, and repository sealing and closure issues with a high thermal source term. At least a decade of research should be done ***before any siting process begins***. Since standards will be set prior to site selection anyway, the study of potential geologic isolation configurations of all three of these elements taken together, prior to starting site selection, would provide at least a minimum amount of assurance that egregious environmental injustice issues would not arise in the siting process. At that point a science-based and consent-based process could proceed in parallel, presuming the first science-based screening has been done with sufficient rigor.

If there is not enough sound science done before a consent-based process begins, the likely result will be that the sites chosen for investigation will be largely in poor, rural communities with low political clout.

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[15] NAS-NRC 1983 Figure 9-6 (p. 264), Figure 9-12 (p. 278), and text on Section 9.1.8 (pp. 276-279)

The site selection process of course does not stop with a set of sites where there is community consent for locating a repository and a set of standards. The BRC recognizes this by recommending a flexible process, in which “managers are able and willing to reevaluate earlier decisions and redesign or change course when new information warrants” and a process with integrity, in which “[t]echnical results are accurately and objectively reported and all uncertainties, assumptions, and indeterminacies are identified and labeled.”(p. 65). We agree that the process should have these attributes as well as others such as “auditability” and “transparency” advocated in the Draft Report.(p. 65)

One key point is missing, however. There is no explicit provision for stopping the process and rejecting a site as unsuitable once the characterization process has begun. This is absolutely essential, especially given the technical problems and misjudgments that have afflicted the U.S. site selection process from Lyons, Kansas, to Yucca Mountain, Nevada. A schematic for representing how a site characterization process that would be flexible and incorporate new data and information with integrity and that includes a provision for rejecting a site is shown in Figure 1, which was prepared as part of an evaluation by the U.S.-based Institute for Energy and Environmental Research (IEER), of the research on a French repository site near the village of Bure in northeastern France.[16] Such a provision would come into play if, at a certain point, the range of performance indicators, including uncertainties, indicates that performance is likely to be unacceptable.

[16] IEER 2004 p. 10

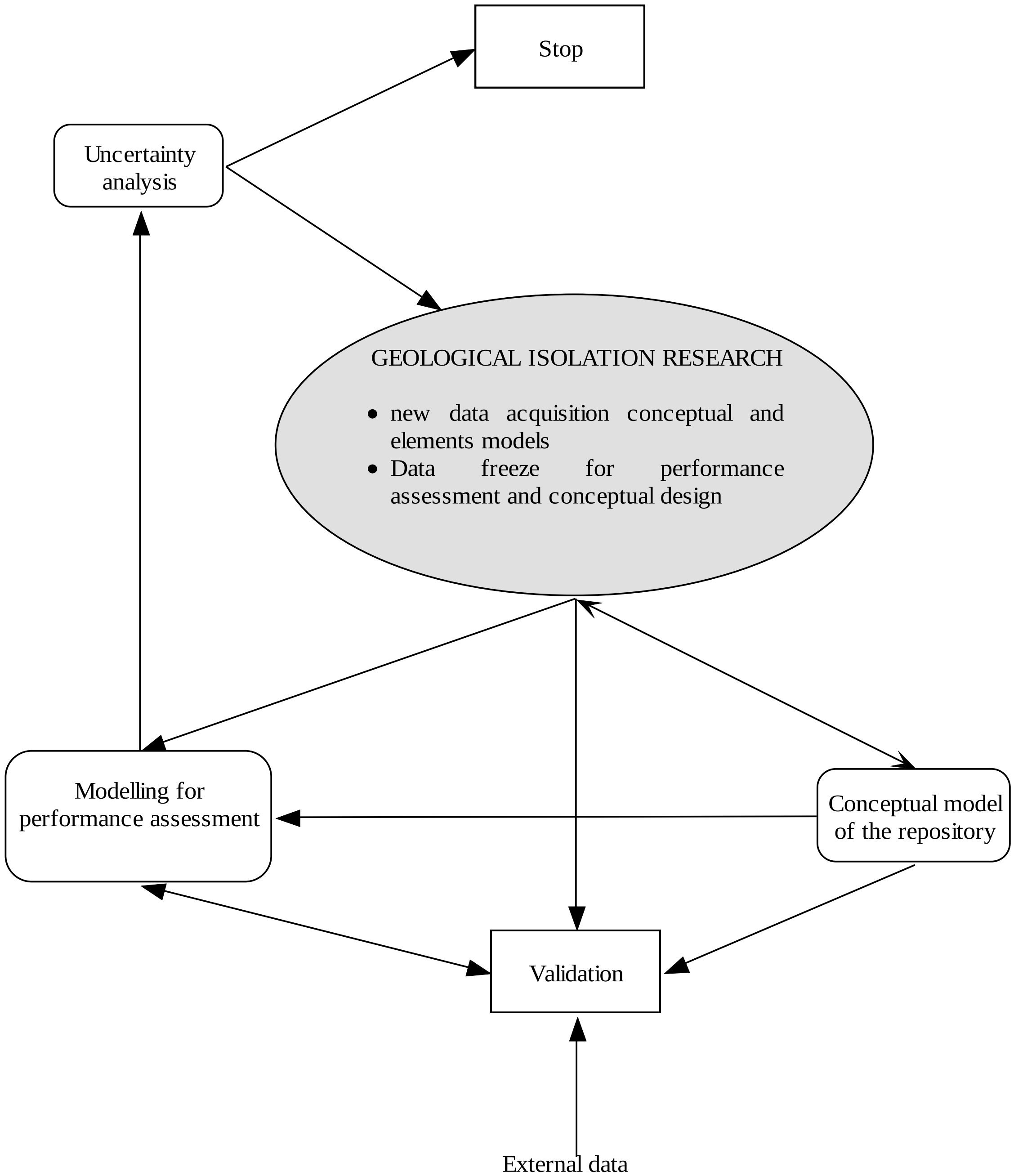

Figure 1: Iterative process for repository characterization, including a decision point for continuation or rejection. (Source: IEER 2004 Figure P-1 (p. 10). Translated into English.)

An iterative process like that in Figure 1 satisfies the flexibility and adaptability criteria recommended by the BRC, but it puts them in a specific scientific context that is essential for the integrity of the process. For instance, the Hanford process should have stopped in 1983, when Dr. Donald White prepared the paper quoted above, unless it could be independently shown to be definitively wrong with information available at that time. Of course, if the characterization process does not meet such an end, then the process continues. At some point, a suitable amount of on-site and other research as well as performance modeling will provide enough confidence to proceed beyond characterization to repository development.

D. Tribal, state, and local government roles

We appreciate and endorse the Draft Report's suggestion that tribes should have the authority to make their own regulations. Indeed, since nuclear waste legislation will need to be modified in any case, tribal and state authority regarding safety and oversight of the process from site selection to repository closure should be a part of the statute. We are not confident that federal regulations will be adequately protective, especially in the current climate, where there is a drift towards relaxing radiation protection in the name of rationalizing regulation and classification. Moreover, there has been a wholesale disregard of the Executive Order on children, though federal departments and agencies are required to follow it. Further, based on our experience with federal agencies, we are not at all confident that the new waste agency will take adequate account of tribal diets and cultural practices that affect radiation dose.

The BRC has had specific testimony from Russell Jim, the manager of the Yakama Nation's Environmental Restoration and Waste Management Program, who stated that the very genetic heritage of the Yakama is related to the foods and medicines in the area:

> Yakama Reservation land would not provide adequate resources to support our people. For that reason, they insisted that resources on the ceded land at Hanford and fish in the Columbia and regional rivers be guaranteed in the Treaty. Use of traditional foods and medicines is of increasing importance today with widespread environmental contamination, ***as the relation between the unique genes of the Yakama, our native foods, and our health is being demonstrated***.[17]

We also endorse the Draft Report's recommendation that tribes, states, local governments, and NGOs be funded.(pp. 66-67) It may be that some NGOs, for instance, may not want the funds. But that should be their choice. The funds should be available. We note that the French stakeholder group overseeing the repository research near Bure in northeastern France has funds not only for its own oversight but also to commission its own independent technical evaluations. This should be a mandatory part of the program with sufficient funds set aside for vigorous participation and evaluation. Of course, this will only be effective if there is adequate access to the site(s), data, and personnel conducting the research, doing the site selection, etc. Access and adequate time for project personnel to respond to technical and other questions of states, tribes, local governments, and NGOs is necessary since it will be very difficult without that to conduct sound independent evaluations.

As noted above, we are also in accord with the principle of a science-based and consent-based process, with the caveat that a certain amount of science should come before any site selection process begins. The difficulties arise in what constitutes "consent." The BRC has pointed to Sweden and Finland as examples of a consent-based process and to WIPP, which eventually became something of a consent-based process. We do not believe that the European examples are very useful given the many levels of devolved power in the United States. For instance, we can agree that federal safety and health standards should set a floor for all repository sites. But why should the Atomic Energy Act preempt states or tribes from setting health protection standards or safety standards stronger than the federal government? After all, the health and environmental effects of deep geologic disposal will not

[17] Jim 2010 p. 2 (emphasis added)

significantly extend across the whole country; rather they will most impact the state and local community the most.

Further, if an independent evaluation by a state, local government, or tribe that has been subjected to scientific review finds during characterization that a site will likely be unsuitable, a consent-based process should make an explicit provision for them to be able to stop further site characterization. Neither Yucca Mountain nor Hanford would have been named in the top three sites if the NWPA process had had such a provision. It will clearly be complex to create it and to prevent frequent and potentially ill-founded attempts to stop characterization at a site. But it seems to us that the ability to say "no" in the face of sufficient adverse information should be a part of consent-based process.

E. Interim spent fuel management

The Draft Report notes that a study by the National Academies on spent fuel storage done post 9/11 at the request of the NRC "concluded that dry cask storage has inherent safety and security advantages over wet pool storage but is only suitable for older spent fuel (more than five years post-discharge)."(p. 52). The Draft Report also recommends a follow-up NAS study:

> Given the magnitude of the [Fukushima] accident and its potential implications for future waste management policies, the Commission recommends that NAS be asked to conduct an independent investigation of the events at Fukushima and their implications for safety and security requirements at SNF and HLW storage sites in the United States, once better information about the accident is available. This study would build upon the 2004 NAS study of storage issues…. [Draft Report, p. 49]

While we endorse a follow-up study by the NAS in light of Fukushima, we do not agree that the issue of hardened dry storage of spent fuel ought to wait for the conclusion of this study or other studies, as proposed in the Draft Report.(p. 53)

Even though there is a great deal about the Fukushima accident that requires further study and will not even be clear for some time, it is abundantly evident that no information or analysis emerging from that event will result in a lowering of risk estimates of storage of spent fuel in reactor pools. The only direction that risk estimates can go is upward. There is no prospect that the 2004 NAS study conclusion that dry storage is inherently safer than storage in reactor pools will be reversed. It is therefore difficult to see why a decision on hardened dry storage should be deferred to the conclusion of that or any other study.

The Draft Report has also stated that an ongoing NRC rulemaking "to increase resistance to terrorist attacks," which includes consideration of hardened storage, "is the appropriate venue for considering and assessing the technical merits of the HOSS [Hardened On-Site Storage] concept." (p. 53). The NRC process is the appropriate venue for decisions about storage, but the BRC has an explicit mandate to consider all aspects of spent fuel pool management and safety without any exclusions for ongoing regulatory processes:

> Specifically, the Commission will provide advice, evaluate alternatives, and make recommendations for a new plan to address these issues, including:
>
> a) …

b) Options for safe storage of used nuclear fuel while final disposition pathways are selected and deployed.[18]

In view of the fact that Fukushima only highlights the dangers of storage in spent fuel pools, with dense storage being more risky and in light of its charter ("…will provide advice, evaluate alternatives, and make recommendations…") the BRC should have provided its own view of dry storage, including hardened storage as well as its own recommendations, rather than punting to the NAS and other studies, or deferring to an NRC rulemaking process. After all, the Draft Report made comments on waste classification (for example, in Section 9.5), even though it is part of ongoing rulemaking and regulatory processes at the NRC.

The Yakama Nation has a very specific interest in hardened dry storage since there is a Mark II Boiling Water Reactor on the Hanford Site property, where the Yakama Nation has treaty rights. Moreover, the reactor is situated in a zone where very severe offshore earthquakes could cause significant damage. Contamination of this land and of the river in the event of a severe spent fuel accident would be devastating to the community which is rooted in the land and the river. Of course, there are 22 other Mark I reactors, as well as 81 other operating reactors with spent fuel pools typically far more loaded than at Fukushima. In light of these facts, we strongly urge the BRC to recommend Hardened On-Site Storage of spent fuel for all spent fuel that has aged more than five years and low-density pool storage for the rest.

The Draft Report has tried to separate the question of onsite versus consolidated offsite storage by opining that "the question of whether steps should be taken to reduce the amount of spent fuel currently stored in reactor pools is distinct from the question of where and how the spent fuel should be stored if that were done." (p. 53). We do not see these issues as distinct, if by that the BRC means independent.

The Draft Report recommends that "one or more consolidated interim storage facilities" – that is, off-site facilities – be established "as expeditiously as possible"(p. xv), and that "the U.S. government proceed to develop consolidated interim storage capacity without further delay." (p. 44) At the same time the Draft Report discusses the past failure to successfully build and open such a storage facility, despite a variety of efforts, including a "consent-based" process, that were tried. The one successful example of siting of a facility that has actually opened has been WIPP. This was a complex and difficult process that took a quarter of a century; the Draft Report timeline extends from "exploratory work" at the site in 1974 to 1999, when the first waste shipment was received at WIPP.(p. 21)

Further, the Draft Report also notes that "[t]rust and confidence in the federal government's basic commitment and competence to deliver on its waste management obligations have all but completely eroded since 1987."(p. 44) The inference therefore, or at least the safe assumption, must be that it would take about as long to site a consolidated storage location before it would actually receive waste. We are not unmindful of some of the advantages of consolidated storage, such as the reduction in federal penalties arising from federal default on contracts with utilities. However, the desirability of a consolidated storage facility is unlikely to shorten a consent-based process. The only "solution" that has the possibility of being quick is a poor one that would undermine everything else the report is trying to accomplish for spent fuel storage and disposal: consolidated storage at a DOE site. This would put the

[18] Blue Ribbon Commission Charter

DOE in the center of waste management for decades. It would involve the DOE in siting. It would pit one of the institutions that has had a big role in the loss of trust and confidence, the DOE, at the center of early and critical waste management decisions. And it would pit the new federal corporation that the BRC recommends establishing in competition with the DOE for the same pot of money – the Nuclear Waste Fund.

In the meantime, spent fuel pools at reactors will be filled to capacity even as dry storage on site expands. For the Yakama Nation, the prospect of a consolidated spent fuel storage facility at Hanford would result in the worst of all worlds. Specifically, the spent fuel imported from other locations would be in addition to the existing liquid high-level waste problem whose path forward is confronted with serious technical difficulties, a clean-up process in which DOE proposes to leave the site and its groundwater resources highly contaminated essentially forever, and a reactor with a spent fuel pool chock full of spent fuel in a seismic zone.

The BRC should examine carefully the risk that its present recommendation for speed would result in a consolidated storage facility being established at a DOE site. Such a result would undermine the essence of the BRC project to establish a new consent-based and science-based process and a new institution for siting and putting into operation at least one deep geologic repository. It would put the DOE in the middle of the spent fuel management business for the foreseeable future and further undermine an already low-level of trust. If the BRC continues to recommend a consolidated storage site, it should be subject to the following caveats:

- DOE sites should be categorically ruled out.
- DOE should have absolutely no role in the siting process.

In any case, the BRC should recommend that aged spent fuel be stored in dry Hardened On-Site Storage facilities at reactor sites. This would make the security of reactor communities independent of the success of the consolidated siting effort. It would also give the new federal institution some time to pick up the pieces of a shattered spent fuel management program and make something coherent of it the second time around.

F. Reprocessing Spent Fuel

We appreciate that the BRC has put its main goal as the development of a deep geologic repository for commercial spent fuel and/or high-level waste. We agree with the Draft Report that no present or foreseeable reprocessing technology will obviate the need for a geologic repository. But we find the BRC's conclusions about reprocessing spent fuel from light water reactors far too limited. Specifically, the BRC recommended the following:

> *As a group we concluded that it is premature at this point for the United States to commit irreversibly to any particular fuel cycle as a matter of government policy. Rather, in the face of an uncertain future, there is a benefit to preserving and developing options so that the nuclear waste management program and the larger nuclear energy system can adapt effectively to changing conditions.* [p. 114]

The issue of the most suitable fuel cycle for the United States to adopt in the future, if any, can be and should be disconnected from whether spent fuel from light water reactors is reprocessed. There is no economic or technical case for reprocessing light water reactor spent fuel. This was explained in detail to the BRC during its May 25, 2010, meeting.[19] This is independent of whether one foresees a big, medium, low, or no future for nuclear energy in the United States beyond the existing set of commercial reactors and also independent of the specific fuel cycle adopted.

The Draft Report itself notes that reprocessing, in order to make use of mixed uranium-plutonium dioxide fuel ("MOX fuel") in light water reactors, increases the cost of nuclear electricity "by a few to several percent" compared to once-through fuel use.(p. 117) However, the Draft Report should also have noted that the cost of the fuel component is greatly increased. With or without MOX fuel use, a light water reactor fuel cycle cannot use more than one percent of the underlying uranium resource.[20] Only breeder reactors with efficient breeding systems can do that as is clear from the Draft Report's comparison of nuclear fuel cycles.(Table 3, pp. 117-119)

The breeding material most suitable for breeder reactors is depleted uranium, of which an ample supply is available at essentially zero raw material cost, though fabrication costs would of course be incurred. The uranium recovered from light water reactor spent fuel is a poorer material for a breeding blanket in terms of isotopic composition compared to DU, besides being far more expensive. With over half a million tons of depleted uranium, a breeder reactor system would provide about the same number of reactor years of operation, assuming a 1,000 MW reactor. Looked at another way the available DU could supply the present level of U.S. electricity generation for about 1,000 years if used in breeder reactors. And the amount of DU is, of course, increasing.

A complete analysis of the value of reprocessing light water reactor spent fuel necessarily leads to the conclusion there is no technical or economic case for keeping open the option of reprocessing spent fuel from U.S. light water reactors. We recommend that the BRC Final Report make an explicit comparison of the use of depleted uranium as a breeder material compared to uranium recovered from spent fuel. We also recommend that the Final Report make clear that the technical, economic, and non-proliferation case for direct disposal of spent fuel from U.S. light water reactors is very strong and that this should remain the U.S. policy independent of future U.S. nuclear energy policy.

[19] Makhijani 2010. The Draft Report makes no comment on or reference to this presentation, which contains significant technical details on reprocessing light water reactor spent fuel.
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Confederated Tribes and Bands
of the Yakama Nation

Established by the
Treaty of June 9, 1855

June 21, 2011

Arnold Edelman, EIS Document Manager
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Washington, DC 20585

Dear Mr. Edelman,

This letter summarizes the Yakama Nation's comments and concerns regarding the proposed action alternatives presented in the Draft Environmental Impact Statement for the Disposal of Greater-Than-Class C (GTCC) Low-Level Radioactive Waste and GTCC-Like Waste (DOE/EIS-0375-D). Our review of the Draft GTCC EIS has found that it is deficient in a number of areas, and will require substantial revisions. Key elements must be thoroughly redone in order for the revised Draft GTCC EIS to be considered technically and legally adequate. We have provided a detailed evaluation of the elements in the attachments that accompany this letter.

The Yakama Nation's vision for the cleanup and closure of the Hanford Site is based on several important principles:

- Recognition of the Yakama Treaty of 1855 as an applicable federal requirement.
- Compliance with Yakama Nation treaty rights, including full access to cultural and natural resources within the ceded land and aboriginal territory, including on the Hanford Site.
- Protection of Yakama Nation tribal members' health and the environment by reducing contamination to levels that are safe under any exposure scenario and for all tribal uses.
- Implementation of permanent cleanup actions that do not rely on the use of long-term institutional controls, stewardship, or surface barriers to prevent exposure to dangerous radionuclides, hazardous chemicals, or other substances.

The key issues or deficiencies in the Draft GTCC EIS include, but are not limited to, the following:

- The Hanford Site is not an appropriate location for the disposal of any additional off-site nuclear waste of any classification for a number of reasons, including the site's proximity to the Columbia River and the high hydraulic conductivity of Hanford soils, the presence of extensive contamination throughout site soils and groundwater, and the direct conflict with ongoing site cleanup activities that have cost tens of billions of dollars over the past 20 years.

- The cumulative impacts analysis for the Hanford Site fails to account for the extensive, and in many cases severe contamination already in place. The levels of contamination observed means that addition of any new waste will push already unacceptable exceedances of applicable or relevant and appropriate requirements even higher.

- Greater-Than-Class-C waste poses a serious threat to human health and the environment, and should be disposed of in accordance with the requirements set by the Nuclear Regulatory Commission in 10 CFR 61, in a deep geologic repository. While the WIPP facility is considered, the Draft GTCC does not consider a new deep geologic repository for disposal of the identified source term. This alternative should be included and evaluated.

- The proposed action alternatives incorporate a large number of unrealistic and unreasonable assumptions in order to meet performance requirements. Evaluation of many of these assumptions demonstrates that the alternatives would not be able to meet even the most basic performance criteria for disposal of the wastes.

- The proposed action alternatives presented in the Draft GTCC EIS rely heavily on the use of institutional controls to reduce exposure to disposed waste. Such designs do not respect Treaty Rights or federal trust responsibilities, and are not realistic over the timeframes required for GTCC waste to decay to safe levels.

- The supporting analysis for the proposed action alternatives is deficient. In particular the sensitivity analysis fails to evaluate any parameters under circumstances worse than the USDOE's base case, which is itself unrealistic.

The Yakama Nation does not support inclusion of the Hanford Site as a candidate location for the construction of a new GTCC waste disposal facility. A preliminary analysis should have resulted in this site's disqualification from further consideration. Furthermore, the Yakama Nation does not support the importation of new, highly radioactive, and long-lived waste to the site for shallow disposal.

The selection of any alternative that includes the importation of additional waste to the Hanford Site would result in substantial violations of federal environmental standards (including drinking water standards) over a broad geographic area for a period of thousands of years, and would increase already severe threats to the Columbia River, a resource of cultural, regional, and national importance.

The presence of high levels of contamination has already resulted in Yakama tribal members being unable to fully exercise their Treaty-reserved rights at the Hanford Site. Implementation of the proposed action alternatives would constitute further violation of these rights. In the event that Hanford remains a location under consideration, the Yakama Nation has provided extensive comments regarding necessary revisions to the proposed action alternatives; however, these comments should not be construed in any way as an acceptance of the proposal to develop, operate, and manage a new disposal facility at the Hanford Site.

We request that you revise the Draft GTCC EIS to correct the deficiencies that have been identified and described in this letter and the accompanying comments. We also request that a revised Draft GTCC EIS that identifies a preferred alternative be circulated for public review and comment.

Sincerely,

/ Athena Sanchez

Harry Smiskin, Chairman, Yakama Tribal Council

cc/enc: Moses Squeochs, General Council Chairman
Donald Isadore, Jr., Yakama Tribal Council
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Attachment 1

Yakama Nation ERWM Program General Comments on the *Draft Environmental Impact Statement for the Disposal of Greater-Than-Class C (GTCC) Low-Level Radioactive Waste and GTCC-Like Waste* (DOE/EIS-0375-D)

This Attachment 1 presents the Yakama Nation Environmental Restoration and Waste Management (ERWM) Program's general comments on the U.S. Department of Energy's (USDOE) Draft Environmental Impact Statement for the Disposal of Greater-Than-Class C (GTCC) Low-Level Radioactive Waste and GTCC-Like Waste (referred to here as the Draft GTCC EIS). The general comments presented here summarize the major issues and concerns identified by ERWM on behalf of the Yakama Nation. Attachment 2 presents targeted comments keyed to specific sections or pages of the Draft GTCC EIS. Attachment 3 provides additional detailed comments prepared by the Institute for Energy and Environmental Research (IEER).

ERWM finds that all of the proposed action alternatives are deficient in numerous ways. Primarily, the proposed action alternatives do not comply with environmental regulations or important criteria such as the federal drinking water standards. Furthermore, the proposed action alternatives will result in unacceptable environmental consequences. It is our position that the Draft GTCC EIS must be thoroughly reanalyzed and reevaluated. A revised EIS that addresses the issues and deficiencies identified by the Yakama Nation in its letter, to which this document is an attachment, should be released for public review. The key issues and deficiencies are expanded upon below.

Comment 1. Hanford should not be considered for construction of a GTCC waste disposal facility.

Comment 1a. The Hanford Site is not appropriate for the disposal of additional nuclear waste.

The Hanford Site was evaluated in 1942 as a location on which to build a massive wartime industrial production facility. The features that were found attractive at that time included access to abundant clean water in the Columbia River; loose gravelly and sandy soils covering much of the site; the presence of large quantities of electrical power; access to railroads; significant tracts of land that remained undeveloped; and the relative ease with which the land could be condemned, its residents evicted, and the property withdrawn from the public domain (Gerber, 2002).

With the exception of the relatively large expanse of land that remains empty under federal control, *none* of the characteristics described above is considered desirable for the purposes of disposing of long-lived, dangerous radioactive waste. Many of these characteristics, such as proximity to the Columbia River and the high hydraulic conductivity of Hanford soils (i.e., loose gravelly and sandy) are *undesirable* when disposing of nuclear waste.

In the 1980s, during the federal government's search for a location to construct a high-level waste repository, the Hanford Site was found to have several questionable site features, including high geothermal gradients, rapid groundwater flow rates, unusually high shear stresses in bedrock basalt, and local seismicity that made the site unsuitable for repository construction (White,1983). Regardless of these characteristics, the status of the Hanford Site as a solely federally held, pre-existing facility that was already substantially contaminated with nuclear waste proved attractive enough that it was included on the short list for consideration as the site of a high-level waste repository.

Based on the analyses and supporting documentation provided by the Draft GTCC EIS, it appears that the Hanford Site's inclusion as an area under consideration for construction of a GTCC low-level radioactive waste (LLRW) disposal facility is not based on advantageous site characteristics or on sound technical analysis, but rather on political expediency and present site status that includes high levels of pre-existing contamination. While the urgencies associated with World War II and the relative lack of knowledge regarding the dangers, toxicity, environmental behavior, and lasting legacy of nuclear waste may not have provided sufficient reason to reconsider construction of the Hanford Site in 1942, we can apply significantly more information and collective knowledge today when evaluating the site as a location for future disposal of highly radioactive and long-lived nuclear waste.

The past activities at the Hanford Site have resulted in extensive contamination throughout site soils and groundwater, making the addition of new waste to the site unacceptable from both a moral and regulatory perspective. Furthermore, the importation of new waste to Hanford is directly contrary to the goals and actions of site cleanup activities that have cost tens of billions of dollars over the past 20 years. Finally, the importation of new waste to the Hanford Site is not compatible with Yakama Nation treaty rights.

> ***Recommendation 1a. The Hanford Site should be removed from consideration in the revised Draft GTCC EIS. The Hanford Site should not be considered further as an appropriate location for the disposal of additional off-site nuclear waste[1].***

Comment 1b. The Hanford Site is geologically unsuitable for GTCC waste disposal.

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[1] Comments that propose revisions to Hanford Site-related content in the Draft GTCC EIS have been included in the event that Hanford remains under consideration, against ERWM's recommendation. Inclusion of revision comments regarding the Hanford Site should not be construed in any way to imply, implicitly or otherwise, that the Hanford Site is an acceptable location for disposal of nuclear waste.

Nuclear Regulatory Commission (NRC) licensing requirements for land disposal facilities (10 CFR 61) require that for a site to be considered suitable for near-surface disposal, it must be devoid of tectonic processes such as faulting, folding, seismic activity, or volcanism. The Hanford Site is located within the seismically active Pasco Basin within the larger Yakima Fold Belt, where tectonic compression continues to the present day (Reidel et al., 1993; Bakun et al., 2002).

Earthquakes in the Hanford region have been calculated to have magnitudes as large as 6.8 (intensity magnitude, M_I; the moment magnitude, M_W, was 6.5 to 7.0 at 95 percent confidence) (Bakun et al., 2002). The potential for earthquakes with magnitudes greater than 7.1 has been identified through local paleoseismic studies (West et al., 1996). In 1872, shaking from a magnitude 6.8 earthquake resulted in ~~"d~~damage intensities [of Modified Mercalli Intensity VI[2]] that extended west throughout the now densely populated Puget Sound basin and southeast to beyond the Hanford Nuclear Reactor Site" (Stover and Coffman, 1993). The event triggered many landslides within the Columbia River Gorge and resulted in other subsidence in the area.

Hanford was regularly swept by massive glacial outburst flooding from Glacial Lake Missoula in the recent geologic past. These floods deposited the glaciofluvial sedimentary units that currently mantle the site bedrock (Fecht and Marceau, 2006), which the proposed action alternatives would use for permanent disposal.

Further, the Grand Coulee Dam (constructed 1933–1942) is approximately 200 miles upstream of the Hanford Site on the Columbia River. While the Draft GTCC EIS briefly considers the extent of a probable maximum flood in the Columbia River and potential 25 percent and 50 percent failure of Grand Coulee Dam, no analysis was made of the effects of a 100 percent dam failure or glacial outburst flooding of the site.

Such events should be considered in the site selection process given the timescale over which GTCC and GTCC-like waste will remain dangerous. Large erosive events such as those that could result from glacial outburst flooding or wholesale failure of dams on the Columbia River could remove a significant portion of the overburden used to isolate the disposed waste. Volcanic damming of the Columbia River or the upstream pooling of water that occurs during glacial outburst flooding could result in complete submersion of the disposal facility[3]. The USDOE presumes that the rate of waste migration is directly proportional to the infiltration rates,

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[2] ~~"…~~.[T]he Modified Mercalli Intensity Scale…[is] composed of 12 increasing levels of intensity that range from imperceptible shaking to catastrophic destruction…The lower numbers of the intensity scale generally deal with the manner in which the earthquake is felt by people. The higher numbers of the scale are based on observed structural damage…[An abbreviated description of Level VI intensity is:] Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight" (USGS 2011b).

[3] Pooling of water at elevations that exceed those observed at the Central Plateau has been recorded in the geologic record through deposition of the Touchet Beds, which were described by Newcomb et al. (1972).

which means that such an event could result in large-scale mobilization of wastes over a very short period, invalidating many of the assumptions used to control the dose to exposed individuals outside the disposal facility.

Recommendation 1b. The revised Draft GTCC EIS should acknowledge and address the risks described in this Attachment 1 and the relevant references. Any further analysis performed for the Hanford Site should evaluate scenarios in detail that include:

- ***100 percent failure of Grand Coulee Dam and lower Columbia River dams***
- ***Volcanic damming of the Columbia River and flooding of the Hanford Site***
- ***Glacial outburst flooding at the Hanford Site***

Comment 2. GTCC waste should be disposed of in a deep geologic repository.

In accordance with NRC regulation 10 CFR 61, GTCC waste must be disposed of in a deep geologic repository unless alternative methods of disposal are proposed to and approved by the NRC. This regulation was enacted in due deference to the danger posed by the high activity, long half-lives, and high biologic quality factors of the wastes that fall into the GTCC classification. The proposed action alternatives included in the Draft GTCC EIS do not adequately isolate and contain the wastes, protect the public, or limit public exposure sufficiently to meet the requirements in 10 CFR 61.

The proposed action alternatives are clearly deficient when evaluated in the context of the highly variable and frequently suboptimal conditions imposed by the real world, as opposed to the static and favorable conditions used in the Draft GTCC EIS to evaluate the alternatives' performance. Attachment 3 provides an alternative analysis of the proposed action alternatives. The alternative analysis demonstrates using *the same information provided in the Draft GTCC EIS* that the proposed action alternatives fail to meet regulatory compliance using the unaltered RESRAD-OFFSITE modeling software. Although appropriate documentation was not provided in the Draft GTCC EIS, it appears that the USDOE chose to modify the existing, accepted software in order to achieve an acceptable level of performance from the proposed action alternatives. This approach is not acceptable and must not be used in the revised Draft GTCC EIS or for the purposes of comparing the proposed action alternatives.

The USDOE has justified its failure to include an alternative for a new deep geologic repository on the premise that the total waste volume does not justify construction of a new facility. While this claim could be acceptable when considered in a vacuum, significant evidence suggests that a new deep geologic repository is required for the nation's nuclear waste and that constructing one should therefore be seriously considered. This evidence includes the Blue Ribbon Commission on America's Nuclear Future's consideration of a deep geologic repository for defense-related high-level waste, as well as the presence of many other orphan wastes that are not addressed in the Draft GTCC EIS, such as the large amounts of depleted or recycled uranium that are also unsuitable for shallow land disposal (see Attachment 3 for additional discussion of orphan source terms).

Finally, the justification applied by the USDOE in rejecting consideration of a new deep geologic repository ignores that such a facility, if built to appropriate standards, could be used for disposal of other highly radioactive and long-lived wastes. This is the same logic that is applied to *justify* the inclusion of the Waste Isolation Pilot Project (WIPP) facility for disposal of GTCC waste.

> ***Recommendation 2. The revised Draft GTCC EIS should include an alternative for construction of a new deep geologic repository of appropriate size and specifications to meet all NRC 10 CFR 61 requirements for the identified source term, as well as other orphan wastes that have not yet been addressed. The new deep geologic repository alternative should be identified as the preferred alternative.***

Comment 3. Transuranic waste should be disposed of in accordance with regulatory requirements regardless of origin.

Waste inventory information provided in Appendix B of the Draft GTCC EIS identifies 402,000 curies of radioactivity that are attributable to transuranic (TRU) radionuclides. The estimated total volume of all the waste destined for disposal is approximately 12,000 cubic meters. Assuming that the entire waste volume has the density of solid rock[4], there is still enough TRU-derived activity to contaminate every cubic meter of waste proposed in the Draft GTCC EIS to more than 100 times the level specified in the Environmental Radiation Protection Standards (40 CFR 191). The Draft GTCC EIS identifies ~~-a~~bout 56 percent of the entire waste inventory…[as meeting] the USDOE definition of TRU waste" (p. 3-18). This suggests that the aforementioned waste contains *at least* 100 times the transuranic radionuclide activity required for deep geologic disposal.

The origin of the TRU radionuclides addressed by the Draft GTCC EIS should be irrelevant when considering disposal alternatives, especially given that the USDOE has now assumed responsibility for the waste's disposal. The long half-lives and high biologic quality factor associated with transuranic waste justify the stringent disposal requirements described in 40 CFR 191. It is not acceptable to use the Draft GTCC EIS as an opportunity to improperly dispose of these dangerous wastes.

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[4] Density of rock is approximately 2,800 kg/m^3. While the assumption that the entire inventory has the density of solid rock is not realistic, any correction for a more appropriate *lower* unit weight will only increase the concentration of transuranics per gram.

The Draft GTCC EIS indicates that 56 percent of the entire waste inventory is derived from cleanup operations at the West Valley Site, New York, and that much of this waste meets the USDOE definition of TRU waste. Importation of waste from the West Valley Site is directly contrary to the goals and objectives of more than 20 years of cleanup work performed at the Hanford Site. The intent of the West Valley Demonstration Project Act (P.L. 96-368), which charged the USDOE with responsibility for cleaning up the West Valley Site, was not that the USDOE would simply move dangerously contaminated waste to an alternative federally held site with a larger pre-existing inventory of waste. The existing level of contamination at the Hanford Site does not provide justification for importation of additional waste; on the contrary, it should be treated as a strong deterrent.

> ***Recommendation 3. The revised Draft GTCC EIS should not consider waste that meets the definition of transuranic waste and transuranic-like waste for inclusion in any of the Draft GTCC EIS action alternatives or other alternatives that utilize shallow land burial. These wastes should be disposed of in a deep geologic repository.***
>
> ***The revised Draft GTCC EIS should include an alternative for construction of a new deep geologic repository that meets the disposal requirements for transuranic waste, including transuranic waste from the West Valley Site.***

Comment 4. The evaluation of cumulative impacts at Hanford is deficient.

The cumulative impacts analysis in the Draft GTCC EIS does not take into consideration the total inventory of pre-existing radioactive waste at the Hanford Site. The Draft GTCC EIS must consider all waste that is excluded or not discussed in the Tank Closure and Waste Management (TCWM) EIS (USDOE, 2009). Existing contamination at the site is the result of extensive waste disposal activities during plutonium production that included liquid waste discharges into open bottom cribs and trenches; leakage from waste tanks in the Central Plateau; operation of the US Ecology Low-Level Radioactive Waste Dump; and cleanup activities performed at the site. Importation of additional waste to the Hanford Site contravenes the efforts that have been pursued by the USDOE, the Washington State Department of Ecology, and the U.S. Environmental Protection Agency (USEPA) for the past 20 years to stabilize and remove radioactive contamination at the Hanford Site at a cost of tens of billions of dollars.

The high concentrations of technetium-99 (Tc-99) and iodine-129 (I-129) expected to be in Hanford groundwater (350,000 and 697 picocuries per liter [pCi/L], respectively) as a result of waste disposal activities identified in the TCWM EIS for Alternative Combination 1 will significantly exceed compliance with USEPA groundwater maximum contaminant levels (MCLs). In the case of beta-emitting radionuclides, exceedances of the drinking water MCL range in magnitude from 700 times (in the case of I-129 alone) to more than 1,000 times (I-129 and Tc-99 together) the allowable limit.

While the USDOE has found it prudent in the Draft GTCC EIS to suggest not adding waste that includes significant Tc-99 or I-129, such a measure would require the construction of multiple disposal facilities and ignores the reality that many other radionuclides are already present in the Hanford subsurface and groundwater including, but not limited to, strontium-90, cesium-137, and tritium. The addition of any beta-emitting radionuclide, or radionuclides with intermediate or long-lived beta-emitting daughter products, would ultimately result in even greater exceedances of applicable regulations, since all beta-emitters contribute toward a common MCL.

High levels of contamination are not confined only to beta-emitting radionuclides. As was the case with I-129 and Tc-99, the TCWM EIS estimates that uranium groundwater contamination will greatly exceed the applicable MCL of 30 pCi/L, even before the addition of the new wastes identified in the Draft GTCC EIS. However, the Draft GTCC EIS fails to acknowledge that such an exceedance would already exist and does not suggest limiting the amount of uranium brought to the Hanford Site.

Finally, the Draft GTCC EIS fails to acknowledge and evaluate the significant concentrations of transuranic radionuclides already disposed of in the US Ecology site, the high concentrations of plutonium that are expected to reach the river corridor, and the large amounts of transuranics buried or discharged on the Hanford Site prior to 1970 (see Attachment 3 for additional detail). The Draft GTCC EIS *does*, however, propose to import more of all of these substances to the Hanford Site under the proposed action alternatives.

> ***Recommendation 4. The cumulative impacts analyses provided in the Draft GTCC EIS are so deficient that they should be discarded and redone in their entirety for the revised Draft GTCC EIS to take into full account the existing contamination as well as contamination that will result from future cleanup and disposal activities.***

Comment 5. The Draft GTCC EIS analysis of proposed action alternatives is deficient.

Comment 5a. Analysis of proposed action alternatives incorporates numerous unrealistic assumptions in order to "meet" performance requirements.

The Draft GTCC EIS analysis of the performance of the proposed action alternatives incorporates multiple simplifying assumptions, some stated explicitly and others implied. Many of these assumptions are not well justified and are generally unrealistic. Selected assumptions made in the Draft GTCC EIS are outlined below to provide some context for additional comments that follow. Flawed assumptions used in analysis of the proposed action alternatives include the following:

- Surface barriers will function flawlessly, preventing all infiltration into the waste interval for a minimum of 500 years.

- Surface barriers will not become degraded as a result of environmental weathering or human or biological activity for a minimum of 500 years.
- Eroded or otherwise degraded barriers will maintain a minimum of 80 percent effectiveness at preventing infiltration into buried waste.
- Stabilizing grout or other forms of waste ~~i~~improvement" will experience no degradation for a minimum of 500 years.
- Erosion rates at the site and of the engineered barriers will not exceed 0.01 millimeters per year for more than 10,000 years[5].
- Infiltration rates at the disposal site will not change at all over the next 10,000 or 100,000 years, and there will be no overland flow or irrigation at the site[6].
- Resident farmers or other occupants will never occupy, or otherwise disturb, land directly over the waste site, even with complete loss of institutional controls and memory.
- All three near-surface disposal alternatives are of equal integrity despite differences in disposal depth, construction materials, waste concentration, and barrier use.
- Groundwater elevations will not change appreciably within the next 10,000 or 100,000 years.
- Waste will be leached only by precipitation that infiltrates straight down from within the disposal facility boundary. At no time during the next 100,000 years will the buried waste encounter lateral groundwater flow.
- Infiltration of precipitation surrounding the disposal facility is *completely uncontaminated*, and therefore dilutes any contaminated water that emanates from the facility.
- At no time in the next 100,000 years will a surface water exposure pathway develop within the disposal facility.

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[5] This erosion rate is extremely low by geologic standards and rarely seen outside of very low-denudation environments acting on very strong or resilient rocks (Bierman and Turner, 1994; Brook et al., 1995), neither of which apply to surface barriers at Hanford.

[6] The assumed infiltration rate for the Hanford Site is 1 millimeter per year; this value is *lower* than the infiltration rate observed on the site at present. The Draft GTCC EIS acknowledges that a change of ±10 percent in precipitation is possible at the candidate sites. However, no discussion is included that describes the corresponding change in infiltration rate. Infiltration may increase significantly with a modest change in precipitation as a result of cooler temperatures (Musgrove and Schrag, 2006). Other complications that were not considered include precipitation falling as snow, which also increases infiltration relative to total precipitation, and deep root penetration into surface barriers, which would also enhance surface infiltration.

Many of these assumptions are demonstrably false, such as the assumed erosion rate, restriction of infiltration to vertical flow, and cleanliness of the site soils. Other assumptions such as the presumption of barrier and grout performance generally contradict both published research and in some cases common sense (such as in the case of institutional controls). This is discussed in greater detail below.

> ***Recommendation 5a. Analysis performed to support action alternatives in the revised Draft GTCC EIS must use realistic assumptions that accurately reflect environmental variables and human behavior.***

Comment 5b. Assumptions of barrier integrity and performance are unrealistic and poorly justified.

All of the proposed action alternatives presented in the Draft GTCC EIS rely on surface barriers in order to meet basic performance criteria in the first 10,000 years following facility closure. This is in part a reflection of the USDOE's assumption that the release of radionuclides from disposed GTCC and GTCC-like waste is directly proportional to the infiltration rate of water through the waste (p. 6-91; Appendix E).

The Draft GTCC EIS characterizes the assumptions of barrier and waste stabilization performance as -conservative because the engineered systems (including the disposal facility cover) [will] last longer than 500 years even in the absence of active maintenance measures" (Appendix E). No substantive documentation is offered to support this assertion. However, such assumptions are not conservative and are not consistent with published research.

Degradation of surface barriers that can reasonably be expected to occur and that could lead to decreased performance include damage from desiccation, freezing, and thawing; differential settlement; deep root penetration by trees or other vegetation; and burrowing by terrestrial mammals, insects, or birds. Research by Smith et al. (1997) found that even without direct human intrusion or vandalism, natural biologic activity may significantly compromise barrier integrity through animal burrowing activity and root intrusion. As part of their conclusions, Smith et al. suggested that monitoring and maintenance of capped, inactive, hazardous waste burial sites should be continued *indefinitely* and not end after the period mandated by regulatory requirements.

In fact, long-term performance problems associated with surface barriers are hardly unusual. In a case study performed in Wenatchee, Washington, Benson and Khire (1997) found that after just two years of observation, cumulative percolation into a test clay barrier had increased from 1 to 3 centimeters as a result of extensive cracking associated with desiccation[7].

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[7] Wenatchee is approximately 70 miles north-northwest of the Hanford Central Plateau and shares climate characteristics as well as orographic patterns with the Hanford Site.

The National Research Council's *Assessment of the Performance of Engineered Waste Containment Barriers* provided an example in which 22 of 77 test pads in active landfills did not achieve their goal hydraulic conductivity when tested (National Research Council, 2007). The report went on to reiterate that clay barriers are generally acknowledged to be susceptible to *significant increases* in conductivity as a result of desiccation cracking, differential settlement, lateral spreading, freezing, thawing, and root penetration.

The National Research Council published a report titled *Long-Term Institutional Management of U.S. Department of Energy Legacy Waste Sites* (2000) that addressed the USDOE's use of barriers as a tool for isolating and containing waste. This report drew a number of conclusions, including the following:

- "Physical barrier systems [that] keep hazardous wastes in isolation will require their own *ongoing* support from [an] institutional management system." (emphasis added)
- "Without constant attention, stewardship measures imposed today are not likely to remain effective for as long as residual contamination presents risks."
- "Given that decisions that affect sites' futures are often made under conditions of considerable uncertainty, the best decision strategy overall...takes seriously the prospects that failures of engineered barriers, institutional controls and other stewardship measures in the future could have ramifications that a good steward would want to avoid."

The USDOE's assumptions in the Draft GTCC EIS are all but mutually exclusive with the conclusions presented above. Analysis offered in the Draft GTCC EIS assumes only the most optimal barrier performance in conjunction with extensive cooperation from the surrounding environment and future human populace. This is not a conservative approach and should not be represented as such. Analysis by the IEER determined that the performance of barriers did not significantly affect the overall performance of proposed action alternatives at the Hanford Site (see Attachment 3). However, this does not excuse reliance on barrier performance, particularly at other sites or at a future Hanford Site with a significantly different climate.

> ***Recommendation 5b. The revised Draft GTCC EIS should present action alternatives that do not rely on surface barriers to maintain their long-term integrity. The revised action alternatives should be capable of meeting performance requirements without depending heavily on assumed climate, environmental conditions, and human behavior.***

Comment 5c. Use of institutional controls in action alternatives is unclear, inconsistent, and unrealistic.

The Draft GTCC EIS states that protection against inadvertent human intrusion will be accomplished in part by “design features [including] institutional controls” (p. 5-95) that would be maintained “as long as necessary to perform their intended protective purposes” (p. 5-96). However, in the same section, the USDOE implies that active institutional controls would be discontinued 100 years after site closure despite the fact that “it would take several millennia for many of the long-lived radionuclides to decay to low levels.” These statements are not internally consistent. It is not possible to maintain institutional controls as long as is necessary, while simultaneously *not* maintaining the same controls as long as is necessary on the basis that the prescribed time period is simply too long. If active institutional controls cannot be maintained for the time period required to ensure that the disposal site is safe for unrestricted access, *then the disposal method used should not rely on institutional controls.*

The Draft GTCC EIS’s inconsistent application of and presumed effectiveness of institutional controls recur repeatedly throughout the document, including in the following statement made to justify the parameters used to calculate exposure:

> ...the long-term human health impacts are addressed by considering the future radiation dose and LCF risk to a hypothetical individual who resides 100 m (330 ft) from the edge of the disposal facility and develops a farm. This resident farmer scenario is assumed to be conservative (i.e., one that overestimates the expected dose and LCF risk) because it assumes a total loss of institutional control and institutional memory with regard to the disposal facility.

The Draft GTCC EIS does not elaborate on how exposed individuals over multiple generations are capable of avoiding—consistently, without fail, and by a margin of *at least 100 meters*—the disposal facility of which they have no knowledge or memory. This statement is not internally consistent and appears to simultaneously concede that any institutional control will ultimately fail, while also remaining effective. This rationale is illogical and unacceptable.

The Yakama Nation ERWM Program has previously commented on the USDOE’s reliance on institutional controls (Yakama Nation ERWM Program, 2010). Those comments noted that institutional controls could not be assumed to remain effective over long periods of time and that they also conflict with Yakama Nation treaty rights.

No government in history has existed for as long as 10,000 years, let alone 100,000. It is unreasonable to assume that measures such as federal ownership of the disposal site and land designations will provide any form of protection against future intrusion. Other similarly passive controls such as unmaintained “fences, signs and other markers” are not expected to provide better protection over such an extended time period.

Recommendation 5c. The revised Draft GTCC EIS should provide alternatives that do not rely on institutional controls to limit doses and achieve an acceptable level of performance within the 10,000-year period required. Any alternative proposed for the Hanford Site must respect Yakama Nation treaty rights and be compatible with clean closure requirements on the site.

Discussion of institutional controls in the revised Draft GTCC EIS must be internally consistent and include the following:

- ***Specific, detailed information on the length of active maintenance.***
- ***Detailed information for long-term monitoring and maintenance or the lack thereof.***
- ***Clearly stated, consistent, and realistic assumptions of the long-term efficacy of the passive institutional controls.***
- ***Plans, or lack thereof, for ensuring the stability of long-term institutional controls through multiple successive governments, so that the site remains isolated for the requisite 10,000 years.***

Comment 5d. Direct intrusion into the disposal facility and facility barriers should be evaluated in detail.

The Draft GTCC EIS acknowledges that "the NRC [has] already determined that for waste classified as GTCC, conventional near-surface land disposal is generally not protective of an inadvertent intruder." The USDOE found this to be sufficient justification for not considering the scenario in any quantitative form for the proposed action alternatives.

However, an intruder in the disposal facility poses serious problems to much of the analysis provided in the Draft GTCC EIS. Intrusion into the disposal facility clearly could result in significant dismantling of the many carefully laid assumptions that have already been identified. Direct physical intrusion into the facility may result in:

- Significantly reduced distances at which exposure to waste and contaminated groundwater occur (which was specifically not evaluated in the Draft GTCC EIS).
- Surface irrigation that dramatically increases infiltration into waste disposal intervals.
- Waste or contaminated backfill that is brought to the surface, allowing for direct ingestion and other exposure pathways.
- Deconstruction of cover by resident farmers to access the clay or other earthen materials for use in lining irrigation ditches or other building purposes.
- Residences that require dug-out foundations or basements being built directly on top of the barrier.

- Regrading or large-scale earthwork associated with redevelopment, conversion to farmland, or other changes in land use that significantly reduce the overburden above the waste interval.
- Intentional intrusion to remove waste under the misconception that it is valuable.

Exposure to an inadvertent or intentional intruder could be significantly higher than any of the estimates provided in the Draft GTCC EIS, which are based on many best-case assumptions and limited exposure pathways. Furthermore, the activities of an intruder clearly have the potential to significantly increase off-site doses. These consequences should not be ignored or downplayed simply as a matter of convenience.

> ***Recommendation 5d. The revised Draft GTCC EIS must incorporate an extensive quantitative evaluation of intentional and unintentional intrusion into any disposal facility related to the proposed action alternatives.***

Comment 5e. Performance assessment of the proposed action alternatives cannot be verified and appears to significantly underpredict future doses.

Analysis performed by IEER using the same parameters as those provided in the Draft GTCC EIS was unable to replicate the reported doses using RESRAD-OFFSITE. Calculations performed for trench and borehole disposal delivered significantly higher doses (trenches: 300 millirem; boreholes: 177 millirem) than those reported in the Draft GTCC EIS.

Because the vault dose reported in the Draft GTCC EIS was similar to the trench dose, it is reasonable to assume that the vault dose is also incorrect. The USDOE acknowledges that some modifications to RESRAD-OFFSITE were made, but does not provide adequate information to account for the large differences between doses predicted in the Draft GTCC EIS and those calculated by IEER. Please refer to Attachment 3 for additional information on this comment.

> ***Recommendation 5e. Calculation of exposure that results from a proposed action alternative disposal facility should be redone. Additional, detailed information should be incorporated into the revised Draft GTCC EIS so that the USDOE calculations can be replicated and examined in appropriate detail.***

Comment 5f. Sensitivity analysis performed for the proposed action alternatives is abnormal, unusual, and non-conservative.

The sensitivity analysis performed for the Draft GTCC EIS proposed action alternative-derived doses does not follow normal protocols that evaluate scenarios both better and worse than the base case provided. Rather, the USDOE has adopted the stance that the base case (including, and heavily relying upon, the assumptions noted above) is the *worst-case scenario* and that parameters affecting proposed action alternative performance can *only improve*. This is unrealistic and scientifically unsupportable even when using appropriate base-case parameters. Taking into consideration the assumptions and parameters provided in the base case, the sensitivity analysis included in the Draft GTCC EIS is meaningless.

A more appropriate sensitivity analysis performed by IEER using parameters less favorable than the USDOE's base case found that doses delivered by a proposed action alternative disposal facility could be substantially larger than those provided in the Draft GTCC EIS. The analysis also identifies significantly reduced travel times to groundwater and reasonable parameters that could result in total removal of surface barriers within 5,000 years. These analyses are discussed in greater detail in Attachment 3.

> ***Recommendation 5f. In the revised Draft GTCC EIS, sensitivity analysis must evaluate facility performance using realistic parameters. The analysis must evaluate scenarios that are less favorable than the USDOE-provided base case.***
>
> ***Sensitivity analysis should also evaluate scenarios in which unrealistic assumptions previously discussed, such as consistent low rates of erosion and infiltration for 10,000 years, are replaced with higher or increasing rates.***

Comment 6. The Draft GTCC EIS must comply with federal and state environmental laws.

The Low-Level Radioactive Waste Policy Amendments Act of 1985 states that GTCC waste is to be disposed of in an NRC-licensed facility that has been determined to be adequate to protect public health and safety. NRC regulations state that GTCC waste is generally not acceptable for near-surface disposal and must be disposed of in a deep geologic repository unless alternative methods of disposal are proposed to and approved by the NRC.

> ***Recommendation 6. The revised Draft GTCC EIS must explain how the selection of a USDOE-operated facility will meet the requirements for NRC licensing and regulation and how such a facility will be determined to adequately protect public health and safety.***

Comment 7. The Draft GTCC EIS must recognize Yakama Nation treaty rights.

The Treaty of 1855 between the United States and the Yakama Nation (12 Stat. 951) is not mentioned in the Draft GTCC EIS. Under that treaty, the United States has accepted a trust responsibility to ensure that the Yakama people and resources are not harmed by federal actions.

The treaty supports protection of natural and cultural resources for the Yakama Nation. The Draft GTCC EIS incorrectly includes trust responsibility and treaty rights under the umbrella of environmental justice, which implies that all treaty rights have been appropriately considered in accordance with the National Environmental Policy Act and other federal laws, which is not the case. Considering tribal views and perspectives is very different from full and fair consideration of tribal treaty rights and federal trust responsibility.

> ***Recommendation 7. The revised Draft GTCC EIS must recognize the Treaty of 1855 as a requirement that applies to the proposed action alternatives. Potential impacts to treaty-reserved rights and resources should be identified and evaluated in the revised Draft GTCC EIS. Any action alternative included in the Final GTCC EIS should adequately address tribal exposures based on full access to treaty-reserved resources, and should be consistent with the USDOE's American Indian Policy.***

Comment 8. The Draft GTCC EIS does not appropriately address cultural and natural resources at the Hanford Site.

Comment 8a. Evaluation of cultural and natural resources is incomplete.

The Draft GTCC EIS frequently uses language that suggests cultural resources in the Draft GTCC EIS reference area have been thoroughly surveyed and evaluated. However, the locations identified have not been professionally surveyed for cultural resources, and the subsurface has not been evaluated. Many of the surveys that have been performed were spatially restricted, were associated with local projects, and did discover physical cultural resources. It is reasonable to expect that significant cultural resources may be present in the Draft GTCC EIS reference area and surrounding the Central Plateau of the Hanford Site (known as the 200 Area), but that those resources are as-yet undiscovered.

As in the TCWM EIS, the Draft GTCC EIS places heavy emphasis on physical objects and artifacts that can be positively identified as of Native American origin. However, there are many other cultural and natural resources that the USDOE does not (and cannot) assign a value to. These resources include the cultural significance of sacred sites within the Hanford Site boundaries and along the Columbia River, as well as protection of all natural resources, including surface waters, groundwater, geologic resources, air, plants, fish, and wildlife within usual and accustomed places.

> ***Recommendation 8a. The revised Draft GTCC EIS should acknowledge that significant cultural resources exist within the reference area for the Hanford Site and that the full extent of impacts to these resources has not been evaluated in detail. The revised Draft GTCC EIS should provide appropriate detail that identifies the cultural resource surveys to date, including their spatial extent and the activities conducted.***

Comment 8b. The Draft GTCC EIS does not appropriately address Tribal Cultural Properties.

The Rattlesnake Mountain and Gable Mountain Gable Butte Cultural District are eligible Traditional Cultural Properties (TCP). The Draft GTCC EIS understates the significance of these sites to the Yakama Nation and other native tribes. This status should be recognized and incorporated into the revised Draft GTCC EIS.

> ***Recommendation 8b. The Cultural Resources section in the revised Draft GTCC EIS should acknowledge and discuss the presence of TCPs in the vicinity of the reference area. The revised Draft GTCC EIS should acknowledge the impact that construction of a new facility will have on TCP visual resources, TCP access, and levels of contamination at TCPs.***

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Attachment 2

Yakama Nation ERWM Program General Comments on the
***Draft Environmental Impact Statement for the Disposal of Greater-Than-Class C (GTCC) Low-Level Radioactive Waste and GTCC-Like Waste* (DOE/EIS-0375-D)**

ID No.	Section	Subsection	Page	Figure, Map or Table Number	Topic	Comment
1	1	1.1	1-2	NA	EIS Contents	Further clarification is requested on the purpose and need to which USDOE is responding. Although there is currently no disposal capability for either GTCC low-level radioactive waste (LLRW) or GTCC-like waste, there is also no path to disposal for a vast quantity of USDOE waste with characteristics that are also similar to GTCC LLRW (e.g., graphite reactor blocks and depleted uranium stockpiles). USDOE should perform a comprehensive National Environmental Policy Act (NEPA) analysis for developing additional disposal capability for all its waste similar to GTCC LLRW.
2	1	1.4	1-4	NA	West Valley Waste	The West Valley Site cleanup accounts for 58 percent of the total waste discussed in the EIS. It is not reasonable that cleanup of this one site is responsible for such a large percentage of the total waste. Cleanup of the West Valley Site should not simply consist of transferring the waste to the near surface of the Hanford Site or some other location. The waste from West Valley should be disposed of in a deep geologic repository in accordance with applicable federal regulations (10 CFR 61, 40 CFR 191).
3	1	1.4.1.3	1-19	NA	GTCC Waste Type	The statement that West Valley-related waste does not meet the requirements for disposal at the Waste Isolation Pilot Project (WIPP) facility is redundant with the definitions already established by the USDOE for GTCC and GTCC-like waste. Inclusion of such a statement is misleading because it implies that this waste is somehow different from other types of GTCC and GTCC-like waste addressed by the Draft GTCC EIS. Remove this text and other text that suggests the WIPP alternative would not be viable for various subclasses of the wastes considered. Further revise the text of the Draft GTCC EIS Introduction to more clearly state that disposal of all the waste at the WIPP facility is a viable alternative.
4	1	1.4.2	1-20	NA	Action Alternatives	10 CFR 61 states, "[t]he primary emphasis in disposal site suitability is given to isolation of wastes, a matter having long-term impacts, and to disposal site features that ensure that the long-term performance objectives of subpart C of this part are met, as opposed to short-term convenience or benefits." Revise the Draft GTCC EIS to specifically identify what long-term storage benefits are achieved using near-surface disposal and how they compare to deep geologic disposal.
5	1	1.4.2	1-21	NA	Surface Barriers/ Institutional Controls	All the conceptual designs for the land disposal alternatives show a surface barrier as a key element to prevent intrusion. Surface barriers do not prevent bioturbation and the potential spread of contamination from burrowing animals. Revise the Draft GTCC EIS to provide disposal alternatives that are not dependent on surface barriers to maintain isolation of wastes. Include in the revised text acknowledgement that any surface barrier is likely to experience significant degradation over time as a result of frost heave, desiccation, solarization, and bioturbation.
6	1	1.4.2.1	1-21	NA	Deep Geologic Disposal	The full range of options for deep geologic disposal in mined repositories is not addressed in the Draft GTCC EIS. Presenting WIPP as the only deep geologic option does not give the concept fair weight in the scheme of the EIS. Revise the Draft GTCC EIS to evaluate disposal in a mined geological formation from a conceptual point of view that does not emphasize the existing legal impediments for WIPP disposal.
7	1	1.4.2.2	1-22	NA	Action Alternatives	Boreholes and trenches as shown are open at the bottom, allowing any leachate to migrate directly to the underlying geologic material. Near-surface contaminants at Hanford pass relatively quickly through the vadose zone to the water table. It is also well established that groundwater can migrate from the central portion of the Hanford Site to the Columbia River in a timeframe of months. The Hanford GTCC reference area is a recognized waste site with significant radiogenic contamination of the underlying soils and sediments; current recommended remedial action includes a 30-year cool-down period. Digging and drilling would significantly disturb and potentially mobilize radioactive contaminants already present at the reference area. Any further site-specific evaluation should include additional detail regarding the expected final location of the disposal facility, the extent of any contaminants present, and plans to mitigate disturbed contamination.

ID No.	Section	Subsection	Page	Figure, Map or Table Number	Topic	Comment
8	1	1.4.2.2	1-22	NA	Action Alternatives	Provide additional detail regarding waste placement, such as how operators will ensure that waste will be placed upright and secured during loading.
9	1	1.4.2.3.1	1-22	NA	Action Alternatives	The approach to land disposal construction phasing/sequencing should be included in Section 5 of the Draft GTCC EIS. Construction sequencing information is scattered throughout the EIS in a disorganized fashion that requires the reader to hunt through several sections to locate the relevant information. Revise the Draft GTCC EIS so that all this information is compiled in at least one location for review.
10	1	1.4.2.3.2	1-23	NA	Action Alternatives	The aboveground vault alternative will not contain waste for 10,000 years without active institutional controls. Revise the Draft GTCC EIS to provide action alternatives that do not include the vault alternative.
11	1	1.4.2.3.2	1-24	NA	Action Alternatives	Revise the Draft GTCC EIS to provide estimates of how much gamma radiation would be attenuated by shielding incorporated into remote handled waste containers and disposal structures.
12	1	1.4.3	1-25	NA	Hanford Site	Using the 100-year floodplain for the purpose of disposal facility location is not reasonable. The location of the site should not be within the 500-year floodplain. Revise the Draft GTCC EIS to incorporate very long-term, large-magnitude flood events that may result from glacial outburst flooding or other, similar events. A waste disposal facility should not be located where such events could potentially damage the facility.
13	1	1.4.3	1-26	NA	Cultural Resources	Hanford cultural and natural resources have not been adequately addressed as part of the Draft GTCC EIS, and the included information is not accurate. Revise the Draft GTCC EIS to include detailed information regarding how cultural resources will be evaluated for any disposal facility at the Hanford Site.
14	1	1.5.1	1-40	Figure 1.5-1	EIS Contents	It is incorrectly implied that the Draft GTCC EIS provides sufficient information for a comparative analysis of proposed action alternative impacts to allow selection of a preferred alternative. Site-specific evaluations are needed for a meaningful assessment of human health impacts before a GTCC waste land disposal alternative(s) or site(s) can be selected as the preferred alternative. Furthermore, public participation in the EIS process has been significantly curtailed without identification of a preferred alternative in the Draft GTCC EIS because there will not be an opportunity for public comment on the preferred alternative if it is not identified until the Final EIS is issued. The USDOE should release a revised Draft GTCC EIS with an identified preferred alternative.
15	1	1.5.1	1-41	NA	Hanford Site	A thorough analysis to support GTCC waste disposal decision-making should have clearly demonstrated that Hanford is not a viable location for disposal of GTCC wastes. Disposal of GTCC wastes would be incompatible with efforts to clean up extensive contamination already present at the site, and importation of additional waste for disposal would result in unacceptable environmental consequences. Revise the Draft GTCC EIS so that Hanford is not included as a candidate site for construction of a disposal facility.
16	1	1.5.1	1-41	NA	Deep Geologic Disposal	The Nuclear Regulatory Commission (NRC) cannot approve GTCC LLRW land disposal alternatives that violate protection against release of long-lived radionuclides (and their shorter-lived precursors) after institutional controls, improved waste form, and deeper disposal have ceased to be effective (10 CFR 61). Disposal of GTCC LLRW and GTCC-like waste in a deep geologic repository is the only method that would ensure isolation of long-lived radionuclides from the environment. Revise the Draft GTCC EIS to identify disposal in a deep geologic repository as the preferred alternative.

ID No.	Section	Subsection	Page	Figure, Map or Table Number	Topic	Comment
17	1	1.5.1	1-42	NA	Long-Term Impacts	The impacts on groundwater beyond 10,000 years are not considered for comparison of proposed disposal sites as the text implies. Revise the Draft GTCC EIS to consider long-term impacts to groundwater beyond 10,000 years to the point of maximum dose and latent cancer fatalities (LCF) risk so that action alternatives at proposed disposal sites can be compared. Provide additional analysis that demonstrates future doses will not result in annual doses that exceed 10 CFR 61 or Radioactive Waste Management Manual (USDOE M 435.1-1) requirements. Action alternatives that cannot meet the long-term requirements for waste containment should be removed from the Draft GTCC EIS.
18	1	1.5.2	1-43	NA	Deep Geologic Disposal	The EIS Notice of Intent (22 FR 40135) indicates a deep geologic repository other than WIPP will not be evaluated due to concerns related to schedule, cost, and waste volume. However, it has now been a quarter-century since Section 3(b)(1)(D) of the Low-Level Radioactive Waste Policy Amendments Act of 1985 (LLRWPAA) designated federal responsibility for disposal of GTCC LLRW; since that time, costs have continued to escalate. In addition, the steps identified by USDOE as required by LLRWPAA Section 3(b)(3)(E) to ensure GTCC LLRW generators bear disposal costs (USDOE, 1987, page 7-2) should be implemented. There also remains a tremendous burden of USDOE waste similar to GTCC LLRW waste with no path to disposal that has not been, but should be, addressed. For the USDOE to now cite concerns of schedule, cost, and limited waste volume in dismissing serious consideration of deep geologic repository alternatives is not acceptable. Revise the Draft GTCC EIS to include this analysis at multiple, appropriate candidate sites.
19	1	1.5.2	1-43	NA	EIS Contents	Revise the Draft GTCC EIS to clarify that Congressional direction in Section 631 of the Energy Policy Act of 2005 does not require an EIS and a Record of Decision (ROD) for a permanent disposal facility for GTCC-like waste. Revise the incorrect implication that the No Action alternative is adequately evaluated; it is not.
20	1	1.5.2	1-44	NA	Waste Volume	Revise the Draft GTCC EIS to acknowledge the direct relationship between the projected volume of GTCC LLRW and the EIS scope evaluating potential environmental impacts using various disposal options. Implementation of the steps identified by USDOE to ensure GTCC LLRW generators bear disposal costs (USDOE, 1987) should be implemented; recovery of waste management costs from commercial generators would provide an incentive for waste reduction and would reduce environmental impacts through pollution prevention.
21	1	1.5.2	1-44	NA	Long-Term Impacts	The resident farmer scenario is dependent on land use designations and institutional controls in violation of 10 CFR 61. The scenario underestimates expected dose and LCF risk and is not based on conservative assumptions as indicated. Revise the Draft GTCC EIS by removing this statement and all other statements that indicate the resident farmer scenario located off site is a conservative analysis.
22	1	1.5.2	1-45	NA	Hanford Site	Site-specific evaluations that consider sensitive populations are needed for an adequate comparison of land disposal impacts before any of the sites can be selected for the preferred alternative. Revise the Draft GTCC EIS to acknowledge that informed decisions require that the specific characteristics and conditions of each site be evaluated in advance and that this information has not yet been provided, making the analysis presented incomplete.
23	2	NA	2-1	NA	EIS Contents	See previous comment regarding clarification on the purpose and need to which USDOE is responding. Also see previous comment requesting clarification that Congressional direction in the Energy Policy Act of 2005 does not require an EIS and a ROD for a permanent disposal facility for GTCC-like waste.
24	2	NA	2-1	NA	GTCC Waste Type	Revise the Draft GTCC EIS to define what the special processing and design will be for the GTCC LLRW waste if near-surface disposal is selected. In particular, describe in detail any volume reduction that is performed and the limits on activity per unit volume that will be enforced.

ID No.	Section	Subsection	Page	Figure, Map or Table Number	Topic	Comment
25	2	NA	2-2	Figure 2-1	EIS Contents	There are no quantitative data provided to support the claim that "estimated potential impacts would probably be small overall or could be mitigated" for nine of the 12 resource areas analyzed (climate, air quality, and noise; geology and soils; water resources; ecology; socioeconomics; environmental justice; land use; cultural resources; and waste management). Revise the Draft GTCC EIS to provide sufficient information and analysis of the various options to demonstrate that potential impacts are bounded.
26	2	NA	2-3	NA	EIS Contents	See previous comments regarding the lack of a preferred alternative in the Draft GTCC EIS. Revise the Draft GTCC EIS to identify disposal in a deep geologic repository as the preferred alternative.
27	2	2.1	2-4	NA	Long- Term Impacts	The No Action alternative has the potential to cause significant long-term environmental degradation, but the EIS's quantitative evaluation does not bound potential long-term impacts. The resident farmer scenario assumes institutional controls will remain intact indefinitely, which is not valid. In addition, the evaluation of long-term impacts does not consider surface runoff and particulate air emission mechanisms even though storage of GTCC waste is at the ground surface. Proper evaluation of the impacts of the No Action alternative is essential for comparison with the proposed action alternatives and selection of a preferred alternative. Revise the Draft GTCC EIS analysis of the No Action alternative to demonstrate that potential long-term impacts are bounded.
28	2	2.3	2-6	NA	Action Alternatives	The Draft GTCC EIS should identify the minimum acceptable depth to groundwater for each of the boreholes, trenches, and vaults to be constructed at the candidate sites.
29	2	2.3	2-6	NA	Action Alternatives	The text states that shallower boreholes could be used for GTCC waste. If the waste is disposed of less than 30 meters below ground surface, it would be considered near-surface disposal. Revise the Draft GTCC EIS to acknowledge this distinction and describe additional engineering and design measures that would be required for such an action.
30	2	2.3	2-9	NA	Hanford Site	A thorough analysis to support GTCC waste disposal decision-making should clearly demonstrate that Hanford is not a viable location for disposal of these highly radioactive and long-lived wastes. See previous comments regarding disposal of additional waste at Hanford. Revise the Draft GTCC EIS so that Hanford is no longer a candidate site for disposal of GTCC waste.
31	2	2.6	2-9	NA	Hanford Site	Oak Ridge was eliminated as a candidate site because it is "not appropriate for disposal of LLRW containing high concentrations of long-lived radionuclides (such as those found in GTCC waste), especially those with high mobility in the subsurface environment." This definition is vague and also applies to the Hanford Site, which also has subsurface conditions that promote movement of contaminants. This is illustrated by the numerous groundwater plumes that have already reached the Columbia River from the Central Plateau. The same criteria that were applied to Oak Ridge should be applied to Hanford, and the Hanford Site should be removed from consideration in the revised Draft GTCC EIS.
32	2	2.7.1	2-10	NA	Short-Term Impacts	The impacts to air quality during the construction phase at the Hanford Site should be of particular concern. Using the reference area as an example, the soils and sediments are highly contaminated. Excavating and moving the reference area soils and sediments have the potential to create additional risks that the Draft GTCC EIS does not sufficiently address.
33	2	2.7.2	2-11	NA	Long-Term Impacts	Surface barriers and institutional controls are not appropriate for isolating waste that will remain dangerous on the timescale that applies to GTCC and GTCC-like wastes. There is no way to ensure that humans can prevent man-made or environmental intrusions for the minimum isolation period of 10 half-lives required for long-lived isotopes. Revise the Draft GTCC EIS to further acknowledge that near-surface disposal is not appropriate, and identify disposal in a deep geologic repository as the preferred alternative.

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34	2	2.7.2	2-11	NA	Long-Term Impacts	The statement "the land currently used for storage would continue to be used" does not address the long-term risk involved in the use of interim storage that was not designed for long-term use. Contrary to the EIS's claim, Alternative 3-5 if implemented at Hanford could have significant impacts. Refer to previous comments regarding subsurface contamination in the Hanford reference area and comments regarding Hanford cumulative impacts. Revise the Draft GTCC EIS in accordance with these comments.
35	2	2.7.2	2-12	NA	Environmental Variables	Assuming that the erosion rate will always be less in western states is not reasonable for the duration of storage. Episodic, very large runoff events are known to result in significant erosion that may not be apparent in short-term records. Additional mechanisms such as wind erosion need to be taken into account, particularly at more arid locations such as Hanford. Revise the Draft GTCC EIS to better quantify erosion in western states so that the rates realistically represent the sum of all exhumation and erosion activities. Include text that acknowledges any assumptions made that artificially reduce the assumed erosion rate for a given region so these adjustments can be accounted for.
36	2	2.7.2	2-12	NA	Environmental Variables	It is not realistic to assume that very low erosion rates observed on a newly constructed barrier can be maintained beyond 100 years. Revise the Draft GTCC EIS to evaluate a variable or increasing erosion rate over time to reflect the impact of barrier degradation.
37	2	2.7.3	2-12	NA	Short-Term Impacts	The impact that will result from spreading the identified volumes of water inland and allowing the water to infiltrate are significant. This water will mobilize contaminants already present in the vadose zone at Hanford. Revise the Draft GTCC EIS to fully describe the impact of artificially increasing the infiltration rate during construction and factor this into the groundwater exposure pathway, which according to the Draft GTCC EIS is proportional to infiltration.
38	2	2.7.3	2-12	NA	Long-Term Impacts	Potential risks to the aquifers at Hanford are not sufficiently addressed. The groundwater under the reference area is already significantly contaminated. See comments in Attachment 1 regarding Hanford cumulative impacts.
39	2	2.7.3	2-12	NA	Long-Term Impacts	Potential long-term impacts from surface runoff were not evaluated. Given that waste is stored at or near the ground surface in the No Action, trench, and vault alternatives, and given that institutional controls are not reliable beyond 100 years, failure to evaluate long-term impacts from surface runoff is inappropriate. Revise the Draft GTCC EIS to include the surface water pathway for exposure.
40	2	2.7.3	2-13	NA	Long-Term Impacts	The Draft GTCC EIS identifies significant impacts to Hanford groundwater including large doses of I-129, Tc-99, U-238, and other radionuclides. Several of the radionuclides that reach groundwater after the first 10,000 years are transuranic. It is not reasonable to add more contamination to Hanford groundwater in any form. Refer to the comments in Attachment 1 regarding cumulative impacts and groundwater. Revise the Draft GTCC EIS so that the Hanford Site is no longer considered for construction of a GTCC waste facility.
41	2	2.7.4.1	2-13	NA	Short-Term Impacts	Revise the Draft GTCC EIS to identify the dose that a Native American cultural resource specialist will receive during excavation activities.
42	2	2.7.4.1	2-13	NA	Long-Term Impacts	The EIS's risk assessment did not include all relevant pathways for exposure. Post-closure exposure pathways should reasonably include surface water, groundwater, soil ingestion, and steam inhalation. Read and review the Yakama Nation Exposure Scenario (Ridolfi, 2007) and incorporate the exposure pathways identified there to the risk analysis presented in the revised GTCC Draft EIS.
43	2	2.7.4.2	2-14	Table 2.7-3	Action Alternatives	Because current storage of GTCC wastes is at the ground surface and institutional controls are not reliable beyond 100 years (10 CFR 61), it is essential to conduct a quantitative evaluation of the impacts of the No Action alternative using the runoff and airborne particulate release mechanisms (in addition to the leaching to groundwater pathway that was evaluated) for a meaningful comparison of the proposed action alternatives.

ID No.	Section	Subsection	Page	Figure, Map or Table Number	Topic	Comment
44	2	2.7.4.2	2-15	NA	Surface Barriers/ Institutional Controls	Refer to the comments in Attachment 1 regarding land use and site occupation following loss of institutional controls. Post-closure exposure is not calculated any closer to the facility than 100 meters from the boundary. This is not a reasonable assumption over a 100,000-year period. Such an assumption also implicitly ignores that the Treaty of 1855 reserves the rights of the Yakama Nation to fish at all usual and accustomed places and to hunt and gather on open lands such as the Hanford Site. Revise the Draft GTCC EIS to incorporate the requirements of the Treaty of 1855, and provide action alternatives that do not conflict with the rights granted by the Treaty of 1855.
45	2	2.7.4.2	2-15	NA	Human Exposure	It is unreasonable to assume that the resident farmer scenario is a conservative estimate. By assuming a total loss of institutional controls and institutional memory of the facility, unintentional or intentional intrusion into the waste site is very likely. Revise the Draft GTCC EIS to include a detailed intentional intruder scenario for any near-surface proposed action alternative.
46	2	2.7.4.2	2-15	NA	Human Exposure	This paragraph contradicts the first paragraph on this page, which states that all institutional controls will be lost. Complete loss of institutional controls and institutional memory allows for much more intrusive and destructive scenarios than a resident farmer who does not come closer to the facility than 100 meters from the boundary. The concept that a farmer or future resident would instinctively avoid a facility of which he or she has no knowledge whatsoever is not justifiable. For example, because the farmer does not know the facility exists, he may choose to locate his farm directly on top of said facility, which may prove particularly attractive after regrading the imported topsoil and barriers into a well-drained field. The provided scenario is not conservative and should not be identified as such. Revise the Draft GTCC EIS to include significantly more intrusive and damaging scenarios that involve direct occupation of the facility, intentional damage to surface barriers, and dramatically increased infiltration such as may occur as a result of irrigation within the facility boundary.
47	2	2.7.4.2	2-15	NA	Long-Term Impacts	This does not take into account the cumulative impacts at the Hanford Site. Please refer to comments in Attachment 1 regarding cumulative impacts. Cumulative impacts need to account for all pre-existing contamination at the site, not just that identified in the Tank Closure and Waste Management (TCWM) EIS (USDOE, 2009) and should include the exposure pathways identified in the Yakama Nation Exposure Scenario (Ridolfi, 2007). Revise the Draft GTCC EIS to include all pre-existing contamination at the Hanford Site in the cumulative impacts analysis.
48	2	2.7.4.2	2-15	NA	Human Exposure	The determination that the surface runoff transport mechanism is not relevant to the No Action, trench, and vault alternatives is technically unjustified. See previous comments about the need to include the surface water exposure pathway in the revised Draft GTCC EIS.
49	2	2.7.4.2	2-15	NA	Human Exposure	Underlying assumptions here and throughout the Draft GTCC EIS reflect systematic overreliance on land use designations and institutional controls to reduce estimated long-term exposures. Revise the Draft GTCC EIS to acknowledge in this section that subsequent NEPA analysis would have to consider exposure pathways unique to specific sites for a more meaningful evaluation of expected dose and LCF risk. Remove speculation on the likelihood of the resident farmer scenario occurring at individual sites and delete the reference to Hanford as an example.
50	2	2.7.4.2	2-16	NA	Surface Barriers/ Institutional Controls	The effectiveness of stabilization agents such as grout to reduce the leaching of Other Waste has not been established, and such agents may be inconsequential when compared to the long half-lives of waste radionuclides. Revise the Draft GTCC EIS to specifically state that the effectiveness of stabilization agents has not been demonstrated, and their performance over very long periods of time has not been evaluated using a scientifically rigorous methodology.

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51	2	2.7.4.2	2-16	NA	Long-Term Impacts	The text incorrectly implies that 100 meters is the minimum distance for the downgradient point of compliance allowed for LLRW performance assessments conducted under the Radioactive Waste Management Manual (USDOE M 435.1-1). Revise the text to explain that, "[a] smaller buffer zone may be used if adequate justification is provided" (USDOE M 435.1-1).
52	2	2.7.4.2	2-16	NA	Environmental Variables	The assumption that the infiltration rate will be 20 percent of the "natural rate" over the waste area has not been shown to apply at the Hanford Site. It is an optimistic assumption that underestimates the total infiltration through the waste interval to help meet performance criteria in the first 10,000-year evaluation period. Revise the Draft GTCC EIS to evaluate higher infiltration rates than 20 percent, including 50 percent, 100 percent and 150 percent of average infiltration. Provide a sensitivity analysis using parameters that are less favorable rather than more favorable to maintaining waste isolation.
53	2	2.7.8	2-21	NA	Long-Term Impacts	The Draft GTCC EIS must consider the full range of impacts associated with proposed land disposal to ensure protection of local ecological and cultural resources. A disposal facility land use would preclude use of the land at any time for other purposes by the public or by Native Americans, regardless of current land use designations. Revise the Draft GTCC EIS to provide more in-depth, site-specific evaluations that fully assess land use impacts for the proposed land disposal alternatives.
54	2	2.7.12	2-23	NA	Long-Term Impacts	Revise the Draft GTCC EIS to clarify that the level of cumulative impacts analysis should be commensurate with potential impacts (USEPA, 1999).
55	2	2.7.12	2-24	NA	Surface Barriers/ Institutional Controls	Clarify that the Draft GTCC EIS uses the resident farmer scenario only for comparative purposes and that subsequent NEPA analyses would have to consider applicable exposure pathways unique to specific sites for a more meaningful evaluation. See previous comments and comments in Attachment 1 regarding use of the resident farmer scenario and reliance on institutional controls and surface barriers. Revise the Draft GTCC EIS in accordance with these comments.
56	2	2.8.4	2-58	NA	Surface Barriers/ Institutional Controls	Assumptions made for the resident farmer scenario reflect systematic overreliance on current land use designations and institutional controls to reduce estimated long-term exposures. See previous comments on use of the resident farmer scenario and reliance on institutional controls. Revise the Draft GTCC EIS in accordance with these comments.
57	2	2.8.4	2-58	NA	Human Exposure	Revise the text to explain that because the resident farmer scenario over relies on current land use designations and institutional controls, any further design considerations or site-specific modeling must consider exposure pathways unique to specific sites for a meaningful evaluation of the expected dose and LCF risk.
58	2	2.9	2-59	NA	EIS Contents	In citing 10 CFR 61, the text incorrectly implies that special considerations may warrant near-surface disposal for <u>all</u> current and anticipated future GTCC LLRW. Revise the Draft GTCC EIS to clarify that near-surface disposal of GGTC LLRW remains generally unacceptable, although <u>some</u> land disposal methods may be acceptable to the NRC for disposal of <u>some</u> waste types, dependent upon a limited concentration of long-lived radionuclides in the waste. Also revise the Draft GTCC EIS to explain that the NRC cannot license a disposal facility or approve disposal methods that violate its regulations to protect against release of long-lived radionuclides (and their shorter-lived precursors) after institutional controls, improved waste form, and deeper disposal have ceased to be effective (10 CFR 61).
59	2	2.9	2-59	NA	Human Exposure	The Draft GTCC EIS supports the implication that protection of individuals from radioactivity during disposal and from intrusion warrants greater consideration than does protection from long-term impacts after facility closure. Revise the Draft GTCC EIS to clearly state that selection of the preferred alternative must give long-term protection of populations from radioactivity equal weight to or greater weight than protection of volunteer radworker individuals during disposal.

ID No.	Section	Subsection	Page	Figure, Map or Table Number	Topic	Comment
60	2	2.9	2-59	NA	Human Exposure	Although proper evaluation of the No Action alternative is required (40 CFR 1508) and essential for evaluation of proposed action impacts, the No Action alternative should not be considered a viable option for a final disposal alternative, even in combination with other action alternatives.
61	2	2.9.3.1	2 - 62	NA	Surface Barriers/ Institutional Controls	Institutional controls can be effective in reducing the potential for inadvertent intrusion and potential intruder exposures. However, institutional controls are effective only insofar as they are in place (U.S. Nuclear Regulatory Commission, 1981). Revise the Draft GTCC EIS to explain that design, operation, and closure of the land disposal facility must ensure protection of any individual inadvertently intruding into the disposal site and occupying the site or contacting the waste at any time after active institutional controls over the disposal site are removed (10 CFR 61). See previous comments on surface barriers and institutional controls. Revise the Draft GTCC EIS in accordance with these comments.
62	2	2.9.3.3	2-63	NA	Surface Barriers/ Institutional Controls	Given that institutional controls are not to be relied upon for more than 100 years (10 CFR 61) and that the long-term effectiveness of the vault alternative depends on maintaining post-closure care, it is not appropriate for the performance evaluation to consider the long-term effectiveness of vault disposal as equal to that of the borehole and trench alternatives. Revise the Draft GTCC EIS to evaluate the proposed action alternatives without the assumption that all three are of equal integrity, which is demonstrably false. See comments in Attachment 1 that address the use of surface barriers and institutional controls at any new disposal facility.
63	2	2.9.4.2	2-67	NA	Cultural Resources	Cultural resources include much more than simply Traditional Cultural Properties (TCPs). As the Draft GTCC EIS has defined it, the entire Hanford Site, including the Hanford Reach of the Columbia River, is a TCP because the entire area has traditional cultural and religious significance to the Yakama people. In the case of the Yakama Nation, Hanford cultural resources are also treaty resources and the United States is obligated to ensure that the Yakama people and resources are not harmed by federal actions. Revise the Draft GTCC EIS to explain that cultural resources are far broader than selected historic locations of occupation or specific food items.
64	2	2.9.4.3	2-67	NA	EIS Contents	Treaty rights are not recognized in the Draft GTCC EIS for actions at Hanford. Revise the Draft GTCC EIS to recognize the Treaty of 1855 (12 Stat. 951) that reserves specific rights and resources for the Yakama Nation.
65	5	NA	NA	NA	Action Alternatives	Revise the Draft GTCC EIS to provide more information on the Standard Waste Box (SWB). Include information on dimensions, materials, and shielding beyond the Class A designation.
66	5	5.1.1	5-5	NA	Action Alternatives	Revise the Draft GTCC EIS to provide additional information regarding how the borehole diameter was selected.
67	5	5.1.3	5-12	NA	Action Alternatives	Revise the Draft GTCC EIS to identify the source of the additional soil for vault cover. The Draft GTCC EIS has already acknowledged that the cumulative work on the Hanford Site has created a "soil deficit," making the source of this material a significant issue.
68	5	5.1.4.3	5-18	NA	Action Alternatives	The assumption that the near-surface land disposal facilities are all of equal integrity is not valid, and any analysis presented based on this assumption is deficient. The Draft GTCC EIS explains that this approach is used to "allow for a comparison of the disposal methods on the basis of the general geophysical conditions at each site." Such an approach is not logical and cannot be justified, because it intentionally ignores highly relevant characteristics of each disposal alternative, such as the depth of disposal, presence of clay liners, types of backfill, concentration of waste, volume and placement of concrete, and other features. Revise the Draft GTCC EIS to consider, in detail, the identified features of each action alternative and compare the integrity of the disposal facilities based on these specific parameters.

ID No.	Section	Subsection	Page	Figure, Map or Table Number	Topic	Comment
69	5	5.1.1	5-5	NA	Action Alternatives	Revise the Draft GTCC EIS to provide additional construction details, including how radiologically contaminated equipment such as the borehole casing will be handled, stored, and disposed of.
70	5	5.2.2	5-24	NA	Action Alternatives	The vault alternative will have significant impacts to geologic and soil resources. Revise the Draft GTCC EIS to evaluate impacts to geologic and soil resources at source areas for fill material in greater detail than is currently provided.
71	5	5.2.4.2	NA	NA	Human Exposure	Revise the Draft GTCC EIS to evaluate chemical hazards. Include Other Waste in the chemical assessment for the wide variety of materials that make up this category, such as sludges, salts, charcoal, scrap metal, glove boxes, solidified solutions, particulate solids, filter, and organic and inorganic material.
72	5	5.2.4.2	5-26	NA	Human Exposure	Revise the assessment of human health in the Draft GTCC EIS to qualitatively evaluate inadvertent and intentional human intrusion. This is a probable and reasonably expected event in the next 10,000 years for any of the near-surface alternatives. It is particularly likely if the vault alternative is selected.
73	5	5.2.4.3	5-26	NA	Long-Term Impacts	Revise the Draft GTCC EIS to identify a long-term monitoring and maintenance period that would follow site decommissioning to ensure that the disposal facility was adequately containing the disposed wastes. The monitoring program should demonstrate that the facility will meet 10 CFR 61 requirements.
74	5	5.2.9.3	5-41	NA	Action Alternatives	The Draft GTCC EIS states that the effects of two atmospheric conditions were considered: “neutral and stable.” Revise the Draft GTCC EIS to explain how these two conditions differ from each other and include new scenarios that address unusual and severe weather such as large hail, tornadoes, and cloudbursts.
75	5	5.3.3	5-49	Table 5.3.2-1	Short-Term Impacts	The values presented in Table 5.3.2-1 do not match the values provided in Appendix D. Large additional off-site requirements for clay are specified in the trench and borehole methods in the appendix. Revise the Draft GTCC EIS to provide consistent resource estimates and provide additional justification for these estimates.
76	5	5.3.4	5-51	NA	Short-Term Impacts	Evaluation of potential impacts only to workers and the general public does not constitute a complete analysis. Hanford is part of the Yakama Nation's usual and accustomed use areas and unrestricted access to it is guaranteed by the Treaty of 1855. The Yakama Nation must be considered a potentially exposed receptor group in the short term and long term. The unique exposure pathways specific to Yakama tribal members must be evaluated, such as high exposure rates for surface water, groundwater, fish, game, and wild plant ingestion; sweat lodge use; and other cultural and subsistence activities that utilize Hanford Site natural resources.
77	5	5.3.4	5-60	NA	Short-Term Impacts	Exposure estimates following a hypothetical accidental radiological release are not complete. In addition to external radiation from groundshine and skyshine, inhalation, and ingestion of contaminated crops, exposure via ingestion of soil and wildlife should also be evaluated and added to the exposure estimates. In addition, because GTCC LLRW includes very long-lived radionuclides, exposure should be estimated for much longer than 1 year following an accidental release. Thousands of years (as for the post-closure estimates) would be more appropriate.
78	5	5.3.4.3	5-63	NA	Surface Barriers/ Institutional Controls	The assumption that individuals will not move closer than 100 meters from the facility boundary is not justified and is not valid, particularly many thousands of years into the future. See comments in Attachment 1 and previous comments in this attachment regarding site occupation and exposure following closure. Revise the Draft GTCC EIS to evaluate exposure to an individual at the center of the disposal facility following closure of the site as soon as active institutional controls are no longer maintained. Incorporate highly damaging scenarios such as regrading, drilling, and plowing of the disposal facility as part of the exposure scenario.

ID No.	Section	Subsection	Page	Figure, Map or Table Number	Topic	Comment
79	5	5.3.4.3	5-63	NA	Surface Barriers/ Institutional Controls	It is speculative to assume that engineering controls combined with natural features will ensure long-term viability of the disposal facility. See previous comments regarding reliance on surface barriers and institutional controls. Revise the Draft GTCC EIS in accordance with these comments.
80	5	5.3.4	5-64	NA	Human Exposure	Clarify what uses of contaminated groundwater associated with leaching were evaluated. The evaluation should include not only irrigating with and drinking the groundwater, but also direct contact and inhalation of water vapors via bathing and, for a resident farmer who is Native American, sweat lodge use.
81	5	5.3.4.3	5-64	NA	Human Exposure	Failure to include a surface water exposure pathway for a resident farmer either at the edge of or on the disposal facility is not justified and is not acceptable. Review previous comments regarding site access, institutional controls and barriers, and post-closure exposure. Revise the Draft GTCC EIS to include a surface water exposure pathway in the post-closure dose assessment beginning 100 years after closure of the facility.
82	5	5.3.4.3	5-65	NA	Human Exposure	Revise the Draft GTCC EIS to decrease the distance of the hypothetical resident farmer from the facility boundary, including exposure within the facility. Sensitivity analysis should evaluate scenarios that are worse, not better, than the minimum design standards specified. Exposure should be evaluated at 50 and 0 meters from the facility boundary, as well as in the most contaminated portions of the facility itself, not at increasingly greater distances from the point of release. Similarly, revise the Draft GTCC EIS to include scenarios with greater rates of infiltration, larger changes in temperature, and higher rates of erosion when evaluating near-surface disposal alternatives.
83	5	5.3.4.3	5-65	NA	Surface Barriers/ Institutional Controls	It is unknown whether controls will remain 100 percent effective for 500 years and 80 percent effective for 10,000 years without implementing a long-term inspection and maintenance program. Revise the Draft GTCC EIS to provide additional, thorough justification for the use of these values. Demonstrate that they are valid assumptions in each region of the United States.
84	5	5.3.4.3	5-66	NA	Human Exposure	The paragraph beginning at line 37 states: "The human health impacts to the hypothetical resident farmer given in this EIS are intended to serve as indicators of the relative performance of each of the three land disposal methods...by using robust engineering designs and redundant measures to contain the radionuclides in the disposal unit, the potential releases of radionuclides would be delayed and reduced to very low levels..." The human health impacts that are calculated in the Draft GTCC EIS are based on so many unjustified and unreasonable assumptions that it is misleading to compare them as a means of evaluating performance of each near-surface disposal alternative. The additional claim that releases can be delayed and reduced is similarly lacking in supporting evidence and based on many of the same faulty assumptions put forth in the analysis of disposal alternatives. No "redundant measures" are proposed or discussed for any of the near-surface alternatives. Furthermore, these statements are not supported by other portions of the Draft GTCC EIS that describe radionuclide releases as high as 2,300 mrem/year resulting from near-surface disposal alternatives or by Appendix E, which states "...[given] the unknown behavior of the engineered barriers and waste containers over a very long period of time, estimates of the peak annual radiation doses and LCF risks to human health are very difficult to predict....". Revise the Draft GTCC EIS to accurately reflect the large degree of uncertainty associated with the performance of the near-surface alternatives. Revise the performance assessment of each alternative so that realistic performance criteria are used. Remove or revise language suggesting that near-surface disposal alternatives can be engineered to perform at unrealistic levels.

ID No.	Section	Subsection	Page	Figure, Map or Table Number	Topic	Comment
85	5	5.3.11	5-87	NA	GTCC Waste Type	This section does not identify potential Resource Conservation and Recovery Act (RCRA) hazardous wastes. Revise the Draft GTCC EIS to identify potential RCRA hazardous wastes and associated volumes. Identify characteristic waste and/or listed waste. Include detailed information on how all RCRA hazardous wastes would be determined, managed, and disposed of in compliance with RCRA regulations. For all waste types discussed, address how the wastes would be managed and disposed of in accordance with state and federal requirements.
86	5	5.3.11	5-89	Table 5.3.11-1	GTCC Waste Type	This table indicates that approximately 18 to 168 cubic yards of hazardous waste (hazardous "solids") will be generated by the three methods of land disposal. Revise the Draft GTCC EIS to identify the hazardous wastes, provide information on how these wastes may qualify as RCRA wastes, and provide management and disposal information on how disposal actions will comply with RCRA.
87	5	5.3.11	5-90	Table 5.3.11-2	GTCC Waste Type	Hanford Site hazardous liquid and solid wastes would be "sent off-site for treatment, recycling, recovery, and disposal at RCRA-permitted commercial facilities." Depending on the type of hazardous waste, recycling and recovery are often not options. Provide more detailed information of how these RCRA wastes would be generated, managed, and disposed of. Revise the Draft GTCC EIS to provide information regarding generator status for these wastes. Provide information describing the storage time prior to disposal of these wastes. Also provide information on RCRA permitting for these wastes.
88	5	5.3.12	5-92	NA	Long-Term Impacts	Revise the Draft GTCC EIS to explain that although the impacts of various disposal alternatives may appear minor when viewed individually, these impacts may be significant when viewed collectively in the context of a site's other past, present, and foreseeable future impacts. Also explain that any additional impacts are unacceptable if the cumulative impacts at a site already exceed regulatory thresholds.
89	5	5.5	5-93	NA	Human Exposure	Failure to evaluate the impacts of direct intrusion into the disposal facility is technically unjustified. See previous comments regarding the direct intruder scenario, and revise the Draft GTCC EIS to address this scenario in detail.
90	5	5.6	5-95	NA	Surface Barriers/ Institutional Controls	Revise the Draft GTCC EIS to specifically note that active institutional controls will not be maintained after the first 100 years of disposal and thus will not dependably prevent inadvertent intrusion into disposed waste. Add additional text to note that disposal depth does not apply to the vault alternative as an effective mechanism for preventing intrusion. See previous comments regarding addition of the surface water exposure pathway to the revised Draft GTCC EIS.
91	5	5.6	5-95	NA	Surface Barriers/ Institutional Controls	According to 10 CFR 61, institutional controls include an environmental monitoring program, but no such plan is presented in this section of the report. Revise the Draft GTCC EIS to include a long-term environmental monitoring plan.
92	5	5.6	5-95	NA	Surface Barriers/ Institutional Controls	Based upon the logic presented in the text, two types of waste will be disposed of within the three disposal options: waste that will not be a hazard within 100 years and waste that will be a hazard for 10,000 years. Based on this assumption, the argument is made to cease active institutional controls after 100 years because "little would be gained by extending the length of the active institutional control period to much more than 100 years after closure" given that the waste would be hazardous for 10,000 years. The justification provided is illogical. Waste that is dangerous for 10,000 or more years should be disposed of in a deep geologic repository because it remains dangerous over that time by definition. Revise the Draft GTCC EIS to describe and evaluate the requirements for waste segregation and identify disposal in a deep geologic repository as the preferred alternative.

ID No.	Section	Subsection	Page	Figure, Map or Table Number	Topic	Comment
93	6	NA	6-1	NA	Hanford Site	The Hanford Site is not an appropriate location for the GTCC waste disposal facility because of its potential for seismic activity, complex subsurface environment, highly transmissive geologic units, proximity to one of the largest rivers in the contiguous United States, and existing high level of contamination. Importation of additional waste to the Hanford Site is contrary to the objectives and actions pursued and performed over the last 20 years of cleanup at the Hanford Site, which remains the largest Superfund site in the United States. Revise the Draft GTCC EIS to identify disposal in a deep geologic repository as the preferred alternative and remove the Hanford Site from the list of candidate sites for construction of a disposal facility.
94	6	NA	6-1	NA	EIS Contents	Full and fair consideration of tribal rights and concerns is not necessarily ensured by presenting tribal perspectives, as stated. Explain that the Treaty of 1855 reserves specific Yakama Nation resource rights. Also revise the text to remove the incorrect implication that treaty rights have been adequately considered.
95	6	NA	NA	Table 6.1.1-2	Human Exposure	Revise the Draft GTCC EIS to identify what portion of the “other toxic pollutants” is made up of carbon tetrachloride.
96	6	6.1	6-1	NA	Environmental Variables	The final location of the disposal facility has not been identified. Therefore, the range of conditions for the entire site should be considered in the Draft GTCC EIS. Using select meteorological stations does not appropriately characterize a site that experiences many environmental extremes. Revise the Draft GTCC EIS to consider environmental conditions over the entire Hanford Site.
97	6	6.1.1	6-3	NA	Environmental Variables	See previous comments regarding environmental variables. Revise the Draft GTCC EIS to give greater consideration to existing wind data such as that published in the reports of the Hanford Environmental Dose Reconstruction Project and collected throughout the site via the Hanford Meteorological Monitoring Network, not just at selected meteorologic stations.
98	6	6.1.1.1	NA	NA	Environmental Variables	Revise the Draft GTCC EIS to identify the temperature gradient from the surface downward and the observed depth of bioturbation at the Hanford Site.
99	6	6.1.1.2	NA	NA	Environmental Variables	Revise the Draft GTCC EIS to provide a reference for the information on carbon tetrachloride emissions in the 200 Area.
100	6	6.1.1.3	6-10	NA	Environmental Variables	Measurement of particulate matter at the site between 2001 and the present does not constitute a full characterization. Revise the Draft GTCC EIS to incorporate older data, including data from periods of active operations at Hanford.
101	6	6.1.2.1	6-14	NA	Environmental Variables	This section does not provide an evaluation, but more a generalized summary that downplays all aspects of the geology and, as a result, the complexity of the site. Significant aspects of the geology are disconnected, such as, first, the movement of groundwater through complex lithology and, second, over a patchwork basalt surface that directs and pools enormous amounts of existing contaminants. Existing contaminants are scarcely mentioned, if at all. The existence of clastic dikes, which have a notable effect on groundwater flow, is also not discussed. Revise the Draft GTCC EIS to address these topics in detail.
102	6	6.1.2.1.3	6-18	NA	Environmental Variables	This section provides a fairly detailed overview of the stratigraphy of the entire Hanford Site. Revise the Draft GTCC EIS to include an additional subsection that discusses the stratigraphy specifically of the potential disposal site.
103	6	6.1.2.1.4	6-22	NA	Environmental Variables	The largest recorded earthquake in Washington State was the North Cascades Earthquake near Lake Chelan. This earthquake had a calculated magnitude of 6.8 (intensity magnitude, M_I; the moment magnitude, M_W, was 6.5 to 7.0 at 95 percent confidence). Recent studies have identified faults proximate to the Hanford Site capable of generating earthquakes of magnitude 7.1 or greater. Refer to comments in Attachment 1 on this topic. Revise the Draft GTCC EIS to include this information. Further revise the Draft GTCC EIS to expand the area in which seismic events may result in significant shaking or damage to a disposal facility at the Hanford Site, to appropriately and accurately reflect the danger posed by seismic hazards in the Hanford vicinity.
104	6	6.1.2.1.4	6-22	NA	Environmental Variables	The probabilistic seismic hazard analysis should be moved to an appendix and significantly expanded. See previous comments on seismic risk and environmental variables and revise the Draft GTCC EIS accordingly.

ID No.	Section	Subsection	Page	Figure, Map or Table Number	Topic	Comment
105	6	6.1.2.1.4	6-22	NA	Environmental Variables	The seismic analysis cited in the Hanford Site NEPA characterization (Duncan et al., 2007) did not determine the ability of Hanford facilities to withstand seismic hazards, as the Draft GTCC EIS asserts. The 1993 Hanford Seismic Hazard Analysis (Geomatrix Consultants, 1993) simply estimated the probability of seismic activity for use in facility design and evaluation at five specific Hanford areas, including the 200 East GTCC reference location. Cite the 1993 Hanford Seismic Hazard Analysis and correctly explain the study's actual purpose and scope. See previous comments regarding seismic risk at the Hanford Site. Revise the Draft GTCC EIS in accordance with these comments.
106	6	6.1.2.1.4	6-22	NA	Environmental Variables	The 1993 Hanford Seismic Hazard Analysis (Geomatrix Consultants, 1993) referenced in the Hanford Site NEPA characterization (Duncan et al., 2007) assessed "...the current state of scientific knowledge about the seismic potential and earthquake ground motion characteristics of the Hanford region." A supplemental seismic study is needed to "evaluate the appropriateness of the assumptions regarding the characteristics of earthquake ground motions at the individual [Hanford] sites" (Geomatrix Consultants, 1993). Revise the Draft GTCC EIS to include this additional evaluation.
107	6	6.1.3.1.1	6-29	NA	Environmental Variables	Revise the Draft GTCC EIS by adding to this paragraph that the Columbia River supports numerous natural resources, including spawning and rearing areas for salmon, steelhead, sturgeon, and other migratory and resident fish species, and is of major cultural importance to numerous Indian tribes.
108	6	6.1.3.1.3	6-35	NA	Environmental Variables	Revise the Draft GTCC EIS by adding to this paragraph the fact that groundwater contaminated with many of the same radionuclides is currently discharged to the Columbia River.
109	6	6.1.3.2.3	6-40	NA	Long-Term Impacts	Revise the Draft GTCC EIS to address potential future changes in groundwater recharge rates that result from changes in precipitation due to natural cycles and from climate change. In addition, increased irrigation of farm land either on the reservation or to the west (upgradient) of the reservation, should be discussed.
110	6	6.1.4	6-43	NA	Human Exposure	Uranium has all the physical, chemical, and radiological characteristics of a transuranic radionuclide and should be included with GTCC-like waste. Because uranium is both radioactive and chemically toxic, the chemical toxicity, exposure, and associated exposure pathways (including dermal absorption) should be considered in addition to radiation exposure and dose estimates. Revise the Draft GTCC EIS to include depleted uranium and other waste uranium as GTCC or GTCC-like waste and perform a thorough evaluation of both radiologic and chemical exposure that results from disposal activities.
111	6	6.1.4	6-44	Table 6.1.4-1	Human Exposure	Native Americans are not given consideration as a unique potentially exposed receptor group. Estimating exposure and radiation doses to just two receptor groups, workers and the general public, is inadequate. Native American exposure must also be evaluated and estimated based on their unique exposure parameters, such as those identified in the Yakama Nation Exposure Scenario (Ridolfi, 2007). Revise the Draft GTCC EIS to include Native Americans as a separate and unique group of receptors.
112	6	6.1.4	6-44	Table 6.1.4-1	Human Exposure	Exposure pathways listed in this table are not complete. In addition to external radiation, inhalation, and ingestion of water, bass, and plants, exposure via ingestion of soil, roots, and wildlife should also be evaluated. Revise the Draft GTCC EIS to include these additional exposure parameters.
113	6	6.1.4	6-45	NA	Human Exposure	Exposure appears to be based on very specific data sets from past monitoring. Although site characterization is not adequate relative to the size of the Hanford Site, there are many additional monitoring data sets available that can be used to estimate worst-case doses. Revise the Draft GTCC EIS to estimate exposure based on a larger set of monitoring data. Additionally, revise the Draft GTCC EIS to estimate future exposures, such as was done in the TCWM EIS (USDOE, 2009), based on projected total groundwater contamination that will result from plumes migrating from the Central Plateau and proposed waste disposal actions.
114	6	6.1.4	6-47	NA	Cultural Resources	Because there is no narrative associated with this (or any) Native American text box, it is unclear how the four categories of goods and services provided by an undisturbed environment and that contribute to human health are evaluated in the Draft GTCC EIS. Revise the Draft GTCC EIS to clearly state how (and where in the document) impacts to these important categories are evaluated in the EIS.

ID No.	Section	Subsection	Page	Figure, Map or Table Number	Topic	Comment
115	6	6.1.10	6-72	NA	Cultural Resources	Provide a reference for stating that humans have been present on the Hanford Site for approximately 8,000 years. Other sources state that there has been human presence at the site for 10,000 years. In addition, the timeframe during which there has been a human presence on the site in fact represents historical use of the site. Therefore, it is inappropriate to state that "historic use of the area began in 1805." Revise the Draft GTCC EIS to specify that the timeframe presented is only for Euro-American use.
116	6	6.1.10	6-72	NA	EIS Contents	Revise the Draft GTCC EIS to include the full name of the Yakama Nation as the Confederated Tribes and Bands of the Yakama Nation (Yakama Nation).
117	6	6.1.10	6-73	NA	Cultural Resources	The entire Hanford Site, including the Central Plateau and 200 Areas, is rich in culturally important sites, many of which do not include physical artifacts that can be easily identified using normal archaeological survey methods. Sacred sites may be seen as such because of their undisturbed views in all directions (e.g., Gable Mountain looks south at the 200 East Area). Many additional sites may not yet have been identified. Revise the Draft GTCC EIS to clarify that the entire site is culturally important to the Yakama Nation regardless of documented archaeological sites.
118	6	6.2.1	6-77	NA	Human Exposure	Revise the Draft GTCC EIS exposure pathways to include contaminated dust.
119	6	6.2.1	6-77	NA	Long-Term Impacts	Revise the Draft GTCC EIS to include text that acknowledges soils of this arid land are particularly susceptible to injury from disturbance, have long recovery times, and have high potential for colonization by invasive weeds.
120	6	6.2.3	6-82	NA	Short-Term Impacts	Revise the Draft GTCC EIS by substantially increasing this section to address the potential effects of releases of site water on the movement of current and possible future contaminated plumes. The proposed location would appear to have the potential to increase the rate of flow toward the Columbia River of existing groundwater plumes from the 200 Area as infiltration increases.
121	6	6.2.4	6-83	NA	Human Exposure	See previous comments regarding inclusion of Yakama Nation members and Native Americans as a unique receptor group. Revise the Draft GTCC EIS to consider all the pathways that affect the Native American exposure group.
122	6	6.2.4	6-85	Table 6.2.4-1	Environmental Variables	Cataclysmic floods that have inundated much of Eastern Washington have occurred historically. Revise the Draft GTCC EIS to evaluate cataclysmic flooding as a hypothetical accident scenario for Hanford.
123	6	6.2.4	6-86	NA	Human Exposure	The resident farmer scenario and other human health evaluations not related to worker health are based on a distance of 100 meters from the disposal area boundary. See previous comments regarding appropriate exposure scenarios, distances from the disposal facility, and contaminant concentrations. Revise the Draft GTCC EIS to appropriately reflect the risk posed by the facility following closure.
124	6	6.2.4	6-87	Tables 6.2.4-2 and -3	Long-Term Impacts	It is unclear how (and whether) the groundwater doses estimated from the GTCC waste inventory will be added to the groundwater contamination that already exists at Hanford. It is critical that the Draft GTCC EIS explain that the estimated doses and associated LCF risk calculated from post-closure contaminant migration will occur <u>in addition</u> to already-existing groundwater contamination from current waste inventories, including extensive plumes of Tc-99 and I-129, which are associated with elevated doses and cancer risks (as estimated in the TCWM EIS; USDOE, 2009). While the presentation in this table may be useful for comparing technologies, it is misleading for comparing sites and considering the appropriateness of Hanford for any of the technologies. See comments in Attachment 1 regarding cumulative impacts.
125	6	6.2.4	6-89	NA	Human Exposure	It is not adequate to evaluate only exposure distances greater than or equal to 100 meters; this distance cannot be considered conservative. See previous comments regarding human exposure, distance from release, and pathways. Revise the Draft GTCC EIS to incorporate these comments.
126	6	6.2.11	6-103	NA	GTCC Waste Type	The description of solid and hazardous waste management is vague. The same inadequate paragraph (verbatim) is included for all the other potential disposal sites. Revise the Draft GTCC EIS to provide detailed descriptions of waste generated (both hazardous and solid) for all potential disposal sites, as well as regulatory requirements, management to comply with those requirements, and disposal options.

ID No.	Section	Subsection	Page	Figure, Map or Table Number	Topic	Comment
127	6	6.3	6-104	NA	Human Exposure	It is incomplete to evaluate potential impacts only to workers and the general public. Hanford is a part of the Yakama Nation's usual and accustomed use areas, to which unrestricted access is guaranteed by the Treaty of 1855. The Yakama Nation must be considered a potentially exposed receptor group in the short term and long term, and the unique exposures of the Yakama people must be evaluated, such as high exposure rates for surface water, groundwater, fish, game, and wild plant ingestion; sweat lodge use; and other cultural and subsistence uses of natural resources. Revise the Draft GTCC EIS to incorporate these pathways and doses as outlined in the Yakama Nation Exposure Scenario (Ridolfi, 2007).
128	6	6.3	6-105	NA	Human Exposure	It is important to explain that the dose estimates presented in this summary will occur in addition to doses from already-existing groundwater contamination from current waste inventories, including extensive plumes of Tc-99 and I-129. It is misleading to present results and state that there will be no LCF without noting that additional doses will certainly occur. Note that doses presented here do not take into account additional doses from existing contamination at Hanford, which suggests that Hanford is an unacceptable location for any of the action alternatives. See previous comments on this topic. Revise the Draft GTCC EIS in accordance with these comments.
129	6	6.4.1.1	6-107	NA	Long-Term Impacts	Disposal within waste sites located in the reference area[1] may involve disturbing contaminated sediments at depths greater than currently accounted for in the prescribed cleanup methods. Revise the Draft GTCC EIS to incorporate all existing contamination and cleanup activities at the Hanford Site in the estimate of cumulative impacts on the site. [1]Underlying the reference area UPR-200-E-83 or Non-Radioactive Dangerous Waste Landfill (NRDWL) or an immediate neighbor of the B/C trenches and one of PUREX's primary liquid effluence disposal trenches 216-A-30.
130	6	6.4.2	6-109	NA	Long-Term Impacts	The text should be revised to clarify that post-closure impacts presented in Section 6.2.4.2 3 indicate that groundwater impacts for the land disposal alternatives (borehole, trench, and vault facilities) would contribute to overall cumulative impacts from past, present, and reasonably foreseeable future actions at Hanford. The level of cumulative impact analysis should be commensurate with potential impacts, and the long-term groundwater impacts should be closely scrutinized (USEPA, 1999). However, a careful examination of cumulative impacts at Hanford would first require a comprehensive cumulative risk assessment for the entire site, which has not yet been conducted. A complete cumulative impacts analysis could then provide an understanding of whether the proposed alternatives might push a resource, ecosystem, or human community beyond a critical threshold and preclude sustainability (CEQ, 1997). The cumulative impacts assessment also needs to further evaluate combined impacts to specific resources (e.g., land use, surface water). The cumulative impacts of proposed alternatives combined with other USDOE actions (e.g., on-site waste disposal) should be documented. In addition, planned land use restrictions by USDOE in conjunction with Department of Interior limitations on land use in the Arid Lands Ecology (ALE) Reserve may result in cumulative impacts that have not yet been fully assessed. Revise the Draft GTCC EIS to incorporate these analyses.
131	6	6.4.2	NA	NA	Long-Term Impacts	Cumulative impacts evaluated in this section are not accurate and do not account for all impacts at the Hanford Site. Revise the Draft GTCC EIS to include all additional impacts identified in the TCWM EIS (USDOE, 2009), such as operation of the waste treatment plant; cleanup of the river corridor; transport of waste to the Central Plateau; impacts from the Environmental Restoration Disposal Facility; impacts from the US Ecology LLRW disposal facility; and existing contamination associated with former Central Plateau waste disposal practices. See previous comments regarding complete assessment of cumulative impacts at the Hanford Site.
132	6	6.5	6-111	NA	EIS Contents	There is no mention of treaty rights in this section. Revise the Draft GTCC EIS to incorporate treaty rights.
133	12	NA	12-1	NA	EIS Contents	Revise the Draft GTCC EIS to provide estimates of resource impacts for generic sites that are not included in the current draft. Provide a discussion of when this evaluation will be conducted, what will be included, and how this information will be available for public review.

ID No.	Section	Subsection	Page	Figure, Map or Table Number	Topic	Comment
134	12	12.1	12-1	NA	Human Exposure	It is incomplete to evaluate potential impacts only to workers and the general public. Since Region IV (western states) allows for all alternative technologies and the majority of reservations are in the western states, it is likely that a generic disposal facility would be located near Native Americans. The Draft GTCC EIS should be revised to include a Native American scenario when estimating doses and cancer risk, including high exposure rates for surface water, groundwater, fish, game, and wild plant ingestion; sweat lodge use; and other cultural and subsistence uses of natural resources.
135	12	12.1	12-3	NA	Surface Barriers/ Institutional Controls	It is not realistic or appropriate to assume that engineered covers and waste containers will not begin to degrade until after 500 years. See previous comments regarding the barrier dependence and expected longevity in the action alternatives. Revise the Draft GTCC EIS to provide alternatives that do not depend on surface barriers and optimistic assumptions to meet performance requirements.
136	12	12.2	12-3	NA	Human Exposure	To say that "…no off-site releases are expected because the waste packages would contain the radioactive materials and because monitoring of the site and nearby vicinity would identify the need for any corrective actions" is not logical, given that the Draft GTCC EIS repeatedly states that no monitoring of the site would be conducted beyond 100 years post-closure. Revise the Draft GTCC EIS to provide more specific information about what monitoring would be implemented, how often it would be conducted, and how long it would continue. Clarify what parameters would be monitored (for example, groundwater, barrier integrity, infiltration) and possible corrective actions that would be pursued if contamination were found to be migrating. Provide contingency plans for the escape of radioactivity from the proposed disposal structures.
137	12	12.2	12-3	NA	Surface Barriers/ Institutional Controls	Revise the Draft GTCC EIS to give examples of the types of engineering controls that would be used in the event of contaminant releases. Describe in detail how likely it is that the proposed controls will control and reduce these releases. Provide examples of additional measures to be taken should engineering controls prove inadequate in completely stopping and subsequently reducing unintentional releases.
138	12	12.3	12-4	NA	Human Exposure	See previous comments regarding intentional intruder scenarios and post-closure exposure scenarios that should be included. Revise the Draft GTCC EIS to include these scenarios and exposures.
139	12	12.3	12-5	NA	Surface Barriers/ Institutional Controls	Revise the Draft GTCC EIS to provide specific corrective actions that would be taken if water were found to be infiltrating waste within the first 500 years of closure. See previous comments regarding assumed barrier performance and infiltration rates. Revise the Draft GTCC EIS in accordance with these comments.
140	12	12.3	12-17	NA	Environmental Variables	See previous comments regarding underlying assumptions used to estimate releases from the proposed disposal facility in the first 10,000 years. Revise the Draft GTCC EIS to provide realistic assumptions based on environmental parameters that are not optimal for facility performance.
141	13	13.3	13-2	NA	EIS Contents	The Yakama Nation's treaty rights are not acknowledged in this section. Revise the Draft GTCC EIS to acknowledge the Yakama Nation's treaty rights.
142	13	13.3.1	13-3	NA	EIS Contents	Revise Section 13 of the Draft GTCC EIS to include the Treaty of 1855 (12 Stat. 951) as a requirement to be considered in the EIS process.
143	13	13.4	13-11	NA	EIS Contents	Executive Orders that may be violated by the Draft GTCC EIS include EO-11514 (Protection and Enhancement of Environmental Quality Requirements for Federal Agencies), EO-13175 (Consultation and Coordination with Indian Tribal Governments), EO-13045 (Protection of Children from Environmental Health Risks), and EO-13423 (Strengthening Federal Environmental, Energy, and Transportation Management). Revise the Draft GTCC EIS to be compliant with these Executive Orders.

ID No.	Section	Subsection	Page	Figure, Map or Table Number	Topic	Comment
144	Appendix B	NA	NA	NA	EIS Contents	The Draft GTCC EIS inadequately discusses uncertainties in the waste volumes and radioactivity that may require storage. Of particular concern is that the inventory will be substantially larger than is estimated or that new, unplanned facilities will generate GTCC or GTCC-like wastes in the future. It seems likely that any facility developed to accept the wastes identified in the Draft GTCC EIS will be the first choice for future incremental additions to the waste repository. Revise the Draft GTCC EIS to further discuss whether the evaluation is intended to address only the wastes identified in Appendix B or whether the facility is expected to be available to handle all such wastes that might be generated in the future.
145	Appendix C	C.1	C-1	NA	Environmental Variables	This section does not deal with the resulting air contamination from construction in contaminated soils and sediments. See previous comments on this topic.
146	Appendix C	C.2	C-2	NA	Environmental Variables	See previous comments regarding soil and sediments at the Hanford Site and revise the Draft GTCC EIS in accordance with these comments. In addition, the mentioned soil, topographic, geologic, and seismic hazard surveys should be included in the Draft GTCC EIS. There are notable omissions in the case of the Hanford Site, such as the problem that clastic dikes pose to both the geology and water resources.
147	Appendix C	C.3	C-3	NA	Environmental Variables	At the Hanford Site, the threat to water resources, which are already severely compromised by existing, uncontrolled, subsurface contamination, is significant, directly affecting groundwater and the Columbia River. The impact discussion in the Draft GTCC EIS focuses on construction impacts and does not touch on what should be the principal concern—adding to the existing contamination burden on the land, soils, groundwater, and river. See previous comments regarding inadequate analysis of cumulative impacts and environmental variables. Revise the Draft GTCC EIS in accordance with these comments.
148	Appendix C	C.6	C-20	NA	Human Exposure	This section does not consider the implications of a catastrophic accident/release. At the Hanford Site, there is a real possibility of large sections of the population being affected. The Draft GTCC EIS should be revised to identify the number of people who would be directly and indirectly affected by a significant release of radiation in the areas under consideration.
149	Appendix C	C.9.3.1	C-29	NA	Human Exposure	The risk model does not consider groundwater contamination. This is particularly important to a site such as Hanford, where the Columbia River directly connects Hanford to large population areas. Revise the Draft GTCC EIS to include this exposure pathway.
150	Appendix E	E.1	E-3	NA	Human Exposure	Failure to evaluate the human health effects of direct intrusion based on the speculated unlikelihood of its occurrence is technically unjustified. See previous comments on this topic. Revise the Draft GTCC EIS in accordance with these comments.
151	Appendix E	E.1	E-5	NA	Human Exposure	Surface runoff should be considered a viable pathway for the near-surface trench and above-surface vault disposal alternatives. The assumption that no erosion would occur over 10,000 years is technically unjustified, especially given that institutional controls (e.g., maintenance measures to reduce erosion) cannot be relied upon and will not be maintained for more than 100 years (10 CFR 61). See previous comments on this topic. Revise the Draft GTCC EIS in accordance with these comments.
152	Appendix E	E.2.1	E-8	NA	Surface Barriers/ Institutional Controls	The Draft GTCC EIS has already established that post-closure monitoring and maintenance will not be conducted beyond 100 years and therefore cannot be depended upon for future protection of the entombed waste. To suggest that these actions will provide long-term benefits to secure the disposed waste is misleading and false. Revise the Draft GTCC EIS to remove the following statement and statements of a similar nature throughout the document: "…[proper] post-closure monitoring and maintenance of the facility would reduce the likelihood, to the extent possible, that anyone would actually be exposed to radioactive contaminants in the wastes."
153	Appendix E	E.2.1	E-8	NA	Long-Term Impacts	See previous comments regarding post-closure exposure and cumulative impacts. Revise the Draft GTCC EIS in accordance with these comments.
154	Appendix E	E.2.1	E-8	NA	Human Exposure	The location used to evaluate long-term human health impacts is not conservative and should not be construed as such. See previous comments regarding locations and types of exposure that should be considered post-closure. Revise the Draft GTCC EIS in accordance with these comments.

ID No.	Section	Subsection	Page	Figure, Map or Table Number	Topic	Comment
155	Appendix E	E.2.1	E-8	NA	Human Exposure	The assumption that the resident farmer scenario at desert sites is conservative because it presumes farming would not be possible due to low rainfall totals is clearly false, given that the entire area is surrounded by irrigated farms. Clearly, the ability to farm does not depend on rainfall totals alone. Revise the Draft GTCC EIS to remove this statement and all others like it and replace them with text that acknowledges (1) that farming could occur at any candidate site sometime within the next 10,000 to 100,000 years and (2) that there is no empirical way to demonstrate this is not the case. See previous comments on this topic.
156	Appendix E	E.2.2	E-9	E-2	Human Exposure	While conceptually straightforward, this section and the associated figure do not account for the feedback loops that this type of long-lived contamination has been noted to follow. Numerous accounts of radionuclides preferentially accumulated in nature have been documented in river and terrestrial ecology. Revise the Draft GTCC EIS to acknowledge and incorporate this feedback.
157	Appendix E	E.3	E-13	NA	Human Exposure	Because current storage of GTCC wastes is at the ground surface and institutional controls are not relied upon for more than 100 years, evaluation of long-term impacts for the No Action alternative should consider surface runoff and airborne releases (including particulates). A quantitative human health analysis of all potential impacts of the No Action alternative is necessary for a meaningful comparison of the No Action and action alternatives. See previous comments on this topic and revise the Draft GTCC EIS to incorporate these pathways.
158	Appendix E	E.6	E-59	Table E-15	Environmental Variables	The infiltration rate provided for Hanford is lower than vadose zone infiltration rates measured at Hanford. A conservative estimate of infiltration has been found to be 10 mm/year. The infiltration rate in the Draft GTCC EIS significantly underestimates the potential movement of contaminants. In addition, the infiltration rate may change significantly over time as a result of climate change and lower temperatures. The minimum 10,000-year period over which the disposal facility must isolate wastes requires that higher rates be considered in the analysis. Revise the Draft GTCC EIS to evaluate higher infiltration rates at the waste site.
159	Appendix E	E.6	E-59	Table E-15	Environmental Variables	See previous comments regarding assumed precipitation and infiltration rates used to analyze the Hanford Site. Revise the Draft GTCC EIS to use increased precipitation and infiltration within a reasonable range that could result from significant climate change in the next 10,000 to 100,000 years.

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Attachment 3

Comments of the Institute for Energy and Environmental Research on the Department of Energy's *Draft Environmental Impact Statement for the Disposal of Greater-Than-Class C (GTCC) Low-Level Radioactive Waste and GTCC-Like Waste* (DOE/EIS-0375-D), published in February 2011

9 June 2011
Prepared for Ridolfi, Inc., by
The Institute for Energy and Environmental Research

These comments on the *Draft Environmental Impact Statement for the Disposal of Greater-Than-Class C (GTCC) Low-Level Radioactive Waste and GTCC-Like Waste* (DOE/EIS-0375-D), published by the Department of Energy (DOE) in February 2011, were prepared by the Institute for Energy and Environmental Research under contract to Ridolfi, Inc. This Draft GTCC EIS is referred to in the comments below as "Draft EIS." IEER had submitted comments to the DOE on its draft implementation (or scoping) plan in September 2007.[1]

Overview and Recommendations for a Revised Draft EIS

Our analysis indicates that the Draft EIS is very incomplete and in many respects scientifically ill-founded. These points are called out explicitly in the discussion below. As a result we have concluded that it is necessary to re-do the draft and republish a Draft EIS for public comment. The recommendations below for a revision indicate the breadth and depth of the scientific and regulatory gaps and problems with the Draft EIS. They are based on the analysis and review of the EIS below (including Appendix A).

Section A Recommendations: DOE's responses to some public comments on scope (with four subsections)

> A revised draft EIS should be published that includes a deep geologic repository alternative other than WIPP.

[1]Arjun Makhijani. *Comments of the Institute for Energy and Environmental Research on the Department of Energy's Notice of Intent to Prepare an Environmental Impact Statement for the Disposal of Greater-Than-Class-C Low-Level Radioactive Waste, Federal Register,* Institute for Energy and Environmental Research, September 21, 2007, on the Web at http://www.ieer.org/comments/gtccnoi.pdf. Hereafter Makhijani 2007.

The EIS should include an alternative that combines hardened on site storage of commercial reactor decommissioning GTCC for 30 to 60 years combined with disposal.

A revised draft EIS should be published that explicitly addresses cancer risks to children and especially female children, to estimate whether the proposed disposal methods meet the standards for public health protection in existing regulations, notably Subpart C of 10 CFR 61.[2] In light of Executive Order 13045, the DOE should also consider non-cancer risks in utero and non-cancer risks to children.

A revised draft EIS should be published that explicitly includes depleted uranium from enrichment plants as GTCC-like waste. This should include both existing stocks of DU at DOE sites as well as stocks of DU anticipated from the centrifuge enrichment plant that has been licensed and operating in New Mexico and the one likely to be operational in the future in Idaho.

Section B Recommendation: Standards to be applied for performance assessment

The DOE should apply the criteria of 10 CFR 61.41 for assessing whether a site and disposal method meets minimal disposal criteria. It is essential to calculate organ doses and to do so for the age and gender that would be the most exposed for a given set of environmental conditions. For CERCLA sites, like Hanford, ARARs, including radionuclide drinking water MCLs and a lifetime cancer risk of at most one in 10,000, need to be maintained. The DOE should also take treaty compliance into account through use of appropriate scenarios and by assuming that institutional controls will end when DOE site cleanup is completed. Sites and disposal methods that do not meet these criteria should be ruled out. Hanford does not meet the criteria for any disposal method and should be ruled out as a disposal site for GTCC and GTCC-like waste. The Draft EIS should be reissued for public comment with the changes in this set of recommendations since the failure to use the appropriate standards and ARARs as reference points is a fundamental analytical and legal problem. The Draft EIS as it stands gives the false impression that the choices of sites and disposal approaches are much wider than they are if reasonable existing health and environmental standards are applied.

Section C Recommendations: Source terms that are not, but should be, included in a revised Draft EIS

Recommendation: The DOE should reissue a Draft GTCC EIS for public comment with the following source terms included:

1. Depleted uranium from enrichment plants
2. Recycled uranium, including the recycled uranium in the DOE complex and that generated from operations at West Valley
3. Hanford reactor graphite moderator blocks

[2] United States. Nuclear Regulatory Commission. *Code of Federal Regulations. Title 10 –Energy: Chapter I – Nuclear Regulatory Commission; Part 61 – Licensing Requirements for Land Disposal of Radioactive Waste*. 1-1-11 Edition. Washington, DC: Office of the Federal Register, National Archives and Records Administration; U.S. Government Printing Office, 2011. On the Web at http://www.gpo.gov/fdsys/pkg/CFR-2011-title10-vol2/pdf/CFR-2011-title10-vol2-part61.pdf.

4. The plutonium-containing waste that was buried as transuranic waste at the US Ecology commercial low-level waste site prior to 1970.
5. Buried transuranic waste and plutonium containing waste in trenches and cribs at Hanford
6. "Immobilized Low Activity Waste" resulting from the high-level waste processing and vitrification work planned at Hanford.
7. High-level waste tanks when they are removed from the Hanford Site after the waste is removed for vitrification.
8. Soil around the high-level waste tanks that contains high-level waste that leaked from dozens of the tanks over the decades.

Section D Recommendations: Health and Environmental Impact

Recommendations

The present Draft EIS does not meet the minimum standards of transparency that would allow an independent verification of the DOE's estimates. Nor does it meet the minimum tests of estimating health and environmental impacts that would give credence to the results that claim that public health would be protected in the trench, vault, or borehole scenarios. It is also far too limited in considering a single geologic repository site, WIPP, that is limited by law to only defense transuranic waste. In other words, the Draft EIS does not meet the test of scientific integrity and a reasonable range of alternative as required by NEPA. The DOE should publish a revised Draft EIS with the following changes in the scenarios:

1. All base case scenarios should assume a complete loss of institutional control. Therefore all resident farmer and tribal scenarios should assume that there will be people residing on the disposal site rather than away from it. These residents would therefore use water from the site below the disposal layer for domestic, agricultural, and cultural purposes.
2. The revised Draft EIS should incorporate the fact of pre-existing contamination on DOE sites when it models disposal at such sites.
3. The revised Draft EIS should have at least one scenario in which the cover is completely eroded away (on the order of 1mm/year of erosion) in order to assess the effect of disposal on surface water and aquatic food contamination. Besides RESRAD default consumption, the Yakama lifestyle scenario should also be evaluated in this case.
4. The revised draft EIS should provide sound, scientific technical justification for key parameters such as the lifetime of grout and infiltration rate as well as possible future rainfall and climate variations. There has been ample work in these areas that is not reflected in the Draft EIS at present.
5. The revised Draft EIS should have a normal sensitivity analysis in which parameter variation results in dose estimates on both sides (higher and lower) of the base case.
6. A realistic assessment of the trench, vault, and borehole disposal options shows that the basic health protection and dose limits would be violated by large margins. These methods are unsuitable for disposal of GTCC and GTCC-like waste and should be explicitly rejected when the Draft EIS is revised. We

understand that Congress is to have its say about a preferred alternative when the Final EIS is published. But that should not prevent the DOE from clearly pointing out that some methods of disposal violate existing regulations and in the case of DOE Superfund sites, ARARs, not to speak of tribal treaty rights.

7. The doses to a resident farmer are far higher when realistic scenarios about loss of institutional control and memory are evaluated (rather than the DOE's assumption of a permanent knowledge of the site boundary). The DOE should include an onsite farmer using irrigation water from the disposal site in its trench, vault, and borehole scenarios.
8. The DOE's recognition that offsite wastes containing Tc-99 and I-129 should not be brought to Hanford for disposal should lead it to the conclusion that no GTCC or GTCC-like wastes should be brought to Hanford for a variety of reasons, including the need to develop more than one site if they are, the exacerbation of contamination at Hanford from other wastes that would be brought in, the need, in fact to remove existing wastes from Hanford in order to meet drinking water standards and other ARARs, etc.
9. The DOE should calculate organ as well as total body effective doses. This will enable an evaluation of the degree to which disposal methods comply with dose limits in existing regulations such as the drinking water standards (40 CFR 141.66) and the low-level waste rule (10 CFR 61 Subpart C).
10. The DOE should consider at least one deep geologic repository other than WIPP as one of the alternatives.

A. DOE's responses to some public comments on scope

The DOE has not given a satisfactory response to a number of public comments regarding the scope and nature of the alternatives to be considered and the manner in which they should be evaluated. The response to some of the key comments on the scope is non-responsive enough to warrant revision of the draft and republication of a new draft for public comment.

1. The DOE has considered no alternative for deep geologic disposal other than the Waste Isolation Pilot Plant (WIPP)

Section 1.5.2 of the Draft EIS[3] states that

> DOE does not plan to evaluate an additional deep geologic repository facility because siting another deep geologic repository facility for GTCC LLRW and GTCC-like waste would be impractical due to the cost and time involved and the relatively small volume of GTCC LLRW and GTCC-like waste.

WIPP is presently restricted by law to defense transuranic waste. Yet, almost all the radioactivity in the source term, as defined by DOE in the Draft EIS, is commercial GTCC. There is no guarantee that Congress would enact a law to accommodate GTCC and GTCC-like waste at WIPP. A number of commenters, including IEER, had asked that WIPP be ruled out, in part for this reason. We understand that the DOE can ask for the law to be changed and that Congressional action will be required prior to

[3] Draft EIS Section 1.5.2 (pp. 1-43 to 1-45) is called: Comments Determined to be Outside EIS Scope.

actual final selection of a preferred alternative. However, it is essential that a repository other than WIPP also be evaluated, since WIPP is restricted by law to defense waste and since deep geologic disposal is the option with the lowest long-term radiological impacts. Moreover, the DOE did not compare the cost and time for creating a new repository with that of expanding WIPP. Finally, the Blue Ribbon Commission on America's Nuclear Future (BRC) may consider an option of a repository for defense high-level waste separate from a commercial spent fuel repository. While WIPP may eventually be considered for such a mission, we note that the BRC is not going to recommend any specific sites for any waste. A new site would therefore also be among the options for defense high-level waste. That site could also accommodate GTCC and GTCC-like waste, a number of other "orphan" wastes, like large amounts of depleted uranium from enrichment plants and recycled uranium from the nuclear weapons complex (see below). Congressional action would be required in all of these cases.

Recommendation: A revised draft EIS should be published that includes a deep geologic repository alternative other than WIPP.

2. *The DOE has rejected Hardened On Site Storage (HOSS) of GTCC without an adequate analysis.*

In Section 1.5.2 (p. 1-43) of the Draft EIS, the DOE states that it did not consider HOSS because the GTCC EIS process is about "permanent disposal" and on site storage does "not meet the purpose and need for agency action." While we recognize that HOSS is not a permanent disposal option, HOSS could be a complement to permanent disposal, especially for commercial GTCC generated by the decommissioning of reactors, which accounts for about 98 percent of the radioactivity considered in the Draft EIS. Onsite storage of reactor decommissioning GTCC for 60 years would greatly decrease the total amount of radioactivity relative to that estimated by the DOE at disposal time (six years after reactor shut down). This is because the vast majority of the radioactivity in reactor decommissioning GTCC consists of relatively short-lived radionuclides such as manganese-54, iron-55, cobalt-60, and others. At the end of 60 years of storage after reactor shut down, this portion of the radioactivity would have decayed away almost totally. Much of it also decays after the six years of storage assumed by the DOE. However, the radioactivity remaining at 60 years after storage is only about 11 percent of that at six years. That remaining at 30 years is about 15 percent of that at six years after reactor shutdown.[4] This decrease in radioactivity would therefore also greatly reduce the largest source of decay heat in the overall GTCC and GTCC-like source term that the DOE has considered in the Draft EIS. It would also greatly reduce the total GTCC and GTCC-like source term to be disposed of.

Onsite storage of commercial GTCC from reactor decommissioning would add little to the cost of the decommissioning of reactor sites, in view of the cancellation of the Yucca Mountain Project. Commercial spent fuel will likely have to be stored on site for decades. While the BRC is considering an option of consolidated storage, the practical failure of the Private Fuel Storage Project in Utah[5] to

[4] Calculated by applying the decay constants of the eight most important radionuclides (carbon-14, manganese-54, iron-55, nickel-59, nickel-63, cobalt-60, molybdenum-93, and niobium-94) to the inventory at 6 years and 60 years. See Appendix C (begins at pdf p. 254)of J. Schelling, C. D. Leigh, et al., *Supporting Nuclear Utility Inventory Estimates for the Greater-Than-Class-C Low-Level Radioactive Waste Environmental Impact Statement Evaluations*. This document is available as Appendix H (begins at pdf p. 226) in *Basis Inventory for Greater-than-Class-C Low-Level Radioactive Waste Environmental Impact Evaluations*, Rev 1, Sandia National Laboratories, May 2008, on the Web at http://www.gtcceis.anl.gov/documents/docs/Task_3_2_Revision_1_FINAL.pdf. Also see Table 4 (p. 16) of this main document.

[5] The project failed in practice to create a storage site even though the federal legal formalities of obtaining a license from the Nuclear Regulatory Commission were successfully completed.

actually open even after obtaining a license from the Nuclear Regulatory Commission (NRC) is an indication that onsite storage of spent fuel is the most likely outcome for the foreseeable future. Even if the storage period is not 60 years, a storage period of just half that would still eliminate by decay almost 94 percent of the radioactivity in the entire GTCC and GTCC-like source term.

Finally, the DOE needs to evaluate the cost impact of a combined onsite storage approach for 30 to 60 years followed by disposal with the option of no onsite storage beyond the six years delay between reactor shutdown and waste disposal now envisioned in the Draft EIS.

Recommendation: The EIS should include an alternative that combines hardened on site storage of commercial reactor decommissioning GTCC for 30 to 60 years combined with disposal.

3. *The Draft EIS has essentially dismissed without analysis the comments made on the implementation plan that it should address the issue of doses and cancer risks to women and children and risks during in utero exposure (p. 1-44 to 1-45). The Draft EIS has also not considered non-cancer risks in utero and to children.*

IEER had made the following recommendation in its comments on the implementation plan:

> The BEIR VII report of the National Research Council concluded that females face a much higher overall risk than males and that children face higher risks than adults. The risk factors for cancer incidence, by sex and age, published in BEIR VII should be used to estimate risks in the GTCC EIS. Non-cancer risks considered in the BEIR VII report should also be evaluated. If any EPA guidance is used it should be EPA Federal Guidance Report 13, and not Federal Guidance Report 11.
>
> We note here that external dose risk factors FGR 13 (and FGR 12) are explicitly based on Reference Man, a hypothetical young "Caucasian" male. The EIS should explicitly reject this model. Dose estimates should be made for the most vulnerable – that is, those most at risk for a given exposure. It is critical in this area therefore to use the BEIR VII report especially for external dose estimates, since it does not suffer from this limitation.
>
> *Recommendation: Radiation dose calculations should include separate estimates of doses to males and females in various ages groups from infant on up. Cancer risks should be based on the results of the BEIR VII report. All cancer risks should consider incidence as well as mortality. Non-cancer risks should also be considered.*[6]

The Draft EIS contains what is essentially a non-response and continues to use Reference Man:

> The concerns with regard to the increased sensitivity of various elements of the population are noted. The EIS presents a comparative analysis of the potential radiation doses and LCF [latent cancer fatalities] risks to members of the general public (as represented by an adult receptor) from use of the various disposal alternatives presented in the NOI. As such, the level of detail requested here is not necessary for the purposes of this EIS, and the hazards associated with management of these wastes are

[6] Makhijani 2007 p. 10

presented in terms of the annual dose and LCF risk to a potentially exposed adult receptor.

The estimates for dose and LCF risk were based on a resident farmer receptor, which is considered a conservative scenario that accounts for the largest number of pathways of potential exposure. The primary pathway of concern, however, is the ingestion of groundwater potentially contaminated with radionuclides released from wastes at the proposed disposal facility. The estimated dose and LCF risk to an adult receptor presented in the EIS are considered conservative (relative to any other potential receptor) because the ingestion rate assumed for water intake is the 90th percentile value for the general public recommended by the EPA (i.e., two liters per day for 365 days per year) (EPA 2000).

Follow-on NEPA evaluations will be conducted, as needed, to assess potential human health impacts on a site-specific basis (accounting for sensitive populations as applicable) when a disposal site or location is identified.

The continued use of an adult male resident farmer is not responsive to the comment at all. The comment that the DOE is using a 90th percentile value for water intake does not compensate for the added doses and risks faced by children even when lower intakes for the latter are taken into account. For instance, the table below shows that the risks for infants and five-year old female children are considerably higher than female 30-year-olds even when lower intakes by children are taken into account. For instance, the risk of breast cancer for a female child is more than 20 times greater than for an adult female, *for the same level of environmental contamination*. The differential between female children and men is even greater than shown in Table 1.

Table 1: Lifetime cancer incidence risk for exposure at stated age, fluid ingestion, females only (fluid intakes adjusted for age)

Cancer	Radionuclide	Infant Risk/Bq	Age 5 Risk/Bq	Age 30 Risk/Bq	Overall Risk Ratio Infant/Age 30 (Note 1)	Overall Risk Ratio Age 5/Age 30 (Note 1)
Leukemia	Sr-90	2.79E-08	3.06E-09	1.13E-09	6.2	1.7
Breast	Sr-90	1.38E-09	2.60E-10	1.68E-11	20.6	10.0
Thyroid	I-131	2.32E-07	8.63E-08	1.77E-09	32.8	12.2

Notes: 1. Fluid intakes for females assumed as follows: infant = 350 cc per day, 5-year old = 900 cc/day; 30-year-old = 1,400 cc/day. The fluid intake figures for children were computed at 50 cc/day/kilogram of weight, using mean weights for the United States. These are total fluid intakes, including, but not limited to, water. 2. Bq = Becquerel.

Source: Adapted from Makhijani, Smith, and Thorne, *Science for the Vulnerable*, Institute for Energy and Environmental Research, 2006, p. 40, on the web at http://www.ieer.org/campaign/report.pdf.

The DOE and all federal agencies are required to take into account the higher sensitivity of children. Indeed, the explicit failure to do so and the explicit reliance on an adult receptor are arguably in violation of the Executive Order on Children. Specifically, Executive Order 13045, *Protection of Children From Environmental Health Risks and Safety Risks*, states:[7]

[7] William J. Clinton. "Executive Order 13045 – Protection of Children From Environmental Health Risks and Safety Risks." *Federal Register*, v. 62, no. 78 (April 23, 1997), pp. 19883-19888. On the Web at http://www.epa.gov/fedrgstr/eo/eo13045.pdf, p. 19885. Emphasis added.

A growing body of scientific knowledge demonstrates that children may suffer disproportionately from environmental health risks and safety risks. These risks arise because: children's neurological, immunological, digestive, and other bodily systems are still developing; children eat more food, drink more fluids, and breathe more air in proportion to their body weight than adults; children's size and weight may diminish their protection from standard safety features; and children's behavior patterns may make them more susceptible to accidents because they are less able to protect themselves. Therefore, to the extent permitted by law and appropriate, and consistent with the agency's mission, each Federal agency:

(a) **shall make it a high priority to identify and assess environmental health risks and safety risks that may disproportionately affect children**;

and

(b) **shall ensure that its policies, programs, activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks.**

It is clear from the phrases in we have put in bold in the above quote that the DOE is both required to identify risks that disproportionately affect children and to ensure that its programs and actions address any disproportionate risks. It is also clear from Table 1 above that disproportionate risks to children do exist, even when female children are compared to female adults. The difference is much greater when female children are compared to male adults. As a result, the Draft EIS's failure to explicitly estimate doses and risks to children fails to even minimally meet the requirements of Executive Order 13045.

Recommendation: A revised draft EIS should be published that explicitly addresses cancer risks to children and especially female children, to estimate whether the proposed disposal methods meet the standards for public health protection in existing regulations, notably Subpart C of 10 CFR 61.[8] In light of Executive Order 13045, the DOE should also consider non-cancer risks in utero and non-cancer risks to children.

4. *The Draft EIS has not included depleted uranium from enrichment plants in its source term.*

IEER provided an extensive factual, regulatory, and analytical basis in its comments on the implementation plan that depleted uranium from enrichment plants should be included as part of the GTCC and GTCC-like source term for this EIS. IEER also provided analysis indicating that the DU from enrichment plants was unsuitable for shallow land burial, which could not meet 10 CFR 61 Subpart C

[8] United States. Nuclear Regulatory Commission. *Code of Federal Regulations. Title 10 –Energy: Chapter I – Nuclear Regulatory Commission; Part 61 – Licensing Requirements for Land Disposal of Radioactive Waste*. 1-1-11 Edition. Washington, DC: Office of the Federal Register, National Archives and Records Administration; U.S. Government Printing Office, 2011. On the Web at http://www.gpo.gov/fdsys/pkg/CFR-2011-title10-vol2/pdf/CFR-2011-title10-vol2-part61.pdf.

health protection criteria.[9] The Draft EIS has not addressed any of the substance of the comments, in effect ignoring them altogether.

Further, the analysis provided by IEER clearly fits into DOE's own definition of GTCC-like waste in the Draft EIS:

> GTCC-like waste refers to radioactive waste that is owned or generated by DOE and has characteristics sufficiently similar to those of GTCC LLRW such that a common disposal approach may be appropriate. GTCC-like waste consists of LLRW and potential non-defense-generated TRU waste that has no identified path for disposal. The use of the term "GTCC-like" is not intended to and does not create a new DOE classification of radioactive waste.[10]

The vast majority of DU from the three gaseous diffusion plants was generated by the DOE and is owned by it. IEER showed that it has characteristics sufficiently similar to GTCC for it to be disposed of in the same manner. For instance, its long-lived alpha-emitting specific activity is well over 100 nanocuries per gram, which is the threshold for GTCC in 10 CFR 61.55. It has no identified path for disposal at the present time. The DOE was required by law to address comments substantively. This comment is a very important one in terms of the scope of the GTCC EIS, the health impact of GTCC and GTCC-like low-level waste, and cost. It is therefore imperative that DOE revise and republish its Draft EIS for public comment to include DU from past, existing, and proposed enrichment plants for technical, environmental, and legal considerations.

Recommendation: A revised draft EIS should be published that explicitly includes depleted uranium from enrichment plants as GTCC-like EIS. This should include both existing stocks of DU at DOE sites as well as stocks of DU anticipated from the centrifuge enrichment plant that has been licensed and operating in New Mexico and the one likely to be operational in the future in Idaho.

B. Standards to be applied for performance assessment

The DOE is charged with the responsibility for providing alternatives for disposal of GTCC (and GTCC-like) waste under the general framework of the NRC's low-level waste rule 10 CFR 61.

> In 10 CFR Part 61, "Licensing Requirements for Land Disposal of Radioactive Waste," the NRC classifies LLRW into four classes (Classes A, B, and C, and GTCC LLRW) on the basis of the concentrations of short-lived and long-lived radionuclides (10 CFR 61.55). By controlling isotope concentrations in each class, the NRC regulations seek to control potential radiation exposures to future receptors, including inadvertent human intruders (e.g., a water well driller) after the period of active institutional control has ended. The NRC states in 10 CFR 61.55 that GTCC LLRW is not "generally acceptable" for near-surface disposal, although the NRC recognizes in 10 CFR 61.7(b)(5) that "there may be some instances where waste with concentrations greater than permitted for Class C

9 Makhijani 2007 pp. 3 to 8
10 Draft EIS v. 1, p. 1-1

waste would be acceptable for near surface disposal with special processing or design."[11]

What is "acceptable" and "not acceptable" for disposal under 10 CFR 61 is primarily defined by whether the disposal meets the health protection criteria specified in terms of maximum dose in 10 CFR 61 Subpart C, which states in part:

> **§ 61.40 General requirement.**
> Land disposal facilities must be sited, designed, operated, closed, and controlled after closure so that reasonable assurance exists that exposures to humans are within the limits established in the performance objectives in §§ 61.41 through 61.44.
>
> **§ 61.41 Protection of the general population from releases of radioactivity.**
> Concentrations of radioactive material which may be released to the general environment in ground water, surface water, air, soil, plants, or animals must not result in an annual dose exceeding an equivalent of 25 millirems to the whole body, 75 millirems to the thyroid, and 25 millirems to any other organ of any member of the public. Reasonable effort should be made to maintain releases of radioactivity in effluents to the general environment as low as is reasonably achievable.

The rule also requires that the health of inadvertent intruders also be protected but does not explicitly provide a dose limit:

> **§ 61.42 Protection of individuals from inadvertent intrusion.**
> Design, operation, and closure of the land disposal facility must ensure protection of any individual inadvertently intruding into the disposal site and occupying the site or contacting the waste at any time after active institutional controls over the disposal site are removed.

It is important to note that no time limit for the protection of the health of the public is specified in 10 CFR 61.

All disposal of low-level waste under 10 CFR 61, whatever its class, must meet these health protection criteria. Despite these very clear rules, the Draft EIS does not use 10 CFR 61 Subpart C as the basic criterion for deciding whether a disposal method is acceptable. For instance, while 10 CFR 61.41 requires the calculation of organ doses, the Draft EIS does not provide any estimates of organ doses. It does not eliminate options that exceed 10 CFR 61.41 dose limits even in terms of whole body effective dose equivalents.

Further, at sites such as Hanford, which are Superfund (CERCLA) sites, the DOE is required to meet other regulatory criteria that go under the collective rubric of Applicable or Relevant and Appropriate Requirements (ARARs). These include groundwater protection to drinking water standards and Superfund standards that limit the cancer risk from residual contamination to the range of 10^{-4} to 10^{-6}, that is, between one in ten thousand and one in a million.[12]

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[11] Draft EIS v. 1, p. 2-59

[12] The CERCLA (or Superfund) remediation standard is at 40 CFR 300.430. http://edocket.access.gpo.gov/cfr_2010/julqtr/pdf/40cfr300.430.pdf. The risk limit is specified at 40 CFR

The Draft EIS does not discuss ARARs for CERCLA sites. Specifically, the EPA defines a 15 millirem per year dose as being acceptable, even though it acknowledges that it exceeds the 10^{-4} lifetime cancer risk specified in the CERCLA regulation.[13] However, the EPA's risk coefficient of 0.000575 fatal cancers per rem for low-level radiation[14] equals a dose limit of about 3 millirem per year to meet the 10^{-4} risk limit. None of the approaches for disposal studied for Hanford meet this 3 millirem/year criterion of 10^{-4} lifetime cancer risk even if it is interpreted as fatal cancer risk and not cancer incidence risk and even if the DOE's estimates of doses are accepted. Specifically, the DOE calculates the annual doses for borehole, trench, and vault disposal as 4.8, 48, and 49 millirem respectively. As is shown in Appendix A and also discussed below, the borehole result is an artifact of selecting a resident 100 meters away from the site boundary, even thousands of years into the future, effectively assuming institutional control for unprecedented periods against historical evidence, against the assumption of maximum institutional control of 100 years in 10 CFR 61, and against the best prevailing scientific judgment that institutional control should not be assumed for more than about 100 years. Specifically, 10 CFR 61.59(b) specifies that "institutional controls may not be relied upon for more than 100 years following transfer of control of the disposal site to the owner." Placing a resident farmer on the site itself, since institutional control cannot be assumed for thousands of years, is the appropriate approach to estimating long-term doses and health effects. The DOE has not done this for any scenario. The doses in such a case would be much higher, as illustrated in Section III of Appendix A.

Finally, it is essential to take treaty compliance issues into account. An assumption of institutional control for thousands of years does not fulfill this criterion.

Recommendations: The DOE should apply the criteria of 10 CFR 61.41 for assessing whether a site and disposal method meets minimal disposal criteria. It is essential to calculate organ doses and to do so for the age and gender that would be the most exposed for a given set of environmental conditions. For CERCLA sites, like Hanford, ARARs, including radionuclide drinking water MCLs and a lifetime cancer risk of at most one in 10,000, need to be maintained. The DOE should also take treaty compliance into account through use of appropriate scenarios and by assuming that institutional controls will end when DOE site cleanup is completed. Sites and disposal methods that do not meet these criteria should be ruled out. Hanford does not meet the criteria for any disposal method and should be ruled out as a disposal site for GTCC and GTCC-like waste. The Draft EIS should be reissued for public comment with the changes in this set of recommendations since the failure to use the appropriate standards and ARARs as reference points is a fundamental analytical and legal problem. The Draft EIS as it stands gives the false impression that the choices of sites and disposal approaches are much wider than they are if reasonable existing health and environmental standards are applied.

300.430(e)(2)(i)(A)(2).) It should be noted that the range is for the combination of chemicals and radionuclides. It is discussed here assuming no carcinogenic chemicals are present.

[13] Stephen D. Luftig (Office of Emergency and Remedial Response) and Larry Weinstock (Office of Radiation and Indoor Air). *Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination*. (OSWER No. 9200.4-18) Washington, D.C.: Environmental Protection Agency, Office of Solid Waste and Emergency Response, August 22, 1997. On the Web at http://www.epa.gov/superfund/health/contaminants/radiation/pdfs/radguide.pdf.

[14] Keith F. Eckerman, Richard W. Leggett, Christopher B. Nelson, Jerome S. Puskin, Allan C.B. Richardson. *Cancer Risk Coefficients for Environmental Exposure to Radionuclides: Radionuclide-Specific Lifetime Radiogenic Cancer Risk Coefficients for the U.S. Population, Based on Age-Dependent Intake, Dosimetry, and Risk Models*. (Federal Guidance Report No. 13) (EPA 402-R-99-001) Oak Ridge, TN: Oak Ridge National Laboratory; Washington, DC: Office of Radiation and Indoor Air, United States Environmental Protection Agency, September 1999, on the web at http://www.epa.gov/radiation/docs/federal/402-r-99-001.pdf, p.179.

C. Source terms that are not, but should be, included in a revised Draft EIS

A number of source terms that should be included in the GTCC-like definition because they do not meet the health criteria of 10 CFR 61 or other ARARs for Hanford:

1. Depleted uranium from enrichment plants,
2. Recycled uranium, including the recycled uranium in the DOE complex and that generated from operations at West Valley,
3. Hanford reactor graphite moderator blocks,
4. The plutonium-containing waste that was buried as transuranic waste at the US Ecology commercial low-level waste site prior to 1970,
5. Buried transuranic waste and plutonium containing waste in trenches and cribs at Hanford,
6. "Immobilized Low Activity Waste" resulting from the high-level waste processing and vitrification work planned at Hanford,
7. High-level waste tanks when they are removed from the Hanford Site after the waste is removed for vitrification,
8. Soil around the high-level waste tanks that contains high-level waste that leaked from dozens of the tanks over the decades.

At present DOE plans to dispose of source terms numbers 3 to 8 in the list above in shallow land burial facilities on the Hanford Central Plateau, notably the Integrated Disposal Facility (East and/or West) and the Environmental Restoration Disposal Facility (ERDF) or to leave them in place where they are now. Yet, the DOE's own calculations show that its plans for the disposal of existing Hanford wastes related to remediation, as well as waste migration from past disposal practices, will result in violation of the drinking water levels by hundreds or even thousands of times to periods extending out hundreds or even thousands of years. While we recognize that variances from CERCLA ARARs are possible, such variances would result in a violation of the treaty rights of the Yakama Nation to unrestricted exercise of hunting, fishing, and gathering and other activities on the area now taken up by DOE Hanford facilities. Moreover, the DOE has not shown that retrievable storage of remediation wastes from Hanford with future disposal in a suitable deep geologic repository is not an option. Variances should not be given when there are viable alternatives to meet the ARARs. Indeed, given the threats to the most important surface water resource in the Northwest, deep disposal may well be the most attractive option, especially in combination with retrieval and similar disposal of wastes that have been disposed of in the past in ways that would not be acceptable today (such as discharge of plutonium-laden liquids to cribs and trenches). When there are not viable technologies available, a research and development program should be initiated.

We have already discussed the reasons for not disposing of the wastes listed in items 6 to 8 in the above list in IEER comments on the Tank Closure and Waste Management Draft EIS for the Hanford Site[15] and will not repeat them here. The rationale for including the other items in the GTCC EIS and designating them for deep geologic disposal is outlined here.

[15] See Attachment 3 to the letter from Harry Smiskin, Chairman, Yakama Tribal Council to David A. Brockman, Manager, Richland Operations Office, U.S. Department of Energy and Mary Beth Burandt, Document Manager, Office of River Protection, U.S. Department of Energy, March 19, 2010.

1. Depleted uranium

This is covered extensively in the IEER's comments on the implementation plan cited above. None of the facts or analysis have changed. The Draft EIS ignored both the facts and the analysis. The only thing that has changed is that the source term is likely to be bigger, since a new enrichment plant had begun operating since those comments were sent and at least one other new plant will be built. Table 2 shows the expected source term for depleted uranium from enrichment plants:

Table 2: Depleted uranium source term from past and future enrichment plant operations

	Current/Projected	**Metric tons**	**Cubic meters**	**Curies**
DOE complex	Current	5.58E+05	6.72E+04	1.90E+05
LES (NM)	Projected	3.09E+05	3.72E+04	1.05E+05
Areva (ID)	Projected	3.46E+05	4.16E+04	1.17E+05
Total	**Current and Projected**	**1.21E+06**	**1.46E+05**	**4.12E+05**

Source: Estimated by IEER from various sources.

2. Recycled Uranium

Recycled uranium has a higher specific activity than depleted uranium. It can range from 400 nanocuries per gram to over 1,000 nanocuries per gram depending on the enrichment level of the uranium (from depleted to slightly enriched). There are about 250,000 metric tons (13,200 cubic meters) of recycled uranium in various degrees of enrichments located at various sites of the DOE complex.[16] If the average activity is assumed to be 1,000 nanocuries per gram, then the number of curies is 250,000, which is somewhat greater than the historical source term of 190,000 curies for depleted uranium from the three DOE complex gaseous diffusion enrichment plants (see the first row of numbers in Table 2 above). The same scientifically based arguments made above for classifying depleted uranium as TRU waste hold *a fortiori* for recycled uranium (RU). That is to say, the specific activity for long-lived alpha-emitting radionuclides of RU is higher and, in addition, recycled uranium contains transuranic radionuclides (mainly plutonium isotopes and neptunium-237) and fission products (mainly technitium-99) that add to its radiotoxicity.

3. Hanford single pass reactor graphite moderator blocks

The DOE has proposed to dispose of the graphite moderator blocks of the single pass reactors in the shallow land disposal sites on the Hanford Central Plateau. This is entirely inappropriate for regulatory and environmental reasons.

About 5,700 cubic meters of graphite moderator blocks from the eight plutonium producing plants contain, all together, 37,000 curies of carbon-14. IEER's calculation shows that this waste is slightly under GTCC in terms of its concentration of radioactivity per cubic meter of waste. Yet, if buried at

[16] United States. Department of Energy. *A Preliminary Review of the Flow and Characteristics of Recycled Uranium throughout the DOE Complex 1952-1999, Project Overview and Field Site Reports.* (F-001-001) DOE, March 2001. p. 8.

Hanford and the carbon-14 reaches the groundwater, its concentration would well exceed the drinking water standards. The DOE's own estimate of carbon-14 contamination due to its disposal practices at ERDF is that the peak concentration will reach 1.3 million picocuries per liter about 520 years from now at the ERDF boundary.[17] The drinking water standard is 2,000 picocuries per liter by DOE's calculation.[18] Hence, according to DOE's own calculation the drinking water limit would be exceeded by 650 times 520 years from the present – well after the loss of institutional control. Moreover, the concentrations would be much greater than the drinking water limit for considerable periods before and after the estimated peak in about the year 2630.

A significant portion of the carbon-14 would likely be oxidized over the long-term since shallow land burial implies oxidizing conditions. If only half of the total is oxidized, about 18,500 curies of carbon-14 dioxide would be released to the atmosphere. This would be larger than the entire carbon-14 source term from all existing reactors from a geologic repository permitted under 40 CFR 191, the EPA rule that applies to all geologic repositories except Yucca Mountain. The permitted amount is 100 curies per 1,000 metric tons of heavy metal. Roughly 100,000 to 120,000 metric tons are to be expected from the operation of existing commercial reactors, which would mean a maximum permitted release of 10,000 to 12,000 curies of carbon-14 in the form of carbon-14 dioxide.

Indeed, it is important to remember in this context that a large, possibly central, part of the reason that Congress asked the National Academies to create a special standard for Yucca Mountain is because the EPA Science Advisory Board concluded that an oxidizing repository environment (like Yucca Mountain) may release carbon-14 in excess of the allowable one-tenth of the EPA estimated inventory and, by implication, that such a repository may not meet the carbon-14 emission part of 40 CFR 191.[19]

While it is difficult to calculate the emissions of carbon-14 from spent fuel disposed of in a deep geologic repository due to the many complex barriers to release and the complex physical and chemical pathways between the disposal location in an engineered deep geologic repository and the atmosphere, it is much less complicated to understand that a substantial fraction of the carbon-14 disposed of in shallow land burial under oxidizing conditions would be oxidized and released relatively rapidly to the atmosphere. Assuming half of the graphite block inventory is released, the total release to the atmosphere would be 18,500 curies. This would result in very small individual radiation doses – on the

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[17] United States. Department of Energy. *Remedial Investigation and Feasibility Study Report for the Environmental Restoration Disposal Facility*. (DOE/RL 93-99 rev.1) Richland, WA: DOE Richland Operations Office, October 1994. On the Web at http://www5.hanford.gov/pdw/fsd/AR/FSD0001/FSD0047/D196061256/D196061256_58632036_76907_802.pdf. Table 4-10 (pp. 4T-10c to 4T-10d)

[18] Drinking water standards for man-made beta and photon emitters, except tritium and strontium-90 are calculated assuming a 4 millirem per year maximum organ or whole body effective dose equivalent (whichever is greater) and a 2 liter daily intake of water by an adult. A list of "Benchmark Concentrations," which are equivalent to federal primary drinking water maximum contaminant levels (MCLs), is given in TC&WM Draft EIS Table O-4 (Appendix O, v. 2, p. O-31). The concentrations are derived from the drinking water annual dose limit of 4 mrem for man-made beta and photon emitters (except tritium and strontium-90) as specified in 40 CFR 141.66.

[19] The Science Advisory Board concluded that the uncertainties in modeling the release were very large and that the release could range from essentially zero to the entire inventory of C-14. The inventory itself was deemed to be somewhat uncertain. The EPA's estimate of inventory was 1 curie per metric ton. (United States. Environmental Protection Agency, Science Advisory Board, *An SAB Report : Review of Gaseous Release of Carbon-14 : Review, by the Radiation Advisory Committee, of the Release of Carbon-14 in Gaseous Form from High-Level Waste Disposal*, (EPA-SAB-RAC-93-010) EPA, April 1993. Hereafter cited as SAB 1993.)

order of ten microrem per person per year[20]) since the carbon-14 dioxide would be dispersed throughout the troposphere. Some of it would remain in the air and some would mix into the oceans. The collective doses to the global population over 10,000 years (less than two half lives of carbon-14) would be high.

Using the parameter of 400 person-rem per curie of carbon-14 dioxide (used by the EPA Science Advisory Board in its estimates[21]) the cumulative dose over 10,000 years would be on the order of 7.4 million rem. The BEIR VII risk factor for cancer incidence is 1.1 cancers per 1,000 person-rem of population dose. This means that 7.4 million person-rem would lead to more than 8,000 cancers globally. This is a very tiny fractional increase in the cancer rate that would not be detectable by any known technique; nonetheless it is a cumulatively large absolute number due to the long-half life of carbon-14 (5,730 years) and the fact that carbon-14 dioxide is chemically identical to non-radioactive ordinary carbon dioxide and as such is taken up by plants for their growth. About half of these cancers – over 4,000 – can be expected to be fatal.

In addition, the lifetime cancer incidence risk from drinking water contaminated with carbon-14 to 1.3 million picocuries per liter to a resident farmer would be about 1 in 10. That is, about 10 percent of a population of resident farmers would get cancer from consuming the water on site over a lifetime, without even taking into account the non-cancer risks associated with the fact the carbon-14 became organically bound and part of the food chain if the water is used for irrigation. One of every two such cancers would be fatal. According to the scaling factors developed by Argonne National Laboratory for the Draft EIS, the dose (and hence risk) from carbon-14 would more than double when all other pathways, including food grown with contaminated water, are taken into account. Note that Argonne assumed that just half the food came from the site, instead of all of it.[22] Overall therefore, one in every five people living a quasi-resident farmer lifestyle. All together, the lifetime cancer incidence risk to a resident farmer from both drinking water and diet would be more than one in five – over 2,000 times higher than the maximum allowable cancer risk of 10^{-4} under CERCLA. It would be more than 1,000 times the maximum CERCLA risk if that risk is interpreted as fatal cancer risk and not cancer incidence risk.

Finally, the Wigner energy stored in the graphite blocks could be released during handling, processing, and transport and cause a fire. This will require particular care regardless of the option chosen for disposal. But it causes a special problem for shallow land burial. Specifically, the low-level waste rule stipulates at 10 CFR 61.56(a)(6) that "[w]aste must not be pyrophoric. Pyrophoric materials contained in waste shall be treated, prepared, and packaged to be nonflammable." The DOE has no proposed method to make the graphite nonflammable before disposal.

In sum, a number of scientific, regulatory, environmental, and health considerations lead to the conclusion that the disposal of Hanford graphite moderator blocks in shallow land facilities, including vaults and boreholes, would be inappropriate.. It is therefore reasonable and appropriate to consider the Hanford graphite moderator blocks as GTCC-like waste and to prepare them for deep geologic

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[20] SAB 1993 p. 21 (where the dose is given as 0.01 mrem = 10 microrem).
[21] SAB 1993 p. 21
[22] Argonne National Laboratory, Environmental Science Division, *Post-Closure Performance Analysis of the Conceptual Disposal Facility Designs at the Sites Considered for the Great-than-Class-C Environmental Impact Statement*, (ANL/EVS/R-10/8), ANL, October 2010, on the Web at http://www.gtcceis.anl.gov/documents/docs/ANL_EVS_R-10_8.pdf. See Appendix C, p. 150 and Table C-1.

disposal where the fractional release of carbon-14 would be very small or even essentially zero if the site is well-selected.

4. The plutonium-containing waste that was buried as transuranic waste at the US Ecology commercial low-level waste site prior to 1970.

Prior to 1970 plutonium containing wastes were disposed of as low-level waste without particular regard to the specific activity of the transuranic alpha-emitting radionuclides in them. In 1970s the category of TRU waste was defined as that containing more than 10 nanocuries per gram of long-lived alpha-emitting radionuclides. The limit of 10 was raised to 100 in the 1980s.

One of the problems with US Ecology waste containing significant concentrations of transuranic radionuclides is that the batches of waste with concentrations more than 100 nanocuries per gram can no longer be segregated from those below that limit. Hence, one reasonable approach is to recover the entire TRU buried waste from the US Ecology site and treat is as TRU waste to be disposed of in a geologic repository. Since this is waste in a commercial site, it would then be an additional type of GTCC-like waste at least for the portion that was more than 100 nanocuries per gram. Since it is not now segregable, it should all be treated as TRU waste for recovery and deep geological disposal, especially since it will exacerbate the violation of drinking water limits and other ARARs at the site due to the other transuranic wastes disposed of on site in the early decades.

Specifically, the issue of transuranic contamination of the groundwater on the Central Plateau and in the longer term, the River Corridor, due to US Ecology operations, should not be seen in isolation from the other transuranic waste that the DOE treats as already disposed of or the plans of the DOE described in the Tank Closure and Waste Management Draft EIS (cited here as TC&WM Draft EIS). That EIS shows that the plutonium contamination from non-tank sources will contaminate water to greater than the drinking water limit far into the future. The drinking water limit for plutonium-239 is 15 picocuries per liter, in the absence of other alpha-emitting radionuclides such as radium-226 and americium-241.

In the TC&WM Draft EIS, the DOE estimated that the peak concentration of plutonium in the River Corridor would occur in the year 2983 – that is more than eight centuries from the present; that level would be 4,250 picocuries per liter,[23] or more than 280 times the drinking water standard. The plutonium would be migrating from the Central Plateau, where the US Ecology site is located with its estimated 140 kilograms of plutonium.[24] In addition, other radionuclides like iodine-129 and strontium-90 would also exceed the drinking water limit for considerable periods.

These facts point to a very different remediation approach for Hanford than assuming buried plutonium contaminated wastes to be already disposed of and therefore requiring no further action. The designation of US Ecology plutonium wastes as transuranic wastes should be an integral part of the evaluation of a strategy that approaches the Hanford Site as one that would be released for unrestricted use after completion of remediation, with such use being defined so as to include and respect the Yakama Nation's treaty rights. We understand that the US Ecology site would eventually revert to the

[23] TC&WM Draft EIS v. 2, Appendix U, Table U-2.

[24] All alpha-emitting isotopes. Calculated from Table 2.D of Department of Health, *Commercial Low-Level Waste Disposal Site, Richland, Washington: Final Environmental Impact Statement*, Volume I, (DOH Publication 320-031) Richland, WA, Washington State Department of Health and Department of Ecology, May 28, 2004, on the Web at http://www.doh.wa.gov/ehp/rp/waste/vol1.pdf. Hereafter referred to as DOH EIS 2004.

State of Washington after operations are finished as per the procedure specified in 10 CFR 61. But this should provide all the more incentive to the State to negotiate an understanding with the DOE that transuranic wastes, broadly defined, at the US Ecology site would be recovered for disposal offsite as GTCC-like waste.

5. Buried transuranic waste and plutonium containing waste in trenches and cribs at Hanford

The DOE considers the pre-1970 waste, whether solid or liquid, discharged or buried at the Hanford Site to be permanently disposed of. Some of it, especially in liquid form, has migrated to the vadose zone and the DOE considers that it would be too difficult to retrieve it. However, this waste is, by DOE's own calculation, going to contribute to massive contamination of the groundwater at the site for centuries. While some parts of the problem are indeed difficult, this is a matter for determined research and development rather than resignation to a highly contaminated future that would violate Yakama Nation treaty rights, among other things.

The source term for pre-1970 buried and discharged plutonium-contaminated waste at Hanford is quite large. About 362 kilograms of solid waste containing plutonium was buried at Hanford, of which the DOE itself has classified about 343 kilograms as being contained in transuranic waste that has plutonium concentrations of more than 100 nanocuries per gram.[25]

Before 1970, liquid waste containing transuranic elements was directly dumped into the soil. According the Appendix S of the Draft Tank Closure EIS the amount of plutonium-239 and plutonium-240 is about 200 kg.[26]

All told, about 543 kilograms of plutonium in defense transuranic waste was disposed of prior to 1970 that should now be recognized (and in the case of 343 kilograms of plutonium in the pre-1970 solid waste is recognized) as TRU waste by the DOE. A critical question is: why does the DOE consider this waste as already disposed of without a serious assessment of the technology needed to recover it and dispose it of according to present law and regulation, which requires repository disposal for defense TRU waste? A second and related question is: why is the DOE recovering the TRU waste from Pit 9 at Idaho, given that (i) there is also a large amount at Hanford, which, moreover, appears to be migrating faster than that at Idaho, and (ii) that the Hanford waste is in much closer proximity to a critical surface water resource, the Columbia River?

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[25] See Table 4-1 of W. O. Greenhalgh, *Pre-1970 Buried Transuranic Solid Waste at the Hanford Site.* (WHC-SD-WM-ES-325, Rev.0) Westinghouse Hanford Company, May 23, 1995, on the Web at http://www.iaea.org/inis/collection/NCLCollectionStore/_Public/27/002/27002757.pdf. Note: this does not include post-1970 TRU waste or US Ecology TRU waste or TRU liquid discharges. Nineteen kg of the 362 kg total in buried plutonium was omitted because it was not identified as TRU waste in the data. Hence the total TRU solid and liquid pre-1970 waste TRU source term is (362-19)+200 = 543 kilograms.

[26] TC&WM Draft EIS, v. 2, Appendix S, total compiled from Tables S-35b to S-60b.

Recommendation: The DOE should reissue a Draft GTCC EIS for public comment with the following source terms included:

1. **Depleted uranium from enrichment plants**
2. **Recycled uranium, including the recycled uranium in the DOE complex and that generated from operations at West Valley**
3. **Hanford reactor graphite moderator blocks**
4. **The plutonium-containing waste that was buried as transuranic waste at the US Ecology commercial low-level waste site prior to 1970.**
5. **Buried transuranic waste and plutonium containing waste in trenches and cribs at Hanford**
6. **"Immobilized Low Activity Waste" resulting from the high-level waste processing and vitrification work planned at Hanford.**
7. **High-level waste tanks when they are removed from the Hanford Site after the waste is removed for vitrification.**
8. **Soil around the high-level waste tanks that contains high-level waste that leaked from dozens of the tanks over the decades.**

D. Health and Environmental Impact

IEER carried out some verification calculations of radiation dose using the DOE's assumptions for a resident farmer 100 meters from the site. We did so using DOE's assumptions as well as more realistic assumptions for parameters relating to the site, using the same software, RESRAD-OFFSITE. IEER also performed some calculations for an onsite resident staying over the disposal site after a complete loss of institutional control and institutional memory. These calculations are shown in Appendix A. The analysis is summarized here in order to connect the analysis to the other comments and to provide a summary basis for the recommendations for a revised Draft EIS. Please refer to Appendix A for more details.

1. DOE's scenario assumptions

The DOE has a number of assumptions that artificially make doses via all but the water pathway disappear and go down to zero. For instance, the DOE assumes an erosion rate of only 0.01 millimeters per year – just four-tenths of an inch in a thousand years. This means that the DOE is effectively assuming that the five-meter cover for the waste will remain functionally intact for hundreds of thousands of years – despite the rain, snow, run off, and winds. Further the DOE makes non-conservative assumptions about infiltration, and hence the amount of water that travels through the waste layer. And, in one of the most surprising and unrealistic of assumptions, the DOE assumes that infiltration of water from any place other than above the GTCC disposal site would be across clean soil so that all other infiltration would dilute water contamination. Given that the proposed Hanford disposal site is on the Central Plateau, at about the core zone boundary, this assumption shows a shocking disregard of the extensive contamination of the Central Plateau from past disposal practices such as discharges into trenches and cribs, and leaks of high-level wastes from the tanks over the decades. It is essential for the DOE to take existing contamination as well as contamination from its proposed cleanup and disposal activities in the core zone into account when estimating the water contamination for a resident farmer 100 meters from the GTCC disposal site.

Assuming that a resident farmer will be at least 100 meters away from the GTCC disposal site boundary thousands of years into the future rests on the notion that the site boundary will be known in some way at that time. This implies some form of institutional control for thousands of years, which is completely unrealistic and contrary to scientific advice and understanding that has been given to the DOE, including by the National Academies. Specifically, the National Research Council has explicitly commented on this in regard to DOE cleanup plans. The same would apply to GTCC disposal. In a report on long-term management, the Council concluded as follows:

> The Committee on Remediation of Buried and Tank Wastes finds that much regarding DOE's intended reliance on long-term stewardship is at this point problematic….
> […]
> Other things being equal, **contaminant reduction is preferred to contaminant isolation and imposition of stewardship measures whose risk of failure is high.**
> […]
> *The committee believes that the working assumption of DOE planners must be that many contamination isolation barriers and stewardship measures at sites where wastes are left in place will eventually fail, and that much of our current knowledge of the long-term behavior of wastes in environmental media may eventually be proven wrong. Planning and implementation at these sites must proceed in ways that are cognizant of this potential fallibility and uncertainty.*[27]

The DOE has ignored this by assuming that a resident farmer will be at least 100 meters from the site in all scenarios. The DOE has not done even a single case that assumes a failure of controls and loss of institutional memory, thus dismissing the advice that it should assume that stewardship measures "will eventually fail." But, surprisingly, it implicitly claims that in adopting the 100-meter distance from the site boundary it is actually following this advice:

> Under Alternatives 3 to 5, the long-term human health impacts are addressed by considering the future radiation dose and LCF risk to a hypothetical individual who resides 100 m (330 ft) from the edge of the disposal facility and develops a farm. **This resident farmer scenario is assumed to be conservative** (i.e., one that overestimates the expected dose and LCF risk) **because it assumes a total loss of institutional control and institutional memory with regard to the disposal facility** and because the radiation doses and LCF risks estimated to occur to this individual would likely never occur.[28]

This statement is internally contradictory. How can a person know to set up their home at least 100 meters from the disposal site in every case if there is a total loss not only of control but also of institutional memory? A total loss of control and memory requires an assumption that a future resident farmer or tribal member will actually live on the disposal site with their families, since they will have no way of knowing where the site boundary was located in the distant past. Therefore the DOE's claim that an assumption that a resident farmer will be at least 100 meters

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[27] National Research Council, Board on Radioactive Waste Management, Commission on Geosciences, Environment, and Resources, *Long-Term Institutional Management of U.S. Department of Energy Legacy Waste Sites,* Washington, DC: National Academy Press, 2000, on the Web at http://www.nap.edu/catalog.php?record_id=9949, pp. 3 and 5. Original italics; bold added.

[28] Draft EIS v. 1, p. 2-15, emphasis added.

away is consistent with a complete loss of institutional control and memory is incorrect and scientifically unsupportable. Moreover, it is not conservative, as shown in Appendix A.

The DOE does not provide adequate technical justification for key parameter choices such as infiltration rate through the waste layer and the lifetime of the engineered barriers even though the former is rather low (resulting in lower dose estimates) and the latter, at 500 years, is rather high, also resulting in lower dose estimates than more realistic assumptions.

2. Verification of DOE's dose estimates for trench disposal method at the Hanford Site

The specific scenario that IEER tried to reproduce was the trench disposal method at Hanford with default parameters as used in the Draft EIS, which estimates a peak dose of 48 mrem/year; the largest component is Remote Handled (RH) Other Waste category, whose peak dose the DOE estimates at 39 mrem per year. The scenario is the DOE's base case with the resident farmer being 100 meters from the site using all the other assumptions as well, so far as they are specified in the Draft EIS.

Figure 1 shows the results of IEER's verification calculations using the DOE assumptions so far as we could determine them from the Draft EIS (see Appendix A for more details).

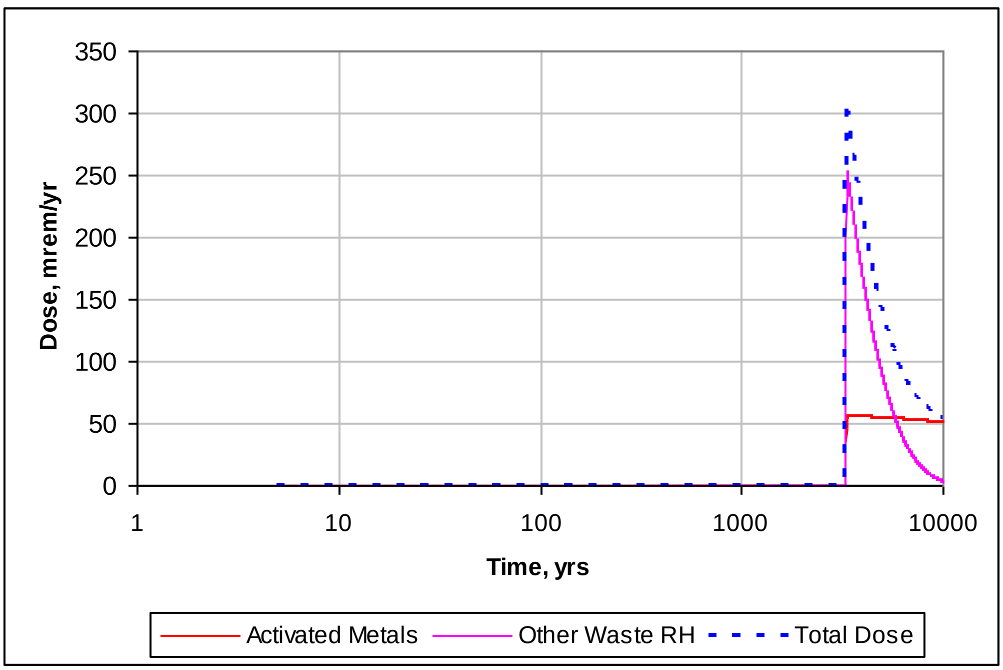

Figure 1: IEER's modeling results for trench disposal of GTCC and GTCC-like waste in a trench at Hanford

As can be seen from Figure 1, IEER's peak dose estimate using the DOE's parameters so far as they could be determined is about 300 millirem per year. The activated metals dose is about 50 millirem and the Other Waste - RH dose is about 250 millirem. The total peak dose is about six times the DOE's estimate of 48 millirem noted above. Figure 2 below shows the results of DOE's trench disposal modeling in more detail.

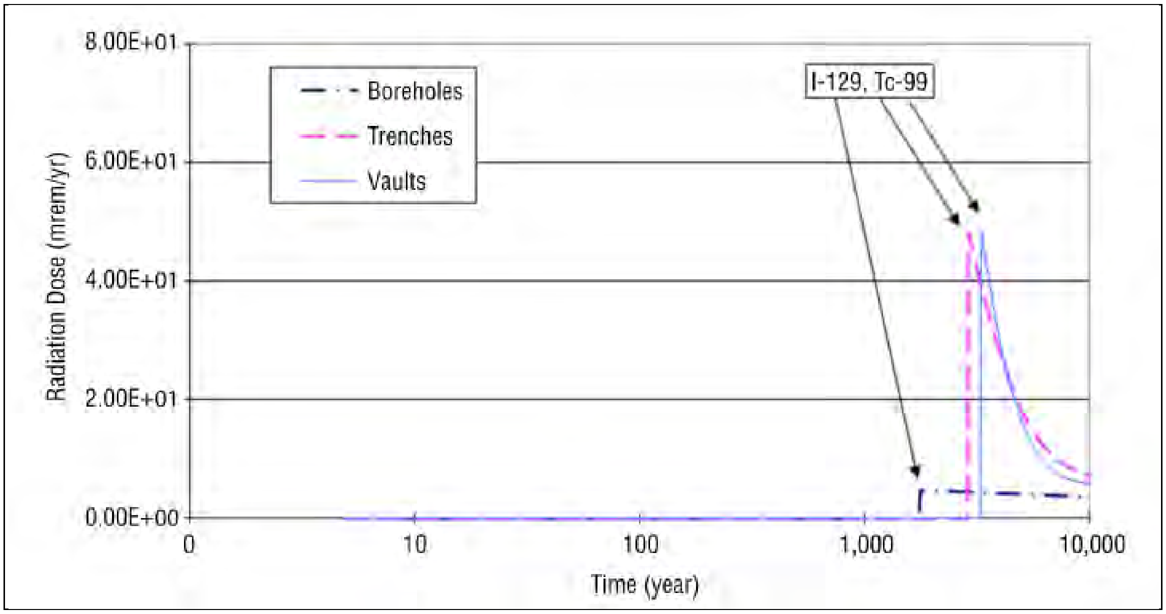

Figure 2: The DOE's modeling results for trench disposal of GTCC and GTCC-like waste in a trench at Hanford
Source: Figure 6.2.4-1 in Draft GTCC EIS (Volume 1)

Further, it should be noted that the vast majority of the dose results from iodine-129 and technetium-99. The water pathway is the only one considered (both direct use and indirect doses via agriculture) and those doses are dominated by I-129 and Tc-99. This is a critical result that has considerable implications for the total body effective dose equivalent used by the DOE to the exclusion of organ dose estimation. This is discussed below when the sensitivity analysis is considered.

The most important conclusions from this verification exercise are:

- The DOE's peak dose estimates for the first 10,000 year period appear to be significant underestimates.[29]
- Both the DOE peak dose estimate and the IEER peak dose estimate are considerably higher than the allowable maximum limit under 10 CFR 61 Subpart C, the NRC's low-level waste dose limit, even for the non-conservative assumptions used in this scenario.[30] Hence, they indicate that trench disposal is unsuitable. Since the vault disposal doses are very similar (49 mrem/yr peak), that approach is also unsuitable.[31]

The reasons for the large differences in results are unclear. One reason may be that the DOE has not used the standard RESRAD-OFFSITE model but rather modified it in a three-step process

[29] On the other hand, the DOE's peak dose estimates for the period between 10,000 and 100,000 years are larger than those of IEER. See Appendix A.
[30] "Non-conservative" is used here in the sense that it does not adequately represent public health protection and that doses tend to be underestimates relative to realistic as well as conservative assumptions. "Conservative" would be designed to give a great deal of confidence that radiation doses and health impacts would likely be below those estimated.
[31] We comment on the borehole method below.

for estimating non-drinking water doses; the reasons that the DOE used this estimation process are unclear to us. Further, the properties of the agricultural areas are not specified either in the Draft EIS or the key reference that the Draft EIS used for dose calculations. It is not possible to properly analyze and verify the DOE's calculations without key input parameters. Further, we have reasons to be skeptical, because much of the approach and several of DOE's assumptions are clearly non-conservative.

3. Sensitivity analysis

The DOE has done a very abnormal, unusual, and non-conservative sensitivity analysis. A normal sensitivity analysis varies the base case parameters on both sides – that is, in ways that would give an optimistic picture and a pessimistic picture in terms of health and environmental outcomes and reflect a realistic range for the possible variation in parameters in the future. A normal sensitivity analysis is also a useful way of exploring the possibility that key assumptions may be wrong in ways that might worsen the health outcomes. This is in keeping with the basic spirit of the National Research Council recommendation that it is important to understand what may occur in technical and institutional barriers fail in the long term and if key assumptions are wrong.

In contrast, the Draft EIS effectively treats the base case as the worst case in its sensitivity analysis even though it contains non-conservative and in some cases dubious and internally inconsistent assumptions. For instance, a normal sensitivity analysis would assume that a farmer might live closer to the site boundary than 100 meters or even within the site boundaries; it would also include a scenario in which a farmer lived farther away. The Draft EIS only considers that case in which a farmer would live farther away. Similarly, for the durability of performance (no infiltration for 500 years and durability of grout for 500 years), the DOE assumes that the performance quality will extend out much farther in time -2,000 to 5,000 years – but makes no provision for failure in a much shorter time. These assumptions not only did not conform to normal sensitivity analysis practice, they also fly in the face of available facts of barrier performance degradation. There are very large uncertainties with respect to the performance of grout, which can and has deteriorated rapidly under certain conditions. Experiments under adverse conditions of large surface to volume ratios done at Oak Ridge National Laboratory, for instance, showed a release fraction of strontium-90 from grout between 3.9% and over 50% in only 80 days.[32]

More details on Draft EIS approach to sensitivity analysis can be found in Appendix A.

IEER performed its own sensitivity analysis to test the effect of erosion (1 mm per year at the upper limit was assumed), climate, and other parameters, using variations both higher and lower than the base case. For instance, the infiltration rate was doubled from 20 to 40% and also halved to 10%. However, the resident farmer was still assumed to be 100 meters outside

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[32] As discussed and cited in Brice Smith, *What the DOE Knows it Doesn't Know about Grout: Serious Doubts Remain About the Durability of Concrete Proposed to Immobilize High-Level Nuclear Waste in the Tank Farms at the Savannah River Site and other DOE Sites*, Institute for Energy and Environmental Research, Takoma Park, Maryland updated October 18, 2004, p. 3. On the web at http://www.ieer.org/reports/srs/grout.pdf. The conditions of the experiment would likely be more adverse than in subsurface disposal, but then 80 days is less than 0.1 percent of the time for which DOE assumes complete barrier integrity.

the site, so some comparison would be possible when other technical parameters were varied. The results of the sensitivity analysis regarding distance from the site boundary to the well are shown in Figure 3.

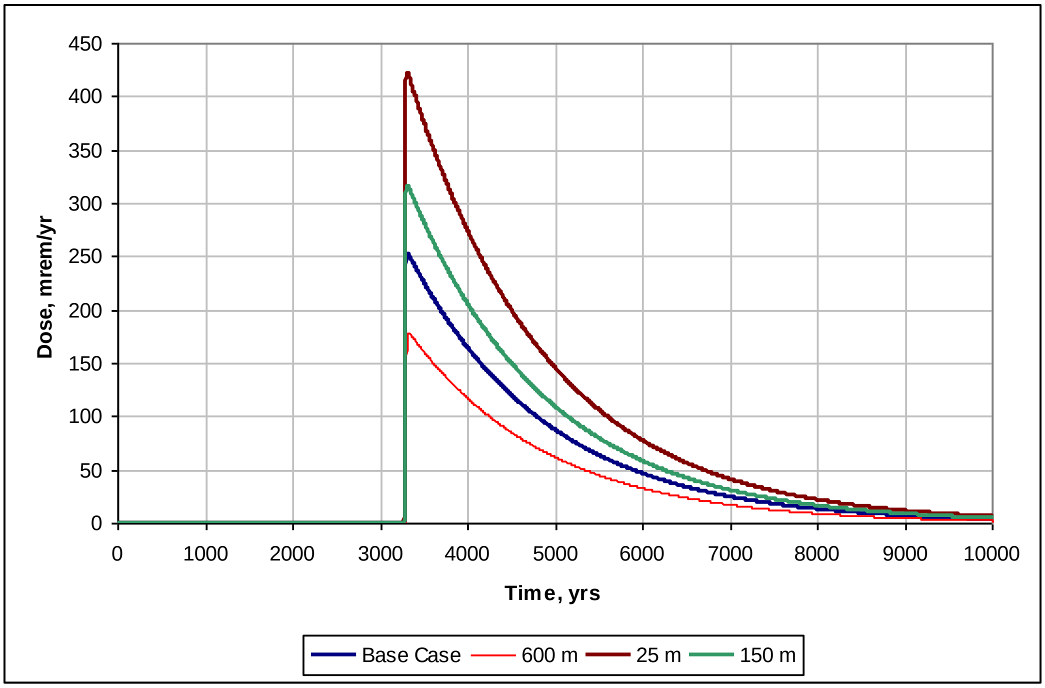

Figure 3: Total Dose for the Different Distances to the Well (Note: Base case distance to the well is 300 m, which is in between the case of very close (25 m) to the site boundary and 600 m).

It is clear that the variation of a single parameter increases the dose from the most important component of the waste in terms of peak dose (Other Waste - RH) from about 250 mrem/year to over 400 mrem per year.

When all parameters are varied the upper limit of dose increases by about a factor of four for total dose and by more than a factor of four for the Other Waste - RH category. See Figure 4 below and Appendix A for more details.

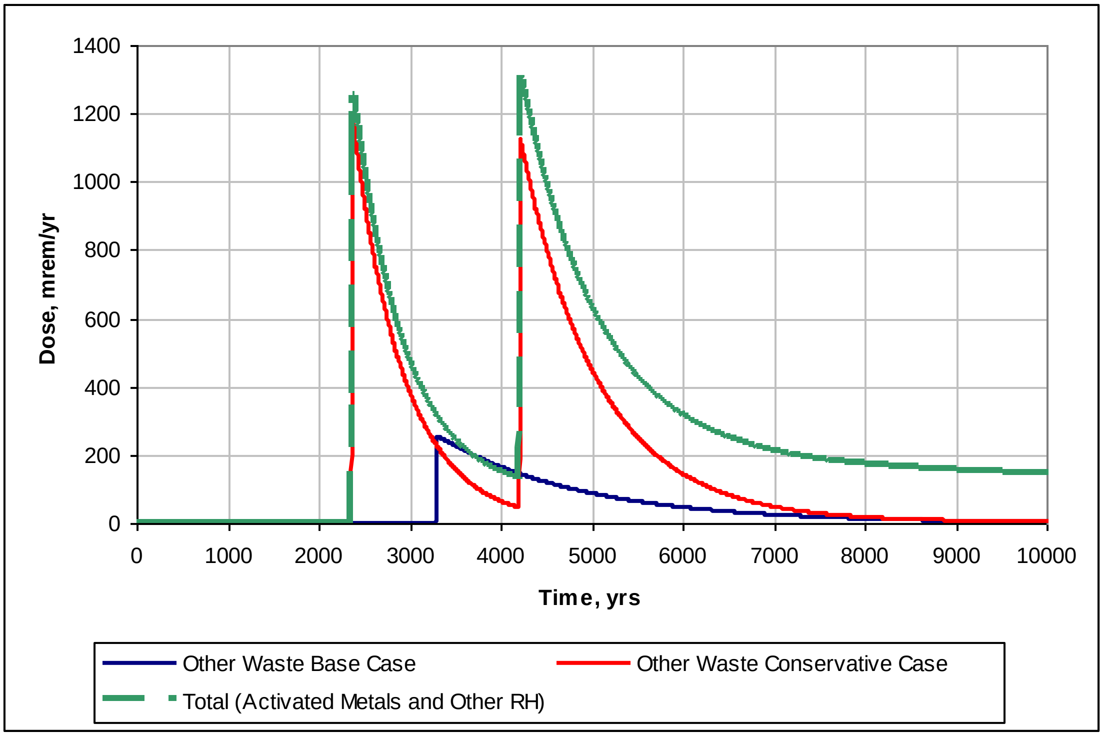

Figure 4: Base Case and Conservative Case for the Other Waste - RH category. (Note: The green line represents the total of activated metals and Other Waste - RH. The red line is Other Waste - RH alone)

Finally, a sensitivity test could be done by estimating organ dose in addition to whole body effective dose. 10 CFR 61 limits the dose to the most exposed organ or to the whole body to 25 mrem/year (except for 75 mrem to the thyroid). For instance, a total body effective dose of 20 millirem, under the limit, from iodine-129 translates into about 400 mrem/year to the thyroid, which would be an unacceptably high dose. It is essential that the revised Draft EIS consider organ as well as total body effective doses. This is because organ dose is essential to determining compliance with radiation protection regulations and with some CERCLA ARARs, such as drinking water standards.

4. Cover erosion scenario

The choice of an extremely low erosion rate in the Draft EIS rules out air and surface water doses, because there is a substantial cover on the waste in all the scenarios. A more conservative erosion rate of 1 mm/year is reasonable for a semi-arid area like Hanford and should be considered. IEER modeled this to evaluate the significant of cover erosion. It turns out that the erosion parameter is especially significant for Hanford and for the Yakama Nation.

An erosion rate of 1 mm/year results in the 5-meter thick trench cover being completely eroded in 5,000 years. Hence, at that point, rain and snow contact the waste, some of which gets washed off into surface water. This means that the dose from the aquatic food pathway is significantly increased. Figure 5 shows the results for the cover erosion scenario. The red line shows the dose from Other Waste RH and the green line shows the total dose. Note that even though the other parameters, such as infiltration have been maintained the same as in the base case IEER model, there is a second peak dose, after the cover erodes, of about 1,600 mrem/year at somewhat over 5,000 years after disposal;

this is much greater than the first peak, which occurs due to groundwater use. The main reason for the higher second peak is the dose from consuming surface water and aquatic food from surface water sources.

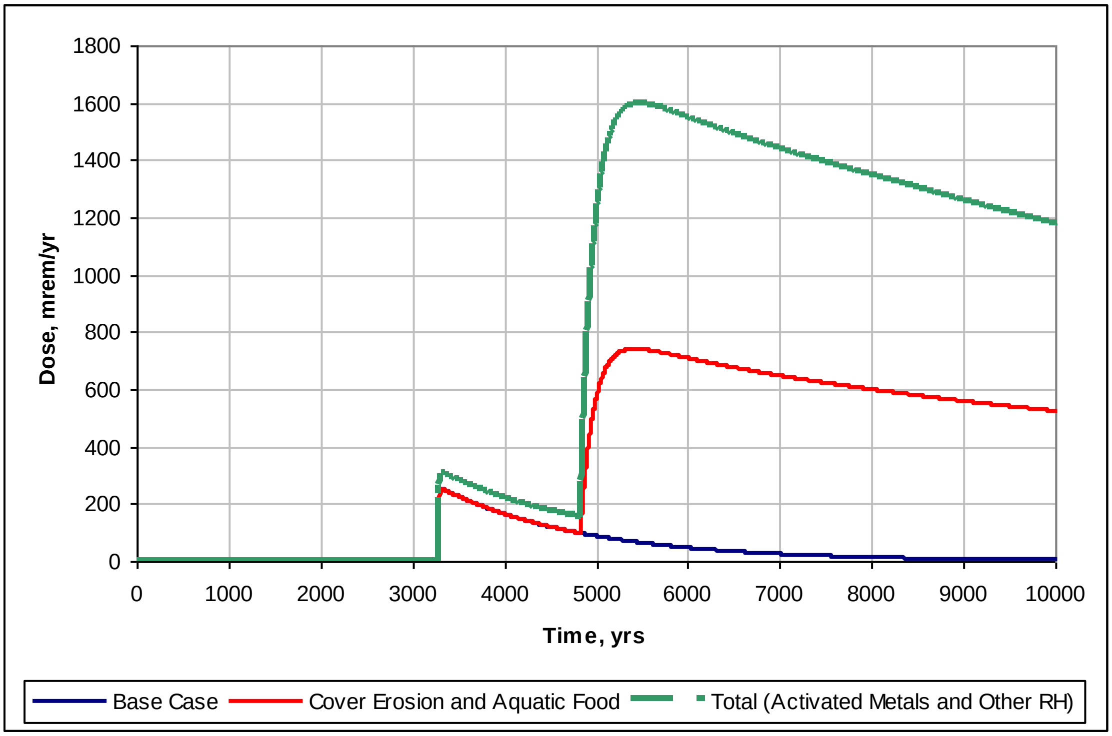

Figure 5. Base Case and Cover Erosion and Aquatic Food Scenario for the Other Waste RH Category (red line). The green line shows dose for the total source term (other waste plus activated metals)

Further, the major contributors to the second peak are the transuranic radionuclides Cm-245, Pu-239, and Pu-240. This is completely different from the Tc-99 and I-129 doses, which are important in the earlier peak.

It should also be noted that the aquatic pathways doses estimated here use the standard RESRAD parameters, which include only 5.4 kilograms of fish consumption per year. The Yakama scenario developed by the Yakama Nation and Ridolfi, Inc., has vastly different and higher fish consumption. At 150 grams per day on average, fish consumption in a traditional Yakama diet would be ten times higher than the RESRAD default value. Similarly other consumption parameters, such as meat and plants, are also different.[33]

5. Borehole disposal and the resident farmer scenario

IEER also tested the case of borehole disposal in several variations with a farmer living at the site boundary, using water that has passed next to the waste, but not over it, and finally using water that has passed through the waste. Infiltration rates were also varied. Figure 6 shows the results. The lowest peak dose was 177 mrem/year about 2,650 years in the future while the

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[33] Ridolfi, Inc., *Yakama Nation Exposure Scenario for Hanford Site Risk Assessment, Richland, Washington*, Yakama Nation ERWM Program, September 2007, Figure 8.

case of using irrigation from the site had two peaks – one of 5,050 mrem/year 235 years in the future due to I-129 and Tc-99 and one at 6,431 mrem/year 372 years into the future due to uranium isotopes. For context, the Draft EIS's estimate of peak dose due to borehole disposal was just 4.8 mrem/year – 37 times lower than the lowest borehole estimate when institutional controls are relaxed and more than 1,300 times lower when there is total loss of institutional control and memory.

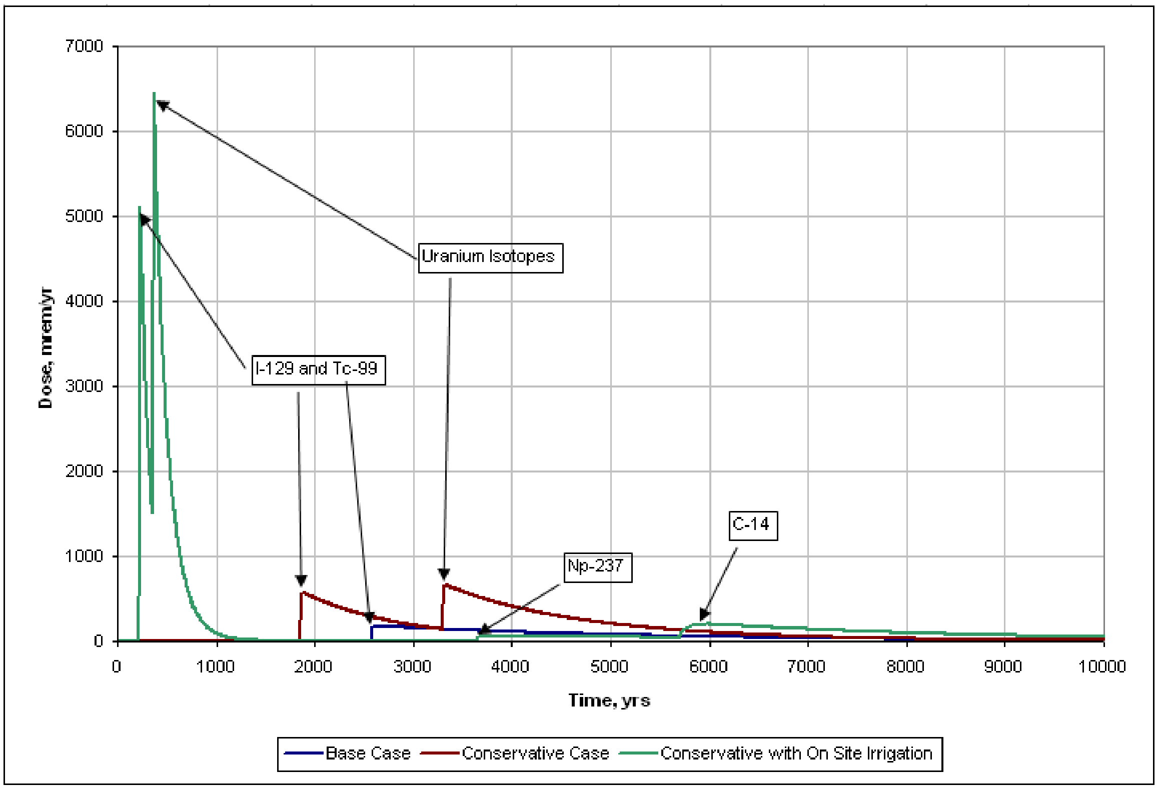


Figure 6: Borehole Land Disposal Alternative for the Group 1 Stored Other Waste - RH Category

Note that the highest dose in the irrigation scenario case is due to uranium – a strong reminder that large amounts of uranium are unsuitable for disposal even in boreholes as much as 40 m deep. So long as the disposal is relatively shallow and water is available beneath the disposal, the method is likely to be a problem from the point of view of a resident farmer and loss of institutional control.

5. Iodine-129 and Technetium-99 at Hanford

We appreciate that DOE acknowledges pre-existing contamination at Hanford by iodine-129 and technetium-99 and the difficulties that this entails for disposal of GTCC and GTCC-like waste at Hanford:

> A potential long-term impact from the GTCC proposed action would be the groundwater radionuclide concentrations that could result if the integrity of the facility did not remain intact in the distant future. The human health evaluation for the post-closure phase of the proposed action indicates that a dose of up to 48 mrem/yr (trench disposal

method) or 49 mrem/yr (vault method) could be incurred by the hypothetical resident farmer assumed to be located 100 m (330 ft) from the edge of the disposal facility. It is estimated that the dose to the hypothetical receptor would be about 10 times lower if the borehole disposal method was used. These doses were calculated to occur about 1,800 years (borehole method), 3,300 years (vault method), and 2,900 years (trench method) after failure of the cover and engineered barriers, which are assumed to retain their integrity for 500 years following the closure of the disposal facility.

> These doses would be primarily associated with GTCC-like RH waste, and the primary radionuclide contributors within 10,000 years would be Tc-99 and I-129. The Hanford TC&WM EIS (DOE 2009) cumulative estimates for Alternative Combination 1 indicate that the peak concentrations for Tc-99 and I-129 would be about 350,000 pCi/L [almost 400 times the drinking water limit] and 697 pCi/L [almost 700 times the drinking water limit], respectively, 2,000 to 3,000 years in the future. The GTCC EIS estimates of the peak concentrations for Tc-99 and I-129 corresponding to the highest dose given above (49 mrem/yr) are about 10,000 pCi/L and 100 pCi/L; these concentrations would occur at approximately the same time as the time reported in the Hanford TC&WM EIS. As stated in the Hanford TC&WM EIS (DOE 2009), when the impacts of technetium-99 from past leaks and cribs and trenches (ditches) are combined, DOE believes it may not be prudent to add significant additional technetium-99 to the existing environment. Therefore, one means of mitigating this impact would be for DOE to limit disposal of off-site waste streams containing iodine-129 or technetium-99 at Hanford. Finally, follow-on NEPA evaluations and documents prepared to support any further considerations of siting a new borehole, trench, or vault disposal facility at Hanford would provide more detailed analyses of site-specific issues, including cumulative impacts.[34]

This is an important acknowledgement that waste containing Tc-99 and I-129 should not be brought to Hanford. Yet it is far too limited in the following ways:

- It does not acknowledge that borehole disposal could result in high doses if institutional control is truly lost.
- It does not acknowledge that at 49 mrem/year total body effective dose equivalent, the drinking water limit would be exceeded by more than 100 times (combined Tc-99 and I-129).[35] By implication, even the borehole disposal dose of 4.8 mrem/year estimated by the DOE would violate the drinking water limit by more than 10 times, presuming the dose comes mainly from Tc-99 and I-129, as is true of the trench disposal case.
- It does not take other radionuclides into account. For instance, we showed above that with onsite irrigation, the peak borehole disposal dose would be from uranium and it would be more than 1,300 times the dose estimated for borehole disposal calculated for Hanford in the Draft EIS.
- It does not take into account the contamination of the site by a vast array of other radionuclides, like plutonium-239/240 and strontium-90, which would also greatly exceed standards far into the future, even though the peak doses may not coincide.

[34] Draft EIS v. 1, pp. 6-110 and 6-111
[35] The drinking water limit for Tc-99, when present alone, is 900 pCi/L and for I-129, when present alone is 1 pCi/L. hence, 10,000 pCi/L of Tc-99 is 11 times the drinking water limit and 100 pCi/L for I-129 is 100 times the limit. When both are present the limit is exceeded by 100+11 = 111 times.

Coincidence of the peak dose is not the only important criterion. Indeed, when all radionuclides are taken into account, the overall timing of the peak dose might change.

- The above quote does not explicitly acknowledge that if GTCC-like wastes containing I-129 and Tc-99 are not brought to Hanford but other GTCC and GTCC-like wastes are, two disposal sites would have to be developed.

Recommendations

The present Draft EIS does not meet the minimum standards of transparency that would allow an independent verification of the DOE's estimates. Nor does it meet the minimum tests of estimating health and environmental impacts that would give credence to the results that claim that public health would be protected in the trench, vault, or borehole scenarios. It is also far too limited in considering a single geologic repository site, WIPP, that is limited by law to only defense transuranic waste. In other words, the Draft EIS does not meet the test of scientific integrity and a reasonable range of alternative as required by NEPA. The DOE should publish a revised Draft EIS with the following changes in the scenarios:

1. All base case scenarios should assume a complete loss of institutional control. Therefore all resident farmer and tribal scenarios should assume that there will be people residing on the disposal site rather than away from it. These residents would therefore use water from the site below the disposal layer for domestic, agricultural, and cultural purposes.
2. The revised Draft EIS should incorporate the fact of pre-existing contamination on DOE sites when it models disposal at such sites.
3. The revised Draft EIS should have at least one scenario in which the cover is completely eroded away (on the order of 1mm/year of erosion) in order to assess the effect of disposal on surface water and aquatic food contamination. Besides RESRAD default consumption, the Yakama lifestyle scenario should also be evaluated in this case.
4. The revised draft EIS should provide sound, scientific technical justification for key parameters such as the lifetime of grout and infiltration rate as well as possible future rainfall and climate variations. There has been ample work in these areas that is not reflected in the Draft EIS at present.
5. The revised Draft EIS should have a normal sensitivity analysis in which parameter variation results in dose estimates on both sides (higher and lower) of the base case.
6. A realistic assessment of the trench, vault, and borehole disposal options shows that the basic health protection and dose limits would be violated by large margins. These methods are unsuitable for disposal of GTCC and GTCC-like waste and should be explicitly rejected when the Draft EIS is revised. We understand that Congress is to have its say about a preferred alternative when the Final EIS is published. But that should not prevent the DOE from clearly pointing out that some methods of disposal violate existing regulations and in the case of DOE Superfund sites, ARARs, not to speak of tribal treaty rights.
7. The doses to a resident farmer are far higher when realistic scenarios about loss of institutional control and memory are evaluated (rather than the DOE's assumption of a permanent knowledge of the site boundary). The DOE should include an onsite farmer

using irrigation water from the disposal site in its trench, vault, and borehole disposal scenarios.

8. The DOE's recognition that offsite wastes containing Tc-99 and I-129 should not be brought to Hanford for disposal should lead it to the conclusion that no GTCC or GTCC-like wastes should be brought to Hanford for a variety of reasons, including the need to develop more than one site if they are, the exacerbation of contamination at Hanford from other wastes that would be brought in, the need, in fact to remove existing wastes from Hanford in order to meet drinking water standards and other ARARs, etc.
9. The DOE should calculate organ as well as total body effective doses. This will enable an evaluation of the degree to which disposal methods comply with dose limits in existing regulations such as the drinking water standards (40 CFR 141.66) and the low-level waste rule (10 CFR 61 Subpart C).
10. The DOE should consider at least one deep geologic repository other than WIPP as one of the alternatives.

Comments of the Institute for Energy and Environmental Research on the Department of Energy's *Draft Environmental Impact Statement for the Disposal of Greater-Than-Class C (GTCC) Low-Level Radioactive Waste and GTCC-Like Waste*

(DOE/EIS-0375-D), published in February 2011

8 JUNE 2011

APPENDIX A

ELENA KALININA

SECTION I

KEY POINTS IN THIS PRELIMINARY REVIEW OF THE POST-CLOSURE HUMAN HEALTH IMPACTS EVALUATION PRESENTED IN DRAFT GTCC EIS

The main goal of the preliminary review was to identify the key technical issues related to the post-closure human health impacts evaluation presented in the draft EIS. In addition to this review IEER has commissioned an independent RESRAD-OFFSITE modeling which was performed to provide more detailed evaluation of some of these issues. The results of this modeling are provided in a Section II of this Appendix.

The following materials were reviewed as a part of this work:

- Summary of the Draft GTCC EIS
- Chapter 3 of the Draft GTCC EIS (Alternative 1: No Action)
- Chapter 5 of the Draft GTCC EIS (Evaluation Elements Common to Alternatives 3, 4, and 5).
- Chapter 6 of the Draft GTCC EIS (Hanford Site: Affected Environment and Consequences of Alternatives 3, 4, and 5).
- Appendix E of the Draft GTCC EIS (Evaluation of Long-Term Human Health Impacts for the No Action Alternative and the Land Disposal Alternatives, specifically subsections on RESRAD-OFFSITE, Simulation Approaches, Inputs, Results, and Sensitivity Analysis)
- User's Manual for RESRAD-OFFSITE, Version 2
- ANL 2010, *Post-Closure Performance Analysis of the Conceptual Disposal Facility Designs at the Sites Considered for the Great-than-Class-C Environmental Impact Statement*, ANL/EVS/R-10/8.

Note that RESRAD-OFFSITE computer code was used in the Draft GTCC EIS to evaluate human health impacts related to all the land disposal alternatives. However, the assumptions, mathematical formulation, and numerical implementation related to this evaluation are not all explicitly described in the Draft GTCC EIS. Because of this, the RESRAD-OFFSITE user's manual that contains all this information was included in the review.

Key Technical Issues Related to the Post-Closure Human Health Impacts Evaluation for the Land Disposal Alternatives

The key issues identified during the preliminary review are considered below.

.

Infiltration Rate

The infiltration rate is one of the most important parameters affecting the long-term waste disposal performance. Even a very limited sensitivity analysis conducted in the draft EIS demonstrated that the peak total dose to the residential farmer is roughly proportional to the infiltration rate. Yet, the base case assumes that the infiltration through the waste will be 20% of the ambient infiltration rate during all the 10,000 year period. Also, the infiltration rate is constant and is equal to the present day ambient infiltration rate for both, 10,000 year period and 100,000 year period.

The justification provided in the draft EIS for assuming that the infiltration rate will be 20% of the ambient infiltration is "based on a study at the SRS that indicated that after 10,000 years, the closure cap at the F-area would still shed about 80% of the cumulative precipitation falling on it, with a higher degree of effectiveness occurring before 10,000 years (Phifer et al. 2007)."[36] This justification is not sufficient. As it is discussed below, the sensitivity analysis does not address this issue because it is limited in its applications.

Maintaining the present day infiltration rate constant for 10,000 years is not a conservative assumption. For instance, extensive long-term climate change studies were performed for the Yucca Mountain project. The following assumptions were made for the Yucca Mountain site:

The first climate stage is a continuation of current present-day climate conditions from present day to approximately 400 to 600 years into the future.

The second climate stage begins approximately 400 to 600 years from present day and is characterized as a monsoon climate with wetter summers relative to present-day climate. The monsoon climate is predicted to last between 900 to 1,400 years.

The third climate stage begins between 1,300 and 2,000 years from present day and is characterized as a glacial-transition climate with cooler air temperatures and on average higher annual precipitation relative to present-day climate. The duration of the glacial-transition climate is estimated to be 10,000 years. Similar assumptions should be applicable to the other sites, especially Hanford. Consequently, the infiltration rate for most of the 10,000 year period will be greater than the present-day infiltration rate. This consideration should be included in the human health impact analysis.

Human Intrusion

Direct physical intrusion, such as by a future inadvertent intruder into the disposal facility after the site closure, is not analyzed quantitatively in the draft EIS. Consequently, the human health analysis does not include the potential impacts from the inadvertent intrusion. Direct intrusion into the waste disposal units was qualitatively considered in Chapter 5.5 of the draft EIS. However, this qualitative approach is not sufficient for justifying exclusion of the inadvertent intruder scenario.

Sensitivity Analysis

The human health impacts were evaluated deterministically for each land disposal alternative. The deterministic dose and risk values were calculated using RESRAD-OFFSITE computer code.

A simplified sensitivity analysis was performed to evaluate potential impacts from the uncertainty in the major parameters. "Three parameters were addressed in this sensitivity analysis: (1) the water infiltration rate through the disposal facility cover after 500 years following closure of the facility, (2) the effectiveness of the stabilizing agent (grout) used for Other Waste, and (3) the distance to the assumed hypothetical receptor. These three parameters address issues related to disposal facility design, waste form stability, and site selection."[37] Ten combinations (ten cases) of these parameters were considered.

The applicability of this sensitivity analysis is limited due to the reasons discussed below.

The sensitivity analysis considered a less conservative effective period for the grout (2,000 yrs and 5,000 yrs) than the one used in the base case (500 yrs).

[36] ANL 2010 p. 26
[37] ANL 2010 p. 154

The sensitivity analysis considered a less conservative exposure distance to the resident farmer from the edge of the disposal facility (300 m and 500 m) that the one used in the base case (100 m).

Note, that a common practice is to consider more conservative parameter values in the sensitivity analysis than the ones used in the base case. This is because the major concern is how much worse, not how much better, it can get. This is especially important in this case because neither the grout effective period nor the distance to the resident farmer used in the base case represent the worst case scenario. 500 yrs for the grout performance and 100 m for the exposure distance are not conservative assumptions. It is not clear why a resident farmer location could not have been on the edge of the disposal facility. No data are provided in support of 500 year grout performance.

The sensitivity analysis considered only two sites. The SRS site represented a site in the Eastern United States (a humid site). The WIPP Vicinity site represented a site in the Western United States (an arid site). The WIPP Vicinity site does not represent the Western sites because the infiltration rate at this site is a few orders of magnitude lower than at the other western sites and as a result none of contaminants reach the groundwater table in either 10,000 or 100,000 years.

Only the trench disposal alternative was considered in the sensitivity analysis. The results do not necessarily apply to the other alternatives.

Very strong limitations are also imposed by considering only Other Waste CH [contact handled] type. As it was noted in the draft EIS "[b]ecause the radionuclide mix for each waste type (i.e., activated metals, sealed sources, and Other Waste) is different, the peak annual doses and LCF risks for each waste type do not necessarily occur at the same time. In addition, the peak annual doses and LCF risks for the entire GTCC waste inventory considered as a whole could be different from those for the individual waste types." (p. 5-66)

Note that the doses associated with the Other Waste CH type are the smallest ones. Much higher doses and LCF risks result either from the Other Waste RH [remote handled] type or for the activated metals, depending on the land disposal alternative. It would make more sense to consider the Other Waste RH type in the sensitivity analysis because it is the major contributor to the doses and LCF risks in the case of the trench disposal.

The sensitivity analysis should have been considered for each site, for each land disposal alternative, and for each waste category and should have used the conservative parameters values in order to be applicable to the different conditions considered in the draft EIS.

As a result, the following statements made in the draft EIS needs additional justification: "The results of the sensitivity analysis for this waste type and disposal method at these two sites can be used to infer conclusions about different waste streams disposed of at other alternate sites by using the three land disposal methods. This analysis also gives some indication of the level of conservatism in the results, which is useful information for the decision-making process."(p. E-21)

Finally, the sensitivity analysis did not consider other parameters that might be of importance, such as radionuclide partition coefficients, irrigation rates, consumption factors, and other. These parameters were considered in IEER's independent modeling described in Section II of this Appendix. The radionuclide partition coefficients (K_ds) and consumption factors were found to be of a great importance to the land disposal performance as described in Section II of this Appendix.

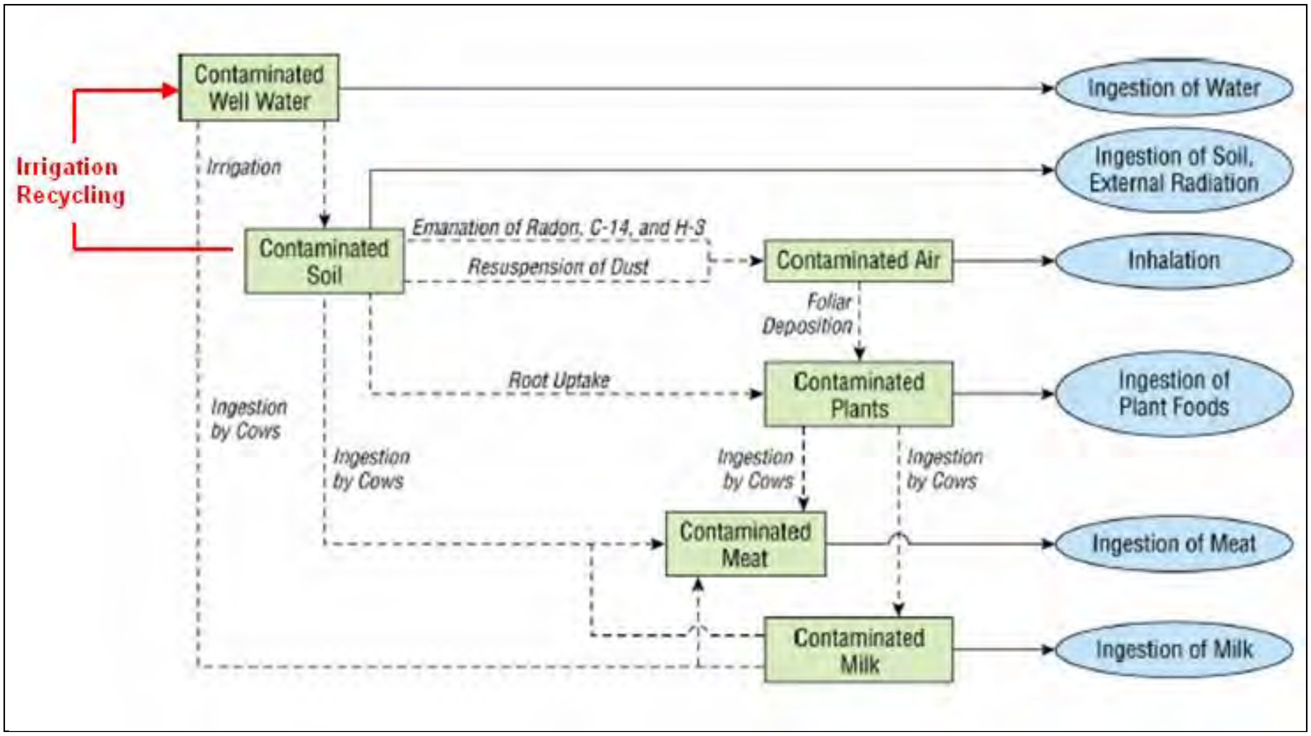
Infiltration along the Length of the Offsite Transport

The conceptual model used in the human health impact evaluation assumes that there is infiltration of clean water along the length of the offsite transport. The clean infiltration water dilutes the contaminant plume at the offsite locations and results in smaller doses and LCF risks, as noted in the draft EIS: "In addition, because of the extra dilution by clean water coming down from the ground surface, the potential radiation dose would also be lower than that in the Base Case." (p. E-22)

The impacts from assuming clean infiltration water are described in the draft EIS as: "The radiation dose incurred by the hypothetical resident farmer considered for post closure impact analyses would decrease with increasing exposure distance, as demonstrated by the results for the Base Case and Cases IX and X (see also Figure E-9). As mentioned before, this result would occur because additional dilution of radionuclide concentrations in groundwater would result from the additional transport distance toward the location of the off-site well. As the distance would increase from 100 m (330 ft) to 500 m (1,600 ft), the maximum annual radiation dose would decrease by more than 70%." (p. E-27)

Note that this assumption is not adequate for this analysis because a significant portion of the offsite soils might be contaminated with the radionuclides deposited from contaminated irrigation water and from the surface runoff and dust originated from the contaminated site. Consequently, the infiltration water leaching through the contaminated offsite soils will be contaminated as well. RESRAD-OFFSITE only partially addresses this problem by considering the additional impacts from contaminated offsite soils. RESRAD-OFFSITE does not consider leaching of radionuclides from the contaminated offsite soils into the groundwater.

The exposure pathways associated with the use of contaminated groundwater implemented in RESRAD-OFFSITE are shown in Figure 1. The red arrow is added to the original figure presented in the draft EIS to demonstrate the missing link (irrigation recycling) between the contaminated offsite soil and the groundwater.



NOTE: This figure was reproduced from Figure E-2 (v. 2, p. E-9) in draft GTCC EIS. The red arrow and text box were added to the original figure.

Figure 1. Exposure Pathways Associated with the Use of Contaminated Groundwater

In summary, both the treatment of the offsite contaminated soils in RESRAD-OFFSITE and the assumption of clean infiltration water along the offsite transport made in the draft EIS, are not conservative and lead to underestimating potential doses and LCF risks.

Toxic Chemicals

The human health impact analysis presented in the draft EIS does not address potential toxic chemical releases from the wastes; it is limited to radioactive constituents only. The toxic chemicals have to be identified for each waste type and some analysis of the potential impacts associated with these chemicals should be performed and presented.

Exposure Distance

A hypothetical individual is assumed to move near the site and reside in a house located 100 m from the edge of the disposal facility. This location was selected "because it is the minimum distance identified in Manual DOE M 435.1-1 (DOE 1999a) for the location of the buffer zone surrounding a DOE LLRW disposal site at which compliance with dose standards needs to be demonstrated." (p. 5-63) On the other hand, it is stated in the draft EIS that "The resident farmer scenario is assumed to be conservative (i.e., one that overestimates the expected dose and LCF risk) because it assumes a total loss of institutional control and institutional memory with regard to the disposal facility." (p. 2-24) The two citations provided above are in contradiction with each other. The location of the residential farmer should not be limited to off site in the case of a total loss of institutional control and institutional memory.

As it was demonstrated in the draft EIS and confirmed by IEER's independent modeling, the closer the exposure location, the higher the doses and LCF risks. Either a base case or a sensitivity analysis should have considered closer locations (immediately at the fence or even on site.

Engineered Barrier Performance

As it is described in the draft EIS "the engineering barriers incorporated in the disposal facility would keep percolating water out of the waste units for 500 years following closure of the disposal facility" and [a]fter 500 years, the integrity of the barriers and waste containers would begin to degrade, allowing for water infiltration into the top of the disposal units at 20% of the natural infiltration rate for the area." The same assumption is used for the grout: "A stabilizing agent (grout) would be used to solidify the Other Waste type, and this grout would maintain its effectiveness for 500 years." (p. E-20)

At the same time, it is pointed out in the draft EIS that the "[d]ata on the performance of waste packages and engineering barriers over an extended time period are limited. … How and when the waste packages and engineering barriers would begin to degrade and how this degradation would progress over time are very difficult to determine." (p. 5-64)

No justification for the performance period of 500 years is provided in the draft EIS. Instead, even longer performance periods of 2,000 years and 5,000 years are considered in the sensitivity analysis.

As was concluded based on IEER's independent modeling results, the engineering barrier performance has little impact on the land disposal performance in the Hanford Site specific conditions. However, this may not be the case for the other sites.

Human Health Impact Results for the 100,000 Year Period

The human health impact evaluation was extended to 100,000 years in the post-closure analysis for the Hanford Site. The results of this analysis demonstrated that a second peak dose (mostly associated with uranium isotopes) occurs around 21,000 years.

IEER's independent modeling demonstrated that the time of peak dose associated with uranium isotopes can occur significantly earlier (around 4,200 years) if uranium K_d is 0.06 mL/g in both unsaturated layers and the saturated zone and if the ambient infiltration rate is 5 mm/yr. The base case considered in the draft EIS assumed uranium K_d of 0.6 mL/g in the first unsaturated layer and saturated zone and uranium K_d of 0.06 mL/g in the second unsaturated layer. The base case ambient infiltration was 3.5 mm/yr. Both, lower K_d and higher ambient infiltration rate are plausible conditions and should have been considered in the draft EIS either in the base case or sensitivity analysis.

Cover Erosion and Aquatic Food Pathway

The base case scenario as implemented in the draft EIS assumes that the cover will not completely erode either in 10,000 or 100,000 years. The base case also does not consider aquatic food consumption. IEER's independent modeling demonstrated that if the cover erodes during the 10,000 year of simulation, it will result in a significant total dose mainly due to the aquatic food consumption. The major contributors to the total dose will be plutonium isotopes and curium-245 transported from the contaminated zone to the surface water body by the surface water.

Justifications for excluding cover erosion and aquatic food pathway are not provided in the draft EIS.

Modeling Approach

The human impact analysis for all sites and all land disposal alternatives was conducted using RESRAD-OFFSITE computer code. Consequently, the assumptions incorporated in this code were inherited by this analysis.

RESRAD-OFFSITE does not allow for modeling of multiple contaminated zones with different release rates. As a result, each waste type was modeled separately using a simplified approach. In this approach, all the wastes included in the specific waste category type (i.e. GTCC Group 1 Projected Activated Metals category) were consolidated in the middle of the disposal facility. The area occupied by the wastes was calculated as the sum of the areas occupied by the disposal units required to store these wastes. The waste thickness was assumed to be equal to the thickness of the overall waste interval used in each disposal alternative. The waste was uniformly distributed within the volume defined by the waste area and waste thickness. A homogeneous waste cover was assumed at the top of the waste with the cover depth equal to the depth of the top of the waste interval used in each disposal alternative.

As a result, the conceptual representation used in the modeling is significantly simplified with regard to the conceptual design of a corresponding land disposal alternative as shown in the draft EIS. It does not account for the combined effects from the different contaminant plumes originating from the different waste sources either in time or in space.

Also, this simplified conceptualization results in the distance of 175 to 225 m (depending on the consolidated source area) between the down-gradient edge of the wastes and the facility fence. The groundwater well was assumed to be 100 m from the fence (275 to 325 m from the wastes) in the draft EIS. The additional distances to the well considered in the sensitivity analysis (Appendix E of the draft EIS) were 300 m and 500 m. According to the conceptual design, the actual distance to the fence can be 50 m for some contaminated sources.

Key Technical Issues Related to the Post-Closure Human Health Impacts Evaluation for the No Action Alternative in Region IV

The long-term human health impacts for the No Action alternative were evaluated using a similar approach as the one used for the land disposal alternatives. It was assumed that all the wastes generated in a specific region will be stored in this region indefinitely. For the modeling purpose, each waste category was considered separately. The waste was consolidated in the center of the 300 m by 300 m disposal facility.

No Action alternative differs from the land disposal alternatives by the following assumptions. No Action alternative assumes that there are neither engineered barriers nor a cover and that the wastes are placed on the ground surface. The DOE No Action alternative does not include atmospheric transport; only the groundwater pathway is considered. The waste inventory represents only the inventory generated in the region considered, not the overall waste inventory. The other conceptual assumptions are the same as in the land disposal alternatives.

The main key technical issues associated with No Action alternative are described below with the focus on Region IV. Note that the key technical issues associated with the land disposal alternatives are also applicable to the No Action alternative because a similar modeling approach and conceptualization were used.

Airborne Releases and Surface Water Runoff

Airborne releases and surface water runoff were excluded from the evaluation of the long-term human health impacts from the No Action alternative. Note that airborne release (gases and water vapor) was included in the evaluation of the land disposal alternatives even though the land disposal facilities provide better waste isolation than the No Action alternative.

The airborne pathway was excluded because "dispersion of any released radionuclides by the wind would greatly decrease the air concentrations." (p. 3-11) This justification is not sufficient for excluding the airborne releases.

The surface water runoff was excluded because "the storage sites would probably have berms or other engineered features to minimize water runoff from the site." (p. E-3) This contradicts the main assumption concerning the total loss of institutional control 100 years after the facility closure.

Both, airborne releases and surface water runoff have to be included in the analysis of the No Action alternative because the wastes are assumed to be stored on the ground surface without any engineered barriers and covers. It is especially important in this alternative because the wastes become available for release 100 years from the facility closure, which is significantly earlier than it was assumed in the land disposal alternatives (500 years after the closure).

Based on IEER's independent modeling analysis performed for the land disposal alternatives, the contaminant transport via surface water runoff might significantly contribute to the total dose.

Infiltration Rate

The infiltration rate on the top of the wastes in the case of No Action alternative is equal to the ambient infiltration rate because there are no engineered barriers in place. This assumption makes the infiltration rate especially important.

The infiltration rate assumed for Region IV was 1 mm/yr. Note that it is 3.5 times lower than the ambient infiltration used for the Hanford Site (3.5 mm/yr). The mean annual present day infiltration rate estimated for the area above the proposed repository at the Yucca Mountain is 15 mm/yr. The mean annual infiltration rates estimated for the monsoon and glacial transition climate are 28 mm/yr and 29.3 mm/yr respectively. While there are some areas in Region IV with infiltration rates below 1 mm/yr (for example, some areas at the Nevada National Security Site(NNSS)), the infiltration of 1 mm/yr is not representative for many other areas in Region IV, including the Hanford Site.

Because the ambient infiltration rate used for Region IV analysis was very low, none of the radionuclides reached the groundwater table in 10,000 years. This resulted in 0 dose because the groundwater pathway was the only exposure considered: "it is estimated that there would be no groundwater dose within 10,000 years for a generic commercial facility located in Region IV because the radioactive contamination would not reach the groundwater table in 10,000 years as a result of the arid conditions at this location." (p. E-19)

Yet, this conclusion of zero dose does not even apply to a generic disposal facility if it is located at Hanford.

Human Health Impact Results for the 100,000 Year Period

The results of the human health impact evaluation for the period of 100,000 years for Region IV reported in the draft EIS indicate that uranium isotopes and plutonium-238 reach the groundwater well around 40,000 years (Figure 3.5-7 in draft EIS). The uranium isotopes were shown to reach the groundwater well in 21,000 years for the land disposal alternatives considered for Hanford. Note that radionuclide leaching rates are significantly slower in the land disposal alternatives because only 20% of the ambient infiltration is assumed to pass through the wastes. IEER's independent modeling of the trench disposal alternative demonstrated that the uranium isotopes may reach groundwater at Hanford in 4,200 years if a more conservative uranium partition coefficient and ambient infiltration rate are used. Consequently, under the No Action alternative, the breakthrough time might be even smaller. This raises another question regarding the applicability of the generic facility in Region IV No Action alternative results to the Hanford Site.

SECTION II

RESULTS OF RESRAD-OFFSITE MODELING OF THE TRENCH LAND DISPOSAL ALTERNATIVE FOR THE HANFORD SITE

This report presents the results of an independent modeling performed to simulate trench land disposal alternative at the Hanford Site. The first objective of this modeling was to supplement a very limited sensitivity analysis conducted as a part of the draft EIS. The second objective was to modify the conceptual assumptions and parameters used in EIS to better represent the Hanford specific site conditions. A modeling approach similar to the one used in the draft EIS was implemented. Using an identical approach would probably be more consistent. However, this was not an option due to the lack of the detailed information needed for this implementation either in the draft EIS or the supporting references.

As a first step in this study, a test base case RESRAD-OFFSITE model was developed in an attempt to reproduce the results reported in the draft EIS. This model represents an interpretation of the conceptual approach and data described in the draft EIS and ANL 2010. This base case model was then modified to conduct sensitivity study and to consider additional parameters and scenarios.

The major results discussed in the draft EIS are the estimated peak annual doses from the use of contaminated groundwater within 10,000 years of disposal. These results for the Hanford Site are presented in Table 6.2.4-2 of the draft EIS. The peak annual doses were estimated for each of the following conditions:

- Land disposal alternative: borehole, vault, and trench
- Waste group: Group 1 stored, Group 1 projected, and Group 2 projected
- Waste category: GTCC and GTCC-like
- Waste type: activated metals, sealed sources, other waste CH, and other waste RH

Because each combination was considered separately, there are 24 individual peak annual doses (3 waste groups x 2 waste categories x 4 waste types) for each land disposal alternative. The total dose versus time for each alternative was calculated as the sum of the individual dose histories and the peak total dose was derived based on this calculation. Note that because the peak times of the individual doses may be different from each other, the peak time of the total dose does not necessarily coincide with any individual peak time and the total peak dose may be smaller than the sum of the individual peak doses.

The total annual doses versus time for the borehole, vault, and trench disposal alternatives are presented in Figure 4-9 (ANL 2010) for the period of simulation of 10,000 yrs and in Figure 4-10 for the period of simulation of 100,000 years.

The results presented in the draft EIS indicate that the vault and trench land disposal alternatives are very similar with regard to the individual peak annual doses, total peak annual doses, and the peak total dose timing. The borehole land disposal alternative has significantly smaller estimated individual doses and total dose than the trench and vault alternatives. Based on these results, we concluded that considering trench land disposal alternative in the independent modeling would be sufficient to represent the case with the highest total dose.

Two cases were selected for modeling. The first case considers the GTCC-like other waste RH in Group 1 stored waste. This case has the DOE's highest peak dose estimate among all the other individual doses (48 mrem/yr). In the second case, the DOE considers the GTCC activated metals in Group 1 projected waste.

The DOE estimates the second highest peak dose in this case (5 mrem/yr). All the other peak doses are significantly smaller (0 to 2.5 mrem/yr).[38]

Modeling Approach

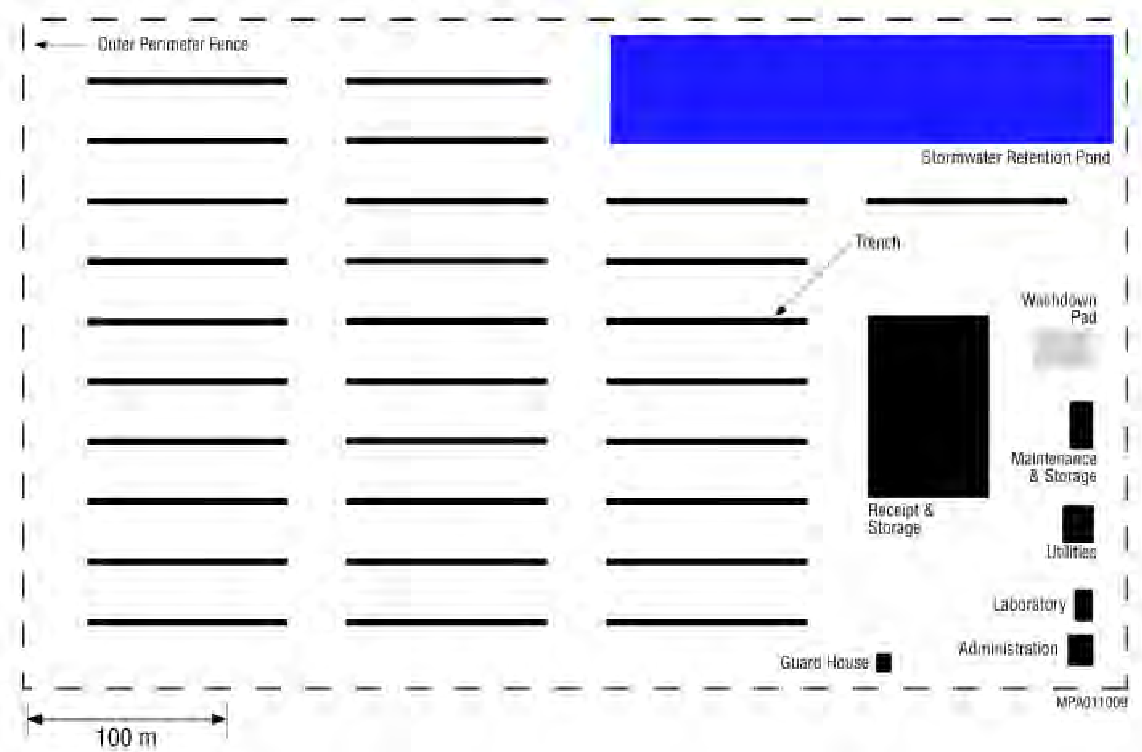
Same simplified modeling approach was used for each case presented in Table 6.2.4-2 in the draft EIS. In this approach, all the wastes included in the specific case were consolidated in the middle of the disposal facility. The area occupied by the wastes was calculated as the sum of the areas occupied by the disposal units required to store these wastes. Table 5.1-3 in the draft EIS shows the number of the disposal units for each waste type. Table 4-2 in ANL 2010 shows the corresponding consolidated waste areas.

For example, 2.1 trenches are required to dispose of the GTCC-like other waste RH in Group 1 stored waste category (2,500 55-gallon drums). The trench horizontal dimensions are 3 m wide and 100 m long (Figure 1). Consequently, the consolidated waste area is 3m x 100m x 2trenches = 600 m^2. The contaminated area is assumed to be a square. The waste thickness was assumed to be equal to the thickness of the overall waste interval used in each disposal alternative. This thickness was equal to 5.6 m for the trench alternative. The waste was uniformly distributed within the volume defined by the waste area and waste thickness. A homogeneous waste cover was assumed at the top of the waste with the cover depth equal to the depth of the top of the waste interval used in each disposal alternative. This depth was equal to 5 m in the trench alternative.

As a result, the conceptual representation used in modeling is significantly simplified with regard to the conceptual design shown in Figures 1 and 2. It is not clear either from draft EIS or ANL 2010 whether the facility area was assumed to be a square as well or whether the actual proposed dimensions were used. For example, in the case of the trench alternative the facility is 550m by 330m. The same area can be represented with a square with the side of 426 m. The square shape was assumed in the independent modeling to be consistent with the square shape contaminated zone (Figure 3).

This conceptualization results in the distance of 175 (source area 2,600 m^2) to 225 m (source area 0.1 m^2) between the down gradient edge of the wastes and the facility fence. The groundwater well was assumed to be 100 m from the fence (275 to 325 m from the wastes) in the draft EIS. The additional distances to the well considered in the sensitivity analysis (Appendix E of the draft EIS) were 300 m and 500 m. According to the conceptual design shown in Figure 1, the actual distance to the fence can be 50 m for some contaminated sources.

[38] Draft EIS, Vol. 1, Table 6.2.4.2, p. 6-87



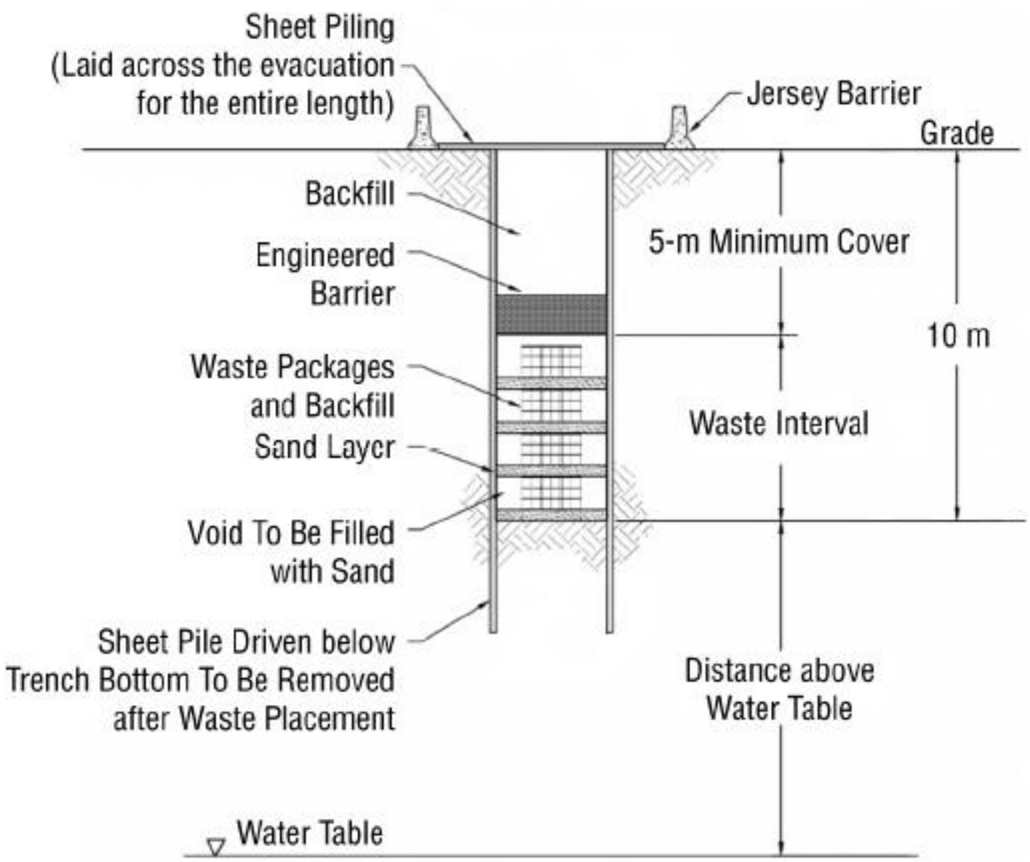
NOTE: This figure was reproduced from Figure D-12 in Draft GTCC EIS (Volume 2)

Figure 1. Layout of a Conceptual Trench Disposal Facility

The following assumptions were used in the modeling (as inferred from the draft EIS):

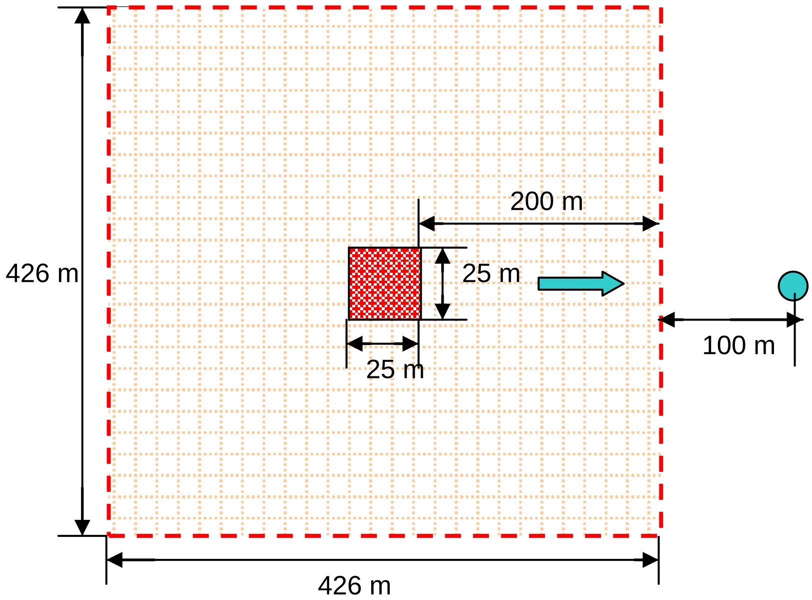
- All agricultural areas and the dwelling site are located outside the facility fence.
- The wastes are intact for 500 years while engineering barriers are in place.
- The water starts infiltrating onto the wastes at 500 years after the facility closure.
- The infiltration rate on the top of the wastes is 20% of the ambient infiltration rate during all the period of simulation (either 10,000 on 100,000 years).
- The ambient infiltration is equal to the present-day infiltration and remains constant during all period of simulation.
- The infiltration rate at the bottom of the waste is equal to the ambient infiltration rate.
- The cover does not erode to the top of the waste during all the period of simulation. Consequently, the contaminant transport via runoff from the contaminated source is not considered.
- The contaminants are released from the wastes to the groundwater based on the contaminant-specific leaching rates.
- Because the cover does not erode to the top of the wastes, the contaminant releases from the wastes to the atmosphere are considered only for gases formed by carbon-14, tritium, and radon.
- There is no surface water (pond) on the site and consumption of the contaminated fish is not considered.
- There is no irrigation within the facility. Only the agricultural areas outside of the facility fence are irrigated.
- Only 50% of the food comes from the contaminated areas.
- Farmer spends 50% of time indoors and 25% outdoors. The remaining 25% of time is spent outside of the contaminated areas.

- The dose conversion factors are for an adult.



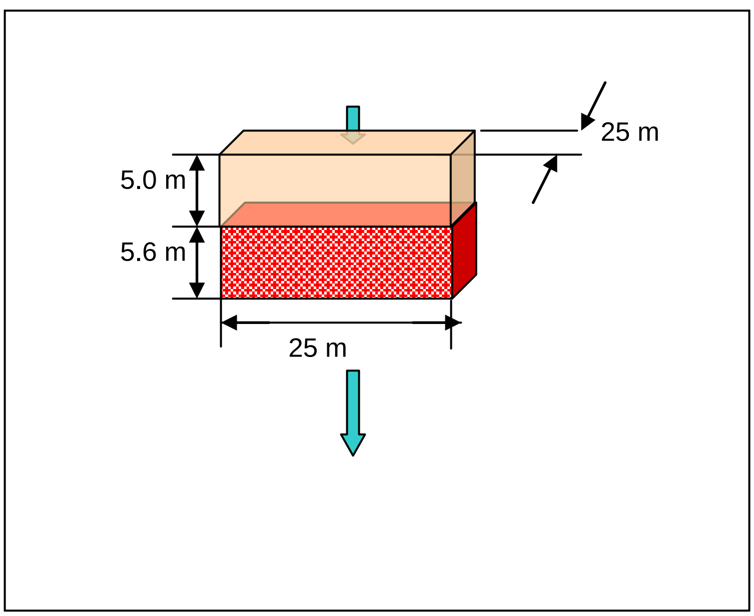
NOTE: This figure was reproduced from Figure D-1 in Draft GTCC EIS (Volume 2)

Figure 2. Cross Section of a Conceptual Trench Disposal Unit



NOTE: The source dimensions corresponds to the GTCC-like other waste RH Group1 stored category. The facility dimensions corresponds to the trench disposal alternative.

Figure 3. Conceptual representation of the contaminated site used in RESRAD-OFFSITE modeling.



NOTE: The small blue arrow represents the infiltration into the waste (20% of ambient infiltration). The large blue arrow represents the ambient infiltration.

Figure 4. Conceptual representation of the contaminated zone used in RESRAD-OFFSITE modeling.

The radionuclide–specific leaching rate r_i (or release fraction) was calculated as:

$$r_i = \frac{I}{\theta_{cz} B_0 R_{cz,i}} \qquad R_i = 1 + \frac{\rho_b K_{d,i}}{\theta_{cz}} \qquad (1)$$

where I is infiltration rate on the top of the wastes, B_0 is the initial thickness of the contaminated zone, and R_i is the radionuclide-specific retardation factor (equal to 1 for non sorbing radionuclides), ρ_b is the contaminated zone bulk density, ϑ_{cz} is the moisture content of the contaminated zone, and $K_{d,i}$ is the radionuclide-specific partition coefficient.

Note that Equation (1) is not provided either in draft EIS or ANL 2010. ANL 2010 provides radionuclide-specific release fractions for activated metals (Table 4-5), sealed sources (Table 4-8), and other waste (Table 4-11). Equation (1) is from RESRAD-ONSITE. It was used to check the release rates in ANL-2010. The same release rates were obtained with I=0.000 m/yr (20% of ambient infiltration rate of 0.0035 m/yr), ρ_b =1.8 g/cm^3, B_0 =5.6 m, ϑ_{cz} =0.2, and radionuclide-specific $K_{d,i}$ values for soil (same as the $K_{d,i}$ vales for the upper unsaturated zone layer in Table 4-17) and for cementitious system (Table E-1 in draft EIS). In the case of activated metals, all the release rates calculated using equation (1) greater than 1.19x10^{-5} 1/yr were substituted with the release rate of 1.19x10^{-5} 1/yr, which corresponds to the corrosion rate of metals.

As it follows from Equation (1), the release rates need to be recalculated if a different infiltration rate I, or different K_d values, or different contaminated zone parameters (bulk density, thickness, and moisture content) are used.

Two conditions regarding the modeling approach remain unclear due to the limited information presented in this regard in the draft EIS and ANL 2010.

The first condition concerns the implementation of release rates used for modeling other waste. It is stated in the ANL 2010 and draft EIS that the releases were simulated using the rates calculated based on the K_ds in cementitious system during the first 500 years (these are very small releases). After 500 years it was assumed that the cement degraded and the release rates based on the soil K_ds were used. This is not clears because RESRAD-OFFSITE uses constant with time release rates. Only one rate for each radionuclide can be specified. In the independent modeling, it was assumed that no release occurs during the first 500 years. The released rates in Table 4-8 based on soil K_ds (Table 4-17) were used after this time.

The second condition concerns the calculation of the total dose. As it is described in the ANL 2010, the total doses were calculated by following a three-step procedure." The first step of the procedure was to calculate the radiation dose from the drinking water pathway for individual radionuclides contained in the waste materials. In the second step, the radiation dose associated with the drinking water pathway was scaled to obtain the radiation dose associated with all the groundwater-related pathways. The all-pathway dose summed across all radionuclides contained in the waste material yielded the final dose results". "The scaling factor is the ratio of radiation dose associated with all groundwater-related pathways to the radiation dose associated with only the drinking water pathway". The scaling factors were developed for each radionuclide in Appendix C of ANL-2010. It is not clear why the three step procedure was necessary when RESRAD-OFFSITE is capable of calculating all the water related doses, including drinking water pathway in one run. All the applicable exposure pathways were considered together in the independent modeling instead of using a three-step approach.

Modeling Parameters

A number of parameters are required for the modeling. Some of these parameters are included either in draft EIS or ANL 2010, some of them required additional calculations.

Initial Radionuclide Concentrations in Contaminated Zone

These initial concentrations are not provided in the draft EIS or ANL 2010. These concentrations were calculated as follows.

The radionuclide inventories were taken from Table B-5 for the case of GTCC-like other waste RH, group 1 stored category. The radionuclide inventories were taken from Table B-6 for the case of GTCC activated metals, group 1 projected category.

The first-order decay equation was used to calculate radionuclide inventories after 500 years during which the engineered barriers were assumed to be in place. For the sake of simplicity, the ingrowth was not accounted for.

The radionuclide concentrations were calculated based on this inventory, contaminated zone volume, and contaminated zone bulk density.

Radionuclide Release Rates and K_ds

These parameters were specified as described above.

Infiltration Rate

The infiltration rate is calculated internally in RESRAD-OFFSIE based on evaporation coefficient, runoff coefficient, irrigation rate, and precipitation. These coefficients were specified the same as in Table E-5 in the draft EIS to get an ambient infiltration rate of 0.0035 m/yr.

Cover Erosion Rate

The cover erosion rate is calculated internally in RESRAD-OFFSIE based on the rainfall and runoff factor, soil erodibility factor, slope length-steepness factor, crop/cover management factor, supporting practice factor, and soil bulk density. These coefficients were specified the same as in Table E-5 in the draft EIS to get an erosion rate of $1x10^{-5}$ m/yr (0.1 m eroded by the end of 10,000 year simulation period or 1 m eroded by the end of 100,000 year simulation period).

Unsaturated and Saturated Zone Properties

These properties were defined based on the data in Table E-5 in the draft EIS.

Agricultural Areas Properties

The properties of the agricultural areas are described in ANL 2010. However, the locations of these areas are not specified. It is only stated that they are outside of the facility fence. The grazing area and the pasture area are assumed to be 10,000 m^2 with irrigation rate of 0.1 m/yr. The fruit, grain, and non-leafy vegetables area and leafy vegetables area are assumed to be 1,000 m^2 with the irrigation rate of 0.2 m/yr.

The data on the dwelling site area and irrigation rate are not provided. The dwelling site used in the independent modeling was set equal to 625 $m^2$and the irrigation was assumed to be 0.

Consumption Fractions

All consumption fraction were set equal to 0.5.

Occupancy Parameters

The occupancy parameters were specified in accordance with the once used in EIS: 50% of time spent indoors, 25% time spent outdoors, 0.05% time spent outside in each of the agricultural area and dwelling site.

Well Pumping Rate

Well pumping rate was set equal to 2,500 m^3/yr. If the user-specified pumping rate is smaller than the total water demand including drinking water, household water and irrigation, RESRAD changes the pumping rate to set it equal to the annual water demand.

The water demand as defined based on the parameters described in EIS is 2,678 m^3/yr. To get the pumping rate of 2,500 m^3/yr, the irrigation rate of the grazing and pasture areas in the independent modeling was set equal to 0.0907 m/yr to make the total water demand go down to 2,493 m^3/yr. It is not clear how this problem was managed in the EIS.

Default Parameters

The default RESRAD-OFFSITE parameters were used for the radionuclide-specific transfer factors, air transport parameters, inhalation, life stock intake, plant factors, and ingestion rates (except drinking water intake of 730 L/d).

Surface Water Parameters

No surface water parameters are provided in EIS because these are only required if the aquatic foods pathway is used. This pathway was excluded from the calculations in EIS.

Site Layout

Site layout used in the independent modeling is shown in Figure 5. The surface water pond was defined because it was used in one of the runs. The location of the well is 300 m from the down gradient edge of the contaminated zone. This location corresponds to the base case. Other locations were considered in the sensitivity analysis.

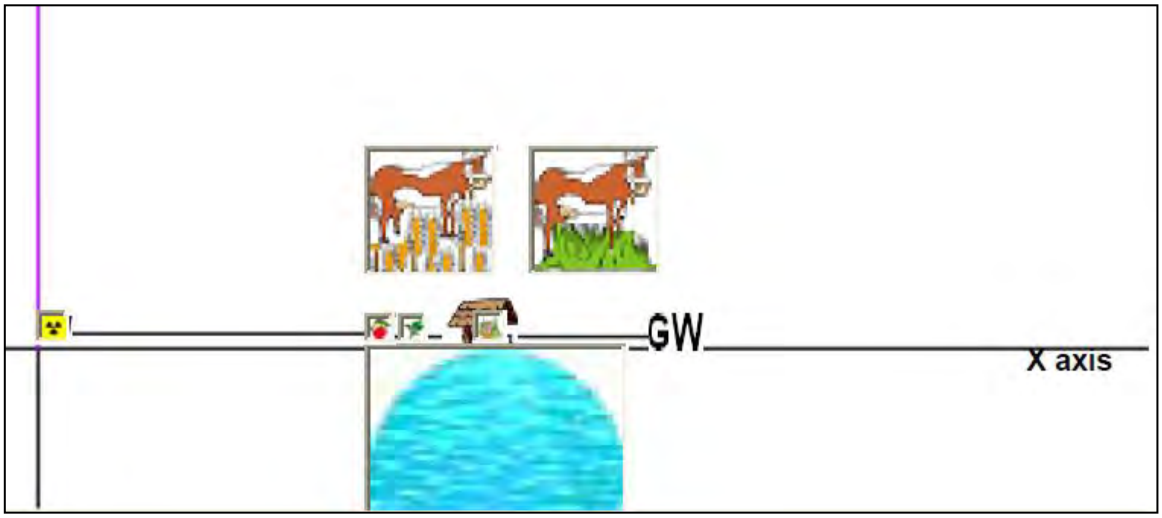


Figure 5. Site Layout Considered in the Independent Modeling

The cross section through the contaminated zone used in the independent modeling is shown in Figure 6.

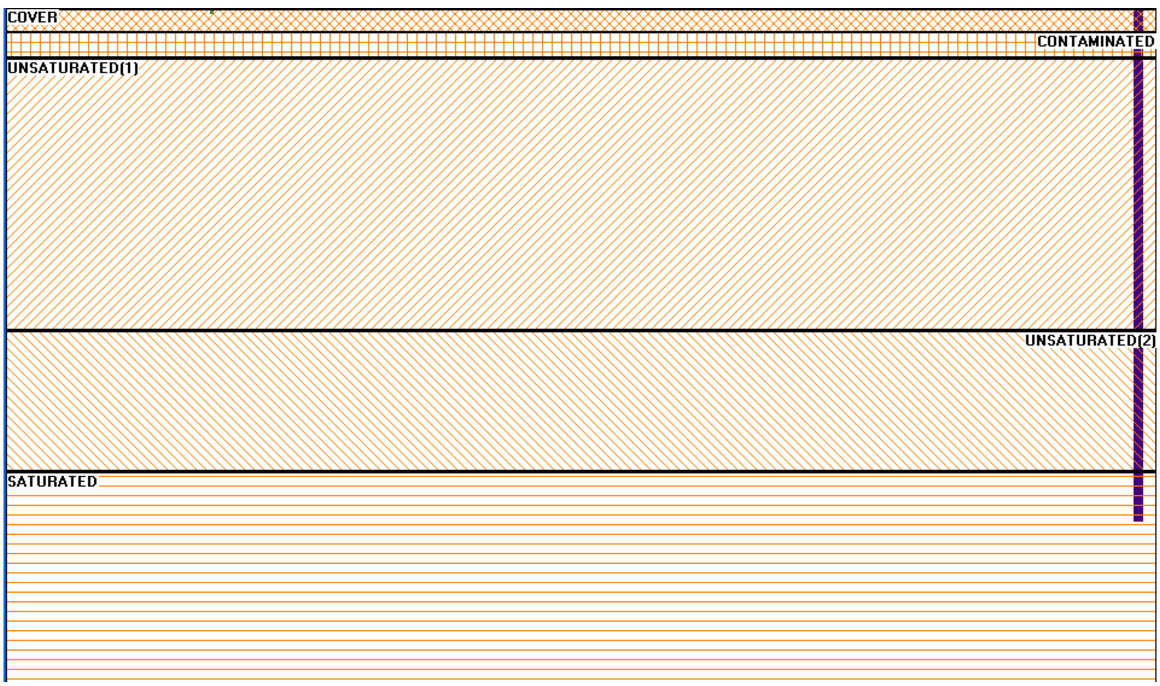


Figure 6. Contaminated Zone Cross Section Considered in the Independent Modeling

Base Case Test Runs

The base case was developed in an attempt to reproduce the results presented in the draft EIS (Table 6.24-2). Two cases were considered: (1) GTCC-like other waste RH, Group 1 stored category and (2) activated metals, Group 1 projected category.

As it was discussed above, the intent was to use the same modeling approach and parameters as in the draft EIS. However, because not everything was clear about the approach and not all parameters were provided, some differences may exist between the independent modeling set up and the set up used in the draft EIS.

The results of the independent modeling are presented in Figures 7 and 8. The results from the draft EIS are reproduced in Figure 9 and 10.

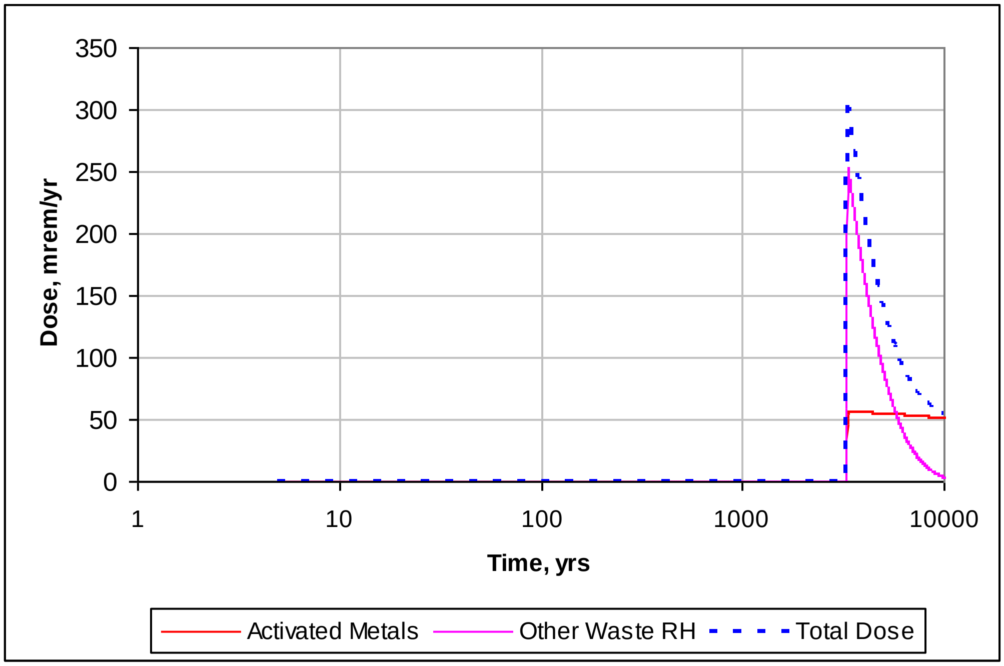


Figure 7. Base Case Independent Modeling Results for the 10,000 Year Simulation Period.

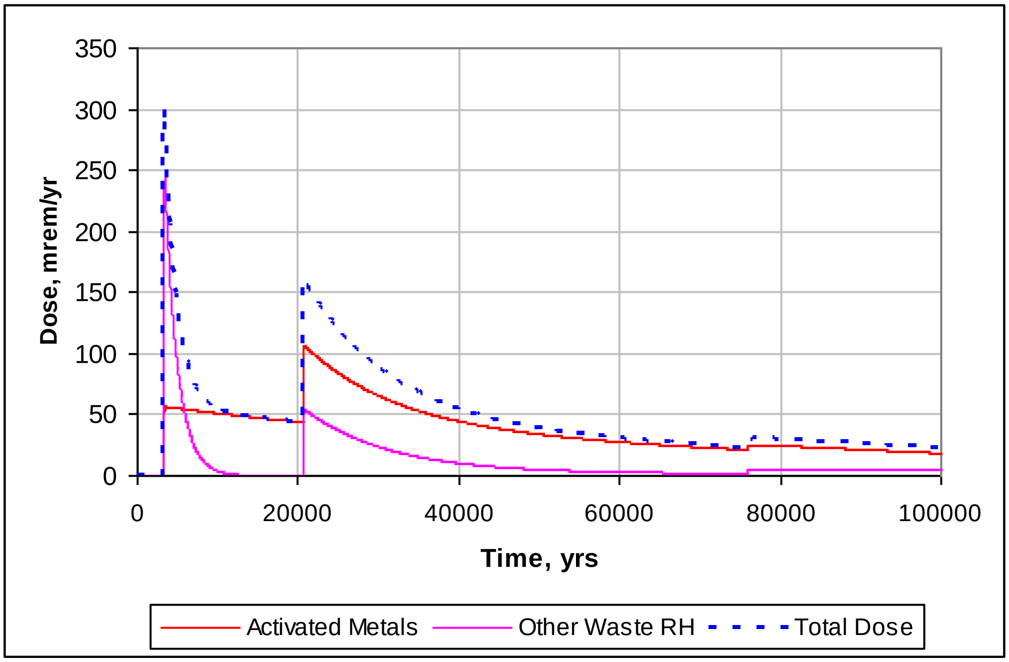
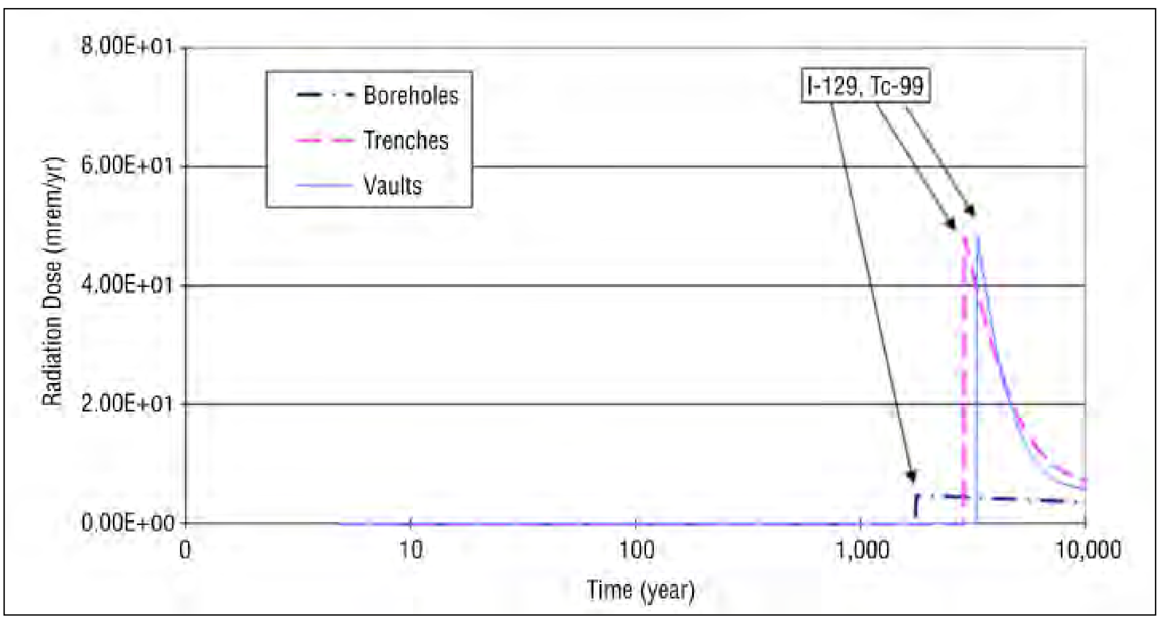
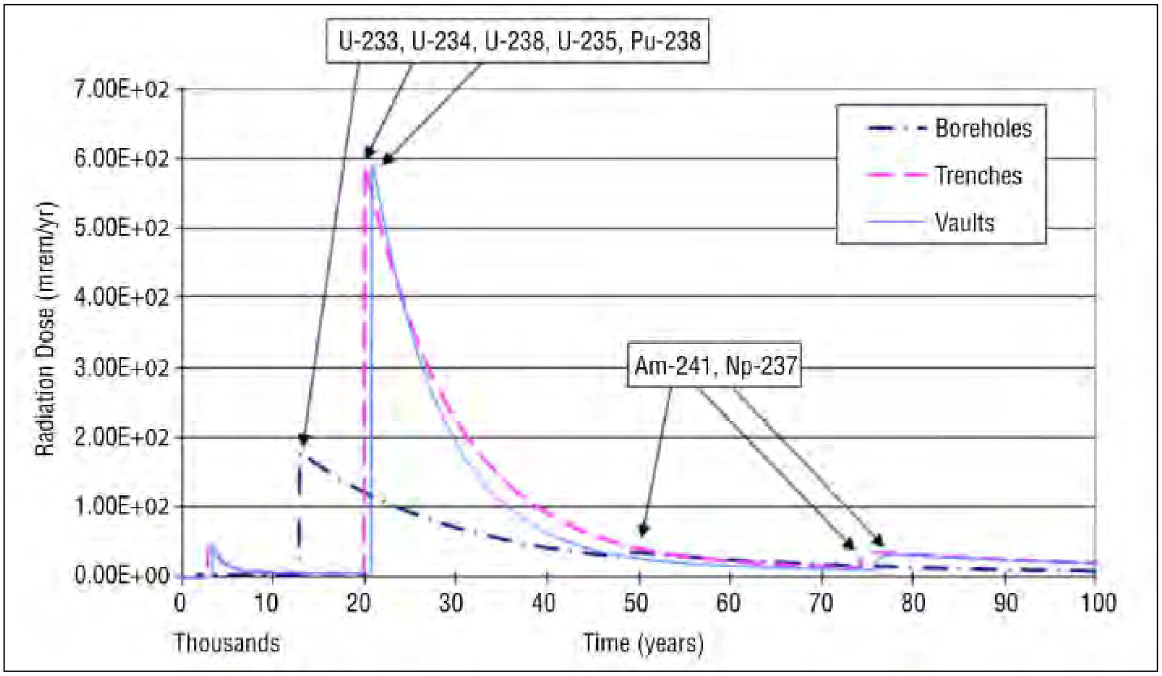


Figure 8. Base Case Independent Modeling Results for the 100,000 Year Simulation Period.



NOTE: This figure was reproduced from Figure 6.2.4-1 in Draft GTCC EIS (Volume 1)

Figure 9. Draft EIS Modeling Results for the 10,000 Year Simulation Period.



NOTE: This figure was reproduced from Figure 6.2.4-2 in Draft GTCC EIS (Volume 1)

Figure 10. Draft EIS Modeling Results for the 100,000 Year Simulation Period.

The peak doses during the 10,000 year period obtained in the independent modeling are 250 mrem/yr (other waste) and 56 mrem/yr (activated metals). The peak time is 3,300 years for both types of waste. This is because the dose is associated with non-sorbing radionuclides – I-129 and Tc-99 in the other waste case and Tc-99 in the activated metals case. All the other radionuclides have partition coefficient greater than 0 and do not reach the groundwater table in 10,000 years in this modeling approach. The total dose shown in Figures 7 and 8 represents the sum of the doses from two categories. The other categories have very small contributions based on the data in the draft EIS (Table 6.2.4-2).

The peak dose timing coincides with the peak time obtained in the draft EIS. However, the peak doses in the draft EIS are noticeably smaller – 39 mrem/yr in the case of other waste and 5 mrem/yr in the case of activated metals. The major contributors are the same – I-129 and Tc-99. The same peak dose timing suggests that the unsaturated and saturated zone transport parameters are the same in both models. The difference in doses may be related to the differences in the release rates and exposure parameters. However, this can only be established by comparing actual RESRAD-OFFSITE input files. As it was discussed above, an attempt was made to use the same parameters as in the draft EIS, but the actual input files are not available to us.

The peak doses during the period of time from 10,000 years to 100,000 years obtained in the independent modeling are 50 mrem/yr. (other waste) and 103 mrem/yr (activated metals). The peak time is 21,100 years for both types of waste. The major contributors to these doses are U-233 in the case of the other waste and U-233 and Tc-99 in the case of activated metals. Uranium has low K_ds values (0.6 mL/g in the 1st unsaturated layer and saturated zone and 0.06 mL/g in the 2nd unsaturated layer) and it reaches the groundwater table in 21,000 years. None of the other radionuclides reach the groundwater table within the 100,000 years.

The peak dose timing during 10,000 to 100,000 year period coincides with the peak time obtained in the draft EIS. However, the total peak doses in the draft EIS is larger (600 mrem/yr). The major contributors are the same as in the independent modeling.

In summary, under the base case conditions assumed in the draft EIS for the Hanford Site the only two radionuclides that reach groundwater table within 10,000 year simulation period are I-129 and Tc-99. These are long-lived radionuclides with 0 K_ds and retardation factor of 1. The time of travel of these radionuclides to the well is around 3,300 years. Because the time of travel to the well is inversely proportional to the retardation factor, only the radionuclides with retardation factors smaller than 3 will reach the well in 10,000 years (~3,300x3). The retardation factor is smaller than 3 when a radionuclide K_d is smaller than 0.23 mL/g, assuming the waste specific balk density and moisture content used in the draft EIS. Among all the radionuclides present in the wastes, the only radionuclide with K_d smaller than 0.23 mL/g is uranium. However, as it was discussed above, this K_d is only considered for the 2nd layer in the unsaturated zone. The uranium K_ds in the 1sr unsaturated layer and in the saturated zone are 0.6 mL/g. Uranium and neptunium isotopes reach the groundwater in about 21,000 years from the beginning of simulation. All the other radionuclides do not reach the well within 100.000 years. Because all the radionuclides that reach the groundwater well within either 10,000 years or 100,000 years are long-lived, the only effect of the engineered barriers under the Hanford specific conditions is in delaying the timing of the peak dose, the dose magnitude remains the same.

Sensitivity Analysis

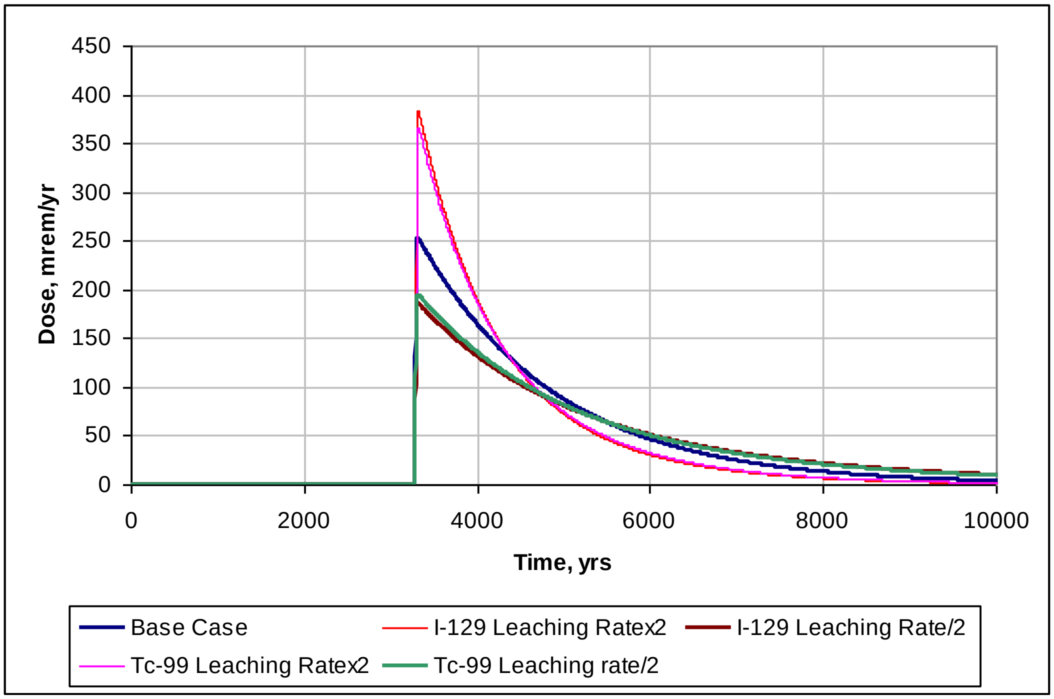
The sensitivity analysis considered only the “other waste” category. The same conclusions should be applicable to the other waste category.

The following parameters were studied in the sensitivity analysis:

- Leaching rates (infiltration rate at the top of the wastes in the case of non sorbing contaminants)
- Ambient infiltration rate
- Irrigation rates at the agricultural areas
- Distance to the groundwater well
- Fraction of food from contaminated areas
- Well pumping rate
- Depth of aquifer contributing to pumping
- Uranium K_d

The parameters that had small impact on the peak dose (within the parameter ranges considered) were: irrigation rate of grazing area and pasture area, well pumping rate, and the depth of aquifer contributing to pumping. The other parameters have either noticeable or significant impact on the total doses.

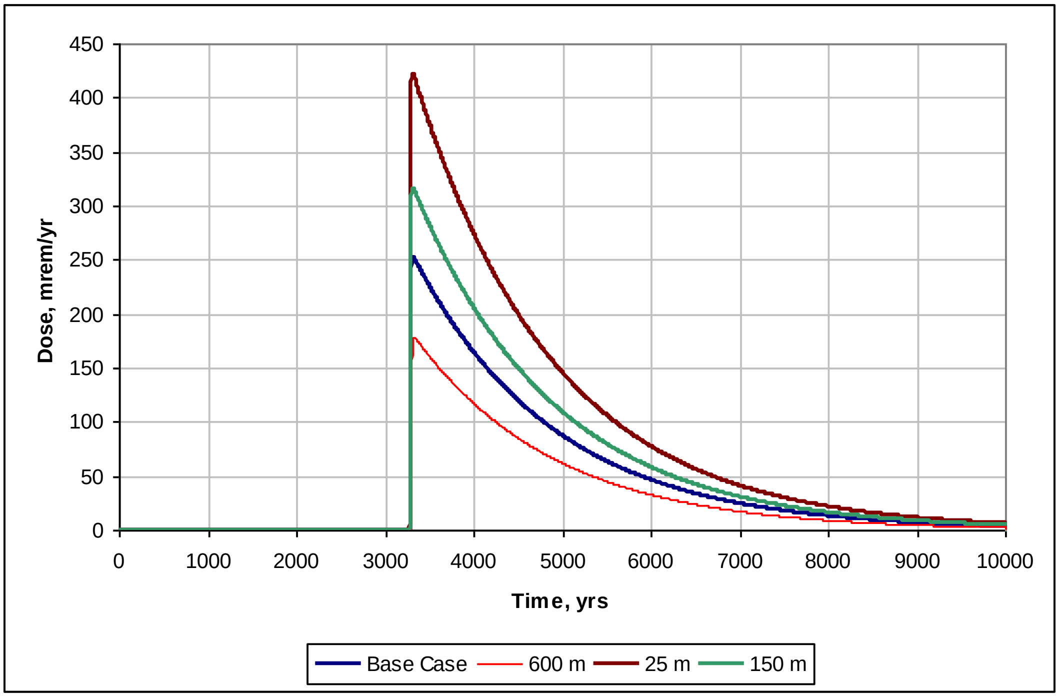
Figure 11 shows the impacts from using 2 times higher and 2 times lower leaching rate for I-129 and Tc-99. Because I-129 and Tc-99 are non-sorbing radionuclides (with retardation factor of 1), this is the same as to change infiltration rate at the top of the waste (Equation 1). A two-times higher infiltration rate represents 40% of the ambient infiltration case and two times lower infiltration rate represents 10% ambient infiltration case. The maximum dose related to I-129 increases 2 times when 2 times higher infiltration rate is used. Same is true for Tc-99. The increase in the total dose is smaller than 2 times because only one leaching rate was varied at the time (either I-129 or Tc-99).



NOTE: Base case leaching rates are 6.31×10^{-4} 1/yr for both I-129 and Tc-99.

Figure 11. Total Dose for the Different Leaching Rates

The impacts from the different distances to the groundwater well are shown in Figure 12. The dose increases 1.5 times due when the distance to the well is 2 times smaller and decreases 1.5 when it is 2 times greater.



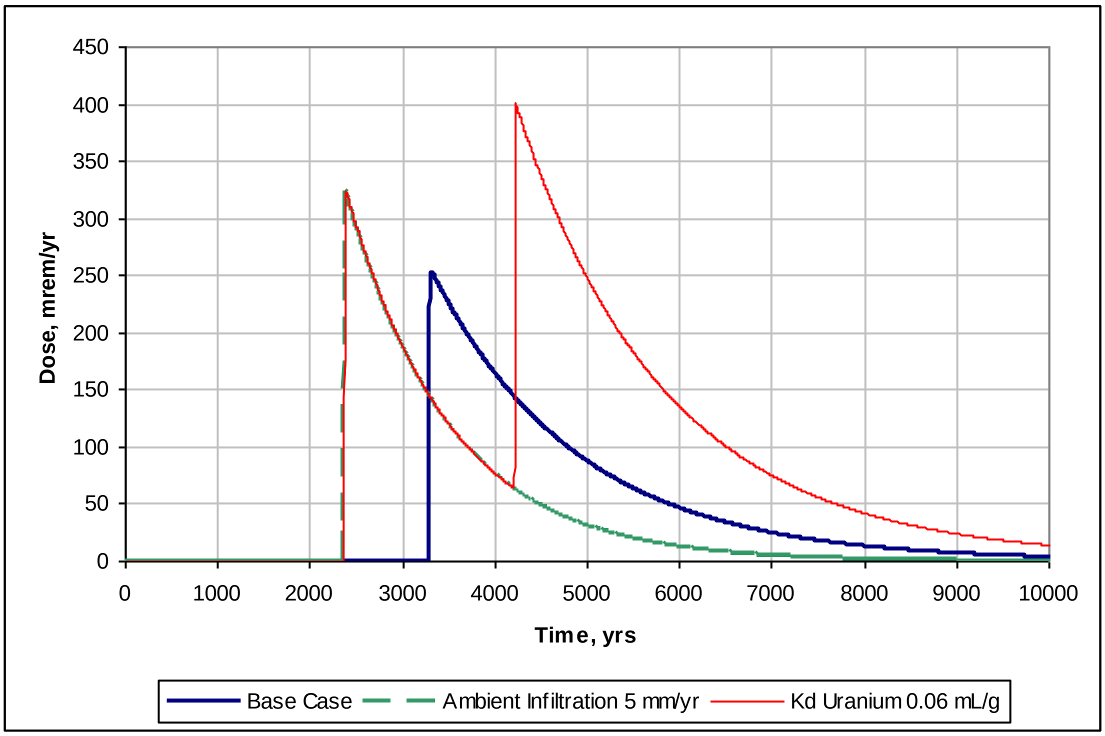
NOTE: Base case distance to the well is 300 m.

Figure 12. Total Dose for the Different Distances to the Well

Figure 13 shows the impacts from the different ambient infiltration rates. When the ambient infiltration rate is 5 mm/yr, the peak dose is higher and it occurs about 1,000 years earlier. The peak dose is higher because the radionuclide release rates are higher (20% of 5 mm/yr instead of 20% of 3.5 mm/yr as in the base case). The peak occurs earlier because the travel time is faster under the higher infiltration conditions.

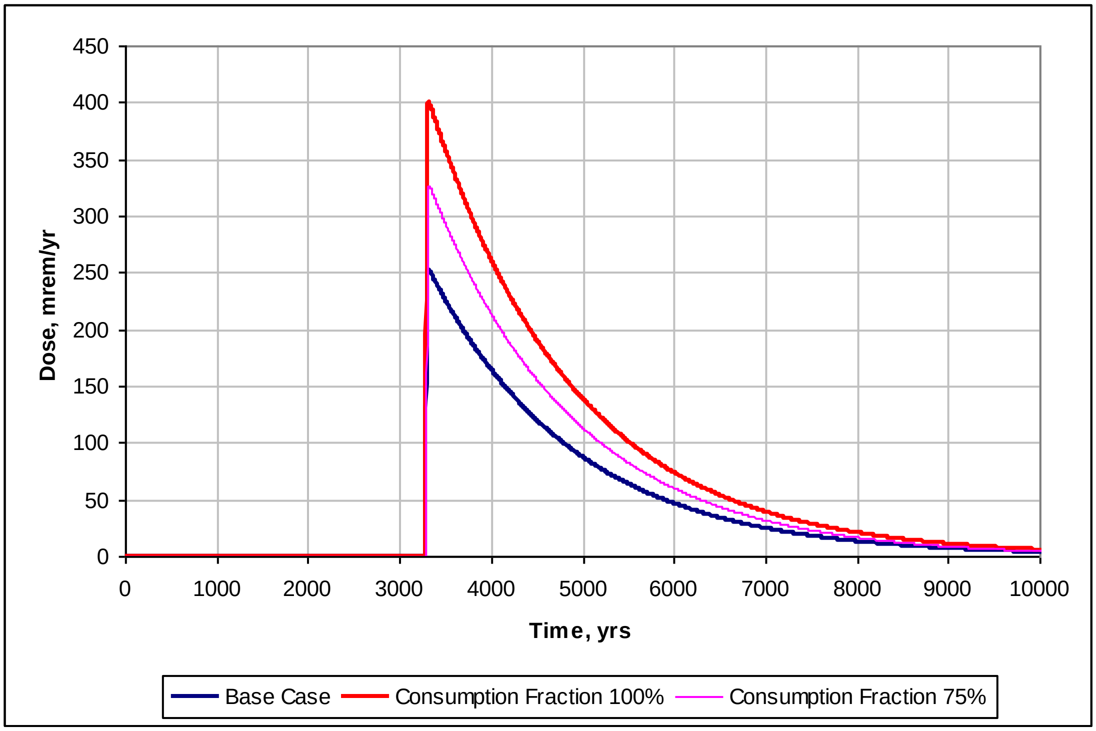
Note that the uranium isotopes do not reach the water table within the 10,000 year period in the base case. This is also true for the case with ambient infiltration of 5 mm/yr. Note that the uranium K_d s were set equal to 0.6 mL/g in the 1st layer of the unsaturated zone and in the saturated zone and to 0.06 mL/g in the 2nd layer of the unsaturated zone. The red line in Figure 13 shows the case with the ambient infiltration of 5 mm/yr in which uranium isotopes were assigned K_d of 0.06 mL/g in the unsaturated and saturated zone. In this situation uranium isotopes reach the groundwater table within 10,000 years and result in the second peak around 4,200 years.

Figure 14 shows the impacts due to the different consumption fractions. When 100% of food comes from contaminated areas (2 times more than in the base case), the total dose increases 1.6 times.



NOTE: Base case ambient infiltration is 3.5 mm/yr, uranium K_d is 0.6 mL/g in 1st UZ layer and SZ

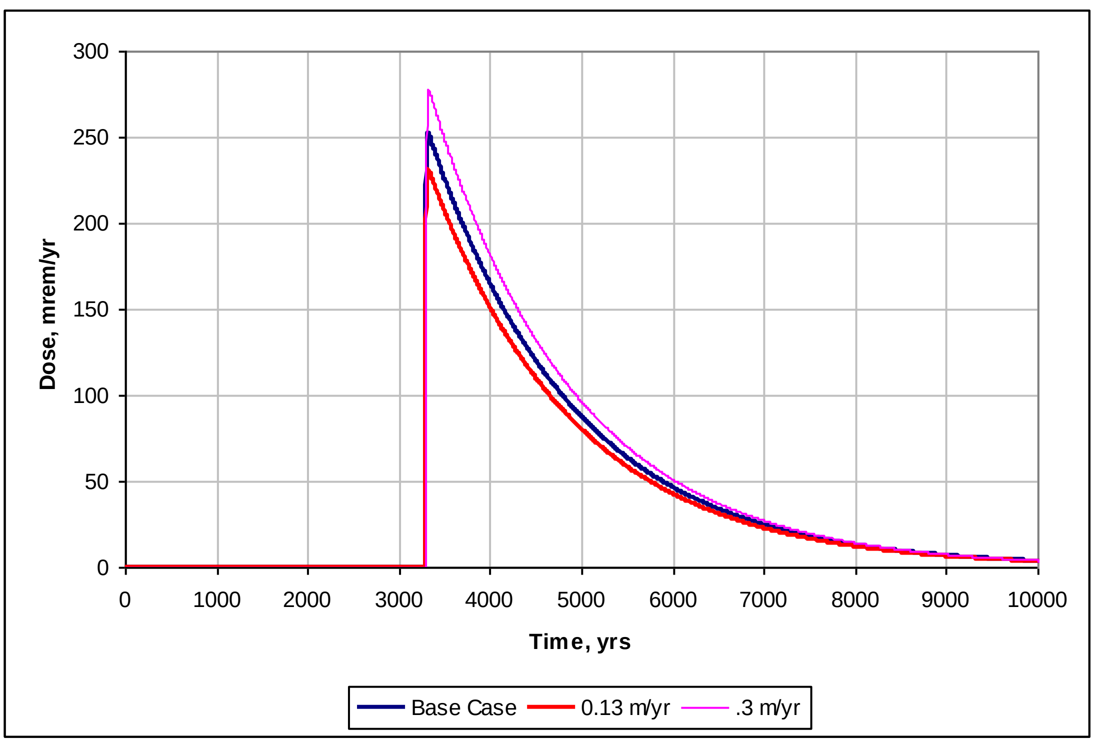
Figure 13. Total Dose for the Different Ambient Infiltration Rates and Uranium Partition Coefficients



NOTE: Base case consumption fraction is 0.5.

Figure 14. Total Dose for the Different Consumption Fractions

Figure 15 shows the impacts from the irrigation rate of the fruit, grain, and non-leafy vegetables. The impacts are smaller than in the previous cases, but still noticeable.



NOTE: Base case irrigation rate is 0.2 m/yr

Figure 15. Total Dose for the Different Irrigation Rates of Fruits, Grains and Non-Leafy Vegetables.

A conservative case was developed to demonstrate the potential impacts from all the sensitive parameters on the total dose both for the other RH waste and for the activated metals categories. The conservative case uses the ambient infiltration of 5 mm/yr. 40% of the infiltration is assumed at the top of the waste. Uranium K_d is 0.06 mL/g in both, unsaturated and saturated zones. Irrigation rate of the fruits, grains, and non-leafy vegetables is 0.3 m/yr. The fraction of food from contaminated areas is 75%. The distance to the well is 200 m (next to the fence). Note that some of these parameters are below the potential maximum values.

Figure 16 compares the base case to the conservative case for the other waste RH category. Figure 17 compares the base case to the conservative case for the activated metals category. The total dose (activated metal and other waste RH) is plotted in both figures as well. In both cases, the peak doses in conservative case are more than 4 times higher.

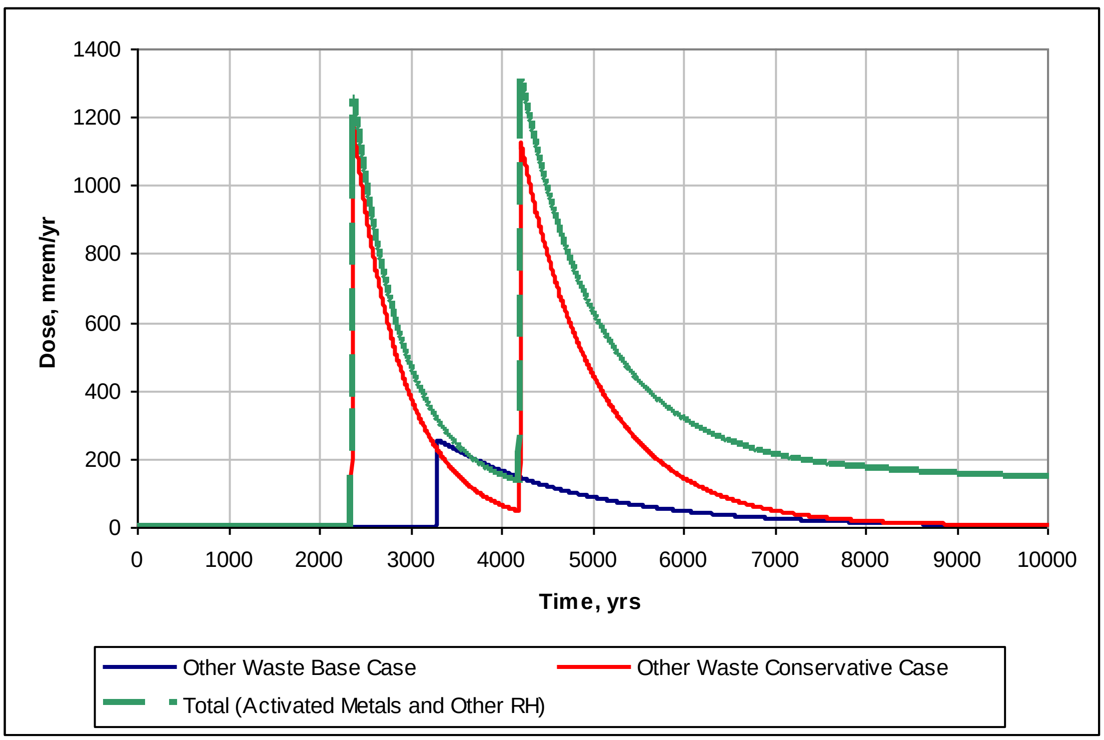


Figure 16. Base Case and Conservative Case for the Other Waste RH Category

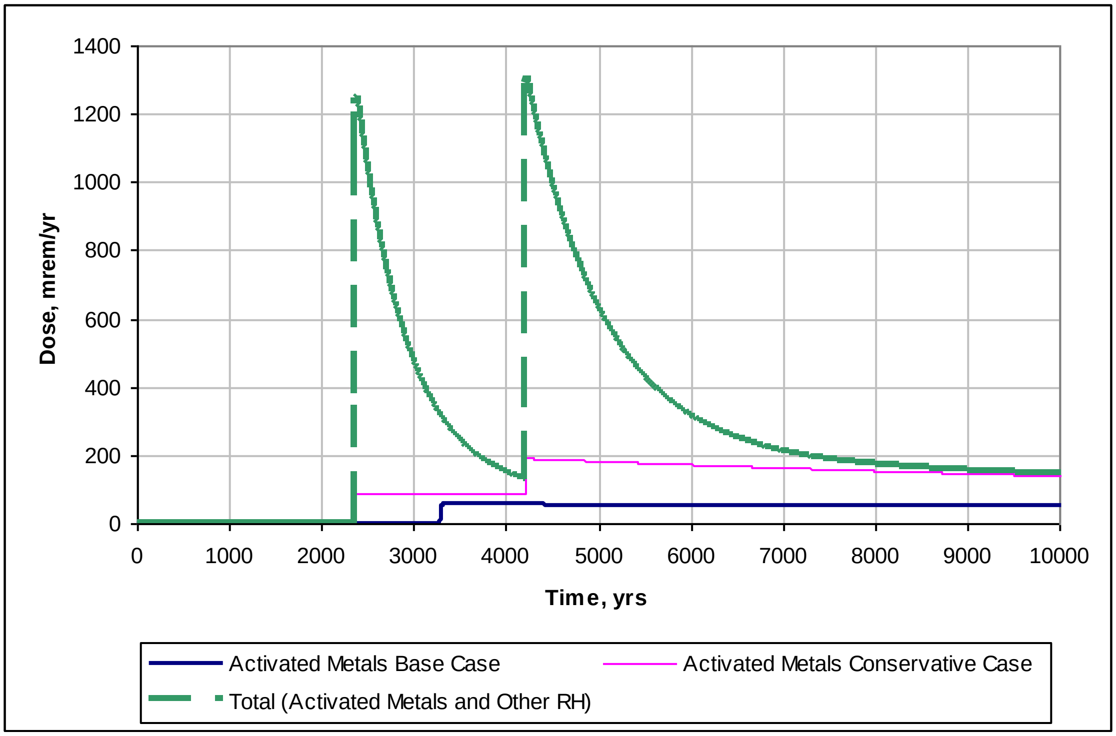


Figure 17. Base Case and Conservative Case for the Activated Metals Category

The contributions of the major exposure pathways for the base case and the conservative case for the other waste RH category are shown in Figures 18 and 19.

In both cases, the major contributors are drinking water ingestion and plant food (contaminated with irrigated water) pathways. Ingestion of milk and meat plays less significant role. The significance of drinking water and plant food changes with time as shown in Figure 19 when uranium isotopes reach the groundwater well around the simulation year 4,200.

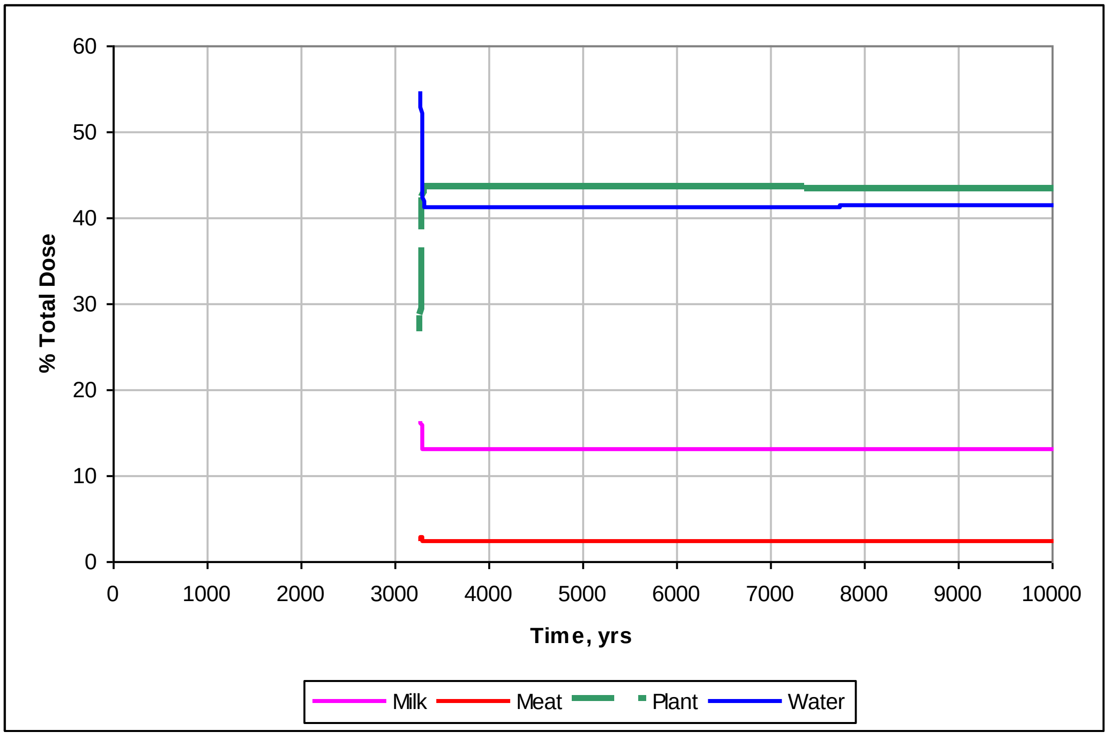


Figure 18. Major Pathway Contributions for the Base Case

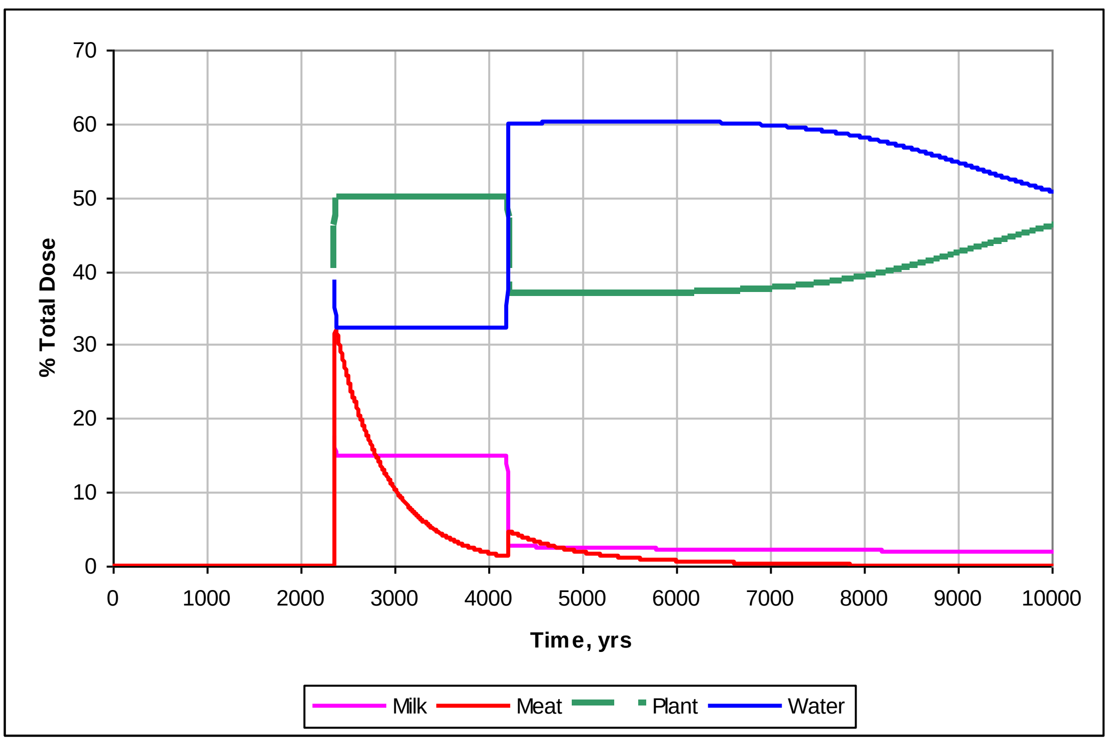


Figure 19. Major Pathway Contributions for the Conservative Case

The conservative case was developed as a demonstration that reasonably conservative parameters below the potential upper bounds still result in a large increase in estimated dose. We note specifically that Figure 16 to 19 show that the drinking water dose in the base case, using DOE parameters, is on the order of 100 mrem per year at the peak, with a similar dose from plants. In the sensitivity test, the peak drinking water is about seven times higher, at about 700 mrem/year, and the plant peak dose is about six times higher at about 600 mrem/year. The peak drinking water and plant doses occur at different times. Nonetheless, the total peak dose in the conservative case developed above is almost six times higher than the base case estimate, which uses the parameters selected by the DOE.

Additional Scenario

An additional scenario was developed to evaluate the significance of the cover erosion and aquatic food consumption that were not addressed in the base case.

As it was discussed earlier (under the modeling parameters), the cover erosion rate is calculated internally in RESRAD-OFFSITE based on the rainfall and runoff factor, soil erodibility factor, slope length-steepness factor, crop/cover management factor, supporting practice factor, and soil bulk density. These coefficients were specified the same as in Table E-5 in the draft EIS. The only exception was the crop/cover management factor that was adjusted to get the cover erosion rate of 1×10^{-3} m/yr, compared to an erosion rate of 10^{-5} m/yr used by DOE. This erosion rate results in the total cover disappearance in 5,000 years.

The aquatic food pathway was activated with the default RESRAD-OFFSITE parameters.
The other modeling parameters were the same as in the base case, except the default runoff coefficient of 0.2 was used. The evaporation coefficient was adjusted accordingly to maintain the ambient infiltration rate of 3.5 mm/yr.

The results of this scenario are shown in Figures 20 and 21 for the other waste RH category and activated metals category respectively. The total dose (the sum of activated metals and other waste RH doses) are also plotted in these figures.

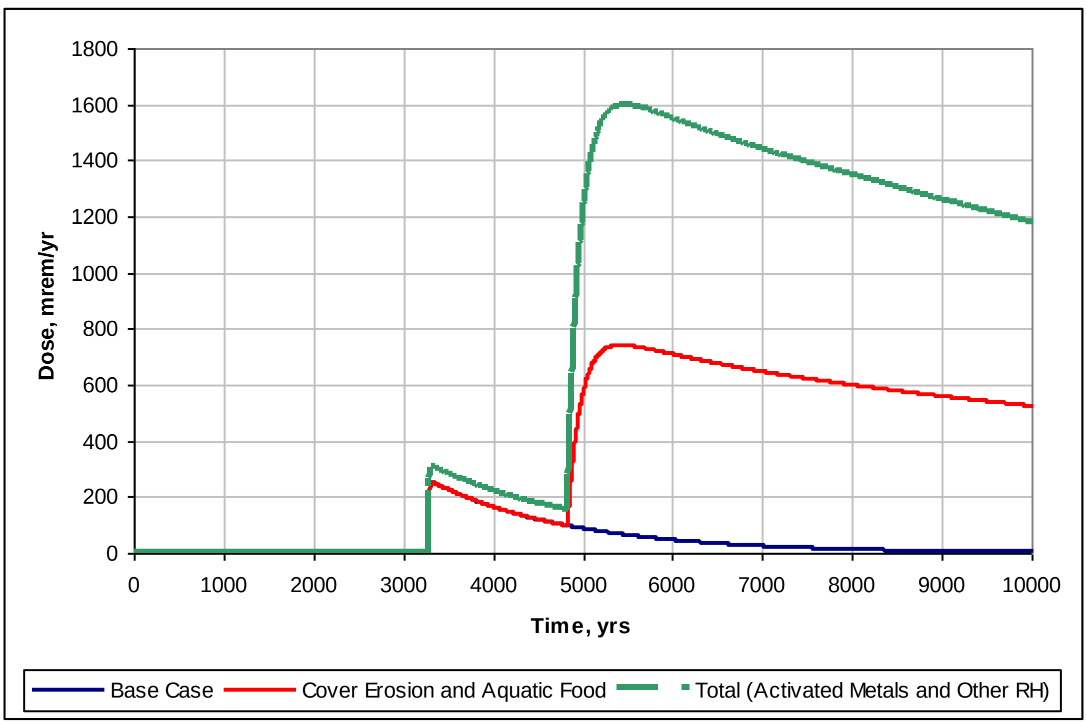


Figure 20. Base Case and Cover Erosion and Aquatic Food Scenario for the Other Waste Category (red line). The green line shows dose for the total source term (other waste plus activated metals)

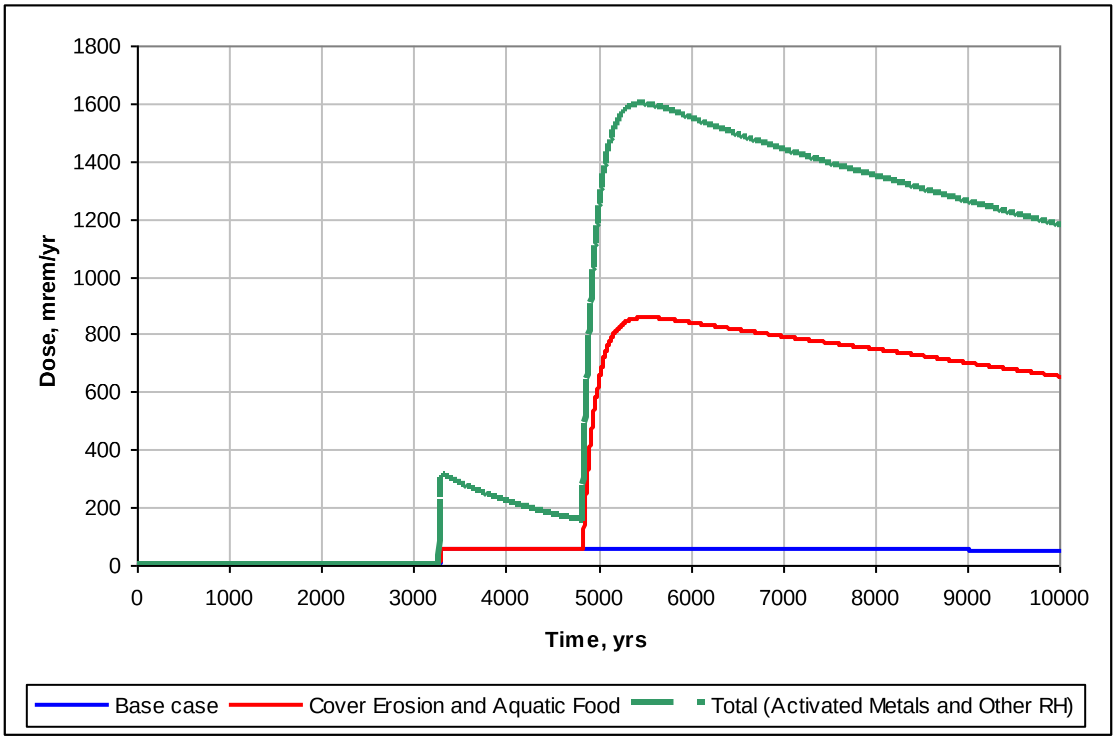


Figure 21. Base Case and Cover Erosion and Aquatic Food Scenario for the Activated Metals Category (red line). The green line shows dose for the total source term (other waste plus activated metals)

As can be seen from these figures, the cover erosion and aquatic food scenario significantly affects the total dose. In both cases, there is a second dose peak, which is 6.5 times higher than the 1st peak. The differences begin to surface when the cover starts to disappear (around year 5,000). At this moment the waste becomes exposed at the surface and is a subject of the surface water transport. The major contributors to the second peak are Cm-245, Pu-239, and Pu-240. The major pathway is the aquatic pathway.

Summary

One of the goals of this report was to attempt to reproduce the major results for the Hanford Site reported by DOE in the draft EIS. Two cases for the trench land disposal alternatives with the highest peak doses (Group 1 GTCC-like Stored Other Waste RH and Group 1 Projected GTCC Activated Metals) were selected for this purpose. An extensive review of the draft EIS and its major supporting reference (ANL 2010) was conducted to identify all the data required to do the simulations with the RESRAD-OFFSITE computer code and to clarify the modeling approach used in the draft EIS. Not all the data were found in these two documents and some of the statements in the draft EIS made regarding the modeling approach remain unclear.

The peak doses calculated for the selected two cases are different (higher for the peak dose within the 10,000 year period and lower for the peak dose within 10,000 to 100,000 year period) than the once estimated in the draft EIS. The major contributors and the timing of the peak doses are very similar to the ones in the draft EIS. The only way to resolve these differences would be to directly compare the RESRAD-

OFFSITE input files used in the draft EIS for these 2 cases with the input files developed as a part of this independent modeling.

Under the base case conditions assumed in the draft EIS for the Hanford Site the only radionuclides that reach the groundwater well within 10,000 years are I-129 and Tc-99, which are non-sorbing radionuclides with K_d equal to 0 (retardation factor equal to 1). The only radionuclides that reach the groundwater well within 100,000 years are isotopes of uranium and Np-237 with relatively low K_ds (retardation factor ranging from 1.5 to 23.5). Because these radionuclides are long-lived, the only effect of the engineered barriers under the Hanford specific conditions is in delaying the timing of the peak dose, the dose magnitude remains the same.

Another goal of this work was to conduct a sensitivity analysis in addition to the one included in the draft EIS. A number of parameters was considered in this additional study. The parameters that had small impact on the peak dose (within the parameter ranges considered) were: irrigation rate of grazing area and pasture area, well pumping rate, and the depth of aquifer contributing to pumping.

The infiltration rate and partition coefficients (K_ds) have the highest impact on the total dose. The radionuclide-specific dose is directly proportional to the ratio of the infiltration on the top of the waste and radionuclide specific retardation factor. The peak total dose within 10,00 year period is directly proportional to the infiltration rate on the top of the waste because in Hanford specific conditions the only contributors to the total dose during this period are non-sorbing radionuclides (I-129 and Tc-99). Because the infiltration on the top of the waste is defined as a percentage (20% in the base case considered in the draft EIS) of the ambient infiltration, the ambient infiltration has great impacts on the total dose as well.

The other parameters that have pronounced impacts on the total dose are: distance to the well; irrigation rate of fruits, grains, and non-leafy vegetables; and consumption fraction. Using more conservative than in the base case values for the sensitive parameters result in 5 time increase in the peak total dose.

Finally, one additional scenario was developed to evaluate the significance of the cover erosion and aquatic food consumption that were not addressed in the base case considered in the draft EIS. The cover erosion resulted in the surface water transport of highly sorbing radionuclides that were immobile in the base case scenario. These radionuclides (Cm-245, Pu-239, and Pu-240) were accumulated in the surface water body and resulted in the high total dose within the 10,000 year period related to the aquatic food consumption.

Conclusions

The ambient infiltration rate and the percentage of the ambient infiltration rate applied to the waste top are the most important parameters affecting the performance of all land disposal alternatives. These parameters should be re-evaluated for the Hanford Site. The possibility of a colder and wetter future climate should be considered when defining the ambient infiltration as well as a possible irrigation within the facility limits. A better justification should be provided for using 20% of ambient infiltration rate at the top of the waste.

The radionuclide partition coefficients (and corresponding retardation factors) are the other parameters of a great importance. These parameters were not studied in the sensitivity analysis included in the draft EIS. For the Hanford specific conditions, the partition coefficients of uranium and neptunium are of major concern.

The consumption fraction of 0.5 used in the draft EIS needs to be justified. The higher consumption fraction leads to a higher total dose because the food injection contributes 50% or more to the total dose.

The distance from the down-gradient edge of the waste to the facility fence used in the draft EIS was from 175 to 225 m. The well was placed 100 m from the fence. This translates in to the distance to the well of 275 to 325 m. Using of this distance needs to be justified. The actual facility design may result in the distance to the well as small as 50 m if located just outside of the facility fence. The closer location will result in a higher dose.

The base case scenario should consider cover erosion and aquatic food pathway because they may greatly affect the land disposal performance.

SECTION III

DEEP BOREHOLE LAND DISPOSAL ALTERNATIVE

The same approach that was used for simulating the trench land disposal alternative was implemented to simulate the deep borehole alternative. The GTCC-like Group 1 Stored Other Waste RH was considered in the simulation for the same reasons it was used in the trench simulations.

The radionuclide inventory at the beginning of simulation is the same as in the trench case. The radionuclide concentrations are different because the consolidated waste area and waste thickness are different for the borehole alternative – 270 m^2 and 10 m respectively (Table 4-2 in ANL 2010).

The radionuclide release rates in the borehole alternative are different from the trench one due to the different waste thickness (Equation 1). The values from Table 4-7 in ANL 2010 were used.

The thickness of the first unsaturated layer is 20 m smaller in the borehole alternative than in the trench alternative because the borehole waste interval is deeper.

The other parameters were kept the same as in the trench base case with the exception of the well which was placed on the down gradient edge of the waste. A different layout was used for agricultural areas and dwelling site, but their layout does not affect the contaminant concentrations in the well.

Three cases were considered. The first case is called Base Case. This case corresponds to the trench base case, but with the well next to the waste instead of 100 m away from the facility boundary.

The second case uses the more conservative ambient infiltration of 5 mm/yr (instead of 3.5 mm/yr) and more conservative percentage of infiltration applied at the waste top (40% instead of 20%). Also, the uranium isotope K_ds are assumed to be 0.06 mL/g in both, unsaturated layers and in the saturated zone. The ingestion fraction is 0.75 for all food types.

The third case uses the same parameters as the second case, except it assumes the irrigation of 0.2 m/yr on the top of the contaminated zone. The irrigation is incorporated by increasing the ambient infiltration rate to 50 mm/yr.

The results of these simulations are shown in Figure 22. The peak dose in the base case is 177 mrem/yr at 2,650 years and it is related to I-129 and Tc-99. The other radionuclides do not reach the ground water well in 10,000 years.

There are two total dose peaks in the second case. The first peak at 1,939 years (550 mrem/yr) is related to I-129 and Tc-99 and the second peak at 3,400 years (647 mrem/yr) is related mainly to the uranium isotopes.

There are 4 peaks in the third case. The first peak at 235 years (5,050 mrem/yr) is related to I-129 and Tc-99. The second peak at 372 years (6,431 mrem/yr) is related mainly to uranium isotopes. The third peak at 3,707 years (62 mrem/yr) is related to Np-237. The fourth peak at 5,897 years (195 mrem/yr) is related to Np-237.

Note that the infiltration rate and radionuclide specific partition coefficient have the greatest impacts on the total dose. The distance to the well is of less importance because the radionuclide transport in the saturated zone is significantly faster than in the unsaturated zone.

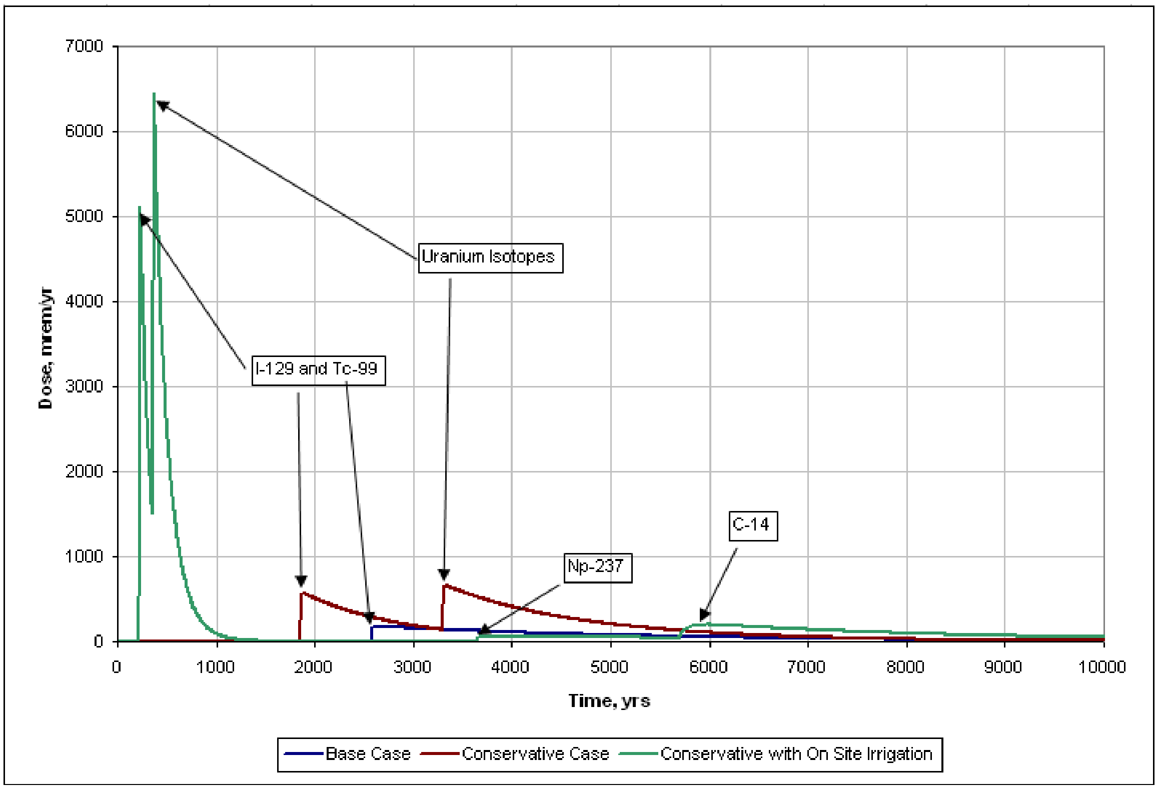


Figure 22. Borehole Land Disposal Alternative for the Group 1 GTCC-Like Stored Other Waste - RH Category