RESEARCH SUMMARY

REPORT TITLE: Control of Water Infiltration Through Shallow Land Burial Trench Covers Annual Report October 1984 - September 1985

PROJECT TITLE/FIN: The Control of Water Infiltration at Humid Area Shallow Land Burial Facilities, B8958

NRC PROJECT MANAGER: Edward O'Donnell

CONTRACTOR: Laboratory of Biomedical and Environmental Sciences, UCLA

PRINCIPAL INVESTIGATORS: Robert K. Schulz, University of California Berkeley and Robert Ridky, University of Maryland

REGULATORY CONTEXT:

A primary problem associated with short and long term management of near surface low-level radioactive waste disposal sites located in humid regions has been intrusion of water into the waste disposal trenches. Water within the disposal trenches not only leaches radionuclides from the wastes, but also upon exiting from the trenches, that water can transport radionuclides into the environment. In some cases, where trenches are excavated in relatively impermeable formations, the trenches may fill with water and run over if such steps as pump out and evaporation of trench leachates are not taken to prevent that occurrence. Thus, to minimize the potential for water borne radionuclide movement from trenches, water infiltration into waste burial trenches should be minimized.

To minimize water control problems 10 CFR Part 61 requires that waste disposal sites are to be located where they are "generally well drained" (10 CFR 61.50 (a)(5)) and the trench covers must be "designed to minimize to the extent practicable water infiltration, to direct percolating or surface water away from the disposed waste, and to resist degradation by surface geologic processes and biotic activity" (10 CFR Part 61.51(a)(4)). The focus of this project is on an assessment of trench cover designs which may be used to control percolation.

Current trench capping practice (Herzog, 1982 NUREG/CR-2478) in humid areas is to use a 1-3 meter cover that is composed of compacted backfill or compacted backfill with a locally derived clay. The covers are graded into a low crown to promote runoff and they are vegetated with grass. The grass is to reduce erosion and to remove infiltrating moisture by evapotranspiration. Experience with the existing covers at the humid area LLW sites has not been good. This is due in part to subsidence which leads to fissuring of the cap and, in part, to increased cap permeability with time due to root growth (and subsequent root decay) which creates water channels. For sites that are well drained the disposal system can accommodate water entry through the caps. Any infiltrating water will exit the disposal trench. However, trenches in low permeability media have experienced "bath tubbing," and they require better protection from water intrusion than the existing cap designs are providing.

Several alternative trench cap design approaches have been proposed for future humid area sites (e.g., capillary barrier system, layered soil system, impermeable barriers, and a bioengineered system). They are intended as improvements over current capping technology. From a regulatory perspective they are designs which may be promising but whose performance is still unassessed.

RESEARCH OBJECTIVES:

The objective of this research is to assess potentially promising methods for controlling deep water percolation through low-level waste disposal trench covers.

RESEARCH FINDINGS AND RESULTS:

The attached report describes the results of preliminary field testing at Maxey Flats. This preliminary work was undertaken to provide a reference for designs of full scale trench caps at the Beltsville, Maryland site.

The principal investigator employed 12 existing small scale (5' diameter X 10' deep) lysimeters in which there was an established vegetative crop and 2 years baseline data on the effectiveness of that crop in controlling deep water percolation. The soil in the lysimeters was a weathered clay rich shale from Maxey Flats that was compacted to the same density as a typical new trench cover. The baseline data indicate that about 20% of the water input (rainfall) was disposed of as surface run-off, 50% was removed by evapotranspiration, and 30% ended up as deep percolation water. During the winter-spring, when evapotranspiration was low, the deep percolation that occurred resulted in a rise of the water level in the bottom of the lysimeters. To reduce percolation run-off was artificialy enhanced by covering 70% of the surface in 6 lysimeters. Six other lysimeters were left with their existing vegetation as a control; however, a number of different crop-management schemes were employed to determine whether there might be a scheme that is optimal for controlling deep water percolation. Results are summarized in figures 6-12 of the attached report. With the control lysimeters there was deep percolation as evidenced by rising of the water in them, especially during the winter and spring months. The variation of crop-management schemes had little effect on deep water percolation. Because of the relative impermeability of the Maxey Flats clay, that excess water would have to be removed by pumping. In contrast, lysimeters with enhanced runoff showed no water level rise and presumably would not need to be pumped. Thus the data obtained to date, albeit in the rather small scale lysimeter experiment, indicate that an enhanced runoff system might serve as a tool for control of water infiltration through shallow land burial trench covers. Basically the system calls for engineered, or positive, guaranteed runoff, along with substantial evapotranspiration.

In summary several points should be noted: (1) In the lysimeters without enhanced runoff containing compacted clay to simulate a conventional trench cap there was approximately 30% deep percolation below the root zone of the vegetation. (2) In the lysimeters with enhanced runoff less water is available for the vegetation. Plants are "stressed" and they enter an overdraft situation where they actively seek what little water is available. In this case, deep percolation below the root zone approaches zero. (3) The results of this small scale lysimeter experiment indicates that the concept of using enhanced runoff with "stressed" vegetation is a promising way to control deep water percolation into burial trenches. A large scale field experiment embodying that concept is underway at Beltsville, Maryland. A drawing of a test cell employing that concept is shown in Figure 14 of the attached report. It should be noted that the results of these tests would be applicable equally to a conventional SLB trench, or any above or below grade structure (such as an earth mounded bunker) which relies on a cover or cap to control/divert surface water infiltration.

REGULATORY IMPLICATION:

The small scale lysimeter experiment indicates that about 30% of the precipitation falling on plots of compacted clay covered with fescue grass or alfalfa will percolate below the root zone of the vegetation. Varying vegetation and cropping methods had very little effect on this deep percolation. Extrapolating those results to disposal facilities in humid areas, one can expect water movement through earthen or clay covers. This is borne out by experience at the commercial LLW sites in the Eastern United States. Improved methods are needed to control surface water percolation at LLW disposal sites where such percolation could adversely affect the performance of the facility.

Edward O'Donnell

Edward O'Donnell
Earth Sciences Branch
Division of Radiation Programs
and Earth Sciences
Office of Nuclear Regulatory Commission

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2. K+ file

FEB 10 1987

Maxey Flats File No 201.6

NOTE TO: Mal Knapp
John Starmer
Maxine Dunkleman
Kathy Schneider, OSP

FROM: Kitty Dragonette KSD

SUBJECT: Price Anderson Claims for EPA Superfund Activities at Maxey Flats

Enclosed is a copy of a claim filed to establish that radioactive releases at the Maxey Flats, Kentucky low level waste site should be covered by Price Anderson.. The enclsed claim is by Battelle. General Dynamics has filed a similar claim. OGC has the lead to respond to both claim letters. According to Bob Fonner, this strategy is based on the fact that activities and liabilities associated with byproduct, source, and special nuclear materials covered by Price Anderson are exempt under Superfund. Such claims could lead to litigation of the issue before EPA could collect. Fonner noted that the nonradioalgical hazards of the wastes and releases would not be covered by Price Anderson in any case so that the claims address only part of the liability. Fonner also indicated that NMSS involvement on what constitutes an "incident" might be needed at some future time but for now, the claims are strictly legal matters.

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KDragonett . 10-8

OGC action for Farmer 2/11/87

VM: File 201.6 (Fletz, K) (Mail)

RECEIVED FEB 5 1987 U.S. NUCLEAR REGULATORY COMMISSION NMSS Mail Section

Battelle
Columbus Division
505 King Avenue
Columbus, Ohio 43201-2693
Telephone (614) 424-6424
Telex 24-5454

January 28, 1987

CERTIFIED MAIL

Director of Nuclear Material
Safety and Safeguards
U.S. Nuclear Regulatory Commission
1717 H Street, N.W.
Washington, D.C. 20555

DOCKETED USNRC FEB 5 1987 NMSS MAIL SECTION DOCKET CLERK

Dear Sir or Madam:

NOTICE OF DEMAND BY THE ENRIVONMENTAL
PROTECTION AGENCY UNDER 42 U.S.C. §§ 9601 ET SEQ.
NUCLEAR DISPOSAL SITE, MOREHEAD, FLEMING COUNTY, KENTUCKY

Battelle Memorial Institute (BATTELLE) and Battelle Columbus Division, an operating division thereof, have received notice under the captioned statute that they are potentially responsible parties (PRP's) for costs related to response or remedial action taken and planned by the Environmental Protection Agency (EPA). A copy of the notice from EPA is appended as Attachment A.

Upon receipt of the notice, Battelle conducted a preliminary survey of the materials which were or may have been sent to the captioned disposal site. That survey indicates that many of the materials were generated, received or otherwise employed by Battelle in performance of Government contracts. Many of these were prime contracts with the Atomic Energy Commission (AEC) and its successor agencies, the Department of Defense (DOD), or the National Aeronautic and Space Administration (NASA). Others were subcontracts with AEC, DOD, or NASA contractors. In performing these contracts, Battelle made extensive use of depleted uranium, source materials, and enriched (or special nuclear) materials. Most of these materials were Government-owned and furnished. Accordingly, by contract and regulation, the Government at all times retained title to the radioactive contaminants and wastes generated in these operations.(1)

Certain of Battelle's contracts, and the contracts under which Battelle subcontracted, contained or were subject to various indemnification agreements, including indemnification against public liability authorized by the Price Anderson Act. See 42 U.S.C. §§ 2014, 2210(d) (1982). Battelle also may be indemnified as a processor of Government-owned and furnished nuclear material produced by AEC or Nuclear Regulatory Commission (NRC) licensees who had entered into indemnification agreements in connection with the operation of production and utilization

(1) The standard Government furnished property clauses appearing in AEC prime contracts explicitly provided that title to property furnished by the Government remained at all times with the Government.

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facilities. See 42 U.S.C. §§ 2133, 2134, 2210(c) (1982). As a result, Battelle is a "person indemnified" within the meaning of the Price Anderson Act. See 42 U.S.C. § 2014(t) (1982).

The attached notice of demand which may create legal liability arising out of or resulting from a "nuclear incident" may result in "public liability" within the meaning of the Act. See 42 U.S.C. § 2014(w). A "nuclear incident" is defined as "any occurrence...causing....loss of or damage to property, or loss of use of property, arising out of or resulting from radioactive, toxic, explosive, or other hazardous properties of source, special nuclear, or by-product material..." 42 U.S.C. § 2014(q).

As a PRP for costs related to response or remedial action taken and planned by EPA, Battelle may be required to take affirmative and costly action. In addition, the issue of responsibility for the costs ultimately may be committed to the Federal Courts for determination. Because EPA's claims are premised solely upon the occurrence of a nuclear incident, any judgment against Battelle or expenditures required of this organization would result in public liability within the meaning of the Act. See 42 U.S.C. § 2014(w) (1982).

In light of the foregoing, this letter, in accordance with 10 C.F.R. § 140.6, constitutes written notice of a claim for property damage arising out of or in connection with the possession or use of radioactive materials. Should you have any questions concerning this matter or should you wish to discuss the issues raised in this letter, please contact the undersigned at (614) 424-6580.

Sincerely yours,

Kathy A. Olson

Kathy A. Olson
Assistant General Counsel

KAO:dkm

Attachment

ATTACHMENT A

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION IV

345 COURTLAND STREET
ATLANTA, GEORGIA 30365

4WD-ER

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

NOV 26 1986

BATTELLE MEM. INSTITUTE
505 KING AVENUE
COLUMBUS, OH 43201

REF: Maxey Flats Nuclear Disposal Site
Morehead, Fleming County, Kentucky

Dear Sir/Madame:

The United States Environmental Protection Agency (hereinafter E.P.A.) has spent and is considering expenditures of public funds to investigate and take corrective action for the control of releases and of threatened releases of hazardous substances at the above-mentioned site. This action is being taken pursuant to Section 104 and other provisions of the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (hereinafter referred to as CERCLA), codified at 42 U.S.C. Section 9601 et seq. and recently amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), P.L. 99-499 (signed by President Reagan on October 17, 1986). For your information, the key term "hazardous substance" is defined at 42 U.S.C. Section 9601 (14).

Potentially responsible parties (PRPs) under CERCLA include current and former owners and operators of the disposal site, persons and entities who generated or produced the disposed of hazardous substances and who made agreements for disposal of such hazardous substances at the site, and persons and entities who were involved in the transport, treatment, or disposal of hazardous substances at the site. Under Section 107(a) of CERCLA, 42 U.S.C. Section 9607(a), under SARA, and other laws, PRPs may be liable for costs incurred by the government in taking corrective actions at the site. Such costs may include, but may not be limited to, expenditures for investigation, planning, cleanup of the site and enforcement activities. By means of this letter, EPA is giving you notice of your potential CERCLA liability and to encourage you as a PRP to undertake voluntary cleanup activities at the above-named site; specifically the remedial investigation and feasibility study (RI/FS) and ultimately the remedial design and remedial action (RD/RA) itself.

Based upon radioactive shipping records (RSR's) gathered by EPA, the Agency has reason to believe that you may be a responsible party under CERCLA, as amended. At this time approximately eight hundred thirty-two (832) PRPs have been linked to the Maxey Flats Disposal Site. Attachment A is a list of such PRPs with their current addresses. Because of the large number of PRPs and the deadline discussed below for the PRPs to undertake the RI/FS, EPA recommends that the PRPs at their earliest convenience organize themselves into a steering committee. It is further suggested by EPA that a steering committee spokesperson be chosen as soon as practical and that the steering committee or PRPs retain an environmental engineering consulting firm to study the draft workplan for the RI/FS which is included as Attachment B to this notice/demand letter. The constituted steering committee, PRPs, or environmental consultants are directed to call the EPA personnel indicated below for further information about the Maxey Flats Disposal Site.

By way of background, in 1963 the Commonwealth of Kentucky commenced operation of a low-level radioactive disposal site at Maxey Flats. Earlier in 1962, Kentucky entered into a licensing agreement with the U.S. Atomic Energy Commission to assume regulatory powers for the management of the low-level radioactive materials. The licensing agreement transferred title of the Maxey Flats Disposal Site to the Commonwealth of Kentucky and the leasing of site operations to the Nuclear Engineering Company.

An estimated 4.75 million cubic feet of waste were deposited at Maxey Flats from the beginning of operations in 1963 to the close of disposal activities in 1977. About 2.4 million curies of atomic by-product material, over 240,000 kilograms of atomic source material, and 430 kilograms of special nuclear material were placed in trenches, pits, and hot wells in the active disposal area on-site which consists of 25 acres. Specific low level radioactive waste disposed of at Maxey Flats included items such as contaminated paper, trash, clothing, laboratory glassware, plastic tubing, filters, ion-exchange resins, and evaporation sludges. Organic materials placed in Maxey Flats included animal tissue, paper, cardboard, wood, plastics, and organic chemicals (found in leachate samples were benzene, naphthalene, d-n-octyl phthalate, and 1,4 dioxane along with others).

The lessee of the Maxey Flats Disposal Site, Nuclear Engineering Company, (now U.S. Ecology) made contracts or agreements with PRPs for disposal of their hazardous substances from 1963-1977 at the site. These arrangements, contracts, or agreements are reflected by the radioactive shipping records (RSR's) collected and separated by EPA. The present volumetric/percentage breakdown of each PRP's contribution of hazardous substances to the Maxey Flats Disposal Site is attached to this notice/demand letter as Attachment C. The volumetric breakdown is being provided only for general information purposes. Further refinements in the volumetric breakdowns by EPA are anticipated.

EPA has determined that "a release" of hazardous substances as defined by Section 101(22) of CERCLA, as amended by SARA, 42 U.S.C. §9601(22) has occurred at the Maxey Flats Disposal Site. Water collected in the disposal trenches and such water, after becoming contaminated, has leached out or was pumped out. Forced evaporation was also utilized to dispose of the contaminated water. As a result of these measures (pumping, evaporation) contaminated water has migrated offsite and water vapor contaminated with tritium has been released into the atmosphere. Elevated levels of radionuclides such as Strontium-90 and Cobalt-60 have been detected off-site. Studies have shown higher-than-normal tritium levels in leaves of trees adjacent to the site. Fractures in sandstone beds outside the trench area contained contaminated leachate. The potential and actual off-site migration of contaminated leachate and radionuclides may pose an environmental threat to local surface waters, groundwater, wells, and landowners.

EPA has already expended public funds producing the draft workplan for the remedial investigation and feasibility study. Approximated or estimated costs of this activity and other costs recoverable pursuant to CERCLA now exceed $130,000. It is anticipated by EPA that it will cost $1,300,000 for the government to conduct the RI/FS and that the ultimate cleanup itself (reflected in the remedial design and remedial action) may cost $30,000,000 or more. The RI/FS will largely determine the scope and cost of the actual cleanup.

Accordingly, you and the other PRPs are requested to organize a steering committee and to notify EPA, in writing, at the address given below, of your willingness to conduct or undertake the RI/FS. See specifically Section 104 of SARA, P.L. 99-499 which has amended Section 104(a)(1) of CERCLA. Your notification and subsequent agreement with EPA to undertake the RI/FS must be made within ninety (90) days of your receipt of this letter. Should you fail to notify or reach an agreement within the ninety (90) day time frame, EPA will assume that you will not conduct the RI/FS and the government will proceed to do the RI/FS itself.

Your written responses to this notice/demand letter should indicate the appropriate name, address, and telephone number for future contact with you and should include a statement of your desire to conduct the RI/FS. Where you are already involved in discussions with state and local authorities, engaged in voluntary action, or involved in a lawsuit regarding the site, you should continue that activity and report the status of those discussions or those actions in your letter. Please provide a copy of your letter to any other party involved in those discussions.

Your written response should be sent to:

Mr. Harold Taylor
Enforcement Project Manager
Investigation and Compliance Section
Emergency and Remedial Response Branch
U.S. Environmental Protection Agency
345 Courtland Street, N.E.
Atlanta, Ga. 30365
(404) 347-2234

Due to the seriousness of the problems at this site and the attendant legal ramifications, EPA strongly urges you to respond within the time frame indicated above. Legal questions should be directed to Mr. James F. Bycott, Assistant Regional Counsel, at (404) 347-2641.

The factual and legal discussions contained in this letter are intended solely for notification and edification purposes. They are not intended to, do not, and may not be relied upon as a final Agency position on any matter set forth herein.

To facilitate information requests, EPA will establish a repository of records at our Atlanta office. Once a steering committee has been selected, the committee can review the documents for copying and distribution purposes. To schedule appointments for reviewing the documents, please contact Mr. Taylor at the above address.

Thank you for your attention and response to this letter.

Sincerely,

Patrick M. Tobin
Director
Waste Management Division

cc: Mr. Alex Barber, Director
Division of Waste Management

Schneider

Kt file

Distribution List

Robert E. Browning	NMSS
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Robert McDougall	NMSS
Robert Fonner	OGS

[redacted]

MAR 10 1987

TRIP REPORT

WHO: Advisory Task Force to The Governor of Kentucky

WHERE: Capitol Annex Building, Frankfort, Kentucky

WHEN: Meeting of March 3, 1987

State Representative Pete Worthington addressed the Advisory Task Force on the issue of continuing State funding for the pumping and evaporation operations at Maxey Flats. He stated his concern that management of Maxey Flats by the Natural Resources and Environmental Protection (NREP) Cabinet is less than satisfactory - citing "seven years of poor project management, almost $10 million expenditures, and the ongoing, potentially serious problem." In October of 1986, Representative Worthington had urged Governor Martha Layne Collins to appoint an Advisory Task Force to "audit the past actions at the site and to make recommendations for the future." He reviewed the history of the site and mentioned the dissension between his office and the NREP with regard to stabilization activities over the past few years.

Representative Worthington urged that pumping and evaporation activities not be continued at this time on the basis that "there is no convincing data today which proves that pumping reduces water levels in the trenches." He suggested that sump water levels be carefully monitored for several months while the pumping is not operative. Pumping and evaporating would cost the State $610,000 in 1987.

The Advisory Task Force did not find the water level data (distributed by Representative Worthington) to be adequate to substantiate his contention that levels are not affected by pumping. The Task Force will hear technical evidence from the NREP Cabinet and from the Human Resources Cabinet on this issue.

Stan Neuder, WMPC
Member, Advisory Task Force

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

K+ file

OCT 13 1983

MEMORANDUM FOR: Don A. Nussbaumer, Assistant Director
Office of State Programs

FROM: Leo B. Higginbotham, Chief
Low-Level and Uranium Projects Branch
Division of Waste Management

SUBJECT: DECOMMISSIONING PLAN FOR MAXEY FLATS

We have reviewed the draft of the Decommissioning Plan for the Maxey Flats Disposal Site, Task 3: Evaluation of Alternatives. Our comments are enclosed. Dr. Stan Neuder is the Branch Technical contact for this project. Please contact him at 427-4607 should any questions arise.

Leo B. Higginbotham

Leo B. Higginbotham, Chief
Low-Level and Uranium Projects Branch
Division of Waste Management

Enclosure:
As stated

8707230305 9pp.

Specific Comments On The Maxey Flats

Decommissioning Plan, (Task 3).

1. Page 8, Intruder Performance Standard:

"Ensure protection of any individual" to what degree?

2. Page 17, 2.2.1.8 Monitoring system:

There are many other reasons for monitoring which were not mentioned. For example, to verify confinement, to detect changes, to indicate trends, to identify potentially problematic situations, to project doses, etc.

3. Page 17-20, Environmental Surveillance Programs:

a. These tables appear to be listings of generic surveillance programs rather than site-specific programs to Maxey Flats. Were these programs in place at Maxey Flats? Note that these programs were not recommended by the NRC for the Kentucky site and indeed may not be totally applicable. These monitoring programs first appeared in NUREG/CR-0570, Addendum, July 1981 for reference disposal sites.
b. Much of this discussion is not applicable to decommission (e.g., establish baseline information, list of pre-operational monitoring activity, etc.).
c. Conspicuously absent are (i) a non-radiological surveillance program and (ii) a surveillance program during the decommissioning activities.

4. Page 20, Table 2-5, Post-Operational surveillance:

a. Define the post-operational period in terms of the active and passive institutional control periods.
b. Here again, the post-operational surveillance program appears to be generic rather than site specific to Maxey Flats. Components of an in-place monitoring program would ordinarily be continued into the active institutional control period.

5. Page 21, Deep dynamic compaction:

The word "only" in the last sentence of the page, which reads "... densification of Maxey Flats trenches require only the development of methods to control potential releases of radioactivity and personnel exposure," is grossly misleading. Densification procedures with pile removal may lead to major radiological and non-radiological hazards off site as well as on site. The control of potential releases will not be readily achieved. Indeed, pile removal may present insurmountabradiation control problems (See Item 42).

6. Page 25, Structural cap

Clarify the extent of structural concrete caps. Are they to be above the trenches only? Explain "bridge over the trenches." Is the cap to be below grade, on the soil surface or raised above the surface? Give examples and briefly explain what kind of cover will protect the cap in the long-term.

7. Page 26, Clay cap:

The bentonite clay layer will only remain relatively impermeable as long as it is kept wet. This limitation condition should be included in the discussion to clarify why the bentonite layer must be protected. It should also be noted that root systems can cause localized drying of the bentonite with attendent shrinking and infilling of the cracks by non-bentonite soil. This may effectively destroy the relative impermeability of the cap.

8. Page 39-40, Trench inventories:

What are the units associated with the given quantities? What are the dates of these inventories? The curie contents listed in Tables 2-8 and 2-9 do not seem to be in agreement. (e.g., it appears that Trench 001 has 306 Ci according to Table 2-9 but only a few mCi according to Table 2-8).

9. Page 42, Table 2-10, Radiological source term:

(a) units missing on all quantities.
(b) define "source term," and how used in the study.
(c) Where were the measurements made? (e.g., adjacent to trench, site boundary, etc.).

10. Page 45, Table 3-1, Potential accidents:

(a) what is the basis or source of information regarding "frequency" of various accident occurrences?
(b) define "performance scenario."

11. Page 46, next to last paragraph, Careful control over quality:

Give details or examples of quality control of the positive trench drains.

12. Page 47, 3.1.3, Observation period:

(a) What specifically is to be observed and why?

(b) What is the duration of the observation period?
(c) What criteria is to be used for determining the duration of the observation period.
(d) How will design performance be evaluated? What are the criteria?

13. Page 47, 3.1.4, Active institutional control period:

What is the rationale for a 100-year active institutional control period?

14. Page 48, 3.3, last few lines, models to evaluate adequacy:

Existing computer or other analytical models are frequently not appropriate for evaluating design adequacy for many reasons (e.g., gross uncertainties of input parameter values, oversimplification in the mathematical descriptions of phenomenological behavior, etc.). Modeling for comparative purposes would be more appropriate and meaningful.

15. Page 51, 4.1, Primary performance requirements:

Add a fourth component, namely "compliance with other standards" to the words "waste isolation, safety and long-term performance."

16. Page 55, 4.1.13, ALARA:

Add the word "public" after "general" in that sentence.

17. Page 56, 4.1.2.3, Operational safety-occupational:

"Occupational" should include radiological as well as non-radiological regulations. How does this differ with section 4.1.2.1, Operational Safety-Radiological?

18. Page 56, 4.1.3.1, Active institutional control period:

(a) Here too, as before (item 13), give rationale for "a minimum of 100 years."
(b) What criteria will be used to terminate the active control period?

19. Page 57, 4.2, Secondary performance requirements:

Site characteristics determination is not a performance requirement.

20. Page 59, Table 4-1, Site Characteristics to be determined for decommissioning:

Add to the list: wind speed and standard deviations, atmospheric pressure, relative humidity, meteorological and radiological background levels.

21. Page 66, Manage surface water:

The management of surface water is also closely related to, and influences, ground-water infiltration.

22. Page 70-72, 5.1.1, Trench consolidation model:

The model used (Sowers-1973) assumes that settlement due to decomposition of waste is negligible and that primary consolidation has been completed. It has not been demonstrated that dynamic consolidation will collapse a significant number of 55-gallon drums or other structural containers. Primary settlement may therefore continue to occur for long periods of time making this modeling formula inapplicable at Maxey Flats. In addition, this formula is an empirical relationship developed on the basis of observations made at sanitary landfills. The applicability of this formula to Maxey Flats has not been demonstrated.

23. Page 74, third paragraph, Structural covers:

Here again "structual covers would be able to span areas where formulation conditions in the trenches are poor" needs clarification. Comments made in item 6, as to the extent of structural caps, apply here as well.

24. Page 77, Figure 5-1, Trench design covers for Modeling:

Define symbols SC, CH, and GP which appear in the figure. Explain "filters."

25. Page 81-83, 5.1.4, Trench drain model:

Has this system of trench drains and laterals (channels) ever been tested anywhere? What about long-term maintenance problems? Will these be sources of radioactivity to the environment? What is the environmental impact of this system? What of the accumulation of radioactivity in the drain materials over time? This system raises many important questions which are not addressed in the document.

26. Page 82, Soil inputs:

Parameter values for trench covers (e.g., hydraulic conductivities) are different from those used in the infiltration modeling. This does not allow for reasonable comparative analysis.

27. Page 83, third paragraph, Closed from solutions to the movement of ground water:

The ground-water modeling seems to be superficial in nature. Not enough details are provided to allow for an adequate assessment of the methodology. The term "closed form" in the text leads one to believe that a simplistic, one-dimensional flow model was used. The statement "These solutions assume that a phreatic surface forms within the laterals" needs elucidation. What are the real-world consequences of that assumption? Explain what is meant by "behavior of the lateral drainage system." Behavior with respect to what?

28. Page 94, 5.1.6.2, Modeling methods:

(a) "... simplified analyses of contaminent transport in the ground water were made..." What are the simplifying assumptions? What are the analyses? Describe the modeling.
(b) "...Ground water measurement through the site rocks was assumed to occur at a rate of 15 meters per year." This statement doesn't make sense. What is moving? Water? leachate? contaminants? If so, which contaminants?

29. Page 94, last two paragraphs, Dose calculations:

What scenarios were assumed for the dose calculations? Was NUREG 1.109 used for all calculations? (NUREG 1.109 is primarily applicable to nuclear power plants). What were the radionuclides and source terms used for the calculations? What was assumed about exposure times and ingestion rates?

30. Page 95, Table 5-2, Site configuration for dose evaluation:

Define "travel time." For what distance and what radionuclides? Are the values listed for trench infiltration (1/10 and 1/100 inch) assumed to apply to the decommissioning period? They do not appear to be conservative estimates. Compare also page 96 of the text, which assumes an infiltration of one inch per year.

31. Page 96, Discussion of dose calculations:

(a) Large volumes of surface water were apparently used, hence large dilution factors result. A realistic scenario would be the nearby drinking water well used by an individual for daily intake. Little or no dilution may occur. This scenario was not addressed.
(b) Which radionuclides and what concentrations were used for the drinking water scenario and for the consumption of milk? What are the assumed pathways? Here again, an in-depth review is not possible because of unsufficient information.

32. Page 99-100, Sources for costs:

Page 99 makes reference to the use of R. S. Means Construction Costs Data 1983 whereas Page 100 specifies the use of costs being provided by Law Engineering Company (without reference). This is ambiguous and does not permit analysis of cost data.

33. Page 101, Table 5-6, Cost Bases:

Cost comparisons between the Corps of Engineers, 1983 information (NUREG/CR-3144) and Law Engineering show wide descrepencies. (e.g., cost of clay cap, cost of flexible liners, etc.).

34. Page 104, Modeling discussion:

The HELP model is questionable for use in determining exact values of infiltration (.01 inches per year). This probably exceeds the limits of this model. Very little input data used in the analysis has been provided making an in-depth review impossible.

35. Page 104, last line:

Describe "filters."

36. Page 105-106, Figure 6-1 and 6.2:

It may be difficult to obtain field permeabilities of 7×10^{-10} for the lower layer as indicated, unless nearby pure benetonites are used. In addition, it may not be possible to compact the local soils to 10^{-7} cm/sec hydraulic conductivity.

37. Page 109, 6.1.4, Trench drain model:

(a) Explain how the drains will be constructed to connect the interior trenches to the surrounding collector trench.
(b) It is our understanding that several of the disposal trenches at the site were excavated into the sandstone layers. This will necessitate the excavation of the drains through the sandstone which could be quite expensive. What is the impact of excavating through the sandstone? The estimates for drain infiltration appear quite low unless an engineered cover is used over the drains. Has the cover been assumed?
(c) Provide rationale for seemingly wide drains (10-60 feet).
(d) Explain "drains are more effective in removing large slugs of water in the trench as apposed to handling continuing water volumes."
(e) How will these deep drains and trenches be maintained?

38. Page 110, Table 6-1:

(a) Drain infiltration values seem too low unless an engineered cover is in place.
(b) Travel time - for what radionuclides?
(c) What distances are assumed for travel time calculations?

39. Page 111, second paragraph, These results demonstrate:

The second paragraph does not follow from the discussion in the previous paragraph.

40. Page 111, third paragraph, A properly constructed drain system:

A "properly constructed drain system" has not been defined.

41. Page 114-115, Migration pathway analysis; Table 6-2, Dose calculations:

(a) No details are provided for the dose calculations with regard to radionuclides, exposure periods, exposure scenarios, pathways considered, critical pathways, assumptions used (e.g., infiltration, leach rates) etc.
(b) "Dose calculated for all other cases are less than performance standards limits." What are the other cases?
(c) ".. these results are preliminary." Why? How will dose calculations be refined?
(d) Cases A through F in Table 6-2 have not been defined. What are they? Are they the same as "design concepts" A through F (pp 133) or "design options" A through F (pp. 136)?
(e) Again, not enough information has been provided for any analyses. Table 6-2 is one of the most important pieces of information in the entire study yet lacks the details necessary for analysis.

42. Page 116, second paragraph, Dynamic compaction:

"...dynamic compaction using driven pile. Piles are driven to 7 meter depth at a spacing of 5 x diameter. The pile are removed as the work progresses." This is another untested, unproven method which may readily produce biological, chemical, and radiation hazards off site as well as on site. What levels of contamination would be expected on the piles themselves upon removal from the ground? What levels of gaseous activities will be released to the atmosphere? The document does not address hazards nor provide environmental impact assessments.

43. Page 116, 6.2.2, Positive trench drains:

(a) Here again, how will the drains be interfaced with existing trenches? See Items No. 37 and 44.
(b) What, if anything, would prevent leakage into and out of drains? What would prevent a "bath-tub" effect in the drains, laterals and surrounding collector trench?
(c) The document does not address long-term maintenance problems of the trench drain system.

44. Page 117, 6.2.3, Cutoff trench:

(a) How will the cutoff (collector) trench, at 21 meters down, interface with the drains at 13 meters down?
(b) Explain "stockpiles" (Pgs. 116 and 117).

45. Page 118, Table 6-3, Construction costs:

The cost of a ground-water flow barrier was not estimated.

46. Page 132, Design concept A:

Design concept A with a lower barrier of hydraulic conductivity 10^{-8} cm/sec will not achieve the desired infiltration of .01 inches per year according to the graph on page 106.

47. Page 133, Table 7-3, Recommended Monitoring:

(a) What is the rationale for monitoring off-site milk? Where are the nearest farms?
(b) This table is not in agreement with Table 2-5 (page 20) for the post-operation period. How do they interface? For example, monitoring of milk, fish and farm crops were not recommended in Table 2-5, but are recommended in Table 7-3.

48. Page 134, Design concept D:

(a) Why is the plastic cover placed at the surface?
(b) Why not use plastic in conjunction with designs A or B?

49. Page 134, Design concept F:

How was the 40 year service life for the asphalt membrane liner determined? A PNL document (PNL-4752, DOE/UMT-0064) specifies a much longer service life.

50. Page 152, top two lines, viability of option C:

Why is there a (premature) inclination to reject option C? Option C is very viable in that the waste is not disturbed.

51. Page 156, last paragraph, Rockwell-Hanford demonstration:

The demonstration of impact compaction at the Hanford site will not be completed before early to mid 1984. Also trench waste conditions at Hanford are quite different from those at Maxey Flats. Results must be generalized with caution.