NUREG-0846

Final Environmental Statement
related to the decommissioning of the Edgemont Uranium Mill

Docket No. 40-1341

Tennessee Valley Authority

U.S. Nuclear Regulatory Commission

Office of Nuclear Material Safety and Safeguards

June 1982

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SUMMARY AND CONCLUSIONS

This Final Environmental Statement (FES) was prepared under the direction of the staff of the U.S. Nuclear Regulatory Commission (NRC) and issued by the Commission's Office of Nuclear Material Safety and Safeguards (NMSS).

1. This action is administrative.

2. After an assessment of concerns and alternatives and the addition of conditions related to the proposed decommissioning project operations, the proposed action permits the decommissioning of the existing uranium milling facilities at Edgemont, South Dakota, including removal or cleanup of mill buildings, removal of tailings sands and slimes from the mill site, and removal of contaminated soil from the mill site and local environs. It is estimated by TVA that approximately 2.1 x 10^6 MT (2.3 x 10^6 tons) of tailings and an undetermined amount of contaminated soil will be removed from the mill site. It is also proposed that all radioactive materials, removed in the course of carrying out the proposed action, be transported by truck and/or slurry pipeline to an impoundment, located about 3.21 km (2 miles) southeast of the mill site, constructed especially to ensure containment of such material for the foreseeable future.

   The project area that will undergo major land disturbance consists of 207 ha (514 acres) [including 104 ha (258 acres) at the disposal site, 12 ha (30 acres) for the haul road to be constructed between the mill and disposal site, and the 86-h (213-acre) mill site], plus the potential removal of at least 17 ha (41 acres) of ponderosa pine and surficial soil east of the mill site and an unestablished, but small, area of surficial soil in the Cottonwood community. The latter two areas have been contaminated by windblown tailings (see Fig. 3.3).

   All disturbed areas will be reclaimed and revegetated. The title to the tailings disposal site will be transferred to State or Federal entities so that any future use can be controlled to ensure the health and safety of the public.

3. Concerns receiving special attention are listed in detail in Sect. 1.5, "Results of the Scoping Process." These concerns include staff, public, and individual issues for which analysis and assessment were necessary. The major categories of concern were that

   a. radioactive material disposal should be accomplished in a manner that would prevent potential human exposure for the foreseeable future;

   b. mitigation measures to eliminate or reduce adverse effects caused by the project should be planned and implemented;

   c. monitoring of project operations should be adequate to rapidly detect any health and safety or environmental problems, either onsite or offsite, so that additional mitigation measures could be instituted as needed;

   d. present and potential radiological releases and exposures to both the general public and occupational workers should be analyzed and project operations planned to keep such exposures as low as reasonably achievable;

   e. project impacts on surface water and groundwater should be considered and mitigating measures planned to eliminate or minimize potential problems;

   f. project impacts on air quality should be reduced as much as possible;

g. the socioeconomic effects of the project should be fully considered; and

h. all feasible alternatives for decommissioning and the effects of such alternatives should be considered.

4. For the proposed decommissioning project, the following alternatives were considered:

a. Alternative of no action: this alternative is not legally or morally permissible.

b. Alternatives for decommissioning: the staff considered

- mill site decommissioning alternatives,
- alternative methods of tailings disposal,
- alternative tailings disposal sites,
- alternative disposal impoundment designs,
- alternative seepage control measures, and
- material transportation alternatives.

The staff evaluated the licensee's proposed decommissioning plan in relationship to the above alternatives. The staff conclusions and recommendations are as follows:

For the proposed tailings management plan (Sect. 2.2.3.7):

a. The staff considers the proposed tailings disposal site (alternative C1) to be adequately remote from people.

b. The proposed tailings disposal site and impoundment cover design provide adequate long-term protection from wind erosion.

c. The conceptual design to prevent long-term water erosion appears adequate. The staff will require that detailed engineering studies be performed and submitted for NRC review and approval before final construction.

d. The staff will require that the tailings impoundment embankment be designed to meet the requirements of Regulatory Guide 3.11, "Design, Construction and Inspection of Embankment Retention Systems for Uranium Mills" thereby ensuring embankment stability even under plausible earthquake conditions.

e. Present evidence indicates that the bottom of the proposed tailings impoundment would be separated from the nearest confined aquifer by about 170 m (560 ft) of relatively impermeable shales. Therefore, the contamination of a major aquifer by seepage from the impoundment is considered remote. The staff will require that the licensee either demonstrate that the shales forming the proposed impoundment base and sides have a maximum permeability of less than - 1×10^{-7} cm/s (0.1 ft/year) or install a clay liner meeting this permeability standard over the base and sides of the impoundment.

If a clay liner is necessary, the licensee will be required to define foundation requirements, determine whether subdrains and filters are needed, and establish criteria for clay emplacement and submit detailed emplacement plans to the NRC for approval.

The staff will also require the licensee to dewater the tailings during emplacement to the maximum extent reasonably achievable. The licensee will be required to design a dewatering system and submit the final design to NRC for approval before construction and installation. Recovered fluid could be used to supplement water used in the slurry transport system, thus minimizing groundwater use.

With these provisions, the staff is of the opinion that seepage from the impoundment would be minimal and pose no threat to water resources.

f. The staff is of the opinion that the licensee's plans to minimize windblown transport of tailings during project operations are generally acceptable. The staff will require that a formal interim stabilization program to control dusting at all times be submitted to NRC. This program shall include periodic documented inspections and monitoring to confirm the adequacy of the stabilization methods implemented.

g. The thickness of the proposed final impoundment cover should minimize the potential for root or burrowing penetration into the tailings and should reduce enhanced gamma radiation to about 3.6×10^{-7} mR/year, which is insignificant compared to background levels. Radon exhalation from the reclaimed impoundment should be reduced to about twice natural background (see Sect. 4.1.9).

The licensee's preferred alternative is to relocate the tailings and contaminated materials to a more remote location for final disposal. The staff has determined that with the implementation of the proposed plan, as modified by the staff requirements, all of the NRC performance objectives for tailings management would be met and therefore the licensee's preferred alternative is acceptable to the staff.

For the more general aspects of the project:

a. The mill buildings decommissioning plan proposed by the licensee (i.e., selective decontamination and/or disposal in the tailings impoundment) is acceptable to the staff.

b. Of 25 sites considered for offsite disposal, the staff considers alternative site 2 (C1) as the best overall choice (see Sect. 2.2.3.3).

   This site eliminates transportation impacts on public roads. The site is amenable to tailings sands transport by slurry pipeline, which minimizes the use of fossil fuel and the increase in fugitive dust from truck transport. (This is the site evaluated in the preceding discussion of the proposed tailings management plan.)

c. The staff approves of the licensee's general plan for mill site decommissioning but recognizes that during decommissioning operations there will be increased erosion and sedimentation downstream of the site, particularly during the stormflow events. The staff believes that, following stabilization of the streambanks, sediment levels in the stream will return to background levels.

d. The staff approves of the licensee's proposal to stabilize the streambed and provide aquatic habitat. The staff, however, considers 10°-bank slopes and plowing and discing along the stream for shrub plantings to be undesirable. The staff prefers erosion to shape the stream banks in a natural manner, with minor use of riprap where necessary. The staff recommends that the licensee work in cooperation with the South Dakota Department of Game, Fish, and Parks.

e. The seed mixture for revegetation of all disturbed areas except the disposal site appears appropriate for expected site uses. The staff recommends that the seed mixture for revegetating the disposal site be modified (Sect. 2.2.3.8) to emphasize the establishment of self sustaining vegetation capable of providing long-term erosion protection.

f. The licensee reports that sufficient suitable topsoil exists at the disposal site for reclaiming all disturbed areas. The licensee would like the option of using fill material from a borrow area near the mill site if this option is cost effective. The staff's position is that use of soil from the disposal site is environmentally preferable to disturbing additional land. To open new borrow areas, the licensee must clearly justify the need and must use environmentally acceptable practices.

The staff conclusion is that the licensee's proposal is generally satisfactory, and with the requirements specified in the above evaluation and conditions listed below, the staff concurs with the proposed project operational plans.

5. From the analysis and evaluations made in this Statement, it is proposed that in the license amendment authorizing decommissioning of the Edgemont mill and site, the licensee be required to conform to the following conditions:

   a. The licensee shall implement the monitoring programs specified and recommended in Sect. 4.2.

   b. The licensee shall implement the mitigation measures specified and recommended in Sect. 4.3.

   c. The licensee shall establish a program that shall include written procedures and instructions to control all decommissioning activities.

   d. Before engaging in any activity not evaluated by the NRC staff, the licensee shall prepare and record an environmental evaluation of such activity. When the evaluation indicates that such activity may result in a significant adverse environmental impact that was not evaluated or that is significantly greater than that evaluated in this Environmental Statement, the licensee shall provide the NRC with a written evaluation of such activities and obtain the approval of the NRC for the activities.

   e. If unexpected harmful effects or evidence of irreversible damage not otherwise identified in this Statement are detected during construction or operations, the licensee shall provide to NRC an acceptable analysis of the problem and a plan of action to eliminate or significantly reduce the harmful effects or damage.

   f. The licensee shall perform and submit for NRC review and approval detailed engineering studies to ensure that the disposal impoundment is designed and constructed to prevent long-term water erosion to the maximum extent reasonably achievable.

   g. The licensee shall design and construct the tailings impoundment embankment to meet the requirements of NRC Regulatory Guide 3.11, "Design, Construction, and Inspection of Embankment Retention Systems for Uranium Mills."

   h. The licensee shall submit for NRC review and approval detailed geological and engineering information which demonstrates that shales forming the base and sides of the impoundment have a maximum permeability of about 1×10^{-7} cm/s (0.1 ft/year). If this cannot be demonstrated, the licensee shall install a clay liner which meets this permeability standard over the base and sides of the impoundment.

      If a clay liner is necessary, the licensee shall define foundation requirements, determine whether subdrains and filters are needed, and establish criteria for clay emplacement.

      All detailed plans for construction of the impoundment, and liner if needed, as well as an evaluation of the need for ground water monitoring at the disposal site shall be submitted to the NRC for review and approval prior to final construction.

   i. The licensee shall design and submit for NRC review and approval a dewatering system to dewater the tailings in the disposal impoundment to the maximum extent reasonably achievable.

   j. The licensee shall perform a detailed hydrologic analysis to determine the effect of withdrawal of groundwater for use in slurry transport operations on Edgemont's municipal water supply. If significant adverse effects are identified, the licensee shall either implement mitigative measures to offset these effects or utilize alternative methods for obtaining the needed water.

k. The licensee shall develop and submit for NRC review and approval a formal interim stabilization program to control dusting at all times. This program shall provide for control of dusting from the mill site, haul roads, and disposal site. Trucks hauling material shall be either sprayed with a dust suppressant or covered to minimize airborne dispersion of particulates. The program shall include periodic documented inspections and monitoring to confirm the adequacy of stabilization methods implemented. The results of TSP monitoring and the inspections shall be reported to the managers of the decommissioning operations as soon as possible.

l. The licensee shall determine the extent of radiologically contaminated soil requiring removal from the mill site in accordance with the procedures outlined in Sect. 2.2.2.4 and shall submit for NRC review and approval the basis for this determination.

m. The licensee shall determine the amount of tailings and contaminated material to be removed from the Cottonwood community and windblown tailings areas in accordance with the procedures outlined in Sect. 2.2.2.6. Supportive information and action levels developed for the Cottonwood community cleanup shall be submitted for NRC review and approval prior to implementation of cleanup operations in the area.

n. The licensee shall reclaim all disturbed areas in accordance with the reclamation plan described in Sects. 2.2.2.7, 2.2.2.8, and 2.2.2.9 and as modified by the staff's recommendation presented in Sect. 2.2.3.8.

o. The licensee shall submit to the NRC, on a semiannual basis, a report detailing the results of all monitoring programs and summarizing the activities conducted in the previous six-month period.

6. With these specific requirements and conditions and conformity with other local, State, and Federal regulations, the expected environmental consequences are as follows:

   a. As a short-term consequence, total suspended particulates may exceed State and Federal standards during project operations under adverse weather conditions. This increase would not be expected to result in harm to plants, animals, or humans. Monitoring will provide early detection of such events, and all practical mitigation is planned.

   b. Land disturbance will occur on 208 ha (514 acres), plus an undetermined amount of land [including at least 17 ha (41 acres)] from which removal of windblown tailings is required. Portions of this land will not be subjected to reclamation for up to seven years. Following successful reclamation, there will be a net gain of 52 ha (127 acres), plus the undetermined acreage presently contaminated by windblown tailings, available for use. This is because the present mill site [86 ha (213 acres)] will be available for use, while the impoundment at the disposal site will only encompass 35 ha (86 acres). However, the disposal site will be available to indigenous wildlife.

   c. The maximum amount of groundwater to be used in the slurry operation for the project and lost to evaporation is 1.29×10^5 m^3 (105 acre-ft) over a five-year period. This will not affect local or regional supplies. After decommissioning, the water in the alluvium under the reclaimed mill site will remain chemically contaminated (mostly sulfate) and unfit for potable use. No significant seepage is expected at the disposal site.

      Surface water (runoff) may be temporarily affected by increased sediment loading. At the mill site, earth-moving activity will be controlled to trap runoff on the site. A sediment pond will be used at the disposal site. The decontamination and reclamation of Cottonwood Creek may result in sediment transport into the Cheyenne River. This transport will cause no effects not already present from normal erosion.

d. The project will provide up to 90 jobs at peak level. Because unemployment rates are low and project operations are scheduled for only six months each year, most employees are expected to be in-migrants. Therefore, the housing and community services will undergo stress. Federal monetary assistance has been requested to aid in mitigating impending impacts.

e. The primary impact to terrestrial biota will result from temporary loss of habitat. However, wildlife habitat at the mill site is already highly disturbed because of past milling operation, and the proposed disposal site is not considered to be unique wildlife habitat. Therefore, temporary loss of this habitat is considered minor. Reclamation is expected to improve the habitat value of all affected land beyond its present condition.

   Aquatic biota in the reach of Cottonwood Creek through the mill site will be destroyed. After reclamation, the diverse aquatic community upstream will repopulate the mill site. No aquatic effects of consequence are expected from other decommissioning activities.

f. The following table shows the predicted annual environmental dose commitments (EDCs) to the local population resulting from decommissioning operations for periods during and after the decommissioning. These doses are compared with the estimated dose from naturally occurring background radiation. As can be seen from the table, the predicted dose from the decommissioning operations is less than that from natural background in all categories.

7. The position of the NRC is that, after weighing the environmental, economic, technical, and other benefits from decommissioning the Edgemont mill and site against the environmental and other costs and considering available alternatives, the action called for under the National Environmental Policy Act of 1969 (NEPA) and 10 CFR Part 51 is to permit the licensee to proceed with the project as described in this Statement, subject to all requirements and conditions presented above.

Predicted annual environmental dose commitments (EDCs) to local population within 1.6-km (1-mile) radius of the mill site resulting from cleanup operations at Edgemont and disposal site

Exposure pathway	100-year EDCs (person-rem/year)[a]							
	Whole body		Bone		Lung		onchial epithelium[b]	
	Decom-missioning	Postdecom-missioning	Decom-missioning	Postdecom-missioning	Decom-missioning	Postdecom-missioning	Decom-missioning	Postdecom-missioning
EDCs	135.0	0.771	286.8	1.512	177.6	0.998	814.7	2.314
Estimated population dose from natural background	306.0	306.0	376.0	376.0	308.0	308.0	1120	1120
Ratio of total annual regional population dose to that from natural background[c]	0.441	0.003	0.763	0.004	0.577	0.003	0.727	0.002

[a]Doses to the whole body, lung, and bone are those resulting from the releases of U-238, U-234, Th-230, Ra-226, and Pb-210 particulates.
[b]Inhalation doses to the bronchial epithelium are those resulting from the inhalation of radon daughters.
[c]Background doses are based on the local population size of 2000.

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1. PURPOSE OF AND NEED FOR ACTION

1.1 INTRODUCTION

This Final Environmental Statement (FES) is issued by the U.S. Nuclear Regulatory Commission (NRC), Office of Nuclear Material Safety and Safeguards (NMSS), as a result of a decision by the Tennessee Valley Authority (TVA) not to pursue renewal of Source Material License SUA-816 for the continued use of existing uranium milling facilities at Edgemont, South Dakota. Consequently, decommissioning of the mill and mill site and alternatives for conducting these activities are the subject of this Environmental Statement. This document has been prepared in accordance with Commission Regulation Title 10, *Code of Federal Regulations* (CFR), Part 51, which implements requirements of the National Environmental Policy Act of 1969 (NEPA; PL 91-190).

The principal objectives of the NEPA process are to build into the agency decision-making process an appropriate and careful consideration of environmental aspects of proposed actions and to make environmental information available to public officials and citizens before decisions are made and actions are taken. The process is intended to help public officials make decisions based on an understanding of environmental consequences and to take actions that will protect, restore, and enhance the environment.

The NEPA states, among other things, that it is the continuing responsibility of the Federal Government to use all practicable means, consistent with other essential considerations of national policy, to improve and coordinate Federal plans, functions, programs, and resources to the end that the nation may

- fulfill the responsibilities of each generation as trustee of the environment for succeeding generations;
- assure for all Americans safe, healthful, productive, and aesthetically and culturally pleasing surroundings;
- attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences;
- preserve important historic, cultural, and natural aspects of our national heritage and maintain, wherever possible, an environment that supports diversity and variety of individual choice;
- achieve a balance between population and resource use that will permit high standards of living and a wide sharing of life's amenities; and
- enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

Pursuant to the above responsibilities and in accordance with 10 CFR Part 51, the NRC Office of Nuclear Material Safety and Safeguards has prepared this detailed Statement based on the foregoing considerations with respect to the application to decommission the uranium mill and mill site at Edgemont, South Dakota.

In accordance with 10 CFR Part 40, Section 31, the licensee has submitted an Environmental Report[1] (ER) to the NRC to support the decommissioning application. In conducting the required NEPA review, Commission representatives (the staff) met with the licensee to discuss items of information in the ER, to seek additional information that might be needed for an adequate assessment, and generally to ensure that the Commission had a thorough understanding of the proposed project. In addition, the staff sought information from other sources to assist in the evaluation, conducted field inspections of the project site and surrounding area, met with State and local officials charged with protecting State and local interests, and conducted a public scoping meeting to identify the significant issues to be analyzed in depth. On the basis of the foregoing activities and other such activities or inquiries as were deemed useful and appropriate, the staff has made an independent assessment of the considerations specified in NEPA Section 102(2).

1.2 SUMMARY OF THE PROPOSAL

On August 16, 1974, TVA purchased an existing mill [together with mineral rights on about 41,000 ha (101,000 acres)] in Edgemont, South Dakota. The mill has never been operated by TVA. Because the mill site does not meet present NRC criteria for siting of uranium mills, TVA proposes to decommission the mill as described below.

Approximately 2.1×10^6 MT (2.3×10^6 tons) of tailings were produced at the Edgemont mill from 1956 to 1972. These tailings, highly contaminated soil, building equipment, and debris will be removed from the Edgemont mill site to the proposed tailings disposal site approximately 3.2 km (2 miles) to the southeast.

At the disposal site, a diversion system will be constructed to divert uncontaminated offsite runoff around the disposal area during operations, an impoundment dike will be constructed across the lower end of the site, and the disposal area will be excavated into shale to provide sufficient volume to contain the contaminated material.

Contaminated material will be removed from the mill site by trucks and a slurry pipeline. A slurry pipeline will be used to transport up to 80% of the sand tailings present at the site. Structures and equipment destined for burial and any remaining contaminated materials will be removed by trucks over specially constructed haul roads.

Reclamation of the disposal site will involve covering the contaminated material with a clay cap, overburden, and topsoil. It is expected that borrow material will be required for reclamation of the mill site; some of this material is expected to be obtained from the disposal site. Excavation of the impoundment should provide most of this material. Nearby land has been secured by TVA, however, to serve as a potential borrow area. The mill site will be recontoured and topsoil will be added; the site will then be revegetated. It is expected that decommissioning activities will result in the release of the mill site for future use subject to land use control measures.

Details of proposed procedures and viable alternatives to the proposed action are discussed in later sections.

1.3 FEDERAL AND STATE AUTHORITIES AND RESPONSIBILITIES

TVA presently holds a Source Material License (SUA-816) which may not be terminated until the licensee has complied with NRC requirements to protect the public health and safety during and after decommissioning. Moreover, the Uranium Mill Tailings Radiation Control Act of 1978 (PL 95-604, November 8, 1978) establishes the role of the NRC in establishing and enforcing requirements for the decontamination, decommissioning, and reclamation of sites, structures, and equipment used in conjunction with tailings by-product materials (in this case, uranium mill tailings).

TVA is subject to Executive Order 12088 (ref. 2), Office of Management and Budget Circulars A-78 and A-81, and Executive Order 11752 (ref. 3), all of which relate to the prevention, control, and abatement of environmental pollution in Federal facilities, as well as certain provisions of the Clean Air Act, as amended;[4] the Clean Water Act, as amended;[5] the Solid Waste Disposal Act, as amended;[6] and the Safe Drinking Water Act amendments to the Public Health Service Act;[7] all of which relate to the applicability of various Federal, State, interstate, or local air, water quality, and solid waste standards. TVA is also subject to the requirements of Office of Management and Budget Circular A-95 (ref. 8), which ensures that major projects are coordinated from the point of view of community impact and land use planning with State and local agencies, and is required to ensure that any action it takes conforms with the policies and guidelines of Executive Orders 11988 and 11990 (ref. 9), which concern floodplain management and wetland protection.

Table 1.1 identifies the permits, licenses, or approvals that will be required to perform this decommissioning in addition to NRC licensing action; the granting or approving authority; and any remarks regarding the status of these permits, licenses, or approvals.

Table 1.1. Applicable permits, licenses, or approvals[a]

Permits, licenses, or approvals	Granting or approving authority	Status
Approval for disposal of nonradiological demolition solid wastes (i.e., roofing, lumber, blocks, brick, metal, etc.)	State of South Dakota and local authority	Approvals will be pursued upon identification of waste types, estimated quantities, and disposal site selection
Approval for disposal of domestic or municipal-type solid wastes (i.e., paper, garbage, glass, etc.)	State of South Dakota and local authority	Approvals to be obtained
Approval for disposal of miscellaneous nonradiological "hazardous" and/or "problem" solid waste (i.e., oils, grease, solvents, polychlorinated biphenyls, caustics, etc.)	Environmental Protection Agency (EPA), State, and/or local authority	Approvals will be pursued upon identification of waste types, estimated quantities, and disposal site selection
Section 404 (dredge and fill permit)	U.S. Army Corps of Engineers	Undetermined at present
401 Certification (dredge and fill permit)	State of South Dakota	Undetermined at present
Historical clearance	State Historic Preservation Officer	Clearance secured
	Advisory Council on Historic Preservation	Need not expected
Threatened and endangered species consultation	U.S. Fish and Wildlife Service (Department of Interior)	Completed
National Pollution Discharge Elimination Standards permit	EPA Region VIII	Permit application will be submitted, if applicable, following finalization of design and mitigation plans
Approval of plans and specifications for water pollution control facilities	South Dakota Department of Water and Natural Resources	To be submitted as applicable following finalization of design and mitigation plans

[a]BLM-TVA land negotiations are not a part of the permitting process.

1.4 NEED FOR ACTION

Congress has found (PL 95-604, November 8, 1978, cited as the Uranium Mill Tailings Radiation Control Act of 1978) that uranium mill tailings located at active and inactive mill operations may pose a potential and significant health hazard to the public if not properly controlled. Protection of the public health, safety, and welfare requires that every reasonable effort be made to provide for the stabilization, disposal, and control of such tailings in a safe and environmentally sound manner to prevent dispersal of tailings to minimize radon diffusion into the environment, and to prevent or minimize other environmental hazards from such tailings.

Title I of the act cited above requires that remedial action be taken at 22 inactive and unlicensed tailings sites and others designated by the secretary of the Department of Energy to ensure the safe and environmentally sound stabilization of tailings and residual radioactive materials.

The Edgemont Uranium Mill, although a licensed facility, has not operated since August 1974. The mill and tailings on the site thus present a similar potential health risk to the public as do those on many of the abandoned sites for which remedial action has been mandated by Congress.

Title II of the Uranium Mill Tailings Radiation Control Act of 1978 authorizes the NRC, after the effective date of the act, to enforce on new licenses or relicensing actions decontamination, decommissioning, and reclamation standards for uranium mill and mill tailings sites.

In contrast to the abandoned sites specified in Title I of the Act, NRC Source Material License SUA-816 (held by TVA) remains in effect for the Edgemont site. This license was amended to require TVA to submit a proposal for decommissioning the site which would meet the NRC performance objectives for tailings management[10] and guidelines for facility decontamination.[11] In this FES, the staff evaluates the alternatives proposed by the licensee as well as alternatives developed by the staff against the NRC performance objectives for tailings management and guidelines for facility decontamination. The purpose of this evaluation is to (1) determine the adequacy of the licensee's preferred alternative, (2) determine whether other alternatives proposed either by the licensee or by the staff are environmentally superior to the preferred alternative, and (3) if superior alternatives are identified, determine whether the additional costs associated with these superior alternatives are warranted. The staff's evaluation of TVA's preferred alternative, which provides for offsite disposal of tailings, has concluded that the plan satisfies the NRC performance objectives for tailings management and guidelines for facility decontamination and that no other alternatives are superior from an environmental standpoint, for this particular project, as discussed in Sect. 2.2.3 of this FES. Because of the social impacts on the town of Edgemont resulting from the close proximity of the tailings and the use of tailings as fill material in the town, TVA has voluntarily committed to move the tailings and to move forward promptly with the cleanup plan once NRC approval is obtained.

In contrast, for the inactive sites specified in the act, it is the responsibility of the Department of Energy, with the concurrence of the NRC, to develop and evaluate alternative remedial action plans for disposal of tailings and long-term stabilization of the sites, taking into consideration the adequacy of these plans from an environmental and tailings management standpoint as well as the cost effectiveness of the various alternatives.

1.5 RESULTS OF THE SCOPING PROCESS

In accordance with the guidelines developed by the Council on Environmental Quality (CEQ) in 40 CFR Part 1501.7, the NRC utilized a scoping process to identify the significant issues concerning this proposed project.

During the review of the licensee's ER, the NRC staff identified major areas of concern that would require careful assessment in the subsequent Environmental Impact Statement. The NRC also issued a *Federal Register* notice requesting comments by interested parties on the project and set a public scoping meeting to be held October 25, 1979, in Edgemont, South Dakota.

Prior to the scoping meeting, these primary issues were identified by the NRC staff:

1. Radioactive material disposal alternatives should be considered in detail, with the prime consideration being the disposal of such material in a manner that would prevent potential human exposure during the foreseeable future.

2. Potential short- and long-term adverse effects from the project should be examined and mitigating measures should be implemented to eliminate such adverse effects insofar as possible.

3. During project operations, adequate monitoring capability should be installed so that any unforeseen safety or environmental problems could be rapidly identified and additional mitigating measures could be instituted to eliminate or reduce the problem to the greatest degree reasonably achievable.

In addition, the staff planned to discuss, in the Environmental Statement, measures to be taken by the licensee to comply with applicable local, State, and Federal regulations in sufficient detail to ensure that such requirements would be met.

At the public scoping meeting, the licensee summarized the proposed project, and comments were solicited from the attendees. The staff also requested additional written comments. The following specific generic issues were raised at the scoping meeting:

1. specific treatment of radiological issues, including
   - present levels of onsite radiation and radon release,
   - present radiation levels from windblown tailings in the Cottonwood community and other offsite locations,
   - increases in radiation release and potential radiation exposure and effects during mill site decommissioning, both to occupational workers and the general public, and
   - the radiation levels expected after decommissioning and reclamation both at the mill and disposal sites;
2. specific treatment of the radioactive materials disposal plan, including
   - criteria for the disposal site,
   - preparation of the disposal site,
   - depth of burial of tailings and other material,
   - preparation of the tailings and material for burial,
   - stabilization of the disposal site, and
   - long-term monitoring requirements at the disposal site;
3. specific treatment concerning potential surface water and groundwater problems, including
   - condition of the groundwater at the mill site after decommissioning,
   - water requirements for decommissioning,
   - effects of removing slimes only,
   - leaching by groundwater at the mill site,
   - surface water and groundwater flow at the disposal site,
   - groundwater levels at the disposal site,
   - erosion by surface water during decommissioning, and
   - seepage control and monitoring at the disposal site.

More specific suggestions were to discuss the following:

1. eventual disposition of the reclaimed land,
2. air pollution from project operations,
3. time period of project operations, and
4. jurisdictional problems regarding land use.

Written comments received from the Black Hills Alliance requested broad treatment of the following alternatives, which may be summarized:

1. What are the alternatives for decommissioning of the mill?
2. What are the radiological effects?
3. What are the effects on workers?
4. What are the effects on the quality and quantity of water available?
5. What are the effects on aquifers?
6. What are the effects on the local social and economic structure?
7. What are the effects on shallow groundwater under the mill site?
8. What are the effects of alternative monitoring strategies on public-data availability during decommissioning? (Other comments in this letter were not germane to the proposed action.)

The Sixth District Council of Local Government submitted written comments related entirely to socioeconomic issues. Sections 3.4 and 4.1.8 and Appendix B, independently prepared by the staff, address these issues.

Written comments were also received from the (1) U.S. Department of Interior, Fish and Wildlife Service; (2) Geological Survey; and (3) National Park Service.

1. The U.S. Fish and Wildlife Service's comments were:

   - Have the consultation procedures specified by the Endangered Species Act Amendments of 1978 (PL 95-632) been followed?
   - Impacts on vegetation from road construction should be considered.
   - A Section 404 Permit from the U.S. Corps of Engineers may be required.
   - The plains top minnow (*Fundulus sciadicus*) is classified as threatened by the State of South Dakota. The licensee should coordinate with the South Dakota Department of Game, Fish, and Parks when restoring the habitat in Cottonwood Creek to preserve the existence of the plains top minnow.
   - A monitoring program to document the continued existence and possible enhancement of Cottonwood Creek as a habitat for the plains top minnow should be initiated.

2. The U.S. Geological Survey comments were:

   - The need for long-term surface water runoff control, long-term maintenance, and future disposition of the disposal site should be discussed.
   - The degree to which the proposed tailings disposal will achieve postreclamation objectives developed by NRC should be discussed.
   - The locations of private wells should be shown on a map, together with the disposal site, topography, and drainage.
   - Criteria for groundwater monitoring should be specified.
   - More information on windblown tailings should be given.

3. The U.S. National Park Service comments were:

   - The mitigating measures for fugitive dust appear adequate (in the ER), but stringent monitoring was urged.
   - The Fossil Cycad National Monument (ER, Fig. 2.1-1) should be deleted. The monument was abolished in 1956.

The staff has addressed each of the above comments on the Edgemont decommissioning project in the appropriate sections of the FES as noted. No comments were received suggesting disapproval of the project.

REFERENCES FOR SECTION 1

1. Tennessee Valley Authority, *Edgemont Uranium Mill Decommissioning Plan Environmental Report*, Docket No. 40-1341, February 26, 1979. Hereafter in this Environmental Statement, the applicant's Environmental Report will be cited as ER followed by a specific volume, section, page, figure, table, or appendix.

2. "Federal Compliance with Pollution Control Standards," *Fed. Regist.* 43(201): 47,707 (1978).

3. 3A CFR Sect. 240.

4. 42 U.S.C. Sect. 7401 et seq. (1976).

5. 33 U.S.C. Sect. 1251 et seq. (1976).

6. Ref. 4, Sect. 6901 et seq.

7. Ref. 4, Sect. 300f et seq.

8. "Federal and Federally Assisted Programs and Reports: Evaluation, Review, and Coordination," *Fed. Regist.* 38(228): 32,874 (1973).

9. "Floodplain Management Guidelines of the U.S. Water Resources Council," *Fed. Regist.* 40: 6030 (Feb. 10, 1980).

10. *Nuclear Regulatory Commission Branch Position on Uranium Mill Tailings Management*, Division of Waste Management, May 13, 1977.

11. Nuclear Regulatory Commission, *Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for By-Product, Source, or Special Nuclear Material*, Division of Fuel Cycle — Material Safety, Washington, D.C., November 1976.

2. ALTERNATIVES INCLUDING THE PROPOSED ACTION

2.1 ALTERNATIVE OF NO DECOMMISSIONING ACTION

The staff considers that the alternative of no decommissioning action would place the Nuclear Regulatory Commission (NRC), the licensee, and other associated regulatory agencies in the position of not fulfilling their statutory responsibilities. This alternative is therefore not legally or morally permissible. As a consequence, only alternatives for decommissioning are considered.

2.2 ALTERNATIVES FOR DECOMMISSIONING

2.2.1 Agency considerations for decommissioning

Assuming decommissioning as the reference overall desired action, the primary goals are to reduce radiation exposure to the public and to return the mill site to productive use. The related required disposal of onsite tailings and other contaminated materials must therefore be accomplished in a manner that protects the health and safety of the public and ensures that such disposal will not result in potential public radiation exposures above applicable standards in the foreseeable future.

2.2.1.1 Decommissioning of onsite buildings

The licensee would have the option of dismantling contaminated buildings and equipment and disposing of sucn material in the same manner and at the same site as used for final tailings disposal or decontaminating such buildings and equipment to acceptable contamination levels as specified in NRC Regulatory Guide 1.86 (Table 2.1).

The licensee would also be allowed to transfer specific equipment to another licensed facility for further use without full decontamination to unrestricted use category.

2.2.1.2 Tailings disposal

The staff evaluated the alternative disposal sites and final disposal and reclamation plans against the following performance objectives developed by the NRC staff to ensure that uranium mill tailings are properly managed and controlled to minimize the potential hazard to public health.

1. Siting and design period:

    - Locate the tailings impoundment area remote from people so that population exposures will be reduced to the maximum extent reasonably achievable.

    - Locate the tailings disposal area so that disruption and dispersion by natural forces is eliminated or reduced to the maximum extent reasonably achievable.

    - Design the isolation area so that seepage of toxic materials into the groundwater system will be eliminated or reduced to the maximum extent reasonably achievable.

2. Decommissioning operations and drying period:

    - Eliminate the blowing of tailings to unrestricted areas during normal operating conditions (including a program of chemical spraying and wetting of tailings surfaces).

Table 2.1. Acceptable surface contamination levels

Nuclide[a]	Average[b,c]	Maximum[b,d]	Removable[b,e]
U-nat, ^{235}U, ^{238}U, and associated decay products, dpm α/100 cm^2	5,000	15,000	1,000
Transuranics, ^{226}Ra, ^{228}Ra, ^{230}Th, ^{228}Th, ^{231}Pa ^{227}Ac, ^{125}I, and ^{129}I, dpm/100 cm^2	100	300	20
Th-nat, ^{232}Th, ^{90}Sr, ^{223}Ra, ^{224}Ra, ^{232}U, ^{126}I, ^{131}I, and ^{133}I, dpm/100 cm^2	1,000	3,000	200
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except ^{90}Sr and others noted above, dpm β-γ/100 cm^2	5,000	15,000	1,000

[a] Where surface contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for alpha- and beta-gamma-emitting nuclides should apply independently.

[b] As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

[c] Measurements of average contaminant should not be averaged over more than 1 m^2. For objects of less surface area, the average should be derived for each such object.

[d] The maximum contamination level applies to an area of not more than 100 cm^2.

[e] The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally, and the entire surface should be wiped.

3. Postreclamation period:

- Reduce direct gamma radiation from the impoundment area to essentially background levels.
- Reduce the radon emanation rate from the impoundment area to about twice natural background.
- Eliminate the need for an ongoing monitoring and maintenance program following reclamation.

Before making recommendations, the staff then weighed environmental costs and benefits and economic costs of the various strategies against each other.

2.2.2 Licensee's proposed plan

2.2.2.1 Final disposal site location and required site preparation

Location

The proposed disposal site is located approximately 3.2 km (2 miles) southeast of the city of Edgemont, at the head of an ephemeral drainage that is a tributary of the Cheyenne River, and is located in Sects. 8 and 17, T9S, R3E with minor portions in Sects. 7 and 18, T9S, R2E (Fig. 2.1). The site is east of county road 6N and south of county road 6E. Of the total acreage [104 ha (258 acres)] to be disturbed at the disposal site, about 96 ha (236 acres) were previously under private ownership and are now or will be under TVA control, 5.7 ha (14 acres)

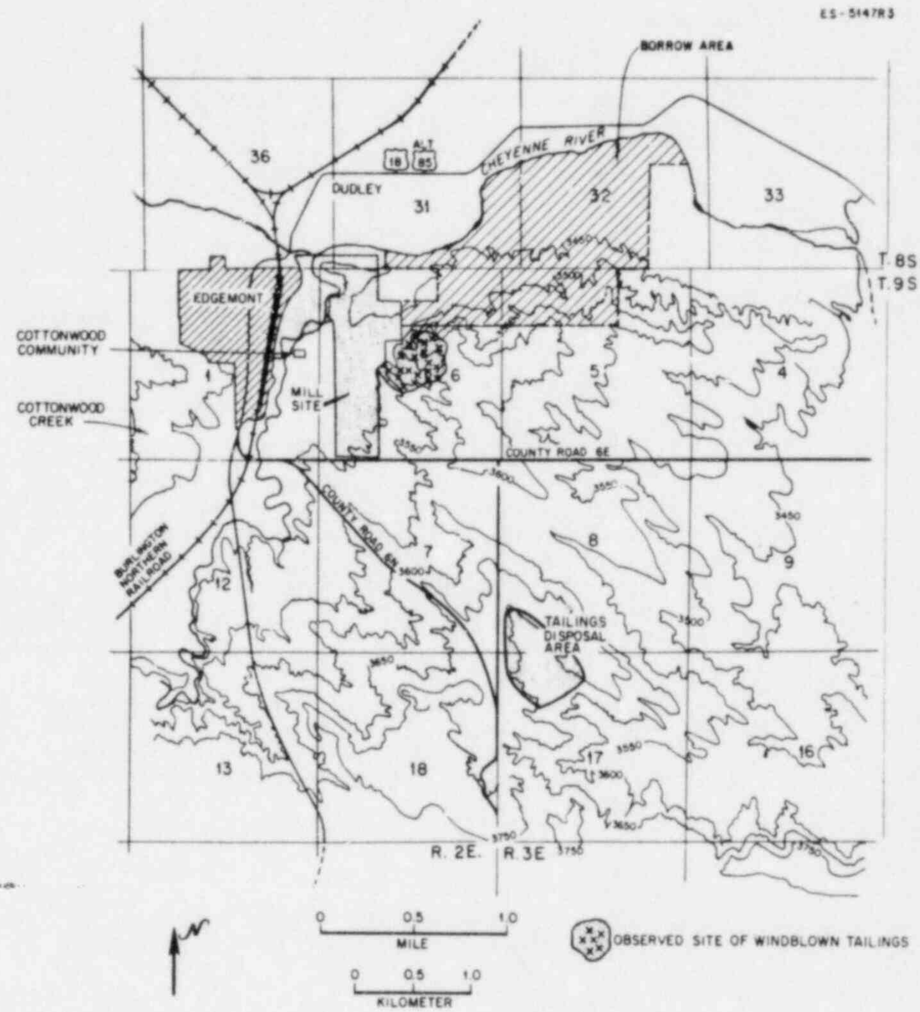

Fig. 2.1. Edgemont mill site, disposal site, and borrow area. Source: Modified from ER, rev. 1, Fig. 2.1-3 and Ford, Bacon & Davis Utah, Inc., *Engineering Assessment of Inactive Uranium Mill Tailings, Edgemont Site, Edgemont, South Dakota*, prepared for the U.S. Nuclear Regulatory Commission, Contract No. E(05-1)-1658, January 1980.

are owned by the State of South Dakota, and 3.2 ha (8 acres) are held by the U.S. Government and are administered by the Bureau of Land Management. The tailings impoundment will be located entirely on TVA land.

Diversion of runoff

Initial preparation of the proposed disposal site tailings impoundment area will involve the construction of a diversion system of isolation courses to prevent offsite runoff from entering the disposal area and to drain any perched water that may be present in the surficial soils during disposal operations (Fig. 2.2). The area of the drainages is quite small, encompassing about 18.6 ha (46 acres) above the level of the impoundment on the west and northwest sides.

A surface runoff isolation course would be prepared at the northwestern portion of the disposal area to divert runoff to an intermittent drainage to the northwest. Two other isolation courses would be constructed along the western edge of the impoundment area to control offsite runoff from the west. This runoff would be diverted to the southeast and will reenter the drainage channel below the impoundment dike. The isolation courses, which would likely be constructed into the basal shale member, should drain any subsurface perched water at the shale-subsoil interface. A natural drainage divide will prevent offsite runoff from entering the disposal site from the northeast. In addition, a sediment pond would be constructed below the impoundment dike area to control any sediments resulting from construction activities.

Impoundment excavation

After the drainage diversion courses and sediment pond are completed, the impoundment area would be excavated into the shale layer by heavy earth-moving equipment. Approximately 3.8×10^6 m^3 (5×10^6 yd^3) of soil and weathered rock would be removed. This excavation may necessitate the removal of any perched water that may remain in the alluvium.

The overburden removed by this excavation would be used in the construction of the impoundment dike. Some of the overburden also could be used for fill at the mill site upon completion of activities and also for the top cover of the impoundment area. The topsoil and subsoil would be segregated and stockpiled for future use in reclamation and would be contoured and seeded to prevent erosion during storage. Approximately 36 ha (90 acres) would be used for stockpile areas (Fig. 2.3).

Soils and shale that form the base of the impoundment area are reported to have permeabilities on the order of 1×10^{-4} to 1×10^{-7} cm/s (100 to 0.1 ft/year). Should further permeability tests determine that the native soils and shale exposed in the impoundment excavation do not provide adequate seepage control, additional excavation and/or the placement of a clay liner over the base and sides of the impoundment will be necessary. Potential borrow areas have been identified as a source of the clay liner material, although the licensee does not presently control such sites.[1] Onsite materials could however be employed for construction of the liner provided they can be shown to be suitable for constructing a liner with a permeability of about 1×10^{-7} cm/s (0.1 ft/year).

Impoundment dike construction

Construction of the impoundment dike would be concurrent with the excavation of the impoundment site. The initial preparation for construction of the dike would include removal of material into unweathered shale and installation of a gravel drain system along the base of the dike area as shown in Fig. 2.4. The drain will be composed of graded sizes of gravel that will filter out soil material and allow for the relief of hydrostatic pressure within the dike. The gravel drain will be constructed within the dike (Fig. 2.4) to remove any water that may enter the dike. To prevent the infiltration of water from the impoundment area, a clay liner with a permeability of about 1×10^{-7} cm/s (0.1 ft/year) will be keyed into the shale bedrock, placed on the upstream face of the dike, and extended along the upstream face of the dike as construction continues.

Material used in the construction of the impoundment dike will be unclassified fill obtained from within the impoundment area. The material will be placed, spread, and compacted in small lifts to ensure proper construction of the dike. The final dike will be about 17 m (55 ft)

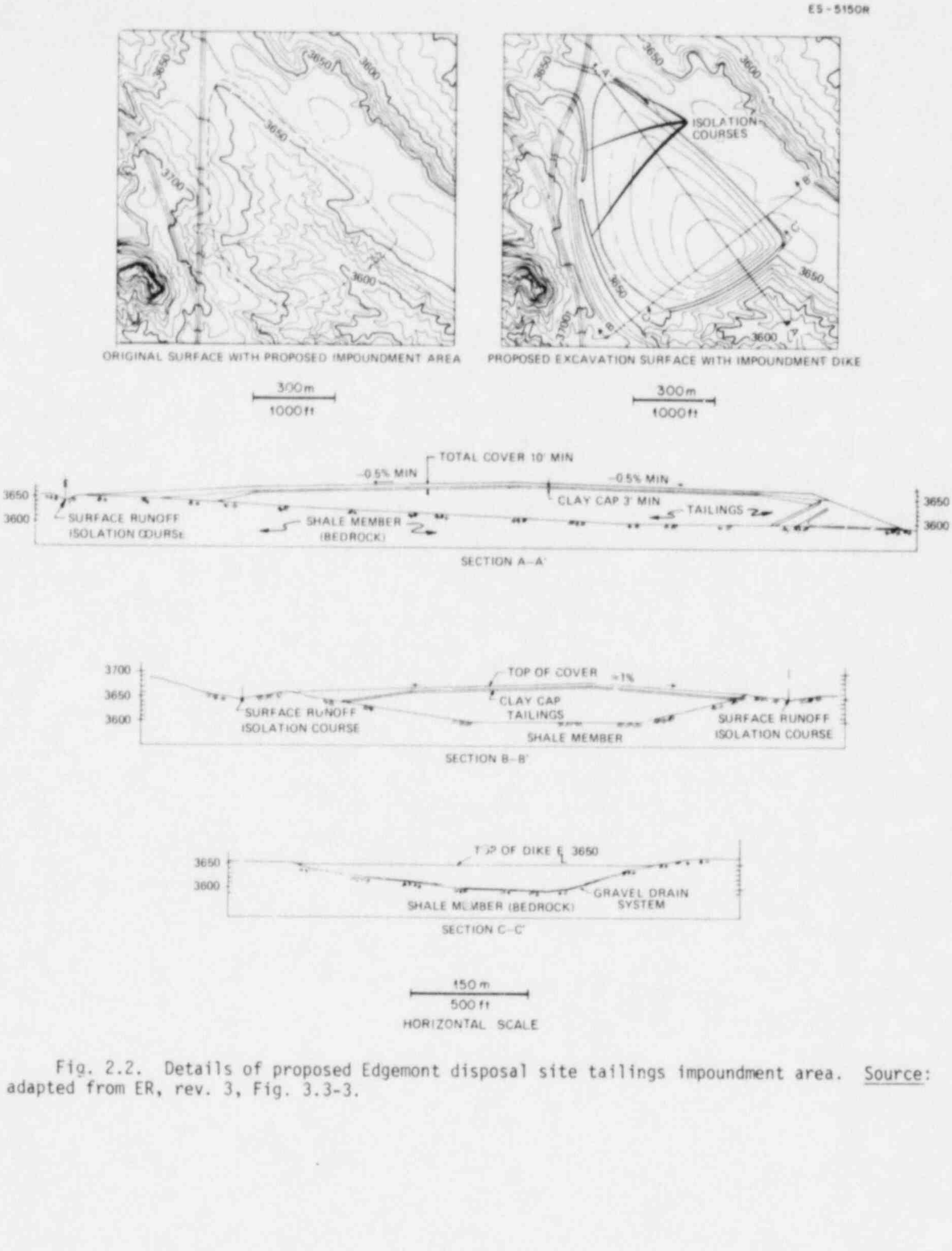

Fig. 2.2. Details of proposed Edgemont disposal site tailings impoundment area. Source: adapted from ER, rev. 3, Fig. 3.3-3.

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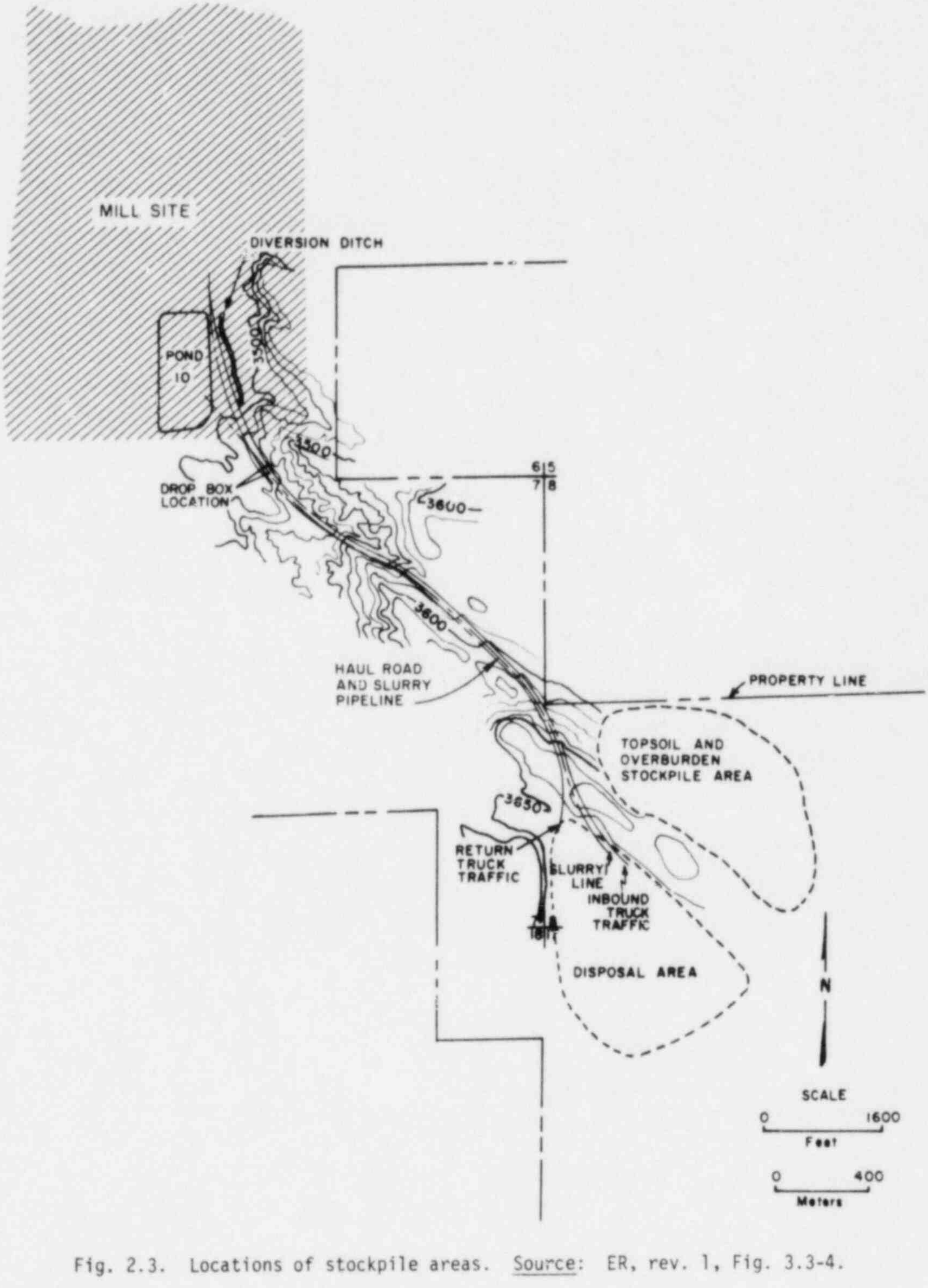

Fig. 2.3. Locations of stockpile areas. Source: ER, rev. 1, Fig. 3.3-4.

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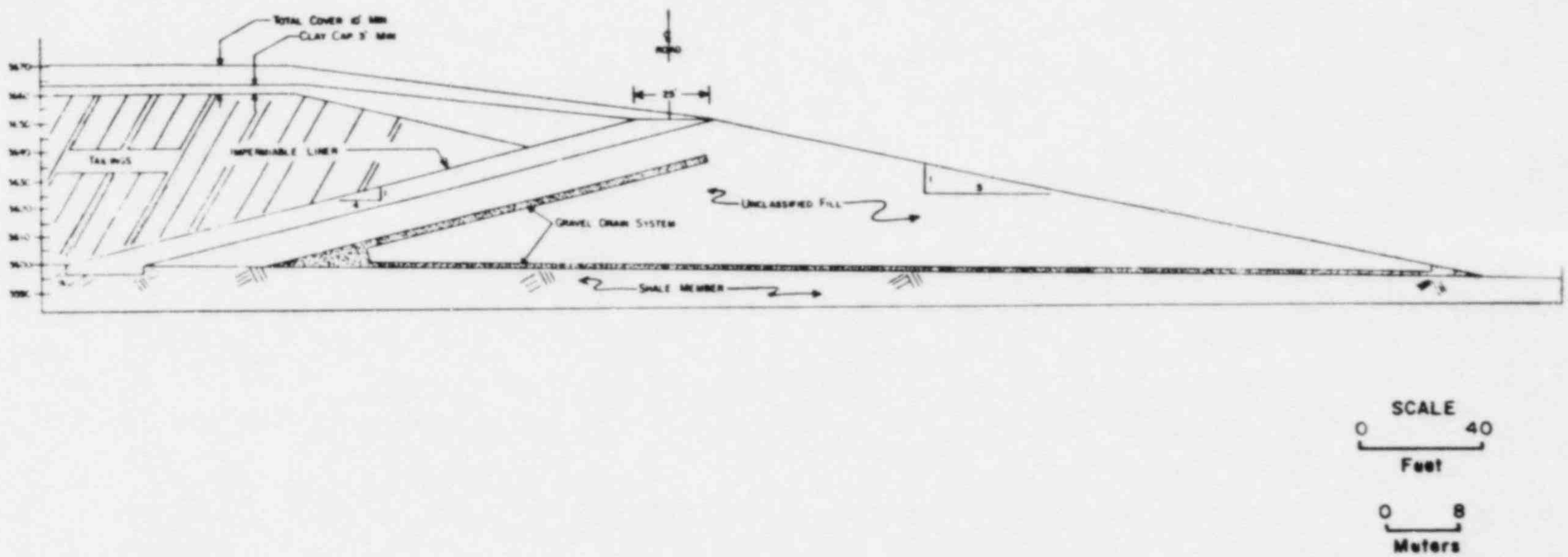

Fig. 2.4. Details of impoundment dike. Source: ER, rev. 1, Fig. 3.3-5.

high and about 549 m (1800 ft) long. The final slope of the upstream face is planned at 4:1, and the downstream face is planned at 5:1. These slopes will be covered with riprap and appropriate filters to protect the embankment from wind and water erosion. Should it be considered necessary for the stability of the dike, the slope could be flattened. The final configuration of the dike may be altered following detailed engineering design studies. The proposed licensing action will require that the final impoundment and dike designs meet the criteria in NRC Regulatory Guide 3.11, "Design, Construction, and Inspection of Embankment Retention Systems for Uranium Mills."

Seismicity

A detailed assessment of the maximum credible earthquake expected at the proposed disposal site over the long term has not been made by the licensee. This would entail compiling a catalog of historic seismic events within a 320-km (200-mile) radius of the site and listing their epicentral distance from the site, magnitude or modified Mercalli intensity, and date of occurrence. From this data, the maximum credible earthquake or earthquakes for desired return periods could be extrapolated. However, previous experience has shown that properly engineered embankments that are constructed of clayey materials that are properly emplaced and compacted can withstand severe earthquakes with no significant damage. On the basis of the low historical seismicity of the region, the absence of capable faults near the proposed site, and the proposed impoundment design, it is highly likely that the proposed disposal site and impoundment system will be able to withstand long-term seismic events without affecting the long-term stability of the impoundment. The licensee will, however, be required to confirm the long-term seismic stability of the impoundment system using procedures described in NRC Regulatory Guide 3.11.

2.2.2.2 Waste transport

Haul road construction

While the disposal site is being prepared, construction of the haul roads will begin. At the mill site, a 17-m (55-ft) two-way traffic haul bed will consist of a subbase of clean sand; a base of coarse, crushed rock; and a final surface of fine, crushed rock. The road will be slightly crowned, with a slope of about 2 cm/m (0.25 in./ft) from the centerline (Fig. 2.5). The haul road at the mill site is for two-way traffic, but separate haul roads will be constructed for one-way traffic to the disposal site and return to the mill site (Fig. 2.3). Each road will be 10 m (33 ft) wide and constructed similar to the mill site haul road (Fig. 2.5).

About 12 ha (30 acres) will be disturbed by the haul road. Topsoil and other removed material will be stockpiled along the route for future reclamation. During construction of the haul road, dust control measures will be implemented. The route will be designed so that curves and grades will be as gentle as practical, but some cut and fill may be required. The route will cross a seldom used county road. It is anticipated that some type of underpass/overpass system will be used to route public traffic under or over the haul roads.

No major drainages will be crossed by the haul roads. Runoff from the mill site haul road will be contained on site. To prevent contamination because of runoff from the haul road, a trench drain system will be constructed along the outside of the roads. The divided portion of the haul road is constructed so that the majority of the runoff is in the median drain section of the haul road. All drainage collected by the trench and median drain systems will be directed to Pond 10.

Haul road operation

The projected schedule of operations is discussed in Sect. 2.2.2.4. A fleet of up to twenty 45.5-MT (50-ton) dump trucks will use the haul roads. Vehicle speeds will be maintained at levels determined safe according to road conditions and loads. Average speeds will not exceed 32 km/h (20 mph) for trucks on the haul road. In loading and unloading areas, average speeds will not exceed 16 km/h (10 mph). Road maintenance activities, such as grading, and dust control activities, such as application of water sprays or sealing agents, will be performed as needed.

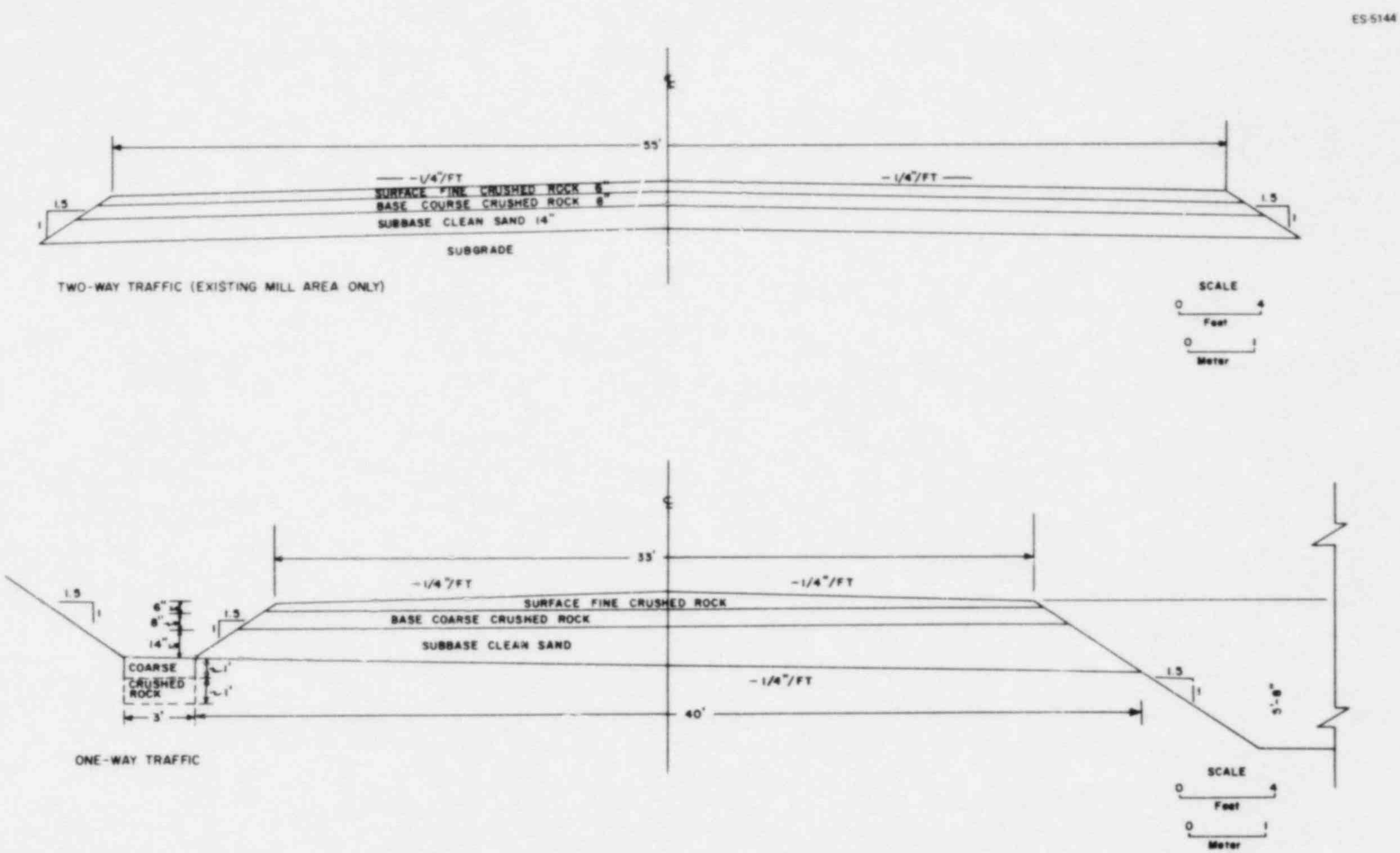

Fig. 2.5. Construction design of haul roads. Source: ER, rev. 1, Fig. 3.4-1.

Slurry pipeline construction and operation

The proposed tailings transport slurry and recycle water pipelines will be constructed between the haul roads (Fig. 2.6). The repulping plant for the pipeline will be located south of the east tailings pile. A 25-cm-diam (10-in.-diam) slurry pipeline will be placed along the east side of Ponds 7 and 10 and then proceed southeast of the mill site to the disposal area. The pipeline will be designed to allow for the mobility at the disposal site necessary for planned placement and distribution of the contaminated materials. A 20-cm-diam (8-in.-diam) pipeline will recycle water from the decant pond, which should form as tailings settle out of the slurry, to the mill site. The pipelines will be designed so that any spills or ruptures will be contained within the median drain system and be returned to Pond 10 with the runoff from the haul roads. If it becomes necessary to remove a blockage in the slurry pipelines, any material removed will be routed to Pond 10 or to the disposal site.

2.2.2.3 Mill site decommissioning

Prior to the licensee's tailings stabilization efforts in 1976, an undetermined amount of windblown sand tailings was released to an area east of the mill site and in the Cottonwood community (Fig. 2.1). Initial surveys indicate a contamination of about 31 ha (82 acres) of these neighboring areas. A detailed field study will be conducted to determine the levels of contamination, to identify which portions of the area require cleanup, and to define the quantity of waste materials present which require removal. It is planned that contaminated soils and wastes from offsite cleanup will be disposed of in the tailings impoundment. The area east of the mill site would be decontaminated after removal of tailings from the mill area, and Cottonwood community areas would be cleaned up during the final decommissioning phase.

Diversion ditch

A diversion ditch would be constructed along the eastern perimeter of the mill site (Fig. 2.7). The diversion ditch would intercept the runoff from five natural drainages with a total catchment area of about 71 ha (177 acres), which includes the windblown tailings area. Runoff collected in the ditch will be considered contaminated and will be directed to Pond 10 and used in slurry operations. The lower reaches of the diversion ditch will be designed for a 100-year flood peak flow of 9.06 m^3/s (320 cfs) and are expected to protect the tailings areas from flooding during the decommissioning operation. The ditch will be gently sloped and vegetated to minimize erosion.

Structure and equipment disposition

The locations, sizes, and type of construction of the existing structures in the mill complex are shown in Fig. 2.8. The licensee proposes the following disposition plan:

Decontaminate	Demolish
Office building	FeV building
Mobile equipment shop and storage shed	Electric shop
Reagent warehouse	Crusher and sampler building
Scale house	Shaker car building
Carpenter shop	Fly ash pump house
	Lime plant building

The licensee is conducting feasibility and cost-benefit studies to determine whether the main mill building should be demolished or decontaminated and refurbished for other uses.

Items such as motors, pumps, and mobile equipment will be surveyed for radioactive contamination. These surveys and available decontamination methods will aid in determining whether to decontaminate, remove, or dispose of each equipment item. Equipment that can be decontaminated for release

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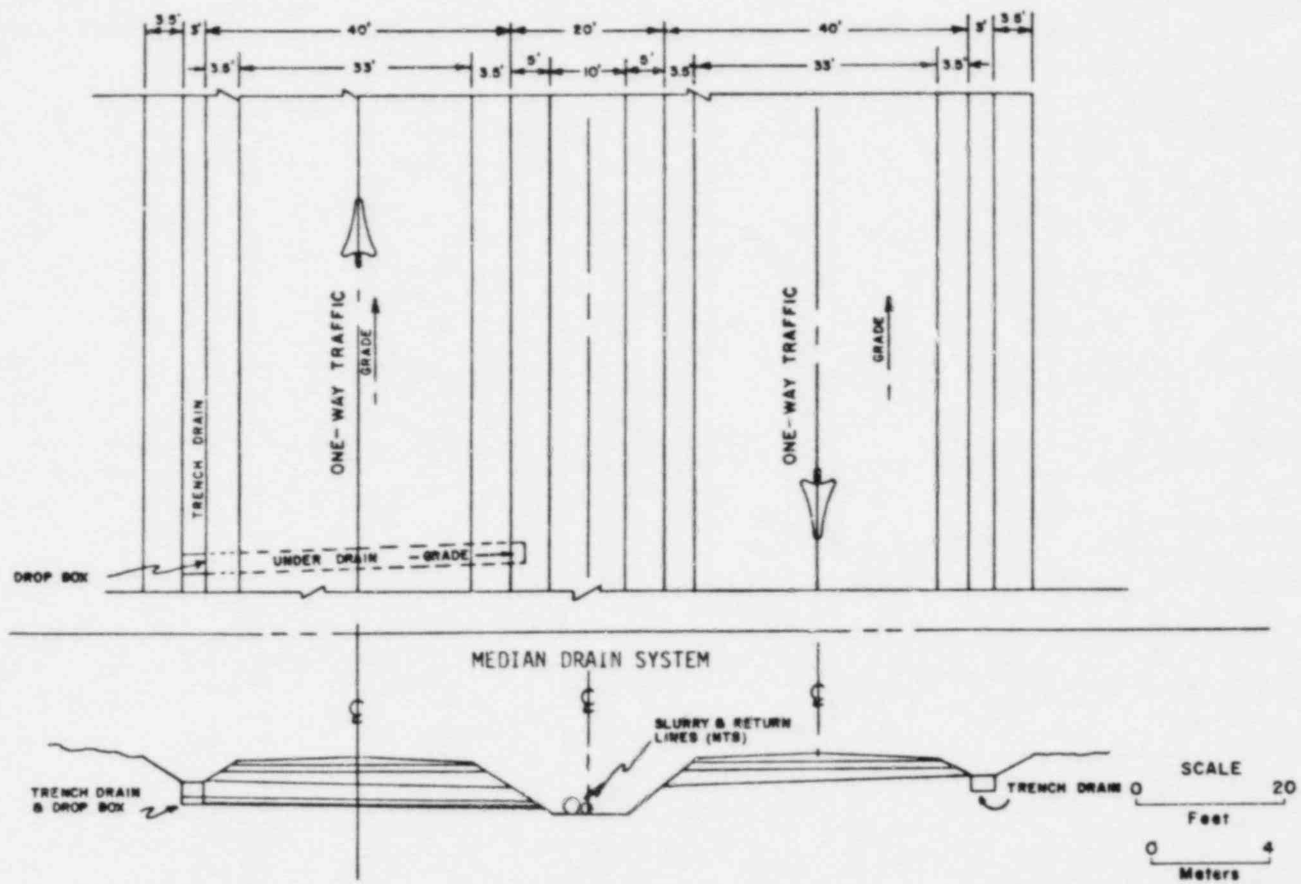

Fig. 2.6. Placement of the slurry and recycle water pipelines. Source: ER, rev. 1, Fig. 3.4-3.

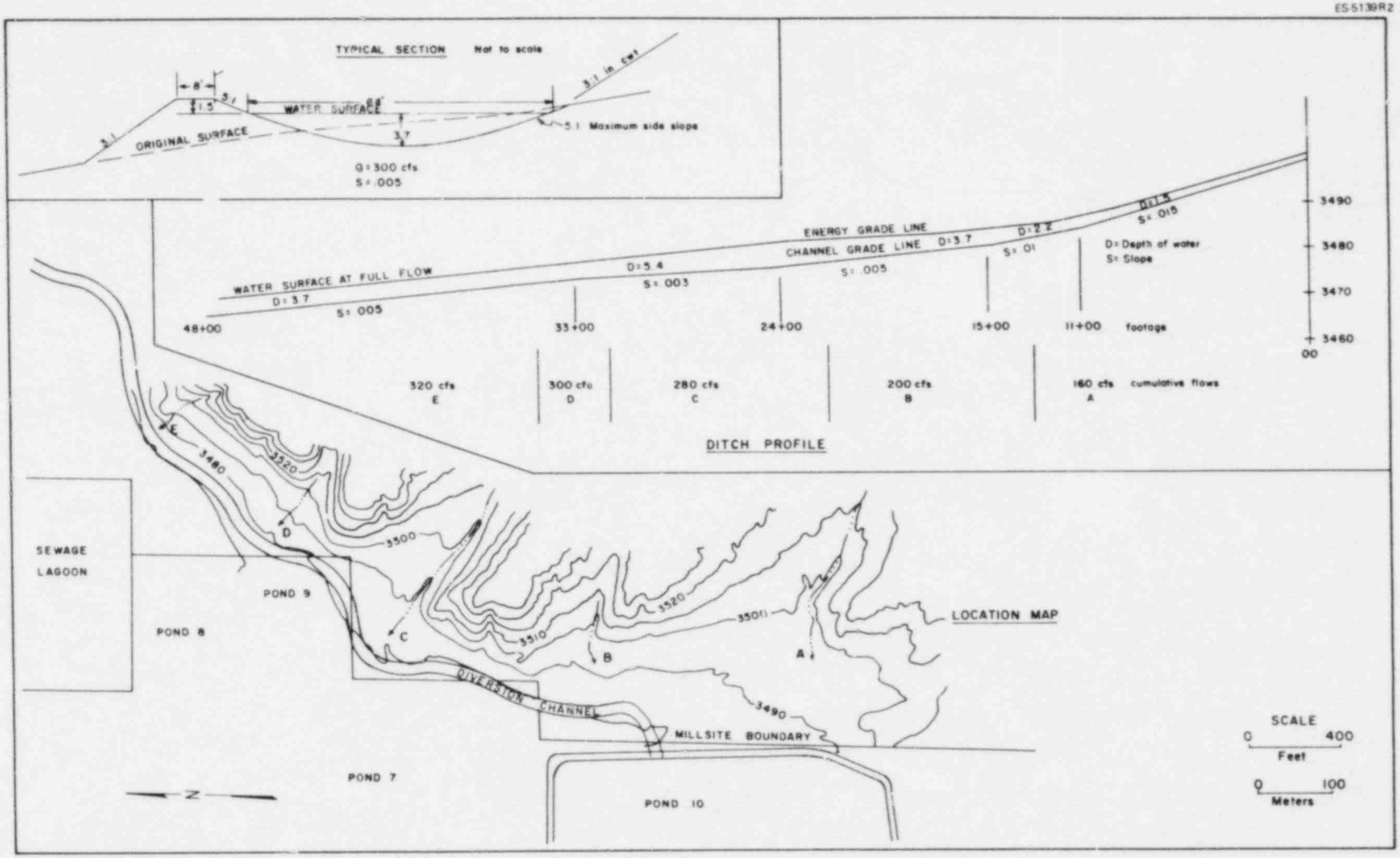

Fig. 2.7. Conceptual design of diversion channel along eastern perimeter of mill site. Source: Modified from ER, rev. 1, Fig. 3.5-1.

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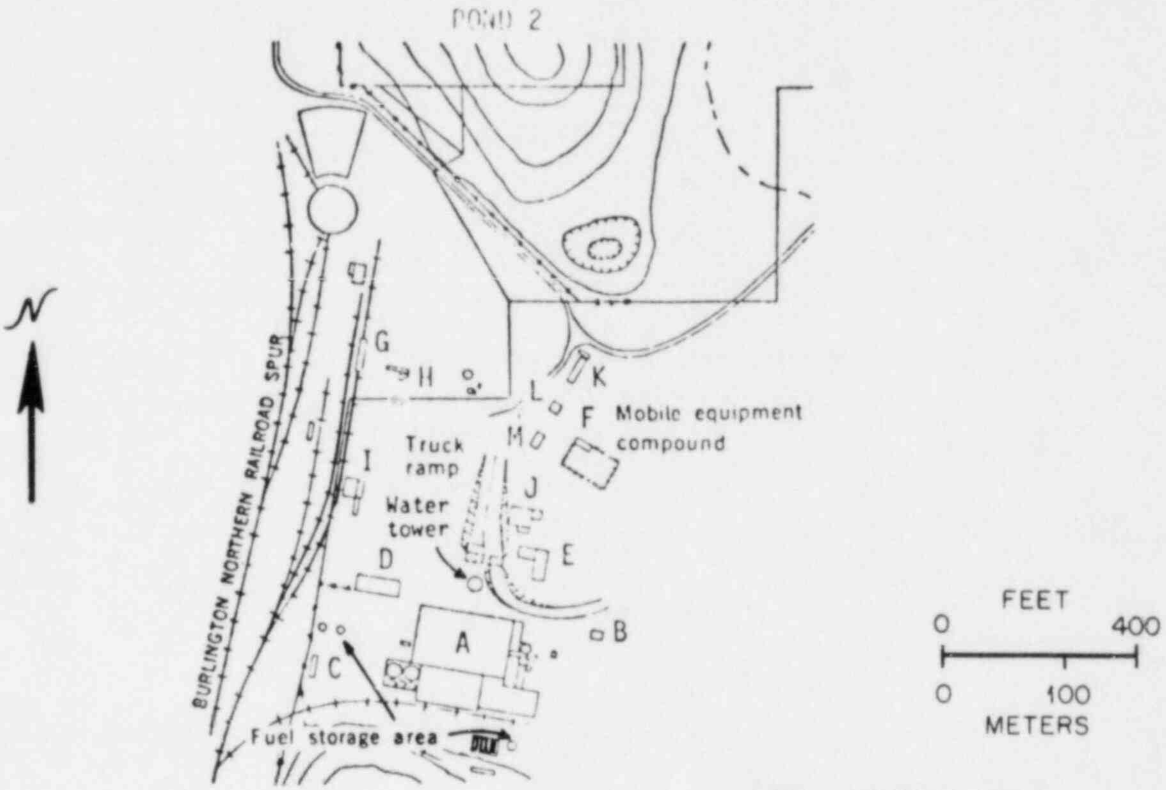

	AREA	CONSTRUCTION
A = MAIN MILL BUILDING	40,000 ft^2	STEEL FRAME
B = "FeV" BUILDING	480 ft^2	STEEL FRAME
C = ELECTRIC SHOP	576 ft^2	WOOD FRAME
D = OFFICE	2,890 ft^2	MASONRY
E = CRUSHER AND SAMPLING BUILDING	1,824 ft^2	STEEL FRAME
F = STORAGE SHED	432 ft^2	WOOD FRAME
G = RAILROAD CAR SHAKER	2,040 ft^2	STEEL FRAME
H = FLY ASH PUMP HOUSE	204 ft^2	WOOD FRAME
I = REAGENT WAREHOUSE	1,120 ft^2	STEEL FRAME
J = MOBILE EQUIPMENT SHOP BUILDING	1,840 ft^2	STEEL FRAME
K = SCALE HOUSE	740 ft^2	STEEL FRAME
L = LIME PLANT	440 ft^2	STEEL FRAME
M = CARPENTER SHOP	720 ft^2	STEEL FRAME

Fig. 2.8. Mill building locations. Source: ER, rev. 1, Fig. 2.2-1.

may be sold. Usable equipment that cannot be feasibly decontaminated will be considered for use in other licensed facilities. The transport of any existing equipment will be conducted in accordance with applicable regulations on transportation and radiation protection.

Decontamination. Decontamination methods may vary, depending on the level of contamination and the type of structure. Specific procedures will be determined on a building-by-building basis.

In general, the decontamination will proceed from interior to exterior and from top to bottom. Methods may include sandblasting, hydrolasing, and treatment with commercial decontamination agents. Items that cannot be readily decontaminated, such as partitions, insulation, or roofing, will be removed and buried in the impoundment area. During decontamination, radiation surveys will be conducted to identify any areas with unexpectedly high levels of contamination.

Dismantling. Demolition methods may vary from building to building according to structure type, contamination level, and location relative to other buildings and the site perimeter. Specific procedures will be determined on a building-by-building basis.

2.2.2.4 Disposal of tailings and contaminated material

During its 18 years of operation, the Edgemont mill produced about 2.1×10^6 MT (2.3×10^6 tons) of uranium mill tailings solids. Infiltration and leaching which occurred over that time and subsequent to its closing have caused the contamination of soils and materials underlying and adjacent to the ponds and piles on the site, including parts of the Cottonwood Creek channel (Fig. 2.9). The estimated quantities of materials (including building and mill process materials) to be removed from the mill site to the final tailings disposal impoundment area are listed in Table 2.2. The staff feels that the estimated volumes may be too large, especially those for contaminated subsoils, and that further studies and decommissioning project operating experience may lead to some reduction in these estimates.

Sequence of disposal operations

The basic sequence of proposed disposal operations includes (1) decontamination and/or demolition of mill structures; (2) slurry transport and disposal of tailings sands; and (3) truck transport and disposal of tailings sands, slimes, and contaminated soils. There will be some overlapping of slurry disposal and truck disposal operations as conditions in the impoundment area permit. Figure 2.10 delineates the decommissioning schedule in detail.

In general, the tailings removal will gradually progress from the northwest corner of the mill site to the southeast corner (Pond 10) to minimize recontamination of previously cleaned areas.

Operations will continue as weather conditions permit. Removal operations will cease during extreme weather conditions, such as heavy rainfall or high winds. An onsite supervisor will determine when operations will be discontinued. Freezing temperatures in combination with other extreme weather conditions will restrict the disposal operations to about six months per year. Removal operations will be performed during the working season so that no contaminated material will be exposed during the winter.

Removal by slurry pipeline

The licensee will provide criteria for determining the suitability of materials to be transported in slurry form. It is estimated that about 80% of the tailings at the mill site are suitable for slurry transport. The tailings in Pond 2, the AEC pile, Area B, and the east pile may also be of the proper consistency for transport in slurry form. As cleanup operations continue, other materials meeting the suitability criteria may be transported by the slurry method.

Topsoil and stabilization cover material will be removed from Pond 2, the AEC pile, Area B, and the east pile by truck as tailings are transported to the repulping plant near the east pile. Continuous operation of the slurry transport system will necessitate the stockpiling of tailing sands at the pulping plant.

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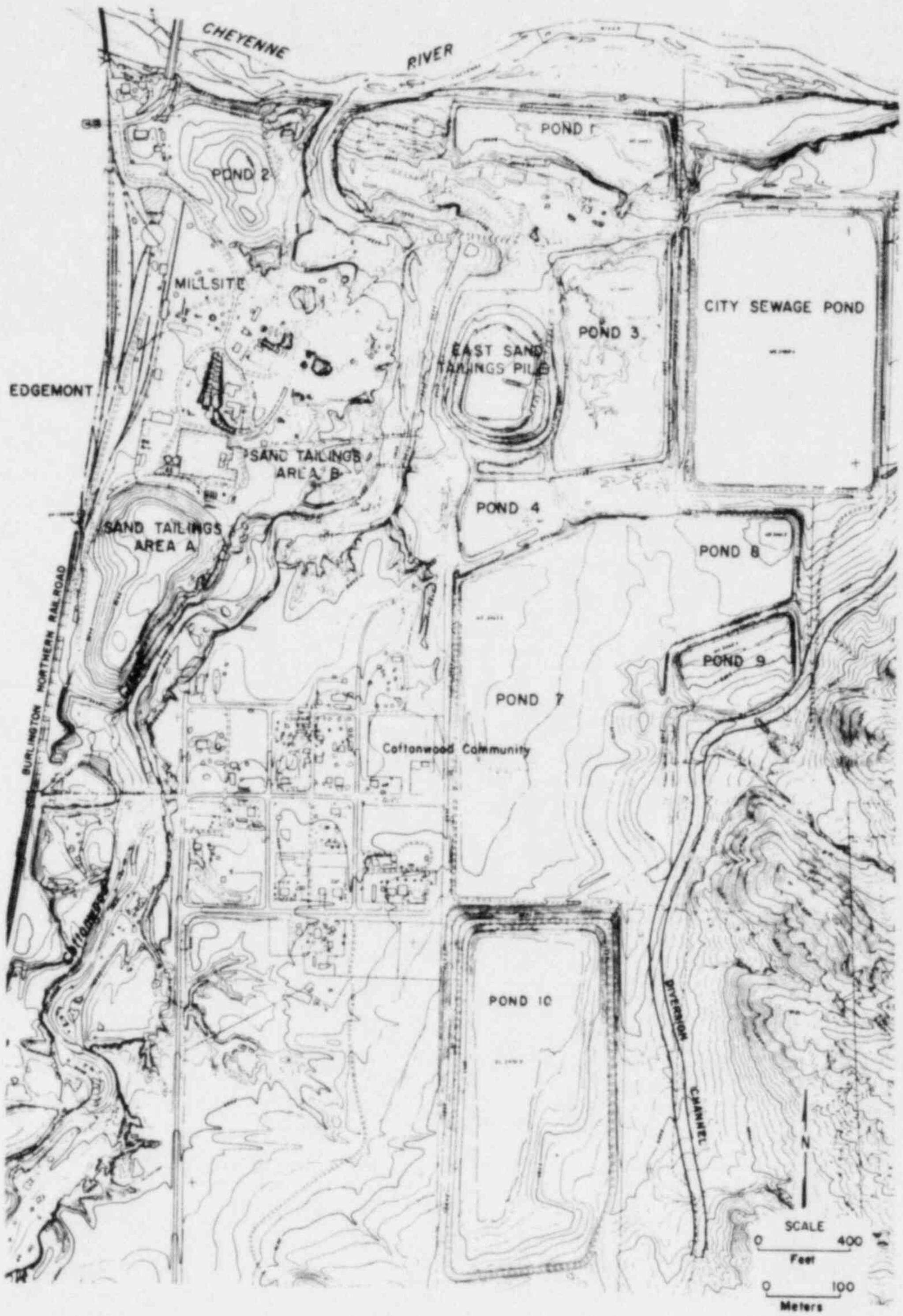

Fig. 2.9. Mill site ponds and tailings piles. Source: ER, rev. 1, Fig. 2.1-2.

Table 2.2. Tailings and related materials present on the site

Area	Material	Volume		Weight[a]
		m^3	yd^3	tons
Pond 1	Sand tailings and slimes	172,000	225,000	371,250
Pond 2	Sand tailings and stabilization cover	123,000	161,000	265,650
Pond 3	Slimes	245,000	320,000	528,000
Pond 4	Sand tailings and slimes	81,000	106,000	174,900
Ponds 7, 8, 9	Sand tailings and slimes	552,000	722,000	1,191,300
	Soil cover	46,000	60,000	99,000
Pond 10	Contaminated dikes and native material	86,000	112,000	184,800
AEC Pile (Area A)	Sand tailings and stabilization cover	169,000	221,000	364,650
Area B	Sand tailings and stabilization cover	90,000	118,000	194,700
East pile	Sand tailings	474,000	620,000	1,023,000
Cottonwood Creek	Creek channel	23,000	30,000	49,500
Subsoil[b]	Contaminated subsoil	914,000	1,195,000	1,971,750
Mill structures	Contaminated structures and equipment	297,000	389,000	641,850
Safety factor (10%)		327,000	428,000	706,200
Total		3,599,000	4,707,000	7,766,550

[a] Assumes an average of 1958 kg/m^3 (3300 lb/yd^3) of material to be moved.

[b] Assumes 1.8 m (6 ft) average for contaminated subsoil below interface and about 502,000 m^3/m (200,000 yd^3/ft) of contamination.

Source: ER, rev. 1, Table 2.3-1.

The tailings sand will be mixed with water to a 50-wt % slurry. The design sand input of 285 MT/h (314 tons/h) will yield a flow rate of about 5822 liters/min (1800 gpm) in the slurry pipeline (Fig. 2.11). At the impoundment, the solids will settle out and the liquids will form a pond. A decant barge will be used to recover about 3960 liters/min (1045 gpm) of the liquid, which is then returned by pipeline to the repulping plant (Fig. 2.12). The remaining liquids, about 985 liters/min (260 gpm), are lost to recycle by entrainment in deposited solids, by evaporation, or as pond water inventory. Therefore, as a counter for these losses, an equal amount of makeup water will be drawn from TVA's existing well at the mill site, from Pond 10, and from dewatering sumps around the mill site. The licensee has a water appropriation permit from the State for the onsite well.

Because the majority of the contamination will be concentrated in the tailings, removal of the sand tailings by slurry pipeline will significantly decrease the potential for the release of airborne contaminants along the haul route. The licensee claims that the slurry deposition of sand tailings in the impoundment area, in addition, will fill void spaces in and around the rubble from mill structures and equipment placed in the bottom of the area. This, the licensee claims, will minimize the differential settlement that might threaten the integrity of the final clay cap and overburden cover of the impoundment area. The staff recommends that the licensee evaluate the potential for incomplete filling of void spaces, estimate the magnitude of differential settlement that could result, and identify mitigating measures to prevent failure of the tailings cap and cover due to settlement cracking. In addition, the staff recommends that the licensee establish field procedures for ensuring that all voids are properly filled and that these procedures be submitted for review.

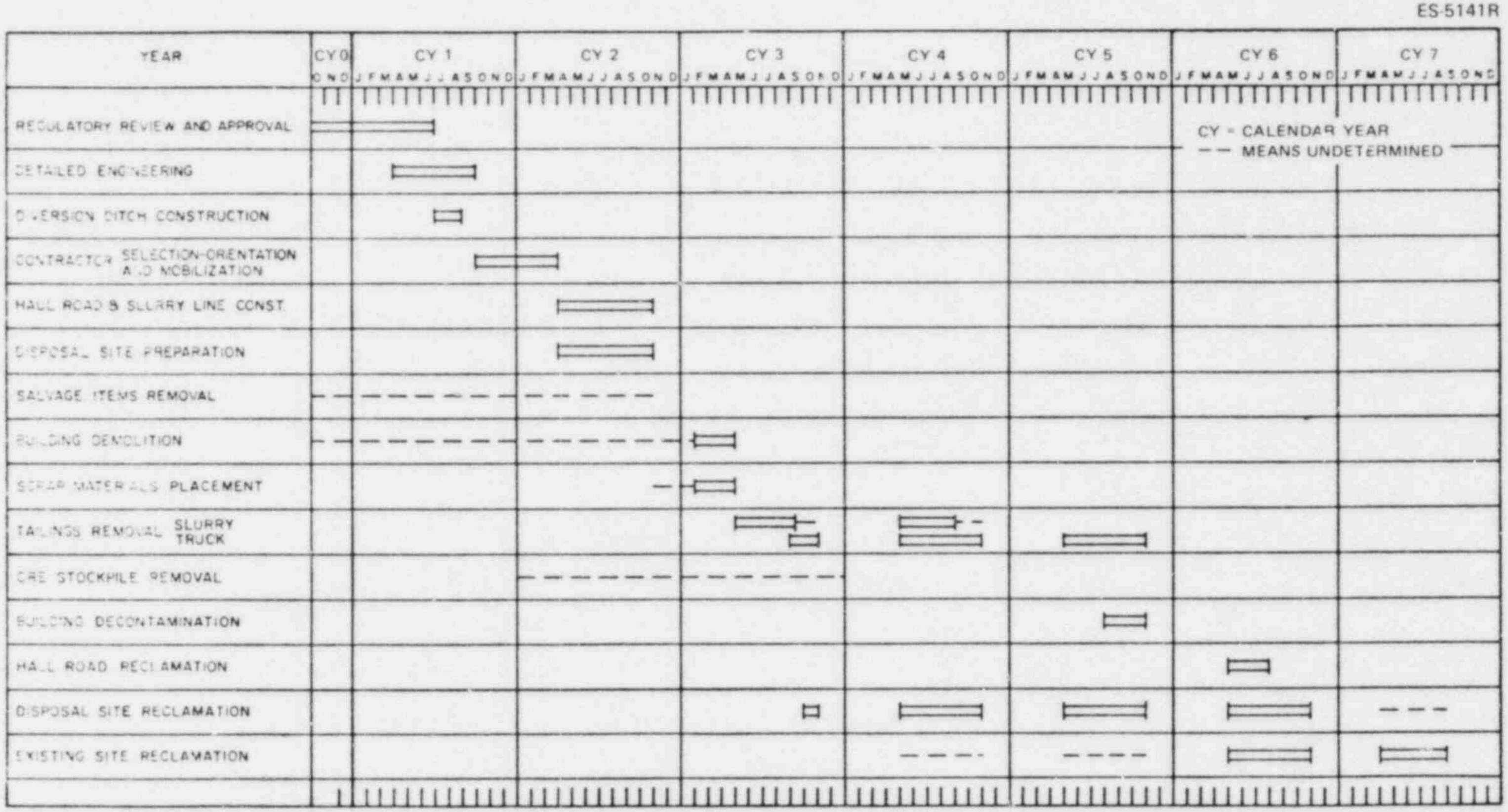

Fig. 2.10. Edgemont decommissioning schedule. Source: ER, rev. 1, Fig. 3.6-2.

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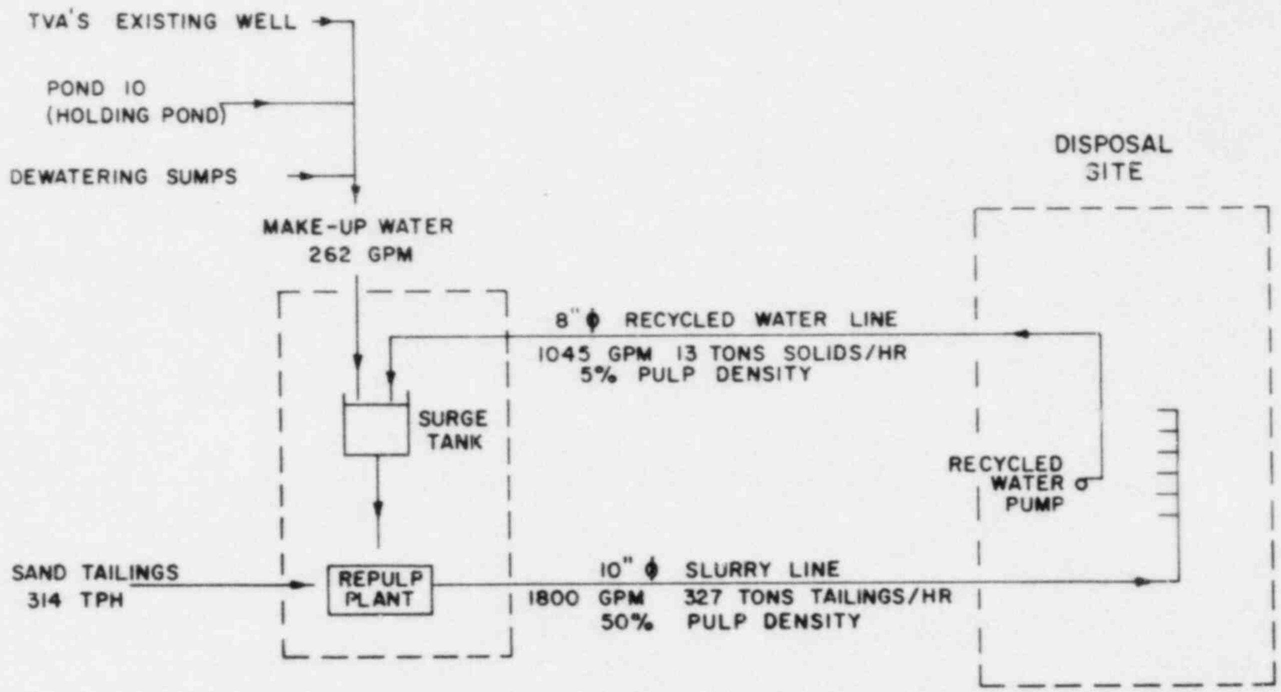

Fig. 2.11. Flow capacity of the slurry and recycle water pipelines. Source: ER, rev. 1, Fig. 3.5-4.

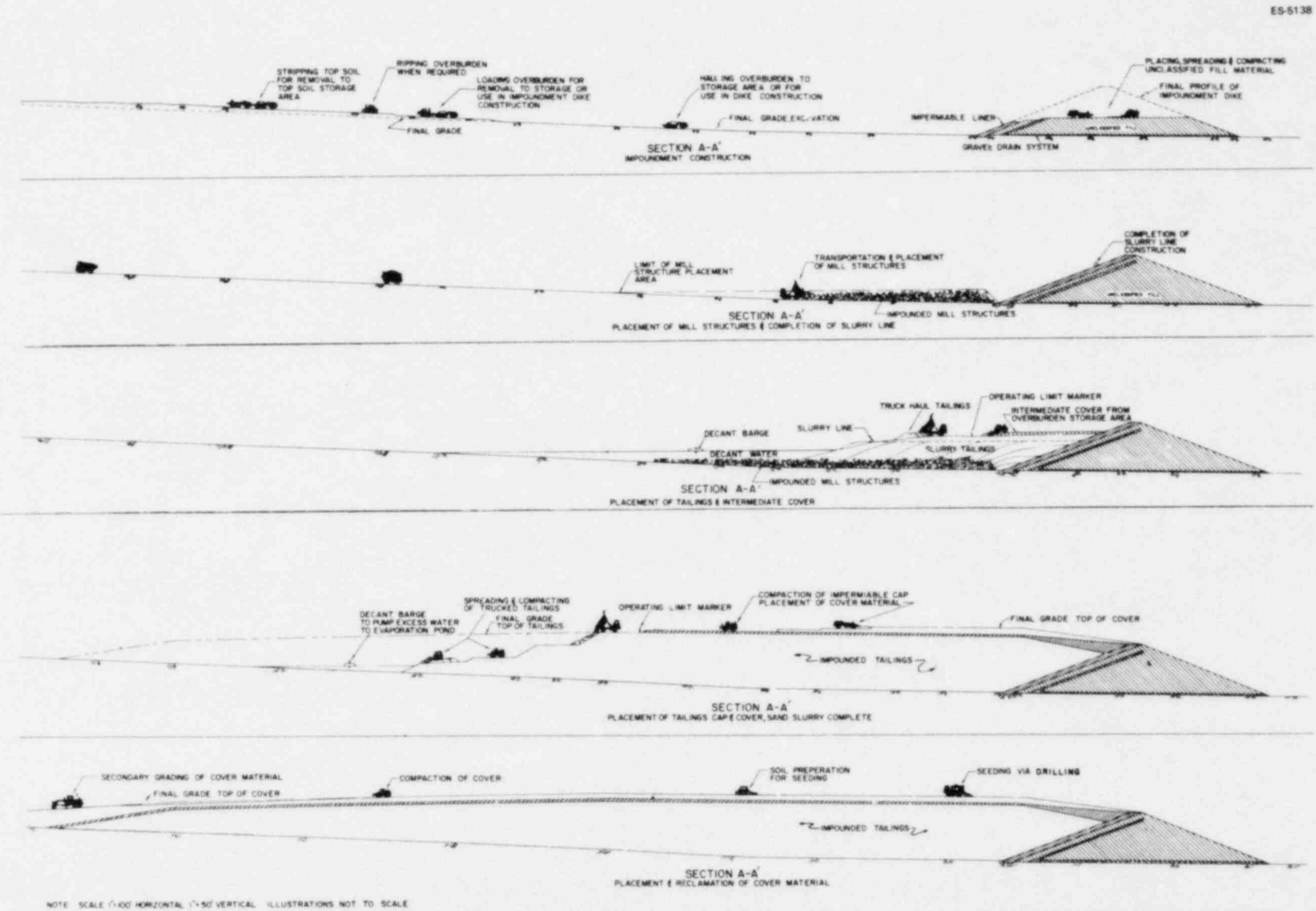

Fig. 2.12. Stages of mill decommissioning at proposed disposal site. Source: Modified from ER, rev. 1, Fig. 3.5-2.

As water drains from the sand tailings deposited by the slurry pipeline, a tailings beach is expected to form. In the event that the slurry is too liquid to form a sloping beach, the staff recommends that small temporary dikes be constructed to prevent broad flowage of slurry and permit establishment of a sloping beach. Once this beach has been established, truck disposal of tailings and contaminated material will commence, proceeding from the impoundment dike in an upstream direction to cover the tailings deposited by slurry pipeline (Fig. 2.12). Material deposited by trucks will be spread and compacted to a density determined acceptable by soils engineering studies. Throughout the slurry disposal operation, the decant pond is expected to proceed in an upstream direction along the leading edge of the deposited tailings. Upon completion of the slurry operation, the decant pond will be pumped to Pond 10 for evaporation.

Treatment of slimes

The milling process separated the solid tailings into two size fractions: sands, which comprise about 80% by weight of the tailings, and slimes, which make up the remainder. The principal contents of Ponds 3 and 7 are slimes. The slimes are generally loose, fine-grained materials with high water contents and very low shear strengths. These properties make them difficult to excavate, handle, and compact with conventional heavy equipment. To overcome this difficulty, the licensee proposes to use the following procedure in the removal of slimes. Excess surface water will be pumped to Pond 10 for evaporation. To increase the evaporation rate, perforated sections of pipe could be used to spray the water over Pond 10 during appropriate climatic conditions. This operation will be directed by an onsite supervisor.

Contaminated topsoil, stabilization cover material, and dike material removed from other tailings areas would be mixed with the slimes in Ponds 3 and 7 to make them manageable for truck transportation to the impoundment and compaction area. This multiple handling of the slime material is expected to eliminate localized concentrations of slimes and to minimize the potential for differential settlement resulting from slime concentrations. The staff recommends that the licensee develop plans to ensure that the slimes are properly mixed with less compressible materials to permit transport by truck and to minimize differential settlements. Field testing of the mix for compressibility will be required to provide a basis for adjusting the composition of the mix in the field.

As removal operations in Pond 3 (and possibly Pond 8) progress toward the Edgemont city sewage lagoon, it will be necessary to protect the integrity of the lagoon. To prevent the collapse of the lagoon embankment, sheetpile or another type of containment device will be placed along the exposed side of the lagoon before nearby removal operations begin.

Mill site land decontamination

As stated previously, the primary goal of mill site land decontamination is to reduce radiation exposure to the public and to return the mill site to productive use after removal of tailings to a new disposal site. All of the uranium tailings will be removed from the site. It is not known, however, to what extent the soils below the tailings piles have been contaminated by seepage of tailings liquor and what quantity of this contaminated soil may have to be removed. The staff expects that a much lower quantity of contaminated soil will have to be relocated than that projected by the licensee.

The licensee has developed preliminary cleanup levels based on radiological characteristics of the residual contaminated material, land use considerations, radiation protection standards, and potential restrictions for the reclaimed site. Selection of specific cleanup levels and cover thicknesses cannot be made until characterization of the amount and degree of residual contamination is completed and decisions are reached regarding the ultimate land use of the reclaimed millsite. Because the contaminated subsoils lie beneath the tailings, they have not been as well characterized as surficial contamination. However, preliminary borings into these subsoils indicate that they are relatively thin, perhaps generally 1.2 m (4 ft) or less in thickness.

Following the approach presented in the NRC Branch Technical Position — "Disposal or Onsite Storage of Thorium or Uranium Wastes from Past Operations: (*Federal Register*, pp. 52061-52063, Oct. 23, 1981) — the licensee has developed cleanup levels and cover thicknesses based on the following criteria: (a) exposure to radon daughter concentrations of no more than 0.02 working levels (WL) if residential use is planned and 0.04 WL if industrial use is planned and (b) a maximum critical organ exposure limit of 170 millirems/year.

The Branch Technical Position identifies acceptable options for disposal of residual contamination with no continuing NRC licensing of the material. The option applicable to the cleanup of the mill site prescribes conditions for burial of land-use-limited concentrations of radioactive contamination in areas zoned for industrial use, with restrictions on site excavation and use of the land for agricultural and residential purposes. In this case, land records are amended to state the presence of buried radioactivity and to prohibit certain activities. This is justified by applying a maximum critical organ exposure limit of 500 millirems/year and a maximum continuous exposure to radon daughter products of 0.02 WL. The licensee has used, as a basis for the proposed mill site cleanup plan, a maximum critical organ exposure limit of 170 millirems/year and a maximum radon daughter concentration (within a building) of 0.02 WL for residential structures and 0.04 WL for industrial structures. The staff's position, reflected in the Branch Technical Position, is that residential construction should be prohibited over areas where residual contamination is buried. In the case of industrial buildings, exposure to 0.04 WL concentration for a 9-h workday would be the equivalent of continuous exposure to 0.015 WL.

The depths of cover soil required to reduce radon daughter concentrations to 0.02 and 0.04 WL and direct exposure to 170 millirems/year for thicknesses of contaminated soil of 0.3, 0.6, and 1.2 m (1, 2, and 4 ft) and for radium-226 concentrations in the contaminated subsoil ranging from 5 to 100 pCi/g were calculated by TVA and verified by the staff using currently recognized methodologies. The required depths of cover are presented in Tables 2.3 and 2.4.

Table 2.3. Thickness of cover soil [meters (feet)] required to reduce radon-222 daughter concentration in buildings to less than 0.02 WL and direct exposure to less than 170 millirems per year[a]

Radium-226 concentration (pCi/g)[b]	Thickness of contaminated layer					
	1.2 m	(4 ft)	0.6 m	(2 ft)	0.3 m	(1 ft)
5	0.3	1	0.3	1	0.3	1
10	0.3	1	0.3	1	0.3	1
20	0.6	2	0.3	1	0.3	1
30	0.9	3	0.6	2	0.3	1
40	0.9	3	0.6	2	0.3	1
50	0.9	3	0.9	3	0.3	1
60	1.2	4	1.2	4	0.6	2
70	1.2	4	1.2	4	0.6	2
80	≥1.2	≥4	≥1.2	4	0.9	3
90	≥1.2	≥4	≥1.2	≥4	0.9	3
100	≥1.2	≥4	≥1.2	≥4	0.9	3

[a]Land use considerations: (1) residential and industrial usage allowed, (2) agriculture not permitted, and (3) excavation not permitted.

[b]Estimated residual concentrations are expected to be determined using direct-radiation field instruments.

Table 2.4. Thickness of cover soil [meters (feet)] required to reduce radon-222 daughter concentration in buildings to less than 0.04 WL and direct exposure to less than 170 millirems per year[a]

Radium-226 concentration (pCi/g)[b]	Thickness of contaminated layer					
	1.2 m (4 ft)		0.6 m (2 ft)		0.3 m (1 ft)	
5	0.3	1	0.3	1	0.3	1
10	0.3	1	0.3	1	0.3	1
20	0.3	1	0.3	1	0.3	1
30	0.3	1	0.3	1	0.3	1
40	0.6	2	0.3	1	0.3	1
50	0.6	2	0.3	1	0.3	1
60	0.9	3	0.6	2	0.3	1
70	0.9	3	0.6	2	0.3	1
80	1.2	4	0.9	3	0.3	1
90	1.2	4	0.9	3	0.3	1
100	1.2	4	0.9	3	0.3	1

[a]Land use considerations: (1) industrial development usage allowed, (2) residential use not permitted, (3) agricultural use not permitted, and (4) excavation not permitted.

[b]Estimated residual concentrations are expected to be determined using direct-radiation field instruments.

The licensee also has developed preliminary cost estimates for removing contaminated material from the mill site and bringing clean cover soil onto the site. Assuming 81 ha (200 acres) of the mill site will require cleanup, 0.3 m (1 ft) of contaminated soil cut uniformly off the 81 ha and transported to the disposal site is estimated to cost $655,000. The cost of covering 81 ha with 0.3 m (1 ft) of clean cover soil is estimated to be $485,000. The difference in the cost of performing these operations is due to the greater hauling distance between the mill site and the disposal site. Detailed characterization of the extent of contamination of subsoil throughout the mill site will enable the licensee to determine the most practical combination of removal of contaminated subsoil and placement of clean cover material, from both an economic and a health and safety point of view, while satisfying the above-mentioned criteria.

Based on further characterization of the residual contamination and the licensee's determination of what should be moved, the NRC staff will perform an independent evaluation to determine cleanup levels, cover thickness, and land use control and the possible need to turn responsibility for the land over to a government agency and riprap those areas adjacent to Cottonwood Creek and the Cheyenne River.

Removal by truck

Trucks of up to 45.5-MT (50-tons) capacity will be used in impoundment operations to transport all materials that cannot be transported by the slurry pipeline system; these materials include building demolition wastes, stabilized slimes mixtures, stabilization cover, dike materials, soil, overburden, and the contaminated alluvium from Cottonwood Creek. Trucks may also haul the tailings sand from the individual piles to the repulping plant.

Truck removal of contaminated material from the mill site to the impoundment area will be over the specially constructed haul roads described in Sect. 2.2.2.2. Water from the onsite well will be used on haul roads, as necessary, to minimize the release of fugitive dust. Contaminated material in the trucks may be watered or sprayed with a suitable material to prevent emissions of fugitive dust during transport. Adverse weather conditions such as high winds, excessive precipitation, or freezing temperatures may temporarily halt the transportation process. Removal operations are expected to continue approximately 6 months per year for 2.5 years.

2.2.2.5 Cleanup of Cottonwood Creek

As cleanup operations proceed from the western portion of the mill site, the removal of contaminated material in and around the Cottonwood Creek channel will be necessary. This phase of the cleanup will require the temporary diversion of the creek. A diversion channel will be constructed of uncontaminated material to divert Cottonwood Creek through the mill site. Figure 2.13 shows the general location of the diversion channel from points A to B. The diversion channel will be constructed to handle runoff from a 100-year flood event. The base of the diversion will be excavated to uncontaminated material. The banks will be excavated outward into existing uncontaminated native materials. However, if the bank material is contaminated, additional soil will be removed and uncontaminated fill material brought in to construct the banks. Uncontaminated fill material will be used as needed to obtain the proper configuration for the diversion channel. During excavation operations, sumps will be used to remove any excess water as discussed in Sect. 2.2.2.4. The diversion channel will be protected from erosion by its careful design and by the use of riprap where necessary.

The channel will be completed from point A to point B (Fig. 2.13) with a temporary dike at each end to prevent floodwaters from entering the excavation. At the time of low flow in Cottonwood Creek, a coffer dam will be constructed at point C to divert the flow of the creek through a pipeline from point D to point E at the Cheyenne River. The pipeline will be designed to accommodate twice the average low flow of the stream. While the flow is being diverted, contaminated material from the creek channel from point F to point G will be removed and the channel stabilized as described above. The flow would then be returned to the decontaminated channel segment (F to G) of Cottonwood Creek.

During the next season at low flow, the coffer dam will again be used to divert the creek through the pipeline. The creek channel between points H and I (Fig. 2.13) will then be cleaned and prepared for flow. Once this is completed, the diversion channel from point A to point B will be connected at the upstream (F-G) and the downstream (H-I) portions of the existing channel. All flow from Cottonwood Creek will then be directed through the diversion channel. Removal of contaminated material to the east of the diversion can then proceed. Once the eastern portion of the mill site has been cleaned, the permanent route for Cottonwood Creek will be prepared. It is expected to follow the original creek channel as closely as practical to form a gently meandering course through the former mill site. When the creek has been reestablished in its permanent channel, any remaining contaminated material will be removed.

2.2.2.6 Final mill site removal operations

Pond 10 cleanup

The removal of tailings and the decommissioning of affected areas will generally progress from the northwest to the southeast (Sect. 2.2.2.4). Pond 10, which lies on the southeastern corner of the mill site, will be decommissioned last. Pond 10 was constructed for use as an evaporation pond during the later phases of the mill-operating life, and no tailings sands or slimes were directly deposited in Pond 10. Contamination in Pond 10 will be limited to soil and overburden in the dikes and the pond bottom, some slimes brought in with the water, and contaminated materials in drainage from the haul roads and pipeline corridors. As Pond 10 will be used as a holding pond for water utilized in slurry transport, TVA has committed to line Pond 10 to prevent any further seepage. However, it may be that the shale forming the base of the pond is sufficiently impermeable, and if this proves to be the case, a liner would not be required.

At the completion of operations, any excess water and contaminated materials in the pond will be mixed with the embankment material surrounding the pond to facilitate handling and disposal. All contaminated materials will then be removed to the impoundment area.

Windblown tailings areas and Cottonwood community

As discussed in Sect. 2.2.2.3, areas of the Cottonwood community and the area east of the mill site have been contaminated by windblown tailings. Because additional contamination may occur during cleanup operations at the mill site, the licensee proposes to delay survey and cleanup of these areas until decommissioning activities on the mill site near completion (ER, rev. 1, p. 2.4-1).

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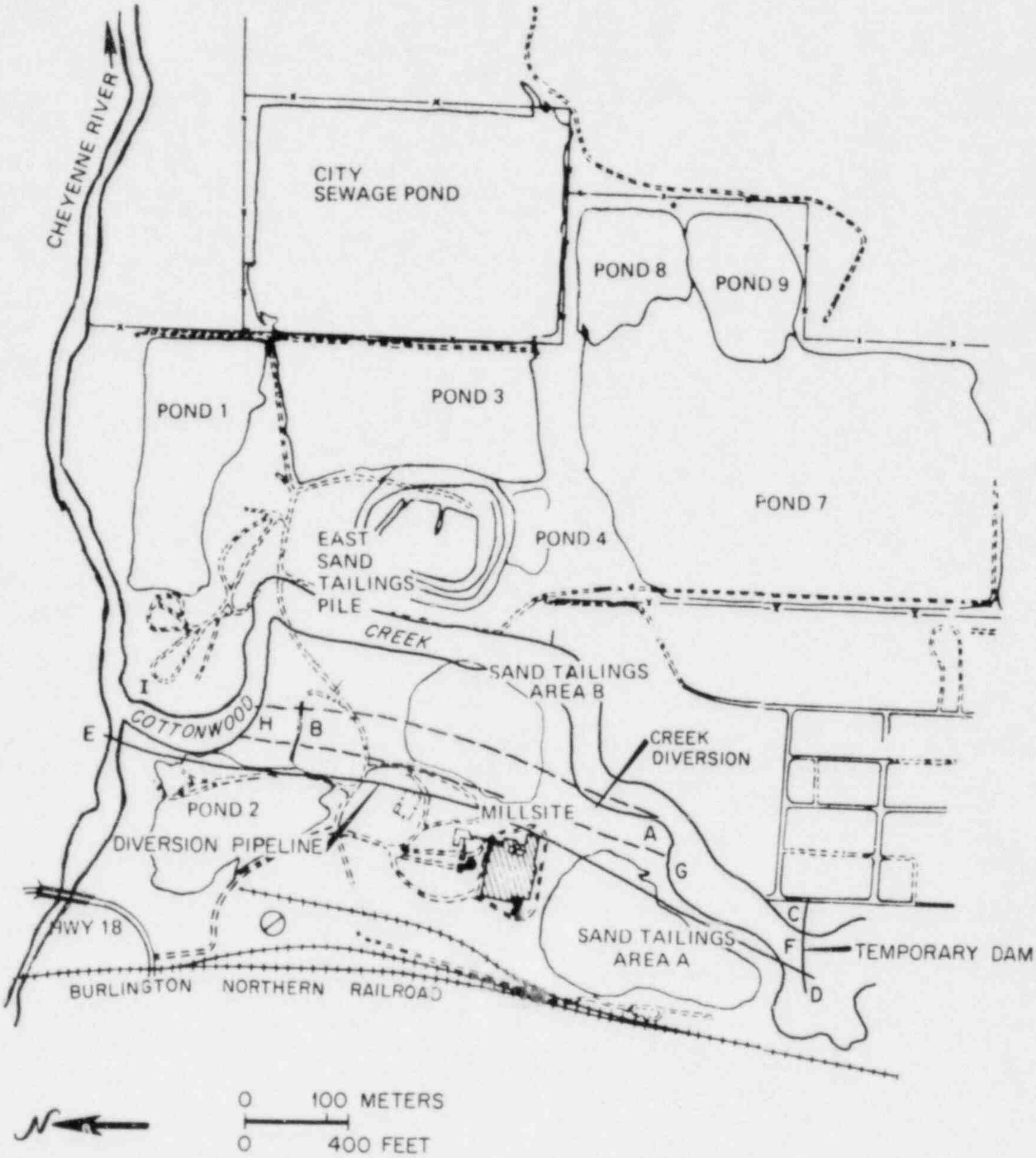

Fig. 2.13. Cottonwood Creek temporary diversion. Source: ER, rev. 1, Fig. 3.5-3.

Windblown tailings areas. This uninhabited area generally east and southeast of the mill site consists of a flat plain near the mill boundary extending into a rocky valley bounded by steep hills. The extent of the area requiring remedial action will be determined at the time of actual decommissioning after tailings removal by measurement of direct radiation (for example, by using an unshielded scintillometer) at points on an approximate rectangular grid at intervals of 4.6 m (15 ft). After extensive measurements in geologically similar areas, background levels have been preliminarily determined by the licensee by scintillometer (cross-calibrated to a pressurized ionization chamber) at a height of 1 m to be 17 μR/h with a standard deviation of about 2 μR/h. [The presence of numerous outcrops of higher-activity shale in this area results in a background radioactivity level greater than that determined by the EPA (12 to 13 μR/h) in previous surveys of the town of Edgemont.] Based on the measured mean and standard deviation (σ_B) of background, a decommissioning action point has been proposed by TVA. The action point is the smallest exposure rate above background that can be detected with 95% confidence. It is computed by $1.64 \times 2 \times \sqrt{2} \times \sigma_B$ and is represented by Action Level 1 (AL1). Action Level 1 is analogous to the lower limit of detection, and based on existing data, it would be equal to 9.3 μR/h above background. When the measured exposure rate above background is greater than AL1, the net exposure rate is significantly greater than background and is expected to be detected 95% of the time. Under this condition, TVA proposes to collect additional data and conduct cleanup operations if contamination is extensive and/or if conditions are favorable with regard to worker safety and cleanup expense (the ALARA concept). If exposure levels exceed 20 μR/h above background [Action Level 2 (AL2)], TVA proposes to conduct cleanup unless it is not feasible to conduct the operations. Because the area is uninhabited and the terrain is very rough, safety of workers will be the primary consideration in determining feasibility. After initial cleanup, the area will be resurveyed as described above. Any areas found to exceed the cleanup levels will be recleaned and surveyed again until the exposure-level criteria are satisfied. Soil samples will be analyzed to document that concentrations of radium-226 at the termination of decommissioning operations are $\leq$ 5 pCi/g. Soil samples will be collected at intervals of about 14 m (45 ft) and will be composited, with 20 samples being collected over each square of 30 m (100 ft) per side. Some localized areas may have naturally high exposure levels because of outcropping of high-activity rock or shale. When such areas are identified and it is demonstrated (e.g., through equilibrium determinations) that their high activity is not due to windblown tailings, then no cleanup action will be required.

Cottonwood community. The inhabited area (Cottonwood community) near the mill is an alluvial plain. The radiological background of this alluvial plain will be measured at a similar site(s) uncontaminated with tailings. From these background measurements, criteria similar to that explained above will be developed. Contamination in this area is primarily from windblown tailings and therefore would not be expected to extend deeper than about 0.3 m (1 ft). TVA proposes to remove this contamination if direct gamma exposure levels exceed action levels to be established in the same manner as those for the windblown tailings area. Soil sampling will be conducted at about two locations near each residence to document radium-226 concentrations following cleanup.

The staff concurs in the licensee's proposed cleanup criteria. However, cleanup will be required anytime AL1 is exceeded unless the NRC staff concurs in TVA's decision not to perform cleanup. In addition, TVA will have to submit background data and proposed action levels for the Cottonwood community for NRC staff review and approval. It is expected that the level of background radiation in the Cottonwood community would be about the same as that determined by EPA for the town of Edgemont — that is, about 12 to 13 μR/h.

Removal of slurry pipeline and haul road

Concurrent with Pond 10 cleanup activities, the slurry pipeline will be removed. Final disposition of the equipment has not been determined by the licensee, but the major options available at this time include use of the equipment at another licensed facility or disposal in the impoundment area. Contaminated soils on the haul roads and in the drains will be removed to the impoundment.

2.2.2.7 Mill site reclamation

The objectives of the licensee's reclamation plan for the mill site are to (1) stabilize soil on the mill site, (2) make the site available for productive use, and (3) restore the riparian community of the rechanneled portion of Cottonwood Creek, providing habitat for indigenous wildlife and improving the scenic quality of the creek (ER, Sect. 4.6.3.1). Final reclamation plans may change, however, depending on the anticipated future use of the site. The licensee's plans to meet these objectives, as summarized below, are discussed in Sects. 4.6.3.2 and 4.6.3.3 of the ER.

Site preparation

The entire 86-ha (213-acre) mill site will be recontoured before being revegetated. The licensee plans to obtain fill material from the disposal site. However, depending upon the volume of contaminated soil removed, the amount of excess overburden at the disposal site, and the flexibility of the engineering schedule, additional acreage may be disturbed to acquire the necessary fill material. Land controlled by TVA for a potential source of fill material is shown in Fig. 2.1. Any borrow areas will be contoured to blend with surrounding land forms and revegetated in accordance with the reclamation plan.

To retain water, thereby improving vegetative cover, and to reduce gully formation, the licensee may construct water-spreading bars below drainages originating on the hill east of the site. The reconstructed channel planned for Cottonwood Creek will approximate the predevelopment configuration, with banks graded to a 10° slope. Deviations from this angle may occur, depending on land use (See Appendix A, TVA comment 1 on Sect. 2). Regardless of land use, the licensee is committed to complying with Executive Order 11988, Floodplains Management, and Executive Order 11990, Wetlands Protection.

The licensee states that sufficient materials suitable for use as topsoil exist at the disposal site for reclaiming both the disposal and mill sites. Topsoil will be applied to a minimum depth of 15 to 20 cm (6 to 8 in.). These areas will then be ripped to a depth of 26 to 31 cm (10 to 12 in.) to discourage a differential interface between the topsoil and subsoil, to reduce compaction, and to increase the soil's water-holding capacity.

Seedbed preparation and seeding

The site will be disked following topsoil application and ripping. The time of seeding will depend upon completion of site and seedbed preparation. If seeding is done during late summer or early fall, a species mixture listed in Table 2.5 will be applied with a drill-type seeder. A 10-m-wide (32-ft) strip along each side of Cottonwood Creek may be planted with a mixture of seed listed in Table 2.5. As discussed below, this understory mixture will be supplemented with shrub plantings during the spring of the second growing season. Native hay mulch may be applied at a rate of 2.2 MT/ha (1 ton/acre) to cover the seed and to aid in moisture retention. The mulch would be anchored with a disk or sheepsfoot roller.

If recontouring is completed before late May, the prepared seedbed will be seeded with 54 kg/ha (48 lb/acre) of barley, rye, or oats. This annual crop should minimize wind and water erosion and provide both organic matter and cover for the reclaimed sites until early fall, when the grass/forb mixture (Table 2.5) can be seeded. This annual crop will be cut to prevent production of seed that would compete with the reclamation mixture. The reclamation mixture will be seeded directly into the existing stubble.

Other areas not immediately available for seeding with the grass/forb mixture because of decommissioning scheduling will also receive the temporary oat, rye, or barley cover crop to minimize wind and water erosion. These cover crops will also be cut to prevent seed formation.

During the second growing season two 2.4-m-wide (8-ft) bands 5 m (16 ft) apart will be plowed and disked along both sides of the reconstructed Cottonwood Creek in preparation for shrub plantings. The shrubs will be overwintered in a lath house for acclimation. Pygmy peashrub (*Caragana pygmea*) and willow (*Salix* ssp.) will be planted at irregular intervals in both bands. Every 20 m (65 ft) will be planted a plains cottonwood (*Populus sargenti*) sapling in place of a willow or peashrub. In the outermost band, Russian olive (*Elaeagnus anqustifolia*), chokecherry (*Prunus virginiana*), and buffalo berry (*Shepherdia argentea*) will be planted at irregular intervals.

Because of the low nutrient content of the soil, the licensee plans to fertilize the seeded areas with 45 to 54 kg/ha (100 to 120 lbs/acre) of nitrogen and 91 kg/ha (200 lbs/acre) of phosphorus. The rates of application will be 50% lower if acrylic or asphalt tacking agents rather than hay mulch are used for erosion control (ER, Sect. 4.6.3.3).

Table 2.5. Seed mixtures proposed for revegetation

Species	Quantity[a]	
	kg/ha	lb/acre
Mill site		
Western wheatgrass (*Agropyron smithii* var. *rosana*)	7.5	7
Thickspike wheatgrass (*A. dasystachyum* var. *critana*)	4	4
Slender wheatgrass (*A. trachycaulum* var. *primar*)	4	4
Russian wildrye (*Elymus junceus* var. *vinall*)	7.5	7
Louisiana sagewort (*Artemisia ludoviciana*)	1	1
Sainfoin (*Onobrychis viciaefolia*) or yellow sweet clover (*Melilotus officinalis*)	4	4
Total	28.0	27
Banks of Cottonwood Creek — undergrowth		
Streambank wheatgrass (*Agropyron riparium* var. *sodar*)	11	10
Western wheatgrass (*A. smithii* var. *rosana*)	11	10
Yellow sweet clover (*Melilotus officinalis*)	2	2
Total	24	22
Disposal site and borrow areas		
Western wheatgrass (*Agropyron smithii* var. *rosana*)	7.5	7
Streambank wheatgrass (*A. riparium* var. *sodar*)	7.5	7
Thickspike wheatgrass (*A. dasystachyum* var. *critana*)	4	4
Sand dropseed (*Sporobolus cryptandrus*)	1	1
Blue grama (*Bouteloua gracilis* var. *lovington*)	1	1
Russian wildrye (*Elymus junceus* var. *vinall*)	1	1
Louisiana sagewort (*Artemisia ludoviciana*)	1	1
Total	23.0	22

[a]Pure live seed.

Source: ER, Tables 4.6-5 and 4.6-6.

2.2.2.8 Tailings and waste disposal site stabilization

The tailings and material in the impoundment will be stabilized against disruption over the long term. Any areas of ponded water remaining after completing deposition of tailings and contaminated materials will be removed or allowed to evaporate. Then the entire impoundment surface will be contoured and compacted. As shown in Fig. 2.2, the impoundment will be capped with 0.9 m (3 ft) of clay which in turn will be covered with unclassified fill to increase the total cover thickness to 3 m (10 ft) or more. The clay and fill will be obtained from onsite excavation or offsite borrow areas.

The cap will be designed to limit the radon-222 flux to about twice natural background levels. This cover will reduce gamma exposure to essentially background levels. To prevent failure of the cover and subsequent exposure of tailings, the impoundment will be designed and constructed to minimize the risk of differential settlement of the covered tailings. The thickness of the cover also protects the tailings from exposure caused by such things as erosion, root penetration, burrowing animals, and human intrusion. The cover will have a "crowned" surface so that all precipitation will run off into the natural drainages around the impoundment. The establishment of vegetation on the cover (Sect. 2.2.2.9) will provide additional protection against erosion. All embankment slopes will be covered with a suitable thickness of riprap and appropriate filters to provide additional protection against wind and water erosion.

2.2.2.9 Reclamation of disposal site and haul roads

The objectives of the licensee's reclamation plan for the disposal site, haul roads, and borrow areas are to (1) stabilize the tailings and (2) provide livestock forage on all disturbed areas. The licensee's plans to meet these objectives, as summarized below, are discussed in Sects. 4.6.3.2 and 4.6.3.3 of the ER.

Site preparation

Following placement of the clay cap and the overburden at the disposal site, soil suitable for plant growth (previously stockpiled topsoil) will be applied to a minimum depth of 15 to 20 cm (6 to 8 in.). The area will then be ripped to a depth of 26 to 31 cm (10 to 12 in.) to discourage a differential interface between the topsoil and subsoil. The area used to stockpile overburden and topsoil will also be ripped, but it should not require additional topsoil. The final reclaimed surface of the disposal site will have a slope of approximately 1% on the northeast and southwest sides and 0.5% on the northwest and southeast sides.

The roads and drainage channels will be ripped and graded to blend with existing land forms. Topsoil from stockpiles along the route will then be applied to a depth of 15 to 20 cm (6 to 8 in.) and ripped. Any additional topsoil required may be obtained from the disposal site or borrow areas.

Seedbed preparation and seeding

Methods proposed for this stage of reclamation are identical to those described for the mill site (Sect. 2.2.2.7). The mixture of seed for final reclamation, however, is somewhat different (Table 2.5). A greater diversity of species is planned for these areas, and a substantial percentage of these seed species is suitable for stabilization of drainage areas. In addition to the species listed, the licensee is considering including the following species: little bluestem (*Andropogon scoparius*), Indian rice grass (*Oryzopsis hymenoides*), sideoats grama (*Bouteloua curtipendula*), green needlegrass (*Stipa viridula*), scarlet globemallow (*Sphaeralcea coccinea*), winterfat (*Eurotia lanata*), and penstemon (*Penstemon* spp.).

2.2.3 Staff evaluation of the licensee's proposal and other alternatives

The Edgemont Uranium Mill Decommissioning Plan must provide adequate protection of the public and environment both from the short-term effects of tailings excavation, transportation, and emplacement and from the long-term effects of tailings storage. The criteria and performance objectives discussed in Sect. 2.2.1 will be used to measure the effectiveness of the decommissioning action in reducing the environmental impacts of remedial measures and in restoring the mill site to productive use.

Within the framework of the objective, various alternative decommissioning plans may be formulated. All such plans may be divided into major elements including mill site cleanup, disposal site selection, disposal impoundment design and site preparation, tailings transportation, tailings stabilization, and site reclamation. Each of these elements may affect the overall viability of the decommissioning plan. Therefore, each of these elements will be examined for its impact upon the viability of the licensee's proposal and other plausible decommissioning plans. The results of the analysis and the staff's recommendations are presented in Sects. 2.2.3.7 and 2.2.3.8.

2.2.3.1 Mill site decommissioning alternatives

Mill site decommissioning involves two general issues: (1) the decontamination and reuse of, or the demolition and disposal of, structures and equipment and (2) disposal of tailings and contaminated material. The specific issues of mill site reclamation and cleanup of Cottonwood Creek are discussed in Sect. 2.2.3.8. Below, however, are the alternative concepts considered in the decommissioning of the mill structures and equipment.

Alternative A1: Demolition and disposal of all structures and equipment

In this alternative, all equipment would be removed from the mill buildings, and all structures would be demolished using procedures designed to minimize the airborne release of radioactive contaminants. Foundations and footings would be broken up and removed. Contaminated soils would be excavated and removed. All equipment, building materials, and soils with radioactive contamination above the limits in the decontamination criteria would be removed to the tailings and contaminated-materials disposal area. Uncontaminated materials could be sold as scrap or removed to a landfill for disposal.

This alternative is acceptable to the staff.

Alternative A2: Selective decontamination and utilization of buildings and equipment

In this alternative, the office building, water tower superstructure, and mobile equipment shop would be decontaminated for unrestricted use. Each piece of processing equipment would be evaluated for possible use in another mill or decontaminated for unrestricted use in other applications. Efforts would be made to decontaminate the main mill building for unrestricted use. Should such decommissioning prove unfeasible, the main mill building and the remaining support buildings would be demolished as in alternative A1. The decommissioning and continued use of buildings and equipment would provide economic benefits and conserve valuable equipment while minimizing the volume of such equipment to be buried.

This is the alternative preferred by the staff and essentially that proposed by the licensee.

Alternative A3: Continued restricted use of the main mill building with selective decontamination and utilization of other buildings

For this option, if the complete decontamination of the main mill building proves unfeasible, the licensee suggests that the building still be used for certain types of industrial activities. Care would be required to minimize risks to personnel and to void inadvertent radioactive contamination of the product and effluents of such operations. Restricted industrial use would postpone indefinitely the final decommissioning of the facility. Therefore, monitoring and financial surety arrangements would be required throughout the life of the mill building.

The other structures would be decontaminated or demolished as described in alternative A2. Some process equipment might be retained for further use, and the remaining equipment would be disposed of as in alternative A2.

This proposal is considered by the staff to be unattractive from an economical, environmental, and health and safety standpoint.

2.2.3.2 Alternative methods of tailings disposal

Alternative B1: Grading and stabilization of tailings piles in place on mill site

Alternative B1a. Under this alternative, all rubble and mill debris left on site and the tailings and contaminated materials from sand-tailings area B would be placed in Pond 1 (Fig. 2.9). Some material in the currently steep-banked and unstabilized east sand-tailings pile would be relocated to Ponds 3 and 4 so that all three areas will become short mounds rising no more than 1.5 to 3 m (5 to 10 ft) above the surroundings [average elevation 1056 m (3465 ft)]. The materials in Pond 10, along with its dike, would be removed to the low points of Pond 7.

Alternative B1b. As another option, the tailings and contaminated materials could be consolidated into a smaller number of disposal areas. Also, the materials in Ponds 1, 2, and 10 and in sand-tailings areas A and B would be removed to Pond 7. There would be no change in the planned handling of the east sand-tailings pile or Ponds 3 and 4. The consolidation would reduce the final disposal area from over 40 ha (100 acres) to about 28 ha (70 acres).

Under either option, the disposal areas would be stabilized by adding a cover [0.9 m (3 ft)] of compacted clay, which in turn would be covered with overburden and soil to increase the total cover thickness to 3 m (10 ft). The terrain around the disposal areas would be graded to provide adequate drainage. A permanent runoff diversion ditch would be provided to protect the disposal areas from drainage entering the site from the east. For protection from erosion by normal runoff and the probable maximum flood, riprap would be placed on the banks of Cottonwood Creek and the Cheyenne River adjacent to the disposal areas. Fill materials and soils for disposal area stabilization and reclamation of other impacted portions of the site would be obtained from offsite sources.

The advantages of onsite stabilization include (1) minimized handling of tailings and contaminated materials and thus reduced operational radioactive exposures and emissions, (2) expedited stabilization of the site relative to offsite disposal alternatives, (3) lower costs, and (4) fewer direct impacts on traffic. Depending on whether Alternative B1a or B1b were to be selected, approximately one-half to two-thirds of the 86-ha (213-acre) mill site might be released for unrestricted use. The stabilized disposal areas would meet the radon-flux- and direct-gamma-radiation limits specified in the NRC Branch Position on uranium mill tailings management.[2] However, a major disadvantage with onsite stabilization is the continued presence of radioactive tailings near a population center (Edgemont). Also, continual monitoring and maintenance of the disposal areas might be necessary to offset the erosional effects of Cottonwood Creek and the Cheyenne River.

By utilizing one or more lined impoundments, placing thick earthen covers over them, and placing riprap on slopes and streambanks, onsite stabilization might be a technologically feasible alternative. However, because the licensee's preferred alternative of offsite disposal and stabilization (discussed below) would provide a much higher degree of certainty for sucessful long-term stabilization of the tailings and contaminated materials, without routine maintenance, the alternative of onsite stabilization was not explored any further.

Alternative B2: Offsite disposal of tailings and contaminated materials

Under this alternative, all tailings, contaminated soils and fill, and mill debris would be removed to a specially constructed disposal impoundment located off site. Uncontaminated fill and soil from offsite sources would be used in the reclamation of the mill site. The advantages of offsite disposal include the potential for both isolation of the tailings away from population centers and release of all of the 86-ha (213-acre) mill site for productive use. The offsite disposal impoundment would be designed to meet current NRC performance objectives for tailings management, specifically in the areas of maintenance-free, long-term stability and isolation of tailings, tailings-cover design, control of toxic element seepage, and protection from human intrusion. The disadvantages of offsite disposal include costs of site acquisition and preparation, effluents related to material handling, total costs, and increased short-term environmental and health impacts and risks related to the transport of wastes and fill materials required for reclamation.

Despite the potential short-term disadvantages and impacts, the staff feels that a properly designed offsite disposal plan will result in superior long-term stabilization without the need for ongoing monitoring and maintenance. Therefore, this alternative, preferred by the licensee, is endorsed by the staff.

2.2.3.3 Alternative tailings disposal sites

In a preliminary engineering evaluation conducted for the NRC,[3] in 1978, 16 potential disposal sites were identified and studied for suitability for long-term tailings disposal. A later engineering evaluation conducted for the licensee[4] considered nine additional sites, for a total of 25 potential sites within 29 km (18 miles) of the mill site. The locations of the sites are listed in Table 2.6. The criteria used in comparative site evaluations were the NRC performance objectives for disposal of uranium mill tailings, the potential disposal capacity of each site, and disposal costs. Of the 16 sites in the NRC-sponsored study, 12 were eliminated from further consideration because of inadequate site configuration (disposal volume), possibility of encroachment on the site, value of the site for other purposes, adverse surface hydrology (excessive upslope drainage), and scarcity of suitable earth for use as stabilization cover. A reevaluation, conducted for the licensee, similarly eliminated 15 of the 25 sites studied.

Table 2.6. Location of alternative tailings sites

Site number	Site location[a]	Distance from Edgemont mill site[b]	
		km	mile
1	Sect. 6, T9S, R3E	1.2	0.75
2	Sect. 8, T9S, R3E	3.2	2.0
3	Sect. 18, T9S, R3E	3.5	2.15
4	Sect. 3, T9S, R2E	5.5	3.4
5	Sect. 6, T9S, R2E	11.3	7.0
6	Sect. 14, T8S, R2E	8.5	5.3
7	Sect. 11, T7S, R1E	17.1	10.6
8[c]	Sect. 1, T7S, R1E	20.0	12.4
9	Sect. 2, T9S, R2E	4.8	2.95
10[b]	East side Rt. 52 near Provo	8.8	5.5
11	Sect. 20, T8S, R3E	8.3	5.15
12	Sect. 18, T8S, R3E	8.8	5.45
13	Sect. 23, T8S, R2E	6.8	4.25
14[b]	Igloo area	16.5	10.25
15	Sect. 20, T7S, R2E	15.3	9.5
16	Sect. 15, T7S, R1E	17.1	10.6
17	Sect. 14, T8S, R2E	~8.8	~5.5
18–25	T11S, R2E and T11S, R3E	Not given	

[a]Ford, Bacon & Davis Utah Inc., *Engineering Analysis of Mill Facility Decommissioning and Long-Term Tailings Stabilization at a Remote Disposal Site, Edgemont Site, Edgemont, South Dakota*, prepared for the Tennessee Valley Authority, Chattanooga, Tenn., January 1979, Appendix E, p. 2.

[b]Ford, Bacon & Davis Utah Inc., *Engineering Assessment of Inactive Uranium Mill Tailings, Edgemont Site, Edgemont, South Dakota*, prepared for the U.S. Nuclear Regulatory Commission, Contract No. E(05-1)-1658, May 1978, pp. 8–10.

[c]Open-pit mine area.

In the period since these studies were performed, the estimate of the total amount of wastes (including tailings) requiring disposal has been revised upward, by the licensee, to 7.1×10^6 MT (7.8×10^6 tons) from 2.3×10^6 MT (2.6×10^6 tons) (ER, rev. 1, Table 2.3-1). As a consequence, the licensee found it necessary to eliminate additional sites based on inadequate disposal volume capacity. The staff feels that less material will require disposal than is currently projected by the licensee. However, because final disposal requirements are difficult to establish, the staff recognizes that the site selected must have sufficient flexibility to allow successful isolation of all material which could reasonably be expected to be generated in the decommissioning activity, even though the estimates may prove conservatively high.

The licensee has selected two sites for detailed assessments including considerations of radiological impacts, waste transportation impacts, and costs. The staff has included two additional sites (alternatives C3 and C4) for discussion because of their potential amenability to use for complete below-grade disposal. These alternative sites are discussed below.

Alternative C1: Site 2, ephemeral drainage basin, Sects. 8 and 17, T9S, R3E (minor portions in Sects. 7, 18, T9S, R3E)

This site, the preferred alternative of the licensee, located about 3.2 km (2 miles) southeast of the city of Edgemont, consists of 104 ha (258 acres) of private, State, and Federal (Bureau of Land Management) lands currently used for grazing. The site is located primarily in Sects. 8 and 17, T9S, R3E (Fig. 2.1). The site lies east of county road 6N and south of county road 6E. No more than six or seven vehicles per day pass near the site.

The portion of the site suggested as a disposal location is at the head of a small ephemeral drainage basin; upstream drainage area is about 18.6 ha (46 acres). Surface water within the basin flows predominantly in direct response to precipitation. From this basin, drainage eventually flows eastward into the Cheyenne River. The configuration of the basin is a roughly triangular area open to the southeast. A drainage divide to the north and west separates the site from the Cottonwood Creek watershed.

Total land disturbance at the site would be about 68 ha (168 acres) and 36 ha (90 acres) used for soil- and overburden-stockpile areas. The site is bounded on the north and west by two ridges that could form the abutments of a containment dike. There are no structures on site; however, a small stock-watering pond covering about 0.04 ha (0.1 acre) is located near the southern boundary. Vegetation on the site consists mostly of grasses and sagebrush; there are no trees. The closest residence to the site is a ranch house about 2.4 km (1.5 miles) to the south. There is a barbed-wire fence next to the road along the west side of the site. No population growth that would infringe upon the site is projected for the area. The disposal site offers good conditions for revegetation. Soil cover at the site consists of about 0.15 to 0.6 m (6 in. to 2 ft) of residual fine-grained silts and sands with varying amounts of clays ranging from 15 to 30% by weight. A light brown, silty-clay (weathered shales) subsoil underlies the surface layer to a depth of 0.6 to 1.2 m (2 to 4 ft). A 1.5-m-thick (5-ft) third soil layer at the site consists of a brown, highly weathered upper zone of shale bedrock strata. The silty clay soils are defined as CL and CH soils by the Unified Soils Classification System.

Bedrock consists of the Greenhorn Formation and the underlying Belle Fourche and Mowry shales, all of which are of Cretaceous Age. The sediments are nearly flat lying with a gentle dip of between 1 and 5° to the south. No fractures (faults or joints) are reported at the site. Permeability of the fine-grained sediments at the site is low, especially in the zone at the soil-bedrock interface. Preliminary site investigations show that the nearest aquifer is at a depth of more than 152 m (500 ft) below the surface. A detailed discussion of the geology of the preferred disposal site (alternate C1) is presented in Sect. 3.7.1.3.

The licensee proposes to construct a partially below-grade impoundment at the site. Construction of a fully below-grade impoundment would require the considerable additional expense of excavating much more unweathered shale, and the additional protection provided would be minimal. The conceptual details of the impoundment design and disposal operations are discussed in Sects. 2.2.2.1 and 2.2.2.8. Excavations at the site would provide sufficient fill material for construction of the impoundment dike and final tailings cover as well as provide some fill for use in mill-site reclamation. If necessary, some clay materials for the impoundment liner (if required) and cap may be obtained off site.

A major advantage of this site is the favorable topography. The ridges that form the northern and western borders of the site will provide excellent protection against wind erosion because the predominant winds are from the northwest. The gentleness and configuration of the topography provide a sufficiently large impoundment area so that the containment dike can be relatively low in height [17 m (55 ft)]. The site is more than 46 m (150 ft) higher than the probable maximum flood on the Cheyenne River. The drainage area of the site is small enough that runoff across the site should not pose serious long-term erosion or stability problems.

The site is underlain by generally fine-grained soils and a thick sequence of shale bedrock with permeabilities in the approximate range of 1×10^{-4} to 1×10^{-7} cm/s (100 to 0.1 ft/year). This sequence of relatively low-permeability geologic materials should help to protect local groundwater supplies from long-term seepage from the impoundment. However, the staff recommends that the licensee establish procedures for defining foundation permeabilities and acceptable impoundment excavation depths to ensure that the permeability of the entire impoundment foundation area is less than about 1×10^{-7} cm/s (0.1 ft/year). If the foundation or parts of the foundation do not meet this permeability criterion, then a clay liner will be used to ensure that contaminated waters from the tailings do not seep into the groundwater system.

Private haul roads can be constructed between the mill and the disposal site so that contaminated materials will not be transported through populated areas, thereby minimizing the potential for accidents and public exposure to the contaminated materials and eliminating disruption of normal traffic on public roads. Transportation costs are relatively low because of the short haulage distance and associated lower fuel consumption. The site location also makes slurry pipeline transport of sand tailings a feasible alternative — an important part of the proposed course of action, which could further reduce environmental and health risks due to tailings transport operations and significantly reduce transportation impacts.

Because all mill-site cleanup, waste hauling, and disposal operations will occur downwind (from the prevailing wind direction) from Edgemont, the impacts of fugitive dust will be minimized. In addition, the licensee states that sufficient materials are available for dike construction and cap, cover, and plant growth media.

The disadvantage is that the 34 ha (86 acres) occupied by the disposal impoundment will be withdrawn from unrestricted use. However, after the successful completion of site reclamation, livestock grazing, as well as wildlife use, may be permissible.

The site is preferred by the licensee and considered acceptable by the staff.

Alternative C2: Site 7, ephemeral drainage basin, Sects. 11 and 14, T7S, R1E

This site is located 17.1 km (10.6 miles) northwest of the Edgemont mill, about 1.2 km (0.75 mile) northeast of the location where the county township road (commonly called road 10) from Edgemont crosses north over the Burlington-Northern tracks south of the old Burdock station. The site, which is in the general vicinity of the area that the licensee has considered for the development of an underground mine and the construction of a uranium mill, is on privately owned land whose mineral rights have been leased by the licensee. Because it is used for grazing, the land has a sparse ground cover of grasses and sage but no trees or bushes. The site is at the head of a drainage basin from which drainage flows south, then eventually west into the Cheyenne River. Two hills form the western boundary of the site and a small ridge forms the northeastern boundary of the site. The use of the site for a tailings disposal area would require at least 28 ha (70 acres) and would necessitate the construction of at least three dikes: two dikes would be required to fill the depression between the hills on the western boundary, and one dike would be required to contain the waste at the lower end of the site. These dikes would probably range in height from about 6 to 18 m (20 to 60 ft). There are no structures on the site except several abandoned wells and the wooden remains of a pump system for an old shallow-water well. It would be required to fill these wells with impervious materials before waste impoundment. The closest residence to the site is a ranch house approximately 3.1 km (2 miles) directly south of the site. A small stock pond, about 0.07 ha (0.17 acre) in size, is at the extreme low elevation of the site and in the drainage pattern beginning at the head of the site. Access to the site from the county road is over an unimproved dirt road now being used by uranium exploration crews.

Soils at this site consist of about 0.6 m (2 ft) of a medium brown clayey silt topsoil. The topsoil contains 90% silt-clay and approximately 10% fine sand. Immediately underlying the topsoil to a depth of about 2.6 m (8.5 ft) is a light brown sandy silt containing 75% silt-clay and 25% fine sand. The soils are underlain by a fine-grained gray shale decomposed at the surface to about 0.15 m (about 6 in.). The shale, very friable and dry, contains thin seams of fine sand.

Bedrock at the site is Cretaceous Age, and the Skull Creek shale exposed at the surface is underlain by the Fall River sandstone and the Lakota Formation. The Skull Creek shale is approximately 58 m (190 ft) thick at the site and contains minute partings along bedding planes and a low density of fractures normal to bedding planes.[4] No major fractures (faults or joint sets) are reported within the site. Some sandstone dikes have been located in nearby valleys but have not been traced through the site. The extent and permeability of sandstone dikes, if they occur at the site, will have to be determined. The permeability of sandstone dikes is likely to be much higher than that of the surrounding shales. Permeabilities are expected to be low in the soils and weathered-shale zones of the site. The shales could have fairly high permeabilities along horizontal partings, but vertical flow is likely to be low. Flow velocities are expected to be low except where the shales are highly disturbed.

Should this alternative site be selected, the licensee would propose to build an above-grade impoundment. The design concepts discussed in Sects. 2.2.2.1 and 2.2.2.8 would be adapted to the conditions at the site. Excavations at the site should provide sufficient fill material for construction of the dikes and final tailings cover. If necessary, clay materials for the impoundment liner and cap would be obtained off site.

One of the advantages of this site is the limited upslope drainage area and relatively gentle slopes at the site that would minimize the potential for long-term stability problems associated with flooding and water erosion. The construction of a clay liner over the relatively low-permeability soils and shales underlying the site should protect underlying aquifers from long-term seepage from the impoundment. In addition, the site is remote from the Edgemont population center, and the reclaimed site would be allowed to return to a natural state for wildlife use.

A disadvantage of this site is that the impoundment would require dikes at both the head and the lower ends to generate sufficient storage volume. Because diking would be necessary at the head or western end of the impoundment, that dike and the tailings cover would be somewhat exposed to the erosional action of the prevailing winds, which would not be the case for an impoundment situated entirely below the ridge line bordering the basin. More significant negative impacts would however be associated with the transportation of contaminated materials from the mill site to the disposal site, although these would be of a short-term nature. Removal of the estimated 7.1×10^6 MT (7.8×10^6 tons) of contaminated wastes would require about 370,000 trips using 19-MT (21-ton) dump trucks (slurry transport would be unfeasible primarily because of the distance involved). This extensive transportation impact on public roads and through the town of Edgemont would greatly increase the potential for traffic accidents and radiological exposure to people. Accidents could also cause contamination of local drainages. Other transportation impacts include a slowdown of local traffic and significantly increased fuel consumption and transportation costs. The use of alternative impoundment designs is discussed in Sect. 2.2.3.4.

Primarily because of the significant negative transportation impacts associated with this site, particularly the increased accident potential and increased potential for radiological exposure due to transportation through a population center (Edgemont), the staff concludes that this site is less favorable than the licensee's preferred site (alternative C1).

Alternative C3: Site 8, abandoned mine pits, Sect. 1, T7S, R1E

This site, located 20 km (12.4 miles) northwest of Edgemont, is bounded on the north by the line separating Fall River County from Custer County and on the north and east by the Harney National Forest. This location was the source of much of the uranium ore fed to the Edgemont mill and has large open-pit mines. Of the three large open-pit mines in the vicinity, either Darrow pits 1 and 3 or pit 5 could be used as a disposal location. The pits vary in depth up to 23 m (75 ft) and are ringed by piles of the overburden removed to mine the ore. Only sparse vegetation exists in the pits or on side slopes, and water erosion has created many gullies on the side slopes. No structures are on the site, and the closest residence is a ranch house about 2.9 km (1.8 miles) west of the site. The elevation at the bottom of the pits is about 1170 m (3840 ft) above mean sea level. Access into the bottoms of the pits could be developed by regrading the former ore-hauling routes. Clay for the cap and probable liner and soil for revegetation would have to be obtained off site.

The bedrock at the site of the two abandoned open pits consists of sedimentary formations of lower Cretaceous Age. Field observations, reference research, and information provided by the applicant indicate that the formations at the site are, in descending order, the Skull Creek shale, Fall River sandstone, and the Fuson shales of the Lakota Formation. The sediments are primarily interbedded shales of black to light gray, sandstone, and limestones. Bedding is near horizontal and has a projected strike of north-northwest and a dip angle less than 5° to the south.

Fractures at right angles to the bedding planes were sparse and scattered. Partings within the shale layers along foliation planes were common. No major faults were reported within the immediate pit areas.

Erosion of the pit walls was moderate to high, especially where the softer shale sediments were exposed. The pit bottoms were partially filled with erosional wash and debris from scaling and slough. Water runoff from a recent (1978) storm ponded in the lower elevations of the pit bottoms. No groundwater seeps or major flow zones were evident, although some of the sandstone layers contained iron precipitate deposits indicating past groundwater flow.

Relative permeability of the individual formations with respect to outward migration of seepage from the pits was not determined. However, seepage could occur within the sandstones and highly fissile shales or along bedding planes. Therefore, the licensee assumed that a clay liner would have to be constructed in the bottom of the pit and be continued up the sides as disposal operations proceeded.

A definite advantage to the use of the pit is that it would not result in the withdrawal of any additional land for unrestricted use and, in fact, would result in the reclamation of the pit area for limited use such as grazing. Other advantages of the pit site include isolation from populated areas, no maintenance, and a smaller disposal area. Another advantage of the pit site is that much of the wastes could be stored below grade, thereby minimizing the potential for long-term stability problems associated with wind and water erosion. However, the licensee has stated that the volume of the pits is not large enough to contain all of the estimated tailings and contaminated materials.

A disadvantage of this site is the possibility of long-term seepage and spread of contaminants resulting from placement of the contaminants next to permeable geologic formations near the water table. Appropriately designed clay liners could however alleviate this concern to an acceptable degree. Another disadvantage would be the elimination of further mining in the pits. The licensee is considering constructing adits in the pit walls to recover low-grade uranium deposits. Transportation impacts associated with this site are, however, the significant disadvantage and are similar to those discussed in Alternative C2. Major transportation impacts include increase in the potential for traffic accidents and radiological exposure to people because of the necessity for hauling wastes through the town of Edgemont and over a significantly greater distance of roads (primarily public) than for site C2.

Primarily because of the significant negative transportation impacts associated with this site, particularly the transportation of large volumes of contaminated materials through a population center and the probability that the pits do not have sufficient capacity to contain the estimated volumes of contaminated materials, the staff concludes that this site is less favorable than the preferred site (Alternative C1).

Alternative C4: Site 3, ephemeral drainage basin, Sect. 18, T9S, R3E

The site is located about 3.6 km (2.25 miles) southeast of the city of Edgemont in Sect. 18, T9S, R3E. The site lies west of county road 6N and immediately to the southwest of alternative site C1.

The site is at the head of a small ephemeral drainage basin and is about 20.2 ha (50 acres) in area. Surface water within the basin flows predominantly in direct response to precipitation. From this basin, drainage flows generally eastward into the Cheyenne River. The site is bounded on the west and southwest by steep cliffs marking the beginning of the adjacent mesa, on the north by a drainage divide that separates the site from the Cottonwood Creek watershed, on the east by a ridge that separates the site from alternative site C1, and is open to the southeast.

The closest residence is a small ranch house about 2 km (1.25 miles) southeast of the site. No population growth that would infringe upon the site is projected for the area.

Soils at the site consist of shallow to moderately deep, well-drained, silty clay loams. Unweathered shale is encountered at depths less than about 100 cm (40 in.). The site is underlain by about 76 m (250 ft) of the lower unit of the Greenhorn Formation, which generally consists of dark gray noncalcareous shale interbedded with thin layers of limestone and clay, as described in Sect. 3.7.1.3. An inactive fault may extend across the western end of the disposal site.

The site is drained by an unnamed ephemeral tributary of the Cheyenne River. The tributary flows into a pond near the western edge of the river's floodplain. An existing small stock pond, about 0.1 ha (0.25 acre), is located near the eastern limits of the site, and a second small pond of similar size is located downstream about halfway to the Cheyenne River. Elevations at the site range from about 1164 m (3820 ft) on the northern watershed divide to 1119 m (3670 ft) below the pond. The drainage area for the site is about 16 ha (40 acres), and annual runoff from the watershed above the site is very low, on the order of 0.51 cm (0.21 in.). The maximum probable flood for the site was estimated to be about 59.5 m^3/s (2100 cfs). Flood peak discharges are generally the result of heavy local thunderstorms.

Groundwater conditions at the site have not been investigated. However, perched water tables may be present near the soil bedrock interface, and potentiometric levels and gradients in the deep aquifers below the site are expected to follow regional trends.

The advantages of this site include isolation from population centers, negligible evidence of flooding, and natural wind protection afforded by the ridges bordering the site. In addition, these ridges would provide natural abutments for the impoundment dike.

One disadvantage of this site is the moderate to high erosion potential due to the relatively steep limestone and shale slopes forming the western and northern borders of the site. Another disadvantage is that because of the relatively small impoundment site area, the impoundment dike would have to be significantly higher than at other sites to contain all of the wastes. In addition, the inferred fault on the east side of the site may pose long-term seepage control or stability problems.

Because of the similarity between this alternative and the preferred alternative (C1) in terms of location and disposal site development, the cost for the impoundment, material transportation, and mill site decommissioning is assumed to be essentially equivalent to that for alternative C1.

Because of the disadvantages described above, the staff concludes that this site is less favorable than the preferred disposal site (alternative site C1).

2.2.3.4 Alternative disposal impoundment designs

Successful long-term isolation of tailings at any site depends on whether the impoundment withstands disruptive influences of water and wind erosion, differential settlement of the tailings and cover material, and natural disasters such as floods and earthquakes. A wide variety of tailings disposal concepts have been examined by the NRC staff for their suitability in long-term management of tailings.[5] Of these, the alternatives for decommissioning the Edgemont mill include above-grade disposal, partially below-grade disposal, below-grade disposal in a mined-out pit, and below-grade disposal in a specially excavated pit.

Alternative D1: Above-grade disposal

This type of impoundment has been widely used in the past. The existing tailings ponds and piles at the mill site are prime examples of simple above-grade impoundments. The terrain of the disposal site determines the configuration of the embankment enclosing the impoundment. Examples include dams across a natural basin and earthen berms constructed on the four sides of an impoundment situated on flat terrain. Diversion ditches, riprap, and similar flood protection measures may be necessary during both waste emplacement and long-term storage periods. The deposited tailings would be stabilized by the placement of a 0.9-m (3-ft) clay cap and additional overburden and soil to increase the cover thickness to 3 m (10 ft). Appropriate grasses, forbes, and shrubs would be planted on the surface to establish sufficient vegetative cover to limit erosion. However, in this case, the steepness of the embankments and the elevation of the impoundment area above the surrounding topography tend to maximize the exposure of the impoundment to the disruptive effects of erosion and natural disasters. Therefore, this type of impoundment may require long-term active care such as maintenance of diversion ditches and repair of erosional damage. The staff finds this alternative unacceptable because extended maintenance and strict land-use controls may be necessary to ensure impoundment integrity. For these reasons, stabilization of tailings in existing impoundments on the mill site (alternative B1) was rejected. In addition, use of this design at the other alternative disposal sites is not considered by the staff to be an acceptable option for similar reasons.

Alternative D2: Site selective/engineered partially below-grade disposal with special design and site features

Although tailings would be deposited partially above grade, judicious selection of the disposal site and careful impoundment design for long-term stability may make this alternative roughly comparable to below-grade disposal concepts (alternatives D3 and D4) in terms of protection against wind and water erosion. The following are general features for this type of impoundment as set forth by the NRC staff.[5]

1. A site is chosen where the upstream drainage area is very small. This would mean, for example, that the impoundment would be near the top of a divide.
2. Site topographic features provide natural shelter of the tailings impoundment area from wind; that is, the face of the impoundment embankment is not exposed directly to prevailing winds.
3. Final reclamation is carried out in such a manner that embankments are contoured to make very gradual slopes.
4. Tailings are covered with reasonably thick soil and overburden materials. The overburden is stabilized with vegetation or rock riprap and cobbles as appropriate to retard any wind and water erosion.
5. The impoundment dike is constructed according to accepted geotechnical engineering standard practices to ensure long-term stability (principles outlined in Regulatory Guide 3.11 are followed).
6. The tailings disposal area is not sited near a geologic fault.
7. Design features combine to cause deposition of sediment on the tailings area from runoff that may cross the impoundment area.

Positive topographical features (minimal upstream drainage, shelter from wind, sediment deposition patterns), establishment of vegetation, and the use of riprap to armor slopes are very important to the effectiveness of this alternative. Therefore, these features must be carefully considered in the site selection, and the impoundment design would seek to exploit them as much as possible.

The proposed disposal site and impoundment design (Sect. 2.2.2.1) display all of these recommended features except those listed in the Item 7. Because of the limited drainage area above the impoundment and limited runoff into the impoundment area, it is not expected that a significant amount of sediment could be accumulated on the impoundment area over the long term. Therefore, rather than creating a depositional condition on top of the impoundment, the staff concluded that it would be more beneficial to grade its surface to effect positive drainage away from the center. The stabilization cover would consist of 0.9 m (3 ft) of clay; added overburden and soil will make the cover 3 m (10 ft) thick. Seepage control and other stabilization features applicable to this alternative are discussed in Sect. 2.2.3.5.

The main advantage of this alternative is the potential for secure long-term isolation comparable to that obtainable with below-grade disposal but at a lower cost. Additionally, this technique of partially below-grade disposal may avoid the problems of tailings emplacement near or under the groundwater table where the occurrence of a shallow aquifer would affect the feasibility of below-grade disposal. The disadvantages associated with site selective/engineered partially below-grade disposal with such special siting and design features include the risk of accidental release of tailings because of embankment failure, potential long-term failure of the impoundment resulting from unforeseen changes in natural conditions (such as climate), and necessary passive monitoring and land-use controls to prevent encroachment on the site and disruption by human activities.

Because partially below-grade disposal with special design features can be designed and constructed to provide reasonable assurances of long-term stability against natural forces, similar to below-grade disposal in a mined-out open pit, the staff concludes that this impoundment design would be an acceptable long-term tailings management alternative for the Edgemont site. In the absence of acceptable mined-out open pits in the Edgemont area, site selective/engineered partially below-grade disposal with special design features is the impoundment design preferred by the staff.

Alternative D3: Below-grade disposal in a mined-out open pit

Placement of the tailings, other contaminated materials, and the impoundment cover below the natural-grade elevation will generally isolate the impoundment from natural disruption by surface water and wind. Impoundments adapted from inactive or abandoned mine pits would not require the construction of confining embankments or dams. Such embankments are the principal points of attack for erosive forces and the most likely failure points. The absence of such above-grade structures would therefore render the below-grade impoundment at least as stable as the surrounding natural terrain. This stability is the main advantage of below-grade storage. The possibility of disposal of contaminated materials in open-pit mines in the area is discussed in alternative C3. While such below-grade burial is preferred by the staff, the location, size, and geohydrologic conditions at the open-pit mines in the Edgemont area negatively impact the feasibility of such a technique in several important ways. In order to transport wastes to these mines, contaminated materials would have to be trucked through a population center, thereby increasing the potential for accidents, spillage of contaminated materials, and radiological exposures to people. Whether sufficient storage volume exists in the mine pits for the estimated total quantity of wastes is questionable. In addition, because potentially permeable geologic formations are exposed in the pit walls and because the exact level of the water table at the site is at present undefined, a potential may exist for seepage of contaminated liquids into the groundwater system. Installation of a clay liner on the pit bottom and sides would probably be required before pit disposal would be acceptable. Therefore, this alternative disposal design is not considered superior to alternative D2 for the Edgemont decommissioning plan.

Alternative D4: Below-grade disposal in a specially excavated pit

In this alternative, disposal area excavation would ensure that the tailings, other contaminated materials, and the impoundment cover lie below the natural-grade elevation. Therefore, no impoundment embankment would be necessary. This type of impoundment could be constructed at or in the immediate vicinity of the surface impoundment sites considered by the licensee (alternatives C1 and C2). The impoundment configuration would be adjusted to avoid highly sloping terrain and drainage courses. If the shale bedrock alone could not provide adequate seepage protection, a clay liner might be installed in the bottom and on the sides. The advantage of this alternative is the below-grade placement of wastes and cover materials. The major disadvantage of this alternative is the additional costs associated with the excavation of the pit. With an assumed 3.6×10^6 m^3 (4.7×10^6 yd^3) of wastes (ER, Table 2.3-1) and a cost of \$0.92 to \$1.30/m^3 (\$0.70 to \$1.00/yd^3) of material, the construction of a special pit at alternative site C1 would add \$4.3 million to \$6.1 million to the cost of the decommissioning. Because a comparable degree of impoundment stability may be obtained with a specially designed partially below-grade impoundment at the same site (as in alternative D2), the added expense of pit construction is not considered justified.

2.2.3.5 Alternative seepage control measures

Alternative E1: Clay liners

If natural hydrogeological conditions of the impoundment base are such that permeabilities greater than about 10^{-7} cm/s are encountered, it would be necessary to emplace clay over portions of or over the entire bottom of the impoundment excavation to inhibit seepage of fluids from the tailings. In that event, the licensee should provide a liner design and material and compaction specifications to ensure that permeabilities of about 1×10^{-7} cm/s (0.1 ft/year) can be obtained for the clay liner. Properties of the clay should be compatible with impoundment fluids to ensure against cracking of the liner or chemical breakdown of the clay minerals.

The installation of clay liners is the seepage control measure preferred by the staff. However, alternative E2 could be employed, provided it can be demonstrated that permeabilities of natural materials exposed in the excavation are uniformly about 1×10^{-7} cm/s (0.1 ft/year). If a liner is needed, detailed plans shall be submitted to NRC prior to installation.

Alternative E2: Excavate impoundment bottom into relatively impermeable soils or bedrock

Under this alternative, the impoundment would be excavated into site soils and/or bedrock to a depth where the permeability has been determined to be about 1×10^{-7} cm/s (0.1 ft/year). Provided the expected maximum groundwater elevation in the area does not intersect the excavation, this alternative would provide reasonable assurances that local groundwater systems would not be contaminated by fluids seeping downward from the tailings. This cannot be determined until the licensee establishes the depth of excavation required for the impoundment.

The major advantage of this alternative is a relatively low cost especially where excavated materials are needed for other uses such as dike, cap, or cover construction. A disadvantage is that soil and bedrock conditions can vary significantly over short distances, and permeabilities measured at one point in the impoundment excavation may not be representative of permeabilities of other points in the excavation. In additi[illegible] vertical joints or fractures in soil and rock may go undetected in boring investigations, yet may provide significant pathways for migration of contaminated fluids away from the impoundment.

Therefore, the staff has concluded that this alternative should be used only where it can be demonstrated with a sufficient number of permeability tests and detailed field mapping of the excavation bottom that permeabilities across the entire bottom and sidewalls of the impoundment excavation are uniformly about 1×10^{-7} cm/s (0.1 ft/year). Otherwise a clay liner would have to be installed (alternative E1).

Alternative E3: Dewatering of tailings in place

Under this alternative, the amount of moisture available to carry toxic contaminants away from the impoundments would be minimized by allowing the fluids in contaminated materials deposited in the impoundment area to form a pond in front of the sand tailings as they are emplaced. These fluids would be allowed to evaporate or would be decanted to a suitable evaporation pond. The staff recommends that measures be employed by the licensee to minimize the amount of fluids contained in the impounded materials before construction of the clay cap and cover.

The design and installation at the base of the impoundment of an underdrain system capable of dewatering the tailings to a greater degree would represent one such method of minimizing the amount of moisture available to allow migration of contaminants from the impoundment to the surrounding environment.

Alternative E4: Solidification of tailings and wastes with cement, asphalt, or other chemical fixants

Various solidifying agents have been suggested for incorporation into tailings so that the resulting solid form would have the desirable characteristics of low leachability and high resistance to the diffusion of radon.[5] The use of such agents on the Edgemont mill tailings would require the reslurrying and probably the neutralization of the tailings.

A common solidifying agent is asphalt, which, if it can be incorporated as an impervious coating on the tailings particles, would retard the diffusion and release of radon to the environment and would effectively prevent the leaching of water-soluble toxicants. A facility for heating and mixing the asphalt with the tailings would be required for implementation of this alternative. About 330 kg (670 lb) of asphalt per metric ton of tailings would be required to produce a suitable mix.[6]

After the selected pretreatments, the tailings could also be mixed with cement to produce, upon setting, a type of low-grade concrete. Properly designed, the same facility could handle the steps of required neutralization and concretion. One part of cement for 20 parts tailings is the estimated minimum. However, a ratio of 1:5 has been shown to yield better strength and leach resistance though at a higher cost.[6]

Commercially available chemical fixants could also be used to solidify the tailings. If this waste stabilization method were implemented, the chemicals would be blended into the tailings slurry and the resulting mixture pumped to an impoundment where solidification would occur within a few days to a few weeks. Either the waste material would be entirely entrapped or the pollutants (primarily heavy metals) would be chemically bound as insoluble complexes.

Although technically feasible and environmentally desirable, solidification of tailings and wastes would be extremely expensive. Assuming a nominal cost of $10.00/MT of tailings (commonly quoted costs range from $7.00 to $36.00/MT of treated wastes),[7] the staff estimates that chemically fixing only the tailings would cost $23 million. Treating the slimes with asphalt or cement would cost between $3.1 million and $4 million. These estimates do not include the additional costs in special-material handling and processing. More significantly, the solidified waste would still have to be disposed of in a tailings impoundment because long-term stability after solidification using these techniques has not yet been demonstrated. In the opinion of the staff, potential environmental advantages do not justify the extra economic costs.

2.2.3.6 Waste transportation alternatives

Alternative F1: Conventional highway trucks

In this option, conventional tractor-trailer and end-dump trucks of 33 MT (36 tons) gross weight would haul wastes over existing public roads. To prevent dusting problems and contamination of public roadways with finely divided tailings and dry soil materials, the trucks would be equipped with heavy rubber covers, and washdown facilities would be provided. With an assumed payload of 19 MT (21 tons), trucks would make 370,000 trips hauling wastes from the Edgemont mill site. This number of trips on the public roads serving any of the disposal sites would cause considerable congestion (especially at the crossing of U.S. 18 and at the railroad tracks), present significantly increased risk of traffic accidents, and increase the costs of road maintenance. For disposal sites C2 and C3, nearly 10 million truck miles would be required. About 2 million truck miles would be required for site C1. The staff does not consider this a desirable option, and it should therefore be implemented only if ultimately unavoidable.

Alternative F2: Off-road trucks

In this option, wastes would be hauled in off-road trucks of 45-MT (50-ton) or 68-MT (75-ton) capacity. A private haul road would be constructed between the mill site and the disposal area. Dust from hauling operations would be controlled by chemical sealants and water sprays applied to the road. Any spilled contamination on the road surfaces would be removed to the disposal area. Depending upon the size of trucks used, about 105,000 trips would be required. From cost and accessibility standpoints, alternative site C1 is the only disposal site for which this alternative is feasible. Application of off-road trucks at this site would not significantly impact the general public.

Alternative F3: Slurry pipeline

In this option, the sand tailings and some of the contaminated soils would be slurried with water and pumped to the disposal area in a slurry pipeline. Excess water would be decanted from the settled wastes and recycled to the mill site. Wastes not suitable for slurry transport (such as slimes) would be removed to the disposal area by conventional or off-road trucks. Total atmospheric emissions from the decommissioning project would be greatly reduced because of wet handling and deposition of wastes and decreased fossil fuel consumption related to haul-truck operations. As advantages of this system, the licensee cites these environmental benefits, along with lower costs similar to those of off-road truck haulage. However, there are no cost advantages for the distant alternative sites C2 and C3 because of the increased costs related to right-of-way acquisition, river and stream crossings, and greater distances involved. In addition, a much greater length of pipeline would have to be monitored and maintained to ensure avoidance of potential spills of contaminated materials in the event of pipeline failure or defects. The slurry pipeline is thus considered by the staff to be clearly desirable only for use in connection with site C1.

Alternative F4: Conveyor systems

Conveyor systems would offer environmental benefits similar to those of slurry pipeline transport. However, increased construction costs and operational inflexibility make this alternative less desirable.

Alternative F5: Railroad systems

Railroad transport of wastes could be possible for alternative sites C2 and C3 because of their location near the existing Burlington-Northern tracks at Burdock. This option would probably require the construction of a spur line and waste-handling facilities near the disposal sites and the acquisition of 91-MT (100-ton) hopper cars for transport of the wastes. Trucks or conveyors would be used to move the wastes from the handling facility to the disposal area. The required multiple handling of the wastes would increase the potential for radioactive and particulate emissions. Even though the use of the rail line would reduce the traffic impact of the C2 and C3 alternative sites, the costs of this alternative would be prohibitive.

2.2.3.7 Summary of evaluation of proposed tailings management plan

Tailings management performance objectives

The proposed tailings management plan has been evaluated against the following performance objectives developed by the NRC staff to ensure that uranium mill tailings are properly managed and controlled to minimize the potential hazard to public health.

1. Siting and design period:

   - Locate the tailings impoundment area remote from people so that population exposures will be reduced to the maximum extent reasonably achievable.

   - Locate the tailings disposal area so that disruption and dispersion by natural forces is eliminated or reduced to the maximum extent reasonably achievable.

   - Design the isolation area so that seepage of toxic materials into the groundwater system will be eliminated or reduced to the maximum extent reasonably achievable.

2. Decommissioning operations and drying period:

   - Eliminate the blowing of tailings to unrestricted areas during normal operating conditions (including a program of chemical spraying and wetting of tailings surfaces).

3. Postreclamation period:

   - Reduce direct gamma radiation from the impoundment area to essentially background levels.

   - Reduce the radon emanation rate from the impoundment area to about twice natural background.

   - Eliminate the need for an ongoing monitoring and maintenance program following reclamation.

Comparison of proposal with performance objectives

Siting and design to ensure remoteness from people. The proposed disposal site (alternative C1) is located about 3.2 km (2 miles) southeast of the city of Edgemont, which is the nearest population center (current population approximately 1800), and about 2.4 km (1.5 miles) north of the nearest residence. Based on the generally favorable site conditions (including natural wind and water erosion protection, depth to major groundwater aquifers, distance from major surface water bodies, low seismicity, etc.), the adequacy of the impoundment system design (embankment stability, cap cover materials, seepage and erosion control, etc.), and the overall ability of the impoundment system to contain the tailings and other contaminated material at the site, the staff considers this site and proposed impoundment design to ensure adequate remoteness from people.

Siting and design to minimize disruption and dispersion by natural forces. Potential interruptions and dispersions from wind erosion, flooding and water erosion, embankment stability, earthquakes, and root and animal penetration would be minimized both by the proposed impoundment design and the natural characteristics of site C1.

1. Wind erosion protection. The proposed disposal site is in a natural basin at the head of an ephemeral drainage. The ridges that form the northern and western borders of the site will shelter the impoundment area from the prevailing winds (generally from the northwest) and should greatly reduce the potential for long-term wind erosion. The impounded materials will be covered with a minimum of 3 m (10 ft) of soil consisting of a 1-m-thick (3-ft) clay cap covered by at least 2 m (7 ft) of unclassified fill. The impoundment surface will be graded and revegetated. Embankment slopes will be covered with a suitable thickness of riprap and appropriate filter material. The natural protection from prevailing winds afforded by the ridges bordering the site, the thick cover of fill materials on the relatively flat impoundment surfaces, and the riprap cover on the embankment slopes should provide adequate long-term wind protection for the proposed tailings impoundment system.

2. Flooding and water erosion protection. The site is at an elevation that is more than 46 m (150 ft) higher than the probable maximum flood on the Cheyenne River; therefore any potential for water erosion at the site from flooding of the Cheyenne River is eliminated. The drainage area upstream from the disposal area is only about 18.6 ha (46 acres). For this reason, the potential for severe water erosion and/or failure of the tailings impoundment system by flooding is considered to be low. A natural drainage divide will prevent water from entering the impoundment area from the northeast. Grading of the impoundment surface to a gently sloping crown will eliminate areas of surface runoff concentration, remove runoff from the site, and provide significant protection against water sheet and gully erosion. Additional water erosion protection will be afforded by the 3-m (10-ft) thickness of cover material and revegetation of the impoundment area. Adequate water erosion protection of the downstream face of the impoundment dike should be afforded by its relatively gentle slope (5:1) and by the riprap cover and suitable filter materials.

The staff recommends that detailed engineering design studies be performed and that final design plans, cross sections, and material specifications for the operational isolation courses and diversion systems, riprap, and suitable filter materials be submitted for review to ensure protection of the impoundment against water erosion. In addition, the licensee should provide, through design, assurances that any water that might exit from the gravel drain near the toe of the impoundment dike during disposal operations will be properly collected to prevent erosion of the toe of the dike.

3. Embankment stability. Boring logs supplied by the licensee indicate that silty clay and bentonite seams ranging in thickness from 0.65 to 15.5 cm (0.25 to 6 in.) occur in the shale underlying the disposal site. At the boring locations, the seams ranged in depth from about 3 m (10 ft) to 14 m (45 ft) below the present ground surface. The shale beds in general, and particularly the bentonite beds, may constitute planes of weakness in the impoundment dike foundation and natural dike abutments that could lead to failure of the dike or natural dike abutments during impoundment excavation or after loading with disposal materials. Therefore, the staff recommends that the final design of the impoundment dike and excavation take into account the location, orientation, and continuity of the bentonite and silty clay seams. The shear strengths of these clay seams and other foundation and construction materials should be determined to permit analysis of the long-term stability of the impoundment system. Final impoundment dike design plans should include material specifications, compaction criteria, and field compaction procedures to ensure the long-term stability of the embankment.

The proposed 5:1 slope for the downstream face of the impoundment dike should provide adequate protection against slope failure of the dike. However, the final slope of the downstream face should be determined by detailed engineering design studies that properly consider the foundation conditions below the dike, as discussed in the previous paragraph, and the engineering properties and shear-strength characteristics of the materials that are used in the construction of the dike. In no case should the slope of the downstream face of the dike be steeper than 5:1. Any suitable excavated material in excess of that needed for the proposed impoundment system could be used to flatten that slope and afford additional protection against possible slope failure and erosion. The downstream face will be further protected against erosion by the use of a suitable filter material overlain by riprap as discussed in the previous section.

The licensee should provide specifications for the gravel drain material within the impoundment dike to ensure that a suitable filter is established between the drain system and the unclassified dike fill to minimize the potential for piping failure of the embankment. Similarly, a suitable filter should be established between the impermeable upstream slope liner and the unclassified fill to prevent piping failure in the event cracks develop in the upstream liner.

Excessive differential settlement in the impoundment dike could cause cracking of the clay liner and/or clay cap. Such cracking could lead to erosion or piping failures of the impoundment system. Therefore, the licensee should address the potential for differential settlement within the dike considering unclassified fill and foundation compressibility and compensate for it by appropriate design features.

4. Earthquakes. Previous experience has shown that properly engineered embankments (similar to the proposed impoundment dike), which are constructed of clayey materials that are properly emplaced and compacted, can withstand severe earthquakes with no significant damage. On the basis of the low historical seismicity of the region, the absence of capable faults at the proposed site, and the proposed impoundment design, it is highly likely that the proposed disposal site and impoundment system should be able to withstand long-term seismic events without affecting the long-term stability of the impoundment. However, the licensee should confirm the long-term seismic stability of the impoundment system using procedures described in Regulatory Guide 3.11. In addition, the licensee should submit for evaluation information documenting the capability of the fault located at alternate site C4 immediately southwest of the preferred disposal site.

5. Root and animal penetration. The thickness of the clay cap and cover materials [total about 3 m (10 ft)] should minimize the possibility of penetration of the cap and cover materials by plant roots and burrowing animals.

Siting and design to eliminate/minimize seepage. Recent geologic information (Sect. 3.7.1.2) indicates that the impoundment system will be separated from major underlying confined aquifers by about 170 m (560 ft) of relatively impermeable shales. Therefore, the possibility of contamination of the major aquifers by seepage through the impoundment and underlying geologic material (shales) is considered to be remote. However, because a major performance objective is to eliminate or minimize seepage from the impoundment system, the potential for seepage from the impoundment was evaluated.

The proposed disposal plan requires excavation of the impoundment site into surficial soils and shales. While the exact depth of excavation has not been established in the licensee's preliminary design plans, it is likely that the impoundment will be excavated into soils and shales with permeabilities ranging from about 1×10^{-4} cm/s to about 1×10^{-7} cm/s (100 ft/year to 0.1 ft/year) or lower. If, as is the current case, the licensee has not and cannot adequately demonstrate that the permeability of the materials in the bottom and sides of the proposed impoundment excavation will be uniformly about 1×10^{-7} cm/s (0.1 ft/year) across the entire site, the staff will require that a clay liner be installed along the bottom and sides of the excavation. The installation of a clay liner that is about 1 m (3 ft) thick across the entire excavation or in any areas where it was not demonstrated that the permeability of natural materials was about 1×10^{-7} cm/s (0.1 ft/year) would ensure that seepage of toxic materials from the impoundment system will be minimized or virtually eliminated and will prevent contamination of local groundwater. If a liner is required, a license condition would be included that would require the licensee to provide test results that ensure that the materials used for the liner would not undergo an increase in permeability characteristics or deterioration of consolidation or stability properties when exposed to tailings impoundment solutions over the long term. In addition, the licensee would develop and submit for review (1) criteria to define foundation conditions that are acceptable for the placement of a clay liner; (2) conditions which will require the use of subdrains and filters; and (3) liner material specifications, compaction criteria, and field compaction procedures.

While the decant system proposed by the licensee will ensure removal of some of the slurried tailings fluids from the impoundment system during disposal operations, much of the tailings fluids will remain at the base of the impoundment area in the sand tailings. Therefore, a license condition would be included that would require the licensee to dewater the tailings to the maximum extent reasonably achievable through the use of an in situ drainage system installed at the bottom of the impoundment to lower the phreatic surface and thus reduce the potential for seepage through the clay liner. Drains would be installed at one or several low points in the impoundment bottom and should be protected by suitable filter materials to ensure that they remain free running. The details of the design and installation of the dewatering system would be submitted to the NRC for review.

Elimination of blowing of tailings during operation. Some of the contaminated materials will be transported by dump truck to the disposal site. Contaminated materials in the trucks will be sprayed with a suitable material, or the trucks will be covered, as necessary, to prevent airborne dispersion of contaminated particles during transport. Cover material will be placed on the impoundment area immediately after a sufficient area of deposited tailings reaches final grade to minimize wind blowing of contaminated materials. The staff concludes that these procedures to minimize blowing of tailings during transport by truck and during disposal are generally acceptable. However, the licensee should develop and utilize an active program to control dusting, including periodic inspections to document the effectiveness of the program. To further minimize the potential for blowing of contaminated materials, the staff recommends that tailings not be transported or emplaced during periods of sustained high winds. In addition, the staff recommends that the surface of tailings and contaminated particulate matter at the disposal site be kept moist with water, slurry liquids, or chemical sprays until they can be stabilized by the intermediate cover.

Reduction of radon exhalation rate and gamma radiation following disposal and reclamation. The results of the evaluation of the adequacy of the proposed tailings cover are provided in Appendix D. Calculations indicate that the net gamma radiation from the tailings would be about 3.6×10^{-7} mR/year, which would be insignificant compared to the natural background radiation (153 mR/year). Radon flux from the impoundment would be about twice the natural background.

Elimination of need for ongoing monitoring and maintenance. After reclamation and a short-term observation and maintenance period for surface cover, the staff expects no further active maintenance will be required for the foreseeable future.

2.2.3.8 Summary evaluation of the overall aspects of the licensee's proposal

The staff considers removal of the tailings and contaminated equipment and soil from the Edgemont mill site and disposal of such material in a manner to ensure long-term stability and isolation from the surface environment without the need for continued maintenance after disposal to be in the public interest and consistent with regulatory policy.

The staff finds that onsite stabilization of tailings, because of the proximity of the city of Edgemont and the possibility of tailings impoundment erosion at that location over the long term, is less attractive than offsite disposal as proposed by the licensee.

Of 25 potential disposal sites studied for suitability for long-term disposal within 29 km (18 miles) of the mill site (Table 2.6), alternative site C1, the licensee's prime choice, is preferred by the staff. It has been concluded that a tailings impoundment can be constructed at that site to meet all performance objectives discussed in Sects. 2.2.1.3 and 2.2.3.7. Site C1 contains sufficient storage capacity to contain the present estimate of tailings and other contaminated materials to be removed from the mill site. The staff considers that this estimate may be high but recognizes the difficulty in accurately estimating total volume to be removed. Any other type surface impoundments with special design features [e.g., alternative D2 (Sect. 2.2.3.4)] might require more than one site for disposal. The staff considers this requirement undesirable.

Open-pit disposal was evaluated (alternatives C3 and D3) by the licensee. It appears certain, though not yet formally documented, that sufficient disposal volume is unavailable. Furthermore, the capacity of the pits would be significantly reduced by the installation of liner materials in a manner that would ensure their stability. Therefore this option is no longer considered a viable alternative for this project. The staff does not recommend excavation of a new pit because a comparable degree of impoundment stability may be obtained with careful site selection and impoundment design, as in alternative D2, without the extra excavation expense and the environmental problems concomitant with disposal of the excess excavated material.

The staff presently recommends alternative site C1, the licensee's preferred site. Although both sites C1 and C2 can be engineered to meet the performance objectives, alternative C1 is preferable to alternative C2 because of significantly less severe transportation impacts, less impoundment diking, and less exposure to potential erosion.

The haul road proposed by the licensee, about 2.7 km (1.5 miles), eliminates transportation impacts on the public roads and minimizes the use of fossil fuel. The staff notes that any other site considered viable would result in greater use of fossil fuel and significant transportation impacts on the public roads. The haul road will disturb temporarily about 12 ha (30 acres) of land. It is unlikely that less disturbance would occur at another site.

The staff is of the opinion that the licensee's plans to use a slurry pipeline to transport tailings and other suitable material from the mill site to the disposal site are acceptable. The plans minimize the use of fossil fuel, represent sound economics, minimize the potential for public exposure to windblown contaminated materials, minimize truck transportation requirements, and are cost and energy effective.

With regard to avoiding contamination of ground and surface waters at the mill site, the staff considers the proposed diversion ditch to control runoff from the natural drainage east of the mill to be a necessary and environmentally sound feature. Otherwise, control of sediment transport from the disturbed contaminated materials on the site would be difficult, if not impossible.

Regarding the decontamination of Cottonwood Creek, the staff supports the staged rerouting and cleanup plan as proposed by the licensee. The staff considers that, if considerable expanses of contaminated sediments are identified within the streambed, diversion of the creek flow would be the most practical way to decontaminate the creek channel, with a minimum of sediment entering the Cheyenne River at the mouth of the creek. It is recognized that any method for full decontamination of the creek channel will destroy the aquatic biota in the creek through the mill site in the short-term, but the staff is of the opinion that this action will have significant long-term benefits by returning the creek to a more natural state. All creek contaminants will be removed to levels determined by NRC in coordination with the State of South Dakota.

The staff notes that during previous mill operation, although fresh tailings and contaminated groundwater degraded the water quality of Cottonwood Creek, no detectable effects on the Cheyenne River or the Angostura Reservoir were observed.[8] With this past history, the staff is of the opinion that any potential effects of remaining contaminated creek sediment entering the river will be transient and will result in no measurable change in water quality or environmental consequences.

Thus, the staff agrees with the licensee's proposal (Sect. 2.2.3) to reroute, clean up, and stabilize the streambed and provide a restored aquatic habitat in a channel as close to the original creek configuration as feasible.

Regarding details of the proposed Cottonwood Creek cleanup, the licensee's plan for reconstruction of the Cottonwood Creek calls for the banks to be graded to an approximate 10° slope. Such a slope may be necessary for initial attempts to stabilize the banks, but erosion should be allowed to shape the banks in a natural manner. Areas of the creek expected to receive severe erosion, such as bends, can be stabilized with riprap. Excessive use of riprap, however, should be avoided. Although the plan for revegetating the creek banks generally appears acceptable, the staff recommends that the licensee work in co- ation with the South Dakota Department of Game, Fish and Parks in this area of the cleanup 'an. The plan to plow and disk two 2.4-m-wide (8-ft) bands along both sides of the creek . r shrub plantings does not appear reasonable. Once the banks have been stabilized with the seed mixture as proposed, heavy machinery should not be used on the slopes. The staff suggests that the shrubs and trees be planted by hand and spaced at irregular intervals. A small Rototiller would probably be adequate for tilling the soil where the shrubs and trees would be planted. The licensee should consider placing roofing felt or plastic aprons around the shrubs and trees to control growth of competing grasses and shrubs and to conserve moisture. Other areas that have been reseeded should be mulched with native hay at a rate of about 4.4 MT/ha (2 tons/acre) rather than the 2.2 MT/ha (1 ton/acre) proposed (ref. 9; see also comment on DES by Herb Davis, Soil Conservationist).

According to the licensee's original plan for reclaiming the mill site, disposal site, haul roads, and borrow areas as presented in Sects. 2.2.2.7 and 2.2.2.9, sufficient suitable topsoil exists at the disposal site for reclaiming all disturbed areas. Fill material for the mill site can be obtained from the disposal site. Thus, while the staff believes that use of soil from the disposal site is environmentally preferable to disturbing additional lands, it appears that opening up new borrow areas may be required (Sect. 2.2.2.7). The staff will require adequate documentation and justification of plans to initiate such activity.

The seed mixture proposed for the mill site and banks of Cottonwood Creek (Table 2.5) appears appropriate, considering the proposed use of the land (Sect. 4.1.5). The seed mixture proposed for the disposal site and borrow areas (Table 2.5) is also generally acceptable but does require some modification. The additional species being considered by the licensee (Sect. 2.2.2.9) should be included in the mixture to the extent practicable. These are little bluestem (*Andropogon scoparius*), Indian ricegrass (*Oryzopsis hym...oides*), sideoats grama (*Bouteloua curtipendula*), green needlegrass (*Stipa viridula*), scarlet globemallow (*Sphaeralcea coccinea*), winterfat (*Eurotia lanata*), and penstemon (*Penstemon* spp.). Including such species would be more in agreement with the seed mixture recommended by the Soil Conservation Service (see response to comments on the DES by the South Dakota State Planning Bureau, Item 23). The U.S. Fish and Wildlife Serv .e (K. D. Keenlyne, U.S. Fish and Wildlife Service, letter to R. A. Scarano, Division of Waste Management, NRC, Oct. 27, 1980) recommended that the licensee consider a seed mixture which includes little bluestem (*Andropogon scoparius*), silver sagebrush (*Artemesia cana*), rice grass (*Oryzopsis hymenoides*), and fourwing saltbush (*Atriplex canescens*). Although silver sagebrush and fourwing saltbush would be of benefit to wildlife, they have deep roots which could breech the disposal site cap, adversely affecting containment of the tailings.

In selecting the seed mixture for the disposal site, primary emphasis should be on establishing self-sustaining vegetation capable of providing long-term erosion protection. Therefore, the staff recommends modifying the seed mixture (Table 2.5) proposed for the disposal site. Streambank wheatgrass, which is naturally found on hillsides and streambanks,[10] does not seem appropriate for a cap graded to a 1% slope. Also, thickspike wheatgrass is more adapted to sandy and gravelly soil than the loamy and/or clayey soils found onsite (Sect. 3.8). Although Russian wildrye, an introduced perrenial, typically has a shallow fibrous root system adapted to the soils in the area, it can be deep rooted.[10] Based on these considerations, the recommendations of the Soil Conservation Service, and the natural perennial ground cover in the vicinity of the site (Table 3.20), the staff recommends the following seed mixture (Table 2.7) as a basis for revegetation for the disposal site.

Table 2.7. Recommended seed mixture for revegetating the disposal site

Species	kg/ha	lb/acre
Western wheatgrass	7.5	7
Sideoats grama	4	4
Blue grama	2	2
Green needlegrass	2	2
Buffalograss	2	2
Sand dropseed	1	1
Total	18.5	18

Other species being considered by the licensee (Sect. 2.2.2.9) may be added to this seed mixture in appropriate amounts to increase the diversity of the plant community, thereby benefiting wildlife. It is extremely important to use local ecotypes that are adapted to site-specific conditions (e.g., soil texture, nutrients, and moisture). (See response to comments on the DES by the South Dakota State Planning Bureau, Item 23, for suggested varieties.)

As recommended by the Soil Conservation Service, a grassland drill with depth control bands and double disc furrow openers should be used for planting.

Yellow sweetclover (*Melilotus officinalis*) is a strong competitor for moisture and may retard the growth of warm season species if its density is too great.[10] Also, excessive seeding rates of small-seeded species such as yellow sweetclover may result in severe competition with grasses, especially if water is limited[11] as it is near Edgemont. Therefore, where this species is used, it may be advisable to broadcast it after the warm season species have become established. As seeding conditions become more severe (e.g., steeper slopes, south- and west-facing slopes) the rate of seeding should be increased 50 to 100%.[11]

The licensee did not discuss any plans to revegetate the ponderosa pine community east of the mill site. The staff recommends that any portion of this community disturbed as a result of cleanup of windblown tailings be planted with species typical of the area.

To ensure the establishment of a self-perpetuating maintenance-free stand of vegetation, a policy of South Dakota, the licensee should, as described in the ER (Sect. 5.1.4.1), monitor all reclaimed areas and take all necessary actions to achieve successful vegetation reclamation. The management of young plants and seedlings is vitally important if the stand is to become self-perpetuating and maintenance-free. It is particularly important to protect reclaimed areas from grazing and/or trampling by livestock, big game, rabbits, and small rodents. Grasshoppers, cutworms, and other insects also often seriously damage newly revegetated areas. Although the burden is on the licensee to successfully reclaim the distrubed areas, the staff highly recommends that grazing by livestock and wildlife be prohibited on these areas until the stand has become established. This will probably require the use of some fencing. Methods to control other grazers and seed-eating wildlife are reviewed by Plummer, Christenson, a' . Monsen.[12]

This reclamation should be considered successful wher 'he cover and density of perennial species in the reclaimed areas equal the cover and d .sity of perennial species at control areas, with this condition being met for two cc secutive growing seasons.

In summary, the conclusion of the staff is tha he licensee's proposal is generally satisfactory and that the project be implemented sut ect to the monitoring and mitigating measures planned by the licensee and as supplemented by e regulatory agencies involved. Detailed plans and evaluations of each aspect of the dec mmissioning project will be subject to review and approval by NRC prior to implementation. The licensee will be required to adhere to the monitoring and mitigating measures in Sect. 4 of this statement and to all applicable licensing requirements of the NRC.

The staff concludes that under these restrictions, long- and short-term adverse impacts will be minimal, and the project will improve the local long-term environment and welfare of the public.

REFERENCES FOR SECTION 2

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2. *Nuclear Regulatory Commission Branch Position on Uranium Mill Tailings Management*, Division of Waste Management, May 13, 1977.

3. Ford, Bacon & Davis Utah, Inc., *Engineering Assessment of Inactive Uranium Mill Tailings, Edgemont Site, Edgemont, South Dakota*, prepared for the U.S. Nuclear Regulatory Commission, Contract No. E(05-1)-1658, May 1978.

4. Ford, Bacon & Davis Utah, Inc., *Engineering Analysis of Mill Facility Decommissioning and Long Term Tailings Stabilization at a Remote Disposal Site, Edgemont Site, Edgemont, South Dakota*, prepared for the Tennessee Valley Authority, Chattanooga, Tenn., January 1979.

5. U.S. Nuclear Regulatory Commission, *Final Generic Environmental Impact Statement on Uranium Milling*, Report NUREG-0706, Washington, D.C., September 1980.

6. M. B. Sears et al., *Correlation of Radioactive Waste Treatment Costs and the Environmental Impact of Waste Effluents in the Nuclear Fuel Cycle in Establishing 'as Low as Practicable' Guides: Milling of Uranium Ore*, Report ORNL/TM-4903, vol. 1, Oak Ridge National Laboratory, Oak Ridge, Tenn., May 1975.

7. U.S. Nuclear Regulatory Commission, *Draft Environmental Statement Related to Operation of Plateau Resources Limited Shootering Canyon Uranium Project*, Report NUREG-0504, Docket No. 40-8698, February 1979.

8. U.S. Environmental Protection Agency, *Environmental Evaluation of Mines Development, Inc., Uranium and Vanadium Milling Operation at Edgemont, South Dakota*, Report PB-256, April 1973.

9. R. J. Lutton, *Evaluating Cover Suggestions for Solid and Hazardous Waste*, Report PB81-166340, U.S. Environmental Protection Agency, Cincinnati, 1980.

10. S. G. Long (ed.), *Characteristics of Plants Used in Western Reclamation*, Ecology Consultants, Inc., Fort Collins, Colo., 1978.

11. C. W. Cook, R. M. Hyde, and P. L. Sims, *Revegetation Guidelines for Surfaced Mined Areas*, Science Series No. 16, Colorado State University Range Science Department, Fort Collins, Colo., 1974.

12. A. P. Plummer, D. R. Christenson, and S. B. Monsen, *Restoring Big-Game Range in Utah*, Utah Fish and Game Publication 68-03, Ephraim, Utah, 1968.

3. THE AFFECTED ENVIRONMENT

3.1 CLIMATE

3.1.1 General influences

The climate of southwestern South Dakota, where Edgemont is located, is characterized by low precipitation, high evaporation rates, abundant sunshine, low relative humidities, and moderate temperatures of extensive diurnal and annual variations.[1,2] The general climate of the project area is semiarid, continental, or steppe; and the winter season is dry.[3,4]

Storm systems originating in the Pacific Ocean, after releasing most of their moisture over the Coastal and Cascade ranges and Rocky Mountains, produce only light precipitation in the Black Hills area. Heavier precipitation occurs when these systems reintensify east of the Rocky Mountains and interact with moist air that is already present or that moves by advection into the area from the southeast. Isolated summertime convective storms may also produce heavy, localized precipitation — primarily over and adjacent to the Black Hills.

Local topography in the area should not influence synoptic scale airflow to any great extent. The adjacent Black Hills, however, are a major barrier to airflow and may cause some airflow variation in the general region.

Temperatures are reasonably represented by data from nearby Ardmore, South Dakota, located approximately 35 km (22 miles) south-southeast of the Edgemont properties. Table 3.1 presents mean monthly, mean annual, and mean daily maximum and minimum temperatures for the Ardmore station for 42 years of record.

Temperatures greater than or equal to 32°C (90°F) are estimated to occur on an average of 60 d/year.[2] The extreme maximum temperature reported for Ardmore is 46°C (114°F).[2] Migrating high-pressure systems moving southward out of Canada frequently influence the area. These systems, combined with elevations of about 1067 to 1158 m (3500 to 3800 ft) MSL, a northern continental location, and infrequent cloud cover, contribute to an average of 198 d/year with temperatures less than or equal to 0°C (32°F). The lowest temperature on record for Ardmore is -38°C (-37°F).[2]

Freezing temperatures generally do not occur after mid-May or before the last of September.[1] However, there are large variations in freeze dates from year to year.

3.1.2 Winds

Long-term wind information is not available for the immediate area. The nearest National Weather Service (NWS) stations with such data are at Rapid City, South Dakota, and Scottsbluff, Nebraska, which are more than 105 km (65 miles) northeast and 160 km (100 miles) south of Edgemont respectively. Table 3.2 presents monthly and annual mean wind speeds and directions for these two stations.

The NWS data from Scottsbluff, Nebraska, considered by the staff to be more representative of site conditions than the Rapid City, South Dakota, data, indicate that the general airflow in the region is most frequently from the west-northwest, with a secondary maximum from the east-southeast. Wind speeds are relatively high, with a mean of 4.8 m/s (10.7 mph). The area-specific wind data is reasonably consistent with the NWS information. However, in the area-specific wind data, the average wind speed during the three-year measurement period is lower by about 1.7 m/s (3.7 mph) than that observed over the longer term NWS period.

Table 3.1. Monthly and annual mean and mean daily maximum and minimum temperatures for Ardmore, South Dakota (1919–1960)

Time segment	Mean [°C (°F)]	Mean daily maximum [°C (°F)]	Mean daily minimum [°C (°F)]
January	−6.8 (20)	0.9 (34)	−14.4 (6)
February	−4.1 (25)	3.8 (39)	−11.6 (11)
March	0.8 (33)	8.3 (47)	−7.1 (19)
April	7.0 (45)	14.9 (59)	−0.8 (30)
May	12.9 (55)	20.7 (69)	5.2 (41)
June	18.6 (65)	26.6 (80)	10.4 (51)
July	23.3 (74)	32.4 (90)	14.3 (58)
August	22.1 (72)	31.3 (88)	12.7 (55)
September	15.9 (61)	25.6 (78)	6.6 (44)
October	8.8 (48)	18.0 (64)	−0.1 (32)
November	1.1 (34)	9.1 (48)	−6.8 (20)
December	−4.8 (23)	2.8 (37)	−12.2 (10)
Annual	7.9 (46)	16.2 (61)	−0.3 (31)

Source: ER, Table 4.1–1.

Table 3.2. Monthly and annual mean wind speeds and predominant wind directions at Scottsbluff, Nebraska, and Rapid City, South Dakota

Time segment	Scottsbluff, Nebraska		Rapid City, South Dakota	
	Mean speed [m/s (miles/h)][a]	Predominant Direction[a]	Mean speed [m/s (miles/h)][a]	Predominant direction[b]
January	4.7 (10.6)	WNW	4.7 (10.5)	NNW
February	5.1 (11.5)	WNW	4.8 (10.8)	NNW
March	5.5 (12.3)	WNW	5.6 (12.5)	NNW
April	5.8 (12.9)	NW	5.9 (13.2)	NNW
May	5.4 (12.1)	ESE	5.5 (12.4)	NNW
June	4.7 (10.6)	ESE	4.8 (10.7)	NNW
July	4.2 (9.4)	ESE	4.4 (9.9)	NNW
August	4.1 (9.2)	ESE	4.6 (10.2)	NNW
September	4.2 (9.5)	ESE	4.9 (11.0)	NNW
October	4.4 (9.8)	NW	5.0 (11.1)	NNW
November	4.6 (10.4)	NW	4.9 (10.9)	NNW
December	4.8 (10.7)	WNW	4.6 (10.4)	NNW
Annual	4.8 (10.7)	ESE	5.0 (11.1)	NNW

[a] Based on 24 years of record.
[b] Based on 13 years of record.
Source: ER, Table 4.1-3.

3.1.3 Precipitation

Maximum precipitation amounts occur during late spring and early summer primarily as a result of the interaction of moist air from the Gulf of Mexico with frontal systems moving across the region. Summertime convective thunderstorm activity also contributes substantially to the precipitation totals during the summer months. Monthly and annual precipitation data from Edgemont (Table 3.3) indicate that approximately one-half of the annual precipitation falls during May, June, and July. Most of the winter precipitation is snow. Based on snowfall records for Ardmore over a nine-year period, the annual average snowfall is approximately 94 cm (37 in.).[2]

Based on records from the NWS station at Rapid City, located about 105 km (65 miles) northeast of Edgemont, it is estimated that precipitation of 0.25 mm (0.01 in.) or more occurs on an average of 90 d/year.[5-7]

Table 3.3. Mean monthly and annual precipitation for Edgemont, South Dakota, 1949–1957

Month	Amount		Years of record
	mm	in.	
January	9	0.3	9
February	11	0.5	9
March	23	0.9	9
April	30	1.2	9
May	73	2.9	9
June	67	2.6	9
July	48	1.9	8
August	29	1.1	8
September	28	1.1	8
October	19	0.7	8
November	10	0.4	9
December	9	0.3	9
Annual	356	14.0	

Source: ER, Table 4.1-2.

The mean annual relative humidity for the area is estimated to be about 52%.[5,7] However, afternoon humidities in the warmer months are often lower than 30%.

3.1.4 Storms

Tornadoes are infrequent in western South Dakota. Of those reported, most occurred in the afternoon and early evening hours during the summertime thunderstorm season. Only nine tornadoes were reported from 1955 through 1967 within a 1°-rectangle (latitude and longitude) that includes the Edgemont area.[8] Thus, the estimated probability of a tornado striking a point within the Edgemont area in any given year is 0.0006,[8,9] which means that the estimated mean recurrence interval for a tornado at any point within the Edgemont area is about 1650 years.

Thunderstorms, relatively frequent in southwestern South Dakota during the summer months, occur on the average of 40 to 45 d/year.[7,10] Hail associated with these thunderstorms generally occurs on an average of 4 to 6 d/year.[10] Extreme winds of short duration generally accompany these thunderstorms, and maximum short-duration rainfalls generally are associated with the more intense thunderstorms.

3.2 AIR QUALITY

The Environmental Protection Agency (EPA) has designated the project area, located in the Black Hills–Rapid City Air Quality Control Region, as an attainment area for sulfur dioxide and total suspended particulates (TSP), indicating that these pollutants are within the Federal air quality standards.[11] The EPA has designated carbon monoxide, ozone, and nitrogen dioxide in this region as "Cannot Be Classified or Better Than National Standards."[11] The only significant nonradiological air pollutant expected to be associated with the proposed action will be TSP.

The licensee has not monitored the existing air quality at the mill site. A TSP monitor was installed about 22 km (14 miles) northwest of the site in April 1979. Results from 17 months indicate that the annual geometric mean for TSP at this location is about 27 $\mu g/m^3$; the highest recorded value of 146 $\mu g/m^3$ occurred on May 21, 1980. Wind speeds in the region are highest in March, April, and May (ER, Table 4.1-3). Data on TSP from State monitoring stations are available for communities in the region. The nearest station, Hot Springs, reported annual geometric means of 54, 45, and 44 $\mu g/m^3$ in 1976, 1977, and 1978, respectively; maximum recorded values for these years were 168, 211, and 132 $\mu g/m^3$, respectively. The Federal secondary standard and State of South Dakota ambient air quality standard for TSP is 60 $\mu g/m^3$ as the annual geometric mean, with a maximum 24-h concentration of 150 $\mu g/m^3$ allowed once yearly. Background concentrations of other pollutants (sulfur dioxide, carbon monoxide, nitrogen dioxide, hydrocarbons, and photochemical oxidants) are all expected to be low in the Edgemont area because of low population density and lack of industrial development.

3.3 TOPOGRAPHY

The mill site is located immediately south of the confluence of Cottonwood Creek and the Cheyenne River, about 4.8 km (3 miles) southwest of the foothills of the Black Hills mountains. The topography of the area is characterized by flat bottomlands and alluvial terraces and gently rolling hills. Elevations at the mill site range from about 1066 m (3500 ft) at the southeastern corner of the site to about 1042 m (3420 ft) along the Cheyenne River, which forms the northern boundary of the site, and along Cottonwood Creek, which flows through the western portion of the site.

Immediately north of the mill site the topography is characterized by about 3.2 km (2 miles) of gently rolling hills followed by rugged northwest-southeast-trending ridges. The topography south of the mill site is characterized by relatively broad, flat bottomlands and alluvial terraces along Cottonwood Creek and northwest-southeast-trending ridges and valleys. About 3.2 km (2 miles) south of the mill site, a line of cliffs marks the beginning of a relatively flat mesa.

The proposed disposal site is located about 3.2 km (2 miles) southeast of the confluence of Cottonwood Creek and the Cheyenne River. The actual site is located at the head of an ephemeral drainage with site elevations ranging from about 1122 m (3680 ft) at the western boundary to about 1096 m (3595 ft) at the southeastern boundary. The disposal site and immediate vicinity is characterized by northwest-southeast-trending ridges and valleys. The cliffs and mesa begin about 0.8 km (0.5 mile) southwest of the proposed disposal site.

3.4 DEMOGRAPHY AND SOCIOECONOMIC PROFILE

The Edgemont mill site is adjacent to and within the town of Edgemont, South Dakota, in the west-central section of Fall River County, approximately 20.9 km (13 miles) by highway east of the Wyoming-South Dakota border, 43.5 km (27 miles) southwest of Hot Springs, the county seat for Fall River County, and 137 km (85 miles) southwest of Rapid City (Fig. 3.1). South of the mill site and west of some of the tailings ponds is a residential area called Cottonwood Community, which has a population of about 75. The Burlington-Northern Railroad borders the site in the west and separates the site from Edgemont's commercial district. Residential areas are west and north of the site across the Cheyenne River. The north area, known as Dudley, has a population of about 60. Except for an Edgemont city sewage pond, the land immediately east of the site is undeveloped (Figs. 3.2 and 3.3). The proposed site for long-term disposal of the Edgemont mill tailings is approximately 3.2 km (2 miles) southeast of the mill site (Fig. 3.3).

Because of the proximity of the communities to the mill and disposal sites and because they are the only communities within reasonable distance that possess amenities such as schools, retail districts, and utilities usually sought by in-migrants,[12] the staff has concluded that Edgemont and Hot Springs will absorb the majority of the socioeconomic impacts resulting from this proposed project. Therefore, the socioeconomic descriptions and impact analyses focus on these communities and the surrounding regions in Fall River County.

3.4.1 Population

Edgemont and Hot Springs are relatively small municipalities; their 1980 populations were 1468 and 4742, respectively. The towns are located in sparsely populated Fall River County, which had an estimated population in 1980 of 8439 and a population density of only about 1.9 persons/km^2 (4.8 persons/sq mile); therefore, the majority of the county's inhabitants (about 6200 of 8400) live in these two communities.* Very little slack exists in the labor

*Population data were obtained from 1980 Census of Population and Housing, PHC 80-V-43, U.S. Department of Commerce, Bureau of the Census. The total land area for Fall River County was assumed to be approximately 4510 km^2 (1740 sq miles) and was based on acreage estimates developed by the South Dakota State Planning Bureau (ER, Table 4.3-1).

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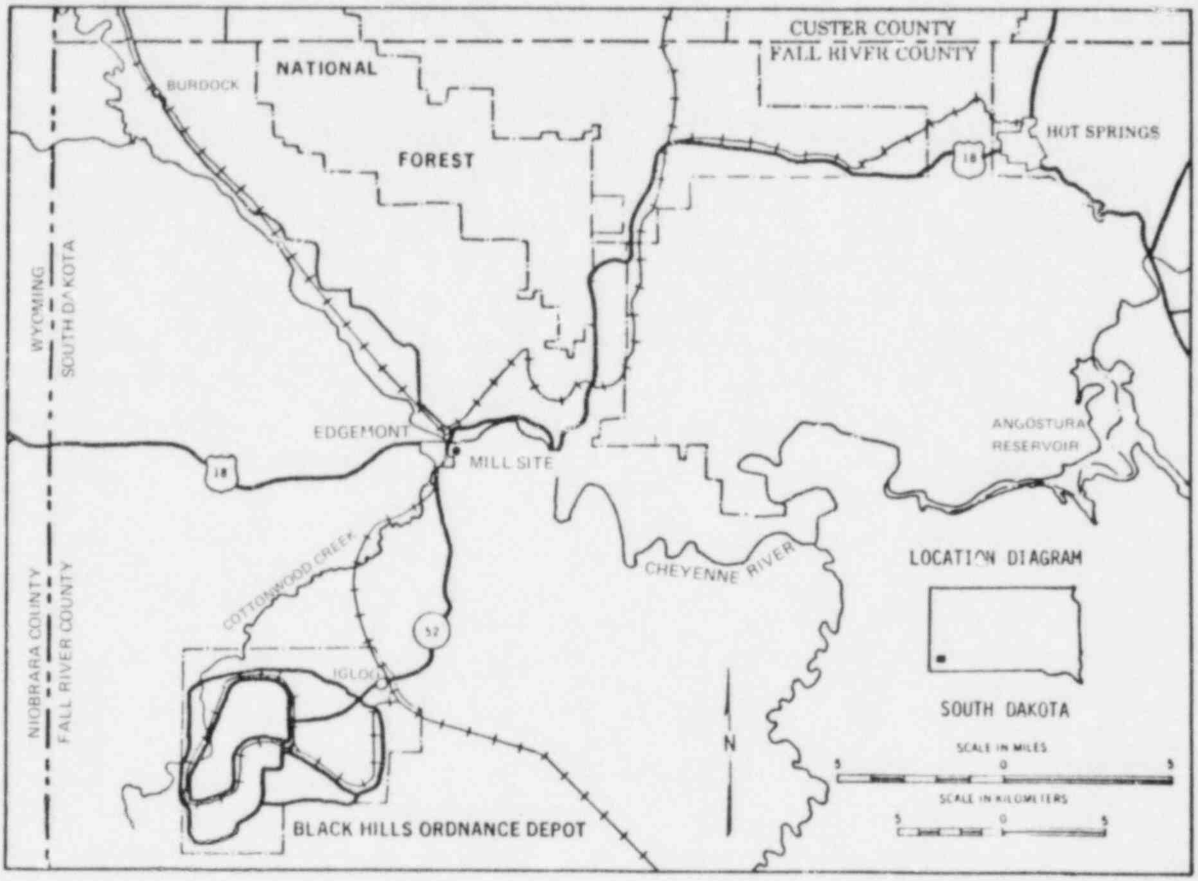

Fig. 3.1. The regional location of the Edgemont mill site. Source: ER, Fig. 2.1-1.

markets — unemployment rates are low (Sect. 3.4.2) — indicating that population levels would be highly correlated with variations in employment opportunities. These communities are, therefore, very susceptible to the "boom/bust" syndrome; that is, an influx or outflow of any important industry significantly alters employment and, consequently, population trends. Populations have fluctuated dramatically in the past. For example, Edgemont, although experiencing a boom-town growth pattern in the 1970s when population doubled because of expanding energy-related development in and around its boundaries, had previously undergone almost the same sudden increase in the 1950s and an equally precipitous decline by the end of the following decade[13] (Table 3.4). This abrupt reversal in the 1960s was caused primarily by the closing in 1968 of the Black Hills Army Ammunitions Depot in Igloo. This closing caused "serious social and economic disruption, high unemployment, and high outmigration [sic]" (ref. 12, p. 3). Additionally, Edgemont's population decreased significantly in 1980 (from about 2000 to 1468) caused by a decrease in railroad-related employment. Hot Springs's population has fluctuated also, but not as severely as Edgemont's (Table 3.4).

The conclusion from the above observations is that historical trends are not very helpful in predicting the future populations of Hot Springs and Edgemont. However, population projections have been developed (Table 3.5). These forecasts, which are based on known industrial commitments, assume that a large influx of industry will occur in the early 1980s and will result in steep, rapid population expansions. After reviewing these projections, the staff has concluded that although the projections are necessarily inexact, they adequately gauge potential trends; that is, for example, Edgemont's population could conceivably more than double by the mid-1980s.

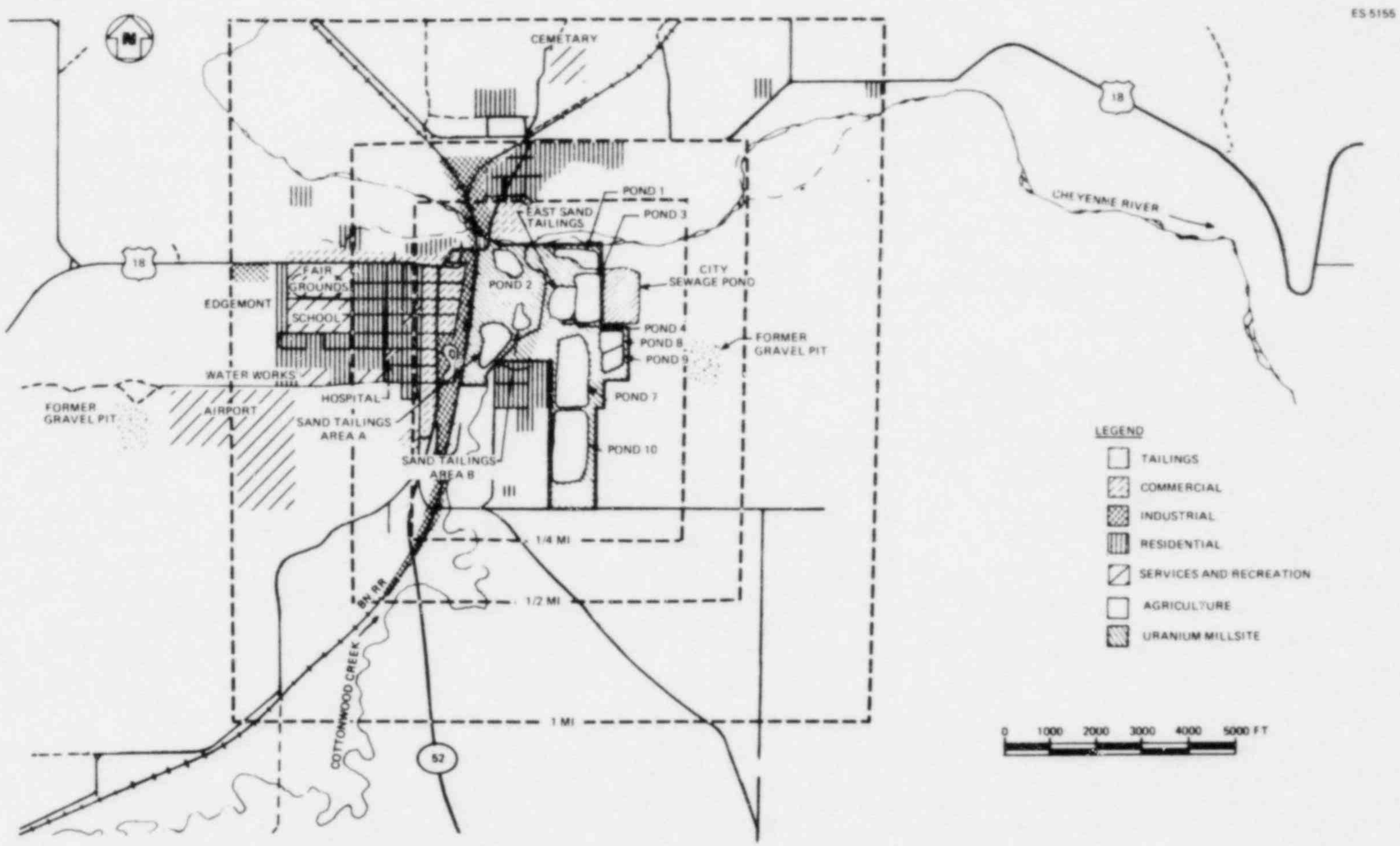

Fig. 3.2. Land use in the Edgemont area. <u>Source</u>: Ford, Bacon & Davis Utah Inc., *Engineering Assessment of Inactive Uranium Mill Tailings, Edgemont Site, Edgemont, South Dakota*, prepared for U.S. Nuclear Regulatory Commission, May 1978, Fig. 4.3.

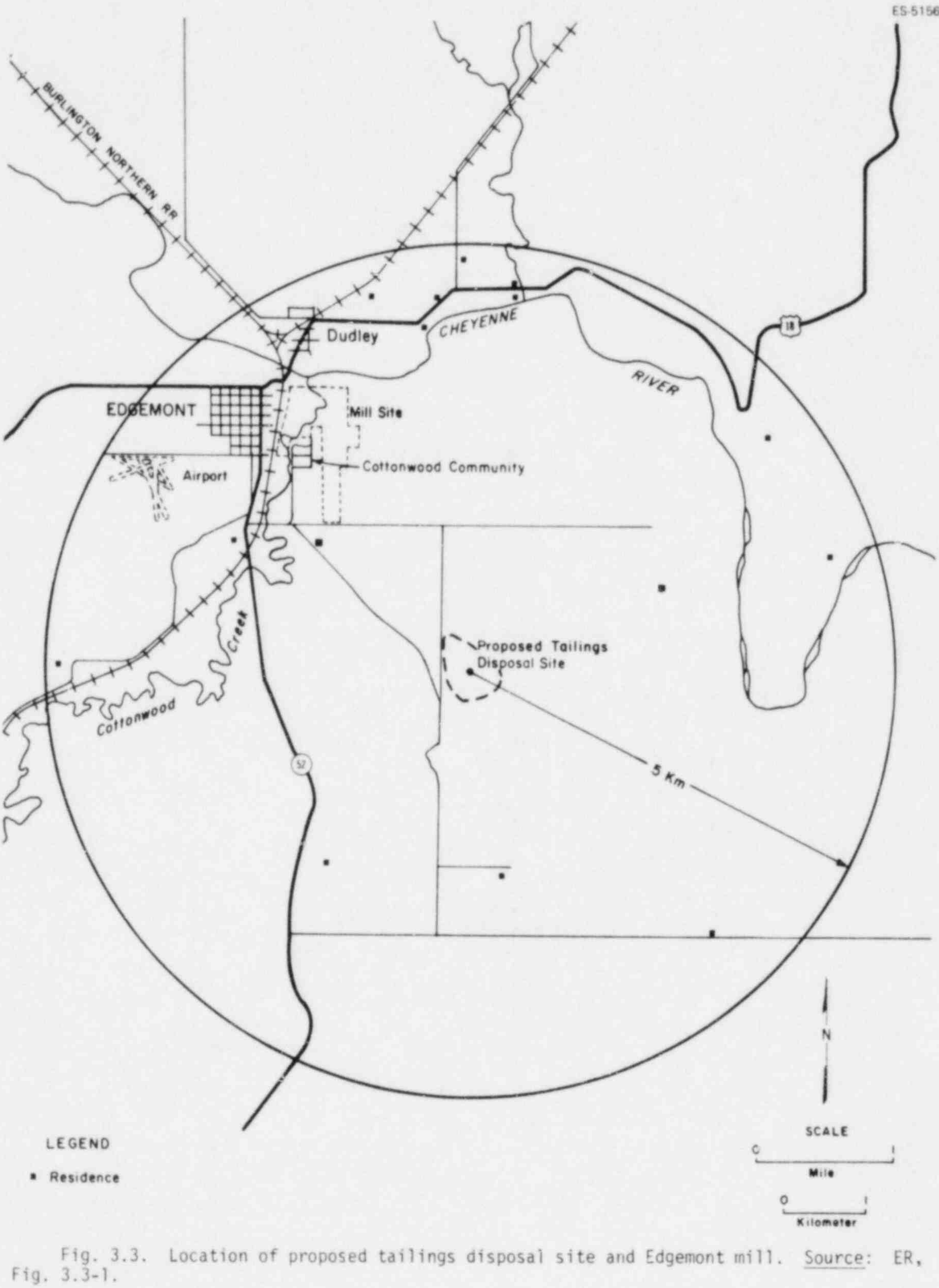

Fig. 3.3. Location of proposed tailings disposal site and Edgemont mill. Source: ER, Fig. 3.3-1.

Table 3.4. Historical population levels and trends for Hot Springs, Edgemont, and Fall River County

Year	Edgemont		Hot Springs		Fall River County	
	Population	Percentage change	Population	Percentage change	Population	Percentage change
1940	1002[a]					
1950	1185[b]	+18	5030[c]			
1960	1772[b]	+50	4943[c]	−2		
1970	1174[b]	−34	4434[c]	−10		
1973			4561[c]	+3	8100[d]	
1975	1800[a] 2000[b]	+38[e]	4670[c]	+2	8000[d]	−1
1976			4797[f]	+3	8300[d]	+4
1977			4759[g]	−1	8344[g] 8700[d]	+3[e]
1979	2200[f]		5000[f]	+5		
1980	1468[h]	+25[i]	4742[h]	+6.9[i]	8439[h]	712.4[i]

[a]Undated document prepared by John Krueger, Edgemont City Planner; original source, U.S. Census Bureau.

[b]Sixth District Council of Local Governments, "Edgemont Recreation Assessment," Rapid City, S.D., April 1979; original source, U.S. Census Bureau.

[c]Sixth District Council of Local Governments, "Hot Springs Outdoor Recreation Assessment," Rapid City, S.D., March 1979; original source, U.S. Census Bureau.

[d]Computerized tabulation entitled "Personal Income By Major Sources 1972–1977," a component of the Regional Economic Analysis, prepared by the Bureau of Economic Analysis, April 1979.

[e]Percent change calculated by taking the average of the population estimates and comparing this composite to the previous population estimates.

[f]Sixth District Council of Local Governments, "Fall River County 601 Designation Application," Appendix B. Rapid City, S.D., June 18, 1979. The original source for the 1979 Edgemont estimate was John Krueger, Edgemont City Planner. The 1976 Hot Springs estimate was derived from a special 1976 U.S. Census tabulation; the 1979 estimate was based on this 1976 figure.

[g]Catherine O'Brien, Bureau of the Census, personal communication.

[h]1980 Census of Population and Housing, Advance Reports, PHC 80-V-43, U.S. Department of Commerce, Bureau of the Census.

[i]Change based on 1970 census data.

3.4.2 Housing

During the late 1960s and early 1970s, a severe housing surplus existed in Fall River County. The 1970 housing census indicated that

> the housing stock of Fall River County . . . was quite large relative to demand. A large number of units were standing empty, a situation which had persisted for some time and resulted in few new homes being built. [From 1962 to 1976, only three houses were built in Edgemont.] . . . [L]ow rents and resale values resulting from the oversupply [apparently tended] . . . to discourage maintenance and improvements. Thus, although a relatively large stock of housing was present, it was aging and its quality was an important and increasing problem. (ref. 12, Appendix F, p. 3)

The housing surplus during this period was caused by out-migration brought about by declining employment opportunities (Sect. 3.4.1). However, in the last five years the housing market has considerably tightened. A housing boom is already occurring because of current energy developments; for example, the county's stock of housing and mobile homes increased by 323 and 336, respectively, from 1970 to 1978, an increase of 10% and 188%, respectively.[12] Therefore, as is usually the case for low-population-density areas that are experiencing rapid development of energy resources, the housing of potential in-migrants may be a critical problem in Edgemont and Hot Springs. Although projecting housing needs is tenuous at best, possibly acute housing shortages may occur in Edgemont and Hot Springs as the population of the county increases during the 1980s. Because the cost of building and financing individual permanent housing units has increased dramatically in recent years, it is anticipated that the housing demand will be for mobile and modular homes and rental properties.[12]

Table 3.5. Population projections for Edgemont and Hot Springs[a]

Year	Source	Edgemont			Hot Springs	
		Low	Medium	High	Low	High
1983	1	2853			6016	
1985	1	3621			6683	
	2	2500	3996	4500		
	3	1652	2708		4906	5813
	4				5137	6053
1986	5	+1549[b]				+1089[b]
1989	5	+1435[b]				
1990	2	2800	3496	4800		
	3	1836	3683		5070	6651
	4				5372	6955
	6	3200				
1995	3	2020	3465		5234	6437
	4				5608	6800
	2	3000	3500			
2000	3	2204	3898		5398	6662
	4				5844	7036
	6	3800				

[a]The wide variations in projections are indicative of the difficulties encountered when dynamic economic conditions have been and continue to be prevalent in a region. Low, medium, and high projections are based on different scenarios for energy development in the region. Each source cited a different set of assumptions.

[b]Increase over baseline population in 1980.

Sources:

1. Sixth District Council of Local Governments, *"Fall River County Energy Impact Plan,"* August 1980.
2. Edgemont City Council, *"Edgemont Comprehensive Plan,"* January 1980.
3. Sixth District Council of Local Governments, *"Public Investment Plan,"* June 1981.
4. Hot Springs Planning Commission and City Council, *"Hot Springs Comprehensive Development Plan,"* June 1981.
5. Tennessee Valley Authority, "Environmental Impact Statements, Edgemont Uranium Mine," Rev. 5, September 1980.
6. Edgemont City Council, *"Edgemont Recreation Plan (Update),"* October 1981.

Based on staff discussions with local officials, the status of and the barriers to housing development in Edgemont and Hot Springs are as follows.

3.4.2.1 Edgemont

As of March 1981, there were 486 residential units in Edgemont: 158 renter-occupied and 328 owner-occupied units. Seventy-two multifamily rental dwellings were available (19 of these were vacant), and 45 single-family units were vacant. These relatively high vacancy rates contrast sharply with the near-zero rates recorded in early 1980 and are a result of the population decrease that occurred in 1980. From 1977 to 1979, the following units were added to the housing inventory: 45 houses (none constructed in 1980), 45 apartments (20 constructed in 1980), a 25-unit trailer park, and 26 older homes (for purchase or rent). One local developer has opened an 8.1-ha (20-acre) planned residential development for single-family and multifamily dwellings, only 3.3 ha (8 acres) of which have been developed.

3.4.2.2 Hot Springs

The Hot Springs housing inventory, as of early in 1981, is summarized in Table 3.6. Although the present recession and rapidly increasing interest rates temporarily increased vacancies in permanent housing and brought construction to a standstill during the first months of 1980, the Hot Springs housing market is expected to be expanded but still strained in the early 1980s. Rental properties especially are expected to be in short supply, although several apartment

Table 3.6. Housing inventories for Hot Springs

Housing types	Number
Residential	
Occupied owner	1225
Occupied rental	651
Vacant	80
Total	1956

Source: Hot Springs Planning Commission and Hot Springs City Council, "Comprehensive Development Plan," Hot Springs, S.D., June 1981.

complexes have been completed recently, and the Century House (Evans Hotel) is being restored to provide 85 units of low-income housing for the elderly.[14] The 1970 housing census indicated that there were 1042 people living in group quarters in Hot Springs. Most of these resided in the local Federal and State medical care facilities (Sect. 3.4.4).[15] Vacant lots are available for additional housing; however, individual building lots are not available for placement of mobile homes because community regulations restrict mobile homes to approved mobile home parks.

3.4.3 Employment

Compared with national figures, the unemployment rates in Fall River County and elsewhere in South Dakota have been very low; for example, the 1979 annual average unemployment rates were, for the county and the State, respectively, only 2.0 and 2.7%. By comparison, the national rate was ~6.0%.[16] The 1978 rate of 1.5% for the county was even lower, and the 1978 State rate of 3.1% was the second lowest recorded (only the Nebraska rate was less). By February 1980, however, the county unemployment rolls had increased to such an extent that 4.1% of the labor force was actively seeking work; by January 1980, the State rate had climbed to 4.2%. Although higher, these percentages are still considerably below the 6 to 8% being currently reported by a recessionary national economy.

County employment estimates for several job categories are presented in Table 3.7. A large percentage of the work force (35% in 1977) is government employees. In 1977, about half of the government employees worked for the Federal government; the other half were employed by State and local governments. Of the approximately 16% of the work force agriculturally employed in 1977, more than 60% were proprietors. Retail trade and services employment ranked third and fourth, respectively.

3.4.4 Economics

3.4.4.1 Overview of the regional economy

For decades, the economy of Fall River County, which was originally settled by homesteaders after the discovery of gold in the Black Hills, has been based (1) on transportation (essentially the Burlington-Northern Railroad), (2) on agricultural activities (ranching and farming), and (3) on the extraction of mineral resources (primarily uranium).[17] As discussed in Sect. 3.4.3, the government employs the largest percentage of the county's work force. Also, because of the proximity to several tourist attractions, tourism is also a major source of income.

Edgemont was founded as a railroad town, and its economy is still heavily dependent on the activities of the Burlington-Northern Railroad. Sheep raising has traditionally been an important industry in the vicinity of Edgemont; however, farmers have recently been switching to cattle.[17] Lignite was mined near Edgemont until the 1930s; and, in the 1950s, uranium mining and milling significantly boosted the local economy.[12]

Tourism, agriculture, and governmentally sponsored medical services form the economic base for Hot Springs. The Veterans Administration Medical Center in Hot Springs, the largest veterans hospital complex in the State, had 449 full-time, 52 part-time, and 47 other employees (consultants) on its payroll as of March 30, 1979. The center's 1979 budget was nearly $12 million,

Table 3.7. Full- and part-time employment by type and by industrial classifications for Fall River County (1972 and 1977)

Job description	Employment levels		Total employment (%)		Percentage change 1972–1977
	1972	1977	1972	1977	
Proprietors					
Farm	353	339	11.4	9.7	–4.0
Nonfarm	294	323	9.5	9.2	+9.9
Total	647	662	20.9	18.9	+2.3
Wage and salary employees					
Farm	174	204	5.6	5.8	+17.2
Nonfarm	2268	2633	73.4	75.3	+16.1
Mining	94	97	3.0	2.8	+3.2
Construction	15	149	0.0	4.3	+893
Manufacturing	90	84	2.9	2.4	–6.7
Transportation and public utilities	122	134	3.9	3.8	+9.8
Wholesale trade	19	25	1.0	1.0	+31.6
Retail trade	322	495	10.4	14.1	+53.7
Finance, insurance, and real estate	57	79	2.0	2.3	+38.6
Services	331	335	10.7	9.6	+1.2
Government	1218	1235	39.4	35.3	+1.4
Total	2442	2837	79.1	81.1	+16.2
Total employment	3089	3499	100.0	100.0	+13.3

Source: Computerized tabulation entitled "Employment By Type and Broad Industrial Sources," prepared as part of the Regional Economic Information System, Bureau of Economic Analysis, April 1979.

of which about $9 million was designated for salaries and the rest for supplies and services.[14] Additionally, the State Veterans Home employed about 106 persons (99 full time) and had an operating budget of almost $1.5 million. [A commercial hospital and privately operated intermediate-care nursing home are also located in Hot Springs and together employed about 90 persons in 1979.[14]]

Primarily because of an expectedly large and rapid influx of energy-related industry, the economies of Edgemont and Hot Springs and, therefore, the county are predicted to prosper as manifold expansions in employment and population occur.

3.4.4.2 Income

Comparative descriptive statistics indicate that, although increasing steadily through time, the personal per capita incomes of residents of South Dakota and Fall River County have consistently lagged behind national averages (Table 3.8). For example, average per capita earnings in South Dakota were estimated to be $6841 in 1978, 14.9% above that recorded in 1977, and 37% better than that calculated for 1975.[18] However, when compared with the nation and with other states, South Dakota has ranked in the lower fourth. The national average was $7810 in 1978, placing the State 35th among all the states, a marginally better showing than in 1975 and in 1970 when the State ranked 37th and 40th, respectively. While slightly higher than that of South Dakota, the per capita income of the county has increased along with that of the State.

Estimated average annual earnings for Fall River County for several job categories are summarized in Table 3.9. Except for the possibly inflated figures for construction, the results are as anticipated. As expected, farm earnings fluctuated erratically from year to year; and mining, transportation, and utilities have consistently been relatively high-paying industries.

3.4.4.3 Finance and taxes

Three banks and one savings and loan company are located in Hot Springs with total assets of $1010 million and $168 million, respectively, according to a city audit dated October 1980.

Table 3.8. Per capita personal income for the United States, South Dakota, and Fall River County (1960–1978) and percentage change (1972–1977)

Year	Income (current $)[a]		
	United States	South Dakota	Fall River County
1960	2201[b]	1758[b]	
1970	3893[b]	3108[b]	
1972	4493	3847	3984
1973	4980	4948	5135
1974	5428	4753	4793
1975	5861	4995	5693
1976	6397	5043	6203
1977	7026	5953	5400
1978	7810[b]	6841[b]	
		Percentage change	
1972–1977	56.4	77.8	35.5

[a]Sixth District Council of Local Governments, "Public Investment Plan, Fifth Stage," Rapid City, S.D., June 1979. All estimates are in current dollars; that is, inflationary trends have not been accounted for.

[b]U.S. Bureau of the Census, *Statistical Abstract of the United States*, 100th ed., U.S. Government Printing Office, Washington, D.C., 1979, Table 730, p. 445.

Table 3.9. Estimated annual income per labor force participant by job type and industry for Fall River County, 1972 and 1977[a]

Job categories	1972	1977	Percentage change
Proprietor earnings			
Farm	16,966	−3,572	−121
Nonfarm	7,602	10,437	37
Employee earnings			
Mining	8,681	13,959	61
Construction	54,400[b]	19,128[b]	−65
Manufacturing	8,067	10,869	35
Transportation and public utilities	10,697	17,724	66
Wholesale trade	8,684	11,840	36
Retail trade	6,571	7,378	12
Finance, insurance, and real estate	8,000	11,772	47
Government	7,142	10,173	42

[a]These estimates were developed by dividing the total reported personal income for each job category by the total employees recorded for each classification. The income figures are from, respectively, computerized tables entitled "Personal Income By Major Sources 1972–1977" and "Employment By Type and Broad Industrial Sources 1972–1977," prepared by the Bureau of Economic Analysis as part of its Regional Economic Information System.

[b]Because these income estimates seem exorbitantly high, the staff believes that either the employee estimates are understated or the incomes reported are biased upward.

Edgemont has one bank but no savings and loan institution. The primary source of income for the county and the municipalities is property taxes. Relevant tax and spending statistics for these entities are summarized in Table 3.10.

Table 3.10. Recent property valuations, mill levies, and budgets for Fall River County, Hot Springs, and Edgemont

	Fall River County	Hot Springs	Edgemont
Approximate property market valuations,[a] $			
1979	95,994,000	26,139,000	10,527,910
1978	89,178,000	23,661,000	8,028,00
1978 mill levies[a]			
Nonschool	18.89[b]	32.45	25.30
School			
Nonagriculture		49.11	49.02
Agriculture		33.11	33.02
Total city budgets,[c] $			
1975		1,138,086 (385,106)[d]	182,425
1976		1,319,600 (522,289)	224,550
1977		1,335,891 (599,370)	266,317
1978		2,425,056 (1,661,744)	279,300
1982[e]			327,000

[a]Earl Fisher, Tax Assessor, personal communication, October 24, 1979. Note: Mill levies for Hot Springs decreased to 18.36 and for Edgemont to 15.29 between 1978 and 1980.

[b]Levy for areas *not* in Hot Springs and Edgemont. The levy for these municipalities is 18.84.

[c]Sixth District Council of Local Governments, "Hot Springs Outdoor Recreation Assessment," Rapid City, S.D., March 1979; and "Edgemont Recreation Assessment," Rapid City, S.D., April 1979.

[d]Amounts within parentheses are the self-supporting portions of the budgets.

[e]"1982-1987 City Recreation Plan Update, Edgemont, S.D."

3.4.4.4 Community services and public facilities

As in most relatively lightly populated regions where development of mineral resources is expanding rapidly, the two largest cities of Fall River County, Edgemont and Hot Springs, are experiencing and will continue to experience some difficulties in meeting community service requirements. To forecast accurately their needs for additional facilities is difficult. Whereas a large industrial development could produce a need for expanded facilities and staff, the unexpected phasing out of another source of employment could relax facility requirements.

Education

The Hot Springs Independent School District (No. 23-2) encompasses about 1660 km^2 (640 sq miles), of which about 440 km^2 (170 sq miles) are in Custer County, and includes Hot Springs, the two small population centers of Buffalo Gap and Oral, and the rural areas around Hot Springs.[14] Statistics for the Hot Springs district are in Table 3.11. As of April 1981, some crowding existed at the Hot Springs elementary school: three classes were in modular classrooms (B. Lynch, Business Manager, Hot Springs School District, telephone conversation with S. Martin, Apr. 1, 1981).

The Edgemont District (No. 23-1) serves all but the eastern part of Fall River County. Edgemont has consolidated all schools at one location. The average grade size is about 35, and the district hired a special education instructor for the 1980-1981 school year (S. Doerr, Edgemont School District Superintendent, personal communication, Apr. 2, 1981). Enrollment and teacher statistics are summarized in Table 3.12.

Table 3.11. Hot springs school district statistics as of September 1980

Expenditures per pupil ~$1933

	Number	Enrollments	Full-time equivalency staff
High school grades 9–12	1	318	22.8
Middle school grades 6–8	1	237	14.5
Elementary school grades K–5			
Hot Springs	1	435	21.5
Maitland	1	5	1
Buffalo Gap	1	23	2
Oral	1	23	2
Totals	4	486	26.5
Special education		14	3

Table 3.12. Edgemont school district statistics as of March 16, 1981

Expenditures per pupil, ~$1270.

	Enrollments	Full-time equivalency staff
High school grades 9–12	129	8.2
Grades 4–8	167	7.4
Grades K–3	169	7.4

Medical services

In the past, access to medical personnel and facilities has been poor for residents in the Edgemont area because there were no resident medical doctors, dentists, optometrists, or hospital facilities. To obtain care, some residents traveled as far as New Castle, Wyoming, 107 km (67 miles) distant. However, this situation considerbly improved during 1980. A formerly vacant hospital in Edgemont is now used for outpatient medical (including emergency) treatment. Edgemont now has a resident dentist and a resident physician's assistant; also a physician from Custer, South Dakota, and a physician from Lusk, Wyoming, commute to Edgemont once a week. A pediatrician from Rapid City provides bimonthly services, and an optometrist and two mental health counselors provide their services once a week (J. Krueger, Edgemont City Planner, personal communication, Apr. 2, 1981). The local volunteer fire department has one ambulance and provides emergency service for Edgemont and the western portion of Fall River County.

Although there are extensive Federal facilities in Hot Springs, only one civilian hospital, the Southern Hills General Hospital, is in the area. This 50-bed, short-term facility is also in Hot Springs and has a low occupancy rate of about 30%. This rate is misleading because 25 beds are actively being utilized (M. S. Flesner, Assistant Administrator, Southern Hills General Hospital, personal communication, Apr. 2, 1981). The hospital staff consists of four full-time physicians, a courtesy staff of 21 specialists who commute from Rapid City, and an active auxiliary of community volunteers. The hospital has a shared service contract with the veterans hospital for such therapy as ultrasound and nuclear medicine (M. S. Flesner, Assistant Administrator, Southern Hills General Hospital, personal communication, Apr. 2, 1981). Attached to the hospital is a 50-bed, intermediate-care nursing home. Both the hospital and the nursing home are privately owned and operated by the Lutheran Hospitals and Homes Society. Also four general practitioners (one is a surgeon), two dentists, and two optometrists are in Hot Springs.

Fire and police protection

The Edgemont police force consists of four full-time patrolmen, two dispatchers, and two patrol cars; the county sheriff's department protects the noncity areas in the vicinity. Fire protection is provided by a 40-member volunteer fire department. Its basic fire-fighting equipment consists of two 1900-L/min (500-gpm) pumpers; a 3800-L (1000-gal), 946-L/min (250-gpm) pumper for rural service; two four-wheel drive, 946-L capacity (250-gal) trucks for grass fires; a 7600-L (2000-gal) tanker and 1100-L/min (300-gpm) high-pressure pump for rural fires; a salvage truck with smoke extractor; and a portable electric generator (R. V. Bossche, Chief, Edgemont Volunteer Fire Department, personal communication, Mar. 24, 1980). The department also has an emergency ambulance. The fire insurance rating for Edgemont is eight on a scale of one (best) to ten (worst).

The Hot Springs Police Department has a paid staff of six officers, a two-man reserve, and two patrol cars; dispatchers are shared by the city and the county sheriff's department. The volunteer fire department is headed by a chief and two assistants and has a staff of about 50 (H. Walker, Chief, Hot Springs Volunteer Fire Department, personal communication, Mar. 24, 1980). The department's equipment is similar to that of Edgemont and includes an emergency ambulance. Fire insurance classification for Hot Springs is seven.

Water supply systems

Edgemont's water is obtained from five deep free-flowing wells. The maximum pumping capacity is $\sim$3.8 x 10^6 L/d (10^6 gpd). The average daily usage varies according to population changes. In 1979, when Edgemont's population was about 2000, the average usage was about 1.9 x 10^6 L/d (5 x 10^5 gpd). The population declined in 1980 to about 1500; therefore, the average usage has probably decreased to about 1.5 x 10^6 L/d (4 x 10^5 gpd). Because the filtering capacity of the system is limited to $\sim$1.9 x 10^6 L/d (5 x 10^5 gpd), peak summer demands, which have been as high as 3.8 x 10^6 L/d, are difficult to satisfy without imposing restrictions and/or bypassing the filter system. Restrictions have been imposed in the past, and residents have cooperated in decreasing their consumption during specified time periods. About $260,000 was spent from funds provided by a Local Public Works Grant to finish a partially completed storage reservoir that has a capacity of about 10.4 x 10^6 L (2.75 x 10^6 gal) and will also serve as a cooling pond to lessen the adverse heat effects on the distribution system. [The water is very hot — 53°C (128°F) — and is high in minerals, which damage water mains and valves.] Housing and Urban Development Community Block Grants totaling $350,000 have been used for the last three years to upgrade distribution lines. An application for additional funds for this purpose through the Federally sponsored 601 Energy Impact Assistance Program was recently rejected. According to J. Krueger, Edgemont City Planner (personal communication, Apr. 2, 1981), Edgemont's water system, which has been improved during the last few years, is adequate for a population of about 1500. However, if the population increases beyond 1500, then the system may become strained, shifting improvement timetables. For example, some of the wells would have to be recased sooner than would be necessary with a population less than or equal to 1500.

The Hot Springs water system, which is city-owned and -operated, was purchased from the Hot Springs Water Company in 1975.[14] Water supplying the system comes from springs 4.0 km (2.5 miles) northwest of the city. The storage and pumping capacity are adequate for a population of about 6500; however, the system, like that of Edgemont, is severely limited by an old, undersized distribution network. Approximately $1.7 million ($1.25 million from revenue bonding) was recently used to construct a concrete storage facility with a capacity of 7.6 x 10^6 L (2 x 10^6 gal), construct a booster pump station, and renovate 4.8 km (3 miles) of distribution line. These projects were completed in 1978. In 1979, using about $200,000 of a Housing and Urban Development (HUD) block grant, new water mains were installed in the Coldbrook neighborhood. In 1980, a main north-south distribution line was installed in the business district. This installation cost $\sim$\$700,000 and was funded via special assessment bonds (J. Scheltens, Hot Springs City Engineer, personal communication, Apr. 30, 1980).

Sewage

Edgemont's collection, discharge, and wastewater treatment facilities are adequate for a population of 1500. However, the wastewater treatment facility, a stabilization lagoon, is designed for a population of 1500 and would therefore be undersized if Edgemont's population increases. Additionally, the lagoon does not meet the requirements established for a National Pollutant

Discharge Elimination System (NPDES) permit. The city has purchased land adjacent to the existing lagoon to be used for future wastewater treatment facility expansions: sufficient land is available for a facility sized to treat the sewage for a population up to ~6500. Edgemont has been mandated by EPA to expand the lagoon to a size sufficient for a population of 1800 by 1985 to satisfy NPDES requirements. Therefore, the city plans to add an additional cell by 1985. As the population increases beyond 1800, additional cells will be added (J. Krueger, Edgemont City Planner, personal communication, Apr. 2, 1981).

The Hot Springs wastewater treatment facilities are old and inadequate: a portion of the city is still using septic tanks. Plans for upgrading the system were funded and approved. However, because of unanticipated short-term increases in demand caused by currently expected energy-related expansions in employment and population, EPA has approved the commencement of a reevaluation study (J. Scheltens, Hot Springs City Engineer, personal communication, Apr. 3, 1981).

Solid waste

Both Hot Springs and Edgemont collect solid wastes and use landfills for disposal.

Transportation

U.S. Highway 18 and State Highway 52 are the major roads to Edgemont. Highway 18, the primary link between Edgemont and Hot Springs, is currently being upgraded in the Edgemont area. International Parks Highway 385 also passes through Hot Springs, providing a north-south route. Continental Trailways and the Burlington-Northern Railroad provide, respectively, bus and rail service for both Edgemont and Hot Springs. Continental Trailways offers direct connections northward to Rapid City via Custer and southward to Lusk and Cheyenne, Wyoming, and to Denver, Colorado. The Omaha-Rapid City bus line also serves Hot Springs, providing one bus north and south each day to Chadron, Nebraska, and then east to Omaha. No commercial airlines serve Hot Springs or Edgemont. The nearest airport providing commercial service is at Rapid City. Both Hot Springs and Edgemont have municipal airports capable of handling small aircraft. The Edgemont airport has a sod runway. The Hot Springs airport has a 1370-m (4500-ft) asphalt runway, a 1160-m (3800-ft) sod runway, and two hangars equipped to provide fuel.

Utilities

The Black Hills Power and Light Company and the Peoples Telephone and Telegraph Company supply, respectively, electrical power and telephone service for both Edgemont and Hot Springs.

Recreation

Edgemont has three major recreational areas, a municipal park, a softball complex, and a school/fairground complex (a park platted in Cottonwood has never been developed).[13] The municipal park has a small fishing pond, picnic facilities, and playground equipment. The school/fairground complex consists of a playground, indoor recreational facilities, the city's only ballfield, a tennis court, and an outdoor basketball court located on the school grounds. In addition, a privately owned swimming pool is available for public use. The fairgrounds are used primarily for an annual fair. Because Edgemont's park and recreation system is limited, the city has expanded its budget for improvements to be made during the next five years.[13]

Table 3.13 contains an inventory of the outdoor recreational facilities in and around Hot Springs [within a 24-km (15-mile) radius] and includes Evans Plunge, a privately run indoor pool fed by several local warmwater springs.[14]

From a regional perspective, tourism and hunting (primarily for antelope, mule deer, and turkey) are major activities. Outstanding tourist attractions include the Black Hills National Forest, Buffalo Gap and Thunder Basin National Grasslands, Wind Cave National Park, Jewel Cave National Monument, Mount Rushmore National Memorial, Custer State Park, and the Angostura Recreation Area.

Table 3.13. Hot Springs outdoor recreation areas

Area	Size		Description
	ha	acres	
Municipal parks			
Butler Park	12	29	Playground equipment, 4 rest rooms, 3 tennis courts, 2 outdoor basketball courts, and 1 lighted and 2 unlighted softball fields
Cold Brook Park	0.4	1	No facilities
Riverside Park	0.6	1.5	Playground equipment and picnic tables
Centinnial Park	0.6	1.5	Green area with lighted fountain and parking
Chautauqua Park	3	8	Picnic area with picnic tables, running water, and fire boxes
Kidney Springs Park	0.2	0.5	Green area with restored gazebo
Southern Hills Golf Course	36	88	Nine-hole, irrigated, grass-green course
Veterans Administration Medical Center Park	0.8	2	One baseball diamond
School system			
Hot Springs High School and Middle School	6	15	Lighted football field, cinder track, two tennis courts, and gym
Hot Springs Elementary School	2.4	6	Playground equipment
Private facilities			
Evans Plunge			Indoor swimming facility with hot spring water
Hot Springs 24-km (15-mile) recreational areas			
Cold Brook Reservoir			Fishing, camping, hiking, and boating
Fall River Archery Club			Archery range
Cottonwood Springs Creek Dam			Picnicking, camping, playground, and hiking
Hot Springs Gun Club			Trap range
Angostura State Recreation Area			Picnicking, camping, fishing, swimming, boating, and water skiing
Cascade Springs			Picnicking, fishing, and swimming
Larive Lake			Swimming and camping
Wind Cave National Park			Hiking

Source: Sixth District Council of Local Governments, "Hot Springs Outdoor Recreation Facilities," Rapid City, S.D., March 1979.

3.5 LAND

3.5.1 Land use

The principal land use in Fall River County is rangeland (85%). The remainder consists mostly of forest (11%) and cropland (3%). Although sheep grazing is important in some areas, rangeland is used predominantly by cattle. Generally, from 2.7 to 3.9 ha (6.6 to 9.5 acres) are required to support one cow or five sheep for one month per year in grasslands; and from 4.1 to 5.1 ha (10 to 12.5 acres), in pine forests (ER, Sect. 4.6.1.1). Range condition in the vicinity of the project area is generally good, but intensive grazing does occur in some areas, particularly near water. Crop production is usually limited to native hay, alfalfa, or grain. Hay crops generally yield less than 3.4 MT/ha (1.5 tons/acre), and wheat crops usually yield less than 3 m^3/ha (35 bu/acre) (ER, Sect. 4.6.1.1.1). Other crops occasionally grown in the county include irrigated corn, dry-land barley, and oats. None of the lands in the area are classified as prime or unique farmlands as defined by the Soil Conservation Service.[19]

The Tennessee Valley Authority (TVA), which controls mineral rights on 4.1 x 10^4 ha (1.01 x 10^5 acres) in Fall River and Custer counties, South Dakota, and in Weston and Niobrara counties, Wyoming, proposes to begin in the 1980s the mining of uranium/vanadium ore deposits at two sites within 24 km (15 miles) of Edgemont.[20] Both underground and surface mining methods will be used.

The existing mill complex, consisting of several tailings disposal areas and process buildings, has not operated since 1974. Presently, land use at the mill site has a nonuse status. The immediate surrounding land is used in a variety of ways. Cottonwood Community, a residential area, is located south of the site. The Burlington-Northern Railroad to the west forms a narrow industrial strip separating the mill from the commercial district of Edgemont. Except for the city sewage pond adjacent to the site, undeveloped land lies east of the site. The Cheyenne River parallels the northern boundary of the site. Farther north [0.37 km (0.25 mile)] is Dudley, another small residential area.

The proposed disposal site is used primarily for grazing. No structures are on the site, but a small [0.04-ha (0.1-acre)] stock-watering pond is located near the southern boundary. The nearest residence is about 2.4 km (1.5 miles) northwest of the site (ER, Sect. 4.3.1.1).

3.5.2 Historical, archaeological, and scenic areas

3.5.2.1 Historical

No sites currently listed in the National Register of Historic Places are located within the Edgemont Uranium Mill and proposed disposal site. Other than the marked location of the Cheyenne and Deadwood Stage, which passes adjacent to the Edgemont Uranium Mill, no Register sites are located near this facility and the disposal site. No sites or structures potentially eligible for addition to the Register were judged to exist within or immediately adjacent to the areas associated with this project.

3.5.2.2 Archaeological

Archaeological surveys were conducted for this decommissioning plan which took place on September 22 and November 16, 1978, and December 20, 1979, and were performed by a TVA staff archaeologist. These surveys were conducted in compliance with the National Historic Preservation Act (NHPA) of 1966, Executive Order 11593 of 1971, and other applicable legislation.

A file record search was initiated for previously known archaeological sites at the South Dakota Archaeological Research Center, Ft. Meade, South Dakota. A literature search was also conducted in the National Register of Historic Places for archaeologically significant sites. No previously reported sites were discovered in either source of information.

The location of the mill site is at the confluence of Cottonwood Creek and the Cheyenne River. The major portion of this area is in the floodplain adjacent to these two permanent streams. This locality might have had a fairly high potential for prehistoric occupation. However, there has been prior disturbance that approaches total alteration of the original surface. The nature of this disturbance is in the form of the previously constructed settling ponds and tailings piles. As such, the potential for discovering undisturbed archaeological materials at this locality is essentially nonexistent.

The proposed disposal site occupies parts of the southwest one-fourth of Sect. 8 and northwest one-fourth of Sect. 17, T9S, R3E, plus small portions of Sects. 7 and 18, T9S, R3E. The approximate center of the area is 3200 m (approximately 2 miles) from the nearest point on the Cheyenne River and 2800 m (1.7 miles) from Cottonwood Creek. The disposal site is considered to have a low to moderate potential for supporting an archaeological site. A single isolated biface fragment was recorded for one of the ridges within the disposal site area. A no-effect determination has been granted for this property by the Soutn Dakota State Historic Preservation Officer (J. J. Little, South Dakota Historic Preservation Officer, personal communication with M. D. Ramsey, TVA, Oct. 17, 1979). If archaeological remnants are discovered during site operations, TVA will be required to notify State and Federal authorities and protect the archaeological resources as instructed.

3.5.2.3 Scenic

No scenic or natural areas were identified on the disposal site. The only feature in the vicinity proposed for special scenic designation is Red Canyon–Fourmile Creek Drive extending from U.S. Highway 18 east of Edgemont to U.S. Highway 16 west of Custer. This road, located several miles from the site, is proposed by the South Dakota Department of Transportation for inclusion in the Federal scenic roads and parkways plan (ER, Sect. 4.3.2.1).

3.6 WATER

3.6.1 Surface water

3.6.1.1 Hydrology

All streams in the Edgemont area – most of which are ephemeral – flow into the Cheyenne River. Surface water features for the Edgemont decommissioning area, which is within the Cheyenne River watershed, are shown in Fig. 3.4. The mill site is on the Cheyenne River at the mouth of Cottonwood Creek. The Cheyenne River begins about 185 km (115 miles) west of Edgemont, flows from west to east along the northern boundary of the site, and drains an 18,500-km^2 (7140-sq-mile) area above Edgemont which includes portions of Wyoming, Nebraska, and South Dakota. The river course approximates the boundary between the Black Hills and the Missouri Plateau sections of the Great Plains Physiographic Province (ER, Sect. 4.2). About 54 km (34 miles) downstream from Edgemont, the Cheyenne River is impounded for irrigation and flood control by the Angostura Reservoir.

The average discharge of the Cheyenne River at the Edgemont station (Highway 18 bridge north of town) over a 35-year period was 2.8 m^3/s (97 cfs or 70,600 acre-ft/year), which is equivalent to 0.48 cm (0.19 in.) of annual runoff from the watershed.[21] The average annual flow for 20 water years (1949 through 1968) ranged from a minimum of 0.37 m^3/s (13 cfs) in 1961 to a maximum of 12.3 m^3/s (434 cfs) in 1962.[21] Sustained flow was recorded during only eight of the years from 1947 through 1977.[22] Flows of the Cheyenne River are influenced by many small reservoirs (9320 in 1965), which may have the potential for decreasing the future flow rate of the river (ER, Sect. 4.2).

During periods of high spring flow, the Cheyenne River channel is completely filled to a depth of 2 to 3 m (7 to 10 ft). Flooding may cause extensive scouring of substrata. During the summer and autumn, little or no flow occurs, and large quantities of silt may be deposited in the channel. At these times the stream channel is braided because debris on the floodplain causes flow in small, intermeshed channels. The State of South Dakota has classified the Cheyenne River as a warmwater, semipermanent, fish-life-propagating stream, which is characterized by riffle and pool habitats.

Cottonwood Creek, which flows through the mill site, drains an area of approximately 388 km^2 (150 sq miles). The stream channel in the vicinity of the mill site, tailings area A, and the east sandpile (Fig. 3.5) was straightened during mill operation. Because no historical flow records are available for Cottonwood Creek, the licensee determined flow characteristics of the stream by using techniques developed by the U.S. Geological Survey (USGS)[23,24] (Table 3.14). The average flow, which TVA estimated to be 0.065 m^3/s (2.3 cfs), is equivalent to an annual runoff of 0.53 cm (0.21 in.). The State of South Dakota has classified Cottonwood Creek as a perennial stream that exhibits fluctuations in flow. Although of lesser magnitude, fluctuations in streamflow of Cottonwood Creek are similar to those of the Cheyenne River. Like the Cheyenne River, Cottonwood Creek is characterized by riffle and pool habitats.

Mill site

The Cheyenne River channel in the vicinity of Edgemont is braided and has a broad floodplain. Flood stages can reach the level of the base of the tailings in ponds 1 and 2. The riverbed in the reach containing the tailings is at elevations between 1040 and 1041 m (3412 and 3416 ft) MSL. The base of the tailings in this reach is near 1044 m (3425 ft). A flow of 390 m^3/s (13,800 cfs), which is a 25-year flood equivalent, reaching an elevation of 1044 m (3425 ft) was recorded at Edgemont in 1971 (ER, Sect. 4.2). A flood on May 20, 1978, reached an elevation of 1044.8 m (3428.2 ft) at the USGS gage (Fig. 3.5) upstream of the mill site and a peak flow of 793 m^3/s (28,000 cfs). The highest recorded flood (May 1922) was 0.11 m (0.35 ft) higher

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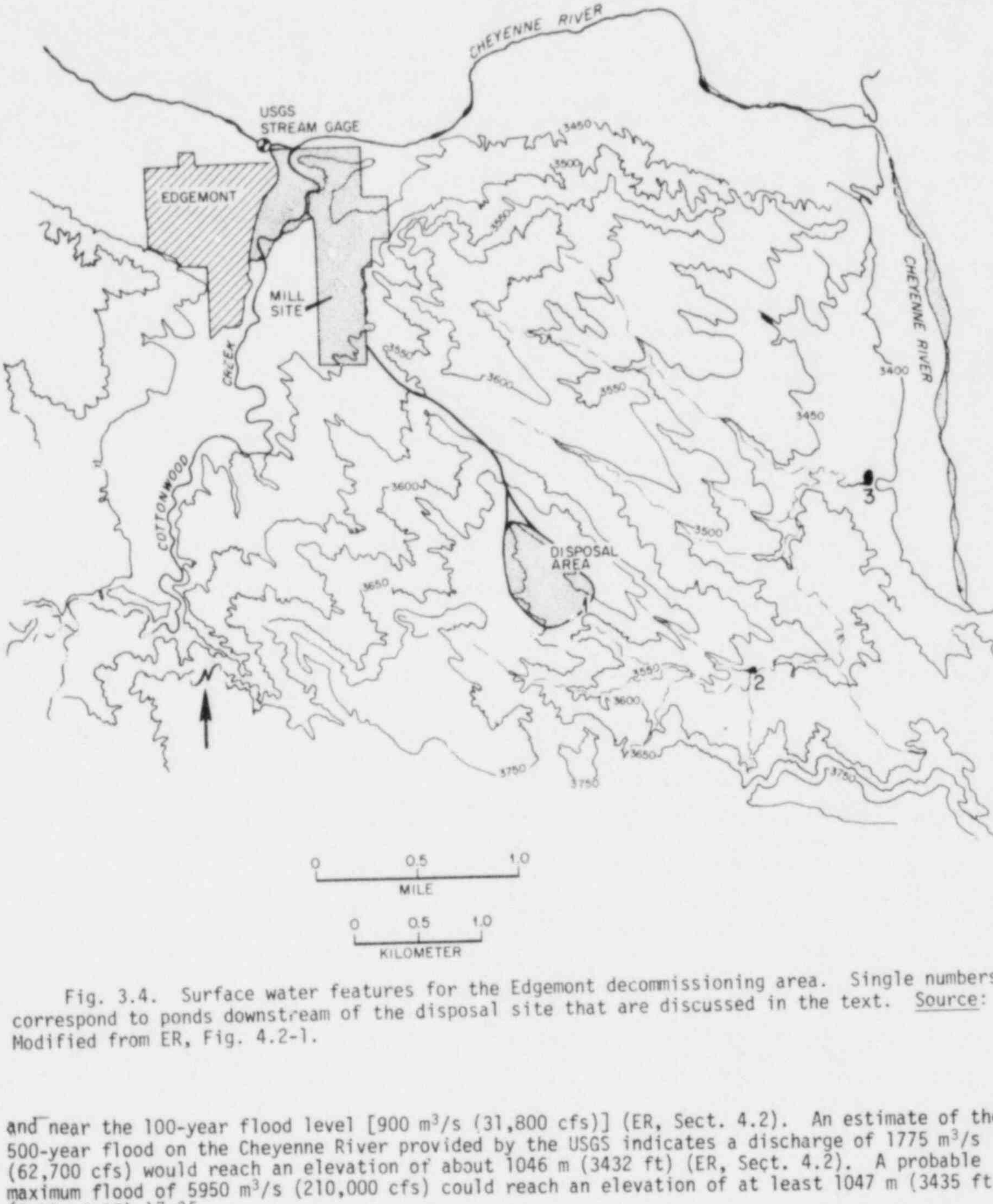

Fig. 3.4. Surface water features for the Edgemont decommissioning area. Single numbers correspond to ponds downstream of the disposal site that are discussed in the text. Source: Modified from ER, Fig. 4.2-1.

and near the 100-year flood level [900 m^3/s (31,800 cfs)] (ER, Sect. 4.2). An estimate of the 500-year flood on the Cheyenne River provided by the USGS indicates a discharge of 1775 m^3/s (62,700 cfs) would reach an elevation of about 1046 m (3432 ft) (ER, Sect. 4.2). A probable maximum flood of 5950 m^3/s (210,000 cfs) could reach an elevation of at least 1047 m (3435 ft) (Table 3.15).[17,25]

Cottonwood Creek, within the reach adjacent to the mill tailings, has cut through the Cheyenne River alluvium and upper bedrock to reach levels of 1041 to 1046 m (3414 to 3430 ft).[24] A theoretical USGS technique[6] was used to estimate 25- and 100-year flood levels for Cottonwood Creek. This technique yielded estimates of approximately 102 m^3/s (3600 cfs) for the 25-year flood and about 222 m^3/s (7850 cfs) for the 100-year flood. Water levels at the site for the

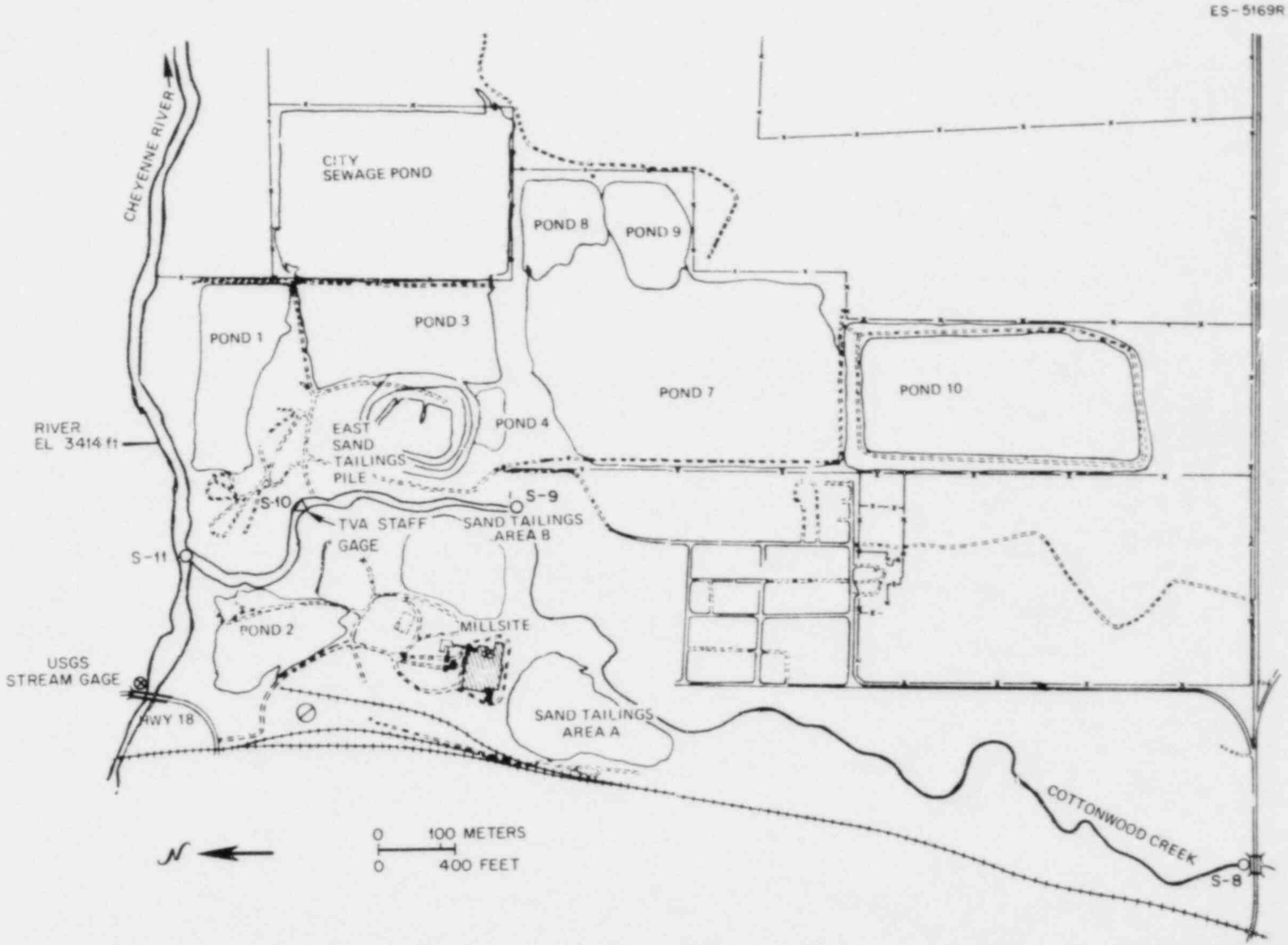

Fig. 3.5. Surface water features of the Edgemont mill site Source: ER, Fig. 4.2-2.

Table 3.14. Estimates of mean annual runoff – drainage area parameters[a] for watersheds above selected locations in the vicinity of the proposed disposal site for the Edgemont Uranium Mill

Selected location[b]	Drainage area		Maximum 24-hr–2-year rainfall		Water content of snow, March 1–16, (25-year recurrence interval)[c]		Mean annual discharge					
	km^2	$miles^2$	cm	in.	cm	in.	m^3/sec	cfs	m^3	acre-ft	cm	in.
Edgemont Uranium Mill site												
Cottonwood Creek	388	150	4.8	1.9[d]	3.6	1.4	0.066	2.3	2.08×10^6	1,690	0.08	0.21
Cheyenne River	18,500	7,140					2.76	97.4	87.04×10^6	70,570	0.07	0.19
Disposal site												
Containment dike	0.52	0.2	4.8	1.9	3.6	1.4	0.00009	0.003	2.7×10^3	2.2	0.08	0.21
Pond near Cheyenne River	11.4	4.40	4.8	1.9	3.6	1.4	0.002	0.072	64.1×10^3	52	0.09	0.22

[a]Significant parameters based on regression analysis as defined by O. J. Larimer, *A Proposed Steamflow Data Program for South Dakota*, U.S. Geological Survey Open File Report, 1970.

[b]Refer to location maps (Figs. 3.4 and 3.5).

[c]Based on U.S. Weather Bureau Technical Paper No. 50 (1964).

[d]Based on U.S. Geological Survey stream gage records for the Cheyenne River at Edgemont Station.

Source: Modified from ER, Table 4.2-1.

Table 3.15. Flood peak discharge at selected locations in the vicinity of the proposed disposal site for the Edgemont Uranium Mill

Selected location[a]	Drainage		Discharge									
			2-year		10-year		100-year		50-year		Max. probable[b]	
	km^2	$miles^2$	m^3/s	cfs	m^3/s	cfs	m^3/s	cfs	m^3/s	cfs	m^3/s	cfs
Edgemont Uranium Mill site												
Cottonwood Creek	388	150	10.7	379	60.3	2,130	217	7,680	159	5,600	1,982	70,000
Cheyenne River	18,500	7,140	86.4	3,050	292	10,300	900	31,800	663	23,400	5,940	210,000
Disposal site												
Containment dike	0.52	0.2	0.28	10	2.5	90	10.8	380	7.4	260	102	3,600
Pond near Cheyenne River	11.4	4.40	1.6	55	11	300	44.5	1,570	31.4	1,110	424	15,000

[a] Refer to location maps (Figs. 3.4 and 3.5).
[b] Reconnaissance-level estimates only.
Source: ER, Table 4.2-2.

100-year flood should not exceed 1049 m (3440 ft) MSL.[17] Physical transport of tailings due to flooding of the Cheyenne River or Cottonwood Creek is possible.

The Cheyenne River and Cottonwood Creek are both gaining streams during most of the year; thus, they are, in part, recharged by unconfined groundwaters in the vicinity of Edgemont. Wells located within the floodplain are recharged by the flow of floodplain surface waters or by the entering groundwater.

Additional sources of surface flow at the site are from the (1) Edgemont secondary sewage treatment outfall line, which may be intermittent depending on system breakdown, (2) city wells, (3) mill fire safety tank, (4) potential seepage from tailings ponds on site, and (5) direct and ponded precipitation runoff. Runoff from an area of about 125.5 ha (310 acres) east of mill tailings ponds 7 through 10 contributes to standing water in the ponds.

Disposal site

The preferred disposal site (Fig. 3.4) is drained by an ephemeral, unnamed tributary of the Cheyenne River. The tributary ends in a man-made pond near the western edge of the river's floodplain at point 3 (Fig. 3.4). Another small man-made pond (Fig. 3.4, point 2) of about 0.1 ha (0.25 acre) is located approximately halfway between the disposal site and the Cheyenne River. A small stock pond of about 0.8 ha (2 acres), which is located at the southern limit of the disposal site (Fig. 3.4, point 1), is impounded by an earth dam about 64 m (210 ft) long, 4.6 m (15 ft) high, and 7.6 m (25 ft) wide at the crest.[25] Most of the runoff from the disposal site is probably contained by this pond. Any overflow from this pond not contained by ponds at points 2 and 3 (Fig. 3.4) could reach the Cheyenne River.[25] Runoff characteristics at points 1 and 2 (Fig. 3.4) are based on techniques developed by the Water Resources Division of the USGS[23,24,26] (Tables 3.14 and 3.15). Annual runoff for the disposal area, although variable, averages approximately 0.53 cm (0.21 in.). More than half the runoff generally occurs during May, June, and July as the result of snowmelt and heavy rainfall. The range of flood peak discharges that could be expected at selected locations in the vicinity of the preferred disposal site is indicated on Table 3.15. Watershed elevations for the disposal site range from about 1165 m (3820 ft) at the highest point on the western watershed divide to about 1091 m (3580 ft) near the proposed dike at the lower boundary of the disposal site (Fig. 3.4, point 1). The disposal site elevation is well above the projected elevation of the 500-year flood [1046 m (3432 ft)] (ER, Sect. 4.2).

3.6.1.2 Water quality

This section describes the nonradiological surface water-quality characteristics of streams affected by the decommissioning of the Edgemont mill.

Water quality in both the Cheyenne River and Cottonwood Creek is influenced by spring runoff and reduced flow during late summer and early fall. During the spring those constituents influenced by runoff, such as suspended solids, color, nutrients, and iron, are increased. During the late summer and early fall, streamflow is predominantly from groundwater that enters the streambed through seeps, springs, and flowing wells (ER, Sect. 4.2).

The South Dakota temperature standards for the Cheyenne River [32.2°C (90°F)] were exceeded in August 1973 and June 1974 (ER, Sect. 4.2). The chemical water quality of both the Cheyenne River and Cottonwood Creek ranges from good to poor. Mean concentrations of barium in both streams and maximum concentrations of arsenic in the Cheyenne River exceed the EPA "National Interim Primary Drinking Water Standards"[27] for finished drinking water (Tables 3.16 and 3.17). Chloride, iron, manganese, and sulfate concentrations in both the Cheyenne River and Cottonwood Creek exceed concentrations identified by the EPA "Proposed Secondary Drinking Water Standards."[28] None of the values discussed above exceed quality criteria for protection of aquatic biota. Conductivity in the Cheyenne River and Cottonwood Creek is above irrigation criteria, and ammonia nitrogen in Cottonwood Creek is above warmwater semipermanent stream criteria according to South Dakota water-quality standards.[29] High chemical oxygen demand exists in the Cheyenne River in the project vicinity. Historically, dissolved oxygen concentrations in both water bodies have been greater than the minimum State standards.[29] Values for pH range from 6.5 to 8.9 (Table 3.18). Alkalinity and hardness values are sufficiently high in both the Cheyenne River and Cottonwood Creek for the water in the streams to be considered very hard. Dissolved solids are also high in both streams. Turbidity and suspended solids in Cottonwood Creek increase downstream through the mill site.

Table 3.16. Summary of chemical surface water quality for the Cheyenne River and Cottonwood Creek in the vicinity of the Edgemont Uranium Mill, South Dakota

Parameter	No. of samples	Observed concentrations		
		Maximum	Minimum	Mean
Cheyenne River (S-4)[a]				
Aluminum, μg/liter	3	400	<200	<300
Ammonia nitrogen, mg/liter	19	0.35	<0.01	0.11
Arsenic, μg/liter	6	53	<2	<13
Barium, μg/liter	5	14,000	<100	<2,900
Beryllium, μg/liter	2	<10	<10	<10
Biochemical oxygen demand (5-day), mg/liter	37	3.0	0.5	1.4
Boron, μg/liter	7	1,300	240	500
Cadmium, μg/liter	7	8	0	2
Calcium, mg/liter	61	650	67	370
Chemical oxygen demand, mg/liter	2	150	16	83
Chloride, mg/liter	66	1,190	30	410
Chromium (total), μg/liter	10	42	0	<9
Cobalt, μg/liter	2	11	<5	<8
Conductivity, μmhos	93	7,690	590	3,980
Copper, μg/liter	9	50	3	20
Fluoride, mg/liter	31	0.8	0.2	0.6
Iron (total), mg/liter	38	80	0.02	5.8
Lead, μg/liter	9	27	0	11
Lithium, μg/liter	3	280	120	210
Magnesium, mg/liter	61	301	22	126
Manganese (total), μg/liter	37	4,150	70	490
Mercury, μg/liter	7	0.9	0.1	<0.3
Molybdenum, μg/liter	9	<100	2	<80
Nickel, μg/liter	7	80	5	<40
Nitrate plus nitrite nitrogen, mg/liter	18	0.64	<0.01	0.18
Organic nitrogen, mg/liter	23	4.1	0.08	1.0
Phosphorus (total), mg/liter	59	1.9	0.0	0.2
Potassium, mg/liter	56	25	1.2	10
Selenium, μg/liter	7	3	<1	<2
Silica (total), mg/liter	23	12	3.9	8.4
Silver, μg/liter	5	10	0	6
Sodium, mg/liter	58	1,310	110	530
Strontium, μg/liter	2	4,700	1,600	3,150
Sulfate, mg/liter	63	3,720	350	1,730
Tin, μg/liter	1	<100		
Titanium, μg/liter	2	<1,000	<1,000	<1,000
Vanadium, μg/liter	9	<500	3.3	<200
Zinc, μg/liter	9	420	<10	80
Cheyenne River (S-5)[b]				
Aluminum, μg/liter				
Ammonia nitrogen, mg/liter				
Arsenic, μg/liter	1	<5		
Barium, μg/liter				
Beryllium, μg/liter				
Boron, μg/liter				
Cadmium, μg/liter				
Calcium, mg/liter				
Chemical oxygen demand				
Chloride, mg/liter				
Chromium (total), μg/liter	2	<5	<5	<5
Cobalt, μg/liter				
Conductivity, μmhos	22	5,500	545	3,925
Copper, μg/liter	2	70	<10	<40
Fluoride, mg/liter				
Iron (total), mg/liter	2	0.40	0.14	0.27
Lead, μg/liter	2	13	<10	<12
Lithium, μg/liter				

Table 3.16 (continued)

Parameter	No. of samples	Observed concentrations		
		Maximum	Minimum	Mean
Cheyenne River (S-5)[b] (continued)				
Magnesium, mg/liter				
Manganese (total), μg/liter				
Mercury, μg/liter				
Molybdenum, μg/liter	2	<100	<100	<100
Nickel, μg/liter	2	<50	<50	<50
Nitrate plus nitrite nitrogen, mg/liter				
Organic nitrogen, mg/liter				
Phosphorus (total), mg/liter				
Potassium, mg/liter				
Selenium, μg/liter				
Silica (total), mg/liter				
Silver, μg/liter				
Sodium, mg/liter				
Strontium, μg/liter				
Sulfate, mg/liter				
Tin, μg/liter	1	<100		
Titanium, μg/liter				
Vanadium, μg/liter	2	<500	<500	<500
Zinc, μg/liter	2	60	10	40
Cheyenne River (S-6)[c]				
Aluminum, μg/liter	3	1,100	200	700
Ammonia nitrogen, mg/liter	2	0.05	0.01	0.03
Arsenic, μg/liter	5	90	<2	<20
Barium, μg/liter	5	15,000	<100	3,100
Beryllium, μg/liter	2	<10	<10	<10
Boron, μg/liter	4	820	260	520
Cadmium, μg/liter	5	4	<1	<2
Calcium, mg/liter	5	490	220	340
Chemical oxygen demand	2	240	19	130
Chloride, mg/liter	5	890	75	420
Chromium (total), μg/liter	6	18	<5	<7
Cobalt, μg/liter	2	27	<5	<16
Conductivity, μmhos	4	6,100	1,490	3,790
Copper, μg/liter	6	50	<10	30
Fluoride, mg/liter	5	0.61	0.43	0.52
Iron (total), mg/liter	6	5.00	0.11	1.36
Lead, μg/liter	6	21	<10	14
Lithium, μg/liter	3	180	150	170
Magnesium, mg/liter	5	190	69	130
Manganese (total), μg/liter	5	3,900	50	1,100
Mercury, μg/liter	4	<0.2	<0.2	<0.2
Molybdenum, μg/liter	6	<100	<100	<100
Nickel, μg/liter	4	100	<50	<60
Nitrate plus nitrite nitrogen, mg/liter	2	0.56	0.10	0.33
Organic nitrogen, mg/liter	2	3.60	0.31	2.00
Phosphorus (total), mg/liter	2	2.80	0.07	1.40
Potassium, mg/liter	3	25	9.6	18
Selenium, μg/liter	5	4	<1	<2
Silica (total), mg/liter	3	8.8	2.1	6.1
Silver, μg/liter	3	10	<10	<10
Sodium, mg/liter	5	910	170	560
Strontium, μg/liter	2	4,600	2,000	3,300
Sulfate, mg/liter	5	2,700	640	1,590
Tin, μg/liter				
Titanium, μg/liter	2	<1,000	<1,000	<1,000
Vanadium, μg/liter	6	<500	<100	<200
Zinc, μg/liter	6	100	<10	50

Table 3.16. (continued)

Parameter	No. of samples	Observed concentrations		
		Maximum	Minimum	Mean
Cheyenne River (S-7)[d]				
Aluminum, µg/liter	2	1,700	<200	1,000
Ammonia nitrogen, mg/liter	2	0.01	0.01	0.01
Arsenic, µg/liter	2	4	<2	<3
Barium, µg/liter	2	230	<100	<160
Boron, µg/liter	1	140		
Cadmium, µg/liter	2	8	<1	<4
Calcium, mg/liter	2	510	470	490
Chemical oxygen demand	2	19	5	12
Chloride, mg/liter	2	160	150	160
Chromium (total), µg/liter	2	<5	<5	<5
Cobalt, µg/liter	2	<5	<5	<5
Conductivity, µmhos	2	3,000	2,770	2,880
Copper, µg/liter	2	40	20	30
Fluoride, mg/liter	2	0.82	0.66	0.74
Iron (total), mg/liter	2	0.65	0.14	0.40
Lead, µg/liter	2	<10	<10	<10
Magnesium, mg/liter	2	100	100	100
Manganese (total), µg/liter	2	100	20	60
Mercury, µg/liter	2	0.6	<0.2	<0.4
Molybdenum, µg/liter	2	100	100	100
Nickel, µg/liter	1	<50		
Nitrate plus nitrite nitrogen, mg/liter	2	1.60	0.17	0.89
Organic nitrogen, mg/liter	2	0.55	0.03	0.29
Phosphorus (total), mg/liter	2	0.29	0.01	0.15
Selenium, µg/liter	2	2	2	2
Silica (total), mg/liter	1	13		
Silver, µg/liter	1	<10		
Sodium, mg/liter	2	230	140	180
Strontium, µg/liter	2	4,900	4,600	4,750
Sulfate, mg/liter	2	2,200	1,600	1,900
Vanadium, µg/liter	2	<100	<100	<100
Zinc, µg/liter	2	30	10	20
Cottonwood Creek (S-8)[e]				
Aluminum, µg/liter	2	700	<200	450
Ammonia nitrogen, mg/liter	2	0.02	0.02	0.02
Arsenic, µg/liter	5	7	<2	<4
Barium, µg/liter	5	5,100	<100	<1,100
Boron, µg/liter	4	1,600	440	930
Cadmium, µg/liter	5	7	<1	4
Calcium, mg/liter	5	620	280	470
Chemical oxygen demand	2	27	17	22
Chloride, mg/liter	5	300	46	240
Chromium (total), µg/liter	5	8	<5	<6
Cobalt, µg/liter	2	<5	<5	<5
Conductivity, µmhos	5	6,100	3,200	5,010
Copper, µg/liter	5	40	<10	30
Fluoride, mg/liter	5	1.0	0.80	0.93
Iron (total), mg/liter	5	3.1	0.41	1.2
Lead, µg/liter	5	17	<10	14
Magnesium, mg/liter	5	260	20	180
Manganese (total), µg/liter	5	720	140	380
Mercury, µg/liter	5	0.4	<0.2	0.2
Molybdenum, µg/liter	5	<100	<100	<100
Nickel, µg/liter	3	50	<50	50
Nitrate plus nitrite nitrogen, mg/liter	2	0.03	0.01	0.02
Organic nitrogen, mg/liter	2	0.18	0.11	0.15
Phosphorus (total), mg/liter	2	0.02	0.01	0.02
Selenium, µg/liter	5	3	<1	<2

Table 3.16. (continued)

Parameter	No. of samples	Observed concentrations		
		Maximum	Minimum	Mean
Cottonwood Creek (S-8)[e] (continued)				
Silica (total), mg/liter	3	8.0	4.4	5.8
Silver, µg/liter	5	3	<1	<2
Sodium, mg/liter	5	5,600	77	1,500
Strontium, µg/liter	2	5,700	3,700	4,700
Sulfate, mg/liter	5	3,300	1,300	2,600
Vanadium, µg/liter	5	<500	<100	<200
Zinc, µg/liter	5	40	10	20
Cottonwood Creek (S-9)[f]				
Aluminum, µg/liter				
Ammonia nitrogen, mg/liter				
Arsenic, µg/liter	2	<5	<5	<5
Barium, µg/liter	1	100		
Boron, µg/liter	1	1,400		
Cadmium, µg/liter	1	<1		
Calcium, mg/liter	1	240		
Chemical oxygen demand				
Chloride, mg/liter	1	260		
Chromium (total), µg/liter	3	12	<5	<7
Cobalt, µg/liter				
Conductivity, µmhos	2	4,800	3,730	4,270
Copper, µg/liter	3	20	10	10
Fluoride, mg/liter	1	1.3		
Iron (total), mg/liter	3	1.6	0.19	0.75
Lead, µg/liter	3	16	<10	<12
Magnesium, mg/liter	1	150		
Manganese (total), µg/liter	1	360		
Mercury, µg/liter	1	<0.2		
Molybdenum, µg/liter	3	<100	<100	<100
Nickel, µg/liter	3	<50	<50	<50
Nitrate plus nitrite nitrogen, mg/liter				
Organic nitrogen, mg/liter				
Phosphorus (total), mg/liter				
Selenium, µg/liter	1	1		
Silica (total), mg/liter	1	21.0		
Silver, µg/liter	1	<10		
Sodium, mg/liter	1	500		
Strontium, µg/liter				
Sulfate, mg/liter	1	840		
Vanadium, µg/liter	3	<500	<100	<400
Zinc, µg/liter	3	40	20	30
Cottonwood Creek (S-10)[g]				
Aluminum, µg/liter	2	700	300	500
Ammonia nitrogen, mg/liter	2	5.9	5.2	5.6
Arsenic, µg/liter	5	20	<2	<7
Barium, µg/liter	5	4,800	<100	<1,000
Boron, µg/liter	4	1,300	370	850
Cadmium, µg/liter	5	5	<1	2
Calcium, mg/liter	5	410	220	290
Chemical oxygen demand	2	19	13	16
Chloride, mg/liter	5	300	63	230
Chromium (total), µg/liter	6	13	<5	<7
Cobalt, µg/liter	2	<5	<5	<5
Conductivity, µmhos	5	4,600	3,250	3,670
Copper, µg/liter	5	40	<10	30
Fluoride, mg/liter	5	1.2	0.11	0.92
Iron (total), mg/liter	5	2.1	0.15	1.1
Lead, µg/liter	6	12	<10	<10

Table 3.16. (continued)

Parameter	No. of samples	Observed concentrations		
		Maximum	Minimum	Mean
Cottonwood Creek (S-10)[g] (continued)				
Magnesium, mg/liter	5	170	100	130
Manganese (total), μg/liter	5	730	220	450
Mercury, μg/liter	5	0.6	0.2	0.3
Molybdenum, μg/liter	6	<100	<100	<100
Nickel, μg/liter	4	<50	<50	<50
Nitrate plus nitrite nitrogen, mg/liter	2	2.0	0.95	1.5
Organic nitrogen, mg/liter	2	1.8	1.4	1.6
Phosphorus (total), mg/liter	2	0.02	0.02	0.02
Selenium, μg/liter	5	5	2	4
Silica (total), mg/liter	3	19	8.8	12.3
Silver, μg/liter	3	10	<10	<10
Sodium, mg/liter	5	5,400	370	1,400
Strontium, μg/liter	2	4,100	2,900	3,500
Sulfate, mg/liter	5	2,200	840	1,600
Vanadium, μg/liter	6	<500	<100	<200
Zinc, μg/liter	6	80	<10	40
Cottonwood Creek (S-11)[h]				
Aluminum, μg/liter	2	900	500	700
Ammonia nitrogen, mg/liter	1	7.4		
Arsenic, μg/liter	6	10	<2	6
Barium, μg/liter	5	6,600	<100	<1,400
Boron, μg/liter	4	1,300	380	750
Cadmium, μg/liter	5	4	<1	<2
Calcium, mg/liter	5	300	220	260
Chemical oxygen demand	2	46	18	32
Chloride, mg/liter	5	310	78	230
Chromium (total), μg/liter	7	13	<5	<6
Cobalt, μg/liter	2	<5	<5	<5
Conductivity, μmhos	5	3,800	2,800	3,380
Copper, μg/liter	7	60	<10	30
Fluoride, mg/liter	5	1.3	0.11	0.86
Iron (total), mg/liter	7	2.9	0.27	1.5
Lead, μg/liter	7	17	<10	<11
Magnesium, mg/liter	5	160	17	99
Manganese (total), μg/liter	5	1,300	220	560
Mercury, μg/liter	5	0.8	<0.2	0.5
Molybdenum, μg/liter	7	<100	<100	<100
Nickel, μg/liter	5	<50	<50	<50
Nitrate plus nitrite nitrogen, mg/liter	1	2.4		
Organic nitrogen, mg/liter	1	4.0		
Phosphorus (total), mg/liter	1	0.03		
Selenium, μg/liter	5	5	2	3
Silica (total), mg/liter	3	17.0	8.8	11.6
Silver, μg/liter	3	<10	<10	<10
Sodium, mg/liter	5	500	280	400
Strontium, μg/liter	2	3,000	2,700	2,900
Sulfate, mg/liter	5	1,800	960	1,450
Vanadium, μg/liter	7	<500	<100	<300
Zinc, μg/liter	7	50	<10	30

[a] Upstream of U.S. Highway 18 bridge at Edgemont.
[b] About 2.5 km downstream of Edgemont.
[c] About 10 km downstream of Edgemont.
[d] Upstream of State Route 71 bridge at Angostura Reservoir.
[e] Upstream of mill property at the county bridge off State Highway 52.
[f] At mill site pipeline extension bridge.
[g] About 9.1 m (30 ft) upstream of the mill road culvert.
[h] At the confluence with the Cheyenne River.

Source: Modified from ER, Table 4.2-4.

Table 3.17. Summary of water quality standards and criteria

Parameter	South Dakota water quality standards[a]	EPA drinking water standards[b]	NAS–NAE[c] Irrigation water criteria	NAS–NAE[c] Livestock watering criteria
Aluminum, μg/liter			5,000	5,000
Ammonia nitrogen, mg/liter	1.0			
Arsenic, μg/liter		50*	100	200
Barium, μg/liter		1,000*		
Beryllium, μg/liter			100	
Boron, μg/liter			750	
Cadmium, μg/liter		10*	10	50
Calcium, mg/liter				
Chemical oxygen demand				
Chloride, mg/liter		250		
Chromium (total), μg/liter		50*	100	1,000
Cobalt, μg/liter			50	1,000
Conductivity, μmhos	2,500			
Copper, μg/liter		1,000	200	500
Fluoride, mg/liter		1.4 – 2.4*	1.0	2.0
Iron (total), mg/liter	0.2	0.3	5	
Lead, μg/liter		50*	5,000	100
Lithium, μg/liter			2,500	
Magnesium, mg/liter				
Manganese (total), μg/liter		50	200	
Mercury, μg/liter		2*		10
Molybdenum, μg/liter			10	
Nickel, μg/liter			200	
Nitrate nitrogen, mg/liter	50 (as NO_3)	45 (as NO_3)*		
Nitrate plus nitrite nitrogen, mg/liter				100
Organic nitrogen, mg/liter				
Phosphorus (total), mg/liter				
Potassium, mg/liter				
Sodium adsorption ratio	10			
Selenium, μg/liter		10*	20	50
Silica (total), mg/liter				
Silver, μg/liter		50*		
Sodium, mg/liter				
Strontium, μg/liter				
Sulfate, mg/liter		250		
Titanium, μg/liter				
Vanadium, μg/liter			100	100
Zinc, μg/liter		5,000	2,000	25,000

[a]State of South Dakota, Department of Environmental Protection, *Surface Water Quality Standards*, SDCL 46-25-107, 1974.

[b]Standards marked with an asterisk (*) are primary drinking water standards. Unmarked standards are the proposed secondary drinking water standards (40 CFR Part 141. 248 and 40 CFR Part 143. 62).

[c]National Academy of Sciences and National Academy of Engineering, *Water Quality Criteria 1972*, Report USEPA R3-73-033, March 1973.

Source: Modified from ER, Table 4.2-4.

3.6.1.3 Surface water use

The State of South Dakota has classified the Cheyenne River in the vicinity of Edgemont as being suitable for (1) warm-water, semipermanent fish-life propagation; (2) limited contact recreation; (3) wildlife propagation and stock watering; and (4) irrigation.[29] Based upon *Water Quality Criteria*, 1972 (ref. 30), water from the Cheyenne River is unsuitable for continuous irrigation use. The mean concentrations of dissolved solids in the Cheyenne River exceed both established criteria for livestock watering and water-quality standards for South Dakota.

Table 3.18. Summary of physical and bacteriological surface water quality data for the Cheyenne River and Cottonwood Creek in the vicinity of the Edgemont uranium mining project

Stream and mileage	Parameter											
	Water temp. (°C)	Dissolved oxygen (mg/liter)	pH (S.U.)	Total alkalinity as $CaCO_3$ (mg/liter)	Hardness as $CaCO_3$ (mg/liter)	True color (PCU)	Apparent color (PCU)	Turbidity (JTU)	Solids: Dissolved (mg/liter)	Solids: Suspended (mg/liter)	Coliform (No./100): Fecal	Coliform (No./100): Streptococcal
Cheyenne River[a] (S-4)												
Max	29.0	13.1	8.9	433	2770	100	6000	2700	7571	8593	4800	
Min	0.0	0.7	7.0	70	260	5	7	8.4	695	0	0	
Mean	11.5	9.6	8.6	189	1390	30	1200	700	3526	692	480	
No. of samples	100	74	94	63	65	5	5	4	67	41	52	
Cheyenne River[b] (S-5)												
Max	36.0	13.7	8.4						4200	17		
Min	0.0	8.3	6.9						3800	17		
Mean	10.7	10.9	7.9						4000	17		
No. of samples	23	21	22						2	2		
Cheyenne River[c] (S-6)												
Max	26.0	12.4	8.2	180	1900	90	6200	3200	6300	5500		
Min	18.0		6.7	84	880	7	14	11	990	9		
Mean	22.8		7.6	130	1400	30	1400	840	3560	960		
No. of samples	4	1	5	4	5	5	5	4	6	6		
Cheyenne River[d] (S-7)												
Max	20	8.4	8.2	163	1692	10	210	68	2700	120		
Min			8.1	160	1600	5	8	4.4	2500	21		
Mean			8.2	162	1646	8	110	36	2600	70		
No. of samples	1	1	2	2	2	2	2	2	2	2		
Cottonwood Creek[e] (S-8)												
Max	23.0	12.3	7.8	260	2592	30	34	11	5600	53		
Min	16.5		6.5	170	1265	5	19	3.8	2300	5		
Mean	20.5		7.3	230	1931	15	28	6.6	4200	27		
No. of samples	4	1	5	4	5	5	5	4	6	6		
Cottonwood Creek[f] (S-9)												
Max	29.5		7.7	320	1217	8	18		2800	38		
Min	22.0		6.9						2400	11		
Mean	25.8		7.3						2600	23		
No. of samples	2		2	1	1	1	1		3	3		
Cottonwood Creek[g] (S-10)												
Mcx	25.0	13.5	8.1	230	1700	25	45	20	3800	30		
Min	21.0		7.0	200	686	5	20	7.9	2600	11		
Mean	22.9		7.5	210	1178	15	33	13	3000	27		
No. of samples	4	1	5	4	5	5	5	4	6	6		
Cottonwood Creek[h] (S-11)												
Max	24.5	13.3	8.1	220	1300	50	420	190	3800	390		
Min	18.0		7.2	180	677	6	24	21	2000	16		
Mean	21.9		7.5	195	1053	22	130	67	2800	127		
No. of samples	4	1	5	4	5	5	5	4	7	7		
South Dakota water quality standards[i]	32.2 (23.9)	5	6.3–9.0 (6.5–8.8)	750				50	1500	90	1000	5000
EPA drinking water standards[j]			6.5–8.5		15			5*	500	4*		
NAS–NAE irrigation water criteria[k]			4.5–9.0									
NAS–NAE livestock watering criteria[k]									3300			

[a]Cheyenne River (S-4): 43°18'20", 103°49'17", upstream of US Hwy. 18 bridge at Edgemont, S. D., data sources, TVA (12/74 through 9/77), U.S. Geological Survey (1/72 through 9/76), and the State of South Dakota (11/72 through 5/77).

[b]Cheyenne River (S-5): 43°18'49", 103°47'16", ~2.5 km (1.6 miles) downstream of Edgemont, S.D., above Red Canyon Creek: data sources, TVA (12/74 through 6/75) and U.S. Geological Survey (7/73 through 6/74).

[c]Cheyenne River (S-6): 43°17'07", 103°44'21", ~10 km (6.2 miles) downstr am of Edgemont, S.D.; data source, TVA (12/74 through 9/77).

[d]Cheyenne River (S-7): 43°18'23", 103°33'43", upstream of SR 71 bridge at Angostura Reservoir, S.D.; data source, TVA (6/77 through 9/77).

[e]Cottonwood Creek (S-8): 43°17'23", 103°49'26", upstream of mill property at the county road bridge, off State Highway 52; data source, TVA (12/74 through 9/77).

[f]Cottonwood Creek (S-9): 43°18'02", 103°49'00", at pipeline suspension bridge; data source, TVA (12/74 through 9/76).

[g]Cottonwood Creek (S-10): 43°18'11", 103°48'59", approximately 9.1 m (30 ft) upstream of the mill road culvert; data source, TVA (12/74 through 9/77).

[h]Cottonwood Creek (S-11): 43°18'18", 103°49'03", at the confluence with the Cheyenne River; data source, TVA (12/74 through 9/77).

[i]State of South Dakota, Department of Environmental Protection, *Water Quality Standards*, SDCL 46-25-07, 1974.

[j]Standards marked with an asterisk (*) are primary drinking water standards. Unmarked standards are the proposed secondary drinking water standards (40 CFR Part 141.248 and 40 CFR Part 143.62).

[k]U.S. Geological Survey, *Water Resources Data for South Dakota, Water Year 1977*, Water Data Report SD77-1, 1977.

Source: Modified from ER, Table 4.2.3.

Cottonwood Creek is classified by the State for the beneficial use of wildlife propagation and for stock watering and irrigation. The pH values recorded from Cottonwood Creek were within National Academy of Sciences-National Academy of Engineering (NAS-NAE) Criteria for irrigation water, South Dakota water-quality, and EPA drinking-water standards.[27,29,30] Cottonwood Creek met chemical water-quality criteria for livestock watering.[30] However, boron, manganese, and fluoride concentrations in Cottonwood Creek exceeded NAS-NAE criteria for irrigation water.[30]

Surface drainage in the Cheyenne River basin is contained in many instances by many small reservoirs, for example, 9320 in 1965 (ER, Sect. 4.2), with a total capacity above Edgemont of 5.6×10^7 m^3 (4.5×10^4 acre-ft). These reservoirs are used for stock watering and irrigation. The Cheyenne River and Cottonwood Creek in the Edgemont area are also used primarily for stock watering and, to a limited extent, irrigation. Few irrigation permits have been issued for the Cheyenne River above the Angostura Reservoir (John Hatch, Deputy Director, South Dakota Water Rights Department, personal communication, Mar. 20, 1980), which was constructed in the 1950s to provide irrigation water for the area.

3.6.2 Groundwater

3.6.2.1 Regional flow system

Groundwater in western Fall River County occurs both in unconsolidated sediments and in bedrock aquifers. The occurrence of groundwater in bedrock aquifers is largely dictated by the structure and the stratigraphy associated with the uplift of the Black Hills. The regional dip and alternating sequence of sandstones (aquifers) and shales (aquicludes) account for the artesian conditions in some of the bedrock aquifers. The quality of water contained in the bedrock aquifers is highly variable.

Most wells in this area, located in the unconsolidated sediments of quaternary alluvial deposits, occur along the larger drainages and comprise the most important existing and future water supply for the area. Groundwater flow in these deposits is usually controlled by the underlying bedrock configuration and the local topography. Recharge occurs by direct infiltration of local precipitation and streamflow.

The principal bedrock aquifers in the area are the Pahasapa Formation (Mississippian Age), the Sundance Formation (Jurassic Age), and the Fall River and Lakota formations of the Inyan Kara group (Cretaceous Age).[31]

The Pahasapa Formation, a local name for the Madison Formation, consists of a gray massive limestone. Only very deep wells obtain water from this formation in Fall River County. Five wells developed in this formation at depths of more than 700 m (2300 ft) provide water for the city of Edgemont, the Burlington-Northern Railroad, and the mill facility.

The Sundance Formation, which consists of alternating marine sandstones and shales, is used as an aquifer primarily near its outcrop area in the central and northwestern parts of the county.

The Lakota Formation consists of cross-bedded, channel-fill sandstones, shale, and locally occurring limestone. The Chilson member of this formation is the primary water-bearing unit. The Lakota Formation lies unconformably over the Jurassic Morrison Formation, which consists mostly of shale and clay. The Fall River Formation consists of a well-bedded, fine-grained sandstone, with lesser amounts of interbedded siltstone and clay. The Fall River Formation is overlain by the Skull Creek shale of the early Cretaceous Age. The Skull Creek shale is considered an aquiclude. The Fall River Formation is the largest producing bedrock aquifer in Fall River County.

3.6.2.2 Site flow system

Existing site

Unconfined groundwater occurs beneath the existing tailings site in unconsolidated quaternary alluvial deposits ranging up to 9 m (30 ft) thick. Extensive intertonguing of sediments from the Cheyenne River alluvial floodplain and Cottonwood Creek exists beneath the tailing site. A potentiometric surface and flow gradient of the unconfined aquifer at the site is given in Fig. 3.6.

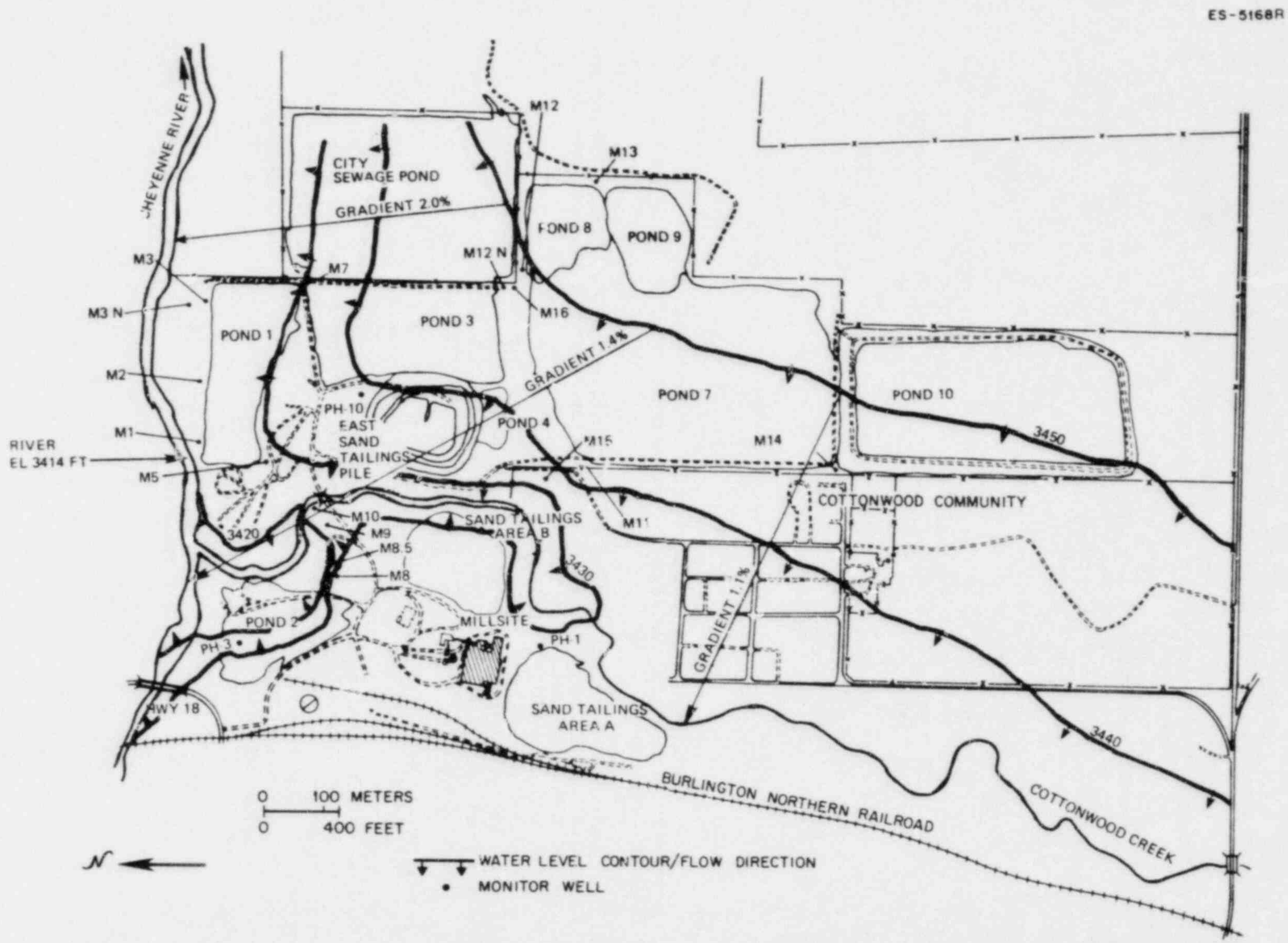

Fig. 3.6. Potentiometric surface and flow gradient of the unconfined groundwater at the existing tailings site. Source: ER, Fig. 4.2-4.

Proposed disposal site

Unconfined groundwater conditions occur in the unconsolidated surficial materials (alluvium) at the proposed disposal site. This perched water generally lies within a few feet of the soil-bedrock contact.[26] Groundwater levels in the vicinity of the stock-watering pond located on the southern side of the site are affected by seepage from the pond. In the absence of the stock pond, the water table in this area would be expected to be lower, probably within a few feet of the bedrock surface.

The surficial materials at the disposal site are underlain by the Lower Greenhorn, Belle Fourche, Mowry, and Skull Creek shales, all of the Cretaceous Age. More than 152 m (500 ft) of these shale units separate the unconfined groundwater in the surficial materials from the underlying Fall River and Lakota aquifers.

3.6.2.3 Regional groundwater quality and use

Evaluation of the water-quality data from quaternary alluvium shows its physical-chemical quality to be very poor. Concentrations of dissolved solids range from 3480 mg/L to 6969 mg/L, and the groundwater is considered to be very hard. The principal cations are sodium and magnesium, and the principal anions are sulfate and bicarbonate. The pH ranges from acidic to slightly alkaline. Concentrations of dissolved solids, iron, sulfate, and chloride are greater than those concentrations specified by the EPA "Proposed Secondary Drinking Water Standards"[28] for finished drinking water. Using the U.S. Department of Agriculture (USDA) diagram for evaluating groundwater for irrigation purposes, the groundwater is unsuitable for irrigation purposes because of its high salinity hazard.[32]

Alluvium is used locally as a water source for domestic and stock water supplies. Many wells are located in the alluvial deposits along the larger streams. The alluvium deposits represent an existing and future water supply zone primarily because of accessibility, adequate amount, and lowest cost outlay resulting from the shallower drilling depths.

An evaluation of the water-quality data from the Fall River Formation shows its physical-chemical quality to be fair to very poor. Concentrations of dissolved solids range from 1010 to 3189 mg/L, and the groundwater is considered to range from soft to very hard. The principal cations are sodium and calcium, and the principal anions are sulfate and bicarbonate. The pH is alkaline, ranging from 7.7 to 8.9. Concentrations of dissolved solids, iron, sulfate, and chloride are greater than the proposed EPA secondary standards. The groundwater is unsuitable for irrigation purposes because of its high salinity and sodium hazards.

Both the Fall River and Lakota formations, which together form the Inyan Kara group, are the principal sources of water for domestic, irrigation, and livestock uses.

3.6.2.4 Site groundwater quality and use

Existing site

Approximately 2.1 x 10^6 MT (2.3 x 10^6 tons) of solid uranium mill tailings, about 80% of which were sand tailings and the balance were slime tailings, were deposited in 11 ponds or piles [the approximate surface area is 50 ha (123 acres)] at the existing site. Except for Pond 10, the storage areas were probably not designed to prohibit or to minimize the migration of leachates beneath the areas. At present, Ponds 3, 4, 7, 8, and 10 contain V_2O_5-bearing liquors of varying assay.

Evaluation of the chemical data from the ponds (see ER, Table 4.2.6) shows the standing water to be acidic and to contain extremely high concentrations of dissolved solids, sulfate, cadmium, chromium, iron, nickel, titanium, and vanadium. Sediment samples from the ponds were heavily concentrated with aluminum, barium, chromium, iron, nickel, titanium, and vanadium. Lower concentrations of other metals were measured in both the water and sediment samples. Leachates migrating from the ponds and tailings piles are a potential source of contamination of the alluvial aquifer, Cottonwood Creek, and the Cheyenne River near the mill site.

The water quality found in the alluvial aquifer beneath the mill site has been determined by the sampling of 14 observation wells (ER, Table 4.2.7) (potentiometers) (Fig. 3.6). Evaluation of groundwater-quality data clearly shows that the groundwater directly beneath the site is contaminated with leachates from the tailings and slimes storage areas.

Groundwater that entered the site from the southeast was found to contain concentrations of dissolved solids on the order of 6500 mg/L. As the water passed under the site, it mixed with contaminated leachates resulting in concentrations of dissolved solids ranging from 14,545 to 32,000 mg/L.

This pattern also was observed west of Cottonwood Creek, but the maximum observed concentration was much lower (15,575 mg/L). This pattern was also found to exist generally for nitrate, sulfate, and most metals analyzed. Extremely high concentrations of dissolved solids, nitrate, sulfate, lead, manganese, and nickel were measured in those wells east of Cottonwood Creek adjacent to the Cheyenne River. As shown in Fig. 3.6, leachate from a large percentage of the tailings and slime storage areas would migrate in the direction of these observation wells. Data from the onsite observation wells east of and adjacent to Cottonwood Creek also indicate contamination by leachates from the storage areas. Samples from those observation wells west of Cottonwood Creek indicate some contamination, but not contamination as significant as that found to the east of Cottonwood Creek.

More recent data has been collected by the South Dakota Department of Natural Resources (Table 3.19). This data is preliminary, and additional samples will be collected and analyzed for evaluation in the near future

Proposed disposal site

No data are currently available to assess the existing groundwater quality at the disposal site; as previously mentioned, however, the quality of water in the alluvial material is generally very poor in the region.

3.7 GEOLOGY, MINERAL RESOURCES, AND SEISMICITY

3.7.1 Geology

3.7.1.1 Regional geology

The mill site and proposed disposal site lie within the Missouri River Plateau and the southwestern edge of the Black Hills uplift (Fig. 3.7). Figure 3.8 contains a complete stratigraphic column for the project area, which includes rocks that range in age from Precambrian to Quaternary. Because sedimentary strata of Cretaceous Age are of primary concern at the existing mill site, the following brief description is restricted to these units.

The Inyan Kara group, of early Cretaceous Age, lies unconformably over the Morrison Formation of Jurassic Age. This group includes the Fall River and Lakota formations, which comprise a complex interbedded sequence of fluviatile channel sandstones, fine-grained floodplain deposits, and lacustrine or marsh deposits of mudstone, shale, and limestone.[33] The Inyan Kara group represents a change in depositional environments from continental to marginal marine.[33,34]

Overlying the Inyan Kara group is the Skull Creek shale of early Cretaceous Age. This unit is composed of a sequence of dark-gray to black marine shales. The Newcastle sandstone, which overlies the Skull Creek shale and is of early Cretaceous Age, is a fine-grained sandstone interbedded with siltstone and, in places, mudstone.[33] Overlying the Newcastle sandstone is the Mowry shale of early Cretaceous Age. This shale consists primarily of gray marine shales.

The Belle Fourche shale, which overlies the Mowry shale and is of late Cretaceous Age, is a dark-gray marine shale and contains a few bentonite seams.[33] The Greenhorn Formation, which overlies the Belle Fourche shale and is of late Cretaceous Age, is a marine shale that contains a few thin beds of limestone and bentonite.[33]

Quaternary terrace gravels, alluvium, colluvium, and eolian deposits unconformably overlie the Cretaceous units throughout this region.

Table 3.19. Water quality data for groundwater at the Edgemont site[a,b]

Location	Natural uranium (pCi/L)	Gross radium, alpha (pCi/L)	Radium-226, dissolved (pCi/L)	Gross alpha		Gross beta	
				Dissolved (pCi/L)	Suspended (pCi/g)	Dissolved (pCi/g)	Suspended (pCi/g)
M1	94.8		2.4 ± 0.4	174 ± 94.2	56 ± 8.1	88 ± 51	44 ± 5
M7	263.4	1.7 ± 0.4		178 ± 136.0	150 ± 42.0	166 ± 94	462 ± 22
M9	261.3		10.3 ± 1.0	30 ± 35		120 ± 15	
M11	196.3	2.9 ± 0.5		119 ± 138.0	36 ± 7.0	97 ± 92	38 ± 5
M14	140.8	1.6 ± 0.4		288 ± 96.0	178 ± 16	60 ± 48	158 ± 11

Location	Chloride (mg/L)	Sulfate (mg/L)	Nitrate (mg/L)	Specific conductance (μmhos)	pH	Arsenic (μg/L)	Cadmium (μg/L)
M1	943	6,500		2.09×10^4	6.91	<10	8.0
M7	1136	14,800		2.32×10^4	7.02	<10	2.0
M9	153	2,000	0.4	3.91×10^3	7.37	<10	8.0
M11	479	19,200	0.6	2.70×10^4	7.22	54	3.0
M14	224	11,850	3.1	1.73×10^4	7.62	<10	1.4

Location	Chromium (μg/L)	Copper (mg/L)	Lead (mg/L)	Iron (mg/L)	Manganese (mg/L)	Total dissolved solids (mg/L)
M1	62	0.150	93	29.00	66.00	2.03×10^4
M7	36	0.100	31	2.26	0.79	2.66×10^4
M9	40	0.015	<10	16.00	0.26	3.42×10^3
M11	44	0.130	18	43.00	0.40	3.00×10^4
M14	45	0.100	84	3.50	0.68	1.74×10^4

[a]Sampled April 26, 1982, by South Dakota Department of Water and Natural Resources.

[b]Numbers based on one sample from each well.

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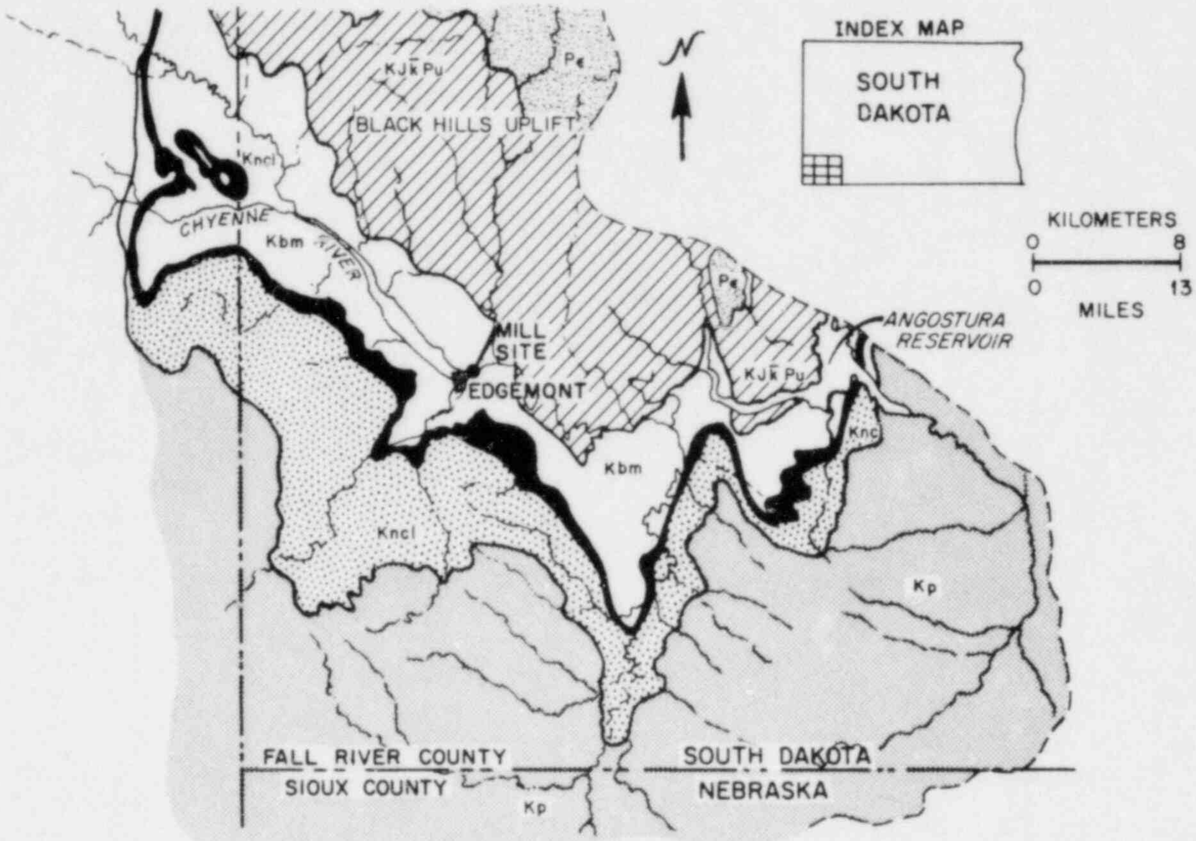

Kp	–	PIERRE SHALE, CRETACEOUS
Kncl	–	NIOBRARA FORMATION AND CARLILE SHALE, CRETACEOUS
Kg	–	GREENHORN LIMESTONE, CRETACEOUS
Kbm	–	BELLE FOURCHE AND MOWRY SHALES, CRETACEOUS
KJTRPu	–	SKULL CREEK SHALE, INYAN KARA GROUP, CRETACEOUS; MORRISON FORMATION, JURASSIC; AND TRIASSIC AND PERMIAN FORMATIONS
Pє		PRECAMBIAN (CRYSTALLINE ROCKS)

Fig. 3.7. Geologic map of Edgemont and surrounding area. Source: R. C. Culler, "Hydrology of the Upper Cheyenne River," *U.S. Geol. Surv. Water-Supply Pap.* 1531 (1961).

3.7.1.2 Site geology

Existing site

The existing tailings site is underlain by alluvial deposits of Quaternary Age. These deposits, which are up to 9 m ([illegible] ft) thick, consist primarily of interbedded lenses and layers of fine-grained sands, silts, and clays, with minor amounts of gravel and are underlain by approximately 66 m (200 ft) of the Skull Creek shale, which acts as an aquiclude between the Quaternary alluvium and the underlying Fall River and Lakota aquifers of the Inyan Kara group (Sect. 3.6.2.1).

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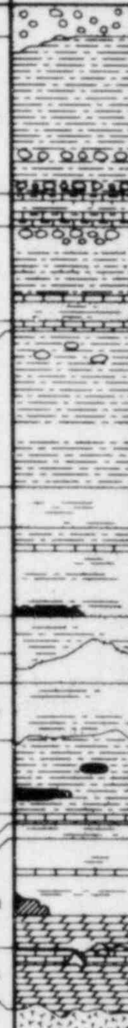
PERIOD	FORMATION NAME	SYMBOL	COLUMN	LITHOLOGIC DESCRIPTION	THKNS IN FEET	HYDROLOGIC CHARACTERISTICS
Quaternary	Alluvium	Qal		Gravel, sand, and silt floodplain deposits. Alluvial terraces and windblown material	1-30	Good to excellent aquifer along floodplains, terraces generally non-productive except for scattered springs
Cretaceous	Pierre Fm	Kp		Dark gray shale, weathering brown or buff and containing many fossiliferous concretions Scattered concretions which form "teepee buttes" Black fissile shale, cone-in-cone concretions	1000+	Relatively no value as an aquifer, locally large diameter wells in stream valleys may yield small amounts of highly mineralized water during wet seasons
	Niobrara Fm	Kn		Gray calcareous shale, weathering yellow and impure chalk with Ostrea Congesta	100-225	No known wells
	Turner sand Carlile Fm Wall Creek sand	Kcr		Light gray shale with large concretions Gray shale with thin sandstone layers Bed of impure limestone Thin sandstone	520-540	Relatively impermeable, possible small yields from Turner and Wall Creek sands
	Greenhorn Lms	Kg		Thin bedded hard limestone, weathering creamy white, contains Inoceramus Labiatus	50	Too thin and dense to be an aquifer
	Belle Fourche Fm Mowry Shale Graneros Group Newcastle sand Skull Creek Shale	Kgs		Light gray shale, bentonite, large concretions Light gray siliceous shale Thin brown-to-yellow sandstone Black shale	870	Newcastle sand may yield water, permeability is variable
	Fall River Fm	Kfr		Interbedded red-brown massive sandstone and Carbonaceous shales	30-165	Largest producer in the area. Yields up to 60 gpm of highly mineralized water (flow). Water quality generally poor, sometimes yields hydrogen sulfide
	Fuson Shale Minnewasta Lms Lakota Fm	Klk		Gray-to-purple shale, thin shales Light gray massive limestone Coarse, hard, cross-bedded sandstone, buff-to-gray, coal beds locally near base	0-180 0-25 130-230	Relatively good aquifer from the lower Chilson member, up to 30 gpm artesian flow
	Morrison Fm	Km		Green-to-maroon shale, thin sandstone	0-125	No known wells, possible aquifer
Jurassic	Unkpapa Fm	Ju		Fine grained, massive, vari-colored sandstone	0-240	No known wells, possible aquifer
	Sundance Fm	Jsd		Alternating beds of red sandstone and red-to-green marine shales	250-450	Produces small amounts of water from the sands suitable for domestic use
Triassic ?	Spearfish Fm	TRs		Red silty shale, limestone, and anhydrite near the top Redbeds Gypsum locally near the base	400	Poor producer, small yields of sulfate water
Permian	Minnekahta Lms	Cmk		Pale brown, to gray dense, crystalline limestone	50	Locally secondary fracture porosity
?	Opeche Fm	Co		Red thinly bedded sandstones and shales, purple shale near top	100	No known wells
Pennsylvanian	Minnelusa Fm	Cml		Converse sand, red-to-yellow cross bedded sand Red marker, thin red shale near middle Leo sands, series of thin limestones Dolomite at bottom with basal laterite zone	755-1040	Permeability variable, tremendous flows of warm mineralized water recorded near the perifery of the Black Hills. Excellent potential
Mississippian	Pahasapa Fm	Cps		Massive, light colored dolomite and limestone, cavernous in upper 100 feet	165-465	Most promising aquifer in the area. The 2 wells in this aquifer produce large amounts of water suitable for domestic use
Precambrian	Metamorphic and Igneous rocks	P€		Granite, schists, quartzite, and slates	---	No potential

Fig. 3.8. Stratigraphic column for Edgemont and surrounding area. Source: J. R. Keene, *Groundwater Resource of the Western Half of Fall River County, S.D.*, Sciences Center, University of South Dakota, Report of Investigations, No. 109, 1973.

Proposed disposal site

The proposed disposal site is located at the head of an ephemeral drainage, a tributary to the Cheyenne River. Local relief is less than 18 m (60 ft), and the site has low erosion potential. Sedimentary rocks of early to late Cretaceous Age are of major importance at the disposal site (Fig. 3.9).

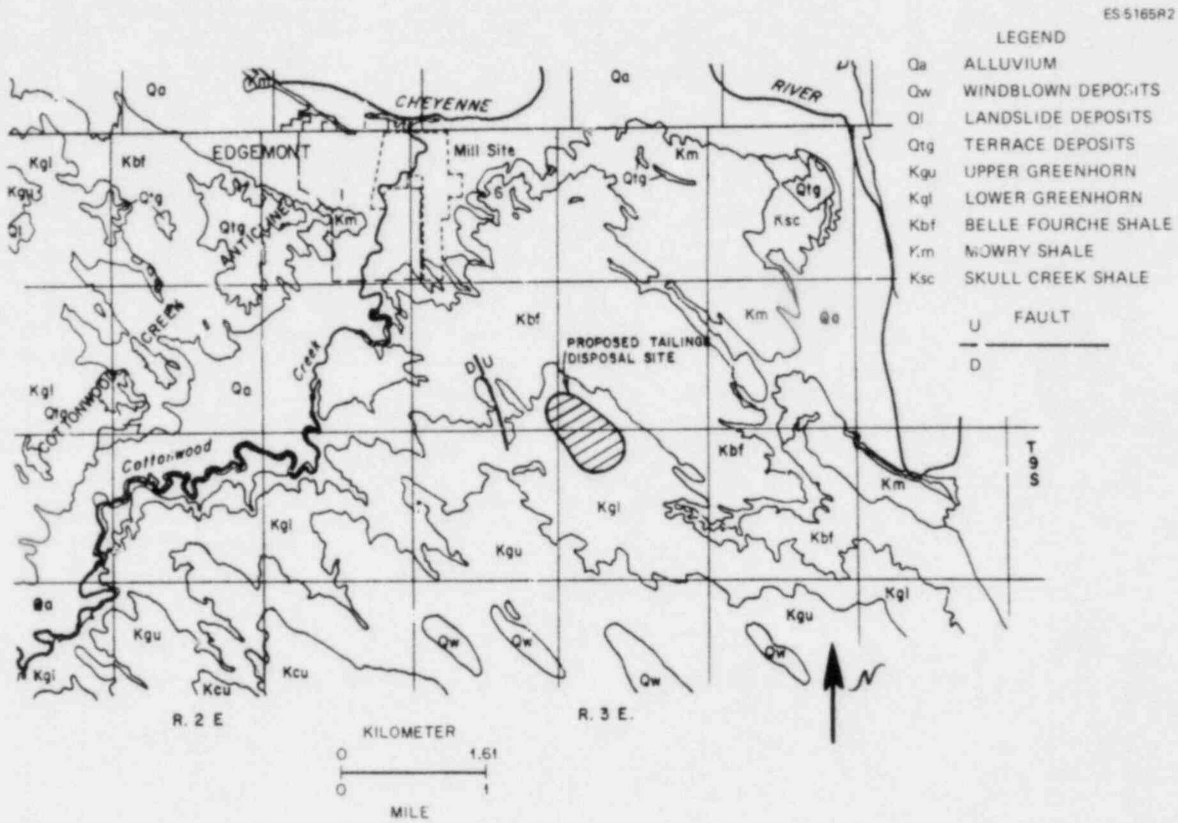


Fig. 3.9. Geologic map of proposed disposal site. Source: ER, rev. 2, Fig. 4.4-2.

A preliminary geotechnical investigation conducted at the proposed disposal site has provided the following subsurface geologic information:

As indicated in Fig. 3.10, four test borings along the proposed impoundment dike (embankment) axis and four test borings in the proposed disposal area were drilled to depths ranging from 7 to 15 m (21.5 to 50 ft). Cross sections of the subsurface materials encountered during drilling are displayed in Fig. 3.11. Data from these test borings indicate three distinct units.

The upper layer consists of residual soils that are probably relatively recent eolian and alluvial/colluvial materials. These materials are typically fine-grained silts and sands with varying amounts of clays, generally ranging from 15 to 30% by weight. The residual soils have a gradational contact with the underlying weathered silty clays (weathered shales) of the Lower Greenhorn Shale Unit.

The weathered silty clays of this formation comprise the second unit and are typically much thicker where the overburden of residual soils is thin and thinner with a corresponding thicker layer of the residual soils. The silty clays are characterized by numerous horizontal partings (very fissile) that are often filled with calcium deposits or stained with iron and sulfur (limonitic staining). Vertical fractures are also common in this zone and impart a blocky

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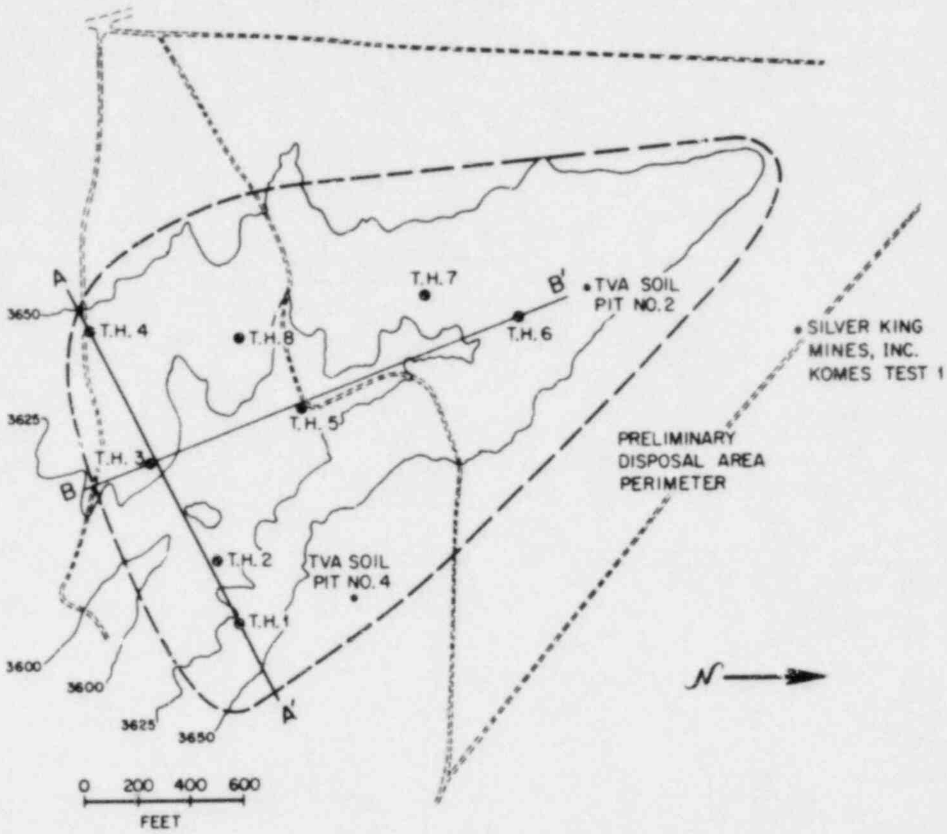

Fig. 3.10. Location of test borings at the proposed disposal site. Source: Francis-Meador-Gellhaus, Inc., *Subsurface Soil Exploration for Proposed Edgemont Uranium Waste Disposal Site*, prepared for Silver King Mines, Inc., Edgemont, S.D., June 1980.

structure to the formation. These silty clay soils are defined as CL and CH soils by the Unified Soils Classification System. Soils of this group are typically very fine grained with medium to high plasticity. Packer tests performed in the silty clay materials indicate that they are relatively impermeable and also have a tendency to self-seal with time.

The materials that comprise the third unit occur below the weathered silty clays and are very dense, slightly fissile, relatively unaltered clays of the Lower Greenhorn Shale Unit. These materials are very hard and can be considered highly impermeable (10^{-8} cm/s or less) to the depths explored.

A stratigraphic column derived from data obtained from the Komes Test 1 test hole (Fig. 3.10) drilled by Silver King Mines, Inc., is presented in Fig. 3.12. The following stratigraphic units are briefly described in descending order.

Surface materials at the disposal site consist of fine-grained alluvial sediments, weathered rock residuum, and eolian deposits. The thickness of the surficial and weathered material ranges from 0 to 15 m (0 to 50 ft).

Underlying the surficial materials is the lower unit of the lower Greenhorn Formation of Late Cretaceous Age. Only 8.5 m (28 ft) of this formation is exposed at the site. The unweathered part of this formation consists of black shale containing thin bentonite seams.

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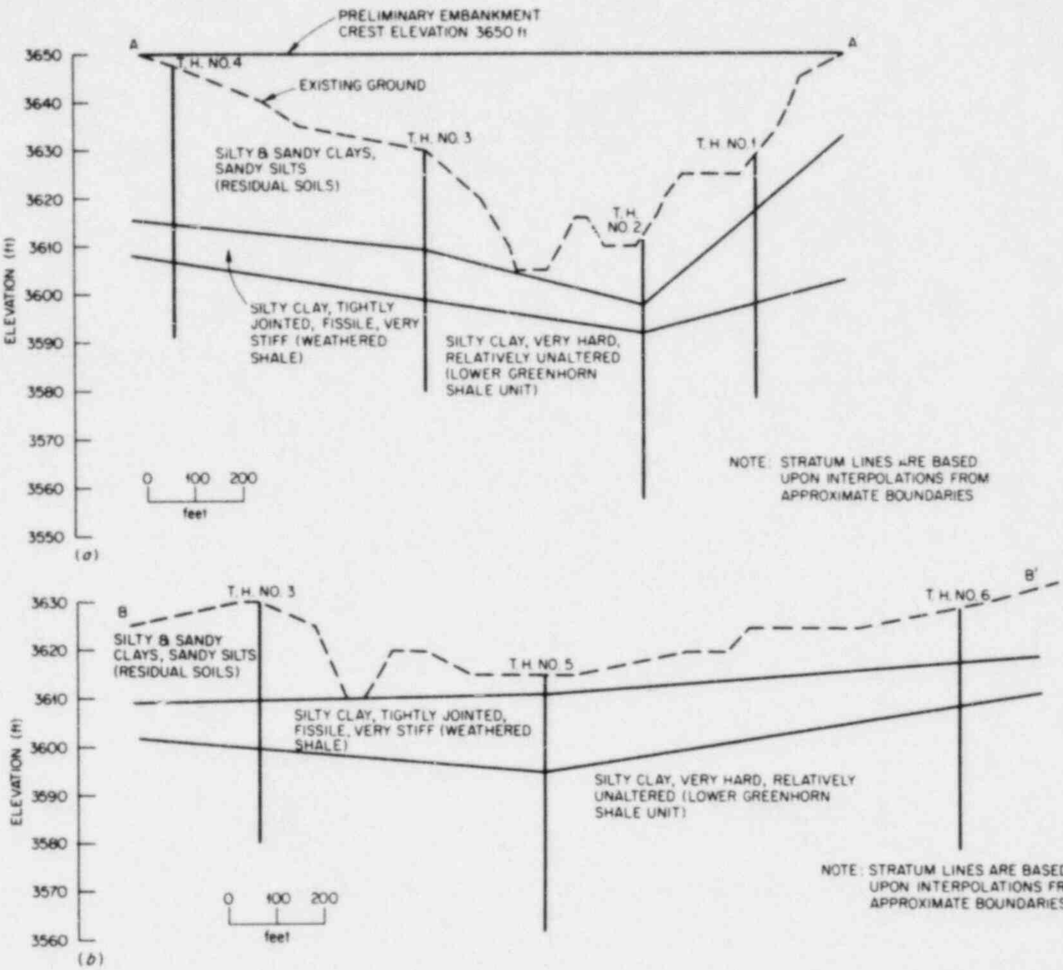

Fig. 3.11. Cross sections of subsurface materials encountered during geotechnical investigation (see Fig. 3.11). Source: Francis-Meador-Gellhaus, Inc., *Subsurface Soil Exploration for Proposed Edgemont Uranium Waste Disposal Site*, prepared for Silver King Mines, Inc., Edgemont, S.D., June 1980.

The base of the proposed disposal site will lie in the Belle Fourche shale, which is of late Cretaceous Age and has a thickness of 56 m (185 ft) adjacent to the site. The Belle Fourche shale is black and contains brown limestone beds and thin bentonite seams.

Underlying the Belle Fourche shale is the Mowry shale of early Cretaceous Age. The Mowry shale is light gray and is comprised of minor amounts of siltstone, sandstone, and thinly laminated beds of bentonite. The thickness of this formation adjacent to the site is 44 m (145 ft).

Below the Mowry shale lies the Newcastle sandstone (early Cretaceous Age), a lenticular, light- to medium-gray siltstone and very fine-grained sandstone. This formation is relatively permeable but is not considered an aquifer in this area because of its lenticular nature and limited areal extent. The thickness of this formation adjacent to the site is 3 m (7 ft).

The Skull Creek shale, which underlies the Newcastle sandstone (early Cretaceous Age), is black fissile shale containing limestone concretions. The thickness of this shale unit adjacent to the site is 66 m (215 ft).

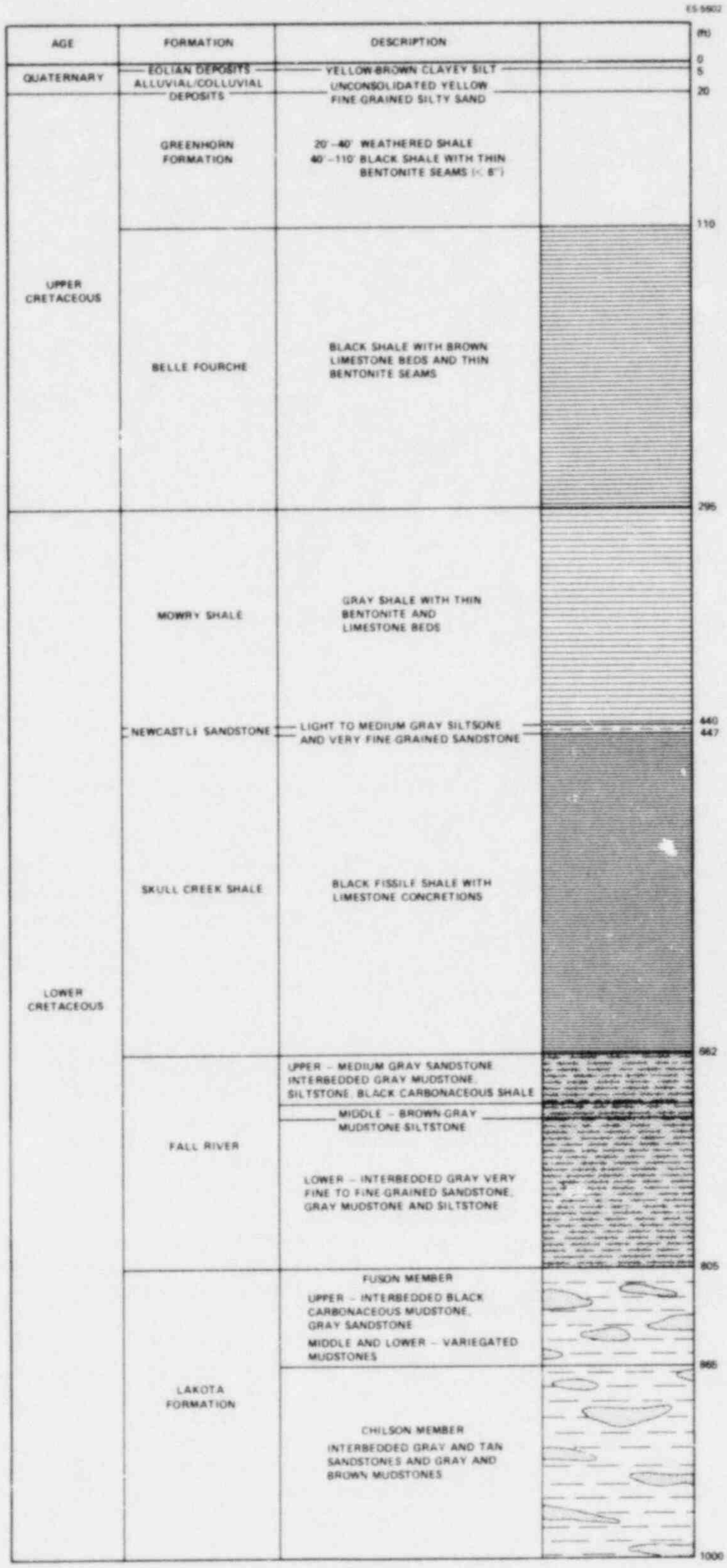

Fig. 3.12. Stratigraphic column based on data from Komes Test I test hole [elevation 1124 m (3687 ft)] (see Fig. 3.11). Source: Francis-Meador-Gellhaus, Inc., *Subsurface Soil Exploration for Proposed Edgemont Uranium Waste Disposal Site*, prepared for Silver King Mines, Inc., Edgemont, S.D., June 1980.

The Inyan Kara group (early Cretaceous Age) lies beneath the Skull Creek shale and includes the Fall River and Lakota formations. These two formations, both discussed in Sect. 3.6.2.1, are not expected to be affected by the proposed disposal plan because of the confining nature of the overlying Belle Fourche, Mowry, and Skull Creek shales.

The structural orientation of the formations at the proposed disposal site generally follows the regional dip of 2 to 4° to the southwest, striking approximately north 25° west. No major disturbance of the underlying geologic structure was encountered over the entire site.

3.7.1.3 Regional structure

The existing mill site and proposed disposal site are located along the southwest flank of the Black Hills uplift, an elongate northwest-trending dome of Laramide Age, approximately 200 km (125 miles) long and 97 km (60 miles) wide. Superimposed on the Black Hills uplift are numerous folds plunging radially outward. Local structures of this type are the Chilson anticline and Sheep Canyon monocline east of the community of Edgemont and the Cottonwood Creek anticline trending southwest from the community of Edgemont (Fig. 3.13). The regional dip of the sedimentary rocks in the project area is 2 to 4° southwest.

Two major structural zones, Dewey Mountain and Long Mountain, are located north and northwest of the project area (Fig. 3.13). The Dewey structural zone consists of sinuous, en echelon, steeply dipping to vertical normal faults. The Long Mountain structural zone consists of small northeast-trending normal faults. Many of the individual faults within this zone have been traced less than 1.6 km (1 mile).

There are two major sets of joints in the southern Black Hills area. These two joint sets strike northeast in the northern and central parts of the area, whereas, in the eastern part of the area, the dominant orientation is to the northwest.[35]

3.7.1.4 Seismicity

The area of southwestern South Dakota, where the Edgemont mill site is located, lies in a relatively quiet seismic region of the United States (Fig. 3.14). Earthquakes in this region have been few and low to moderate in magnitude. Few damage-producing earthquakes have originated in this region. According to the National Geophysical and Solar-Terrestrial Data Center, only seven earthquakes of significance have occurred within a 200-km (124-mile) radius of the proposed disposal site from the first documented earthquake in 1895 through 1976.[36]

The strongest observed earthquake, with an intensity of VII based on the modified Mercalli intensity scale, occurred in 1964 and was centered approximately 178 km (110 miles) east-southeast of the proposed disposal site. Some damage was reported in Alliance and Rushville, Nebraska.[37] Acceleration attenuation curves were used to estimate the maximum acceleration of rock that could be expected at the proposed disposal site from such an earthquake as less than 0.04 gravities.[38]

The epicenter of the nearest tremor to the site, which occurred in 1895, was located approximately 80 km (50 miles) northeast of the site. The tremor was reported to have had an intensity of V, but no damage was associated with that tremor. The maximum acceleration of rock at the site for a seismic event of such intensity would be much less than 0.01 gravities.

A recent probabilistic acceleration map of the contiguous United States indicates that the horizontal acceleration of rock at the project site is about 0.04 gravities, with 90% probability of not being exceeded in 50 years.[38] On the basis of the historic seismicity record and the tectonic framework of the region, it is highly unlikely that an earthquake of large magnitude will affect the disposal area in the foreseeable future.

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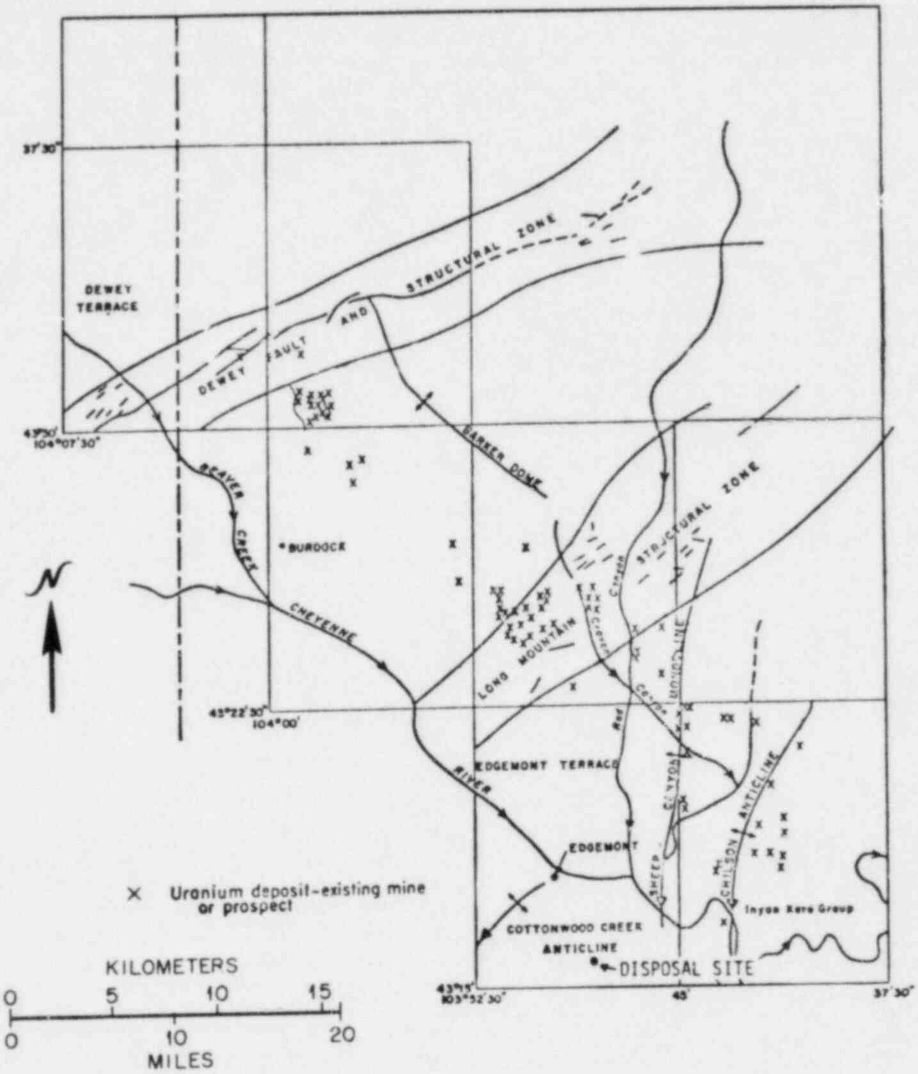

Fig. 3.13. Map of geologic structures in the area of Edgemont, South Dakota. Source: G. B. Gott, D. E. Wolcott, and C. G. Bowles, "Stratigraphy of the Inyan Kara Group and Localization of Uranium Deposits, Southern Black Hills, South Dakota, and Wyoming," *U.S. Geol. Surv. Prof. Pap.* 763: 27-33 (1974).

3.7.2 Mineral resources

3.7.2.1 Uranium

Uranium is currently the most economically important mineral resource known in Fall River County. Numerous uranium deposits and occurrences have been delineated in rocks of the Inyan Kara group of Cretaceous Age. This area has been referred to as the Edgemont mining district. Production of uranium ore started in this area as early as 1952. Most of the early deposits contained the yellow uranium minerals carnotite and tyuyamunite and were mined from shallow open pits on short adits.

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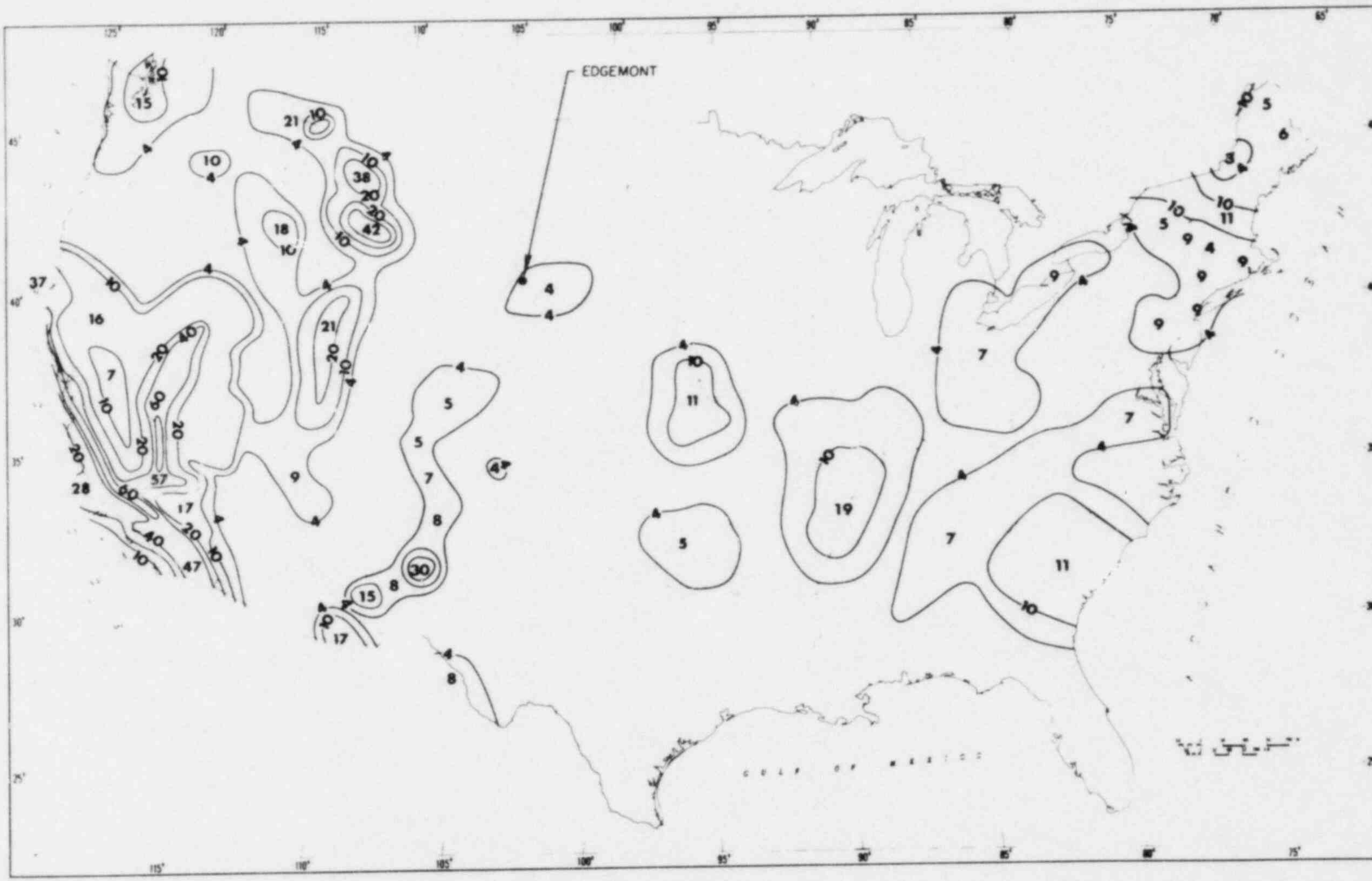

Fig. 3.14. Preliminary map of horizontal acceleration (expressed as percent of gravity) in rock with 90% probability of not being exceeded in 50 years. Source: U.S. Geological Survey Open-File Report 76-416, 1976.

3.7.2.2 Oil and gas

Several exploratory wells have been drilled in Fall River County. Because most wells have proved to be unsuccessful, only a small amount of oil has been produced from this area.

3.7.2.3 Coal

Although limited quantities of low-grade coal have been mined from the Chilsom member of the Lakota Formation in Fall River County, the prospect for commercial development seems unlikely.

3.7.2.4 Sand and gravel

Sand and gravel previously used for road building in the area are abundant in the alluvium of the Cheyenne River and the higher level terrace deposits in the county.

3.8 SOILS

A soil association map for the mill site, the preferred tailings disposal site, and the surrounding area is presented in Fig. 3.15. Characteristics of those soils expected to be disturbed directly and indirectly by decommissioning activities at the mill site, haul road, disposal site, and soil-stockpiling and borrow areas are presented in Table 3.20.

Soils in the area generally vary from a loose, friable silt-clay loam to a sticky or plastic clay. Although most of the soils on the disposal site have formed from weathering of the Lower Greenhorn Formation, a few soils have formed from eolian deposits (ER, Sect. 4.5.1). It is planned that Norka silt loam and Nunn clay loam from the disposal site and immediate vicinity will be used for reclamation.

Norka silt loam is a deep, well-drained, gently sloping soil that is formed from eolian deposits on uplands. According to the applicant's consultation with the Soil Conservation Service (Sect. 4.5.1), Norka soil is medium in fertility and moderate in organic matter and has a good tilth and deep root zone. The available water capacity is high, and permeability is moderate to moderately slow. The shrink-swell potential is moderate, and runoff is slow to medium. Norka soil has good potential for use as cropland, range, windbreaks, and most types of recreation; it also has a fair-to-good potential for most engineering uses.

The Nunn clay loam is a deep, well-drained, very gently sloping soil found on terraces, alluvial fans, and uplands. The Nunn soil is medium in fertility and moderate in organic matter content. The good tilth and deep root zone of this soil make it well suited for use as cropland. The available water capacity is moderate to high, permeability is moderately slow, and runoff is characterized as slow to medium (ER, Sect. 4.5.1).

In June 1980, Norka silt loam and Nunn clay loam associations within the proposed disposal site and along its immediate boundaries were sampled to determine the volume and suitability of material for use as plant growth media. Approximately 751,000 m^3 (982,800 yd^3) of soils suitable for plant growth exist in this area. The soils are predominately sandy loams ranging in depth from 165 cm (70 in.) to 300 cm (120 in.) (ER, Sect. 4.5.1.2). The following chemical and physical characteristics of the soils were all considered "good" based on a Wyoming Department of Environmental Quality publication regarding suitability ratings of soils for use as topsoil (ER, Table 4.5-2): pH; electrical conductivity; saturation percentage; texture class; and copper, molybdenum, and soluble calcium and magnesium. Levels of major nutrients such as nitrogen and phosphorus were not presented in the Environmental Report (ER). The ER recognized, however, that such nutrients are generally lacking in the regional soils and concluded that application of commercial fertilizer will be necessary to improve the suitability of the soil for use in reclamation (ER, Sects. 4.5.1.2 and 4.6.3.3).

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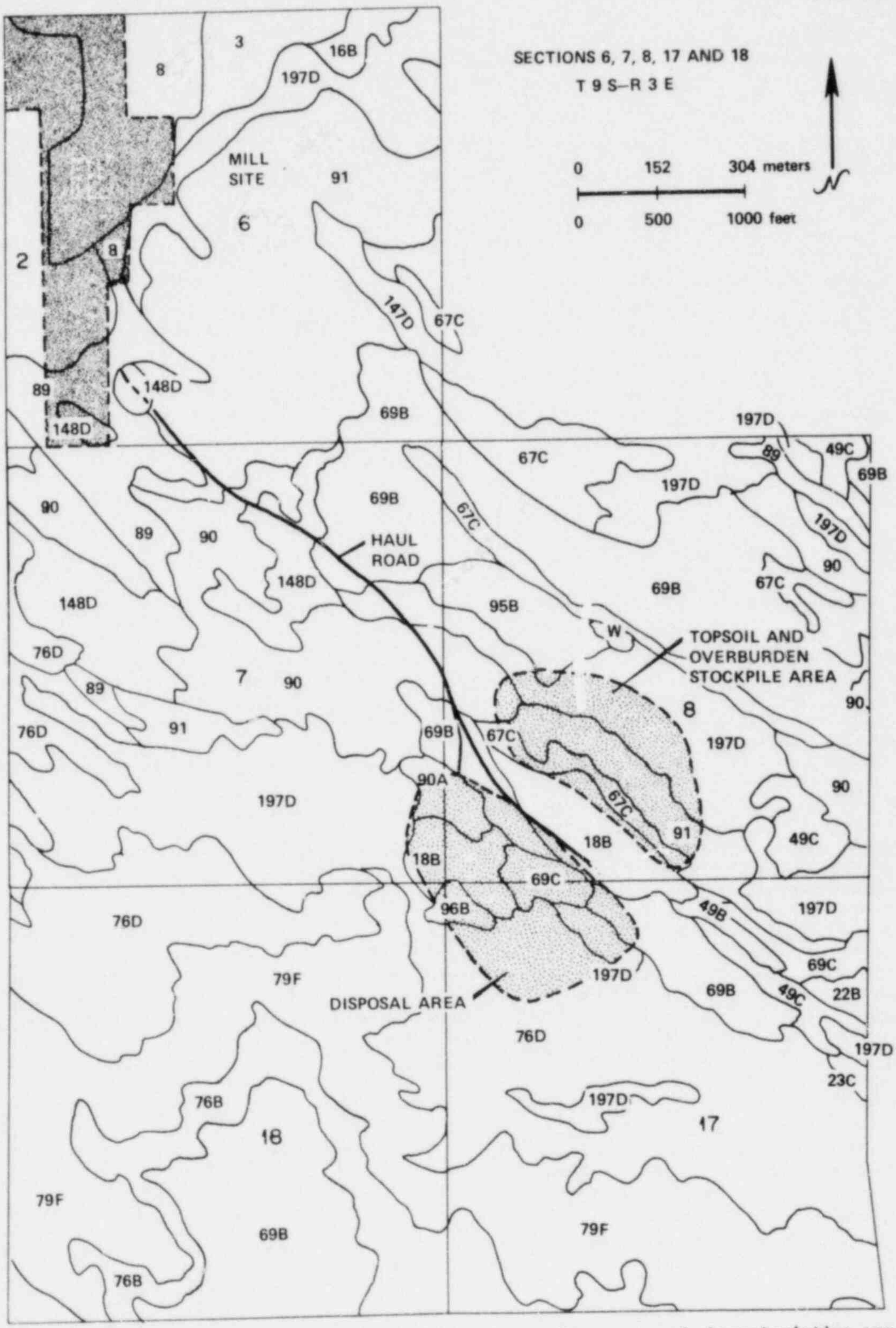

Fig. 3.15. Soil association map. Soil mapping unit, name, and characteristics are given in Table 3.20. Source: Modified from ER, Fig. 3.3-4 and L. M. Mills, TVA, personal communication, March 20, 1980.

Table 3.20. Characteristics of soils expected to be disturbed by project-related activities

Map symbol[a]	Soil mapping unit name	Cropland capability unit[b]	Pasture and hay land groups[c]	Slope (%)	Thickness of "A" horizon (cm)	Suitability as topsoil[d]	Depth to bedrock (cm)	Suitability of soil material for plant growth[e]
2	Lohmiller silty clay loam	IIIc2	F	0–2	20	Fair	>152	Fair
3	Haverson loam	IIIc2	F	0–2	15	Good	>152	Good
8	Glenbuerg fine sandy loam	IVe6	H	0–2	15	Good	>152	Good
18B	Nunn clay loam	IIIe1	F	2–6	20	Fair	>152	Fair
67C	Colby-Norka silt loams, Colby part	VIe3	GN	6–15	18	Fair	>152	Fair
69B	Norka silt loam	IIIe1	F	2–6	15	Good	>152	Good
69C	Norka silt loam	IVe1	F	6–9	15	Good	>152	Good
76D	Minnequa-Midway silty complex, Minnequa part	VIe3	GN	6–25	33	Poor	51–102	Poor
89	Bradhurst clay	VIs6	NS	2–9	10	Poor	>152	Poor
90	Grummit-Snomo clays, Grummit part	VIe12	NS	3–15	15	Poor	<51	Poor
91	Grummit-rock outcrop complex, Grummit part	VIIe5	NS	3–40	15	Poor	<51	Poor
95A	Kyle clay	IVs3	I	0–2	10	Poor	>152	Poor
95B	Kyle clay	IVe3	I	2–6	10	Poor	>152	Poor
148D	Dwyer loamy fine sand	VIIe3	NS	2–6	15	Poor	>152	Fair
197D	Pierre-Grummit clay Pierre part	VIe4	IN	6–25	10	Poor	51–102	Poor

[a]See Fig. 3.16.

[b]The capability of each of the following mapping units for agricultural uses reflects on its suitability for use in reclamation:

IIIc2 Deep, loamy soils on nearly level (0 to 2%) bottom lands and foot slopes that sometimes receive beneficial overflow. The main limitation is inadequate moisture, and the main hazard is wind erosion.

IIIe1 Deep and moderately deep, loamy soils on gently sloping (2 to 6%) uplands. The main limitation is moisture shortage, and the main hazards are wind and water erosion.

IVe1 Moderately deep and deep, loamy soils on undulating and sloping (6 to 9%) uplands. They have severe water and moderate wind erosion hazards. The main limitation is inadequate moisture.

IVe3 Deep and moderately deep, clayey soils on gently sloping (2 to 6%) uplands. The main limitations are inadequate moisture and an unfavorable rooting zone, and the main hazards are water and wind erosion.

IVe6 Deep and moderately deep, moderately sandy soils on nearly level (0 to 2%) bottom lands, terraces, and uplands. They have severe wind erosion hazards. The main limitations are inadequate moisture and low water-holding capacity.

IVs3 Moderately deep, clayey soils on nearly level (0 to 2%) uplands. The main limitations are inadequate moisture and unfavorable rooting zone, and the main hazard is wind erosion.

IVe3 Deep and moderately deep, clayey soils on gently sloping (2 to 6%) uplands. The main limitations are inadequate moisture and an unfavorable rooting zone, and the main hazards are water and wind erosion.

VIe3 Moderately deep and deep, calcareous, loamy soils on undulating to hilly (6 to 25%) uplands. These soils have severe water and moderate wind erosion hazards. The main limitations are inadequate moisture and steep slopes.

VIe4 Deep and moderately deep, clayey soils on sloping to steep (6 to 25%) uplands. These soils have severe water and wind erosion hazards. The main limitations are inadequate rainfall and unfavorable rooting zones.

VIe12 Shallow, clayey soils on nearly level to moderately steep (0 to 25%) uplands. These soils have a severe water erosion hazard, limited rooting depth, and are not suited for cultivation.

VIs6 Dense clay soils on nearly level to sloping (0 to 9%) uplands and toe slopes. The main limitations are unfavorable rooting zone and salts, and the main hazard is water erosion.

VIIe3 Shallow to deep, sandy soils on steep (25 to 40%) uplands. They have severe wind and water erosion hazards. The main limitations are low or very low available water capacity and steep slopes.

VIIe5 Shallow, clayey soils on steep and very steep (25 to 50%) uplands. They have a severe water erosion hazard.

[c]The following grouping of soils for use as pastureland and hay land reflects on their suitability for use in reclamation:

Group F Loamy or silty soils well suited for all climatically adapted plants.

Group H Sandy soils with choice of species and yields limited by limited available water capacity and wind erosion hazard.

Group GN Steeper slope phases (9 to 40%) of limy soils with thin surface layers not recommended for pasture plantings because of erosion hazard.

Group NS Soils not suited for pasture plantings because of severe limitations in depth of rooting zone, water intake rate, available water capacity, or low fertility.

Group I Clayey soils with choice of species and yields limited by very slow water intake rate and slow permeability.

Group IN Steeper slope phases (6 to 40%) of clayey soils not recommended for pasture plantings because of erosion hazard.

[d]Suitability for use as topsoils refers generally to the A horizon.

[e]This column refers to suitability of materials to 152 cm or to bedrock that will support vegetation or is a medium of plant growth, based upon general texture, structure, erodibility, available water capacity, soluble salt content, depth, and accessibility or availability.

3.9 BIOTA

3.9.1 Terrestrial

Natural plant communities in the vicinity of Edgemont are classified as potential shortgrass prairie, Black Hills ponderosa pine, and sagebrush steppe (ER, Sect. 4.6.1.1). The grasslands are dominated typically by western wheatgrass (*Agropyron smithii*), blue grama (*Bouteloua gracilis*), and buffalo grass (*Buchloë dactyloides*). Major species within the ponderosa pine communities include ponderosa pine (*Pinus ponderosa*), Rocky Mountain juniper (*Juniperus scopulorum*), and sedge (*Carex* spp.). The sagebrush steppe association is reflected in the occurrence of big sagebrush (*Artemesia tridentata*) and black greasewood (*Sarcobatus vermiculatus*) communities. In addition to the three major vegetation assemblages, the riparian habitat found along Cottonwood Creek and the Cheyenne River provides a wide diversity of habitat conditions.

3.9.1.1 Flora

Because nearly all of the mill site (including Cottonwood Creek) has been disturbed by the milling activities, very little natural vegetation remains. About 50 ha (123 acres) of the 86-ha (213-acre) site are covered by tailings in 11 distinct areas (Fig. 3.5). Approximately 30 ha (74 acres) have received varying degrees of reclamation in the past with varying degrees of success.[17] Although some of the flatter areas have been stabilized with yellow sweet clover (*Melilotus officinalis*) and crested wheatgrass (*Agropyron desertorum*), significant erosion is occurring on the slopes of some of the tailings piles bordering Cottonwood Creek.

A ponderosa pine community is located immediately east of the mill site. An undetermined amount of windblown sand tailings have contaminated an estimated 32 ha (80 acres) of this habitat.[17]

The composition and average ground cover of plant communities located between the mill and proposed tailings disposal area and at the disposal site itself are listed in Table 3.21. The plant communities consist of both short and medium-tall grasses and sagebrush typical of the region in general. Staff inspection of the area in October 1979 confirmed that no unique natural communities occur in areas to be disturbed.

Table 3.21. Natural perennial ground cover in the vicinity of the Edgemont mill and proposed tailings disposal site

Community	Average ground cover (%)	Representative dominant species
Big sagebrush, medium stand	40	Big sagebrush, buffalo grass, blue grama, western wheatgrass, prairie sandreed
Big sagebrush, heavy stand	58	Big sagebrush, blue grama, buffalo grass, western wheatgrass threadleaf sedge
Rough breaks	14	Big sagebrush, wild buckwheat, blue grama, buffalo grass, side oats grama
Grassland	29	Buffalo grass blue grama, prairie sandreed, little bluestem, western wheatgrass

Source: ER, Table 4.6-1.

According to South Dakota Statutes 41-2-32, 41-2-18, and 34A-8-3, the State has not classified any plant species as threatened or endangered.[39] In addition, no Federally listed endangered or threatened plant species occur in the vicinity of the project.[40]

3.9.1.2 Fauna

Numerous species of wildlife are known to occur in the Black Hills and outlying areas.[41-43] Although principal species in the project area are those that depend upon grassland/sagebrush habitat, the diversity is great because of the riparian habitat along Cottonwood Creek and the Cheyenne River, the ponderosa pine adjacent to the east boundary of the mill site, and the rimrocks and canyons in the Edgemont area (ER, Sect. 4.6.1.2).

Because of the diverse structure, species composition, and increased density of trees, shrubs, sedges, forbs, and grasses, riparian habitat provides food, shelter, and breeding areas for numerous animals including turkey (*Meleagris gallopavo*) and white-tailed deer (*Odocoileus virginianus*). Turkey, raptors (hawks and owls), and mule deer (*Odocoileus hemionus*) utilize the pine stands extensively, and the rimrocks and canyons in the Edgemont area provide habitat for several species of raptors as well as their prey.

As described in the previous sections, nearly all of the mill site has been disturbed by the uranium milling activities. Perching birds found along Cottonwood Creek are the dominant species of wildlife using this area. For the last few years, a white-tailed deer (*Odocoileus virginianus*) with a single fawn has been observed at the mill site each year.

Communities in the vicinity of the project are important directly to several wildlife species and indirectly by modifying the environment. Shrubs tend to collect snow, and their shade results in a slow release of moisture in the spring, creating microhabitats favorable for mixed grasses and forbs. Shrublands are especially important as browse for antelope (*Antilocapra americana*) and mule deer. Further, sagebrush shrublands are used by sage grouse (*Centrocercus urophasianus*) for feeding and strutting grounds.

Limited onsite surveys of the sagebrush/grass and grass associations of the disposal site were conducted in the spring and summer of 1980 (ER, 4.6.1.2). Five species of mammals and 11 species of birds were observed (ER, Tables 4.6-3 and 4.6-4); all are considered common to the area. Big game (deer and antelope) utilization studies showed use of the disposal site by big game over the entire year.[17]

Estimations of the densities of selected game species that could be supported on the undeveloped lands within a 19-km (12-mile) radius of Edgemont are given in Table 3.22. In addition, habitat within the region is available for ring-necked pheasant (*Phasianus colchicus*), sage grouse (*Centrocerus urophasianus*), and mourning dove (*Zenaidura macroura*), although no sage grouse presently occurs in Fall River County. Hunting of sage grouse may occur if populations return. A referendum was passed in November 1980 that will allow hunting of mourning dove. The hunting of predators, such as red fox (*Vulpes fulva*) and bobcat (*Lynx rufus*), is common in the region.

Table 3.22. Estimations based on sport hunting of density capability for selected game species in the vicinity of Edgemont

Species	Crude density capability	
	No./km^2	No./sq mile
Deer (*Odocoileus* spp.)	1.5–2.7	4.0–6.9
Antelope (*Antilocapra americana*)	0.2–0.6	0.6–1.5
Sharptail grouse (*Pedioecetes phasianellus*)	0.3–20.9	0.8–54.2
Turkey (*Meleagris gallopavo*)	0.6–0.7	1.5–1.7
Cottontail rabbit (*Sylvilagus* spp.)	0.0–3.9	0.0–10.0
Ducks	4.1–20.2	10.5–52.3
Muskrat (*Ondatra zibethica*)	4.2–5.7	10.9–14.8
Coyote (*Canis latrans*)	1.1–1.5	2.9–4.0
Prairie dog (*Cynomys ludovicianus*)	20.4–28.0	52.9–72.6

Source: C. Keeler, South Dakota Department of Wildlife, Parks, and Forestry, personal communication, Jan. 3, 1980.

The staff contacted the U.S. Fish and Wildlife Service regarding the presence of threatened and endangered species. Endangered species that may occur at the site and vicinity are the bald eagle (*Haliaeetus leucocephalus*), American peregrine falcon (*Falco peregrinus anatum*), and black-footed ferret (*Mustela nigripes*).[40] Field surveys conducted by the licensee in 1976, 1979, and 1980 did not reveal the presence of any of these species in the vicinity of the project (ER, Sect. 4.6.1.2). Staff inspection of the area in October 1979 confirmed that no habitat suitable for these species occurs in areas to be disturbed. The peregrin falcon, however, is known to inhabit the Black Hills region, and the bald eagle could be found in the area during winter as a transient. The ferret is not known to inhabit the area but potentially exists because of the presence of prairie dogs, a primary food source. However, no prairie dog towns are located in the immediate vicinity of the project.[44] The Northern swift fox (*Vulpes velox hebes*), classified as threatened by the State of South Dakota,[44] is known to occur in Fall River County. Jon Sharps, Endangered Species Coordinator for Region 1, South Dakota Department of Game, Fish, and Parks, doubts if any are present in the Edgemont area because of lack of suitable habitat (J. Sharps, South Dakota Department of Game, Fish, and Parks, Rapid City, personal communication, Nov. 20. 1979).

3.9.2 Aquatic

The extent of habitats available in the Edgemont area depends in part on surface water flow. The gradient of the Cheyenne River from the Wyoming line to the Edgemont area is low and creates an aquatic habitat characterized by long reaches of moderate depth [generally less than 15 cm (5.9 in.)] interspersed by occasional deep pools [>75 cm (29.5 in.)] and shallow riffles [<5 cm (1.9 in.)]. Irregularities in substrate elevations combined with low flows produce small sloughs and backwater areas with little flow.[45] The topography of Cottonwood Creek is similar to that of the Cheyenne River. Variance in stream flow are such that the substrate may be scoured by flood flow, covered with deposited silt, or exposed and subjected to drying, which causes changes in habitat availability.

The aquatic flora and fauna of Cottonwood Creek and the Cheyenne River are characteristic of western semiarid regions. Expected wide fluctuations in diversity and number of species occur as a result of frequent changes in habitat availability. Cottonwood Creek exhibits rich aquatic communities[46] (phytoplankton, zooplankton, macrobenthos, and fish), probably results of relatively stable flow regime and of varied habitat provided by submerged and emergent aquatic vegetation (ER, Sect. 4.6.2). Thirty-four fish species (20 native and 14 introduced) representing nine families have been reported for the Cheyenne River.[47] Samples taken by consultants for TVA at ten sites in the Cheyenne River showed that seven species representing four families occur on or near the Edgemont site. Of these seven species, only bluegill and black bullhead are considered sport species; the remainder are forage species.

No significant fishery exists for either of the two sport species in the vicinity of Edgemont[45] (ER, Sect. 4.6). The Angostura Reservoir [54 km (33.5 miles) downstream of Edgemont] was characterized by the South Dakota Department of Game, Fish and Parks in a 1971 unpublished report as providing good fishing in the spring and fall. A 1975 survey described summer fishing as good with moderate pressure and winter fishing as good with light pressure and revealed that walleye (*Stizostedion vitreum vitreum*) and smallmouth bass (*Micropterus dolomieui*) were the predominant species.[48] Species caught during the 1975 survey are shown in Table 3.23.

Rare and endangered species

No rare, threatened, or unique phytoplankton, zooplankton, or marcrobenthos species nor unique habitats were identified from either Cottonwood Creek or the Cheyenne River. In 1976, the plains topminnow (*Fundulus sciadicus*), a South Dakota threatened species, was taken from the Cheyenne River. The consultants found submerged and emergent aquatic vegetation, which is the preferred habitat for this species. The licensee took further samples (Fig. 3.16) in 1979 but did not find individuals of this species (Table 3.24) or their preferred habitat.[45] Natural fluctuations between wet/dry years and high/low flows within a year may cause habitat variation that could influence the presence or absence of this species in the Edgemont area. For example, although Bailey and Allum[47] did not record the plains topminnow in the Cheyenne River drainage in South Dakota, the presence of *F. sciadicus* in headwater streams of the Cheyenne River in Wyoming[49] could serve as a source of individuals in the Cheyenne River near Edgemont.

Table 3.23. Fish species collected in gill and trap nets from Angostura Reservoir, South Dakota, June 1975

Carp	*Cyprinus carpio* Linnaeus
Golden shiner	*Notemigonus crysoleucas* (Mitchill)
River carpsucker	*Carpiodes carpio* (Rafinesque)
White sucker	*Catostomus commersoni* (Lacépède)
Redhorse	*Moxostoma* sp.
Black bullhead	*Ictalurus melas* (Rafinesque)
Channel catfish	*Ictalurus punctatus* (Rafinesque)
Bluegill	*Lepomis macrochirus* Rafinesque
Smallmouth bass	*Micropterus dolomieui* Lacépède
Crappie	*Pomoxis* sp.
Yellow perch	*Perca flavescens* (Mitchill)
Walleye	*Stizostedion vitreum vitreum* (Mitchill)

Source: South Dakota Department of Game, Fish and Parks (unpublished data).

A joint survey of the Cheyenne River in the Edgemont area was conducted by TVA and the South Dakota Department of Game, Fish, and Parks in July of 1980 for the plains top minnow (Jon Sharps, South Dakota Department of Game, Fish, and Parks, personal communication, Apr. 3, 1980). Additional sampling did not find the species or its preferred habitat.

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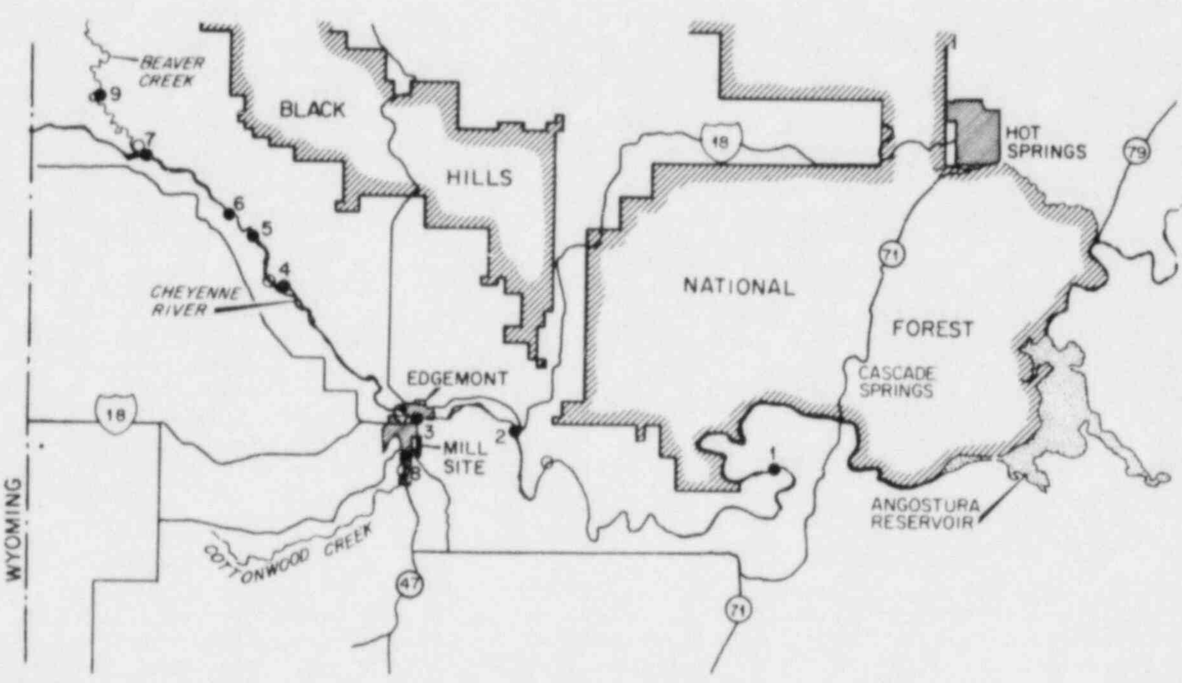

Fig. 3.16. Fish sample stations, Cheyenne River Basin, May 18 through May 22, 1979. Source: Modified from R. B. Fitz, *Fisheries Resources of the Cheyenne River Basin, Fall River County, South Dakota, May 18-22, 1979*, Tennessee Valley Authority, Fisheries and Aquatic Branch, Division of Water Resources, Norris, Tenn., July 1979, Fig. 1.

Table 3.24. Fish species distribution and relative abundance in the Cheyenne River Basin, May 1979

Species	Relative abundance (%) at station								
	1	2	3	4	5	6	7	8	9
Plains minnow *(Hybognathus placitus)* Girard		2	20	29	27	45	74		7
Sand shiner *(Notropis stramineus)* Cope	92	83	62	22	28	22	*a*	55	50
Plains killifish *(Fundulus kansae)* Garman	4	*a*	4	22	7	6	19	36	1
Fathead minnow *(Pimephales promelas)* Rafinesque	4	4	*a*	14	2	15	1		10
Flathead chub *(Hybopsis gracilis)* Richardson		*a*	9	9	28	4	2		15
Longnose dace *(Rhinichthys cataractae)* Valenciennes			3	1	3	5	1	9	11
River carpsucker *(Carpiodes carpio)* Rafinesque		*a*		1	2		1		1
Channel catfish *(Ictalurus punctatus)* Rafinesque		5		*a*		1			2
Green sunfish *(Lepomis cyanellus)* Rafinesque			*a*	*a*	1	*a*	*a*		2
White sucker *(Catostomus commersoni)* Lacepede		6					*a*		
Carp *(Cyprinus carpio)* Linnacus			*a*		*a*		*a*		
Black bullhead *(Ictalurus melas)* Rafinesque					*a*				*a*

[a]<1 %.

Source: Modified from R. B. Fitz, *Fisheries Resources of the Cheyenne River Basin, Fall River County, South Dakota, May 18–22, 1979*, Tennessee Valley Authority, Fisheries and Aquatic Branch, Division of Water Resources, Norris, Tenn., July 1979, Table 2.

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4. ENVIRONMENTAL CONSEQUENCES, MONITORING TO DETECT IMPACTS, AND MITIGATION OF IMPACTS

4.1 IMPACTS ASSOCIATED WITH PROPOSED ACTIONS

4.1.1 Air quality

The major nonradiological atmospheric pollutants from the decommissioning activities will be gaseous emissions from internal combustion engines and total suspended particulates (TSP) from scraping and loading the tailings and borrow material, from transporting this material, and from wind erosion of exposed surfaces (e.g., disturbed lands and stockpiled soils). In general, these emissions will not produce significant long-term (annual-average) impacts on the air quality of the region. The utilization of a slurry pipeline and nearby disposal site will significantly reduce emissions generated in transporting the tailings and contaminated material. The proposed plan would therefore result in relatively minor short-term impacts to air quality compared with other alternatives that involve the exclusive hauling of materials by truck to a more distant location.

The projected annual-average ambient concentrations of pollutants from internal combustion engines (SO_2, NO_x, CO, and hydrocarbons), calculated by the licensee using EPA's Climatological Dispersion Model, are well below Federal and State standards (ER, Sect. 4.1.2.2.4). Consequently, impacts from these emissions are expected to be insignificant.

The amount of TSP generated during the decommissioning operation will be related primarily to the amount of material (tailings and soils) transported. It is anticipated that the entire mill site [86 ha (213 acres)] and disposal site [104 ha (258 acres)] will be disturbed. Construction of the haul road and diversion ditch will disturb an additional 12 ha (30 acres) and 5.3 ha (13 acres), respectively. Additional lands will be disturbed for cleanup of contaminated areas east of the mill site and for obtaining borrow material in excess of that available from the disposal area. The licensee used the amount of material to be moved (ER, Table 4.1-10) in conjunction with soil-particulate-size distributions, moisture contents. wind speeds and turbulence characteristics, vegetative cover, vehicle speeds, and proposed techniques to reduce fugitive dust to estimate the total fugitive dust emissions during decommissioning activities (ER, Sect. 4.1.2.2.3). This information was then used by the licensee to derive worst-case estimates of the short-term (24-h) and long-term (annual-average) emission rates for TSP based on onsite meteorological data (ER, Sect. 4.1.2.2.4).

Short-term impacts from TSP were studied by selecting three 24-h periods of onsite wind data that will result in the highest predicted concentrations and inputting these data with the estimated emission rates into the U.S. Environmental Protection Agency's (EPA's) PAL (Gaussian-Plume Algorithm for Point Area and Line Sources) model (ER, Sect. 4.1.2.2.4). The maximum ambient concentrations of TSP for these three periods are expected to be 335 $\mu g/m^3$, 237 $\mu g/m^3$, and 63 $\mu g/m^3$, respectively. Two of the worst-case 24-h periods occurred during a time when decommissioning operations are likely to have ceased due to winter conditions (mid-February and early March). The third worst-case 24-h period occurred in late July. If meteorological conditions similar to those in mid-February/early March occur during the operational period, the 24-h Federal secondary and State of South Dakota ambient air quality standards for TSP (150 $\mu g/m^3$) are expected to be exceeded, although infrequently. The nonradiological air quality monitoring program (Sects. 4.2.1.2 and 4.2.1.3) will provide an operational check on the frequency of the concentrations in excess of Federal and State standards and will indicate the need to apply appropriate mitigative actions as committed to by the licensee.

As with the short-term estimates, the annual-average ambient concentrations of TSP were estimated based on the expected worst year of operation with regard to emissions. Using EPA's Climatological Dispersion Model, the applicant predicted the highest annual-average concentrations of TSP to occur east of the haul road and in Cottonwood community (ER, Sect. 4.1.2.2.4).

The maximum annual-average TSP concentration expected to result from the decommissioning operation (23 μg/m³), when added to background levels in the vicinity (27 μg/m³; see Sect. 3.2), will not exceed the Federal secondary and State annual-average ambient air quality standard for TSP (60 μg/m³).

The staff agrees with the licensee's predictions on air quality. However, this is based on the licensee's assumptions regarding fugitive dust control including. (1) average vehicle speed at the mill site will not exceed 16 km/h (10 mph); (2) average vehicle speed along the haul road will not exceed 32 km/h (20 mph); (3) some type of road carpet will be used in addition to watering to achieve a 60% reduction in fugitive dust emissions; (4) the main transfer routes on the mill site and between the disposal site and overburden stockpile will be watered; (5) the extent of the disturbed area at any one time will be limited as much as possible; and (6) disturbed areas (mill site, disposal site, and stockpiled soils) will be revegetated as soon as practicable.

The licensee believes that stopping work because of high wind speeds will not effectively diminish fugitive dust generation (ER, Sect. 4.1.2.3.2). The rationale for this belief is that the increase in dust during periods of high winds will be offset by the enhanced dispersion associated with the increased wind speed. The staff believes that this view should be adopted only for periods of intermittent high wind speeds (gusting). For periods of sustained high winds, the staff notes that although the resultant ambient concentration of the pollutant may not increase, the area affected by a given concentration will be greatly expanded. This is of particular importance because the dust will carry radionuclides. Therefore, the staff recommends that decommissioning operations be temporarily stopped when sustained wind speed exceeds 40 km/h (25 mph).

Air quality of the area will be monitored during the project to determine if the mitigative methods are adequate or if additional or modified procedures are necessary (Sects. 4.2.1.2 and 4.2.1.3). If inadequate, effective measures will be implemented.

4.1.2 Radiological environment

Normally, background radiological environment is discussed in Sect. 3, "The Affected Environment." This discussion is to establish baseline values for comparison with potentially adverse impacts to be discussed in this section.

Because the Edgemont site environment presents an already radiologically contaminated situation with a chronic low-level release of radioactive materials to unrestricted areas, the background radiological environment is briefly presented here to emphasize that the objective of the project is to remove an existing problem. The staff's assessment of the incremental radiological impacts of the project is presented in Sect. 4.1.9.

The Edgemont mill produced about 2.1×10^6 MT (2.3×10^6 tons) of uranium tailings. These tailings were disposed of as sands and slimes in piles and ponds on the mill site (Fig. 2.9). Although most of the tailings have been temporarily stabilized by earthen cover, radon flux measurements taken on the site have ranged up to 970 pCi/m²·s. The natural background radon flux in the area is about 2.8 pCi/m²·s (ref. 6). Radon gas concentrations above background levels have been detected up to 1.1 km (0.7 mile) from the site.

Direct gamma radiation levels as high as 3780 μR/h (on ponds) have been measured on site, with measured values of over 1000 μR/h on ponds 1, 2, 3, and 7. In general, gamma levels from 70 to 260 μR/h were measured on the tailings sand piles. These may be compared with a normal background level of about 13 μR/h.

Site conditions require remedial action, the subject of this Final Environmental Statement (FES).

4.1.3 Soils

Lands to be affected by the proposed project are listed in Table 4.1; the soils are depicted in Fig. 3.15. In addition to the mill site, 5.3 ha (13 acres) of soils will be disturbed along the eastern edge of the mill for construction of a diversion ditch, and an unknown amount of land east of the mill will be disturbed by removing tailings that have blown into this area (ER, Sect. 3.5).

Table 4.1. Land area affected by the proposed project[a]

Location	Area	
	ha	acres
Mill site	86	213
Diversion ditch at mill site	5.3	13
Disposal area	68	168
Soil stockpiles	36	90
Haul road	12	30
Total	207.3	514

[a]Additional areas may be disturbed for (1) fill material required at the mill site and (2) removal of tailings blown east of the mill site.
Source: ER, Sect. 3.0.

Removal of topsoil and natural vegetation will accelerate wind and water erosion. Generally, these impacts are expected to occur primarily during the summer montns when project activity will be the greatest. To minimize soil erosion, all soils stored for later use will be contoured and seeded (ER, Sects. 3.3 and 3.4). Areas not immediately available for reclamation because of decommissioning scheduling will be seeded with a temporary crop of barley, rye, or oats (ER, Sect. 4.6.3), and heavily travelled areas will be sprinkled with water from the onsite well (ER, Sect. 3.5). Up to 80% of the sand tailings at the site will be moved by a slurry pipeline, thereby minimizing dust generation (ER, Sect. 3.2). Contaminated material moved by trucks will be sprayed, as necessary, with a stabilizing agent to minimize fugitive dust during transport. Erosion by rainfall will be minimized by constructing (1) water diversion ditches at the mill site (ER, Sect. 3.5) and disposal area (ER, Sect. 3.3), (2) trench drains along the outside of the haul roads and a median drain between the haul roads that empty into Pond 10 on the mill site (ER, Sect. 3.4), and (3) a sediment pond below the impoundment dike to control sediments resulting from construction of the disposal pit (ER, Sect. 3.3).

Soils at the disposal site which are suitable for plant growth will be stored north of the disposal area (Fig. 3.15). Topsoil from the haul road will be stored along the route for use in reclamation. The licensee has recently determined that it appears likely that sufficient suitable topsoil exists at the disposal site for reclaiming all disturbed areas. However, the licensee might be required to obtain fill material from other areas. Use of soil from the disposal site is environmentally preferable to disturbing additional lands and should receive first priority. If opening up new borrow areas will be required for fill and topsoil material, these will have to be clearly justified by the licensee.

Although topsoil and subsoil will be segregated prior to storage, a reduction in the quality of the soils is unavoidable. Moving the soils will disrupt existing physical, chemical, and biotic soil processes, and the heavy machinery required to move the material will cause soil compaction, which is not conducive to plant growth. Ripping the soil and applying the recommended fertilizer rates (ER, Sect. 4.6.3) will enhance the likelihood of successful revegetation, but a temporary decrease in natural soil productivity is probable.[1] If reclamation efforts are successful, long-term impacts to the soil are not expected to be significant.

4.1.4 Mineral resources

The project as proposed or with any of the identified alternatives will not affect future recovery of any known mineral resources. There are no known commercially valuable mineral resources underlying the proposed disposal site (site C1).

4.1.5 Land use

The proposed action should have no significant direct adverse impacts on land use. The mill site currently has a nonuse status, and the mill has not operated since 1974. Decontamination and reclamation of the site [86 ha (213 acres)] would allow productive use of this area.

Although Fall River County does not have a comprehensive land use plan or zoning ordinance, Edgemont's temporary zoning ordinance designates that portion of the mill site within the city limits as industrial. Because the railroad borders one side of the site and the city sewage lagoon the other, it can be expected that the permanent zoning of this area will also be industrial. Therefore, the remainder of the site would be most suitable for industrial use as well.

Preparation of the proposed disposal site for long-term isolation of tailings and contaminated materials will temporarily remove about 122 ha (301 acres) of grazing land [68 ha (168 acres) for disposal area, 36 ha (90 acres) for stockpiled soils, 12 ha (30 acres) for haul roads, and 5 ha (13 acres) for a diversion ditch along the mill site]. At least 17 ha (41 acres) of ponderosa pine may be lost as a result of cleanup of windblown tailings east of the mill site (ER, Table 4.6-2), although techniques are currently under evaluation which would allow cleanup of this area without disturbing the trees. Additional areas in the vicinity of the mill probably may be disturbed for borrow material (ER, Sect. 3.2), although the staff encourages minimization of such action (Sect. 4.1.1.3). All disturbed areas, with the exception of the tailings impoundment, will be revegetated with species primarily suitable for livestock grazing (Sect. 2.2.2.9). The impoundment will be revegetated with species which will not specifically promote livestock grazing but will allow wildlife utilization of the area. This measure will help to ensure that vegetative cover over the tailings impoundment will be sustained over time, providing erosion protection. The staff recommends that the seed mixture include species that accommodate wildlife as well as permit forage production for livestock (Sect. 2.2.3.8).

The effect of decommissioning on land use would be a net increase of about 51 ha (127 acres) available for productive land use. Given time, it is possible that even the reclaimed disposal site could be released to grazing. Land use control (as required by Sect. 202 of the Uranium Mill Tailings Radiation Control Act of 1978) will ensure that no disruption by either natural erosion or by human or animal activities will take place.

Because no significant direct adverse impacts on land use are anticipated, no mitigation measures were proposed by the licensee (ER, Sect. 4.3.1.3). The staff concurs with this decision. Mitigation measures for potential adverse impacts from such causes as dust and erosion, which could affect land use, are discussed in their respective sections.

4.1.6 Water

4.1.6.1 Surface water physical effects

Mill site

The major impacts of the decommissioning plan on the existing surface water features at the mill site are: (1) permanent reduction of surface water contamination resulting from runoff and flood erosion of existing tailings, (2) elimination of contamination from standing water in the tailings ponds following removal of the tailings and associated liquids, (3) alteration of existing local drainage patterns during decommissioning by construction of a ditch to divert surface runoff from the area east of the mill site to Pond 10, (4) removal of all contaminated materials from the margins and streambed of Cottonwood Creek, (5) restoration of the channel as close to its original course as feasible, and (6) revegetation of the stream margins.

The licensee proposes to reroute the reach of Cottonwood Creek flowing through the mill site through a temporary diversion channel constructed in uncontaminated native material (Sect. 2.2.2.5). During the two years of staged construction and stream decontamination, which would occur during low flow to minimize transport of contaminated sediment, the stream would be diverted through a pipe (Sect. 2.2.2.5). Following decontamination of the site, a new permanent route close to the original course would be constructed for the creek (Sect. 2.2.2.5). The stream margins would be stabilized along meandering bends by using riprap where needed and then revegetated, according to the plan presented in Sect. 2.2.3.8. Riprapping and revegetation would reduce erosion and subsequent sedimentation. Erosion and sediment transport from the temporary diversion channel will occur as the result of construction and transport of unconsolidated material. Measures taken to stabilize the bed and margins of this channel will minimize erosion (Sect. 2.2.2.5). Following the routing of the creek, erosion of the new stream channel will occur until the streambanks are shaped by erosion and unconsolidated materials are carried from the streambed.

The full extent of contamination of streambed sediments in Cottonwood Creek is not known at this time. Lack of information exists on the quantity of streambed materials that will have to be removed from the creek to remove sediment contaminated with radionuclides or heavy metals. If only isolated pockets of contamination occur within the stream, these areas could be isolated and removed with minimal impacts to surface hydrology. In anticipation that contaminants are spread throughout the streambed sediments, it has been proposed, as discussed, to reroute the stream while removing these materials. The extent of material to be removed depends in part on the extent of transfer of contaminant materials from groundwater into stream alluvium and surface waters (Sect. 4.1.6.4). A data base defining types and quantities of contaminated material must be determined by the Tennessee Valley Authority (TVA) in coordination with the U.S. Nuclear Regulatory Commission (NRC) and the State of South Dakota, and the extent of contaminated material in both Cottonwood Creek and the Cheyenne River must be determined by the licensee before the effects of removal of the streambed material on hydrology and water quality can be fully determined. The extent of contaminated groundwater beneath the mill site and the time necessary for the groundwater to cleanse itself are not known (Sect. 4.6.1.4).

Disposal site

The major impact of the decommissioning plan on the surface water features at this site will be the complete and permanent alteration of surface water features of the 68-ha (168-acre) site (Sect. 2.2.2.1).

Alteration of drainage to the ephemeral stream will reduce the volume of annual runoff received by the stock ponds downslope and could cause a reduction in the peak flood flows in the drainage courses downstream of the disposal site. Permanent loss of the small stock pond [0.04 ha (0.1 acre)] at the toe of the containment area (Fig. 3.4, Pond 1) will occur because of construction of the disposal area. Given the close proximity of Pond 2 (Fig. 3.4) to this site, the availability of another pond downstream (Fig. 3.4, Pond 3), and the numerous small ponds in the Edgemont area, the staff considers this loss to be minor.

Construction of a sediment pond downslope of the impoundment dike could result in increased erosion and sedimentation in the existing ephemeral drainage channels until construction is completed and the disposal area revegetated. The sediment pond, however, should prevent downstream transport of sediment and resultant streambed alteration. Any sediment not contained by the sediment pond could reach the two stock ponds downstream and ultimately the Cheyenne River (Fig. 3.4). In the opinion of the staff, use of the best available technology for impoundment construction, diversion ditches to intercept runoff, and sediment ponds to retain sediment from runoff will minimize the impacts to surface water hydrology associated with the disposal site.

Temporary increases in erosion and subsequent sedimentation in the small intermittent drainage courses along the haul road/slurry pipeline route (Sect. 2.2.2.2) will be minimized by culverts and ditches. A trench-drain system along the haul road/slurry pipeline route (Sect. 2.2.2.2) will be designed to contain any spilled or contaminated materials. The potential for contamination of surface water from the drainage system will be minimized by drainage of the system to and containment within Pond 10.

4.1.6.2 Potential surface water quality effects

Potential adverse surface water quality impacts associated with the decommissioning of the Edgemont mill could result from area runoff, point-source discharges, dredging, seepage, or accidental spills of toxic or hazardous materials. Surface water quality impacts may also occur as the result of groundwater recharge of Cottonwood Creek following decommissioning (Sect. 4.1.6.1).

The primary adverse impacts associated with the decommissioning are surface runoff and resultant erosion and sedimentation. Erosion during the decommissioning can occur from the mill site, haul road and slurry pipeline route, disposal site, and borrow areas. The licensee's proposed specific constructional techniques designed to reduce erosion and sedimentation are discussed in Sect. 2.2.2 of this document and in Sect. 4.2 of the ER. These techniques should ensure that, over the short term, the quantity of suspended material is within an order of magnitude of the mean values for suspended solids in the vicinity of the site (Sect. 3.6.1, Table 3.18). This will minimize any long-term impacts of sediment on water quality and should minimize further water contamination by heavy metals contained in the tailings and potential runoff from the site.

Although the contaminated tailings will be removed from the mill site, some water quality degradation of Cottonwood Creek is expected to continue as the result of groundwater inflow from beneath the mill site. The extent of present and projected groundwater contribution to surface water quality degradation cannot be determined because the extent of groundwater contamination beneath the site and the time necessary for the groundwater to be cleansed are not known (Sect. 4.6.1.4).

The licensee, however, will conduct a comprehensive surface and ground water monitoring program to document postdecommissioning water quality conditions and to determine the need for any additional monitoring and/or use restrictions.

Mill site

Increased levels of suspended contaminants are associated with surface runoff from the exposed tailings.[2] These mill tailings are of particular concern at the Edgemont site because of potential radioactive and trace metal contamination (i.e., aluminum, barium, chromium, titanium, nickel, iron, vanadium) of the tailings (ER, Sect. 4.2.2.2.1.2). The Cheyenne River does not currently meet recommended standards for drinking water[3,4] or for agricultural use[5] because of high concentrations of barium, arsenic, iron, manganese, and dissolved solids (see Sect. 3.6). However, during decommissioning, the levels of iron, manganese, and dissolved solids may be further accentuated by runoff from the site. In addition, during decommissioning, levels of aluminum, sulfate, chromium, barium, and vanadium may be increased. The proposed diversion ditches around the mill site and sumps or sediment basins within the mill site are designed to intercept or contain runoff before it reaches Cottonwood Creek so that water quality impacts can be minimized (Sect. 2.2.2.3).

The licensee has not determined the extent of heavy metal contamination of streambed sediments in Cottonwood Creek or the Cheyenne River as a result of tailings erosion nor the method of isolation and removal of the contaminated materials from the Cheyenne River. The licensee proposes to remove any contaminated material occurring in the Cheyenne River during low flow (ER, Sect. 4.2.2.2) and should do so only after consultation with the NRC in coordination with the State of South Dakota to locate contaminated areas and to establish acceptable concentrations that may remain in the river. Determination of impacts to water quality from migration of the trace element contaminants in the Cheyenne River depend upon the concentration, sediment particle size, and location of the contaminated material within the river relative to stream flow, all of which are unknown at this time. However, EPA[2] found that although operation of the Edgemont mill caused Cottonwood Creek to be contaminated, this contamination did not extend into the Cheyenne River; thus, contamination in the river should be minimal. The extent of contamination in the river, however, may be greater than the 1973 EPA study indicates because it has been shown that leakage has occurred from ponds adjacent to the river (ER, Sect. 4.2).

Additional impacts to water quality from the decommissioning activity include potential accidental leakage or breaks in the outfall line from the Edgemont city sewage lagoon as it crosses the mill site. If breakage of the line occurs, sumps and pumps will be used to isolate the leakage and return it to the lagoon while the system undergoes repair (ER, Sect. 4.2).

Also included as accidental or potentially unavoidable discharges to adjacent water bodies are potential spills of fuels or oils. These materials, which will be stored in diked areas designed to retain 110% of the total volume contained within the area (ER, Sect. 4.2), are the only hazardous materials to be stored onsite.

Disposal site

Any point-source discharge associated with surface runoff at the disposal site will be contained by the sediment pond. Because this pond will be designed to remove all particles larger than 0.005 mm in diameter during a 10-year, 24-h precipitation event, only clay particles would reach the Cheyenne River. Some of these clay particles could eventually be carried as far downstream as the Angostura Reservoir, where they would be deposited. The limited erosion from the disposal or mill sites should not result in significant adverse impacts to either the Cheyenne River or the Angostura Reservoir because both carry naturally heavy silt loads during runoff events (J. Hatch, personal communication, March 1980).

4.1.6.3 Reclamation

As the result of decommissioning the mill site and subsequent stabilization and reclamation (Sect. 2.2.3.8), water quality and hydrologic and water use characteristics of Cottonwood Creek at the mill site should be similar to upstream areas of the creek. Reclamation of the mill site should also significantly reduce windborne erosion and resultant erosional input into adjacent water bodies (see Sect. 4.1.5).

The haul road and slurry pipeline route will subsequently be returned to approximate predecommissioning conditions (Sect. 2.2.3.8). This reclamation and revegetation will reduce erosion into nearby Cottonwood Creek

Following completion of tailings disposal and installation of the clay cap and top soil, the disposal site will be revegetated according to the plan outlined in Sect. 2.2.3.8. Stabilization at the disposal site and reclamation/revegetation of the surrounding area should reduce erosion and sedimentation carried into the ephemeral drainage channels and subsequently the Cheyenne River to levels typical of surrounding undisturbed drainage courses.

4.1.6.4 Groundwater

The groundwater under the mill site is presently chemically contaminated by past and present seepage from and through the tailings piles and ponds on the site. Removal of the tailings and other contaminated materials from the mill site will allow natural processes, primarily subsurface flow, eventually to restore this groundwater to its previous condition by transporting excess soluble ionic species into Cottonwood Creek and the Cheyenne River.

Such transport is presently occurring and does not result in measurable degradation of either stream. The staff is of the opinion that continuation of this natural process is the only practical solution for restoration of groundwater quality under the mill site. The staff recommends that shallow wells not be permitted on the mill site after reclamation. No radiological contamination of groundwater in excess of standards is presently observed or expected after reclamation.

The disposal site will be designed and constructed to preclude groundwater contamination. Preliminary tests indicate that a very thick sequence of shale material underlies the site and will isolate the tailings and contaminated materials from contact with groundwater. Dewatering of the slurried tailings will result in the presence of a negligible amount of solutions available for transport of contaminants. If a clay liner is used, it will add an extra margin of safety regarding seepage control. The staff concludes that the project, over time, will result in an overall improvement from present conditions, and adverse impacts to groundwater resources would be the same or greater if an alternative other than the staff's preferred alternative for tailings disposal were implemented.

4.1.7 Biota

4.1.7.1 Terrestrial

Decommissioning and stabilization

The primary impact to terrestrial biota from decommissioning the mill will result from temporary loss of habitat. This impact, however, will be minor because the mill site is already highly disturbed (Sect. 3.9.1) and because the land proposed for the disposal site is not considered to be unique wildlife habitat (Sect. 3.9.1.1). Lands to be affected by the proposed project are listed in Table 4.1. Very little natural vegetation exists at the mill site, even along Cottonwood Creek, because of past milling activities. Attempts to revegetate portions of the site in the past, using introduced species, resulted in varied degrees of success (Sect. 3.9.1.1).[6] Therefore, decommissioning and restoration of this site is expected to improve its ecological characteristics. A big game utilization transect established on the disposal site in December 1979 has shown no use by either mule deer or antelope during winter, spring, or summer seasons; a similar utilization study revealed no use by big game of the disposal site over the entire year.[6] Nongame bird and small mammal surveys in 1980 indicate that population levels are lower on the disposal site than on other nearby areas sampled in 1975 and 1976 (ER, Sect. 4.6.1.2.2). Furthermore, vegetation to be disturbed is not considered to be unique habitat for any wildlife species in the area. Because similar habitats are common throughout the region (Sect. 3.9), it is expected that the temporary inaccessibility of this relatively small amount of land to wildlife will not significantly reduce the amount of habitat for any wildlife populations.

Land clearing, operation of heavy equipment, and other construction activities will destroy small animals that move too slowly to escape or that retreat to burrows for protection. Other animals will be displaced, possibly reducing their populations because of predation or increased competition for food, territory, and other habitat requirements. Although many of these species are important members of the terrestrial food web, their population densities are believed to be low (Sect. 3.9), and their loss would represent an insignificant regional impact.

Suspended particulate matter emitted into the air by construction activities (Sect. 4.1.1) will eventually be deposited in part on the surrounding vegetation, possibly reducing plant vigor or causing the plants to be less palatable. Gaseous emissions from internal combustion engines may also interfere with the physiological processes of the vegetation. Although the magnitude of these potential impacts is not known, it is expected to be negligible. No significant deleterious effects have been demonstrated at other construction projects of similar or greater magnitude. Moreover, if any impacts do occur from fugitive dust and/or gaseous emissions, they will be minor and short term.

Noise from project activities is not expected to affect seriously the area wildlife. Few data are available to demonstrate the effects of noise on wildlife, and much of what is available lacks specific information concerning noise intensity, frequency, and duration of exposure.[7] Some typical ranges of sound levels from common construction activities are listed in Table 4.2. Noise associated with the project may initially cause migration by some wildlife away from the immediate vicinity, but those that remain or return will generally become habituated to construction noises and activities.[7] Also, because this project does not involve the continued operation of any facility in the future, ambient noise levels are expected to return to normal once the area has been reclaimed.

Table 4.2. Sound levels from construction equipment

Source	Sound level, dB(A), at indicated distances from source				
	15 m	30 m	61 m	152 m	305 m
Trucks, cranes, bulldozers, etc., with diesel-type internal combustion engines	70–95	64–89	58–83[a]	50–75	40–69
Air compressors and other stationary sources, typically diesel powered	76–86	70–80	64–74	56–66	50–60
Pile driver	105	99	93	85	79
Front-end loaders	73–86	67–80	61–74	53–66	47–60

[a]Source levels above 80 dB(A) are usually produced by a combination of several pieces of equipment operating at the same time.

Source: U.S. Senate, *Report to the President and Congress on Noise*, Senate Document 96–63, U.S. Government Printing Office, Washington, D.C., 1972.

Increases in personnel associated with the decommissioning project will adversely affect most wildlife in the area. Although some species may be benefited, most of the larger mammals will abandon habitats in close proximity to intense human activity. Additional stress will be placed on the terrestrial biota as a result of greater legal and illegal hunting pressure and destruction of habitat by off-road recreational vehicles. An insignificant increase in wildlife losses is expected to occur as a result of greater vehicular traffic on ighways.

Federally listed endangered species that may occur at the site and vicinity are the bald eagle (*Haliaeetus leucocephalus*), American peregrine falcon (*Falco peregrinus anatum*), and black-footed ferret (*Mustela nigripes*) (Sect. 3.9.1.2). Field surveys of the project vicinity in 1976, 1979, and 1980 did not reveal the presence of any of these species. Further, habitat suitable for these species does not exist in areas to be disturbed by the project (Sect. 3.9.1.2). The peregrine falcon is known to inhabit the Black Hills region, and the bald eagle can be found as a transient in the area during winter. However, because habitat in the project vicinity is not considered to be unique for these raptors, the staff believes that the proposed action will not affect these species. Jon Sharps, Endangered Species Coordinator for Region 1, South Dakota Department of Game, Fish, and Parks, concurs with the staff's conclusion. Although the black-footed ferret is not known to inhabit the area, the potential exists for this species to occur in the region because of the presence of prairie dogs, a primary food source for the ferret.[8] However, no prairie dog towns are known to be located within 3.2 km (2 miles) of the mill or proposed disposal site.[9] Dr. Raymond Linder, Leader for the U.S. Fish and Wildlife Service's black-footed ferret recovery team, knows of no sightings of ferrets in Fall River County; the most recent sighting of a ferret was in the spring of 1979 in Todd County, South Dakota, more than 250 km (150 miles) east of the project site (personal communication, February 2, 1981). The U.S. Fish and Wildlife Service concurs with the staff's conclusion that the proposed action will not affect any Federally listed endangered species that may occur in the vicinity of the site.[10] Although the northern swift fox (*Vulpes velox herbes*), classified as threatened by the State of South Dakota,[9] is known to occur in Fall River County, it is unlikely that any are present in the Edgemont area because of lack of suitable habitat (Jon Sharps, personal communication, Nov. 20, 1979).

Reclamation

Although the primary objective of the licensee's reclamation plan for the mill site, disposal site, haul roads, and borrow areas is to stabilize the soil and tailings and to provide livestock forage (Sects. 2.2.2.7 and 2.2.2.9), many of the species proposed for revegetation are native to the area and should benefit wildlife as well. Use of additional native species is recommended by the staff (Sects. 2.2 and and 3.8).

Revegetation of the riparian community along Cottonwood Creek, which runs through the mill site, (Sect. 2.2.3.8) has been designed not only to stabilize this area but also to further enhance the wildlife values of the area. The staff recommends that any portion of the ponderosa pine community disturbed as a result of cleanup of windblown tailings should be replanted with species typical of the area (Sect. 2.2.3.8).

4.1.7.2 Aquatic

Decommissioning and stabilization

One of the major consequences associated with the proposed decommissioning which could adversely affect aquatic biota is rerouting Cottonwood Creek to a decontaminated reach and removal of contaminated material from the floodplain and streambed of the creek (Sect. 4.1.6.1). The licensee's proposed plan for decommissioning of Cottonwood Creek (Sect. 2.2.2.5) would involve diverting the stream for two nonsequential six-month periods, with the resultant destruction of the associated biological communities in the affected reach during both periods. The staff believes that if this is done such that erosion and sedimentation are minimized and the streambank stabilized and revegetated, long-term adverse impacts to the stream community through the mill site should be minimal, though these communities would be lost in the short term prior to restoration.

If, in meeting requirements for decontamination, extensive areas of the creekbed through the mill site are identified as contaminated, the biota through this section, as discussed previously, would be destroyed. However, from a study by Wade and Wright, [Tennessee Valley Authority (TVA)],[11] it appears that Cottonwood Creek upstream of the mill site has a diverse aquatic community from which repopulation of the stream reach through the mill site would occur. This should minimize long-term effects on the aquatic biota.

Following decontamination, reconstruction of the stream channel will be necessary. The licensee should consult with qualified fisheries biologists in reconstructing the channel. The U.S. Fish and Wildlife Service recommends that the stream should have meandering bends and that, instead of uniformly regrading the stream banks to a 10°-slope, the stream banks should be permitted to develop naturally or have structures built that produce undercut banks and other instream flow structures (J. W. Sayler, U.S. Fish and Wildlife Service, personal communication, Dec. 22, 1980). The licensee plans to place natural or man-made obstructions (i.e., such as concrete boulders and diversions) within the stream in order to provide diverse habitats (i.e., pools and riffles) and stable, diverse substrate for reestablishment of aquatic communities. These substrate materials or obstructions should be sufficiently numerous so as to be characteristic of undisturbed streams in the area. Decontamination and stabilization of the streambed and stream margins of Cottonwood Creek (Sect. 2.2.3.8) and provision of more diverse habitats within the stream should mitigate short-term impacts associated with decommissioning by permitting recolonization of a diverse aquatic community. Revegetation of the stream margins should reduce erosion and sedimentation and, over time, provide overhanging vegetation of aquatic habitat enhancement.

During decommissioning, biological communities in the Cheyenne River and Cottonwood Creek should be protected from increased erosion and sedimentation from tailings removal and transport from the mill site or accidental spills of hazardous or toxic materials. Diversion ditches east of the mill site and along the haul road will restrict drainage at the site (Sect. 2.2.3). Removal of windblown tailings will reduce wind erosion and transport of contaminated material into the adjacent water courses. The containment and diversion measures proposed by the licensee should reduce the impacts associated with the mill decommissioning on the aquatic biota of Cottonwood Creek and the Cheyenne River. Until the groundwater beneath the site has been purged of contaminants, impacts to the biota from trace metals resulting from groundwater discharge to surface waters at the mill site may continue. The impacts associated with this groundwater discharge should be minimal because of the normally large dilution capacity of the streams in relation to the seepage inflow and capacity of the alluvium to neutralize, absorb, and retain a large portion of the seepage contaminants (ER, Sect. 4.2).

Specific impacts to aquatic communities at the disposal site are anticipated only as a result of destruction of the stock-watering pond at the toe of the containment area (see Fig. 3.4). This impact is considered of minimal significance because of the very small size of the pond and the assumption that the resident aquatic community is similar to that of other ponds in the area. Effects on other pond communities downstream of the disposal area are not expected because of their distance from the site, limited erosional input because of runoff diversion around the disposal site, and sediment retention by the sediment pond to be located immediately downslope of the containment dike. No significant impacts to the biota of the streams draining the disposal site are expected because of the ephemeral nature of these streams. Effects on Cottonwood Creek and the Cheyenne River are not expected because of their location and distance from the disposal site. In the event that runoff from the disposal area reaches the Cheyenne River, the aquatic biota could be affected during decommissioning by the increased sediment and trace elements carried by the runoff. However, any effect should be minimal because aquatic organisms in the Cheyenne River are already subjected to heavy sediment loads associated with increased flows in the river (Sect. 3.6.1.2) and because flow in the river should dilute any contaminants (ER, Sect. 4.2).

Reclamation

Reclamation of the stream margins of Cottonwood Creek through the mill site by stabilizing revegetation or riprap, where necessary (Sect. 2.2.2.5), should prevent most erosion from the mill site, particularly during periods of increased runoff. This stabilization should minimize impacts to the biota from runoff and erosion (Sect. 4.1.7.2). Habitat stability and diversity within the decontaminated stream channel will be provided by natural or man-made obstructions placed in the reclaimed stream. These obstructions should increase streambed stability and provide spawning and refuge areas for aquatic biota within the stream. Overhanging riparian vegetation following streamside revegetation will provide additional aquatic habitats. Habitat stability and diversity will enable recolonization of the stream by numerous aquatic species moving upstream from the Cheyenne River or migrating and drifting downstream from above the mill site.

4.1.8 Socioeconomic effects

4.1.8.1 Introduction

Quantitatively predicting the socioeconomic impacts of the proposed mill decommissioning project is extremely difficult. Because the socioeconomic environment in the area surrounding the project has seldom been stable, historical trends are not very useful for forecasting. In addition, an already dynamic situation has been made even more so because of potential energy-related industrial development on a relatively large scale. Nevertheless, impact assessments have been formalized by local planners and the licensee The staff has reviewed these forecasts, the assumptions upon which these forecasts were based, and additional impact assessment sources. The staff has included in this review discussions with the licensee and with various authorities in the Edgemont–Hot Springs region and has independently developed a set of assumptions upon which to base the analyses (see Appendix B). The following impact assessments, when quantified, because of the uncertainties involved, should be read with caution. The staff feels, however, that the analysis possesses the basic validity necessary to gauge the impacts of the decommissioning project.

Some of the more important project-related impacts are summarized in Tables 4.3 and 4.4. Overall, when compared with the composite impacts of proposed new industries, the impacts of the proposed project are small. The staff believes that, in a socioeconomic sense, the long-term beneficial effects of the safe removal and ultimate disposal of aesthetically displeasing, property-value-reducing radioactive materials to a remote location will far outweigh any short-term socioeconomic costs to the local communities.

Table 4.3. Estimated incremental impacts on employment population, and housing caused by Edgemont mill decommissioning construction activities[a]

	Total regional impacts	Edgemont		Hot Springs	
		Low range	High range	Low range	High range
Employment opportunities	136-153				
Population influx	243-281	151-170	200-228	44-53	92-111
Families	47-57	28-33	37-45	10-12	20-25
School-age children	31-50	25-29	44-40	8-10	18-22
Housing demands	125-139	81-88	108-116	19-23	42-49

[a]Based on peak construction employment (78 seasonal and 5 permanent employees). See Appendix B for assumptions.

Table 4.4. Estimated incremental impacts on employment, population, and housing caused by Edgemont mill decommissioning operation activities[a]

	Total regional impacts	Edgemont		Hot Springs	
		Low range	High range	Low range	High range
Employment opportunities	158-179				
Population influx	306-349	180-201	246-278	61-72	127-148
Families	64-75	36-41	51-59	14-16	29-134
School-age children	56-65	31-36	44-51	12-14	25-30
Housing demands	145-161	90-99	119-131	26-32	55-63

[a]Based on peak operation employment (70 seasonal and 21 permanent employees). See Appendix B for assumptions.

4.1.8.2 Employment

It is apparent to the staff that the project will have two distinct phases: construction and operation. Construction is planned to occur for about six months during the first project calendar year (CY). Employment for this phase will be steady and will peak at about 80 during the initial four months. The operation phase is planned to start at a very low level in the first CY and will last approximately 5.5 years. Table 4.5 illustrates this employment timetable referenced to an assumed May 1982 construction phase start date. It should be noted that employment due to construction will phase down as employment due to operations increases. Because of inclement weather, most work will be conducted during the warmer months (~May

Table 4.5. Basic employment levels, over time, for construction and operation, Edgemont mill decommissioning

Type of employment	1982	1983	1984	1985	1986	1987
Permanent	5	20	21	14	11	2
Seasonal	78	52	70	59	37	19
Total	83	72	91	73	48	21

Source: ER, Table 4.8-2.

through October). Operations employment will steadily increase until a maximum (~90 employees) is reached in the third year. Thereafter, operations employment needs will steadily decline to minimum levels during the last years of decommissioning.

Construction activities will add, as an upper limit, 53 to 70 secondary jobs. Operation activities should cause, at most, 67 to 88 new secondary jobs (see Appendix B for an explanation of the assumptions utilized to develop these estimates). The predicted total maximum number of incremental job opportunities caused by construction is between about 136 and 153 (Table 4.3). As many as 150 to 179 total new jobs could result from project operations (Table 4.4). (For additional information, see Appendix A, response to comments of Sixth District Council of Governments.)

4.1.8.3 Population

Because the unemployment rates in the affected region are low (Sect. 3.4.3) and considerable economic development is impending, the staff anticipates that the labor markets in the Edgemont-Hot Springs area may be very restricted during most of the 1980s. Therefore, a high percentage of the job opportunities created by the proposed project will have to be filled by nonlocal or in-migrating workers (Appendix B). Consequently, project-induced population increases and, hence, population-related impacts could be relatively large.

Assuming a worst-case scenario – that is, assuming that (1) peak employment levels are ~83 during construction and ~91 for operation; (2) none of the basic and secondary workers are from the same family; (3) most of the basic and secondary workers are in-migrants; and (4) all local hirees were previously unemployed – the total population influx generated by construction activities could range from about 243 to 281 persons (Table 4.3). About 306 to 349 new residents could conceivably in-migrate because of operation activities (Table 4.4). Edgemont's population could increase by about 150 to 228 during construction and by approximately 180 to 278 during operation. The Hot Springs increases would range, respectively for construction and operation, from about 40 to 110 and from about 60 to 150 (Tables 4.3 and 4.4 and Appendix B). When compared with the respective Edgemont and Hot Springs 1980 population estimates (~1500 and 4700), population increases of these sizes are relatively significant. However, when compared to the projected long-term populations for these communities, the contributory effects are considerably less. The Edgemont and Hot Springs 1982 populations could possibly range from 3400 to 5700 and from 7400 to 7500, respectively (Table 3.4). The mill decommissioning project may thus combine with other developments to significantly affect Edgemont, Hot Springs, and, consequently, Fall River County, but the project, by itself, would cause only a small portion of the overall impacts. All anticipated industrial developments would have to occur, however, for this to be the case.

4.1.8.4 Housing

Assuming a worst-case scenario, that is, the assumptions outlined in Sect. 4.1.8.3 and further assumptions that (1) nonmarried in-migrants will each require a separate residence and (2) a zero vacancy rate will prevail, about 125 to 139 new housing units may be needed during construction. About 145 to 161 new units may be needed to house operation-induced employees (Tables 4.3 and 4.4 and Appendix B). Because of typical housing preferences[12,13] and the rapidly escalating purchase costs of single-family homes, the staff anticipates that most demand will be for rental properties and privately owned mobile and modular homes. These incremental housing needs, though possibly high, are only a small fraction of total anticipated requirements. Approximately 2700 housing units existed in Hot Springs and Edgemont in 1980-1981 (Table 3.5). However, local planners estimate that as many as 571 additional units may be needed by 1983 (ref. 14). Edgemont, which is expected to receive the brunt of the housing demand, is less capable of absorbing the impact than is Hot Springs because of fewer available vacant lots.[14] Consequently, Edgemont may have to annex large areas of land or allow scattered development around its fringe.[13]

4.1.8.5 School enrollment

The short-term construction activities, to be conducted during summer months, will minimally impact school enrollments. Only about 31 to 50 new students will be enrolled (Table 4.3 and Appendix B). However, operation activities, which will be long-term and involve more employees, could significantly impact school enrollments. The staff estimates that as many as 56 to 65 new students (Table 4.4) may enter the local school systems. Of these students, from about 31 to 51 could enroll in the Edgemont School District and 12 to 30 in the Hot Springs School District. Some additional classrooms and teachers may be needed to accommodate these increased enrollments. The staff did not, however, quantitatively estimate the number of additional teachers and classrooms that could be required because the communities have several options and combinations of options that could be utilized to handle enhanced enrollments. In addition, it is difficult to estimate the age distribution of incoming students and, consequently, enrollment in elementary schools, high schools, and special education classes.

4.1.8.6 Personal income

The staff estimates that the project, including construction and operation, will generate approximately $7.8 million (1979 dollars) in personal incomes within the local economies (for comparative purposes, the total personal income in Fall River County was about $49.2 million in 1977). This income estimate does not include the additional incomes from incremental markups induced by increased commodity demands, local expenditures for project-related supplies, or interest charges for credit purchases. These beneficial impacts will, over time, be unevenly distributed (Table 4.6).

Table 4.6. Estimated project-induced personal incomes and tax revenues in the affected local economies (1982-1987), 1979 dollars[a]

Year	Personal incomes ($)	Tax Revenues ($)
1982	1,441,000	82,538
1983	1,626,000	75,354
1984	1,846,000	102,880
1985	1,535,000	82,886
1986	982,000	52,030
1987	385,000	16,513
Totals	7,815,000	412,201

[a]Assumes that construction and operation activities commence in 1982

4.1.8.7 Public sector finances

The staff estimates that the project will generate for both construction and operation activities approximately $400,000 (1979 dollars) in tax revenues (Table 4.6). Because the affected communities will have to spend additional funds for potable and wastewater treatment facilities, school and medical facilities, and street and road improvements, the staff doubts that the project will generate sufficient public funds to compensate for required additional expenditures. Local planners anticipate that a very serious shortfall in public funds will occur over the next few years because of the expected influx of industries.[14] Accordingly, Federal monetary assistance has been requested to aid in mitigating impending impacts.[14]

4.1.8.8 Public services and facilities

Public facilities and services will be differentially impacted by project-related population increases.

Water and sewage

Assuming peak per capita daily usage of approximately 1022 liters (270 gal),[14] total maximum usage for each year of the project was estimated by the staff (Table 4.7). During the operation period, about 50 to 75% of this usage could occur in Edgemont. However, up to 90% of the usage could occur in Edgemont during the construction period. Both the Hot Springs and the Edgemont water systems should be able to handle these additional loads since both systems have been upgraded. Neither of the cities' sewage systems are currently capable of processing additional wastes; however, both systems, under EPA mandate, will be expanded and improved in the middle 1980s.

Table 4.7. Estimated project-induced increments in peak water usage (1982-1987)[a]

Year	Peak water usage	
	liters/d	gpd
1982	168,600–241,200	44,500–63,600
1983	339,600–425,600	89,600–112,300
1984	435,400–545,700	114,900–144,900
1985	353,082–452,900	95,400–119,500
1986	243,824–305,600	64,344–80,600
1987	96,800–121,300	25,500–32,000

[a]Assumes that construction and operation activities commence in 1982

Health services

The Hot Springs health services and facilities can adequately supply incremental health needs. Edgemont's health services and facilities are limited, but, given no extensive population increases, are reasonably adequate. If Edgemont's population does increase significantly (e.g., up to 2500 or more residents) because of energy-related developments, then — if no additional services are provided — a more serious shortfall would result.

Roads

Although it is doubtful that the decommissioning project, by itself, will significantly impact local traffic, local planners estimate that a considerable amount of public funds will have to be spent to improve local roads in order to handle anticipated total community development-related traffic increases in the 1980s.[14] Approximately $150,000 has been spent in 1981 (Steve Koser, Edgemont finance officer, personal communication to Richard McLean, Oak Ridge National Laboratory, Jan. 13, 1982).

Recreation

Local public recreation facilities will be only marginally impacted by the project.

Fire protection

Additional fire and police protection requirements will be negligible.

4.1.8.9 Aesthetics and noise

The proposed disposal site will be minimally visible to the public. Because construction activities will cause some increases in truck traffic, noise will be generated. However, these adverse impacts will be short term. A slurry pipeline will transport most of the tailings, and thus, noise and traffic impacts should be insignificant during the operation phase.

4.1.9 Radiological assessment

4.1.9.1 Introduction

This section represents the staff's assessment of the incremental radiological impacts resulting from the operation of the proposed project and the methodology used to perform the evaluation. The evaluation includes estimates of resulting concentrations at the restricted area boundaries of the mill site and resulting dose commitments to nearby individuals and the general population within 1.6 km (1 mile) (town of Edgemont, including Cottonwood community) of the mill site.

All potential pathways that are likely to contribute a significant fraction of the dose commitment have been included in the analysis. One pathway which is usually included in a radiological assessment but is omitted here is the milk pathway. Because of the existence and enforcement of a city ordinance which restricts free grazing of livestock within the city limits, it is reasonable to assume that any penned livestock present would be fed primarily stored feed, and would not be significantly affected by the decommissioning. There is presently no dairy industry in the Edgemont area.

4.1.9.2 Estimated releases

A summary of the information and data assumptions used to calculate the annual releases of radioactive materials from the mill site and disposal area is presented in Table 4.8. The estimated annual releases of radioactive material are outlined in Table 4.9. A more detailed description of the release estimates is provided in Appendix C. Furthermore, releases in the postdecommissioning period are assumed to be within 5 pCi/g or less for particulates (U-238, U-234, Th-230. Ra-226, Pb-210, and Po-210) and 2 $pCi/m^2 \cdot s$ radon flux, **the calculated flux from the reclaimed impoundment (radon reduction calculations appear in Appendix E).**

A schedule of operation based on 2.5 years of disturbance, transport, and disposal of tailings and contaminated materials was used in estimating the parameters and releases for the decommissioning project as proposed.

4.1.9.3 Exposure pathways

Potential exposure pathways by which people would be exposed to radioactive materials resulting from the project are presented in Fig. 4.1. Pathways of concern for the airborne effluents include inhalation of radioactive materials in the air, external exposure to radioactive materials in the air or deposited on ground surfaces, and ingestion of contaminated food products (i.e., vegetables and meat).

There will be no planned releases of radioactive materials directly into surface waters. While there is a possibility of some small amount of seepage of radioactive liquids from the tailings impoundment into the groundwater system, this amount will be minimal if the seepage control measures recommended in this Statement are employed. Therefore, seepage is not considered to be a significant pathway of human exposure in this radiological assessment.

Table 4.8. Principal parameter values used in radiological assessment of decommissioning for Edgemont facility

Parameter	Value
Average activities in tailings solids, pCi/g[a]	
U-238	63.5
Th-230	702.4
Ra-226	705.2
Pb-210	705.2
Activities for tailings slimes, pCi/g	
U-238	269.9
Th-230	2985.2
Ra-226	2997.1
Pb-210	2997.1
Activities for tailings sands, pCi/g	
U-238	11.9
Th-230	131.7
Ra-226	132.2
Pb-210	132.2
Decommissioning and disposal time period, years	2.5
Estimated amount of tailings to be moved, metric tons	2.09×10^6
Estimated total amount of material to be moved to disposal site, metric tons	3.72×10^6
Release rate from machinery and activities at the Edgemont site, %	2.4×10^{-3}
Release rate from machinery and activities at the disposal site, %	1.2×10^{-3}
Dust-to-tailings activity ratio, dimensionless	2.5
Assumed reduction factor for tailings dusting mitigation measures, %	0.0
Specific radon flux from exposed beach, $\frac{(pCi/m^2 \cdot s\ Rn\text{-}222)}{(pCi/g\ Ra\text{-}226)}$	1.0
Tailings impoundment areas, hectares (acres)	
Pond 1	4.5 (11.1)
Pond 2	3 (7.4)
Pond 3	6 (14.8)
Pond 4	2 (4.9)
Pond 7	7 (17.2)
Pond 8	3.5 (8.6)
Pond 9	3.5 (8.6)
Pond 10	2 (5.0)
East pile	12 (29.5)
Area A	4 (9.8)
Area B	2.5 (6.2)
Disposal site	29 (71.1)
Dispersed area of tailings	32 (80)

[a]Activities are based on an ore grade of 0.25% U_3O_8 and the following loss to tailings: U-238 9%; Th-230 99.5%; Ra-226 99.9%; Pb-210 99.9%. Slimes are considered to be 4.25 times as radioactive as the average tailings. Sands are considered to be 0.19 times as radioactive as the average tailings.

Source: Ford, Bacon and Davis Utah, Inc., *Engineering Assessment of Inactive Uranium Mill Tailings, Edgemont Site, Edgemont, South Dakota*, prepared for the U.S. Nuclear Regulatory Commission, Contract No. E(05-1)-1658, May 1978.

Table 4.9. Estimated annual releases of radioactivity resulting from cleanup operations at Edgemont mill and disposal site

Source of release	Annual radioactive releases (Ci/year)[a]				
	U-238	Th-230	Ra-226	Pb-210	Rn-222
			Edgemont		
Machinery and handling	3.18E−03[b]	3.51E−02	3.53E−02	3.53E−02	0.0
Pond 1	1.95E−03	2.16E−02	2.16E−02	2.16E−02	1.00E+03
Pond 2	2.74E−04	3.03E−03	3.04E−03	3.04E−03	6.67E+02
Pond 3	1.24E−02	1.37E−01	1.38E−01	1.38E−01	1.33E+03
Pond 4	9.74E−04	1.08E−02	1.08E−02	1.08E−02	4.41E+02
Pond 7	2.92E−03	3.24E−02	3.24E−02	3.24E−02	1.55E+03
Pond 8	1.46E−03	1.62E−02	1.62E−02	1.62E−02	7.75E+02
Pond 9	1.46E−03	1.62E−02	1.62E−02	1.62E−02	7.75E+02
Pond 10	1.83E−04	2.02E−03	2.02E−03	2.02E−03	4.50E+02
East pile	1.10E−03	1.21E−02	1.22E−02	1.22E−02	2.66E+03
Area A	3.65E−04	4.04E−03	4.06E−03	4.06E−03	8.83E+02
Area B	2.74E−04	3.03E−03	3.04E−03	3.04E−03	5.58E+02
			Disposal site		
Machinery and handling	1.59E−03	1.76E−02	1.77E−02	1.77E−02	0.0
Disposal pit windblown	1.46E−02	1.62E−01	1.62E−01	1.62E−01	6.39E+03
			Dispersed tailings		
	1.58E−02	1.75E−01	1.75E−01	1.75E−01	7.21E+03

[a] Releases of all other isotopes in the U-238 decay series are also included in the radiological impact analysis. These releases are assumed to be identical to those presented here for parent isotopes. For example, the release rate of U-234 is assumed identical to that for U-238. Release rates of Pb-210 and Po-210 are assumed equal to that for Ra-226.

[b] Read as 3.18×10^{-3}, or 0.00318.

4.1.9.4 Radiation impacts to individuals

Four locations near the mill site were chosen to assess the impacts to individuals: one 0.40 km north-northwest of the mill site, one in the Cottonwood community 0.43 km south-southeast of the site (in the prevailing wind direction), one 0.23 km west of the mill site, and one 0.68 km north of the mill site in the Dudley area.

Table 4.10 presents a summary of the individual dose commitments calculated for these locations. For each of the nearest residences, it was assumed that individuals ingest meat from cattle that graze on land 1.5 km from the center of the mill site. It is also assumed that locally grown vegetables are consumed at each of the nearest residences. As previously mentioned, the milk pathway is not considered to be significant in this situation.

Table 4.11 presents a comparison of individual dose commitments to NRC radiation protection standards and with background radiation estimates. Under 10 CFR Part 20, air concentrations of radioactive materials in unrestricted areas are limited to maximum permissible concentrations (MPCs). It should be pointed out that in none of the locations near to restricted areas are the MPCs expected to be exceeded. As to be expected, after decommissioning operations cease, air concentrations will be well below the MPCs. Table 4.12 summarizes these observations.

4.1.9.5 Radiation dose commitments to populations

The annual environmental population dose commitments predicted within 1.6 km (1 mile) of the mill site are presented in Table 4.13, along with estimated annual environmental population dose commitments to the same population from natural background radiation sources. The population distribution data for this area is presented in Table 4.14.

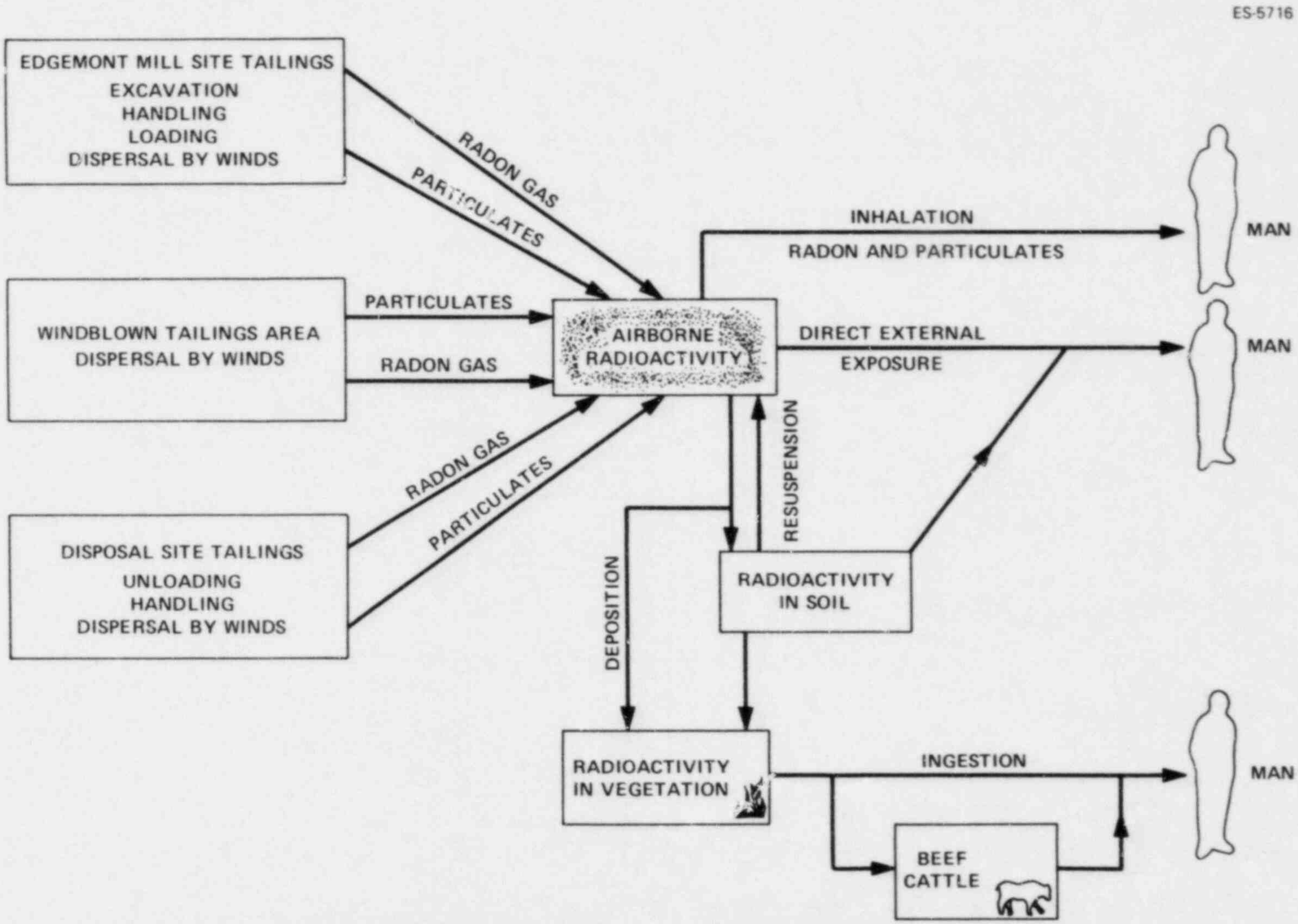


Fig. 4.1 Radioactive emissions from decommissioning and exposure pathways to man.

Table 4.10. Predicted annual dose commitments to individuals in vicinity of Edgemont site (millirems per year of exposure)[a,b]

Exposure pathway	Whole body		Bone		Lung		Bronchial epithelium	
	Decommissioning	Postdecommissioning[c]	Decommissioning	Postdecommissioning	Decommissioning	Postdecommissioning	Decommissioning	Postdecommissioning
North-northwest residence, 0.40 km from mill								
Inhalation	1.67E+00	1.04E–02	4.52E+01	2.78E–01	4.19E+01	2.27E–01	8.68E+02	2.47E+00
External ground	6.02E+00	5.76E+00	6.02E+00	5.76E+00	6.02E+00	5.76E+00		
External cloud	5.44E–01[d]	1.55E–03	5.44E–01	1.55E–03	5.44E–01	1.55E–03		
Vegetable ingestion	1.41E+01	3.78E–01	1.69E+02	4.32E+00	1.41E+01	3.78E–01		
Meat ingestion[e]	6.31E+00	2.77E–01	7.86E+01	3.27E+00	6.31E+00	2.77E–01		
Total	2.86E+01	6.43E+00	2.99E+02	1.36E+01	6.89E+01	6.64E+00	8.68E+02	2.47E+00
Cottonwood residence, 0.43 km southeast of mill (nearest residence in prevailing wind direction)								
Inhalation	1.94E+00	1.79E–02	5.27E+01	4.79E–01	5.00E+01	4.00E–01	1.25E+03	3.55E+00
External ground	6.61E+00	6.29E+00	6.61E+00	6.29E+00	6.61E+00	6.29E+00		
External cloud	6.39E–01	1.82E–03	6.39E–01	1.82E–03	6.39E–01	1.82E–03		
Vegetable ingestion	1.53E+01	4.76E–01	1.84E+02	5.48E+00	1.53E+01	4.76E–01		
Meat ingestion[e]	6.31E+00	2.77E–01	7.86E+01	3.27E+00	6.31E+00	2.77E–01		
Total	3.08E+01	7.06E+00	3.23E+02	1.55E+01	7.89E+01	7.44E+00	1.25E+03	3.55E+00
Edgemont residence, 0.23 km west of mill (Nearest residence)								
Inhalation	2.13E+00	1.39E–02	5.78E+01	3.70E–01	5.36E+01	3.02E–01	7.96E+02	2.26E+00
External ground	7.66E+00	7.36E+00	7.66E+00	7.36E+00	7.66E+00	7.36E+00		
External cloud	5.40E–01	1.53E–03	5.40E–01	1.53E–03	5.40E–01	1.53E–03		
Vegetable ingestion	1.80E+01	4.90E–01	2.16E+02	5.60E+00	1.80E+01	4.90E–01		
Meat ingestion[e]	6.31E+00	2.77E–01	7.86E+01	3.27E+00	6.31E+00	2.77E–01		
Total	3.46E+01	8.41E+00	3.61E+02	1.66E+01	8.61E+01	8.43E+00	7.96E+02	2.26E+00
Town of Dudley, 0.68 km north of mill								
Inhalation	8.64E–01	5.58E–03	2.35E+01	1.49E–01	2.24E+01	1.27E–01	5.59E+02	1.59E+00
External ground	2.92E+00	2.76E+00	2.92E+00	2.76E+00	2.92E+00	2.76E+00		
External cloud	6.18E–01	1.76E–03	6.18E–01	1.76E–03	6.18E–01	1.76E–03		
Vegetable ingestion	6.73E+00	1.83E–01	8.10E+01	2.09E+00	6.73E+00	1.83E–01		
Meat ingestion[e]	6.31E+00	2.77E–01	7.86E+01	3.27E+00	6.31E+00	2.77E–01		
Total	1.74E+01	3.23E+00	1.87E+02	8.27E+00	3.90E+01	3.35E+00	5.59E+02	1.59E+00

[a] Doses are integrated over a 50-year period from one year of inhalation or ingestion.

[b] Doses to the whole body, lungs, and bone are those resulting from the inhalation of U-238, U-234, Th-230, Ra-226, Pb-210, and Po-210 particulates. Doses to the bronchial epithelium are those resulting from the inhalation of radon daughters.

[c] Doses in these columns reflect cleanup to 5 pCi/g or less soil concentration for particulates (U-238, U-234, Th-230, Ra-226, Pb-210, and Po-210) and 2 $pCi/m^2 \cdot s$ radon flux.

[d] 5.44E–01 should be read as 5.44×10^{-1}, or 0.544.

[e] Ingestion doses result from the consumption of the meat of cattle grazing 1.5 km southeast of the mill.

Table 4.11. Comparison of annual dose commitments to individuals with NRC radiation protection standards and with background radiation estimates (mrem/year)

	Whole body		Bone		Lung		Bronchial epithelium	
	Decom-missioning	Postdecom-missioning	Decom-missioning	Postdecom-missioning	Decom-missioning	Postdecom-missioning	Decom-missioning	Postdecom-missioning
NRC limit (10 CFR 20)	500		3000		1500		3.3×10^{-2} WL[a]	
Estimated background radiation dose[b]	153		188		154		4.48×10^{-3} WL[c]	
Location								
NNW residence (0.40 km from mill)	28.6	6.43	299.0	13.6	68.9	6.64	1.64×10^{-3}	4.65×10^{-6}
Fraction of NRC limit	0.057	0.013	0.100	0.005	0.046	0.004	0.049	0.0001
Fraction of background	0.187	0.042	1.59	0.072	0.447	0.043	0.366	0.001
Cottonwood (0.43 km SE of mill)	30.8	7.06	323.0	15.5	78.9	7.44	2.42×10^{-3}	6.86×10^{-6}
Fraction of NRC limit	0.062	0.014	0.108	0.005	0.053	0.005	0.073	0.0002
Fraction of background	0.201	0.046	1.72	0.082	0.512	0.048	0.540	0.0015
Edgemont (0.23 km W of mill)	34.6	8.41	361.0	16.6	86.1	8.43	1.67×10^{-3}	4.73×10^{-6}
Fraction of NRC limit	0.069	0.017	0.120	0.006	0.057	0.006	0.050	0.0001
Fraction of background	0.226	0.055	1.92	0.088	0.559	0.055	0.373	0.001
Town of Dudley (0.68 km N of mill)	17.4	3.23	187.0	8.27	39.0	3.35	1.57×10^{-3}	4.45×10^{-6}
Fraction of NRC limit	0.035	0.0[illegible]	0.062	0.003	0.026	0.002	0.047	0.0001
Fraction of background	0.114	0.021	0.995	0.044	0.253	0.022	0.350	0.001

[a]Radiation standards for exposures to Rn-222 and daughter products are expressed in Working Level (WL). WL means the amount of any combination of short-lived radioactive decay products of Rn-222 in 1L of air that will release 1.3×10^5 mega electron volts of alpha particle energy during their radioactive decay to Pb-210.

[b]Source: G. L. Montet et al., *Descriptions of United States Uranium Resource Areas, a Supplement to the Generic Environmental Impact Statement on Uranium Milling*, Report NUREG/CR-0597, ANL/ES-75, prepared by Argonne National Laboratory for the U.S. Nuclear Regulatory Commission, June 1979. The staff assumes the population dose due to background is equivalent to the general background dose for the Western Great Plains.

[c]The WL corresponds to the suggested bronchial epithelium background dose of 560 mrem in reference *b*.

Table 4.12. Comparison of predicted air concentrations during Edgemont decommissioning with 10 CFR Part 20 limits for unrestricted areas

Radionuclides	10 CFR 20 limits[a] (pCi/m^3)	Restricted area boundary locations											
		0.9 km east[b]				0.9 km east-southeast[b]				Water tower			
		Decommissioning		Postdecommissioning[c]		Decommissioning		Postdecommissioning[c]		Decommissioning		Postdecommissioning[c]	
		Predicted value (pCi/m^3)	Fraction of limit	Predicted value (pCi/m^3)	Fraction of limit	Predicted value (pCi/m^3)	Fraction of limit	Predicted value (pCi/m^3)	Fraction of limit	Predicted value (pCi/m^3)	Fraction of limit	Predicted value (pCi/m^3)	Fraction of limit
U-238	5.0	3.71E–3[d]	7.42E–4	2.50E–5	5.01E–6	4.16E–3	8.31E–4	3.64E–5	7.28E–6	5.21E–3	1.04E–3	2.27E–5	4.53E–6
U-234	4.0	3.71E–3	9.28E–4	2.50E–5	6.26E–6	4.16E–3	1.04E–3	3.64E–5	9.10E–6	5.21E–3	1.30E–3	2.27E–5	5.66E–6
Th-230	0.3	4.10E–2	1.37E–1	2.77E–4	9.24E–4	4.60E–2	1.53E–1	4.03E–4	1.34E–3	5.75E–2	1.92E–1	2.50E–4	8.35E–4
Ra-226	2.0	4.12E–2	2.06E–2	2.78E–4	1.39E–4	4.61E–2	2.31E–2	4.04E–4	2.02E–4	5.78E–2	2.89E–2	2.51E–4	1.26E–4
Pb-210	4.0	4.11E–2	1.03E–2	2.78E–4	6.94E–5	4.61E–2	1.15E–2	4.03E–4	1.01E–4	5.77E–2	1.44E–2	2.51E–4	6.28E–5
Bi-210	200.0	4.11E–2	2.05E–4	2.77E–4	1.39E–6	4.60E–2	2.30E–4	4.03E–4	2.02E–6	5.77E–2	2.88E–4	2.51E–4	1.26E–6
Po-210	7.0	4.11E–2	5.87E–3	2.77E–4	3.96E–5	4.60E–2	6.57E–3	4.03E–4	5.76E–5	5.77E–2	8.24E–3	2.51E–4	3.59E–5
WL[e] concentrations	0.0333	3.33E–3	1.00E–1	9.46E–6	2.84E–4	3.82E–3	1.15E–1	1.08E–5	3.26E–4	1.97E–3	5.90E–2	5.58E–6	1.68E–4
Sum of fractions[f]			2.75E–1		1.47E–3		3.11E–1		2.05E–3		3.05E–1		1.24E–3

[a]Values from 10 CFR Part 20, Appendix B, Table II, column 1.

[b]Distances and directions are from water tower (see Fig. 2.8).

[c]These columns indicate the predicted concentrations at these locations after the Edgemont cleanup operations have been completed.

[d]Read as 3.71×10^{-3}, or 0.00371.

[e]WL denotes working level. A one-WL concentration is defined to be any combination of air concentrations of the short-lived Rn-222 daughters Po-218, Pb-214, Bi-214, and Po-214 that, in 1 L of air, will yield a total of 1.3×10^5 MeV of alpha particle energy in their complete decay to Pb-210. Predicted values given for outdoor air are those calculated on the basis of actual ingrowth from released Rn-222.

[f]Compliance with 10 CFR Part 20 is not achieved if the sum of the fractions is greater than 1. That is, if radionuclides A, B, and C are present in concentrations C_A, C_B, and C_C and if the applicable maximum permissible concentrations (MPCs) are MPC_A, MPC_B and MPC_C, respectively, then the concentrations shall be limited so that the following relationship exists: $(C_A/MPC_A) + (C_B/MPC_B) + (C_C/MPC_C) < 1$.

Table 4.13. Predicted annual environmental dose commitments (EDCs) to local population within 1.6-km (1-mile) radius resulting from cleanup operations at Edgemont and disposal sites

Exposure pathway	100-year EDCs (person-rem/year)[a]							
	Whole body		Bone		Lung		Bronchial epithelium[b]	
	Decommissioning	Postdecommissioning	Decommissioning	Postdecommissioning	Decommissioning	Postdecommissioning	Decommissioning	Postdecommissioning
Inhalation	1.717	0.009	46.72	0.255	44.36	0.236	814.7	2.314
External ground	122.0	0.712	122.0	0.712	122.0	0.712		
External cloud	1.115	0.003	1.115	0.003	1.115	0.003		
Vegetable ingestion[c]	7.550	0.035	87.79	0.407	7.550	0.035		
Meat ingestion[c]	2.588	0.012	29.22	0.135	2.588	0.012		
Total	135.0	0.771	286.8	1.512	177.6	0.998	814.7	2.314
Estimated population dose from natural background	306.0	306.0	376.0	376.0	308.0	308.0	1120	1120
Ratio of total annual regional population dose to that from natural background[d]	0.441	0.003	0.763	0.004	0.577	0.003	0.727	0.002

[a]Doses to the whole body, lung, and bone are those resulting from the releases of U-238, U-234, Th-230, Ra-226, and Pb-210 particulates.

[b]Inhalation doses to the bronchial epithelium are those resulting from the inhalation of radon daughters.

[c]Ingestion dose commitments do not reflect potential food export and thus may exceed dose commitments actually received by the local population.

[d]Background doses are based on the local population size of 2000.

Table 4.14. Population distribution within 1.6 km (1 mile) of Edgemont site

Distance from site [km (miles)]	Direction															
	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
0.0–0.40 (0.0–0.25)	0	0	0	0	0	0	2	12	7	0	0	0	25	44	61	27
0.40–0.80 (0.25–0.50)	22	17	0	0	0	0	0	42	12	0	108	184	223	218	44	37
0.80–1.6 (0.50–1.0)	81	76	0	0	0	0	0	0	3	54	79	80	343	162	27	10
Total[a]	103	93	0	0	0	0	2	54	22	54	187	264	591	[illegible]4	132	74

[a] Total 0–1.6 km (0–1 mile) population is 2000 persons.

As can be seen from Table 4.13, predicted population dose commitments are significantly below natural background radiation. Following completion of the project and reclamation of the mill and disposal sites, radiation doses will be at essentially background levels. Although this project necessitates increased exposure to radioactive materials in the short term, it provides for the elimination of the present health risk over the long term.

4.1.9.6 Occupational dose

Comprehensive radiation protection practices will be utilized during decommissioning activities. These practices will include the use of training programs, contamination control procedures, personnel monitoring methodologies, and, as necessary, respiratory protection devices.

The scope of this NRC staff review has not included a review of the site's radiological safety program. The staff will review the radiological safety program, as it is developed by the licensee, and NRC approval of the program must be obtained before any activities having radiological implications are undertaken. The objective of this program should be consistent with the concept of maintaining exposure to employees as low as reasonably achievable (ALARA). Workers will be monitored to ensure that exposure rates are within applicable guidelines, and in the event that abnormally high exposures are detected, mitigative action shall be taken.

4.1.9.7 Radiological impact on biota other than man

Although no guidelines concerning acceptable limits of radiation exposure have been established for the protection of species other than man, it is generally agreed that the limits for humans are also conservative for other species. Doses from particulate effluents to terrestrial biota are quite similar to those calculated for man and arise from the same dispersion pathways and considerations. No adverse radiological impact is expected for resident biota.

4.1.9.8 Summary of radiological impact

While it may be said that the assumptions used as the basis for this assessment may lead to overestimation of the dose commitments, the staff feels that the methodology utilized is justified. The staff realizes that implementation of special design and operational features aimed at reducing particulate and radioactive emissions may result in significantly lower dose commitments to individuals and the population as a whole, but it is impossible to accurately quantify these reductions. The staff feels that in spite of the predicted dose commitments, the long-term benefits of eliminating a chronic health risk far outweigh the short-term impacts associated with this action.

4.2 MONITORING PROGRAMS

The following sections present monitoring programs designed to evaluate the impacts of the proposed action. Details of specific monitoring programs for air quality, radiological environment, soils, land use, surface water and groundwater quality, and biota are presented on the following pages. These programs are summarized in Tables 4.15 and 4.16.

Table 4.15. Radiological environmental monitoring for Edgemont uranium mill decommissioning

Medium	Number of stations *	Monitor type	Monitoring frequency	Type and frequency of analysis
Air particulate	5	Low volume [flow rate ~0.08 m^3/min (~3 ft^3/min)]	Continuous with weekly filter change	Weekly: gross beta and alpha; monthly composite: total U, Th-230, Ra-226, and Pb-210
Air radon progeny	5	Radon progeny monitor	Continuous during working season; no less than 1 week/month at any time	Radon progeny—monthly average
Groundwater	6	Grab sample	Quarterly	Total U, Ra-226 (total fraction)
Surface water	5(2 on Cottonwood Creek; 3 on Cheyenne River)	Grab sample	Monthly	Gross beta; total U, Th-230, and Ra-226 (total fraction)
Sediment	5(2 on Cottonwood Creek; 3 on Cheyenne River)	Grab sample	Semiannually	Total U, Th-230, and Ra-226; selected samples analyzed for Pb-210 and Po-210
	Disposal site	Grab sample	When reclamation is nearly completed	Total U, Th-230, and Ra-226
Soil	6	Grab sample	During growing season and at end of working season	Pb-210 and Ra-226
Vegetation	6	Grab sample of forage and food crops if available	Twice annually (growing season and end of working season)	Pb-210 and Ra-226
Direct radiation	10 to 14	Thermoluminescent dosimeter	Changed quarterly	Direct radiation

* Locations shown on Figures 4.2 and 4.3

Table 4.16. Nonradiological environmental monitoring for Edgemont uranium mill decommissioning

Medium	Number of stations *	Monitor type	Monitoring frequency	Type and frequency of analysis
Air—TSP	6—5 near project sites, 1 in Burdock (22 km northwest of mill site)	High-volume	At least 24 h per 6-d period[a]	Weight analysis per 40 CFR Part 50 regulations
Surface water	3 (Cheyenne River and Cottonwood Creek)	Automatic sampler	At least one per 24-h period every 2 weeks	pH, conductivity, turbidity – each sample; TSS, TDS, SO_4, Cl, V, Ni, Mn, Se, As, Mo – at least three times per year
Sediment	5 (2 on Cottonwood creek, 3 on Cheyenne River)	Grab sample	Semiannually	SO_4, Cl, V, Ni, Mn, Se, As, Mo
	2 (ponds downgradient from disposal site)	Grab sample	Annually	Ag, Al, As, B, Ba, Be, CA, Cd, Cl^-, Co, CO_3, Cr, Cu, F^-, Fe, Hg, Li, K, Mg, Mn, Mo, N, Ni, NO_2^{3+}, NO_3, P, Pb, pH, S^-, Se, SO_4, Sr, V, Zn
Biological	Disturbed areas	Periodic observation for erosion and excessive gullying		
	Reclaimed areas	Line-intercept method to determine if adequate plant cover and species diversity has been achieved		
	Cheyenne River (5 sites)	Fish and macroinvertebrate surveys to detect short- and long-term changes in communities and to document standing crops and diversity		
	Cottonwood Creek (disturbed reach)	Survey after decommissioning to document recolonization of restored reach of stream, standing crops, and diversity		

[a]According to South Dakota ambient air sampling schedules.

*Locations shown on Figures 4.2-4.5

4.2.1 Nonradiological air quality

4.2.1.1 Predecommissioning

The licensee did not monitor the existing air quality at the site. However, limited background TSP data are available from a high-volume sampler that has operated near Burdock, South Dakota [approximately 22 km (14 miles) northwest of Edgemont] since April 1979. Additional data on TSP in the region were available from State monitoring stations, the nearest being located about 32 km (20 miles) northeast at Hot Springs. Predecommissioning monitoring will be conducted for approximately one year before project activities begin.

4.2.1.2 Decommissioning and stabilization

Total suspended particulates will be monitored throughout the decommissioning and stabilization phases of the project. In addition to the continued operations of the TSP sampler located 22 km (14 miles) northwest of the site, the licensee will establish a monitoring network of five standard high-volume TSP samplers (ER, Sect. 5.1.1, and monitoring submittal). Monitor locations are: (1) southeast of the mill area, approximately 500 m (1640 ft) east of the haul road; (2) in Cottonwood community, approximately 150 m (490 ft) from the site boundary; (3) west of the mill area in the city of Edgemont, approximately 250 m (820 ft) from the site boundary; (4) north-northeast of the mill area, approximately 3000 m (9500 ft) from the site boundary; and (5) east-southeast of the disposal area, approximately 500 m (1640 ft) from the site boundary. These locations are in general agreement with those proposed by the State of South Dakota (ER, Appendix D). The licensee will sample every sixth day from midnight to midnight (in accordance with the South Dakota ambient air sampling schedules) prior to decommissioning operations to obtain baseline data and during inactive periods of decommissioning. The sampling frequency may be increased during the active periods of decommissioning, depending upon the type and extent of anticipated activities and the results of the monitoring program (ER, Appendix D). The results will indicate whether mitigation being used is adequate or if additional or modified procedures are necessary (ER, Sect. 4.1.2.3.2).

During decommissioning, stabilization, and reclamation (Sect. 4.2.1.3), results from TSP monitoring and records of implementation of dust control measures should be made available to the director of decommissioning operations as soon as possible. This procedure is especially important during dry periods with high winds, not only to determine the effectiveness of mitigation measures but also to give an additional indication of when dust control measures are needed.

The proposed monitoring plan also includes continued operation of the meteorological station, although it will be moved because decommissioning activities will disrupt its operation. The new location, the same as the TSP sampler No. 1 listed above, will be near enough to the project to provide representative data but far enough away to avoid having its operation adversely affected by the project.

Modification of the air quality monitoring plan may be necessary as the final decommissioning design is completed and as the actual decommissioning progresses. Any significant adjustment to the monitoring network during or prior to project operations will be presented to the State before its implementation (ER, Appendix D).

4.2.1.3 Reclamation

Following completion of the decommissioning activities, TSP monitoring (Sect. 4.2.1.2) will be discontinued, except for the site east-southeast of the disposal area and either the Edgemont or the Cottonwood community sites. These two monitors will continue to operate until the reclamation program has been determined to be successful (Sect. 2.2.3.8).

4.2.2 Radiological environment

A radiological environmental monitoring program will be conducted to determine the radiological impacts of decommissioning operations on the environment. The monitoring program (Table 4.15) outlined below, proposed by the licensee and modified as necessary by the staff, will be implemented approximately one year before the beginning of decommissioning activity and will continue until one year after the placement of final cover material unless radiological abnormalities exist. The program includes the collection of air, surface water, groundwater, sediment, soil, and vegetation samples, along with direct radiation monitoring. In addition, a site survey will be conducted at the disposal site before decommissioning and at both the mill and disposal sites to document completion of the decommissioning.

The monitoring program is designed to ensure monitoring of critical pathways in areas of high population density. Background measurements at remote locations are planned to determine more accurately the effects of mill decommissioning. Air particulate and radon progeny monitors are located in regions of maximum potential impact as estimated by atmospheric dispersion models. Air particulate sampling locations are coordinated with those of nonradiological sampling. Soil and sediment will be sampled to determine longer-time-period impacts. Vegetation sampling is designed to monitor significant pathways that may be impacted by the decommissioning operations (e.g., vegetables grown for human consumption and forage grown for livestock during the spring growing season and at the end of each working season).

4.2.2.1 Air

Low-volume air samplers will be placed at six locations around the existing mill site and the disposal site. The locations of these monitors are shown in Figs. 4.2 and 4.3 and are the same sites as for the nonradiological air sampling except for the Cottonwood community sampling site. The five sampling sites are: (1) one each in the vicinity of Edgemont and Cottonwood community to ensure monitoring in the areas of highest population density, (2) one in the area of infrequent plume direction at a sufficient distance from the cleanup activities to ensure background monitoring, and (3) two in the area of highest expected windblown tailings concentration resulting from cleanup activities. The sampling station in Cottonwood community will be located in the area of highest expected exposure and will be moved as necessary depending on cleanup operations at the mill site. Any relocation would occur to ensure that the sampler is placed at the location determined to receive the greatest impact from decommissioning operations. Samples will be collected continuously at a flow rate of about 0.08 m^3/min (3 ft^3/min). Filters will be changed weekly and composited for monthly analysis for uranium, thorium-230, radium-226, and lead-210. Air filters will be analyzed weekly for gross alpha and beta content. Determination of radon-222 progeny concentrations will be made at the five locations at which radiological air particulates are sampled. Sampling will be conducted continuously during the yearly period of decommissioning work.

4.2.2.2 Groundwater

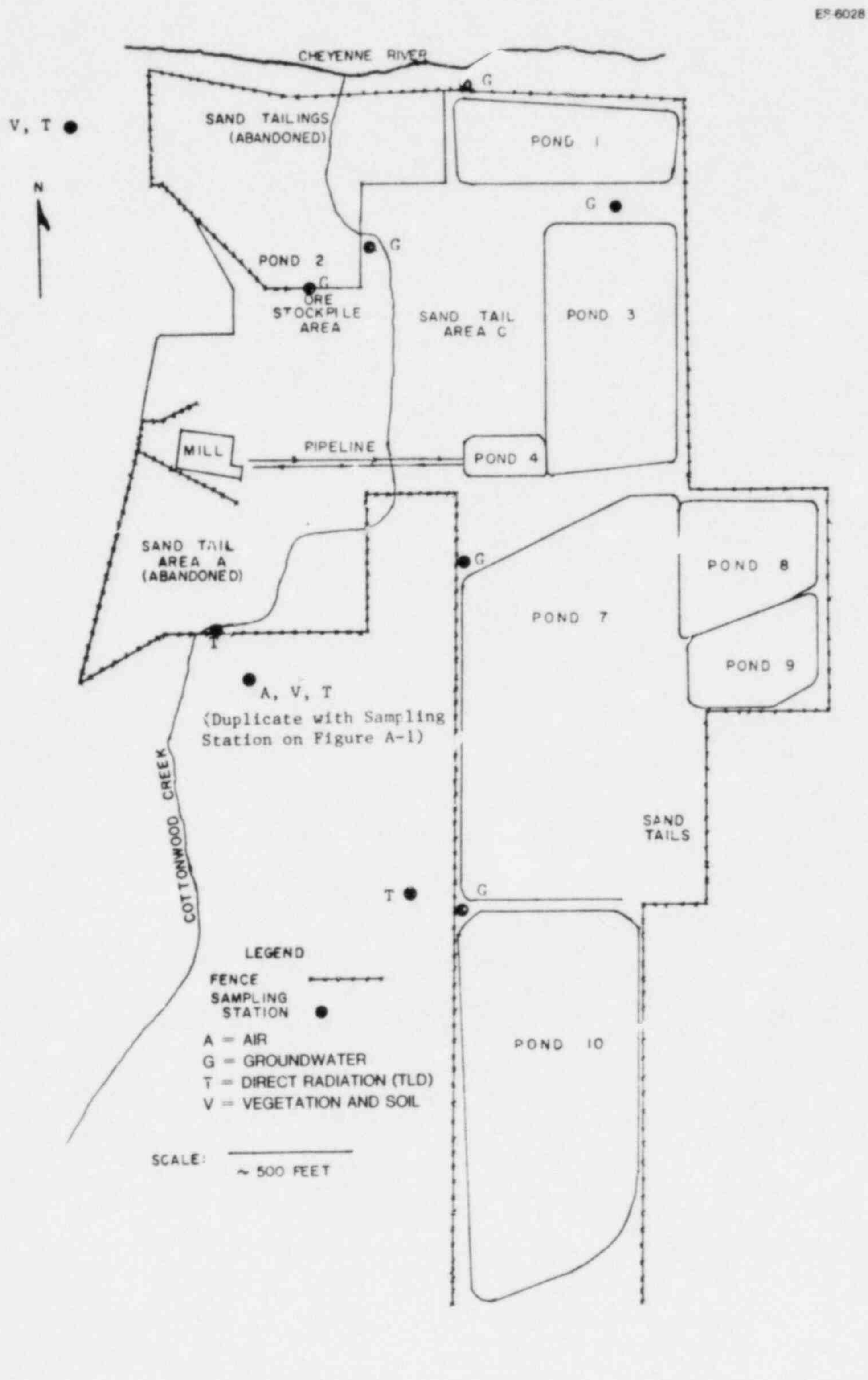
Groundwater samples will be taken quarterly from five observation wells on the existing mill site. This monitoring will continue through the decommissioning project as possible (in decommissioning the site, the wells will eventually be completely removed).

Previous groundwater and surface water sampling results show that concentrations of thorium-230, lead-210, and polonium-210 are very low, generally on the order of 1 to 10% of NRC Maximum Permissible Concentrations. Concentrations of uranium and radium-226 are somewhat higher. The staff has evaluated geohydrological information concerning the mill site and contaminated groundwater there and has determined that decommissioning activities should not result in any significant increase in the levels of these radionuclides in the groundwater. Therefore, the staff feels it adequate to analyze groundwater samples for radium-226 and total uranium only. The locations of the monitor wells from which the samples will be taken are shown on Fig. 4.2.

Because of concerns that flow of contaminated groundwater to the northeast of the mill site and towards Cottonwood community might be encouraged by decommissioning activities, the installation of additional monitor wells in these areas will be required unless the licensee provides adequate technical justification that this will not occur. The need for these wells (and their locations, if needed) will be determined by the staff following a review of additional information. Similarly, the need for groundwater monitoring at the disposal site will be determined based on detailed hydrogeological characterization of the site.

4.2.2.3 Surface water

Surface water samples will be taken monthly from three locations on the Cheyenne River and two locations on Cottonwood Creek in the vicinity of the mill site. Sampling locations proposed


ES 6028
CHEYENNE RIVER
G
V, T
SAND TAILINGS
(ABANDONED)
POND 1
N
G
POND 2
G
G
ORE
STOCKPILE
AREA
SAND TAIL
AREA C
POND 3
MILL
PIPELINE
POND 4
SAND TAIL
AREA A
(ABANDONED)
G
POND 8
POND 7
POND 9
T
A, V, T
(Duplicate with Sampling
Station on Figure A-1)
COTTONWOOD CREEK
SAND
TAILS
T
G
LEGEND
FENCE
SAMPLING
STATION
A = AIR
G = GROUNDWATER
T = DIRECT RADIATION (TLD)
V = VEGETATION AND SOIL
POND 10
SCALE:
~ 500 FEET

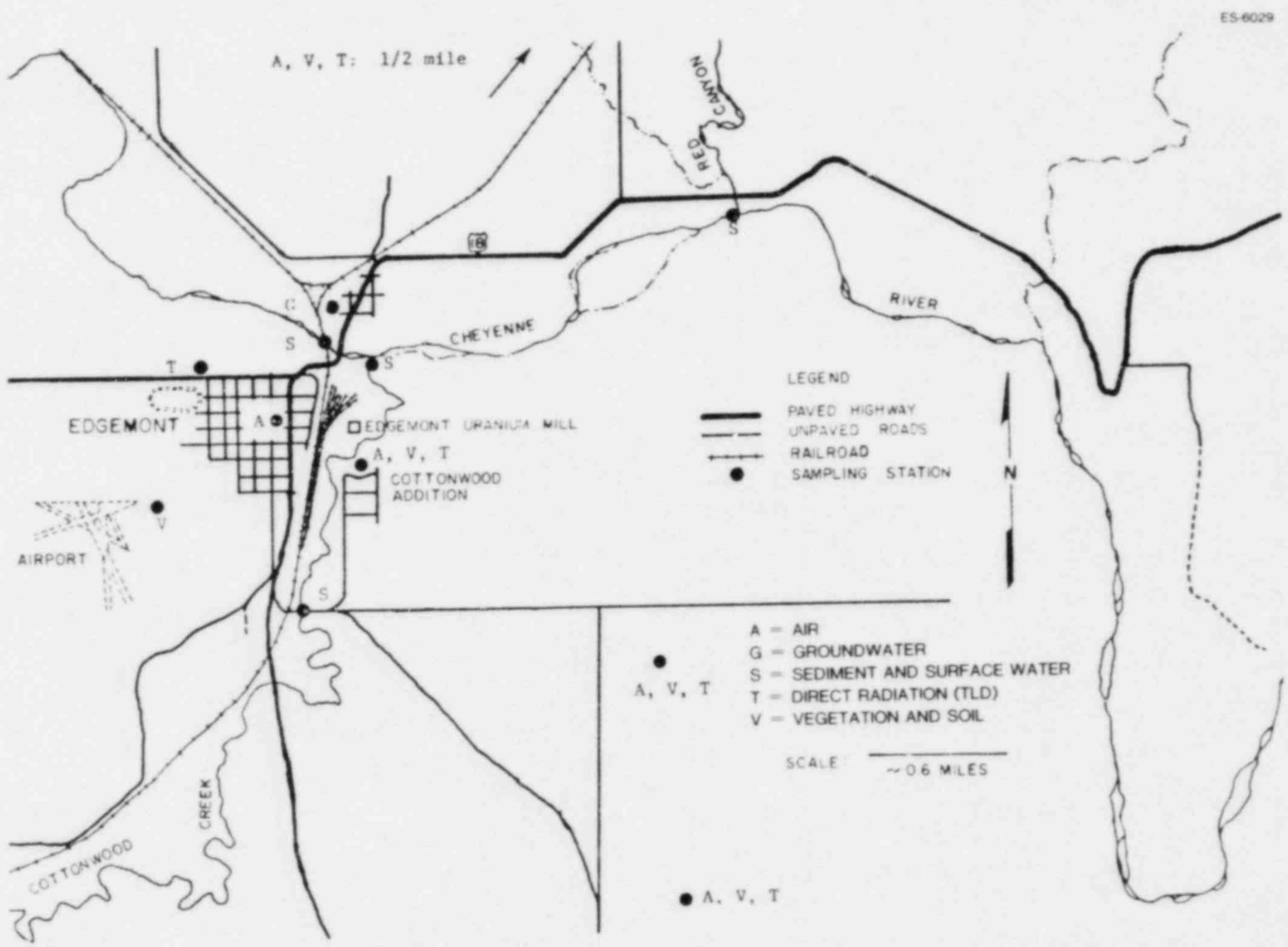


Fig. 4.3. Offsite sampling stations.

by the licensee are shown in Fig. 4.3. The licensee proposed to analyze monthly samples for gross beta and to analyze composited samples quarterly for total uranium, thorium-230, and radium-226. The staff feels that an additional station should be located just downstream from the confluence of the creek and the river and that the sampling station located downstream on the river is too remote from the site to be of any value. Therefore, the staff will require the licensee to add another sampling station and relocate the downstream station to a point much closer to the mill site. Additionally, the staff has determined that quarterly analysis of composited monthly samples is not adequate and will require monthly analysis for all parameters listed above.

4.2.2.4 Sediment

Sediments of the Cheyenne River and Cottonwood Creek will be sampled semiannually at the same locations as the surface water sampling stations. Samples will be taken along transects across the stream, with three to five discrete sample sites along each transect. The top 7.6 to 15 cm (3 to 6 in.) of sediment will be sampled and analyzed for total uranium, thorium-230, and radium-226. Selected samples will also be analyzed for polonium-210 and lead-210.

Depending on the information gathered from early monitoring efforts, sediment sampling may be increased or decreased accordingly. However, the staff feels that modifications should be made only after the extent of sediment contamination is determined.

In addition to this sediment monitoring to be conducted near the mill site, monitoring will also be conducted at the tailings disposal site. It is anticipated that the disposal site will be designed to have no discharge; thus, under current plans, monitoring in this area will not be conducted until reclamation of the disposal area is near completion. At that time, sediment samples will be collected from the retention pond downgradient from the tailings disposal area. These samples will be analyzed for the parameters listed above to document radionuclide concentrations in the pond before its reclamation.

4.2.2.5 Soil and vegetation

Soil and vegetation samples will be collected from the six locations shown in Figs. 4.2 and 4.3. Vegetation samples will be collected once during the growing season and once after the end of each working season's decommissioning activities. Radium-226 and lead-210 analyses will be performed on all samples. Both forage and food crops will be sampled if available.

4.2.2.6 Direct radiation

Direct gamma radiation will be monitored quarterly at from 10 to 14 locations, which will be determined based on source and environmental transport factors. This will include thermoluminescent dosimeters, which are located at the air monitoring station and at other sites. Eight locations are shown on Figs. 4.2 and 4.3. Additional locations will be selected in the Cottonwood community primarily at residences that border on the mill site boundary. These additional locations will be established and submitted to the NRC for approval.

4.2.2.7 Site surveys

A survey of the disposal site and its immediate environs will be conducted before decommissioning activities begin. This survey will include gamma dose rate measurements, surface soil sampling, and radon-222 flux measurements. Similar surveys will be conducted at the existing mill site and the disposal site after reclamation activities are completed to document post-decommissioning radiological conditions.

1. Gamma dose rate measurements — Measurements will be made at approximately 100-m (328-ft) intervals in perpendicular traverses across the disposal area and at the same locations used for collection of air particulate samples. The approximate center of the disposal area will be the location at which the traverses cross. Each measurement "arm" will be no less than 1500 m (4920 ft) in length.

2. Soil — Surface soil samples will be taken at approximately 300-m (984-ft) intervals in perpendicular traverses across the disposal area and at the same locations used for the collection of air particulate samples. Each measurement "arm" will be no less than 1500 m (4920 ft) in length. All samples will be analyzed for uranium, thorium-230, radium-226, and lead-210.

3. Radon flux measurements — Necessary radon flux measurements will be taken once a month over a three-month interval, preferably during the summer.

4.2.3 Soils

4.2.3.1 Predecommissioning

Soils in the vicinity were studied by the Soil Conservation Service. Soil unit maps were provided as well as descriptions of the characteristics of each soil mapping unit. In June 1980, the licensee sampled the Nunn clay loam and Norka silt loam associations within the proposed disposal site and along its immediate boundaries to determine the volume and suitability of material for use as plant growth media. The soils were analyzed for the following chemical and physical characteristics: pH, electrical conductivity, saturation percentage, texture class, copper, molybdenum, and soluble calcium and magnesium.

4.2.3.2 Decommissioning, stabilization, and reclamation

The reclamation plan is intended (1) to minimize erosion on the disturbed areas so that the erosion rate is consistent with the surrounding areas and (2) to return the lands to productive use (Sect. 2.2.2.7). In all disturbed areas, soils will be monitored to this end. Soils will be monitored for their potential for erosion and physical and chemical properties that may affect plant growth. The soil will be periodically observed for signs of excessive erosion that may occur on steep slopes or areas of low infiltration rates that may be subject to high runoff. If excessive soil loss or gullying is observed, corrective measures will be made to mitigate the situation. If a soil is identified as having a high clay content or a high concentration of sodium or other soluble salts, then reclamation on these soils will be monitored for possible treatment.

4.2.4 Mineral resources

No monitoring efforts are required or needed.

4.2.5 Land use

The licensee acquired land use data from published reports, from correspondence with personnel of various governmental offices, and from onsite visits (ER, Sect. 4.3). No other special methodology was required.

The licensee should ensure that the decommissioning operation does not infringe on the activities (e.g., transportation routes) of the nearby residents to the maximum practicable extent.

The reclamation plan, as proposed by the licensee with recommended changes by the staff (Sect. 2.2.3.8), should allow the land at the disposal site to be used in a manner similar to its use prior to the decommissioning activities, and the land at the present mill site shall be released for unrestricted use, with limited land use control measures.

4.2.6 Water

4.2.6.1 Surface water

Predecommissioning

Hydrology. A summary of the flow data for the Cheyenne River is presented in Sect. 3.6. Flow characteristics were determined and a stage-discharge relationship developed for Cottonwood Creek from discharge measurements and culvert flow formulas (Table 3.14, Sect. 3.6; and ER, Sect. 4.2). Flow characteristics of the ephemeral stream draining the proposed disposal area will be determined by the licensee. These samples will provide baseline data for comparison with samples taken during decommissioning (ER, rev. 5).

Water quality. A summary of the results of the surface water quality sample analyses and number of samples taken is presented in Tables 3.15 and 3.17 of Sect. 3.6. The water quality data included in these tables as well as ER Tables 4.2-8 and 4.2-9 indicate that elevated chemical and trace metal levels at the mill site should continue to be sampled during predecommissioning, decommissioning, stabilization, and reclamation (Sect. 4.2.6.1) to ensure that contaminants released during decommissioning are determined and that data for all sampling periods are comparable. For example, sulfate, chloride, manganese, arsenic, nickel, molybdenum, selenium, and vanadium should be monitored because these elements are toxic to humans and aquatic life and have the potential for bioaccumulation.

Background information on water quality of the ephemeral stream draining the disposal area was not provided by the licensee. There is no flow except during precipitation events. The licensee will conduct a predecommissioning monitoring survey of the ephemeral stream channels at the disposal site during 1981 (ER, Sect. 5.1.2.2.1). The survey will be conducted prior to, during, and after a typical precipitation event to establish predecommissioning baseline water quality at the site.

Decommissioning, stabilization, and reclamation

Hydrology. Surface water monitoring will include periodic visual inspections during decommissioning to ensure maintenance and functioning of surface water diversion ditches. This monitoring program will also assess erosion at the disposal site and determine corrective action if required (ER, Sect. 5.1.2.1.1).

Automatic samplers and continuous flow recorders placed at strategically located stations will be used for surface water monitoring in the mill site area. Three stations have been proposed by the licensee (see Fig. 4.4): Cheyenne River upstream of the mill site (CRC), Cheyenne River downstream of the mill site (CRE), and Cottonwood Creek upstream of the mill site (CCC). Stations CRC and CCC would serve as controls while CRE would be the effects station. Flows will be determined at stations CRC and CCC through stage-discharge relationships. (Station CRC relationships are available from the USGS, but CCC relationships will have to be established.) Stages will be continuously monitored during the sampling season (which will basically be limited by freezing weather conditions). Flows at station CRE will be estimated by adding flows from CRC and CCC and, if necessary, estimates of any discharges occurring on the mill site.

Water quality.

1. Mill site. A system of diversion structures will isolate runoff and potential hazardous spills within the slurry pipeline and haul road route (Sect. 2.2.2.2) and drain to Pond 10 (ER, Sect. 4.3.3). This diversion system, as well as the diversion ditch to be constructed east of the mill site (Sect. 2.2.3), will be inspected by the licensee routinely to ensure integrity, proper maintenance, and erosion control (ER, Sect. 3.5).

During baseflow conditions (nonstorm runoff), the automatic samplers located at stations CRC, CRE, and CCC on Fig. 4.4 will be activated for a 24-h period once every two weeks. One-liter discrete samples will be collected at a rate of one per hour. After the 24-h sampling period, each station will be serviced. Field parameters (pH, conductivity, and turbidity) will be determined for each discrete sample. The first set of samples collected will be further analyzed for the laboratory parameters listed in (a) below. Stage records will be retrieved and the average flow will be determined for each 1-h sample period. The 24-h flow-composited turbidity and conductivity will be calculated. The samples will then be processed according to the following criteria.

(a) If the calculated 24-h turbidity at CRE is greater than the calculated 24-h turbidity at CCC and 1.5 times the calculated 24-h turbidity at CRC, the discrete samples at each station will be flow-composited and the composite samples analyzed for the following laboratory parameters: TSS, TDS, SO_4 Cl, V, Ni, Mn, Se, As, and Mo. Each of these specific ions is present in high concentrations in the tailings ponds and will serve as a good indicator of decommissioning effects upon water quality. Both total and dissolved concentrations will be determined.

(b) If the calculated 24-h conductivity at CRE is greater than the calculated 24-h conductivity at CCC and 1.1 times the calculated 24-h conductivity at CRC, the discrete samples at each station will be flow-composited and the composite samples analyzed for the laboratory parameters. The composite samples will be filtered, and only the dissolved concentrations will be determined.

(c) If the turbidity or conductivity data for CRE indicate that one or a series of discrete samples exhibit high values (spikes) that are not obviously correlated with corresponding data for CRC or CCC, the portion of the spiked samples remaining after implementation of the above criteria will be composited and analyzed for the laboratory parameters. If sample volumes are insufficient to analyze all parameters, metals would receive top priority, followed by the two anions, followed by TDS and TSS. If criteria (a) and (b) have not been met but spikes are found, equivalent "normal" samples from stations CRC and CCC should also be analyzed for laboratory parameters to allow evaluation of the spiked samples.

(d) Correlations between TSS and turbidity and TDS and conductivity will be established by analyses of selected discrete samples from each station using the remaining sample portions. If the maximum turbidity or conductivity is less than 1.5 times the minimum turbidity or conductivity, respectively, the discrete samples with the "maximum" turbidity or conductivity value will be analyzed for the appropriate parameter. If the maximum turbidity or conductivity is greater than 1.5 times the minimum turbidity or conductivity, respectively, the discrete samples with the maximum, minimum, and median turbidity or conductivity values will be analyzed for the appropriate parameter to the extent possible using remaining sample volumes. The analyses will be discontinued after correlations are established. If the correlations are found to be strong and stable, the relationships will allow estimates of suspended solids and dissolved solids for any period with corresponding field data. Additionally, if strong correlations are detected between TDS or TSS and any of the specific ions analyzed, specific ion estimates can be made based only on turbidity or conductivity.

(e) If criteria (a) or (b) do not result in analyses for the laboratory parameters, three sets of flow-composited samples will be analyzed per year. The first set of samples taken will be analyzed for the laboratory parameters regardless of criteria (a) or (b). If no other samples have been analyzed for the laboratory parameters by the middle of the working season, a set taken at that time will be analyzed for those parameters. Also, if no additional samples have been analyzed for the laboratory parameters by the end of the working season, a set will be analyzed for those parameters. Total concentrations of each parameter will be determined.

When flow conditions allow safe wading, field parameters will also be determined at CRE at the time the sampler is serviced at approximately three to five equally spaced points across the stream cross section to determine whether the station is well mixed. If a difference of greater than 10% for conductivity or 50% for turbidity exists between the low and high values across the cross section, a composite sample (equal volume per point) for the cross section will be prepared and analyzed for the laboratory parameters. Equivalent samples will also be taken and analyzed as necessary at the other two stations to allow interpretation of the data. Dissolved concentrations will be analyzed if the conductivity criterion is exceeded while both total and dissolved concentrations will be analyzed if the turbidity criterion is exceeded. Stagnant portions of the cross section will be avoided, and the actual number of sampling points will be determined based on field conditions.

During storms, the automatic samplers will be activated by rainfall. One-liter discrete samples will be collected at preset rates that may vary with time, both during a storm and from storm to storm. Field parameters (pH, conductivity, and turbidity) will be determined for each discrete sample. Stream stage and rain gauge records will be retrieved and used to composite the discrete samples for the estimated period of onsite runoff. The flow-composited samples will be analyzed for both total and dissolved concentrations for the parameters previously listed (up to a maximum limit of six storm events per year). If the period of onsite runoff covers less than about half of the total runoff period for the storm event, another set of composites will be prepared covering as much of the total storm period as possible considering the automatic sampler limitations. This second set of composites will be analyzed for the same parameters as the first set. Discretes at CRE will be evaluated for "spikes" as outlined for baseflow conditions, and additional samples will be selected from the discretes at each station for correlation of TSS/turbidity and TDS/conductivity as outlined for baseflow conditions.

In addition, sediments sampled as described in Sect.4.2.2.4 will be analyzed for SO_4, Cl, V, Ni, Mn, Se, As and Mo on a semiannual basis.

Data review mitigation measures

If field parameters indicate potential project impacts at CRE, the site will be inspected to identify potential contamination sources. These inspections in conjunction with the results of the laboratory analysis and known decommissioning activities for the period of interest should allow determination of the probable source of contaminants. Based on a review of project impacts, of site characteristics, and of existing mitigative measures, a determination will be made regarding what additional measures may be feasible.

2. Disposal site. Water samples could be taken occasionally from the two ponds located downgradient from the disposal site, but interpretation of the data would be difficult because of the high evaporation rate and partial or no flushing between storm events or during a typical year. Consequently, it is proposed that the monitoring objective be achieved through analyses of only sediment samples from P1 and the first pond downgradient of the spoil area (either P2 or P3). These locations are shown on Fig. 4.5. Sediment from two ponds downgradient of the disposal site (Fig. 4.5) will be analyzed to characterize any changes in composition caused by runoff from the spoil pile and other land disturbance in this area. Sediment samples will be taken from P1 and the first pond downgradient of the spoil area (either P2 or P3). One sample per pond will be collected annually at approximately the deepest wadeable point in the ponds. The top 7.6 cm (3 in.) will be analyzed for grain size distribution, and the following analyses will be performed for the portion with particle sizes below 63 μm (silt and clay): Ag, Al, As, B, Ba, Be, Ca, Cd, Cl, Co. CO_3 (total), Cr, Cu, F, Fe, Hg, Li, K, Mg, Mn, Mo, N (Kjeldahl), Ni, NO_2, NO_3, P (total), Pb, pH, S, Se, SO_4, Sr, V, and Zn. After baseline values are established, the parameters may be reduced to key indicators based on spoil characteristics.

4.2.6.2 Groundwater

Predecommissioning groundwater monitoring

Existing site. In the alluvial aquifer beneath the existing site, the licensee completed 14 monitor wells, from which preoperational groundwater level and quality data have been collected and compiled over the past three years. These data, along with information recently collected by the South Dakota Department of Water and Natural Resources, are discussed in Sect. 3.6.2.2.

Proposed disposal site. Prior to construction, the staff will determine the need for monitor wells completed in the shallow alluvial aquifer hydraulically downgradient from the proposed disposal area. This determination will be made following an evaluation of detailed geohydrological characteristics of the site.

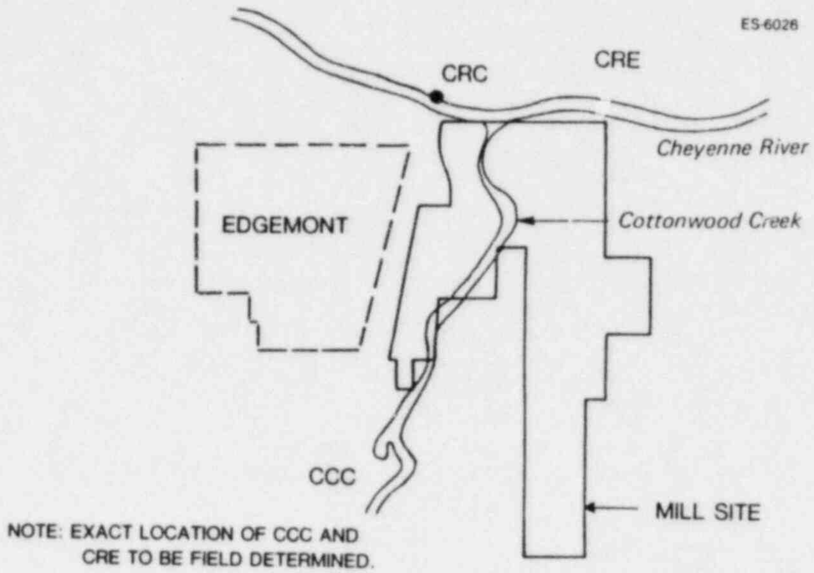


Fig. 4.4. Nonradiological water quality monitoring stations at the mill site.

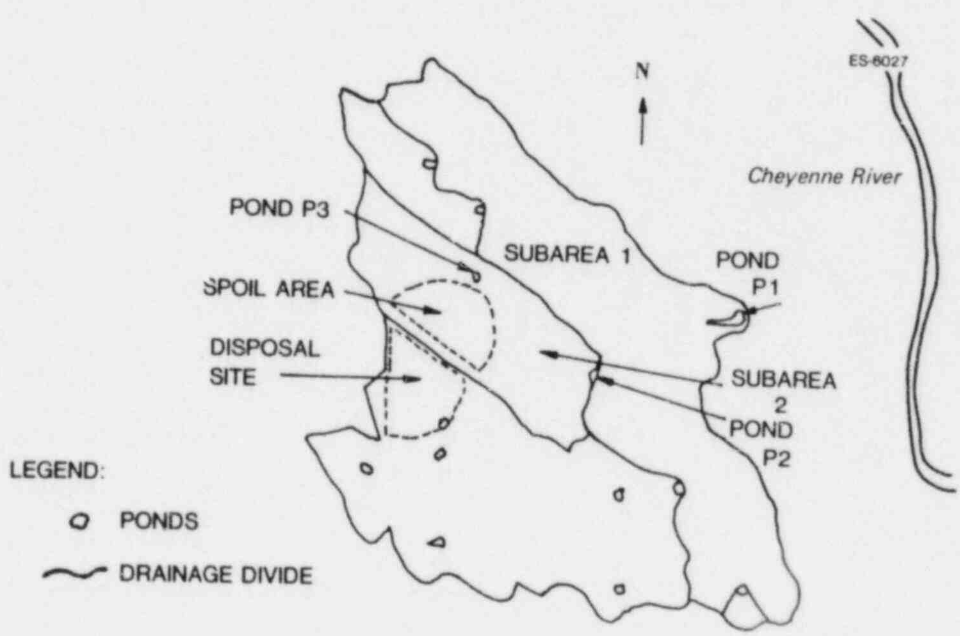


Fig. 4.5. Drainage at the preferred disposal site.

Decommissioning, stabilization, and reclamation

Existing site. During the decommissioning and reclamation of the mill site, the staff will require that groundwater levels be monitored in observation wells in the immediate vicinity of the mill site to ensure that groundwater hydraulic gradients that might enhance offsite transport of leachates are not developing. It has been shown that the direction of groundwater flow at the mill site is towards the Cottonwood Creek and Cheyenne River. Surface-water sampling has shown that contaminants present in the alluvial groundwater are not entering the surface water in significant quantities and that the dilution by surface waters results in low concentrations of these contaminants in the streams. For these reasons the staff feels that no useful purpose would be served by analyzing groundwater samples for any parameters other than those radionuclides discussed in Sect. 4.2.2.2. The surface-water monitoring program described in Sect. 4.2.6 will be adequate to ensure that impacts on water quality from the decommissioning project are as projected. If the monitoring program shows unexpected levels of contaminants in surface waters, monitoring of groundwater may be required to determine the cause, and it would then be implemented as necessary.

Postreclamation groundwater monitoring

As the removal of the existing tailings and related material approaches the final stages, the staff will require that the licensee obtain representative samples of the groundwater underlying the site to document water quality characteristics.

The licensee does not propose to perform any short- or long-term monitoring of the groundwater at the existing site upon completion of the decommissioning. Upon completion of reclamation activities, it will be determined whether additional monitoring is necessary.

4.2.7 Biota

4.2.7.1 Aquatic biota

Predecommissioning

Samples were taken by the licensee from two tributaries — one site downstream of the mill and disposal site on the main stem of the Cheyenne River, and four sites along Cottonwood Creek, including areas above, through, and below the mill site — in September 1975 and June 1976 to determine the composition and diversity of nonfish aquatic biota (zooplankton, phytoplankton, and microinvertebrates) in the vicinity of TVA Edgemont properties.[9] In addition, TVA biologists sampled ten sites on the Cheyenne River and three of its tributaries to determine the fisheries resources of the area.[15] Additional sampling was conducted by the South Dakota Department of Game, Fish, and Parks and the licensee in the Cheyenne River and Cottonwood Creek during July 1980 to corroborate findings of the TVA biologists in 1979. The plains top minnow (*Fundulus sciadicus*), a South Dakota threatened species reported from the Cheyenne River by Mines Reclamation Consultants in 1976 (ER, Sect. 4.2), was not found by TVA biologists in 1979 nor by the Department of Game, Fish, and Parks. The minnow was not found in either the Cheyenne River or Cottonwood Creek in 1980.[16] All the fish species obtained during the predecommissioning surveys are widespread,[17] and none occur on the South Dakota list of threatened and endangered species.[16]

The fauna and flora of the stock pond in the disposal area, while not determined by the licensee, are probably characteristic of other small stock ponds in the area. The biota of the ephemeral stream through the disposal site, while not investigated by the licensee, is probably typical of other ephemeral streams in the area because of the similarities in topography, ephemeral nature, and potential habitats.

Decommissioning, stabilization, and reclamation

Aquatic monitoring (fish and macroinvertebrates) will be based on documenting recolonization of the area of Cottonwood Creek to be impacted by the decommissioning activities. Cleanup of Cottonwood Creek (ER, Sect. 3.5) may require the temporary rerouting of a reach of Cottonwood Creek. This relocation would destroy existing substrate in this reach and the biological communities that inhabit this substrate. After cleanup, Cottonwood Creek will be returned to the original stream course, and substrate, instream fisheries structures, and riparian vegetation comparable to the original stretch will be provided. A survey of Cottonwood Creek (baseline data already collected) will be made after decommissioning at such a time as deemed appropriate to document recolonization of the restored reach. The monitoring program will concentrate on documenting the standing crops and diversities of fish and macroinvertebrates. It is believed that recolonization of the new streambed by upstream populations will occur without a significant overall loss to the biological health and diversity of the creek. With the implementation of management practices for the control of erosion, and the prevention of sediment discharge as a result of runoff, impacts to the fish fauna and habitat will be temporary and minimal. Special precautions will be necessary to ensure that during the decommissioning and disposal operations, accidental spillage of hazardous or toxic wates do not enter adjacent surface drainage ways. Aquatic studies for the decommissioning project will, in general, parallel previous surveys. Five sites will be evaluated on the Cheyenne River to allow an upstream control as well as downstream stations to detect possible short- and long-term changes within the biological community. Locations (Stations 1, 2, 3, 5, and 6 in Fig. 3.16), which were established during a sampling trip in the spring of 1980, will approximate those sites used in the baseline studies. Monitoring will be seasonal (four times a year) during tailings removal. Sampling results will be correlated with climatic and flow data. Because of the great variability in flows, only biological collections made within comparable flow regimes will be utilized to detect changes from baseline conditions.

4.2.7.2 Terrestrial biota

Predecommissioning

The licensee obtained data for the general vicinity of the project from published literature, discussions with personnel from various governmental agencies, and field surveys of TVA Edgemont leases for uranium production. General field surveys of the site and immediate vicinity were conducted in 1976 and 1979. A transect was established on the disposal site in December 1979 to determine big game utilization of the area by season. The average percent ground cover was estimated for each community in the vicinity of the disposal site in 1980. Limited onsite surveys of small mammals and birds within the sagebrush/grass and grass associations on the disposal site were conducted in the spring and summer of 1980.

Decommissioning, stabilization, and reclamation

Sampling stations will be established to monitor plant cover for determining the success of reclamation. Plant cover and species diversity will be determined by a line intercept method. The number of samples to be taken will depend upon the size of the area. A minimum of at least 20 samples should be taken, or, if the area is small, then 1% of the area should be sampled. The total number of samples must be sufficient for analytical comparison by use of a similarity index or statistical analysis. The intercept lines will be 25 m (82 ft) long and located by the random location of ten points. At each point, two intercept lines will be established along a random compass direction with both ends of the line marked with a permanent stake. Control stations will be established in nearby undisturbed native communities.

The success of reclamation should be based upon the performance standards associated with the site. The vegetation should be a perennial-type that is adapted to the soil and of the same seasonal variety native to the area and capable of self-regeneration. Reclamation will be considered as complete when the cover and density of the reclaimed areas is equal to the plant cover and density of perennial species within the control areas. This condition must be met for two consecutive growing seasons. Once this condition is met, sampling will be discontinued.

4.3 MITIGATION MEASURES

4.3.1 Air quality

In an effort to control air quality, the licensee should develop and implement a program designed to minimize fugitive dust emissions. The program should conform to the following conditions, made as assumptions when calculating expected emissions (Sect. 4.1.1):

1. limit average vehicle speeds on the mill site to 16 km/h (10 mph) and on the haul road to 32 km/h (20 mph);

2. achieve 60% dust control by watering or other methods;

3. limit disturbed areas (where project activities are being conducted) to as small a working area as possible, and

4. revegetate disturbed areas as soon as feasible.

In addition, the staff will require that when there is visible evidence of dust being blown from the site(s) from any source (traffic, dumping, loading, scraping, or wind pickup), that immediate efforts to minimize such transport be initiated. Further, the staff recommends that decommissioning operations be stopped temporarily when sustained wind speeds exceed 40 km/h (25 mph) (Sect. 4.1.1).

Results from TSP monitoring (Sects. 4.2.1.2 and 4.2.1.3) and records of implementation of dust control measures should be made available to the director of the decommissioning operations as soon as possible. This is especially important during dry periods with high winds, not only to determine the effectiveness of mitigation measures but also to give an additional indication of when dust control measures are needed.

The staff will require that the surface of tailings and contaminated particulate matter of the disposal site be kept moist with water, slurry liquids, or chemical sprays until they can be stabilized by the intermediate cover (Sect. 2.2.3.7).

The licensee has suggested some type of road carpet on the haul road in addition to watering to minimize dusting. Because this roadway will be removed during reclamation and is carefully designed to capture runoff pollutants, the staff concurs and will require that the road be appropriately treated to prevent dusting during use.

4.3.2 Radiological environment

Mitigation measures for radiological considerations are essentially the same as those required for air quality, except for special emphasis on the disturbed areas containing tailings.

To confirm that the air quality mitigation measures are effective for the tailings area, the staff will require that air monitors be operated continuously during tailings (or slimes) removal operations to detect offsite transport of radionuclides. If unexpectedly high values are observed, the licensee shall determine the cause and provide a plan for mitigation for NRC approval. This control program shall include documented inspections.

4.3.3 Water

4.3.3.1 Surface water

The licensee proposes to mitigate surface water impacts, primarily from sediment-containing runoff to the Cheyenne River, by alteration of drainage patterns. The staff approves of the proposal to divert contaminated surface runoff from the area east of the mill site to Pond 10 by constructing a diversion channel (Fig. 2.7). The staff recognizes that some sediment transport will occur before revegetation but feels this will be of minor consequence since all sediment will be contained in Pond 10.

The staff approves the licensee's proposal to control grading on the mill site in a manner to capture and impound rainfall on the site during operations. The licensee will monitor site runoff to document the effectiveness of this erosion control and modify the site operations as required.

The licensee has proposed a temporary diversion of Cottonwood Creek (Fig. 2.13) so that the existing stream channel can essentially be dredged out and eventually a new channel can be constructed. The staff concurs with this plan, contingent upon confirmation that the contamination of the creek bed is widespread, as is currently anticipated.

General staff comments on mitigating measures to control surface water impacts are as follows:

As the creek is decontaminated, the staff concurs that natural and man-made materials (i.e., concrete boulders) be placed in the existing stream as proposed by the licensee for the rerouted stretch of the stream (Sect. 2.2.2.5). These materials should be located in the stream channel along the stream margins and, where possible, in association with vegetation. It is felt that these materials will adequately reduce erosion of the stream margins and prevent the stream from cutting into possibly residually contaminated areas. The stream reach in the vicinity of tailings pile A (Fig. 2.9) may be unstable because a new channel will probably have to be constructed through this area. The addition of natural and man-made material in this area will help stabilize the substrate, provide habitat for colonization by aquatic biota, and prevent new erosion. If the entire stream through the mill site is rerouted as planned, the streambed and margins should be reconstructed of natural and man-made materials to create approximate streambed conditions upstream of the mill site.

Long-term impacts on surface water hydrology, water quality, and aquatic biota resulting from transport of contaminants remaining in the groundwater beneath the mill site will be mitigated in part by removal of the contaminated tailings and further by time and transport from the site (see Sects. 4.2.1.5 and 4.2.2.5).

At the disposal site, construction of a sediment pond downslope from the impoundment dike should prevent downstream sediment transport and streambed alteration. The licensee will be required to utilize diversion ditches and sediment ponds during initial construction to minimize any potential effects of sediment transport to the Cheyenne River.

4.3.3.2 Groundwater

Impoundment design specifically engineered, as currently planned, to minimize seepage in the disposal area is the only available mitigation measure to protect groundwater.

In decommissioning, use of already contaminated water from the alluvial zone will encourage the infiltration of natural groundwater, thus improving the quality of alluvial groundwater at the mill site.

4.3.4 Biota

No effective short-term mitigation measures to protect biota are available. However, long-term impacts to aquatic biota will be minimized by repopulation from upstream.

4.4 STAFF ASSESSMENT OF MONITORING PROGRAMS AND MITIGATION MEASURES

The staff considers the monitoring programs proposed by the licensee and modified by the staff (Tables 4.15 and 4.16) to provide a suitable basis for observing and documenting the impacts of project operations.

The staff is aware that many of the proposed activities remain conceptual in nature. For this reason, the staff will require that before engaging in any activity not evaluated by the NRC staff, the licensee shall prepare an evaluation of the environmental consequences. If such evaluation indicates a potential for significant adverse environmental impacts, the licensee shall provide a written evaluation of the activity, including proposed monitoring and mitigation measures, and submit this evaluation to NRC for approval.

If the monitoring programs disclose unexpected harmful effects or evidence of irreversible damage not identified in this Statement or reducible by improved application of existing mitigation measures, the licensee shall provide to NRC an acceptable analysis of the problem and a mitigation plan to eliminate or significantly reduce the harmful effects or damage. With the above restrictions, the staff considers that the environmental monitoring program and proposed mitigation measures are at the state of the art and will protect the environment and the public to the greatest degree reasonably achievable.

4.5 INDIRECT EFFECTS

4.5.1 Lack of resource development

No valuable resources, as currently defined, that may be developed will be affected by the permanent disposal of the Edgemont tailings and other contaminated materials.

4.5.2 Possible conflicts between proposed action and objectives of Federal, State, regional, and local plans and policies

All of the above authorities are agreed that disposal of the Edgemont tailings and associated materials is desirable.

The specifics of monitoring and mitigation measures for the protection of the environment are subject to approval by many of the above authorities, and any conflicts will be resolved by conformance with legislative mandates of responsibility, when assigned, or negotiated agreement.

4.5.3 Effects on urban quality, historical and cultural resources, and society

The project will not affect any of the above items.

4.5.4 Energy requirement and conservation potential

The project has minimized energy requirements by locating the disposal site at the nearest acceptable location meeting long-term disposal criteria. In addition, much of the tailings will be transported by slurry pipeline, an energy-efficient method. No further conservation appears feasible.

4.5.5 Potential effects of accidents

Because of the nature of the proposed activities, the potential for significant impacts from accidents during the decommissioning of the Edgemont Mill will be small. The impoundment, haul roads, slurry pipelines, and operating procedures will be designed to minimize the possibility and to mitigate the consequences of any accident that may occur. The staff analyses of potential accidents and their effects are presented below.

4.5.5.1 Impoundment failure

During the placement of tailings in the impoundment, there will be some very slight risk of impoundment failure by flooding or by slope failure. The staff believes the probability of such failure and subsequent release of radionuclides to be negligible. The impoundment will be designed to meet Regulatory Guide 3.11 design criteria covering flood-resistant design, retention-dam static and seismic-slope stability, loading factors, settlement, and seepage effect on the dam structure.

The location of the impoundment at the head of a drainage basin, the use of drainage diversion ditches to further reduce drainage area, and the provision of adequate freeboard to accommodate the probable maximum flood (PMF) make the breaching of the impoundment by flooding a highly unlikely event.

The slurry transport phase of the operation will last less than two years, after which time the tailings will evaporate to dryness or otherwise be mixed with dry solids transported to the impoundment by truck. Therefore, the retention-dam structure will not be saturated by seepage as would retention dams for conventional mill tailings disposal which store liquids for 10 to 20 years. The engineered embankments and drainage blanket for seepage removal included in the proposed impoundment design will also provide an additional level of protection. On this basis, spontaneous failure of the dam with release of tailings is judged to be only a remote possibility, with even less likelihood of occurrence than the failure of an impoundment at an operating mill.

4.5.5.2 Slurry pipeline failure

The proposed slurry pipeline system will transport 1.678 x 10^6 MT (1.85 x 10^6 tons) of sand tailings to the impoundment within a period of 1 to 1.5 years. A decant return line will parallel the slurry line and will recycle water to the slurry plant on the mill site. The pipeline route from the mill site to impoundment will lie within the median ditch between the proposed haul roads. In the event that one of the pipelines should fail, the spilled slurry or solutions would be confined to the median ditch and haul road surfaces. The spill would be detected by truck drivers using the road or by slurry plant personnel noting a significant drop in pipeline pressure. Upon detection of the leak, the pipeline systems would be shut down and the spilled material would be isolated. Cleanup of the spill could be performed immediately or it could be deferred until the end of operations when the haul roads and pipeline systems are removed, with all contaminated materials being transported to the impoundment for disposal. In either case, contaminated materials would not be released to the environment. Therefore no significant or long-term effects are expected from an accidental failure of the slurry pipeline system.

4.5.5.3 Transportation accidents

To haul 5.37 x 10^6 MT (5.92 x 10^6 tons) of tailings and contaminated solids and 2.46 x 10^6 MT (2.70 x 10^6 tons) of uncontaminated borrow soils and impoundment cap materials between the mill site and the proposed impoundment, a distance of about 3.2 km (2 miles), 45.5-MT (50-ton) trucks will be employed. Over the course of the decommissioning activity, material haulage will require approximately 172,500 round trips totaling 1,110,900 km (690,000 miles). All of this mileage will be on the proposed haul road. With the exception of a little used county road crossing the haul road route just within the proposed impoundment site, public roads will not be affected by materials haulage. The licensee is investigating the use of an underpass to isolate the county road and local traffic completely from the haul-road operations. Therefore direct public involvement in any waste transportation accidents is not expected.

The use of parallel one-way roads for outgoing and incoming trucks will reduce the collision hazards to the truck operators. Based on published statistics[18] giving an accident frequency of 1 x 10^{-6} to 1.6 x 10^{-6} per km (1.6 x 10^{-6} to 2.6 x 10^{-6} per mile), it is likely that one or two accidents may occur during the decommissioning operation. Based on an injury rate of 0.51 per accident,[18] one transportation related injury may be expected. For an accident fatality rate of 0.03 per accident,[18] the probability of a fatality resulting from waste haulage accidents would be no greater than 0.06. These estimates are based on highway accident data and may therefore represent a conservative estimate of the risks involved.

An accident involving the spill of contaminated materials such as tailings slimes may release some small quantities of radioactivity to the environment. Such spills would be cleaned up promptly, and all residual contamination in areas adjacent to the haul roads near the spill would be decontaminated along with the roads at the end of the project.

4.6 UNAVOIDABLE ADVERSE ENVIRONMENTAL IMPACTS

4.6.1 Air quality

The unavoidable impacts on air quality from the Edgemont decommissioning stem primarily from earth-moving activities. The area's air quality will be monitored during operations (Sect. 4.2.1.2) to determine whether mitigative methods are adequate or if additional or modified procedures should be implemented. The staff anticipates the impact on regional air quality to be minimal. The staff also expects that, at downwind local areas in both Edgemont and Cottonwood, the State and Federal 24-h air quality standard for TSP (150 $\mu g/m^3$) will be exceeded occasionally. The staff believes that no operational controls can prevent this occurrence under severe weather conditions. Decommissioning operations prone to dusting will be suspended during conditions of sustained high wind.

4.6.2 Land use

The mill site presently has a nonuse status. During decommissioning, 207 ha (514 acres) will be disturbed by preparation of the disposal site, construction of the haul road, and cleanup of the mill site. An additional small disturbance of land will occur during cleanup of contaminated areas off site. However, this disturbance will be temporary.

After reclamation, the 86-ha (213-acres) mill site will become available for unrestricted use, and 34-ha (86-acres) of the disposal site will be removed from agricultural use but will remain available to small indigenous wildlife.

4.6.3 Water

4.6.3.1 Surface water

The cleanup of Cottonwood Creek on the mill site will cause a short-term increase in sediment transport into the Cheyenne River. Other decommissioning activities will cause increased sediment transport in surface runoff even though mitigative measures are planned to minimize such transport. After reclamation, there will be a complete and permanent alteration of the surface water features at the disposal site. All of these effects are of minor importance on either a local or regional basis.

After reclamation, the water quality in Cottonwood Creek will be somewhat improved. However, since Cottonwood Creek is recharged by unconfined groundwater, water quality and streambed sediments may be temporarily degraded by inflow of contaminated groundwater from beneath the mill site.

4.6.3.2 Groundwater

Up to 1.29×10^5 m^3 (105 acre-feet) of water may be removed from the Pahasapa aquifer. This amount is minor in terms of the water available in the aquifer and will be replenished by normal recharge. The staff will require that consideration be given to using the chemically contaminated water in the alluvium under the mill site for slurry transport operations to decrease water use from the Pahasapa aquifer and hasten the restoration of alluvial water conditions under the mill site by natural processing.

Groundwater at the disposal site is not expected to be affected.

4.6.4 Mineral resource

No known or currently commercially valuable mineral resources will be affected by this project.

4.6.5 Soils

Although clean topsoil and subsoil will be segregated prior to stockpiling for later reclamation use, a reduction in the quality of the soils is unavoidable. Moving the soils will disrupt existing physical, chemical, and biotic soil processes; and compaction by heavy machinery will reduce water and air circulation needed for plant growth.

During reclamation, ripping, fertilizing, and using soil amendments should make these impacts insignificant over the long term.

4.6.6 Ecological

4.6.6.1 Terrestrial

Vegetation will be removed from all areas affected by the decommissioning operation. Plant species composition and diversity will be altered because of this disruption of the natural vegetation and subsequent revegetation.

Loss of habitat for most wildlife populations on disturbed areas will occur because of project operations. It is likely that many less mobile forms of wildlife will be destroyed.

Habitat removal will be temporary, but the natural diversity of plant species may not recover.

4.6.6.2 Aquatic

During the cleanup of Cottonwood Creek, all aquatic communities in the disturbed reach will be destroyed. Assuming that the creek is fully reclaimed, the diverse aquatic community upstream from the mill site will repopulate the reach through the mill site more diversely than at present.

The only aquatic impact at the disposal site results from the destruction of the small existing stock-watering pond. Because many other similar ponds are nearby, this impact is considered minimal.

4.6.7 Radiological

Because most of the existing piles and ponds on the mill site have been covered with soil and vegetated, there is a potential for an increase in windblown tailings and an almost certain short-term increase in radon emanation during decommissioning activities.

The decommissioning activities will be carefully monitored and supervised. In the opinion of the staff, such releases will be less than those occurring during previous mill operation. Those releases will be temporary, and after disposal site closure the present chronic low-level releases will no longer be present, except for release of radon in levels approaching background.

4.6.8 Socioeconomic

The staff estimates that the project will not generate enough tax revenue (about $400,000 in 1979 dollars) to compensate for potential costs for needed potable and wastewater facilities and street and road improvements. The short-term nature of the project and the projected six-month working year will encourage transient labor which may result in housing deficiencies.

The staff, however, believes that the long-term beneficial effects of the disposal of tailings and the cleanup and release of the mill site for unrestricted use (potentially as an industrial site) more than outweighs any short-term economic costs to the local communities.

4.7 RELATIONSHIP BETWEEN SHORT-TERM USES OF THE ENVIRONMENT AND LONG-TERM PRODUCTIVITY

4.7.1 The environment

4.7.1.1 Surface elements

The short-term increases in suspended particulates and radiological emissions associated with decommissioning activities is more than offset by the removal of a chronic low-level radiological contamination source. The short-term loss of wildlife habitat and aquatic resources will be replaced by long-term conditions more conducive to viable ecological resources.

4.7.2 Society

Any short-term socioeconomic problems encountered by local governmental services will be offset by the long-term disposal of low-level radiological materials in a stable permanent site. Social stresses on employees and families are short term and will not extend into the future.

4.8 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

4.8.1 Land and mineral resources

After reclamation, a small net gain in land resources will occur. If, over time, the disposal area is made available for grazing, this gain will increase. No known or currently commercially valuable mineral resources are expected to be affected by the project.

4.8.2 Water and air resources

Water used during the project is recycled to the atmosphere for distribution elsewhere. The aquifer(s) used will be recharged by precipitation. The air is self-cleaning of pollutants at the concentrations expected.

4.8.3 Vegetation and wildlife

These resources are renewable; and although some irreversit`e and irretrievable commitment is required, the commitment is relatively minor.

4.8.4 Material resources

Decommissioning, disposal, and reclamation will require a commitment of human and financial resources. Commitments of machinery, vehicles, and construction materials are required. Foss:. fuels are required for operation. None of the resources are in short supply relative to the size of and the necessity for the project.

4.9 THE NRC STAFF COST-BENEFIT SUMMARY

4.9.1 General effects

Uranium produced at the Edgemont site was primarily purchased by the government for defense purposes. Some of the production was used to produce nuclear power reactor fuel. The environmental costs of the onsite tailings and contaminated materials and their long-term disposal are prorated against and affected by the need for fissionable material for defense stockpiles and the benefits of energy generation. However, a review of the specific site-related benefits and costs of long-term disposal at the Edgemont site is appropriate.

4.9.2 Socioeconomic effects

The project will primarily be completed by imported labor because of low local unemployment rates. The imported labor will impact housing availability and, to a lesser extent, schools. Sewage systems may have to be expanded and water systems may need upgrading. It is unlikely that tax revenues from the project would generate sufficient public funds to compensate for needed expenditures. Local business will improve, but this monetary gain may be affected by the competition for personnel.

4.9.3 Environmental effects

Because the tailings disposal operation will be conducted on the mill site and the remote disposal site with material transport by slurry pipeline or trucks over a contained corridor between the two sites, little noise or dust will affect the general public. The radiation exposure of the nearby public may be temporarily increased during project operation, but monitoring and mitigating measures will keep such potential exposure well below permissible guidelines for protection of the health and safety of the public. After project completion, the mill site will be available for productive surface use, and the chronic low-level excess radiological exposure, which presently exists near the site, will no longer be present.

4.9.4 Staff assessment

The staff concludes that the adverse environmental impacts and socioeconomic costs over the short term are more than offset by the removal of the radioactive materials from the Edgemont mill site. The application of the mitigating measures suggested by the licensee and the regulatory agencies involved will reduce the short-term adverse impacts to acceptable levels.

Over the longer term, removal of the uranium tailings from the Edgemont mill site and subsequent subsurface disposal will eliminate a chronic low-level radioactive exposure potential for the forseeable future and will allow future surface use of the mill site.

In considering the short-term land disturbance, the minimal radiological impact and the societal impacts of the project compared with the long-term advantages of elimination of surface radiological contamination near inhabited locations, net reclamation of land for surface use, and disposal of the radioactive materials, the staff opinion is that the benefits outweigh the costs and that the project should proceed with the conditions specified in the summary and conclusions.

REFERENCES FOR SECTION 4

1. U.S. Environmental Protection Agency, *Assessment of Environmental Aspects of Uranium Mining and Milling,* Report EPA-600/7-76-036, Washington, D.C., 1976.

2. U.S. Environmental Protection Agency, *Environmental Evaluation of Mines Development, Inc., Uranium and Vanadium Milling Operation at Edgemont, South Dakota,* Report PB-256 453, April 1973.

3. U.S. Environmental Protection Agency, "National Interim Primary Drinking Water Regulations," *Fed. Regist.* 40(248): 59566-87.

4. U.S. Environmental Protection Agency, "Proposed National Secondary Drinking Water Regulations," *Fed. Regist.* 44(140): 42198-202.

5. National Academy of Science and the National Academy of Engineers, *Water Quality Criteria, 1972,* U.S. Government Printing Office, Washington, D.C., 1972.

6. Ford, Bacon & Davis Utah, Inc., *Engineering Assessment of Inactive Uranium Mill Tailings, Edgemont Site, Edgemont, South Dakota,* prepared for the U.S. Nuclear Regulatory Commission, Contract No. E(05-1)-1658, May 1978.

7. U.S. Environmental Protection Agency, *Effects of Noise on Wildlife and Other Animals,* Office of Noise Abatement and Control, Report NTID300.5, Washington, D.C., 1971.

8. F. R. Henderson, P. F. Springer, and R. Adrian, *The Black-Footed Ferret in South Dakota,* South Dakota Department of Game, Fish, and Parks Bulletin, Pierre, S.D., 1969.

9. Tennessee Valley Authority, "Responses to U.S. Nuclear Regulatory Commission Questions," Docket No. 40-1341, January 1980, pp. 1-19.

10. J. W. Salyer, U.S. Fish and Wildlife Service, letter to R. A. Scarano, Chief, Uranium Recovery Licensing Branch, NRC, Mar. 17, 1981, Docket No. 40-1341.

11. D. C. Wade and J. R. Wright, Jr., *Investigations of the Composition and Diversity of Nonfish Aquatic Biota on the TVA Edgemont Uranium Properties,* Tennessee Valley Authority, Division of Water Resources, Report TVA/EP-78/06, Chattanooga, Tenn., December 1979.

12. Old West Regional Commission, *Construction Worker Profile: Final Report,* prepared by Mountain West Research, Inc., Washington, D.C., December 1975.

13. U.S. Nuclear Regulatory Commission, *Final Generic Environmental Impact Statement on Uranium Milling,* Report NUREG-0706, Vol. 2, September 1980.

14. Sixth District Council of Local Governments, "Fall River County Energy Impact Plan," Rapid City, S.D., August 1980.

15. R. B. Fitz, *Fisheries Resources of the Cheyenne River Basin, Fall River County, South Dakota, May 18-22, 1979,* Tennessee Valley Authority, Division of Water Resources, Fisheries and Aquatic Ecology Branch, Norris, Tenn., July 1979.

16. R. M. Koth and R. C. Ford, *Fisheries Resources of the Cheyenne River Basin, Fall River County, South Dakota, July 7-9, 1980,* S.D. Department of Game, Fish, and Parks, Wildlife Division Report 80-8, 1980.

17. R. M. Bailey and M. O. Allum, *Fishes of South Dakota,* Miscellaneous Publication No. 119, Museum of Zoology, University of Michigan, 1962.

18. U.S. Atomic Energy Commission, Directorate of Regulatory Standards, *Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants,* Report WASH-1238, December 1972.

5. PROFESSIONAL QUALIFICATIONS OF THE EDGEMONT DECOMMISSIONING PROJECT FES TASK GROUP

The following individuals were responsible for independent analysis of information provided by the licensee in the ER and in responses to questions subsequently submitted requesting new information or clarification of material in the original ER. This terdisciplinary group obtained information from Federal, State, and local sources to supplement material provided by the licensee and also participated in the scoping process. There are no known relationships between the individuals or the organization that prepared this statement with industries regulated by the NRC and suppliers thereof that might give rise to an apparent or actual conflict of interest regarding the work described in this proposal.

A review of pertinent literature sources was also done to ensure that potential environmental consequences would be fully assessed and that the final recommendations made by the staff would be in conformance with the state of the art and with the interest of the National Environmental Policy Act.

The qualifications of each individual are listed so that primary responsibility for information in particular sections is apparent. Because much of the Environmental Statement represents joint efforts by the staff, it is impractical to provide a separate listing of contributors to many subsections.

Frank S. Anastasi

U.S. Nuclear Regulatory Commission

Washington, D.C.

Frank Anastasi is a project manager for the Uranium Recovery Licensing Branch of the Division of Waste Management. He is involved with the preparation of environmental impact statements and the evaluation of impacts associated with uranium milling. As a project manager, he coordinates technical support activities with licensing actions related to various uranium recovery operations and provides technical assistance to the staff on geology-related matters. Before joining the NRC, Anastasi worked as a field engineer on land development and construction projects.

Education:

- Received a B.S. degree in geology from the University of Maryland in 1980

Jeffrey S. Baldwin

Energy Division

Oak Ridge National Laboratory

Jeffrey Baldwin is a research associate in the Environmental Impacts Section. Since May 1979, his work has involved environmental impact assessments of various nuclear fuel cycle facilities such as fuel fabrication facilities, uranium ore-buying stations, uranium ore-processing mills, and in situ solution mining of uranium. Before coming to Oak Ridge National Laboratory, Baldwin was a research associate with the National Uranium Resource Evaluation at the Oak Ridge Gaseous Diffusion Plant. His training has been in trace element geochemistry, hydrogeology, uranium geology, and coal geology. Baldwin's research has included the development of geochemical exploration models using trace element data from stream sediment, stream water, and groundwater to delineate areas of uranium mineralization; research concerning trace element, pyrite, and sulfur distribution in eastern U.S. coals; and various research topics relating to surface water and groundwater quality.

Education:

- Received an A.B. degree in geology from West Georgia College in 1973
- Received an M.S. degree in geology from the University of South Carolina in 1976
- Is currently working toward an M.B.A. degree at the University of Tennessee

Giorgio Gnugnoli

U.S. Nuclear Regulatory Commission

Washington, D.C.

Giorgio Gnugnoli is primarily responsible for generating the NRC's independent analysis of radiological impacts from the airborne effluents from uranium milling facilities. His technical training is in mathematics, and his experience includes mathematical/computer modeling with applications in engineering and statistics. Since joining the Uranium Recovery Licensing Branch (WMUR) in 1978, he has assisted in the preparation and completion of the Generic Environmental Impact Statement on Uranium Milling, the 40 CFR 190 Compliance Assessment for NRC Licensed Uranium Recovery Facilities, and nearly all environmental assessments involving radiological impacts from uranium milling. His activities include technical monitoring and direction of NRC research contracts with the national laboratories, as well as providing mathematical, statistical, computer, and other technical support to the project managers on the staff.

Prior to joining the NRC, he was a faculty member of Georgetown University and Randolph-Macon College, simultaneously subcontracting with consultants to various U.S. government agencies.

Education:

- Received a B.S. degree in mathematics from Georgetown University in 1972
- Received an M.A. degree in mathematics from Georgetown University in 1974
- Completed all course work at Georgetown University for a Ph.D. degree in mathematics in 1976
- Passed Ph.D. comprehensive examinations at Georgetown University in mathematics in 1976

Affiliations:

- Holds membership in The American Mathematical Society (AMS), The Society of Industrial and Applied Mathematics (SIAM), The Mathematical Association of America (MAA), and The American Association of University Professors (AAUP)

Minton J. Kelly

Energy Division

Oak Ridge National Laboratory

Minton Kelly is the manager of the Nuclear Fuel Cycle Projects in the Environmental Impacts Section. He coordinates the preparation of Environmental Assessments and Statements using interdisciplinary groups of specialists chosen by the requirements of each project. His original experience with environmental studies was in 1947-1948 when he supervised collection of chemical, meteorological, and physical data in estuarine Louisiana as part of a long-range ecological study on oyster mortality. From 1968 through early 1971, he worked with an interdisciplinary team whose responsibilities were to develop methods to assess the radiological impact of proposed Plowshare projects. With the passage of the National Environmental Policy Act, he became a member of the original team at Oak Ridge National Laboratory developing impact statement methodology. He also supervised the preparation of Nuclear Reactor Environmental Statements until mid-1974. Kelly accepted his present job assignment in August 1977. His other experiences include (1) supervision of instrument integration for the bottom stage of the initial manned moon rocket; (2) electrical and communications design for the Arabian American Oil Company; and (3) development of instrumentation for chemical kinetic studies, radiation resistant insulators, and equipment for studying postulated breeder reactor accidents.

Education:

- Received a B.S. degree in electrical engineering from Texas A&M University in 1947
- Received an M.S. degree in physical chemistry from Texas A&M University in 1951
- Received a Ph.D degree in physical chemistry from Texas A&M University in 1955

Affiliations:

- Elected a Fellow in the American Institute of Chemists
- Holds membership in Sigma Xi

Larry B. Lamonica

Science Applications, Inc.

Oak Ridge, Tennessee

Larry Lamonica is a chemical engineer with additional training and experience in the areas of nuclear engineering, air pollution control, and water-quality management. He has been responsible for assessing proposed milling processes and for aiding in the preparation of project description, accident, and alternative sections of seven uranium milling and mining projects. Lamonica's contribution to a study on comparative risks of electricity generation with uranium and coal involved definition of a model mine/mill complex and the ensuing definition of source terms based on generic effluent data from this type of facility.

Education:

- Received a B.S. degree in chemical engineering from Brigham Young University in 1977
- Is working toward an M.S. degree in chemical engineering at the University of Tennessee

Samuel C. Martin

Science Applications, Inc.

Oak Ridge, Tennessee

Samuel Martin is an economist specializing in econometrics, environmental impact assessment, program planning, and power system voltage and loading distribution problems. He has been responsible for the preparation of alternative sections for six uranium milling and mining environmental impact statements. In addition, Martin was responsible for updating the socioeconomic sections of the Programmatic Environmental Impact Statement for the Department of Energy's Strategic Petroleum Reserve Program. His duties have also involved the preparation of guidelines to determine unit operations for the High-Temperature Gas-Cooled Reactor Recycle Facility at Oak Ridge National Laboratory.

Education:

- Received a B.S. degree in electrical engineering from Clemson University in 1967
- Received an M.S. degree in industrial management from Clemson University in 1968
- Received an M.A. degree in economics from the University of Tennessee in 1977
- Is working toward a Ph.D degree in economics from the University of Tennessee

Affiliations:

- Holds membership in the Southern Economic Association, Mid-Continent Regional Science Association, South Carolina Academy of Sciences, and Phi Kappa Phi
- Is a registered engineer-in-training in South Carolina

Richard B. McLean
Energy Division
Oak Ridge National Laboratory

Richard McLean is a research staff member in the Energy Division. His technical training is in marine biology with an emphasis in the behavioral components of a marine benthic faunal community. He has authored or coauthored 26 scientific papers dealing mainly with community interaction of selected marine biota and freshwater fish. Previous technical experience includes research at Florida State University and Lerner Marine Laboratory, Bimini, Bahamas, investigating movements, migrations, and orientation of spiny lobsters.

He has participated in ecological surveys of shorelines and reefs at several sites in Florida and the Bahamas. Most recently his research effort has been directed at fish predator-prey dynamics in southeastern reservoirs. Other responsibilities have included being leader of the Environmental Analysis and Assessments Project and being the lead ecologist evaluating environmental impacts on a number of proposed nuclear power plants. He has also testified as an expert witness at a number of Atomic Safety and Licensing Board hearings.

Education:

- Received a B.A. degree in biology from Florida State University in 1968.
- Received a Ph.D. degree in marine biology from Florida State University in 1975.

Affiliations:

- Holds membership in the American Institute of Biological Sciences, the American Society of Zoologists, the Animal Behavior Society, and the Society of the Sigma Xi.

Virginia R. Tolbert
Environmental Sciences Division
Oak Ridge National Laboratory

Virginia Tolbert is in the Aquatic Ecology Section and is actively involved in the Environmental Impacts Program. Before coming to Oak Ridge National Laboratory in 1979, she held an appointment at the University of Tennessee as a postdoctoral fellow. Her research, sponsored by the U.S. Department of Energy, concentrated on the ecological effects of contour surface mining for coal on benthic insect communities. She is also interested in systematics of benthic insects, stream restoration, and environmental impact analysis of energy development on aquatic ecosystems. At Oak Ridge National Laboratory, she has participated in environmental impact assessments of geothermal energy, development; uranium mining and milling; and oil shale development. She has also participated in preparation of environmental report guidelines and environmental guidance for preparing major acquisition projects for the U.S. Department of Energy Division of NEPA Affairs. The research/assessment activities have dealt with aquatic habitats in deserts, grasslands, and deciduous forest ecosystems.

Education:

- Received a B.S. degree in biology from East Tennessee State University in 1970
- Received an M.S. degree in ecology from the University of Tennessee in 1972
- Received a Ph.D. degree in ecology from the University of Tennessee in 1978

Affiliations:

- Holds membership in the Ecological Society of America, the American Council for Reclamation Research, the North American Benthological Society, the Entomological Society of America, the Cambridge Entomological Society, and the Association of Southeastern Biologists

Larry D. Voorhees

Environmental Sciences Division

Oak Ridge National Laboratory

Larry Voorhees, team leader for the nuclear fuel cycle projects in the Environmental Impact Program, joined the laboratory in 1976. In 1975 he was employed by North Dakota State University to coordinate and conduct fauna surveys in western North Dakota to assess the environmental impacts of construction and operation of a surface coal mine and gasification complex. His research has centered primarily on wildlife management. At Oak Ridge National Laboratory, he has participated in environmental impact assessments of biomass plantations; siting, construction, and operation of nuclear power plants; and various phases of the nuclear fuel cycle including uranium mining, ore-buying, milling, and fuel fabrication. The research and/or assessment activities have been in grasslands, deserts, and both coniferous and deciduous forests.

Education:

- Received a B.A. degree in biology from University of Minnesota at Morris in 1970
- Received an M.S. degree in zoology from North Dakota State University in 1972
- Received a Ph.D. degree in zoology from North Dakota State University in 1976

Affiliations:

- Holds membership in the Wildlife Society, the Ecological Society of America, Sigma Xi, and the North Dakota Natural Science Society
- Member of the Committee on Roadside Maintenance of the Transportation Research Board, National Research Council

In addition, the Environmental Statement was reviewed by cognizant members of the Nuclear Materials Safety and Safeguards staff and the NRC legal staff for conformance with NRC policy and regulatory guides.

The NRC Environmental Project Manager who has primary responsibility for all aspects of the proposed project is:

Frank S. Anastasi
U.S. Nuclear Regulatory Commission
Mail Stop 467-SS
Washington, DC 20555

6. LIST OF AGENCIES RECEIVING FINAL ENVIRONMENTAL STATEMENT

The following Federal, State, and local agencies have been sent copies of the Final Environmental Statement:

Department of the Army, Corps of Engineers
Department of Commerce
Department of the Interior
Department of Health and Human Services
Federal Energy Regulatory Commission
Department of Energy
Department of Transportation
Environmental Protection Agency
Department of Agriculture
Advisory Council on Historic Preservation
Department of Housing and Urban Development
Office of the Governor, State of South Dakota
Department of Agriculture, State of South Dakota
Department of Game, Fish, and Parks, State of South Dakota
Department of Water and Natural Resources, State of South Dakota
Sixth District Council of Local Governments, Rapid City, South Dakota
Department of Environmental Protection, State of South Dakota
Bureau of Land Management

Appendix A

COMMENTS ON THE DRAFT ENVIRONMENTAL STATEMENT AND NRC RESPONSES

Appendix A

COMMENTS ON THE DRAFT ENVIRONMENTAL STATEMENT AND NRC RESPONSES

In this appendix, the letters of comment on the Draft Environmental Statement pertaining to the Edgemont project are reproduced in full. The staff responses are printed conveniently close to each comment. Specific comments and responses are keyed by numbers in the margins of the letters and at the beginnings of the corresponding responses. In addition, changes in the text have been made where needed.

Letters of comment were received from the following groups and/or individuals and are reproduced on the page indicated.

United States
Department of
Agriculture

Economics
and Statistics
Service

Washington, D.C.
20250

RESPONSE

September 30, 1981

Mr. Ross A. Scarano, Chief
Uranium Recovery Licensing Branch
Division of Waste Management
U. S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Mr. Scarano:

Thank you for forwarding the Draft Environmental Statement concerning the decommissioning of the Edgemont Uranium Mill, Tennessee Valley Authority, located in Fall River County, South Dakota.

No response is required.

We have reviewed the material on Docket No. 40-1341 and have no comments.

for [signature]
MELVIN L. COTNER
Director, Natural Resource
Economics Division

United States Department of Agriculture

Soil Conservation Service

Federal Building
200 Fourth Street S. W.
Huron, South Dakota 57350

RESPONSE

November 2, 1981

Mr. Ross A. Scarano, Chief
Uranium Recovery Licensing Branch
Division of Waste Management
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Scarano:

This is in response to the draft environmental statement on the plan to decommission the Edgemont Uranium Mill in Fall River County, South Dakota. We have reviewed those aspects of the draft environmental statement that might impact on prime agricultural land in South Dakota. The relocation area is not prime agricultural land, therefore, the proposed actions will have no adverse effects on prime agricultural land.

No response is required.

In consulting with local conservation district officials, it was found that the general consensus was to proceed with project actions, as soon as possible to relieve problems in Edgemont.

This concludes our remarks.

Sincerely,

R. D. Swenson

R. D. Swenson
State Conservationist

cc: Norman A. Berg, Chief, Soil Conservation Service, USDA, Washington, DC.

RESPONSE

United States Department of Agriculture — Forest Service — Rocky Mountain Region — 11177 West 8th, P.O. Box 25127, Lakewood, CO 8

Reply to: 1950

Date: NOV 12 1981

Ross A. Scarano, Chief
Uranium Recovery Licensing Branch
Division of Waste Management
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Scarano:

Thank you for the opportunity to review and comment on the draft Environmental Impact Statement related to the decommissioning of the Edgemont Uranium Mill.

No response is required.

The National Forest System is not directly affected by the Edgemont Mill closure. We, therefore, have no comments. However, the information in the EIS with respect to radiation exposures, geologic environments and groundwater hydrology will be quite useful to us in dealing with various matters pertaining to uranium exploration and mining in the Black Hills.

Sincerely,

for CRAIG W. RUPP
Regional Forester

FS-6200-11 (8-80)

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
REGIONAL/AREA OFFICE
EXECUTIVE TOWER - 1405 CURTIS STREET
DENVER, COLORADO 80202

REGION VIII

October 5, 1981

IN REPLY REFER TO:

8SOQ-906d

RESPONSE

Mr. Ross A. Scarano
Chief
Uranium Recovery Licensing Branch
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Scarano:

Thank you for the opportunity to review and comment on the draft Environmental Impact Statement related to the decommissioning of the Edgemont Uranium Mill, Edgemont, South Dakota.

No response is required.

Your draft has been reviewed with specific consideration for the areas of responsibility assigned to the Department of Housing and Urban Development. The review considered the proposal's compatibility with local and Regional comprehensive planning and impacts on urbanized areas. Within these parameters, this document is adequate for our purposes.

If you have any questions regarding these comments, please contact Mr. Carroll F. Goodwin, Area Environmental Officer, at (FTS) 327-3102.

Sincerely,

Raymond D. McKinney
Director
Program Planning and Evaluation

AREA OFFICE
DENVER, COLORADO

DEPARTMENT OF THE ARMY
OMAHA DISTRICT CORPS OF ENGINEERS
6014 U.S. POST OFFICE AND COURTHOUSE
OMAHA NEBRASKA 68102

RESPONSE

REPLY TO ATTENTION OF

MROPD-M

13 October 1981

Mr. Ross A. Scarano, Chief
Uranium Recovery Licensing Branch
Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Scarano:

We have reviewed the Draft EIS for the decommissioning of the Edgemont Uranium Mill and our comments follow.

The placement of any dredged or fill material in any wetland or other waterway of the United States requires a permit from the Corps of Engineers, according to Section 404 of the Clean Water Act. In the case of Cottonwood Creek, work might be authorized under a Nationwide permit, rather than an individual permit, if certain conditions are met. If any fill in a water body is planned, TVA must apply for a 404 permit by contacting our Regulatory Functions Branch at Box 5, Omaha, Nebraska 68101.

Thank you for this review opportunity. We look forward to reviewing the next report on this project.

Sincerely,

ARVID G. THOMSEN
Chief, Planning Division

The staff concurs.

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

ER 81/2009

NOV 3 1981

Ross A. Scarano, Chief
Uranium Recovery Licensing Branch
Division of Waste Management
Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Scarano:

We have reviewed the draft environmental impact statement for the Decommissioning of the Edgemont Uranium Mill in Fall River County, South Dakota. The Bureau of Land Management is a cooperating agency in the preparation of this statement and other Interior bureaus provided input at early stages of the NEPA process.

Our review of the statement indicates that our previous concerns have been adequately addressed. We agree with the conclusions and recommendations summarized on Pages iii through vii of the EIS. The recommended disposal site (C1) is our preferred alternative for disposal of contaminated material from the Edgemont Mill as are the other selected alternatives A2, B2, D2, E1, and F3 to decontaminate the site.

(1) We suggest that the NRC staff recommendations concerning reconstruction of the Cottonwood Creek stream channel be followed rather than using 10° bank slopes as are mentioned in the EIS. The recommendations outlined by the U.S. Fish and Wildlife Service in its October 27, 1980, letter to NRC should be followed. The reconstructed channel should be meandered and riprap should only be used on meander bends to control erosion. Channel design should include (but not be limited to) within stream structures, bank structures, and pool and riffle areas. The stream banks, rather than being graded to 10° slopes, should be allowed to undercut through the process of natural erosion or by the construction of overhanging bank structures. The stream bank should also be designed to allow for the establishment of overhanging vegetation. The stream bed should be varied rather than have a uniform cross section or substrate.

(2) It is stated that no post-operational ground-water monitoring of the proposed disposal site will be required if operational monitoring during the decommissioning procedures does not detect appreciable seepage to ground water (p. 4-28). Because of the reportedly low permeability involved for the mass of the sedimentary materials, effects of seepage would be greatly delayed. Therefore, the statement should evaluate the migration time for seepage to reach ground-water observation points in terms of the following: (1) the project's operational time frame; (2) the minimum permeability acceptable for the natural materials or liner containing the tailings; and (3) the hydraulic gradients within the tailings as well as in the unconsolidated water-bearing materials downgradient from the site.

(3) If there is an interrelated Federal action associated with this project (i.e., the need to secure a permit from the Corps of Engineers pursuant to Section 404 of the Clean Water Act), the U.S. Fish and Wildlife Service will be required to submit separate evaluation and comments on the permit pursuant to the Fish and Wildlife Coordination Act (16 U.S.C. 661, et. seq.). We would not anticipate a major problem with this project provided our comments and those of the NRC are followed concerning stream reconstruction.

RESPONSE

1. The staff concurs (item d, page v) with the Department of the Interior's position regarding reconstruction of Cottonwood Creek in stating that "the staff, however, considers 10°-bank slopes and plowing and discing along the stream to be undesirable." The staff evaluated the licensee's proposed plan of reconstruction in Sects. 2.2.3.8 and 4.1.7.2 and concluded that the stream should be allowed to be shaped by erosion. The staff, following comments by J. W. Sayler, U.S. Fish and Wildlife Service (Dec. 22, 1980), suggested that instead of the proposed plan that "the stream have meandering bends" and that "the streambanks should be permitted to develop naturally or have structures built that produce undercut banks and other instream flow structures." The licensee's plan to place natural or man-made obstructions within the stream in order to provide diverse habitats and stable, diverse substrate for reestablishment of aquatic communities is supported by the staff.

   The staff concurs with the Department of the Interior that the streambanks should be designed to allow the establishment of overhanging vegetation. The staff believes that the vegetation should help reduce the long-term erosion of the stream margins to minimize sedimentation within the stream.

2. The need for groundwater monitoring at the proposed disposal site can not be fully determined at this time. More information on the geohydrologic characteristics of the site, the depth of impoundment excavation, etc., is needed to determine whether an engineered liner will be required as a control against seepage. Those factors mentioned by the commentor, as well as other considerations, will be taken into account in the staff's evaluation of the need for groundwater monitoring at the disposal site.

3-4. The staff appreciates the assistance and suggestions that the Fish and Wildlife Service have provided throughout the development of this project, and we will continue to coordinate appropriate activities with Fish and Wildlife staff.

RESPONSE

Ross A. Scarano, Chief

(4) Our professional staff is available to provide technical assistance on channel relocation. If this is desired, please contact Mr. C. L. Sowards, U.S. Fish and Wildlife Service Area Manager, P.O. Box 250, Pierre, South Dakota 57501.

Sincerely,

Bruce Blanchard, Director
Environmental Project Review

DEPARTMENT OF HEALTH & HUMAN SERVICES Public Health Service

Food and Drug Administration
Rockville MD 20857

NOV 12 1981

Mr. Ross A. Scarano, Chief
Uranium Recovery Licensing Branch
Division of Waste Management
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Scarano:

The Bureau of Radiological Health staff have reviewed the health aspects of the Draft Environmental Statement (DES) (NUREG-0846) related to the decommissioning of the TVA's Edgemont Uranium Mill (Docket No. 40-1341) and have the following comments to offer:

1. The applicant's proposal appears to meet the performance objectives for decommissioning and tailings management such that it provides adequate assurance that the potential individual radiation doses will meet current radiation protection standards upon completion of the decommissioning operations.

2. The environmental exposure pathways presented in Section 4.1.9, Radiological Assessment, and Figure 4.1, page 4-18, cover all the potential radioactive emission pathways that could result in exposure to individuals and local populations in the environs. The dose computational methodology and models in Appendix C used in the estimation of the radiation dose to individuals and dose commitments to populations within 1.6 km. (1 mile) of the mill site have provided reasonable estimates of the doses resulting from decommissioning operations. Table 4.10 presents the predicted annual dose commitments to individuals in the vicinity of the Edgemont site, and Table 4.11 compares the dose commitment with the NRC radiation protection standards and with background radiation estimates. Since the object of the decommissioning project is to reduce individual and population exposures, the dose reduction factors are equally as important as the fractions presented. It would be helpful, from a health effects standpoint, if Section 4.1.9.4 could be expanded to discuss the reductions and indicate the cost/benefit as related to the individual dose. The dose reduction factors based on the totals for all pathways for the four selected locations for whole body, bone, lung and bronchial epithelium are about 5, 22, 11 and 350, respectively. Table 4.13 presents the predicted annual environmental dose commitments to local populations within a 1.6 km. radius of the mill site. The dose reduction factors based on the totals for all pathways for the whole body, bone, lung and bronchial epithelium as a result of the decommissioning operation are 175, 190, 177 and 352, respectively. The dose reduction factors should also be discussed in Section 4.1.9.5 and the text expanded to indicate the cost/benefit as it relates to population dose.

As an alternative, Section 4.9.3 could be used to present a cost/benefit analysis of the individual and population doses.

RESPONSE

1. No response is required.

2. The major purpose of the radiological assessment is to predict the radiologic impacts from decommissioning activities and to compare these projected impacts with applicable NRC radiation protection standards. Table 4.10 does not show existing doses to the population but compares projected doses from decommissioning activities with projected doses following reclamation and completion of the project. The staff's evaluation of the radiological impacts shows that all the project activities can be carried out in a manner that will result in keeping radiation doses to the public within NRC standards. The staff has not attempted to quantitatively justify the project on the basis of health effects.

3. The radiological monitoring program is not included in this DES. The applicant will develop a comprehensive environmental monitoring program and it will be included in the Final Environmental Statement (FES). We will forego commenting on the scope of the environmental monitoring program, presuming that the monitoring program given in the FES will be reasonable. It is recognized that such a program should provide the key elements needed to assure public health and safety during the decommissioning operation.

4. The discussion in Section 4.3 on mitigation measures is considered to be an adequate assessment of the potential radiation exposure pathways. However, it would be helpful if some guidance could be provided on alert levels for radioactivity in the air, surface water, and ground water that would require the applicant to determine the cause and provide a plan for mitigation of the radioactivity levels in environmental media.

Thank you for the opportunity to review and comment on this Draft Environmental Statement.

Sincerely yours,

John C. Villforth
Director
Bureau of Radiological Health

RESPONSE

3. The radiological monitoring program is presented in Sect. 4.2.2 of the FES.

4. Because of the sporadic nature of releases from a large earth-moving operation such as this decommissioning, it is more appropriate to provide for ongoing monitoring rather than setting alert levels. TVA will be required to conduct periodic audits of monitoring data to determine if (1) releases are as low as reasonably achievable, (2) mitigative measures are effective, and (3) project impacts are within ranges predicted in the FES.

Based on the findings of these audits, any corrective action that is necessary will be taken and documented accordingly. The NRC staff will independently review all monitoring data and documentation on a semiannual basis.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION VIII
1860 LINCOLN STREET
DENVER, COLORADO 80295

NOV 27 1981

REF: 8AH-R

Mr. Ross Scarano
Uranium Recovery Licensing Branch
Division of Waste Management
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Scarano:

In fulfillment of our responsibilities under Section 309 of the Clean Air Act, enclosed are the comments by the Region VIII Office and its contributors within the Environmental Protection Agency on the Draft Environmental Statement (DES) (NUREG-0846) for the decommissioning of the Edgemont Uranium Mill by the Tennessee Valley Authority.

We have a number of reservations concerning this DES. There is no information on a radiological monitoring system, on the quality of groundwater at the proposed disposal site, on the extent of soil contamination around and beneath the existing tailings pile, on the criteria by which contamination will be defined, on the levels to which decontamination will be pursued, or on the criteria by which emissions controls will be required for the various processes. The consequences of these omissions are evident in the DES. For example, due to the lack of information on the extent of contamination, the definition of contamination, and the extent to which the area will be decontaminated, there is no firm estimate of the quantity of material which will require disposal. "The staff feels that the estimated volumes may be too large, especially those for contaminated subsoils, and that further studies and decommissioning project operating experience may lead to some reduction in these estimates." Hence, although costs are briefly mentioned for a few of the alternatives, the cost-benefit analysis which is an integral part of an adequate environmental statement could not be prepared due to lack of data.

The major health risk associated with the Edgemont Uranium Mill is the use of mill tailings in and around dwellings of Edgemont. Yet no evaluation of this situation is included while the clean up of wind blown tailings to the east of the mill is, for example, addressed. This is an apparent contradiction in decommissioning policy and in the remedial action goal - the protection of public health.

RESPONSE

Because of the conceptual nature of much of TVA's proposal, it was not possible to present all the details of every element of the project in the DES. The FES contains much more information concerning monitoring programs, existing groundwater quality, and methods for determining the extent of contamination and cleanup levels for removal of contaminated soils.

Cleanup of tailings in and around dwellings in Edgemont is not within the scope of this Statement. This Statement deals only with the proposed licensing action for decommissioning the TVA mill. Part of the decommissioning action is cleanup of windblown tailings around the mill site. The Edgemont Cleanup Action Program, jointly sponsored by the NRC, Battelle Pacific Northwest Laboratory, and the State of South Dakota, is involved with identifying structures in the town which have been contaminated and determining the need for remedial action. This work is not related to the proposed decommissioning and is beyond the scope of this FES.

We rate the Edgemont decommissioning DES in Category 3-Inadequate. This means that the DES does not adequately assess the environmental situation surrounding the proposed action. Accordingly we cannot make a determination concerning the environmental impact of the decommissioning action. Our detailed comments are attached. In general we feel the remedial action at this site should be compatible with the remedial actions planned at the inactive uranium milling sites which were addressed by the Uranium Mill Tailings Radiation Control Act of 1978. Should you have any questions concerning these comments, please contact Mr. John Giedt at FTS-327-6008.

Sincerely,

Steven J. Durham
Regional Administrator

RESPONSE

NRC staff has met with EPA Headquarters and Region VIII staff to discuss EPA's specific concerns. Based on changes to the FES and our responses to this letter which were reviewed in detail with EPA staff, we feel this FES will resolve EPA's concerns with the project.

REF: 8AH-R

RESPONSE

EPA REGION VIII
SPECIFIC COMMENTS ON
DECOMMISSIONING DES
(NUREG 0846)
TVA EDGEMONT URANIUM MILL

1. Page 1-3 - Table 1.1 This table states that a PSD permit might be needed from EPA Region VIII. Because this operation will consist of almost all fugitive emissions, the current PSD regulations will not require a permit for the operation. However, a general concern about the draft document is the lack of dust control practices for the six months each year that operations will cease. Wind blown emissions from disturbed areas will be very significant unless emission control practices are implemented. A plan should be developed that includes such items as spraying stabilizing compounds on some areas, restricting vehicular movement, watering areas where the soil will form a crust, etc. Water trucks should be frequently used on temporary roads that are used by heavy equipment.

1. Reference to the PSD regulations has been removed from Table 1.1. Methods to control fugitive dust are discussed in Sect. 4.3.1. Complying with all mitigation measures specified and recommended in Sect. 4.3 is proposed as a condition of the license (DES, p. vi). In addition, there is a specific license condition (FES, p.vii) that will require a formal interim stabilization program to control dusting during all phases of decommissioning, including the approximate six-month inactive period each year. This program will require periodic documented inspections and monitoring to confirm the adequacy of the stabilization methods being implemented.

2. Page 2-1 Section 2.2.1.2. This section states that NRC will determine decontamination limits as the project progresses because a final determination of what limits are achievable will only be possible at some locations when the tailings are removed. Why cannot cores be taken to determine the extent of soil contamination? The document does not present a clear picture of what sort of criteria might be used in determining how much of the site's topsoil will be removed as part of the cleanup. The possibility of instituting land use controls is mentioned here in passing but is not discussed.

The fact that these items and several others throughout the DES are not defined (or even discussed) precludes meaningful comment on them by EPA.

2. Some boring has been done to determine the extent of contamination. Much more detailed site characterization, which is needed before final decisions are reached concerning the amount of contaminated soils which will require removal, will be performed once TVA is authorized to initiate decommissioning operations. However, as the document states, "final determination will not be feasible at some locations until tailings are removed from the site."

Section 2.2.1.2 describes proposed cleanup levels for removal of residual contamination at the mill site and possible land use restrictions.

3. Page 2-7 Impoundment dike construction and page 2-36 Alternative E-1. The use of native clays must be suspect due to the possible presence of humate materials and the questionable behavior of clays in an acid environment. What analyses are planned for this possibility?

3. Clays with organic materials are unsuitable for the construction of a liner. Analyses of clays in an acid environment have been reported in the literature, with varying results. TVA will be required to perform tests with acidic effluent on clays to be used in the dike construction to ensure that the material is suitable. Dewatering of the tailings and strict quality control regarding liner material selection and placement will also be required.

4. Page 2-10 Haul road construction. The underpass/overpass system alluded to for routing public traffic around the haul road seems extravagant. The need for such a design should be discussed in more detail, with regard to anticipated traffic volumes and accident potentials.

5. Page 2-10 Haul road operation. The commitment for minimizing emissions from the haul road operation appears non-existent. The document says that dust control activities will be performed as needed. What type of criteria will be used to decide when and how to apply emission control practices?

6. Page 2-10 Slurry pipeline construction. The slurry pipeline and return line location in the road divider ditch are subject to vehicle damage because of their elevation and proximity to haul road. While we understand the rupture containment aspects of the ditch, it is suggested that the haul road divider be elevated above the road bed to carry the pipelines. This would protect the lines from vehicle damage. It would also make line repairs easier because the lines would most likely be immersed in tailings and dirt or standing water in the trench in the event of a rupture. We feel a discussion of these options would be appropriate in the FES.

7. Page 2-10 Section 2.2.2.3 Mill site decommissioning. This section calls for a detailed field study to determine levels of contamination, areas for cleanup, and quantities of waste. This should have been the first step in decommissioning planning. Why was the survey not completed earlier so that the resulting data could be included in the DES? This information definitely is needed in the Final Environmental Statement (FES).

   Monitoring procedures and the results of the Cheyenne River water and sediment analysis are needed in the FES, especially for downstream locations. Other literature indicates that a dam break released 200 tons of tailings into the river in 1962. Since then, other tailings or leachate have certainly entered this drinking water source, requiring detailed analysis. The information is also needed to determine the effect on the river of the site restoration.

RESPONSE

4. An underpass for the one public road intersected by the haul road, which is proposed by TVA, would help to ensure public safety and reduce the potential for accidents.

5. Contaminated materials in trucks will be sprayed with a suitable material, or trucks will be covered, as necessary, to prevent airborne dispersion of contaminated materials. Noncontaminated water will be used for dust control on roads. Section 4.3.1 describes the criteria to be used to decide when and how to apply emission control practices, and this will be a condition of the proposed licensing action. Dust control on the haul roads will be one of the many areas to be covered by the stabilization program discussed above.

6. See response to EPA comment 10a-d. In addition, the staff does not feel that elevating the pipelines will decrease the potential for pipeline rupture from vehicle damage. Also, we feel that in case of pipeline rupture, it is more beneficial to have the material contained in a ditch.

7. This work will be carried out and the data reviewed by the NRC prior to approval of final plans for removal of contaminated soil from the site. Section 2.2.1.2 describes cleanup plans and proposed cleanup levels for removal of residual contamination. The staff does not feel that detailed information on actual contamination levels is necessary prior to approval of the proposed decommissioning action.

   Monitoring programs for surface water and sediments, as discussed in Sect. 4.2 of this FES, have been designed to determine the effect of the decommissioning project on the Cheyenne River.

It appears that offsite wind-blown tailings will be returned to the pile, and that Cottonwood Community and Cottonwood Creek are to be cleaned up. However no mention is made of clean up of the tailings used within the Edgemont community. There does not appear to be any rationale for this ommission. Since the predominant health risk is associated with the use of tailings in some Edgemont dwellings, justification for the lack of corrective action is needed in the FES. Perhaps a voluntary action by TVA would be appropriate. Actual cost of such clean up would be an insignificant fractional increase to the overall decommissioning expense. A cost benefit analysis for the Edgemont clean up is warranted in the FES.

Additionally, we feel it appropriate that a discussion be presented in the FES which explains the recent Congressional action authorizing NRC to clean up the Edgemont Mill vicinity property and dwellings, and a further explanation as to why NRC has not carried out the clean up. Ignoring the residential contamination of Edgemont leaves unresolved the major and most controversial issue of the site, and hence leaves the document incomplete. To date, NRC has not provided us with an adequate description of its perceived responsibilities under this Congressional action. From both the above stated health risk concern, and from the stand point of logistics, we cannot understand how this issue, which is so directly associated with the mill, can be disassociated from the decommissioning plan. Since the wastes developed in the necessary cleaning up of the Edgemont area must be returned to the millsite and disposed of with other tailings, discussion of the Edgemont clean up issue needs to be included in the FES.

8. <u>Page 2-13 Dismantling.</u> This section states that all nonsalvageable materials and equipment will be buried in the impoundment area. If such articles are not placed very carefully, they could jeopardize the integrity of the impoundment liner. What plans have been made to avoid impoundment liner penetration?

9. <u>Page 2-13 Section 2.2.2.4</u>. This section states that further studies may lead to some reduction in the estimated quantities of material to be removed and disposed. To what studies does this refer and what criterion will be used to determine whether the soil, etc. is contaminated?

10. <u>Page 2-16 to 2-18 Removal by slurry pipeline.</u> The use of a slurry pipeline has the following negative aspects which should be discussed:

    a. Any breakage and/or mechanical failure shuts down the transport system. A vehicle failure only shuts down a fraction of the transport system.

RESPONSE

The cleanup of residential properties which may have been contaminated with tailings is the subject of separate NRC involvement and Congressional action and is not within the scope of the proposed action. The NRC is not ignoring the situation, but remedial action for city dwellings is not germane to the decommissioning of the mill site, and a discussion of recent Congressional action pertaining to that issue is not warranted in this FES. In addition, Congress did not authorize NRC to clean up the Edgemont vicinity properties and dwellings, but rather authorized NRC to conduct radiological surveys and engineering assessments and propose remedial actions as warranted.

8. If a clay liner must be used, it is important that the liner be kept intact. The liner would be compatible not only with impoundment fluids to ensure against cracking, but any materials put into the impoundment area would be placed in such a way as to ensure that the liner be protected. TVA will be required to develop procedures that will control what goes into the impoundment and how it is placed.

9. Detailed site characterization must be completed before more accurate estimates can be developed. See Sect. 2.2.2.4 for a discussion of the approach that will be taken to determine what soils will require removal.

10a-d. Slurry pipeline systems are a proven, dependable technology used for many years in mining operations. The advantages of the slurry system include 24-h operation, less cost (trucking – $1.40–$1.90 per ton, slurry pipeline – $1.10–$1.50 per ton), much less chance for windblown contamination of tailing sands, and better compaction at the disposal site. Because both truck and slurry transport will be used simultaneously, any shutdown of the slurry system will only temporarily decrease the total amount of materials moved. A pipeline rupture will be contained in the ditch, and the line will be readily accessible for repairs. The slurry system requires only one handling of the material. Materials transported by truck must be spread at the disposal site and thus handled twice. Personnel that would operate the slurry system exclusively comprise a small fraction of the total work force. Savings in transportation cost and the advantage of 24-h operation outweigh any loss of productivity due to downtime of the system.

b. The slurry system will require at least two and possibly three material handlings (i.e. load and slurry, dewater and dump and distribute.) Scraper or truck hauling will only require one or two material handlings.

c. It appears that 10% of the total volumes of pond 2, AEC pile and area B are considered to be cover (Table 2.2 DES) and not amenable for pipeline transport, and that the safety factor yardage is also not amenable for slurry transport. This would account for 1/2 of the waste volume that will have to be hauled to the disposal area, making vehicle hauling of the wastes more attractive.

d. The operation of both hauling equipment and pipeline transport will require two separate work disciplines that probably cannot be interchanged to take advantage of slack periods.

e. Standing water in the disposal impoundment area will render the tailings plastic, and complicate the plating process (clean cover material placed over tailings) because of conflicts with materials hauled from the millsite. We are skeptical of when (if at all) the tailings beach wll be sufficiently firm to allow truck traffic of hauled wastes. If performed prematurely, the loaded vehicles may bog down and possibly squeeze the tailings into the plate. (The Mexican Hat tailings will not support wheeled vehicles in many places and rip-rap placed on top of the Shiprock tailings pile has sunk into the tailings.)

If cover material is not to be placed before disposal of hauled wastes, the plastic nature of slurried wastes may still present incompatible conditions between the two processes. The process described shows little difference from the slurry impoundment of an active mill's residue. We are unaware of documented haulage experience from such lined impoundment beach areas.

f. From a radiological standpoint, it would be preferable to place the slimes on the bottom of the disposal area impoundment because they contain more of the radioactivity per unit weight than the process sands. When slurrying, the sands tend to settle out first, forcing the slimes toward the top of the pile. Hauling the tailings should permit some segregation of sands and slimes in the disposal area. This could allow the use of the sands to form the primary barrier against radon diffusion and potentially reduce the amount of final cover needed.

RESPONSE

10e. Interior drains for removal of excess water to an evaporation pond will accelerate dewatering and drying of the tailings. TVA will be required to submit plans for dewatering the tailings to the NRC for review and approval.

10f. Segregation of sands and slimes will be necessary to ensure that slimes are not slurried, and TVA proposes to slurry only sands which would dewater faster. Although placing slimes in the bottom would have the advantage mentioned, the disadvantage of instability and the possibility of re-wetting the slimes makes this option unattractive. Detailed engineering plans for tailings placement will be reviewed by NRC staff before approval is given, and these factors will be addressed.

g. Due to the above concerns regarding the slurry procedure, we feel a mechanical dewatering option should be included for the new waste site.

11. Page 2-17 Figure 2-10. It would appear that the haul road and slurry line construction cannot be conducted concurrently unless another access road to the disposal site is constructed. Also, it appears that land decontamination other than the tailings piles is not included in the schedule. Since it will require a significant effort and time to accomplish, it should be listed as a separate topic.

12. Page 2-18 Treatment of slimes. We concur with the NRC recommendation that the slimes be recovered simultaneously with the slurry transport of sands (should this be the method used) in order to lower the amount of well water required as makeup in the slurry system.

13. Page 2-21 Removal by truck. The control practice to minimize contaminated material in the trucks by wetting down with water or crusting material is appropriate. However, again there does not appear to be a firm commitment, because the report says "may be" and not will be or should be. We assume that the water drawn from the onsite well is not contaminated. If it were, it would not be wise to use it to suppress fugitive dusts from the road.

14. Page 2-21 Section 2.2.2.5. The benefits that would be gained by diverting and cleaning up Cottonwood Creek may not be fully realized because recharging of the creek occurs with water flowing under the millsite. The recharge water is apt to carry contaminants into the stream for a number of years. It is also not clear as to whether some groundwater clean up will be instituted. For instance, are contaminants from the mill presently entering the Cheyenne River via the groundwater path? If so, what will be done to reduce the flux of contaminants in the short term?

15. Page 2-23 Section 2.2.2.7. It is not clear as to whether the applicant intends to place cover material over the old mill tailing area during decommissioning of the site and whether the cover might be compacted to reduce water flow through the contaminated soil which is not removed. If the entire pond area and tailings area are to be ripped prior to revegetation, it would seem advisable to make a determination as to whether this would increase the amount of recharge to the shallow ground water systems. If increased recharge is

RESPONSE

10g. See response to 10e.

11. The haul road and slurry line construction will be completed within the time frame indicated. Completion of a segment of the haul road will allow the slurry line to be constructed on that completed segment, thus allowing simultaneous work on the road and pipeline to be carried out. Removal of contaminated soil will take place within the time frame for tailings removal.

12. No response is required.

13. The information referred to is in Sect. 2.2.2, "Licensee's proposed plan," hence the wording "may be." Section 2.2.3, "Staff's evaluation of the applicant's proposal and other alternatives," states that contaminated materials in the trucks will be sprayed with a suitable material to prevent airborne dispersion of contaminated particles during transport (DES, p. 2-41). This statement has also been included in Sect. 4.3.1. Item 5b of the Summary and Conclusions (FES, p. vi) proposes that the licensee be required to comply with the mitigation measures specified and recommended in Sect. 4.3.
Water from the onsite well is drawn from an uncontaminated confined aquifer. Therefore, use of water from the onsite well to control dust from the contaminated material on the trucks and from the haulroads is considered to be acceptable.

14. Full benefits of diverting and cleaning up Cottonwood Creek indeed may not be realized because of those concerns expressed. There are no plans to clean up the existing alluvial aquifer. Contaminants from the mill may presently be entering the Cheyenne River; however, dilution in the river has kept concentrations low enough to be no cause for concern. The EPA's 1973 environmental evaluation of the Edgemont site concluded that sediment samples from the Cheyenne River and Angostura Reservoir contained background levels of contaminants and that water quality of these surface waters was not impacted by the tailings. Increased recharge would be from precipitation of a fairly neutral pH which would not cause significant leaching of contaminants.

15. As stated in the DES, the amount of soil that will be required to be removed beneath the tailings disposal site is uncertain. Therefore, at this time, it is not known whether cover materials will be required at the site. The staff believes that during decommissioning the amount of recharge to the shallow groundwater system may increase but does not necessarily deduce that the concentration of contaminants reaching Cottonwood Creek will increase. In addition, it should be noted that current plans call for decommissioning the mill site for industrial use.

possible, will there be a short term water quality impact on the Cheyenne River caused by increased ground water flux into the River. Considering the fact that one of TVA's objectives is to reclaim the mill site for livestock forage, it is imperative that decontamination operations have a definite numerical goal-especially for those elements which are likely to be concentrated in forage plants.

16. Page 2-24 Section 2.2.2.8. How long is it expected to take for evaporation to remove the slurry water from the tailings impoundment and pond 10?

17. Page 2-26 Section 2.2.3 Staff Evaluation. As stated previously, we presume that the goals for reclaiming the millsite are, in general, to reduce the human and environmental impacts. The most significant human impact from the millsite is acknowledged to originate from radon daughter products (0.01 cases of lung cancer per year for the Edgemont population FBDU-78.) The expenditure of $20M-30M to avoid one potential lung cancer case in 100 years (assuming a stable population) has not been well justified. Further discussion is needed as to whether or not the tailings can be contained and isolated from the biosphere on site. Can the millsite be decontaminated at a reasonable cost to allow unrestricted use of the area? A discussion is needed which justifies the added expense of moving the contaminants to another area which will also have restricted use. Due to our experience with the site, and the lack of data in the DES, we have reservations as to whether the site can be, or should be decontaminated and the tailings relocated.

18. Page 2-38 Alternative F-2. Discussion is presented stating that chemical sealants and water sprays would be applied to the haul road to control emissions. The effectiveness of this technique will depend on the chemical stabilizer type, amount and frequency used, and the water truck frequency. A plan describing the procedures and frequency to be used should be prepared, presented, and followed. The plan should also include how decisions will be made to deviate from the regualr schedule when weather conditions decrease or increase the potential for emissions. Records should be kept on the rate and frequency of application.

19. Page 2-38 Alternative F-5. Would it not be more economical to construct a spur into the tailings site, and eliminate the need for double handling (truck, rail) at the front end?

RESPONSE

16. Net evaporation in the Edgemont area is about 0.9 m (3 ft) per year. Maximum depth of pond 10 is 2.4 m (8 ft). After the diversion ditch and other extraneous sources of input are eliminated, the pond should evaporate in less than three years. Methods of enhancing the evaporation rate will be considered.

17. In 1978, TVA's NRC license was amended to require TVA to submit a proposal for decommissioning the site which would meet the NRC performance objectives for tailings management and guidelines for facility decontamination. In this FES, the staff evaluates the alternatives proposed by the licensee as well as alternatives developed by the staff against the NRC performance objectives for tailings management and guidelines for facility decontamination. The purpose of this evaluation is to (1) determine the adequacy of the licensee's preferred alternative, (2) determine whether other alternatives proposed either by the licensee or staff are environmentally superior to the preferred alternative, and (3) if superior alternatives are identified, determine if the additional costs associated with these superior alternatives are warranted. The staff's evaluation of TVA's preferred alternative, which provides for offsite disposal of tailings, has concluded that the plan satisfies the NRC performance objectives for tailings management and guidelines for facility decontamination and that no other alternatives are superior from an environmental standpoint. Because of the social impacts on the town of Edgemont resulting from the close proximity of the tailings and the use of tailings as fill material in the town, TVA has voluntarily committed to move the tailings and to move forward promptly with the cleanup plan once NRC approval is obtained.

18. General plans to minimize fugitive dust emissions are presented in Sect. 4.3.1. Subsequent to issuance of the DES, the licensee has committed to recording the dates that dust control measures are used and reporting them with the results of the monthly hi-vol samples. To improve the usefulness of the monitoring and mitigation efforts, TSP monitoring results will be made available to the director of the decommissioning operations as soon as possible. This will be especially important during dry periods with high winds, not only to determine the effectiveness of mitigation measures but also to give an additional indication of when dust control measures are needed. This concept has been included in Sect. 4.3.1. In addition, the stabilization program discussed previously will require periodic inspections to document the effectiveness of dusting controls.

19. The staff does not understand the comment and does not feel that it needs to be pursued since the preferred alternative does not involve rail transport.

20. Page 2-40 Siting and design. This section states that there are over 500 feet of impermeable shales beneath the proposed impoundment site. Would a subgrade disposal not be possible at this site? Considering the fact that a subgrade disposal would not require construction of a dike, what additional expense beyond that associated with the partially below grade disposal option would a subgrade impoundment require?

21. Page 2-40 Root and animal penetration. The size of the cover materials (rip rap) is directly related to the size of the burrowing animals that the cover will discourage. Will such a sizing of materials be accomplished?

22. Page 2-41 First full paragraph. Given the fact that acid often has an adverse impact on the integrity of clay liners, there should be an analysis as to whether low pH leachate could cause fractures to open sufficiently to allow movement into the underlying aquifer. There should be consideration given to requiring some neutralization of the tailings as they are being deposited at the disposal site.

23. Page 2-41 Elimination of blowing tailings during operation. Will the partially dried out tailings be able to support the heavy equipment necessary to spread cover material immediately after a sufficient area of deposited tailings reaches final grade?

24. Page 3-35 Proposed Disposal Site. It is hard to imagine how the planning for the disposal impoundment can be finalized without any ground water data. At least one of the soil test holes should have been drilled to the water table. There should also be an analysis of the extent of fracturing in the shales underlying the site to determine if seepage from the impoundment could enter a bedrock aquifer.

25. Page 4-2 Section 4.1.2. What are the determined original radiological environments at the present site and the proposed disposal site?

26. Page 4-2, 4-24, and 4-33. This section states that the ambient air quality monitors will be used to determine if the dust mitigative measures are adequate or if additional procedures should be implemented. A much more effective and immediate evaluation tool is to increase dust control practices whenever visible emissions are observed, and when vehicles are using the roads or wind causes visible emissions from disturbed areas.

RESPONSE

20. Construction of a subgrade impoundment at the proposed site would increase the costs disproportionately with respect to the benefits to be gained and therefore was not given further consideration.

21. The tailings will be covered by a minimum of 1 m (3 ft) of compacted clay and 2.1 m (7 ft) of overburden. Plant species proposed for reclamation (Sects. 2.2.2.9 and 2.2.3.8) have relatively shallow roots and should not penetrate the tailings. Most wildlife burrows are also relatively shallow, although black-tailed prairie dogs (*Cynomys ludovicianus*) have been known to burrow to a depth of 4.4 m (14.5 ft) (W. B. Davis, *The Mammals of Texas*, Texas Game and Fish Commission, Bulletin No. 27, Austin, Tex., 1960). However, it is not expected that prairie dogs will easily penetrate compacted clay.

22. TVA will be required to perform tests on any clay to be used as liner material to ensure that the effluent will not affect its permeability. It should be noted that the pH of the effluent will not be as low as that from a typical mill circuit. In addition, the shale in the impoundment's foundation is sufficiently thick to buffer the pH naturally. Carbonate minerals are major constituents of most shales, and even the clay minerals have some buffering capacity.

23. Sandy tailings are expected to support heavy equipment soon after reaching final grade.

24. The staff does not believe that the quality of groundwater at the proposed disposal site will significantly affect the design of the impoundment. A preliminary geotechnical study was performed at the site which included water-pressure in situ permeability tests (see Sect. 3.7.1.2 and Figs. 3.10 and 3.11). These tests indicated permeabilities on the order of 10^{-7} cm/s.

TVA will be required to perform a hydrogeological analysis to ensure that the shales underlying the site are not significantly fractured and to determine appropriate measures to prevent seepage from the impoundment.

25. It is assumed that prior to construction and operation of the Edgemont Uranium Mill, the site exhibited radiological characteristics similar to other natural alluvial plains in the area, with background gamma radiation levels on the order of about 13 μR/h. Regarding the disposal site, one might assume a slightly higher background due to the presence of shales; however, preoperational monitoring, as detailed in Sect. 4.2, will provide more site specific information.

26. The staff concurs (see Sect. 4.3.1).

27. Page 4-23 Section 4.2. This section states that the monitoring programs will be prepared for inclusion in the FES. All such items should have been discussed in detail in the DES in order that the reviewing agencies might be able to provide helpful comments.

28. Page 4-25 Section 4.2.5. Will NRC prepare any documents on which others may comment relative to its preliminary decision on any land use restrictions?

29. Page 4-32 Section 4.5.5. The assessment of the impact of accidental injury or death to persons decontaminating the millsite is not fully evaluated. The risks of accidental injury and death to all persons involved with the work should be assessed and included in the cost/risk benefit assessment of the work.

30. Page 4-35 Section 4.6.8. The socio-economic impact is not fully addressed in the DES. It is quite possible that pursuit of the proposed remedial actions could impose a cost in the range of $22M-30M 1981 dollars. It appears that this cost, under the present plans, will have to be passed on to the TVA customers. Similarly, it is likely that tax revenues generated by this project will not compensate the community for the associated municipal costs. Considering the fact that much of the Edgemont mill's product was used for defense related purposes, should not consideration be made of DOD or DOE participating financially in the cleanup?

31. Page 4-36 Section 4.9.1. This section states that a review of the specific site-related benefits and costs of long term disposal at the Edgemont site is appropriate. Has such an analysis been made?

RESPONSE

27. Because of the conceptual nature of the proposal, specific monitoring programs had not been developed in time for inclusion in the DES. Finalized monitoring plans are included in the FES, however.

28. No, but resolution of this matter will involve local and State officials.

29. The risks of accidental injury or death due to the major activity at the site decommissioning — transportation — has been addressed in Sect. 4.5.5. Other possible accidents would be similar to any other construction-type operation. In 1980 there were 6.8 incidences per 100 worker years. This rate translates to less than four incidences of lost-time injury per year at Edgemont. One percent of these injuries may result in death; thus, the death rate is not more than 0.04 per year.

30. TVA is seeking monetary assistance from other Federal agencies for the mill cleanup. Also see response to TVA comment 3d on Sect. 4.

31. This analysis is discussed in Sects. 4.9.2 through 4.9.4.

RESPONSE

Department of Energy
Washington, D.C. 20585

MAR 1 1982

Mr. Samuel J. Chilk, Secretary
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Chilk:

NUREG-0846 entitled "Draft Environmental Statement Related to the Decommissioning of the Edgemont Uranium Mill" has been reviewed by the Department of Energy as requested.

The proposed Edgemont decommissioning action, which involves the movement of tailings, could establish a precedent for remedial actions concerning the Department's cleanup activities at inactive uranium processing sites as mandated by Public Law 95-604, the Uranium Mill Tailings Radiation Control Act of 1978, and also establish a convention for future decommissioning operations for licensed mill sites and for commingled mill tailings sites. Such a cleanup alternative would substantially increase the Department's cost/resources and the private sector's remedial action activities without resulting in significant environmental quality and health and safety benefits.

In accordance with Public Law 96-540, the Department's FY 1981-1982 Authorization for National Security Programs, the Department is currently evaluating the extent to which the Federal Government should apportion and share in the cleanup costs for commingled tailings pile sites which include the Edgemont site. Future Federal contributions to such cleanup activities could also be significantly increased if tailings piles have to be moved from their present locations. Consequently, the draft statement has been subjected to an in-depth staff review because of its potential impact on the Department's programmatic policies, remedial action implementation requirements, and cleanup activities.

One major finding is that the draft statement does not provide adequate technical justification to support the proposed action of moving the tailings from the Edgemont site. Clearer correlations between costs and benefits for the alternatives considered are needed. Comparative risk analyses should also be discussed in more detail in Section 4.9 of the statement to establish the basis for the proposed action while permitting the reader to make an informed choice among the alternatives considered. Consideration should be given to the alternative of in situ stabilization of the tailings. If the more extensive option of relocation of the tailings is selected on any basis other than health and environmental benefits, then that basis should be made unambiguously explicit in the draft statement. For completeness, the draft statement should also speak to the feasibility, environmental impacts, and cost of removal of radioactive constituents by in situ or other extraction techniques.

The NRC is not attempting to establish a precedent for offsite disposal of tailings in the cases of inactive sites designated for remedial action. However, in response to this concern, the staff met with the Department of Energy, the Environmental Protection Agency, and others to discuss the issue. Several sections of the FES have been revised to include mutually agreed upon language that clearly points out the distinction between the Edgemont Decommissioning Project and the DOE/EPA Remedial Action Projects at inactive sites.

As presented in the FES, the approval of the TVA's decommissioning plan is a specific licensing action: the licensee submitted a proposal for decommissioning the mill site and tailings areas, and the staff has evaluated the proposal for conformance with applicable performance objectives. The licensee's proposal was aimed toward removing the tailings from adjacent to the town of Edgemont and the Cheyenne River to a more remote location for disposal, and the staff found this to be acceptable. In evaluating the proposal, the staff looked at various alternatives and found none superior to TVA's plan. The staff's role on this licensing action was not to find technical justification for moving the tailings or for onsite stabilization, it was to ensure that the decommissioning project was carried out in a manner consistent with current licensing policy and health and safety practices.

The Department's comments, delineated in the three enclosures, were prepared by the Office of Operational Safety. Questions on this matter should be referred to Dr. William E. Mott (301-353-3016).

Sincerely,

William A. Vaughan
Assistant Secretary
Environmental Protection, Safety,
and Emergency Preparedness

3 Enclosures

General Comments on NUREG-0846

1. The draft statement discusses the relevant issues in general terms and dwells on secondary topics in detail, e.g., microorganisms in the local waters, techniques and seeding requirements for cultivating relatively small areas of rangeland rather than addressing health benefits that will accrue to the regional public by effecting the proposed action which is the primary concern.

2. The proposed action is not substantially supported by technical data. The results of the action will be peripheral to long-term objectives. Transporting on the order of 4.1 million tons of tailings material--in addition to unspecified quantities of cover material and sediments from Cottonwood Creek and the Cheyenne River--a distance of about two miles to questionably isolate the equivalent of about 35 pounds of contained radium residues, at a cost which is not even estimated in the text, is not readily understandable. A low estimate by the staff for the proposed undertaking is about 30 million dollars based upon prior related Ford, Bacon, and Davis, Utah, Inc., estimates. The anticipated cost per perceived benefit derived is extremely high in our view, i.e., on the order of millions of dollars per health effect benefit. Costs of alternatives discussed should be presented.

3. The document should note that the estimated dose commitments involved in this project are small percentages of the average annual dose commitments normally derived from natural background radiation in the region.

4. DOE finds guidance as to whether or not the criteria are absolute upper limits, ambiguous, and unclear as to whether they can be exceeded under any circumstances. For example, a performance objective is "to locate the tailings impoundment area remote from people so that population exposures will be reduced to the maximum extent reasonably achievable." The population density of Fall River County is 1.9 persons per square kilometer (4.8 persons per square mile). Relocating the tailings a distance of two miles further away, in the same geologic setting, does not seem to reasonably achieve much benefit for the estimated cost.

5. "A major objective of the project is to remove an existing problem" (page 4-2, fifth paragraph). DOE believes that the existing problem will only be transposed to another proximate location without resolving the problem, i.e., the contained radium and other radionuclides are moved from one place to another at a substantial cost rather than being removed from the tailings by in situ extraction or by in situ stabilization of the tailings. Such alternatives were apparently not seriously considered among the alternatives evaluated.

6. The proposed decommissioning alternative discussion for this licensed site should include more detail on potential health risks and public benefits that could conceptually result in an ineffective expenditure of funds. Significant anticipated positive results are not apparent.

7. Decontamination criteria and standards for the decommissioning activity are not technically developed; criteria applied should be consistent with health risks and other characteristics that relate to the site and its environs.

RESPONSE

1. While it may appear that "relevant issues" are discussed in general terms, the staff is satisfied that all aspects of the proposal have been adequately evaluated. Certainly there are more detailed plans for various phases of the decommissioning to be developed; however, the staff feels that the impacts from the proposed action have been accurately projected based on the existing information.

2. Decommissioning of the Edgemont mill is dictated by current NRC policy. The staff disagrees that long-term objectives will not be met. The tailings will be disposed of in a relatively remote location utilizing the best practical technology to ensure isolation from the biosphere to the maximum extent reasonably achievable. Unstabilized tailings piles and ponds will be removed from close proximity to both the town of Edgemont and the Cheyenne River, which is the major threat to stability of the tailings in their present location. Another benefit, although intrinsically impossible to quantify, is the removal of the social and economic stigma that Edgemont has suffered under for many years.

   Costs of alternatives are presented in a relative manner. The staff did not identify any alternatives superior to the licensee's proposal, and therefore it was not necessary to discuss the matter further.

3. This fact is mentioned in the radiologic assessment (Sect. 4.1.9) and pointed out in Table 4.11.

4. The staff does not understand the statement concerning the "criteria." However, regarding the population density and benefits of moving the tailings, the fact is that presently about 1400 residents of Edgemont live practically next door to the tailings. In relative terms, moving the tailings 3.2 km (2 miles) from town to an uninhabited area and disposing of them as planned does isolate the tailings from the population.

5. The staff disagrees with these statements. The problem is not the radium and other nuclides contained in the tailings but is the presence of the tailings adjacent to the town of Edgemont and within the floodplain of the Cheyenne River, thus exposing the residents of the town to the radionuclides and the tailings to the erosional forces of the river and Cottonwood Creek. This problem will be resolved by implementing the decommissioning plan.

6. Such a discussion is not within the scope of this FES.

7. Although cleanup levels and decommissioning standards were not yet developed at the time of printing the DES, more information concerning decontamination limits and the technical basis for these limits is presented in Sect. 2.2.2.4 of this FES.

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8. Health risks, costs, and benefits of the decommissioning of natural low-level radioactive material have not been thoroughly analyzed considering the existing regional geology. The potential open pit mining activities and the prevalence of uraniferous lignite deposits in the area and their contribution(s) to the regional health risk need to be addressed (see page 3-11).

9. The document attaches undue importance to variations that are not significant nor meaningful from a health protection or environmental standpoint, e.g., water quality analyses of essentially unused or ephemeral surface waters, location of nearest confined aquifer at the existing and/or proposed disposal site, and the high minerals content in Edgemont's water supply.

10. A number of decommissioning action decisions appear to have been made without any basic technical data, i.e., where information was "not known" (see pages 4-5 and 4-6) or are in the "conceptual" stage (page 4-31).

11. Although "seepage is not considered to be a significant pathway of human exposure in this radiological assessment" (page 4-15), it is discussed at length as a pertinent radiological hazard that requires the removal of the tailings from their present location, and page 4-17 states "It should be pointed out that in none of the locations near to restricted areas are the MPCs expected to be exceeded under 10 CFR Part 20."

12. The NRC staff refers to the licensee as an "applicant" which can be misconstrued by a reader. For exactness, the public should be informed that the facility is licensed. What is proposed is "amending" the license to permit a license termination.

13. The UDAD code used in the dose commitment calculations are based on overly conservative assumptions or modeling methods. It does not strictly represent the physical processes they are intended to model.

14. The DES describes some of the socioeconomic consequences of the proposed action. However, much of the information is incomplete, intangible, or unknown as stated.

RESPONSE

8. The objective of this project is not to remove natural radioactive material but to isolate the tailings and decontaminate the mill site. There is no need to address the contribution of natural radioactivity to regional health risk in this FES.

9. The staff does not believe that "undue importance" has been placed on water quality analysis of "essentially unused or ephemeral surface waters." Although these water sources are presently unused, their future use is a possibility.

Analysis of the ephemeral waters downstream of the disposal site will provide baseline water quality information that may be compared with water quality data following decommissioning to determine containment success and to detect any subsequent leakage at the disposal site.

10. Although there are some instances where detailed information was not available at the time of printing the DES, sufficient technical data has been presented in this FES and reviewed by the staff and is an adequate basis for making the decisions related to the project which appear in this document.

11. In their present location and condition, seepage from the tailings is a potentially significant exposure pathway. However, the radiological assessment evaluates the impacts and potential pathways resultant from the decommissioning operations, and because of precautionary measures (impermeable shales or clay liner, dewatering system, etc.) seepage is not considered a signficant exposure pathway in the decommissioning.

12. The text has been amended.

13. The staff disagrees and has found the UDAD code to be an adequate model for calculating dose commitments.

14. The socioeconomics sections have been updated with information published since issuance of the DES.

Specific Comments on NUREG-0846

1. Page iii, item 2, first paragraph, line 5 - Define expression "local environs."

2. Page iii, item 2, first paragraph, line 7 - In lieu of the phrase "an undetermined amount of contaminated soil..." supply a quantified estimate.

3. Page iii, item 2, second paragraph, lines 5 and 6 - Supply a quantified estimate in lieu of "an unestablished, but small, area of surficial soil in the Cottonwood Community." Provide a basis for excluding other surrounding communities, e.g., Edgemont, South Dakota, from the discussion.

4. Page iii, item 2, third paragraph - A more definitive statement including licensing requirement should be made concerning the title to the tailings disposal site.

5. Page iv, For the proposed tailings management plan, item c - Specify if approval for "final construction to prevent long-term water erosion" will be effected before initiation of the project. In view of this and subsequent staff claims of need for review and approval of detailed clay emplacement plans, dewatering system design, slurry transport system (page iii, item 2, discusses truck and/or slurry pipeline), interim stabilization program to control dusting, the value of issuing this report and the timely issuance of the FES according to NRC regulations is questioned.

6. Page v, item c, lines 4 and 5 - Clarify the expression "sediment levels in the stream will return to background levels."

7. Page v, item d, line 1 - Clarify the expression "stabilized the streambed."

8. Page vi, item 5, line 1 - Insert "concerning the licensee's proposals" after "evaluations."

9. Page vi, item 6b - The converted values of ha to acres are not consistent in some instances.

10. Page vi, item 6c - Should indicate what the ground water requirement is for.

11. Page vii, item 6e, second paragraph, line 1 - Change "will be" to "may be."

12. Page vii, item 6e, last paragraph - Should note that the values tabulated are 100-year EDC's.

13. Page 1-2, Section 1.2, Summary of Proposal, fifth paragraph - Should discuss final administrative proposal(s) for the disposal site, e.g., site ownership, custodianship, and responsibilities for continuing control.

14. Page 1-2, Section 1.3, first paragraph, line 4 - Insert "Title II" after "1978."

15. Page 1-3, third line from bottom of page - "Abandoned" should read "inactive;" and second line from bottom of page - insert "and others designated by the Secretary of the DOE" after "tailings sites."

RESPONSE

1. This refers to the windblown tailings areas and the Cottonwood community.

2. About 2×10^6 tons of contaminated soil may have to be removed if you assume that 1.8 m (6 ft) is contaminated and that there is 5×10^5 m^3 per meter of contamination (Table 2.2, FES).

3. The amount of wind-blown soil is not known until a detailed survey is completed. NRC, Battelle Pacific Northwest Laboratories, and the State of South Dakota are working with Edgemont on a cleanup action program. This program is not part of TVA's decommissioning project.

4. This matter has been more clearly discussed in this FES and appears in the summary and conclusions section.

5. All detailed plans will be consistent with the general plans presented by the licensee and evaluated by the staff. The proposal included all the pertinent information necessary for an adequate assessment of impacts, and, regardless of how certain objectives are achieved, the results should be as projected. Review and approval of detailed plans for various phases of the project will be conducted as the project progresses and these detailed plans become available.

6. Once the tailings have been removed from the mill site, the contaminated materials removed from the streambed, and the stream banks stabilized with vegetation or riprap, little sediment should be transported from the mill site into the stream (Cottonwood Creek, particularly). After stabilization and revegetation of the mill site, including the stream margins, sediment levels in the stream in the vicinity of the mill site should be similar to those upstream.

7. The expression is "stabilize the streambed," which refers to the licensee's plans to place natural or man-made obstructions (i.e., concrete boulders and diversions) within the stream in order to provide aquatic communities (DES, Sect. 4.1.7.2, p. 4-10). The staff recommended that the licensee consult with the U.S. Fish and Wildlife Service and qualified fisheries biologists in reconstructing the streambed so that the substrate materials would be of sufficient type and number to be characteristic of undisturbed streams in the area. By stabilizing the streambed, substrate movement should be minimized, which will reduce sediment transport within the mill reach.

8. This is not a necessary addition.

9. These typographical errors have been corrected.

10. The text has been amended.

11. The aquatic biota will be destroyed because the channel will be moved and the existing creek dug out to remove contamination.

12. This is plainly stated in the heading of the referenced table.

13. This was mentioned on page iii of the DES and is presented in the FES as well. The UMTRCA dictates that the disposal site be turned over to the Federal government or to the State, if so requested.

14. The suggested revision is not necessary.

15. The text has been amended.

16. Page 2-1, fifth paragraph, lines 2 and 3 - State that the tailings will be removed from the site without discussing available alternatives. This may imply that a decision was made initially and other alternatives were considered as an academic exercise.

17. Page 2-1, fifth paragraph, lines 9 and 10 and ff - The statement implies that standards/criteria for cleanup limits are not available; reference has been made to EPA regulations - 40 CFR 192.

18. Page 2-4, Figure 2.1 - Should show location of Cottonwood Community.

19. Page 2-6, Figure 2.3 - The figure should indicate the location of the Cottonwood Community.

20. Page 2-7, lines 3 through 5 - The permeability limit should be consistent with statements in last paragraph on page 2-3.

21. Page 2-13, fifth paragraph, last sentence - Requires further discussion.

22. Page 2-18, fourth paragraph, last line - Discuss the decontamination of Pond 10.

23. Page 2-21, fourth paragraph, lines 1 and 2 - Discuss basis for statement about removal of contaminated material in and around the Cottonwood Creek channel.

24. Page 2-24, sixth paragraph, line 5 - Discuss the basis for selecting a clay cap of 0.9m (3 feet), relative to the "specified" radon-222 flux and the gamma exposure level reduction.

25. Page 2-27, Alternative A3, first paragraph, lines 4 and 5 - Provide a basis for the statement "Restricted industrial use would postpone indefinitely the final decommissioning of the facility."

26. Page 2-27, last paragraph on page and page 2-28, top of page - Provide supporting technical information for the staff's conclusion of unacceptability to support conjectures.

27. Page 2-28, Alternative B2, first paragraph, lines 3 through 5 - Discuss the relative benefits of reclaiming 213 acres at the mill site while removing 258 acres from use for the proposed disposal site.

28. Page 2-30, fourth paragraph - The stated depth to ground water is 152m (500 feet); omission of the depth of the disposal area (assumed 15m) does not provide a sound basis for requiring a clay foundation area at the disposal site to attain a permeability of 1×10^{-7} cm/s to mitigate long term seepage.

29. Page 2-31, sixth paragraph - Cottonwood Community is the site of more immediate concern than Edgemont. Discuss the impacts on it rather than on Edgemont.

30. Page 2-31, second paragraph from bottom of page, last line - Provide a basis for the statement "the reclaimed site would be available for limited use."

31. Page 2-31, last paragraph, last sentence - The amount of material to be removed from the site (7.1×10^6 MT) does not coincide with the amount of tailings (2.1×10^6 MT) discussed in the summary of the proposal on page 1-2.

RESPONSE

16. Section 2.2.1.2 of the DES was a preliminary plan for land decontamination. This section has been expanded and moved to Sect. 2.2.2.4 of the FES where the licensee's plans for decommissioning are discussed.

17. The EPA is currently reviewing the 40 CFR Part 192 regulations and has urged the staff not to place significant emphasis on the existing standards in determining cleanup limits for the Edgemont mill site.

18. DES Fig. 2.1 has been revised.

19. The Cottonwood community is shown in Fig. 2.1.

20. Permeability values on p. 2-3 are reported values, not limits.

21. The sentence states, "During decontamination, radiation surveys will be conducted to identify any areas with unexpectedly high levels of contamination." This is an action to be taken by the licensee when decontaminating buildings and equipment to ensure that workers do not unknowingly encounter highly contaminated equipment which could pose a health problem.

22. Pond 10 decontamination is discussed in Sect. 2.2.2.6.

23. *Complete* removal of contaminated material from the site requires removal of those in the creek as well.

24. The licensee proposed a clay cap of 0.9 m (3 ft) and additional fill of 2.1 m (7 ft) to provide for (1) reduction of radon exhalation to approximately twice natural background, (2) reduction of gamma radiation, and (3) to ensure long-term isolation of the tailings. While the first two criteria might be met over the short term with less cover material, the proposed cover thickness provides a higher degree of certainty in isolating the tailings over the long term. The staff has evaluated the proposed cover thickness and has determined it to be adequate and consistent with the NRC performance objectives for tailings management.

25. Alternative A3 provides for only selective decontamination of structures on the site. Some contaminated structures would remain and therefore final decommissioning of the site would be postponed indefinitely.

26. The text has been revised to provide a more firm basis for the staff's conclusions.

27. Net gain in reclaiming the mill site is 127 acres (p. vii, No. 6).

28. A clay liner will be used only if the shale under the site has a permeability greater than 10^{-7} cm/s. The groundwater depth makes any contamination of that water highly improbable provided that shale permeability is low.

29. The scenerio would apply to Cottonwood community as well except fewer people would be affected.

30. Following completion of decommissioning and reclamation activities, the site would no longer be licensed by the NRC and would be available for productive use.

31. Other materials beside tailings include subsoil and Cottonwood Creek sediment.

RESPONSE

32. Page 2-31, last paragraph, last line - Explain why 21-ton dump trucks are proposed in this instance; 50-ton dump trucks are to be used as stated on page 2-10; 36-ton trucks are described on page 2-37 and 50-ton or 75-ton trucks are to be used on page 2-38.

32. The size of trucks used in any one alternative is largely dependent on distance and the type of roads over which they must travel. Therefore, alternative plans utilized different size trucks.

33. Page 2-41, fourth paragraph - Provide a basis for the need of requiring a tailings cover that would result in a net gamma radiation from the disposal site about nine orders of magnitude below natural background and discuss the anticipated costs involved in producing such a cover.

33. As the staff pointed out in the response to comment 24, the thickness of the cover was chosen to satisfy concerns of long-term stability and isolation of the tailings from the biosphere and to reduce radon exhalation.

34. Page 2-41, last sentence on page - "A detailed evaluation of the proposed plan against these technical criteria as well as any minor modifications to the plan needed to meet the criteria, will be presented in the FES." This indicates a weakness in the comprehensive evaluation of the proposed action in the DES.

34. This part of the text has been deleted due to changes in the regulations.

35. Page 2-42, second paragraph - "The staff finds that onsite stabilization of tailings is unacceptable because of the proximity of the City of Edgemont and the probability of tailings impoundment erosion at the location over the long term." The statement requires technical substantiation based on page 4-34, second paragraph from bottom of page where it is noted that most of the existing piles and ponds on the mill site have been covered with soil and vegetated; discussion is absent about improving existing impoundment measures in situ.

35. The text has been revised to explain more clearly the basis for the staff's determinations.

36. Page 2-42, seventh paragraph - The statements made require substantial discussion and verification for acceptance by the reader considering the potential benefits that may be derived.

36. See response to EPA comment 6.

37. Page 2-42, last paragraph on page - The case for diverting the creek flow and decontamination of the existing creek channel requires a detailed discussion of what actual public health and environmental benefits would be derived from such activities in view of the natural dilution and dispersion of contaminants that is occurring (see first paragraph, page 2-43). Potential occupational risks in performing the proposed activity must also be factored into the discussion. The phrase "all creek contaminants" in the last sentence is too vague and too encompassing for the actual requirements that are needed and finally, the standards to be applied should be set by the EPA and the State of South Dakota for implementation by the NRC.

37. The purpose of rerouting the creek is to allow it to resume its original course through the site and allow removal of tailings where the creek presently flows. The environmental benefits of cleaning the creek will be the improvement of aquatic habitat and the esthetic quality of the site. Regarding the determination of the level of contaminants to be removed from the creek, we plan to coordinate this effort with the South Dakota Department of Water and Natural Resources. However, it is premature to discuss this until sediment sampling is conducted and the extent of contamination is known.

38. Page 3-8, Table 3.4 - Percent change data for most recent years at Edgemont, South Dakota, should be included in Table.

38. This table has been revised.

39. Page 3-18, first paragraph - TVA proposes to begin both underground and surface mining of uranium/vanadium ore deposits at two sites within 24 km (15 miles) of Edgemont. Provide a discussion of how the proposed decommissioning plan will result in significantly reducing potential health impacts to the regional population and to the environmental quality considering TVA's planned activities.

39. See response to Sixth District Council comment 2.

40. Page 3-19, Section 3.6.1.1, lines 4 and 5 - The direction of flow of the Cheyenne River, east to west, is not compatible with the last statement of the paragraph, i.e., "downstream from Edgemont...Angostura Reservoir."

40. The phrase "from east to west along the northern edge of the site" has been changed to "from west to east along the northern edge of the site" to reflect this comment.

41. Page 3-25, Table 3.16 - The absence of surface water quality values for S-5 and the lack of notation of some of the sampling points on Figures 3.1 through 3.5 is noted. A summary discussion of the conclusions to be drawn from the tabulated data is called for relative to the possible effect(s) resulting from performing the proposed action.

42. Page 3-34, last paragraph on page - The statements made would apply equally to all ground water in the region including the proposed disposal site area which raises a question of the benefit(s) to be derived from performing the proposed action in view of its anticipated cost(s).

43. Page 3-35, second paragraph - The statements made are not clear from the data presented and require more discussion to justify the conclusion that ground water mixed with contaminated leachates results in excessive dissolved solids concentrations.

44. Page 3-35, third paragraph - The depth of the observatory wells should be noted and comments made about the potential/practical use of this quality water. The "before" and "after" dissolved solids concentrations are both of equally unusable quality.

45. Page 3-35, Section 3.7.1, Geology, through page 3-42 - The text indicates a marked similarity in geologies between the existing site and the proposed disposal site which raises a question about the value of moving the existing tailings about two miles from its present location. This should be addressed at the end of the section at length, considering the potential efforts and costs involved relative to the benefits to be derived.

46. Page 3-43, Section 3.7.2.1, Uranium - The paragraph states that natural uranium minerals are quite prevalent in the county and at shallow depths which would indicate an above normal natural radon flux level. Provide a discussion about this and the performance objective of reducing the radon emanation rate from the impoundment to no more than 2 $pCi \cdot m^{-2} \cdot s^{-1}$.

47. Page 4-2, fourth paragraph, last sentence - "Effective measures" should be exemplified.

48. Page 4-2, eighth paragraph - Can be misleading and should be more specific as to where measurements were made and reproducibility.

49. Page 4-2, Section 4.1.2, <u>Radiological environment</u> - Delete; the sentence is innocuous.

50. Page 4-3, Section 4.1.3, <u>Soils</u> - The discussion indicates that in reclaiming 213 acres at the mill site, at least another 301 acres would be affected by the proposed project. The logic of this should be discussed.

51. Page 4-4, first paragraph - Provide a basis for stating that the reclaimed area, in the midst of an industrially zoned area would be used as pasture land.

RESPONSE

41. The information presented in DES Table 3.16 is part of a baseline sampling program conducted by the licensee. Exacting conclusions can not be drawn from these data because some values included in the table, particularly from sites S-5, S-7, and S-9, are based on only one or two samples. Because there is no information on conditions under which the limited number of samples was taken, it is not possible to determine if these samples reflect actual long-term water quality conditions. However, from the data presented in this table and discussion in the text, we know that (1) barium, arsenic, and chemical oxygen demand in the Cheyenne River and barium in Cottonwood Creek exceed EPA primary drinking water standards, (2) chloride, iron, manganese, and sulfate exceed secondary proposed standards in both water bodies, and (3) conductivity is above irrigation criteria. Levels of these chemical parameters are high in the tailings. In addition, concentrations of cadmium, chromium, nickel, titanium, dissolved solids, aluminum, nitrate, and most metals (Sect. 4.6.2.4) are high in the tailings or groundwater beneath the site. These parameters do not exceed current water quality standards, but might do so in the event of a spill or accidental release during decommissioning or while the groundwater continues to "naturally cleanse itself." Additionally, since surface waters recharge the alluvial aquifers, increased levels of chemical constituents entering surface waters from the tailings could be carried into groundwater.

42. The staff disagrees. Regional alluvial groundwater unaffected by tailings seepage contains much lower concentrations of these elements than does the alluvial groundwater at the mill site. Furthermore, seepage prevention measures to be taken will ensure that the groundwater at the disposal site will not be adversely affected as the groundwater at the mill site has been.

43. Tables of supporting data have been added to Sect. 3.6.2.4. For additional detail, see Ford, Bacon & Davis Utah, Inc., *Engineering Assessment of Inactive Uranium Mill Tailings, Edgemont Site, Edgemont, South Dakota*, prepared for the U.S. Nuclear Regulatory Commission, Contract No. E(05-1)-1658, May 1978; see also Tennessee Valley Authority, *Draft Environmental Impact Statement, Edgemont Uranium Mine*, Jan. 24, 1979.

44. The wells penetrate the alluvium at the site. For depth data see Ford, Bacon & Davis Utah, Inc., *Engineering Assessment of Inactive Uranium Mill Tailings, Edgemont Site, Edgemont, South Dakota*, prepared for the U.S. Nuclear Regulatory Commission, Contract No. E(05-1)-1658, May 1978. The staff expects that it will be necessary to restrict use of the water following decommissioning and that the water would not be suitable for any practical use.

45. The similarities of the geology of the two sites are not a factor in arriving at a value in moving the tailings. Of significance are the characteristics of the disposal plan that will isolate the tailings from the erosional forces of the Cheyenne River and Cottonwood Creek, eliminate blowing of tailings and prevent seepage from the impoundment.

46. The text now states the natural background radon flux of the area. The performance objective is to reduce the radon flux to about twice natural background, and as the staff's calculations which appear in Appendix E show, the licensee's proposed cover thickness accomplishes this goal.

47. The text has been changed appropriately. Also see responses to EPA comments 1, 5, 13, 18, and 26.

48. See response to comment 8 of South Dakota State Planning Bureau.

49. The staff does not understand the comment.

52. Page 4-4, third paragraph - The validity of the statements are tenuous and should be elaborated upon or deleted. The statements raise a question about the value for this project.

53. Page 4-4, last paragraph on page - In the discussion of the major impacts at the mill site, items (1) and (4) are questionable as is the need for removal and ability to remove "all" contaminated material. (See first paragraph at top of page 4-5 and third paragraph, page 4-6.)

54. Page 4-6, third paragraph, first sentence - Applies to conditions prior to the present licensee's tenure. A substantial amount of tailings coverings have since been performed to mitigate suspended contaminants surface runoff. The statements relating to trace metal contamination require validation before being asserted.

55. Page 4-7, fourth paragraph, first sentence - The assertion that the ground water quality under the mill is due to past and present seepage from and through the tailings piles and ponds on the site requires justification.

56. Page 4-7, sixth paragraph, lines 1-3 - Should also include a statement of how this geology differs from existing mill site's geology to account for the variation with the statement under item 55.

57. Page 4-15, Section 4.1.9.2, first paragraph, last two lines - The source of the 5 pCi/g particulate standard should be stated.

58. Page 4-17, Section 4.1.9.4 - Discusses radiation impacts to individuals during decommissioning and post decommissioning but does not address the existing situation for comparison. This is essential to the justification for enacting the licensee's proposal and the Commission's approval of the proposal. A clarification of when the statement "It should be pointed out that in none of the locations near to restricted areas are the MPC's expected to be exceeded" applies should be made. The Section and the associated tables 4-10 through 4-12 should include radiation impacts of the prevailing site conditions. This section should also include a discussion of the "degree of improvement in the radiologic exposures expected from the proposed action on a percentage or equivalent basis relative to background estimates.

59. Page 4-19, Table 4.10, footnote C - Should provide the reference for the noted cleanup standards.

60. Page 4-20, Table 4.11 - Data should be discussed at length in the text and conclusions presented.

61. Page 4-21, Table 4.12 - Data should be discussed in detail in the text and conclusions presented.

62. Page 4-22, Table 4.13 - Same as items 60 and 61.

63. Page 4-23, first paragraph - Should discuss the incremental change(s) (both positive or negative) in radiation impacts to the population including a clear definition of "the present health hazard."

RESPONSE

50. While 301 acres would be disturbed during project operations, the majority of these acres will be reclaimed over the long-term period. Therefore, the decommissioning project will result in a net increase in land available for productive use.

51. The text has been revised and the statement deleted.

52. The statements referred to are made to summarize the previous discussion of land use, and the staff disagrees with the comment.

53. Permanent reduction of surface water contamination resulting from runoff and flood erosion of existing tailings (1) will be achieved by removal of the source of surface water contamination, that is, the tailings. The staff has revised item (4) to say "removal of contaminated materials. . . ."

54. Although migration of most of the contaminated materials into Cottonwood Creek occurred prior to the licensee's ownership of the site, as part of the decommissioning effort, the licensee is responsible for disposal/stabilization of the contaminated material found in conjunction with the mill site. Section 4.2.2.2.1.2 of the ER states that "sediment samples from the (tailings) ponds were heavily contaminated with aluminum, barium, chromium, iron, nickel, titanium, and vanadium." The staff stands by the statement on trace metals in the DES.

55. This statement becomes evident when comparing offsite water quality with onsite water quality.

56. The staff disagrees with this comment.

57. The staff feels that this quantity is a reasonable estimate considering the natural background of the area. In addition, it is similar to the existing 40 CFR Part 192 standards (although we recognize that standard is expected to be revised).

58. NRC regulations require that the Edgemont mill be decommissioned. The licensee has proposed a method for accomplishing this task, and the staff has evaluated the plan to ensure that it meets the performance objectives for tailings management and guidelines for facility decontamination. The purpose of this Environmental Statement is to evaluate the impacts of the proposed action, not to evaluate the existing situation. As mentioned in our response to comment 2 of this letter, there are other compelling reasons for decommissioning the mill site.

59-62. The staff feels the radiological assessment adequately discusses these data.

63. The radiation impacts are presented in a comparison of effects during the decommissioning operations and following completion of the project (post-decommissioning).

64. Page 4-23, Section 4.1.9.8, Summary of Radiological Impact - The text and data presented do not confirm the statement presented, i.e., "the long-term benefits of eliminating a chronic health hazard far outweigh the short-term impacts associated with this action."

65. Page 4-23, Section 4.2, Monitoring Programs, first paragraph - The statements made indicate that previous conclusions were based on "feelings" rather than "facts." The validity of the DES is thereby questionable.

66. Page 4-24, first paragraph, line 1 - Discuss the need for TSP monitoring rather than radon flux monitoring, a basic performance objective, considering that the piles have been covered and vegetated (4-34).

67. Page 4-25, Section 4.2.3.1, Predecommissioning - Explain why radiologic conditions, e.g., radon flux and radium content of soil were not measured.

68. Page 4-26, line 11 - EPA standards referred to should be specified. Prior discussions indicated that none of the potential water sources would comply with EPA drinking water standards.

69. Page 4-26, line 24 - Should establish whether EPA will function in a consultative or concurrence role.

70. Page 4-27, lines 7 and 8 - The meaning of "quantify water quality impacts of the decommissioning...." is not clear.

71. Page 4-27, fifth paragraph, Water Quality - Discuss the merits of this activity.

72. Page 4-27, seventh paragraph, Proposed Disposal Site - The paragraph should indicate whether such down gradient wells from this direction from the mill site have been in use previously.

73. Page 4-28, Section 4.2.7, Biota - The staff's proposed requirements appear to be excessive in view of the actual, natural conditions and should be justified. It appears that duplicative efforts between the licensee and the State agencies will occur in this activity.

74. Page 4-33, second paragraph - Comparison of accidental risks (potential deaths) from the decommissioning activities with potential health benefits from the activities should be made.

75. Page 4-34, first paragraph - Provide a figure of the estimated volume of water available from the Pahasapa aquifer to support the contention of the "minor" use of water for this project.

76. Page 4-34, last paragraph on page - Supporting data for staff's opinion should be references or furnished.

77. Page 4-36, Section 4.9 - The NRC cost/benefit summary is completely inadequate; costs involved relative to benefits anticipated are essentially ignored. No efforts have been made to quantify these elements for the reader. Supporting data should be furnished as an appendix.

RESPONSE

64. The staff does not concur.

65. The monitoring section of the statement has been completely revised to present the various programs which will be implemented. In no way is the validity of the Environmental Statement compromised based on the staff's statements regarding preliminary monitoring needs as presented in the DES.

66. TSP monitoring is required due to the extensive dust-generating activities involved with what is essentially an earth-moving project. Furthermore, TSP monitoring has been quite appropriately required by the State of South Dakota.

67. The radiological monitoring program, as presented in Sect. 4.2.2 will be implemented, and these activities will be carried out beginning in the summer of 1982.

68. The standards referred to are the EPA drinking water standards.

69. The text has been revised accordingly.

70. By monitoring runoff during each precipitation event, the licensee would have measurements of the quantities of suspended solids carried during each event. Values obtained from several such events rather than a single event (which might be an abnormal storm, predicting a greater volume of suspended solids than is normally transported) can be used by the licensee per ER Sect. 5.1.2.2.1 to determine if "additional mitigative measures are warranted."

71. Monitoring during reclamation, using the same program as during predecommissioning, will ensure that the results (i.e., data) are comparable. Comparable data among monitoring programs will enable the licensee and the NRC to determine whether acceptable levels of contaminants associated with the tailings have been attained.

72. The staff is not aware of any wells currently in use located downgradient from the proposed disposal site.

73. The staff does not agree. The staff's discussion of the monitoring program for aquatic biota is based on the monitoring program originally presented by the licensee in the ER (Sect. 5.1). This program is based on a follow-up of the predecommissioning monitoring program conducted by the licensee in 1975, 1976, and 1980 and will be used to determine the effectiveness of the reclamation effort and recolonization of Cottonwood Creek in the vicinity of the mill site. Consequently, the staff does not feel that the requirements of the monitoring program are excessive. The staff believes that the licensee will conduct the monitoring program in coordination with the State.

74. This comparison is not required.

75. The Pahasapa Formation, a minimum of 50.3 m (165 ft) thick, contains over 1.58 m^3 (128 acre-ft) per 2.8 x 10^3 ha (1 sq mile). It is highly unlikely that removal of 1.3 x 10^5 m^3 (105 acre-ft) over a period of three years would affect other users. In addition, normal recharge would replace the withdrawn water after the project use ceases.

76. The radiological assessment presents the projected releases in the postdecommissioning period. It is obvious that an operating uranium mill of the 1960s generated more releases than will the reclaimed disposal site.

77. The staff does not agree.

Specific Editorial Comments on NUREG-0846	RESPONSE
1. Page iii, item 3, c, line 1 - Change "shall" to "should."	1-8. The text reflects summaries of stated concerns and will not be amended.
2. Page iii, item 3, f - Insert "should" after "quality."	
3. Page iv, item 3, g - Insert "should" after "project."	
4. Page iv, item 3, h, line 2 - Insert "should" after "alternatives."	
5. Page iv, item 4, d, line 1 - Change "would" to "will."	
6. Page iv, item 4, e, line 4 - Change "would" to "will."	
7. Page iv, item 4, e, third paragraph, line 1 - Change "would" to "will."	
8. Page iv, item 4, last line - Change "would" to "will."	
9. Page v, item 4, f, line 2 - Change "would" to "will."	9-11. The text has been revised as appropriate.
10. Page v, item 4, g, lines 1 and 2 - Change "would" to "will." line 3 - Change "would" to "should."	
11. Page v, third paragraph, lines 2 and 3 - Delete "and that this is the preferred alternative of the staff."	
12. Page vi, line 2 - Insert "will" after "applicant" and change "applicant" to "licensee."	12. See response to DOE general comment 12.
13. Page vii, item 3, first paragraph - Requires rewording for smoother reading.	13. The text has been amended.
14. Page 1-2, second paragraph, line 2 - Change "highly contaminated" to "radioactively contaminated."	14. The staff does not feel that this change is necessary.
15. Page 1-2, second line from bottom of page - Reference Executive Orders 11988 and 11990.	15. These references have been noted.
16. Page 1-3, third line from bottom of page - Capitalize "act."	16. The text has been amended.
17. Page 1-4, sixth paragraph, line 4 - Change "to be held" to "which was held."	17. The text has been amended.
18. Page 1-6, item 2, first bullet, line 1 - Delete hyphen in "surface-runoff." Page 2-10, fourth paragraph, line 1 - "Applicant" should read "licensee."	18. The text has been amended.
19. Page 2-13, line 3 - "Listed" should read "are shown."	19. The text has been amended.
20. Page 2-13, fifth paragraph, line 2 - "Hydrolising" should be replaced by a more meaningful word.	20. This term describes use of hydrolytic enzymes.
21. Page 2-13, seventh paragraph - Delete, the paragraph is redundant. Page 2-16, fifth line from bottom of page - "Applicant" should read "licensee."	21. The text has been amended.
22. Page 2-18, second paragraph, line 9 - "Applicant" should read "licensee."	22-23. The text has been changed.

23. Page 2-18, third paragraph, lines 5, 7, and 11 - "Applicant" should read "licensee."

24. Page 2-18, third paragraph, line 11 - Delete "all."

Page 2-18, fourth line from bottom of page - "Applicant" should read "licensee."

Page 2-23, sixth paragraph, line 1 - Delete hyphens in "86-ha (213-acre)."

. fourth and second lines from bottom of page - "Applicant's" should ...see's."

...n 2.2.3, Title - "Applicant's" should read "licensee's."

29. Page 2-2... last line, Alternative A2 - "Applicant" should read "licensee."

30. Page 2-27, Alternative A3, first paragraph, line 2 - "Applicant" should read "licensee."

31. Page 2-28, Alternative B2, second paragraph, last line - "Applicant" should read "licensee."

32. Page 2-28, Section 2.2.3.3, first paragraph, lines 3 and 11 - "Applicant" should read "licensee."

33. Page 2-28, Section 2.2.3.3., second paragraph, lines 2, 4, and 6 - "Applicant" should read "licensee."

34. Page 2-28, last paragraph, line 1 - "Applicant" should read "licensee."

35. Page 2-29, line 3 - "Applicant" should read "licensee."

36. Page 2-30, second paragraph, line 1 - "Applicant" should read "licensee."
    fourth paragraph, line 5 - "Applicant" should read "licensee."

37. Page 2-30, last line on page - "Applicant" should read "licensee."

38. Page 2-31, fourth paragraph, line 1 - "Applicant" should read "licensee."

39. Page 2-32, first paragraph, last line - "Applicant's" should read "licensee's."
    sixth paragraph, line 3 - "Applicant's" should read "licensee's."
    seventh paragraph, line 6 - "Applicant's" should read "licensee's."
    last paragraph, last line on page - "Applicant's" should read "licensee's."

40. Page 2-36, line 4, Alternative D4 - "Applicant" should read "licensee."
    line 4, Alternative E1 - "Applicant" should read "licensee."
    line 6, Alternative E2 - "Applicant" should read "licensee."

41. Page 2-37, line 3 - "Applicant" should read "licensee."

42. Page 2-33, Alternative F3, line 7 - "Applicant" should read "licensee."

43. Page 2-40, lines 4, 8, 31, 38, 47, 49 - "Applicant" should read "licensee."

RESPONSE

24. The staff disagrees. The text stands.

25. The text has been changed.

26. Hyphenation is correct. The text stands.

27-47. The text has been changed.

5	RESPONSE
44. Page 2-41, lines 4, 7, 16, 19, 23, 16, 39, 55 - "Applicant" should read "licensee."	
45. Page 2-42, lines 1, 18, 26, 30, 35, and 46 - "Applicant" should read "licensee."	
46. Page 2-43, lines 7, 22, 24, 41, 53, and 57 - "Applicant" should read "licensee."	
47. Page 2-44, line 4, 6, and 8 - "Applicant" should read "licensee."	
48. Page 2-45, Reference 8 - "Report PB-256" should read "Report PB-256, 453."	48. The text has been amended.
49. Page 3-3, last paragraph, line 2 - "Applicant" should read "licensee."	49-50. The text has been changed.
50. Page 3-19, fifth paragraph, line 4 - "Applicant" should read "licensee."	
51. Page 3-29, footnote g - Conversion of 9.1 km to miles is incorrect.	51. The text has been amended.
52. Page 3-45, sixth paragraph, line 2 - "Applicant" should read "licensee."	52-63. The text has been changed.
53. Page 3-50, line 4 - "Applicant" should read "licensee."	
54. Page 4-1, second paragraph, line 2, and second paragraph from bottom of page, last line - "Applicant" should read "licensee."	
55. Page 4-1, third paragraph, lines 7 and 11 - "Applicant" should read "licensee."	
56. Page 4-2, second paragraph, lines 1 and 2, and third paragraph, line 1 - "Applicant" should read "licensee."	
57. Page 4-3, second paragraph, lines 3 and 5 - "Applicant" should read "licensee."	
58. Page 44, fourth paragraph, line 2, and last paragraph, line 11 - "Applicant" should read "licensee."	
59. Page 4-5, last line on page - "Applicant's" should read "licensee's."	
60. Page 4-6, third paragraph, lines 1 and 3 - "Applicant" should read "licensee."	
61. Page 4-9, second paragraph, lines 1 and 6, and fourth paragraph, line 4 - "Applicant's" should read "licensee's."	
62. Page 4-10, first paragraph, lines 1 and 7, and second paragraph, line 6 - "Applicant" should read "licensee."	
63. Page 4-11, first paragraph, line 8 - "Applicant" should read "licensee."	
64. Page 4-12, first paragraph, last line 6 "year" should be plural.	64. This section of the text has been revised.
65. Page 4-15, Section 4.1.9.2, first paragraph, last line - A closing parenthesis has been omitted.	65. The text has been amended.

RESPONSE

66. Page 4-23, third line from bottom of page - "Applicant" should read "licensee."

67. Page 4-24, lines 3, 18, and 40 - "Applicant" should read "licensee."

68. Page 4-25, lines 5, 19, 22, 25, 30, 33, and 35 - "Applicant" should read "licensee."

69. Page 4-26, lines 1, 14, 15, 20, 22, and 36 - "Applicant" should read "licensee."

66-69. The text has been changed.

70. Page 4-26, line 39 - Delete hyphen in "water-quality."

71. Page 4-27, lines 7, 9, 14, 34 - "Applicant" should read "licensee."

72. Page 4-27, line 14 - Delete hyphens in "surface-water-monitoring."

73. Page 4-28, lines 6, 10, 13, 21, 28, 35, 37, 42, 48, and 49 - "Applicant" should read "licensee."

74. Page 4-29, lines 8, 16, 20, 33, and 45 - "Applicant" should read "licensee."

75. Page 4-30, lines 6, 16, 20, 30, and 36 - "Applicant" should read "licensee."

76. Page 4-31, lines 2, 14, 18, 19, and 24 - "Applicant" should read "licensee."

77. Page 4-33, line 5 - "Applicant" should read "licensee."

78. Page B-3, line 2 - "Applicant" should read "licensee."

79. Page C-4, fourth paragraph from bottom of page - "Shines" should read "slimes."

70-79. The text has been amended.

TENNESSEE VALLEY AUTHORITY

CHATTANOOGA, TENNESSEE 37401

400 Chestnut Street Tower II
December 1, 1981

RESPONSE

Mr. Ross A. Scarano, Chief
U.S. Nuclear Regulatory Commission
Uranium Recovery Licensing Branch
Mail Stop SS 483
7914 Eastern Avenue
Silver Spring, Maryland 20910

Dear Mr. Scarano:

In the Matter of the) Docket No. 40-1341
Tennessee Valley Authority)

This is in response to your letter to me dated September 24, 1981 which forwarded for TVA review and comment the "Draft Environmental Statement related to the decommissioning of the Edgemont Uranium Mill." We have reviewed the subject draft environmental statement (DES). TVA stands by its proposed decommissioning plans and offers the enclosed comments for clarification and correction of specific concerns.

One item that we believe should receive immediate attention is the further development of the environmental monitoring program (Section 4.2, page 4-23). By my letters to you dated September 29, 1981 and October 28, 1981, TVA provided the proposed environmental monitoring program for the Edgemont uranium mill decommissioning project. We believe this proposed monitoring program meets the requirements specified in the DES. To ensure that TVA can proceed with the necessary monitoring based on a fully approved program, timely review and development of a coordinated program is now essential.

Also, by my October 26, 1981 letter to you, TVA provided proposed radiological cleanup criteria for the decommissioning project. Your timely approval of the project cleanup criteria is also needed before TVA can develop overall cleanup strategy and detailed cleanup levels. In addition, we assume that these criteria will need to be finalized for inclusion in the project final environmental statement.

With regard to the monitoring program and cleanup criteria discussed above, we believe it necessary to meet with you concerning finalizing these items at your earliest convenience. David Dunn of my staff will be in touch with your staff to establish a date and agenda for the necessary meeting.

RESPONSE

Mr. Ross A. Scarano

December 1, 1981

We welcome the opportunity to work with you in developing responses to comments on the DES submitted by other interested parties.

If you have any questions regarding these items or regarding the enclosed DES comments, please call David Dunn at FTS 858-2699 in Chattanooga.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

L. M. Mills

L. M. Mills, Manager
Nuclear Regulation and Safety

Enclosure

ENCLOSURE

TENNESSEE VALLEY AUTHORITY
COMMENTS ON THE
NRC DRAFT ENVIRONMENTAL STATEMENT
RELATED TO THE
DECOMMISSIONING OF THE EDGEMONT URANIUM MILL

SUMMARY AND CONCLUSIONS

1. It was previously indicated in a November 3, 1980 letter to L. M. Mills from Ross A. Scarano that the requirements of 40 CFR 190 (1981) would not be applicable to the Edgemont uranium mill decommissioning project. If this condition is still accurate, it should be clearly specified in this section along with the reasons why it is not considered applicable. However, if this condition is no longer applicable the DES should justify the decommissioning project in light of 40 CFR 190 which generally precludes activities which may expose members of the public to more than 25 mrem per year.

2. Page iii, item 2 (third paragraph)--The tailings disposal site will in part be owned by TVA as well as other entities. The paragraph does not reflect this accurately and suggests that TVA will transfer title when, in fact, it may only transfer custody of the property it owns. A suggested rewrite of the second sentence would be, "The title to or custody of the tailings disposal site may be transferred . . . ." Also see comment 4 in Chapter 2.

3. Page v, Proposed Tailings Management Plan recommendations (g)--The statement that the final impoundment cover "would reduce enhanced gamma radiation to below background levels" is not clear.

4. Page v, General Aspects,(f)--See comment 15 in Chapter 2.

5. Page vi, item 5(a)--The environmental monitoring program should be specified to evaluate both the <u>environmental</u> <u>and</u> radiological aspects of the project activities.

<u>Chapter 1</u>

PURPOSE OF AND NEED FOR ACTION

1. Page 1-2, Section 1.2--The DES should clearly state that TVA is a Federal agency and provide a history of the site; TVA's acquisition of it; and the stabilizing efforts TVA has taken. We suggest that the following language be used as the lead in paragraph:

    The Tennessee Valley Authority (TVA), is a corporate agency and instrumentality established under the TVA Act of 1933 as amended. TVA operates the Nation's largest power system supplying the power requirements for an area of approximately 80,000 square miles containing over seven million people. In carrying out its responsibilities under the TVA Act,

-1-

RESPONSE

1. As previously explained in the November 3 letter, the decommissioning project is not subject to 40 CFR Part 190 because it has been determined that such activities do not constitute "normal operations" as specified in the regulation.

2. The Uranium Mill Tailings Radiation Control Act dictates that title to the disposal site be transferred to the Federal government or to the State.

3. The text has been revised to give the expected gamma radiation emission from the reclaimed impoundment.

4. The text has been amended as suggested and reflects information in the response to TVA comment 15 on Sect. 2.

5. The text has been revised accordingly.

1. We believe that the text sufficiently informs the reader of the purpose and need for action of the mill decommissioning. The text has been amended to state that TVA never operated the mill.

TVA is pursuing a wide range of options to meet the need for future electrical generating capacity in a manner that maintains and enhances a quality environment. To that end, a portion of TVA's capacity consists of nuclear power electric generating units. In order to guarantee the availability of fuel for these units, TVA has investigated a number of alternatives, including long-term contracting and mining of TVA uranium reserves.

In addition, the second sentence (starting with "Because the mill . . .") of the first paragraph should be deleted and replaced with the following.

The mill has never been operated since its acquisition by TVA. On August 29, 1978, NRC issued an amendment to the Source Materials License (SUA-816) directing TVA to develop and submit to NRC for approval plans for decommissioning the mill site. The plans submitted are described herein.

Suggested language for an additional paragraph following the above is:

Interim actions taken by TVA since the purchase of the property include, but are not limited to, temporary site stabilization and reclamation; the return of windblown tailings to within the site boundary; reduction of the height of the East pile; the erection of a new security fence; routine maintenance; removal of safety hazards; and radiological and environmental investigations and monitoring.

2. Page 1-4, third paragraph--As discussed in the TVA Edgemont Uranium Mill Environmental Report (ER), Section 1.1.2, page 1.1-1, TVA will use the NRC performance objectives and guidelines in setting remedial action criteria. TVA intends to meet the NRC performance objectives and guidelines and will accomplish this to the maximum extent reasonably achievable. In decommissioning the project as proposed, it is believed that TVA will accomplish all of the NRC performance objectives. However, this is different than committing to comply with the objectives as stated in this section.

Chapter 2

ALTERNATIVES INCLUDING THE PROPOSED ACTION

1. The information provided in TVA's ER for use in your DES analysis was based on a conceptual plan and preliminary engineering. However, we believe the DES describes certain alternatives and proposed decommissioning plans as if they were definitely going to be carried out; this may not accurately reflect final decommissioning activities. Based on final detailed engineering, which will be coordinated with you, certain current plans may be subject to change. Examples of this are final plans for mill site reclamation, page 2-23, Section 2.2.2.7; slurry pipeline plans, page 2-10 and page 2-18; and cleanup of Cottonwood Creek, page 2-21, Section 2.2.2.5.

RESPONSE

2. No response is required.

1. In most cases, the DES/FES discusses general plans for which engineering details must be developed. In the development of detailed plans, which will be subject to approval by the NRC, we agree that some changes may occur. However, these changes should not alter the general plans or associated impacts.

2. Page 2-1, Section 2.2.1--We do not believe that returning the mill site "to productive use" is the primary goal of decommissioning. The primary goal appears to be reducing radiation exposure and the potential for such exposure. An additional goal, as is stated, may be to minimize land areas on which extensive use restrictions must be placed, considering the feasibility of mitigative actions. This comment also applies to Section 2.2.1.2, page 2-1.

3. Page 2-3, item 2 under "Postreclamation period"--It should be noted that the stated 2 pCi/m^2/s is an above-background value. This comment also applies to page 2-24, Section 2.2.2.8, page 2-39, Postreclamation period and to page 2-41, Paragraph 4.

4. Page 2-3, Section 2.2.2.1, Location--This section should specify that a major portion of the disposal site area is now under TVA control. Suggested language is ". . . about 96 ha (236 acres), which were previously under private ownership, are now or will be under TVA control . . . ."

5. Page 2-10, Section 2.2.2.3, Paragraphs 1 and 2--Plans regarding the diversion ditch have been modified from those previously provided. Figure 2.7 is no longer applicable. The following rewrite describes the most recent plans.

Paragraph 1, last 2 sentences--"The area east of the mill site would be decontaminated after removal of tailings from the mill site. The Cottonwood Community areas also would be . . . ."

<u>Diversion System</u>: (Paragraph 2 replaced in its entirety)

"A diversion ditch would be constructed along the eastern perimeter of the mill site. The diversion ditch would intercept the runoff from five natural drainages with a total catchment area of about 71 ha (177 acres), which includes the windblown tailings areas. Runoff collected in the ditch will be considered contaminated and will likely be directed to pond 10 which will be appropriately enlarged in capacity to contain runoff from the catchment area. This pond would serve as an evaporation pond. The diversion ditch will be designed to protect the tailings area from flooding during the decommissioning project. The ditch will be gently sloped and vegetated as possible to minimize erosion."

These modified plans will require revision to page 4-4, Section 4.1.6.1 and page 4-30, Section 4.3.3.1.

Also Figure 2.1 as referenced in paragraph 1, Section 2.2.2.3, does not indicate Cottonwood Community or Cottonwood Creek.

6. Page 2-13, Section 2.2.2.4--The second sentence should be rewritten to reflect the past impact of mill operations. Suggested language would be, "Infiltration and leaching during use of and subsequent . . . ." Also in the paragraph it is stated that the TVA estimated volumes of materials to be disposed of may be too large, especially the TVA

RESPONSE

2. Reducing the potential for radiation exposure to the public is, of course, a major objective of the project. The text has been revised to state this.

3. The text has been revised accordingly.

4. Suggested corrections have been incorporated into the FES.

5. Changes have been made in Sects. 4.1.6.1 and 4.3.3.1 as necessitated by the licensee's above changes.

Figure 2.1 has been revised to include Cottonwood Creek and Cottonwood community.

6. A minor revision of the text has been made regarding the impact of mill operations in the past.

estimates for contaminated subsoils. Our initial estimates were conservative to ensure a sufficient disposal site volume. However, we agree that based on further studies a reduction in these estimates may be possible. TVA will remove any of the contaminated subsoil which would present a risk if not removed in the opinion of TVA's Environmental Policy and Compliance Staff or which does not conform to NRC/EPA guidelines. This comment also applies to page 2-1, Section 2.2.1.2 and page 2-28, Section 2.2.3.3.

7. Page 2-18, Treatment of Slimes, second paragraph--Topsoil would be mixed with the slimes only if the topsoil is determined to be contaminated or if it cannot otherwise be economically stockpiled. This paragraph should be rewritten to reflect this condition.

8. Page 2-23, Section 2.2.2.6, Cottonwood Community--This section should also reflect cleanup of the contaminated windblown tailings area east of the mill site. These two areas will both be surveyed and cleaned up near the completion of mill site decommissioning activities. See comment 5 above. In addition, the second sentence should read, "Because of the possibility of additional limited contamination occurring during . . . ."

9. Page 2-23, Section 2.2.2.7, Mill site reclamation--In general, reclamation of the mill site must be a function of the anticipated future use of the site once decommissioning cleanup is achieved. A sentence should be added in this section to reflect the necessary flexibility to reclaim the site in a manner consistent with the anticipated use. The objectives regarding reclamation as stated here are currently accurate, however, it should also be stated that an additional primary goal of reclamation is to stabilize the soil on the mill site. These comments also apply to page 4-4, Section 4.1.5 and page 4-9, Section 4.1.7.1, Reclamation.

10. Page 2-23, Site preparation, paragraph 1--The last sentence should include the phrase, " . . . and revegetated according to the proposed reclamation plan."

11. Page 2-23, Site preparation, paragraph 3--We anticipate site preparation to include deep ripping after application of topsoil and subsoil so that a differential interface between the topsoil and subsoil will not develop. Such an interface could create an area for accelerated water erosion, perched water due to a change in infiltration rate and possible site for accumulation of sodic material. This paragraph should be rewritten to reflect this intent. Also, the word "minimum" should be inserted before "depth" so that the second sentence reads "Topsoil will be applied to a minimum depth of 15 to 20 cm (6 to 8 in.)."

RESPONSE

7. Suggested corrections have been incorporated into the FES.

8. The text has been revised and Sect. 2.2.2.6 now discusses the windblown tailings east of the mill site.

9. The staff concurs and has revised appropriate sections of the FES accordingly.

10. The staff agrees. The text has been changed accordingly.

11. Sections 2.2.2.7 and 2.2.2.9 have been altered to reflect these changes and others proposed by TVA (see comments 14-16 on Sect. 2). The staff's evaluation of the proposed reclamation plan as revised has also been changed accordingly (Sect. 2.2.3.8).

12. Page 2-30, Paragraph 1, line 3 - There is a geological fault in the vicinity but not on the site itself. This fault is referenced on page 2-33 in the last sentence of the ninth paragraph.

13. Page 2-41, paragraph 3, lines 2 through 4--The statement is made that "contaminated materials in the trucks will be sprayed." Since covering the truck might be preferable to spraying and since the material may already be wet, the following rewrite of the sentence is suggested: "Contaminated materials in the trucks will be sprayed with a suitable material or the trucks will be covered, as necessary, to prevent airborne dispersion of contaminated particles during transport."

14. Page 2-43, paragraph 3

General--(This comment also applies to Section 2.2.2.5, page 2-21, and Section 4.1.7.2, page 4-10.) Reconstruction of Cottonwood Creek will be designed in consultation with TVA's qualified fishery biologists, the U.S. Fish and Wildlife Service, and the South Dakota Department of Game, Fish, and Parks. Since the subject section of Cottonwood Creek was channelized when under previous ownership and the amount of contaminated material to be removed from the stream has not been determined, the amount of reconstruction to be required is uncertain at this time. The cleanup procedure for Cottonwood Creek will involve removal of contaminated material as determined necessary. Stream restoration efforts will seek to make aquatic habitat at the mill site similar to reaches above the site. Stream reconstruction will include meanders (as space allows), riffle and pool areas, and stabilized banks with vegetation or structures which also provide fish cover. Reconstruction of the bank with uncontaminated fill material will be considered in the event contaminated material is removed.

The plowed strips or rototilled plots for the trees and shrubs are necessary to reduce competition for moisture until the trees and shrubs are established. We believe that placing roofing felt or plastic aprons around the trees would cause an increase in soil temperatures and would be aesthetically unappealing. Consideration will be given to more appropriate mulches such as straw. Planting of shrubs and trees at irregular intervals may be done to give a more natural appearance. A uniform bank slope of 10 degrees would not look natural in comparison to undisturbed reaches of the creek. Therefore, depending on ultimate land use (i.e., livestock grazing, wildlife, or industrial), plans for reconstruction of Cottonwood Creek may vary including slopes that differ from 10 degrees. However, irregardless of the land use, the requirements of Executive Order 11988, Floodplains Management, and Executive Order 11990, Wetlands Protection, will be met even if the property is relinquished from Federal control. These comments also apply to page v, General Aspects (d) and page 2-23, Section 2.2.2.7.

15. Page 2-43, Section 2.2.3.8, Paragraph 4--A distinction needs to be made here between topsoil and fill material in order to clarify the real need for borrow material. Current estimates are that sufficient suitable topsoil exists at the disposal site for reclaiming all disturbed areas. However, as stated in a March 26, 1981 letter from L. M. Mills to Ross A. Scarano, excess fill material should exist at

RESPONSE

12. The necessary corrections have been made.

13. The staff agrees, and the text has been rewritten.

14. The staff concurs with the licensee's plan to restore aquatic habitat in Cottonwood Creek as it flows through the mill site so that it will be similar to that upstream of the site. On the advice of the U.S. Fish and Wildlife Service (Sect. 4.1.7.2, DES), the staff recommended that the streambeds be stabilized where necessary with riprap and that the plan for reconstruction of the creek be done in consultation with the Fish and Wildlife Service and the state. Consultation can ensure that, if fill material is required, erosion can be limited to providing overhanging banks and not alteration of the stream channel.
The staff realizes that the plowed strips or Rototilled plots would reduce competition for moisture. However, use of a mulch (straw, roofing felt, or plastic aprons) around the trees and shrubs should enhance their chance of survival. Although roofing felt or plastic aprons may result in higher soil temperatures, they usually provide a more effective barrier than straw to competing grasses and weeds. Concern over the aesthetics of roofing felt or plastic aprons is not justified when one considers the state of disturbance the site will be in during the reclamation period. The staff concurs with planting the shrubs and trees at irregular intervals. The staff also agrees that a 10° slope for the banks of Cottonwood Creek would not look natural. The staff's evaluation of the licensee's proposal remains unchanged. Commitments by the licensee to comply with Executive Orders 11988 and 11990 were added to Sect. 2.2.2.7.

15. All sections of the document have been changed to reflect this information.

the disposal site for use at the mill site, but the amount of fill needed for mill site reclamation would likely exceed this excess. The actual additional amount of material finally required as borrow will be a function of the amount of contaminated material requiring removal from the mill site, the engineering schedule affecting use of the disposal site material at the mill site, the cost effectiveness of using the disposal site material versus other borrow materials, and the final grade of the mill site. These factors will be considered in justification of any actual plans to initiate borrow activity. Consistent with these parameters and that of achieving adequate reclamation, the total amount of borrow will be held to a minimum.

Based on additional study, TVA has located and acquired an area to provide for a potential source of borrow. Attached is a location map of the area TVA has acquired to provide for a potential source of borrow.

A conflict exists between this position and that discussed in other sections of the DES. Specifically, page v, General Aspects (f), page 2-23, Section 2.2.2.7, paragraph 4, and page 4-3, paragraph 2, should be revised to reflect the situation more accurately as it is described here.

16. Page 2-43, Section 2.2.3.8, paragraph 5--The proposed seed mixtures include plants utilized by wildlife and would not exclusively promote livestock grazing. Several of the plant species suggested by the U.S. Fish and Wildlife Service are not appropriate for the specific conditions of this project. Silver sagebrush (Artemesia cana) prefers moist shaded sites along the bottoms of draws and may root to a depth of 20 feet. Because of the gradual domed shape of the disposal site upon completion of decommissioning and the grading of other areas to blend with surrounding landforms, few if any draws or preferred sites for silver sage will exist. Also, because of the deep rooting characteristics of silver sage (possibly resulting in penetration of the disposal site cap and therefore potentially negating the caps effectiveness), it is inappropriate as a reclamation species for the project. Fourwing saltbrush (Atriplex canescens) is also capable of producing a deep rooting system. Little bluestem (Andropogon scoparius) naturally occurs on steep slopes and areas of shale. When capping and grading of the site is complete, few if any areas like this will occur. However, it, along with Indian rice grass (Oryzopsis hymenoides), will be given consideration as an appropriate addition to the seeding mix. We are also considering the addition of sideoats gama (Bouteloua curtipendula) and green needlegrass (Stipa viridula) to the mixture. All shrub species and yellow sweetclover (Melilotus officinalis) should be avoided on the disposal site due to their deep rooting characteristics. We are considering the following forb species for the disposal site in place of shrubs to increase the diversity and benefit wildlife.

Scarlet globemallow	Sphaeralcea coccinea
Winter fat	Eurotia lanata
Penstemon	Penstemon spp.

This comment also applies to page v, General Aspects (e).

RESPONSE

16. These proposed changes represent a conscientious effort to achieve a plant community that will not only be suitable for wildlife but will also be compatible with long-term stabilization of the tailings. These changes have been incorporated into Sect. 2.2.2.9. Additional changes recommended by Rodney Baumberger, SCS Range Conservationist in Rapid City, have been incorporated into Sect. 2.2.3.8. In addition, the staff agrees with TVA's discussion regarding deep-rooted species and has reflected this by making further changes in Sect. 2.2.3.8. Also see response to specific comment 23 of the State of South Dakota State Planning Bureau.

Chapter 3

THE AFFECTED ENVIRONMENT

1. Page 3-1, Section 3.1.2, paragraph one--the following sentence should be added at the end of this paragraph: "Collection of area-specific hourly-average wind speed and direction information began in March 1977."

2. Page 3-1, section 3.1.2, paragraph two, lines 6 and 7 - The last sentence should be revised to read, ". . . the average wind speed during the first three years of information is lower by about 1.7 m/s (3.7 mph) than that observed over the longer term NWS period."

3. Page 3-8, Table 3.5. See comment 3 (e) in Chapter 4.

4. Page 3-18, Section 3.5.1, first paragraph - This paragraph should accurately present the status of the Edgemont mine and mill (i.e., that there are no definite proposals). A suggested rewrite in the third line would be ". . . Wyoming, may begin in the 1980's . . . ."

5. Page 3-48, Section 3.9.1.1, paragraph 1--We disagree with the statement that revegetation was unsuccessful. Some reclamation efforts on the tailings were very successful. The present ground cover on some of the areas is as good as or better than surrounding natural vegetation. This comment also applies to page 4-7, Section 4.1.7.1.

6. Page 3-49, Section 3.9.1.2, Table 3.21--Although the figures given in the table are realistic for the Edgemont vicinity, they are not directly applicable for the disposal, haul road, and mill sites.

Chapter 4

ENVIRONMENTAL CONSEQUENCES, MONITORING TO DETECT IMPACTS, AND MITIGATION OF IMPACTS

1. Page 4-7, Section 4.1.6.4--We propose that the following be inserted between the second and third paragraphs of this section.

> The fill material used to reclaim the mill site represents a potential source of dissolved solids loading to the alluvial groundwater system. Fill material obtained from shales may contribute quantities of sodium, calcium, sulfate, and bicarbonate if sufficient water is available to leach the ions from the overburden. The net result of such leaching would be to extend the period of contaminant flushing. These potential effects are considered to be insignificant.

In general, it would be preferable from a water quality perspective to minimize the amount of fill material used to reclaim the site. (See comment 15, chapter 2, regarding minimizing fill used in reclamation of the mill site.)

RESPONSE

1. Suggested corrections have been incorporated into the FES.

2. Suggested corrections have been incorporated into the FES.

3. Suggested corrections have been incorporated into the FES.

4. Suggested corrections have been incorporated into the FES.

5. Sections 3.9.1.1 and 4.1.7.1 have been rewritten to reflect more accurately the results of the reclamation efforts in the past.

6. The text has been changed to indicate that the estimations of densities given in Table 3.21 are what could be supported on *undeveloped* lands. Results of the big game utilization studies on the disposal site have also been included.

1. The staff agrees that the fill material may be a short-term source of additional ions to be released to the groundwater; however, all reasonable efforts will be made to mitigate the short-term impacts of placement of fill material. The amount of fill material used to reclaim the site will depend upon the final contour.

2. Page 4-9, Section 4.1.7.1, Reclamation--Add the phrase "and wildlife habitat" after "livestock forage" in the first sentence of this paragraph.

3. Page 4-11, Section 4.1.8.

<u>General</u>

We agree with the overall conclusion reached in this section that no significant socioeconomic impacts are expected from the decommissioning project. However, we do have specific concerns with the analysis as presented. The three primary reasons for concerns are elaborated on below. In addition, we have several specific comments on technical aspects of the analysis which expand on the general comments. We would appreciate the opportunity to work with you regarding resolution of these concerns.

First, we find that the analysis in the DES provides a rather tenuous basis for the conclusion of no impact primarily because of the assumptions used to estimate the population influx. These assumptions do not reflect the expected seasonal nature of the work force and result in a population estimate which is more than double that provided in TVA's ER. This concern is elaborated on in comment (a) of this section. Although we believe the population estimate is unrealistically high, we agree that no impact should occur because of the likelihood of excess capacity in most local services resulting from the recent estimated population decrease (refer to comment (f) of this section). If such a decrease had not occurred, we would contend that an influx of that size would be large enough to cause significant impacts.

The second primary concern with the DES analysis concerns the relationship between the DES and the ER. Specifically, the socioeconomic inventory (Section 3.4) and analysis (Section 4.1.8) contained in the DES do not refer to TVA's Environmental Report as a source of information nor does it appear to have been used. The ER should be listed as a source, if used, and major differences between the information used in the DES and ER (such as those discussed below) should be discussed in the final EIS. If the ER has been consciously ignored, that too should be acknowledged.

The third concern deals with the tendency of the analysis to attribute to decommissioning many impacts which would actually result from areawide development or existing deficiencies in local services. Additional information on the magnitude and nature of anticipated cumulative impacts would be appropriate particularly with regard to population and fiscal projections. Also, greater recognition of the existing deficiencies in many local services would be appropriate. Such clarification would help avoid misinterpretation of the relatively small magnitude of anticipated socioeconomic impacts from decommissioning.

<u>Specific Comments</u>

a. The DES analysis has utilized a different set of assumptions

RESPONSE

2. The first sentence has been modified, stating that many of the proposed species for revegetation should benefit wildlife as well as livestock.

3. Socioeconomic issues were discussed with the State of South Dakota, the Sixth District Council of Local Governments, and TVA to resolve these concerns. There are two major reasons why the employment opportunities and population projections related to the mill decommissioning presented in the DES were different from those presented by TVA in the ER. The reasons are (1) the staff assumed that there were two phases of mill decommissioning, each dominated by a specific type of worker, and (2) the staff used maximum impact assumptions (more conservative than those in the ER). The staff has reevaluated the analysis and made the following changes: (1) Table 4.5 has been replaced with information from Table 4.8-2 in the ER and shifts the starting date of the project to 1982; (2) Tables 4.3 and 4.4 have been changed to reflect the information in the new Table 4.5; and (3) an additional analysis, shown in Table 1 accompanying this response, incorporates the assumption used in the ER which states that 10% (compared to 67.5% used by the staff) of the secondary workers will bring their families with them. The difference between these assumptions alone accounts for 55% of the difference between projections of the mill-related population influx found in the ER and those presented in the FES.

In the FES the staff retained the conservative assumptions used in the DES to predict population influx, thus affecting projections of numbers of families, school-age children, housing, etc., because we are presenting a maximum impact analysis. We have contrasted our conclusion with those reached by TVA in the ER to give the reader several conclusions from which to choose. In establishing the staff's assumption, the 1975 study by the Old West Regional Commission on construction worker profiles was used. We believe, despite the six-year age of the document, that this is a good source of information. The study covers 14 case histories in five mid-western states. We believe results from this study are valid and cannot be ignored. The staff could find no published studies to support many of the assumptions used by the licensee. Unpublished studies do not mean the assumptions are invalid. In fact, many assumptions are based on a consensus of a group of local, State, and TVA planners. These may be the best assumptions for the Edgemont area, but it is difficult for the staff to independently evaluate the basis for the assumptions.

Deficiencies in local services and facilities at Edgemont and Hot Springs are a problem that probably has resulted from years of dynamic economic conditions. These deficiencies are pointed out repeatedly in the FES. Mill decommissioning will aggravate deficiencies associated with sewage treatment and the water system. The FES has been revised where necessary to emphasize these points. The staff's position on cumulative effects has been stated in another response.

3a. See response to TVA general comment 3 on Sect. 4.

RESPONSE

Table 1. Estimated incremental impacts on employment, population, and housing caused by Edgemont mill decommissioning during peak operational employment

Corresponds to Table 4.4 in FES[a]

	Total regional impacts	Edgemont		Hot Springs	
		Low range	High range	Low range	High range
Employment opportunities	158-179				
Population influx	229-249	172-187	206-224	23-25	57-62
Families	33-35	25-26	30-32	3-4	8-9
School-age children	29-30	22-23	26-27	3-3	7-8
Housing demands	145-161	109-121	131-145	15-16	36-40

[a]This table uses assumptions found in Appendix B except for the following: 10% of the total secondary workers will bring families into the Edgemont area.

regarding employment characteristics than those contained in TVA's ER. The assumptions used in the DES result in a significantly higher estimate of the peak population influx and subsequent impacts on housing, schools, and local government finances. For example, the estimate of the population influx contained in the DES is a range from 426 to 534 while the estimate by TVA in the ER is 196. The primary reason for the large discrepancy is the different characterization of decommissioning employment. The ER indicates that most activity will occur between May and October and that 75 percent of the decommissioning employment in each year will be employed for only that period (seasonal employees). The remaining 25 percent will be operational or permanent employees. Both groups were projected to have significantly different characteristics (e.g., most of the seasonal workers would not stay the entire year nor bring families while most of the operational workers would). In contrast, the DES does not consider the seasonal nature of employment and assumes there will be two employment phases--one year of construction and five years of operation--with each phase having contrasting employee characteristics (similar to those used in the ER). As a result, the peak year population influx estimated in the DES is attributed solely to operational employment (the majority of which are expected to bring families) and is therefore significantly higher than the ER's estimate (which assumed that only 25 percent of the workers would be operational). The difference between the two sets of assumptions and the resultant difference in the estimates of population influx, secondary employment, housing needs, and school enrollments should be recognized in the final EIS. It should be noted that TVA's projections were coordinated with State, regional, and local planners at the time the ER was prepared and were accepted by them.

b. The DES analysis also utilized a different set of assumptions regarding location patterns of the inmoving workers among Edgemont and Hot Springs than was contained in TVA's ER. The assumptions used in the TVA analysis were coordinated with State, regional, and local planners. Such differences should be recognized in the final EIS.

c. Although Table 4.5, page 4-12, accurately lists the yearly employment totals for the project, the source given for the table and the two-phase breakdown is erroneous. The April 7, 1980 letter listed as the source actually provided information on the projected employment and population effects of all projects in the area and did not separate out this information just for mill decommissioning. The proper source for that information is Table 4.8.2 of the ER which lists decommissioning employment by seasonal and operating type for each year. There was no breakdown into construction and operation phases given in either the referenced letter or Table 4.8.2 of the ER.

d. The discussion of public sector revenues (Section 4.1.8.7, page 4-14) is vague and should be clarified. For example, Table 4.6, page 4-13, lists estimates of yearly project-related tax revenues without including the sources of those tax revenues (e.g.,

RESPONSE

3b. Assumptions made by the staff of the distribution of the population influx expected in Edgemont and Hot Springs covers a range that includes those made by TVA. The reasoning behind the assumptions of the staff are found in Appendix B.

3c. See response to TVA comment 3 on Sect. 4.

3d. Potential tax revenues listed in Table 4.6 were calculated from expected income due to sales, gas, and property taxes; liquor sales; mining lease remittance; and permits, fines, and licenses. The 1980 Fall River County Energy Impact Plan lists sources of revenue in 1981 as follows: property tax (16% of total revenue), sales tax (11%), rentals (2%), fines and forfeits (0.5%), permits and miscellaneous (4%), personal property tax replacement (2%), bond issue (63%), and tax in lieu (1%). Some of these sources of revenue may not apply to seasonal residents. Revenues generated by the project may not match the immediate community costs of the mill decommissioning. However, the long-term gains of the mill site cleanup will more than likely offset any short-term loss. Estimates of the total costs to Edgemont in the next three to five years of all expected energy development is given in the *Fall River County Energy Impact Plan*, August 1980. These projected costs exceed $8 million. TVA estimates that at the height of the mill decommissioning activity about 20% of people coming into the area will be moving in because of the mill (Table 4.8-4, ER); by the last year of decommissioning only 2.5% will be related to the mill (Table 4.8-5, ER). Proportioning the $8 million between the range of 2.5 to 20% equals a $200,000 to $1,600,000 cost for the decommissioning. The anticipated $400,000 benefit of the project (Sect. 4.6.8) may not cover the projected costs.

property, sales, income). Also, the discussion states that the project will not generate sufficient tax revenue to compensate for local costs to expand various services thereby giving the impression that the project is responsible for those costs. Similar statements are also included in Sections 4.6.8, page 4-35 and 4.9.2, page 4-36. In reality, most of those expenses are actually required to solve existing deficiencies. In addition, it seems inappropriate to state that the project-related revenue will not compensate for local costs without giving estimates of those project-related costs.

e. The population projections in Table 3.5, page 3-8, do not reflect the current or anticipated area employment situation or the apparent recent decrease in Edgemont's population (from an estimated 2,200 in 1979 to 1,471 in 1980). For example, the 1982 low-range projection for Edgemont of 3,388 indicates an increase of over 100 percent from 1980 population of 1,471. This projection seems inconceivable given the currently depressed uranium market and subsequent delays in area energy-related development as well as the drop in Edgemont's population. Clarification of the basis for these projections would be appropriate for inclusion in the final EIS. Such clarification should include definitions of the low, medium, and high ranges; an estimate of normal or baseline growth; and recognition of fluctuations in area employment levels.

f. The analysis presented in the DES does not recognize the apparent recent decrease in Edgemont's population (discussed above) in determining the conclusion of no impact. The decrease would be expected to result in an increase in the capacities of many local services thereby permitting accommodation of the decommissioning population influx without creating an impact. Discussion of this factor and more information on existing capacities of local services would increase the validity of the conclusion reached in the DES. For example, the estimated influx of as many as 125 students should be compared to any current or projected excess capacity in the school system to determine if the system could absorb the students without expansion.

4. Page 4-15, Section 4.1.9.2, Last two lines of first paragraph--Use of the 5 pCi/g and 2 pCi/m^2/s values may not be appropriate for the decommissioning project. Other cleanup standards may apply, or the means to comply with the stated values may be such that other wording would be more clear. TVA has proposed an alternative set of cleanup criteria and the means by which to determine compliance with such (see letter from L. M. Mills to Ross A. Scarano dated October 26, 1981). These proposed criteria should be considered in determining appropriate decommissioning cleanup levels. Finally, there is a typographical omission in the last line.

5. Page 4-16, Table 4.8--Assumed reduction factor for tailings dusting mitigation measures of zero percent may be overly conservative. Values in the range of 50 percent may be appropriate. We do note the statement in Section 4.1.9.8 that the assumptions "may lead to overestimation of the dose commitments." This comment also applies to page C-4, item 1.

RESPONSE

3e. The current population and population projections through the year 2000 and numbers of existing housing units have been updated with the 1980 census data and with documents published more recently than those used in the DES. Table 3.5, as well as appropriate sections in the FES, reflect the new data. It is interesting to note, however, that the new projections do not change the conclusion reached in the DES that the population in Edgemont could double by mid-1985 if all proposed energy-related projects become a reality. The doubling of the population is predicted despite the recent population decrease that was due mainly to the Burlington Northern layoffs (DES, p. 3-5).

3f. The recent decrease in school enrollment will increase the options available to educators to cope with any enrollment increases (FES, Sect. 4.1.8.5). In addition, it should be noted that many seasonal families with school-age children may elect to leave their children in the schools from which they came since the seasonal work schedule is projected to go from May-October. Families may be brought into the Edgemont area only during the June-August time period. The analysis presented in the FES is based on maximum effect.

4. The 2 pCi/m^2.s value is based on the expected radon exhalation from the tailings following reclamation and the 5 pCi/g value is based on expected soil concentrations following cleanup.

5. The NRC staff acknowledges that this assumption might be conservative for an operating uranium mill; however, the tailings areas at the Edgemont site are liable to give rise to greater levels of dusting because of the following:

The following is a list of documents that support the 50-percent reduction value:

a. EPA-450/3-77-010, "Technical Guidance for Control of Industrial Process Fugitive Particulate Emissions," by PEDCo Environmental, Inc., March 1977.

b. U.S. Environmental Protection Agency, "Supplement No. 8 for Compilation of Air Pollutant Emission Factors (including supplements 1-7), EPA Pub. No. AP-42, May 1978.

c. State of Wyoming, Division of Air Quality, "Guideline for Fugitive Dust Emission Factors for Mining Activities," January 1979.

d. U.S. Environmental Protection Agency, "Investigation of Fugitive Dust - Sources, Emissions and Control," by PEDCo - Environmental Specialists, Inc., PB-226 693, May 1973.

6. Page 4-1 , Table 4.8, footnote a--An ore grade of 0.25 percent U_3O_8 is quite conservative for the Edgemont site. Here again we note the statement in Section 4.1.9.8; however, based on the historical average ore grade for Edgemont, we believe use of a 0.20 percent U_3O_8 would be more appropriate.

7. Page 4-22, Table 4.13, "External ground" pathway--It is not apparent why the values during the decommisisoning are at the stated magnitude. Lower values would be expected considering, for example, the results listed in Table 4.10. Specifically, it appears that the values for the external ground pathway in Table 4.13 are excessive by a factor of 10.

8. Page 4-23, Sections 4.1.9.5 and 4.1.9.8--Use of the words "health hazard" may be ill-advised unless the document includes an assessment of or justification for the claim.

9. Page 4-23, Section 4.2--This entire section needs to be revised to reflect the current monitoring program as submitted to Ross A. Scarano from L. M. Mills, dated September 29, 1981, and October 28, 1981. As review and coordination of the program occurs and plans are finalized with TVA, this section can be developed in detail for incorporation in the FES.

A specific comment in the area of groundwater monitoring is as follows:

Page 4-27, Section 4.2.6.2--There is an apparent discrepancy between this section and others (page 4-7, Section 4.1.6.4; page 4-31, Section 4.3.3.2; and page 4-34, Section 4.6.3.2). If the "natural process is the only practical solution for restoration of ground water quality under the mill site" and the "disposal site is designed and constructed to preclude ground water contamination", then the stated ground water monitoring and the associated cost are unnecessary.

RESPONSE

- The tailings areas are not covered by tailings pond liquids and therefore subject dryer and larger areas to wind erosion.
- There are significant areas that are dried-out slimes and thus would expose more radioactive tailings dusts to wind erosion.
- There wil be excavating, dumping, and hauling activities to aggravate the normal dust loss from windblown suspension.

In light of these considerations, which are not usually present in more state-of-the-art tailings disposal areas, the staff feels justified in remodeling the decommissioning effort in this conservative manner. There are too many unknown factors involved with the decommissioning project to justify using a dust-reduction factor. Although this will present a worst-case scenario, the assessment does project that the decommissioning can be carried out in a manner whereby all appropriate exposure standards will be met.

6. The staff believes that an analysis biased toward maximum dose is desirable over a less conservative estimate when there are major unknowns in the assumptions. Therefore we chose to use an ore grade of 0.25% in the analysis.

7. The values presented under the postdecommissioning columns in Tables 4.10, 4.13, etc., are results of expected surface cleanup to 5 pCi per gram of U-238, Th-230, RA-226, Pb-210, and Po-210 and of approximately 2.0 pCi/ m^2·s radon flux.

8. The text has been revised accordingly.

9. The monitoring sections of the Environmental Statement have been completely revised to present the various monitoring programs. The staff's position regarding groundwater monitoring at the mill site is presented in Sect. 4.2.2.2 and 4.2.6.2.

10. Page 4-31, Section 4.3.3.2, paragraph 2--The intent of this statement is unclear.

11. Page 4-33, Section 4.6.3.1, paragraph 2--The degradation of Cottonwood Creek after reclamation is a continuation of an existing impact. Since decommissioning should not accentuate this problem, it should not be identified as an unavoidable adverse impact associated with the project.

12. Page 4-36, Section 4.9--The overall cost/benefit summary appears to be rather preliminary. It is assumed the FES will provide a more indepth cost/benefit analysis, including a discussion of benefits to the population versus project expenditures.

APPENDIX C

DETAILED RADIOLOGICAL ASSESSMENT

Page C-4, item 1--Assuming no reduction efficiency for mitigative measures is questionable. This relates to comment 5 of Chapter 4.

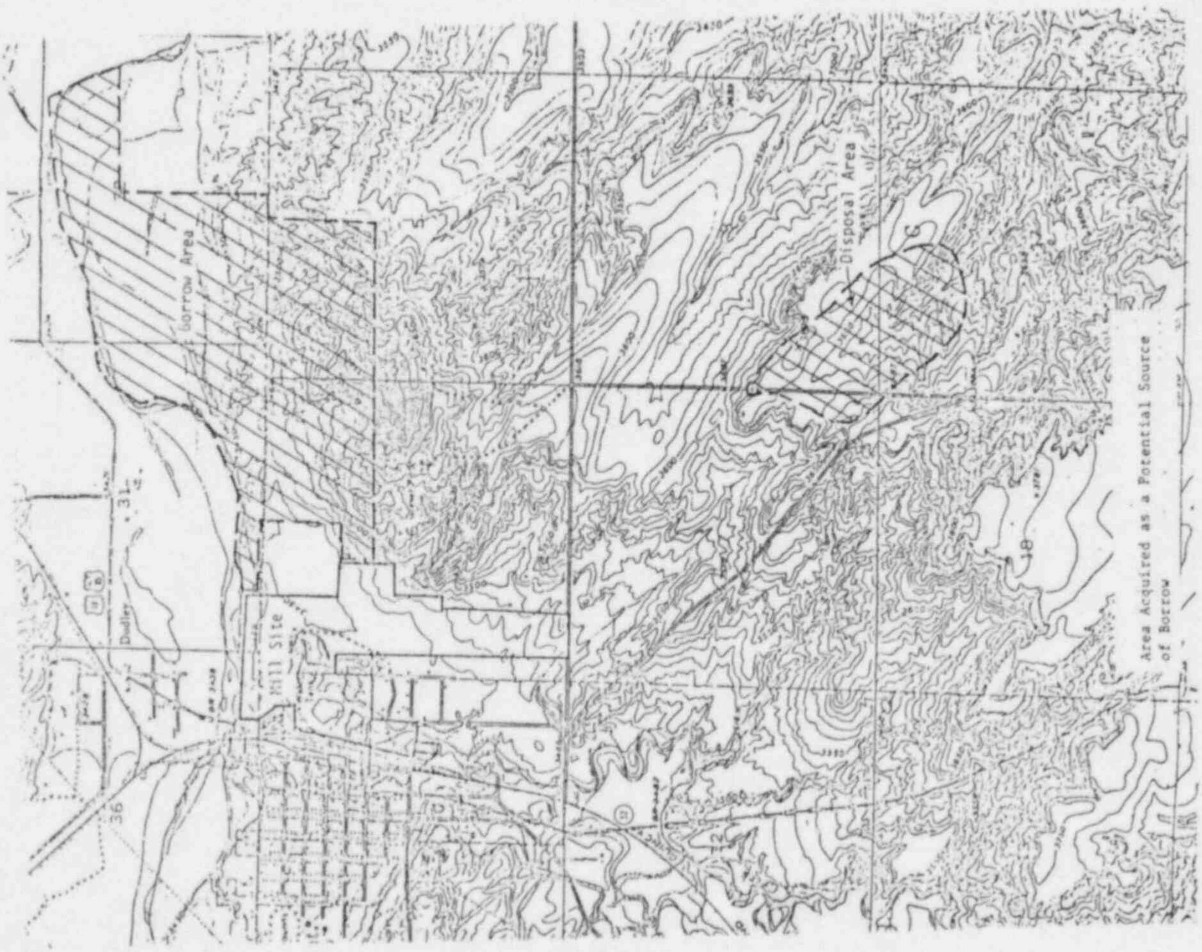
RESPONSE

10. The paragraph has been rewritten to read more clearly.

11. While the continued degradation of the creek may be seen as an existing process, the staff feels that it should be acknowledge because it will continue to occur even after reclamation of the site is completed.

12. The primary benefit of the project is reducing exposure of the Edgemont population to the tailings. There are also benefits which cannot be accurately quantified, such as removing the socioeconomic stigma of having the tailings located adjacent to the town. Justification of the project on the basis of a more detailed cost/benefit analysis is not required.

C. See response to comment 5 on Chapter 2.


Borrow Area
Mill Site
Disposal Area
Area Acquired as a Potential Source of Borrow

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November 12, 1981

Mr. Ross A. Scarano, Chief
Uranium Recovery Licensing Branch
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Scarano:

The Radiation Protection Bureau of Environmental Improvement Division - Health and Environment Department of the State of New Mexico has reviewed the Draft Environmental Statement prepared by the Nuclear Regulatory Commission (NRC) for the Edgemont Uranium Mill Decommissioning. It is the opinion of the Section that the costs to accomplish such a decommissioning plan would be excessive for any assumed health and safety benefits achieved by the public in Edgemont and the surrounding area.

We note that costs and health benefits for the various alternatives are not clearly identified and that this information is crucial for such decision making. It is our conservative estimate that the decommissioning plan recommended by the NRC would cost $25 tp $30 million to implement and complete. The magnitude of such costs borne by the Federal Government to correct postulated health effects that have not been adequately quantified may very well not be justifiable. Even if the alternative to reclaim the site in place under the current NRC standards was selected, we estimate a cost range of $12 to $18 million (alternative B1 page 2-27). This cost could be further reduced upon application of more reasonable standards now being contemplated by the Environmental Protection Agency (EPA) and Department of Energy (DOE).

This document does not discuss current radiological impacts (pre-decommissioning) vs. impacts resulting from decommissioning and benefits from post-decommissioning. It ignores what existing impacts are now in terms of radiological standards (MPC's) or estimated loss of life via risk of premature death from exposure and dose. Therefore, there is no comparision of whether or not the transportation loss of life (moving the tailings pile) is an acceptable risk, or more importantly, the occupational risk involved in moving the tailings pile. No occupational dose assessment is reported. Occupational risk may very well exceed current existing risks even with flooding in the area of the tailings pile. A risk/benefit analysis was not indicated.

RESPONSE

The commentor argues that the NRC cannot reject the no action alternative without having conducted a risk/benefit analysis and, further, that little evidence was presented to document that any harm could be expected under status quo conditions. NRC's rejection of the no action alternative is appropriate in view of the Congressional mandate contained in the Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA). Section 2.(a) of UMTRCA states that "[T]he protection of the public health, safety and welfare . . . requires that every reasonable effort be made to provide for the stabilization, disposal, and control in a safe and environmentally sound manner of such tailings in order to prevent or minimize radon diffusion . . . and . . . other environmental hazards . . . ." In addition, Sect. 161.x of the Atomic Energy Act of 1954, as amended, requires that "the need for long-term maintenance and monitoring of such sites . . . will be minimized and, to the maximum extent practicable, eliminated . . . ." Such clearly expressed congressional objectives simply could not be satisfied under a no action alternative.

The FES presents the staff's evaluation of the alternatives proposed by the licensee as well as alternatives developed by the staff against the NRC performance objectives for tailings management and guidelines for facility decontamination. The purpose of this evaluation is to (1) determine the adequacy of the licensee's preferred alternative, (2) determine whether other alternatives proposed either by the licensee or the staff are environmentally superior to the preferred alternative, and (3) if superior alternatives are identified, determine if the additional costs associated with these superior alternatives are warranted. The staff's evaluation of TVA's preferred alternative, which provides for offsite disposal of tailings, has concluded that the plan satisfies the NRC performance objectives for tailings management and guidelines for facility decontamination and that no other alternatives are superior from an environmental standpoint for this particular project. Because of the social impacts of the town of Edgemont resulting from the close proximity of the tailings and the use of tailings as fill material in the town, TVA has voluntarily committed to move the tailings and to move forward promptly with the cleanup plan once NRC approval is obtained.

Without conducting and reporting a risk/benefit analysis, NRC cannot state that the alternative of no action cannot be considered due to legal and moral reasons. The NRC cannot reject this alternative based on moral issues that affect our society as a whole. Little scientific evidence has been presented in the document to show that any harm could be expected to the local population.

The document states that the releases in moving the entire pile will be less than those during previous operations. However, the decommissioning releases will take place in a very condensed time frame and therefore increase the dose rate to the populations exposed. This assertion is therefore, not a justification for moving the pile with little adverse effects. Decommissioning as proposed, results in 20-30% of MPC's to whole body and bone!

Damage or effects from the 1971, 1978 floods that exceeded the pile base elevation were not reported. Study of the effects could indicate that little or no health effects could be expected from later floods.

The standards promulgated by the NRC on October 3, 1980 are under litigation from the uranium industry, and seriously questioned by Federal agencies, State governments and the U.S. House and Senate because they were not considered to be adequately based on health considerations to the general public. These views were presented in public hearings in New Mexico in great depth with a variety of concerned parties present and have not been successfully refuted by the NRC. As a result, the Environmental Improvement Board (EIB) of the State of New Mexico has adopted modified regulations and standards for its uranium industry that it feels are justifiably based on radiation health hazards to the work force and the general public. Action is underway through the courts and the Congress concerning the enforcement of the published NRC regulations.

If decommissioning of the Edgemont Mill is to be used as a model for future decommissioning of inactive and active uranium mills throughout the country, we believe the costs to the U.S. and the State governments as well as the uranium industry will be excessive and unrealistic in comparison to the estimated health benefits achieved.

This State recommends that the least costly option of reclamation be implemented or that only interim stabilization be accomplished at this time until reasonable standards based on scientific data and realistic health considerations are properly promulgated by the EPA for decommissioning and reclamation of uranium mill sites.

Sincerely,

Gerald W. Stewart

Gerald W. Stewart, Health Program Manager
Uranium Licensing Section
Radiation Protection Bureau

TBC/GWS/dm

RESPONSE

By utilizing one or more lined impoundments, placing thick earthen covers over them, and placing riprap on slopes and streambanks, onsite stabilization might be a technologically feasible alternative. However, because the licensee's preferred alternative of offsite disposal and stabilization would provide a much higher degree of certainty for successful long-term stabilization of the tailings and contaminated materials, without routine maintenance, the alternative of onsite stabilization was not explored any further. Despite the potential disadvantages and impacts, the staff feels that a properly designed offsite disposal plan will result in superior long-term stabilization without the need for ongoing monitoring and maintenance.

While the experience gained from this project should prove to be valuable for future decommissioning and remedial action projects, the staff's endorsement of offsite disposal in the case of the Edgemont tailings should not set a precedent for similar disposal at other active or inactive sites. The appropriate method of decommissioning and/or remedial action for other sites must be determined on a site-specific, case-by-case basis.

In addition, the staff's radiological assessment shows that exposures will be within appropriate radiation protection guidelines and the staff's analysis of accident potential shows the occupational risk to workers to be acceptably low.

South Dakota
DEPARTMENT OF GAME, FISH AND PARKS
DIVISION OF WILDLIFE

3305 West South Street
Rapid City, SD 57701
(605) 394-2391

November 13, 1981

Mr. Harry J. Pettangill
Section Leader
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Attention: Uranium Recovery Licensing Branch

Dear Mr. Pettangill

Please accept the following comments and suggestions regarding the Draft Environmental Statement Related to Decommissioning of the Edgemont Uranium Mill. Docket Number 40-1341 USNRC September 1981.

1. The Department of Game, Fish and Parks has made two wildlife surveys of the proposed commission site. Observations of the site showed that Black-tailed Prairie Dogs (Cynomys ludovicianus) have moved into that immediate area. Thirteen-lined ground squirrels (Citellus tridecemlineatus) were also observed there. Both of those species are ground dwellers and could conceivably burrow into the uranium tailings pile, become contaminated, and in turn, be caught and eaten by several endangered species that do or could inhabit the area. These species are, but are not limited to: the Bald Eagle (Haliaeetus leucocephalus), the Peregrine Falcon (Falco peregrinus), and the Black-footed Ferret (Mustela nigripes).

2. Because of this potential, a monitoring system to determine radio activity levels in mammals and birds should be done for a sustained period of time. In reviewing the DES, I notice that there seems to be no such plan for a monitoring system, i.e. page 4-29, 4.2.7.2, Terrestrial biota. During decommissioning, stabilization, and reclamation, "Monitoring the terrestrial biota is not specifically planned for the decommissioning and stabiliization phases of the project."

3. Base-line studies to determine usage of the area of selected birds and mammals should be done on a sustained basis to determine species composition and population densities of terrestrial faunna utilizing the area.

Thank you for the opportunity to comment.

Sincerely

Jon C. Sharps
Endangered Species Coordinator

JCS:mg
cc: John Kirk
Ron Fowler

RESPONSE

1,2. In response to a Fish and Wildlife Service letter of December 22, 1980, regarding the potential presence of threatened and endangered species at the disposal site, the staff prepared a "Biological Assessment" (February 5, 1981). On March 17, 1981, the Fish and Wildlife Service concurred with the staff's conclusion of the assessment that no Federally listed or proposed endangered species are expected to be adversely affected by the proposed project. Nevertheless, the potential does exist for prairie dogs to burrow into the tailings. Black-tailed prairie dogs have been known to burrow to a depth of 4.4 m (14.5 ft); 13-lined ground squirrels probably do not burrow deeper than about 1.2 m (4 ft) (W. B. Davis, *The Mammals of Texas*, Texas Game and Fish Commission, Bulletin No. 27, Austin, Tex., 1960). The tailings will be covered by a minimum of 1 m (3 ft) of compacted clay and 2.1 m (7 ft) overburden. Although it is unknown whether prairie dogs could penetrate the compacted clay, the low specific activity of the tailings would offer little potential for contamination of burrowing species to the extent that it would result in adverse effects to animals higher in the food chain. TVA's monitoring proposal includes provisions for sampling vegetation for radionuclide content; if abnormal levels are found, remedial measures would be taken.

3. Although the proposed project may affect terrestrial biota over the short term, no significant long-term effects are expected; therefore, the staff does not feel that further surveys are warranted.

STATE PLANNING BUREAU
State Capitol
Pierre, South Dakota 57501
605/773-3661
SOUTH DAKOTA Office of Executive Management

RESPONSE

November 5, 1981

Mr. Harry J. Pettengill, Section Leader
U.S. Nuclear Regulatory Commission
Washington, DC 20555

ATTN: Uranium Recovery Licensing Branch

Dear Mr. Pettengill:

Considering the length of time involved in preparing the Draft Environmental Statement (DES) on decommissioning the Edgemont uranium mill, we were hoping that substantial redrafting would not be necessary. Since any delay in the decommissioning continues to expose the citizens of Edgemont to possible radiation hazards, we hope NRC will address our comments and redraft the DES as soon as possible.

Our comments are intended to expedite the decommissioning in an efficient manner. South Dakota is firmly committed to seeing that the decommissioning is completed with utmost regard for social, environmental and health considerations. We would request that the Nuclear Regulatory Commission initiate contacts with the state prior to and during preparation of future revisions to the DES and the final environmental impact statement. Many of our concerns with the DES could have been resolved if the state had been consulted during its development. As it stands, the DES is not consistent with the Edgemont Uranium Mill Decommissioning Plan which the Tennessee Valley Authority (TVA) prepared. TVA's plan was the result of frequent negotiations between the state and TVA. As an example, the methodologies for population, housing and public facility projections in the DES and TVA's plan are at obvious odds with each other. The state is very concerned that future projections include both the socio-economic impacts of decommissioning, and the impacts of construction and operation of projected uranium mining if the two phases take place concurrently or the impacts overlap.

Other comments which the state made on TVA's plan and were not thoroughly addressed in the DES include:

1. Radiation monitoring schedules at the mill site and disposal area;
2. Maintenance of containment of radiation at the disposal site;

During the scoping process, the staff met and contacted numerous state and local officials regarding the proposed project. Additionally, the staff met with various persons from the State Planning Bureau and Department of Water and Natural Resources on April 8, 1982 to discuss concerns raised in this letter and the enclosed memoranda. In the recent meeting, a revised socioeconomic analysis was discussed and the staff presented details of TVA's proposed monitoring and cleanup plans. The following responses were also presented and discussed in detail.

RESPONSE

3. Prospectus for returning the land and associated aquifers and waterways at the disposal site to unrestricted use.

The State of South Dakota appreciates the opportunity to comment on the DES and we look forward to a joint effort in addressing our concerns.

Sincerely,

Tony Merry
Commissioner
STATE PLANNING BUREAU

TM:CM:jrr

Socio-Economic Considerations

The State Planning Bureau has reviewed the socio-economic portions of the DES. Many discrepancies exist between the DES and the Edgemont Decommissioning Plan and Environmental Report which was prepared by the Tennessee Valley Authority (TVA). In many instances the DES references materials which are outdated and no longer applicable. The TVA, the Sixth District Council of Local Governments, and the State of South Dakota have worked together very closely in developing methodologies for population projections and subsequent housing and public facility needs. We would urge the Nuclear Regulatory Commission (NRC) to review TVA's plan for consideration for inclusion in the revised DES or final environmental impact statement.

Reference materials are available which can substantially enhance the context of the DES. For a complete listing of reference materials note the list of recently published documents which was supplied by the Sixth District Council of Local Governments in their October 26, 1981 comments to the NRC.

RESPONSE

The staff has reviewed the socioeconomic portions of the DES and has made extensive revisions that reflect updated information. Our approach in determining the socio-economic impacts has been compared and the State Planning Bureau in the FES to that of TVA.

Specific Comments on Socio-Economic Aspects

(1) Section 3.4.1 Population - Published census data for 1980 can be used to update the present populations in Fall River County, Edgemont and Hot Springs. The new data shows the county population at 8,439; the Edgemont population at 1,468 and the Hot Springs population at 4,762.

(1) Population data has been updated. Also see responses to TVA comments 3e and 3f on Sect. 4.

(2) Table 3.5 makes no reference to the population influx of persons involved with the projected uranium mining and milling operation that TVA has scheduled. According to the most recent timetable of TVA, the mine construction will begin in 1983. Although there is a likelihood that workers involved with decommissioning will transfer to the mining operation, some increase in the work force will be realized. We would recommend that Mr. George DeVeny, Supervisor, Socioeconomic Analyses Section, Division of Community Services, TVA, Knoxville, Tennessee (615) 632-6990 be consulted in any future revisions to this section.

(2) The staff recognizes the need for local governments to plan for all anticipated increases in growth. Some of the analyses performed in this FES address cumulative impacts such as those concerned with population projections. However, it is not within the scope of a site-specific environmental impact statement to address impacts due to other, nonrelated activities. The analyses presented in the FES should prove valuable to State and local planners as an aid in preparing an assessment of the total potential energy-related activities in the area.

(3) Section 3.4.2.1 Edgemont Housing. The 1980 published census data shows that there are 685 residential units, not 486.

(3) Section 3.4.2.1 has been revised.

(4) Table 4.5 Peak Employment Levels. The projected employment schedule shows that from 65 to 80 persons are employed in 1981 for decommissioning. The table should be changed since no activity is taking place.

(4) Table 4.5 has been revised to reflect on updated schedule.

(5) Section 4.1.3 Population. The projected population of this section indicates that Edgemont and Hot Springs will have increases in population in 1982 in the amount of 3,400-5,700 and 7,400 to 7,500 respectively. Since TVA's schedule does not call for moving the tailings until the 1983 construction season, it is very unlikely that such population increase will take place in 1982.

(5) Section 4.1.3 has been revised to reflect the new scheduling times.

(6) Section 4.1.8.4 Housing. TVA's schedule of events (see comments on 4.1.3) for decommissioning would delay the greater needs for housing until 1983. The Fall River County Energy Impact Plan should be consulted for housing projections.

(6) See responses to TVA comments 3e and 3f on Sect. 4. The Fall River County Energy Impact Plan has been used in revising this section.

MEMORANDUM

RESPONSE

To : Richard L. Howard, Deputy Director
Department of Water and Natural Resources

From : Randy Brich, Environmental Specialist III
Office of Air Quality and Solid Waste

Subject: Review Comments on Draft Environmental Statement
Related to the Decommissioning of the Edgemont
Uranium Mill - NUREG-0846

Date : November 2, 1981

INTRODUCTION

The United States Nuclear Regulatory Commission (NRC) staff cost-benefit summary in the Edgemont Draft Environmental Statement (DES) (p. 4-36) states that the environmental effects due to noise and dust will be slight since the tailings disposal operation and mill site decommissioning will be accomplished using trucks and a slurry pipeline over a contained corridor between the existing millsite and remote disposal site. The DES further states that

> "the radiation exposure of the nearby public may be temporarily increased during project operation, but monitoring and mitigating measures will keep such potential exposure well below permissible guidelines for protection of the health and safety of the public. After project completion, the millsite will be available for unrestricted surface use, and the chronic low-level excess radiological exposure, which presently exists near the site, will no longer be present."

On page 2-1 the DES states that

> "the primary goal of millsite land decontamination is to return the mill site to productive use after removal of the tailings to a new disposal site. All of the uranium tailings will be removed from the site. It is not known, however, to what extent the soils below the tailings piles have been contaminated (heavy metals and radionuclides) by seepage of tailings liquor and what quantity of this contaminated soil may have to be removed. The staff feels that the exact cleanup limits to be met should be based on site-specific considerations and on an evaluation of the environmental benefits of moving increasingly lower levels of contamination vs. the economic cost of such action. These cleanup

Dick Howard
Page 2
November 2, 1981

limits can only be determined once the exact depth and concentration of contaminated material are known. At the Edgemont site, such a final determination will not be feasible at some locations until tailings are removed from the site. In determining exact cleanup limits, the major consideration will be to ensure that resulting radiation exposures to individuals using the decontaminated land will be within current radiation exposure guidelines and as low as is reasonably achievable. Depending on the cutoff limit ultimately established for removal of contaminated soils for disposal at the new impoundment area, it may be necessary to institute some land use controls at the reclaimed mill site; i.e., residential development of the site would not be permitted."

With these statements in mind the following general and specific comments are offered to either clarify an existing point or request additional justification concerning apparent discrepancies.

GENERAL COMMENTS

1 The DES does not specifically state actual decontamination values for the cleanup of wind-blown tailings or the contaminated alluvial material beneath the ponds. The USEPA recently published the DEIS for Remedial Action Standards for Inactive Uranium Processing Sites (40 CFR 192) which sets rather stringent cleanup standards in order to allow the decontaminated areas to be released to unrestricted use. Since these standards have already been developed, it seems reasonable to follow the Draft Standards as closely as possible. Deviations from these Draft Standards should be documented and an evaluation of the associated environmental effects should be compiled.

2 The DES states that "Details of specific monitoring programs for air quality, surface and ground water quality, external radiation and soils must be developed by the applicant and submitted to the NRC for review and approval prior to implementation." The Department of Water and Natural Resources (DWNR) should be allowed to be involved in the review process of the proposed monitoring plans prior to their implementation and inclusion in the Final Environmental Statement (FES).

3 The DES does not discuss the implications of the long half-life of the thorium-230 isotope (80,000 years). According to Table 4.8 in the DES, 99.5% of the total thorium-230 activity in the ore remains in the tailings, or several thousand Curies of thorium-230. Consideration should be given to stabilization efforts designed to accommodate such a lengthy time period. Denudation rates applicable to semi-arid terrains indicate that 3 meters (10 feet) of earth would be removed under natural processes in about 33,000 years at which time only 26 percent of the thorium-230 will have decayed (Lande, 1980). The tailings would be exposed to wind and water erosion if reburial does not occur.

RESPONSE

1. The EPA is presently reviewing the 40 CFR Part 192 regulations and has urged the staff not to place significant emphasis on the existing standards in determining cleanup criteria for the Edgemont mill site and surrounding areas. TVA has conducted extensive field surveys in the areas of windblown tailings and has taken an approach geared toward identifying areas where gamma radiation is significantly above natural background, investigating these areas to determine if tailings are present, and if this is the case, removing the tailings and contaminated material. After initial cleanup, the area would be resurveyed to ensure that established cleanup levels have been achieved. Regarding cleanup of contaminated material at the mill site, criteria will be established so that the level of direct radiation and radon concentration will be returned to the range necessary for the anticipated future use of the site, be it residential or commercial. The goal of mill site cleanup is to return the site to productive use with possible restrictions on the type of use (residential vs industrial), building construction, and excavation.

2. TVA's proposed monitoring programs were presented to the DWNR staff for comment. The finalized approved monitoring program is presented in the FES.

3. The location and design of the disposal impoundment should ensure that long-term stability will not be a problem. The denudation rates cited, as Landa aptly points out, require qualification:

> "The regional denudation rates do not consider local conditions such as position in drainage basin and topographic wind breaks, which may cause local erosion rates to deviate considerably in either direction from the regional mean."

By locating the impoundment at the head of the ephemeral drainage, subjection to sheet erosion and gullying caused by running water would be minimized. Additionally, the reclaimed surface will be contoured to very gentle slopes, will be sheltered from the prevailing winds by the natural ridges which form the northern and western boundaries of the site, and will be armored with riprap to further protect the integrity of the impoundment. Finally, the disposal site will be licensed by the NRC, controlled by a government agency, and subjected to routine inspections to ensure that mitigative measures can be taken if erosion threatens the stability of the impoundment.

While no one can guarantee stability for periods as long as 80,000 years, especially in light of the geologic and climatic changes which we know will occur during the future, the staff feels the design of the impoundment represents the best effort possible utilizing current technology and offers every prospect for successful long-term isolation of the tailings from the environment.

4 According to a published USGS report (Landa, 1980) reduction of th radon flux to meet NRC goals (2 pCi/m^{2}-s) could require 12 meters (40 feet) of cover depending on the cover material particle size distribution, bulk density, moisture content, and other factors affecting permeability of radon emanation. Reduction of radon emanation to the maximum extent (about 99 percent) requires internment below 12 meters (40 feet), especially in view of the previously cited erosional rates.

5 The plan does not discuss the possibility of neutralizing the pH of the tailings, especially the slime fraction, in order to lower the solubility of the thorium-230 and radium-226 isotopes. Consideration should be given to neutralization of the pH as an added precaution against migration of the radionuclides into the alluvial ground water system.

6 The DES states in several places that the impoundment will be designed for containment of the radioactive tailings for the forseeable future, however, no definition of this term is provided in the text. The DES does not adequately address final ownership and responsibility for the original mill site and proposed disposal site.

SPECIFIC COMMENTS

1. Page 1-3, Table 1.1

   The granting or approving authority for the approval for disposal of both nonradiological demolition solid wastes and domestic or municipal type solid wastes, should be listed as State of South Dakota and local authority. Footnote "b" should read, "Department of Water and Natural Resources, Office of Air Quality and Solid Waste". Also in this table Department of Environmental Protection should read, "Department of Water and Natural Resources."

2. Page 2-10, Section 2.2.2.3, First Paragraph

   This section states that the wind blown sand tailings east of the mill site would be decontaminated before construction of the mill area diversion ditch. It is understood that prevention of runoff impacts from the wind blown area to the Cheyenne River are of primary importance, however, there is no mention of any post-decommissioning radiological surveys to ensure that recontamination does not occur. The Final Environmental Statement (FES) should include some provisions for post-decommissioning radiological surveys of this area in order to ensure that the area did not become recontaminated as a result of the decommissioning activities.

RESPONSE

4. The staff has determined that radon flux from the reclaimed impoundment would be reduced to about twice background with the implementation of the proposed plan. Following deposition of tailings and contamianted material in the impoundment, a compacted clay cap of at least 1 m (3 ft) in thickness would be installed, followed by a minimum of 2.1 m (7 ft) of fill. The staff's calculations of the radon attenuation take into account the specific characteristics of the local soils which will be used for cover material and can be found in Appendix E of the FES.

5. Although some of the tailings will be put into the impoundment in a slurry form, the applicant will dewater the tailings before placing the clay cap and cover material over them. The impermeable shale (or the clay liner if required), which will form a barrier against seepage on the sides and bottom of the impoundment, and the compacted clay cap placed over the tailings will totally encapsulate the tailings and preclude both infiltration of moisture into the tailings and seepage of any residual moisture from the impoundment. Therefore, because there will be no significant amount of free water available to transport contaminants, the staff feels attempts to neutralize the pH of the tailings would offer no additional benefit and are not warranted.

6. Revised language presented in the FES more clearly explains ownership, use, and control of both sites. The disposal area will be licensed by the NRC and managed by the Department of Energy or if so requested, by the State of South Dakota. Provisions for the arrangement are specified in the Uranium Mill Tailings Radiation Control Act of 1978. As for the mill site, current cleanup plans call for decontamination to a degree that will allow restricted industrial use of the site. The details of this plan are presented in Section 2.2.2.4.

1. Suggested corrections have been incorporated into the FES.

2. Since the publication of the DES, TVA has modified the plans for cleanup of offsite windblown contamination. As stated in Sect. 2.2.2.3 of the FES, the areas of windblown tailings will be cleaned up following removal of tailings from the mill site. After the windblown tailings are removed, gamma radiation and soil surveys will be performed to ensure that all contamination which requires cleanup has been removed.

3. Page 2-10, Section 2.2.2.3, Subsection Diversion Ditch.

   The potential for significant contamination of the Cheyenne River may exist. Periodic monitoring of the diversion ditch discharge for radiological parameters should be undertaken to provide a means of assessing actual conditions.

4. Pages 2-27, 28; Sections 2.2.3.1-2. Alternatives A2 and B2 are the State preferred alternatives. (see attachment number 1)

5. Page 2-39, Section 2.2.3.7.

   The performance objectives do not describe criteria for decontamination of wind blown sand tailings or material that may be translocated during construction activities. Removal of contaminated areas should be contingent upon specific criteria that will allow for decontamination of these areas.

6. Page 3-31, Table 3.18

   The dissolved oxygen (DO) values exceed the maximum saturation for the temperatures given at (S-6, S-7, S-8, S-10, and S-11) locations. See page 480 of "Standard Methods for the Examination of Water and Wastewater," 13th Edition, 1971.

7. Page 4-2, Section 4.1.1 Air Quality

   The DES states that non-radiological air quality will be monitored, however, there is no indication of the anticipated "turn-around-time" on the sample analysis. The FES should address a "turn-around-time" estimate and evaluate dust mitigation measures based on the actual estimate.

8. Page 4-2, Section 4.1.2 Radiological Environment

   In the fourth paragraph the DES states that "radon gas concentrations above background levels have been detected up to 1.1 km (0.7 mile) from the site". The DES does not state what the background radon gas concentration for Edgemont vicinity is, nor the location, duration or frequency of the measurements.

9. Page 4-5, Section 4.1.6.1. Subsection Mill Site

   The second paragraph discusses the lack of an existing data base which defines types and quantities of contaminated material in both Cottonwood Creek and Cheyenne River. The Department of Water and Natural Resources (DWNR) is in agreement with the U.S. NRC that compilation of an extensive data base should be required of the applicant prior to rerouting of Cottonwood Creek. DWNR plans to take an active role in the design of the proposed monitoring plan.

RESPONSE

3. Another recent modification of the decommissioning plan concerns the diversion ditch. Because the runoff collected by the ditch will be considered contaminated (windblown tailings will not be cleaned up until after removal of tailings from the mill site), it will be routed to Pond 10 onsite. Therefore, no effluent from the diversion ditch will be discharged to the Cheyenne River floodplain as previously planned, and this eliminates the need to monitor the discharge for radiological parameters.

4. No response is required.

5. Following removal of tailings and contaminated material from the mill site and the subsequent cleanup of windblown contamination from offsite areas, all areas will be subjected to gamma radiation surveys, and soil samples will be analyzed for radium content to document that established cleanup levels have been achieved. Criteria for land decontamination are discussed in Section 2.2.2.4.

6. The staff has examined Table 422:I, "Solubility of oxygen in water exposed to water-saturated air," in the 14th edition of *Standard Methods for the Examination of Water and Wastewater* (1975) and concurs with this comment. Based on this table, the values for sampling sites S-6, S-7, S-8, S-10, and S-11 of Table 3.18 would be expected to be 8.2, 9.2, 8.7, 8.4, and 8.5. Because this table was taken from the ER (Table 4.2-3), the staff contacted TVA for an explanation. TVA's response was that the dissolved oxygen meter used in the survey was calibrated before use but not after; thus, the data are probably in error. This explanation was presented to James R. Richardson of the State of South Dakota Planning Bureau by L. M. Miller of TVA in a letter dated Jan. 30, 1981, in response to the Bureau's review of revision 5 of the ER.

7. TVA's monitoring submittal states the monthly hi-vol sample results will be provided to the State of South Dakota within 35 d after the end of each sampling month. The staff will require that results from total suspended particulates and radiological monitoring and records of implementation of dust control measures be made available to the decommissioning operations managers as soon as possible and that the effectiveness of these measures be evaluated periodically so that additional measures may be implemented as necessary.

8. According to the Ford, Bacon and Davis, Utah, Inc., engineering assessment of the Edgemont site (1978), background radon levels of 1.1 and 1.5 pCi/L were found at sample locations 3.3 miles south and 1.3 miles west of the mill site, respectively. These measurements were taken in August 1977, and during this time winds blew from the mill site towards Edgemont for several days. The average background concentration to the west of the mill site was found to be 1.2 pCi/L during this survey. A concentration of 1.3 pCi/L was recorded at a motel located 0.4 km (0.7 mile) west of the mill site. The survey was conducted for a 7-d period, and these concentrations are 24-h average concentrations.

9. The staff concurs with this comment.

10. Page 4-15, Section 4.1.9.1 Radiological Assessment - Subsection Introduction

In the second paragraph of this subsection the DES states that the milk pathway was omitted from the radiological assessment. The DWNR contends that the milk pathway is an important parameter of potential exposure and its omission could cause an underestimate in the potential dose commitment. Also, DWNR staff observed a couple of penned goats during July, 1981, adjacent to the west fence bordering tailings pond #2. The DWNR believes that at least one of the goats is presently confined in the same location. In this regard, DWNR requests that the milk pathway (goats) be included in the radiological assessment in order to more accurately reflect actual field conditions.

11. Page 4-15, Section 4.1.9.2. Estimated Releases

Line 6 of Section 4.1.9.2. appears to have several typographical errors in it. This also appears to be the only place that a quantitative cleanup standard is given. If so, perhaps the FES could discuss the cleanup standards in somewhat greater detail.

12. Page 4-16, Table 4.8

The source for the assumed average activities for the radiological parameters should be referenced in the FES.

13. Page 4-23, Section 4.1.9.6. Occupational Dose

The DWNR wishes to review the radiological safety program prior to its inclusion in the FES.

14. Page 4-23, Section 4.2. Monitoring Programs

The DWNR wishes to review all environmental monitoring programs prior to their inclusion in the FES.

15. Page 4-24, Section 4.2.2. Radiological Environment

The DWNR wishes to review the environmental monitoring program (EMP) prior to it's inclusion in the FES.

16. Page 4-25, Section 4.2.3.2. During Decommissioning, Stabilization, and Reclamation

The DES states that a soils radiological monitoring program will be accomplished, however, no monitoring criteria or action levels are provided. The DWNR requests that the operation and monitoring plan be submitted to the DWNR for review prior to its inclusion in the FES.

RESPONSE

10. There is a city ordinance prohibiting open grazing of animals. Local officials have assured the TVA that this ordinance was and is enforced (March 30, 1981, letter from TVA to R. A. Scarano of NRC). Penned goats, then, do not have access to open grazing areas and thus are limited to stored feed. Thus, the NRC staff believes that without any dairy industry and without access for dairy animals to contaminated pasture, it would be unrealistic to include the milk pathway with respect to nearby individuals and population.

11. This line was mistyped, and corrections have been made to the text. The stated values were used as assumptions for basing calculations of releases following completion of decommissioning activities, and the staff still feels these assumptions are valid. The basis for these values are expected soil concentrations of 5 pCi/g and expected radon exhalation of 2 pCi/m^2.s.

12. The footnote to Table 4.8 identifies the basis for the average activities of the uranium tailings solids. The assumed values of ore grade and radionuclide specific activities were based on submittals from TVA, ref. 6 of Sect. 4 of the DES, and staff estimates when site-specific information was not available.

13. The review and approval of an operational radiological safety program is a separate NRC action, which requires development of a Safety Evaluation Report (SER). Because all details of some activities are not yet finalized, the staff has agreed to accept a generic program outline at this time, with TVA to fill in all details before the staff completes the review. Regardless of when the program is finalized, it will be subject to NRC approval, and we would welcome any comments that the DWNR staff might have on the proposal.

14-17. Various monitoring programs were reviewed by the DWNR in meetings with the staff on April 8, 1982.

Dick Howard
Page 6
November 2, 1981

17. Page 4-27, Section 4.2.6.2 Groundwater

The DES states that ground water monitoring at both the existing site and the proposed disposal site will be accomplished prior to, during, and after decommissioning. The DES does not provide the parameters to be monitored, methods, or frequency of sampling. The DWNR requests that this information be included in the FES.

18. Page 4-28, Section 4.2.7.1 Aquatic Biota

In the fifth line, the DES reads micro-invertebrates, perhaps macro-invertebrates were the intended organisms.

19. Page 4-31, Section 4.4 Staff Assessment

The DES states that an evaluation of environmental consequences will be submitted to the USNRC by the applicant for any activity not previously evaluated, due to its conceptual nature. The DWNR requests that the same evaluations be submitted to the DWNR for review.

20. Page 6-1

The Department of Environmental Protection was abolished by executive order June 30, 1979.

The following comments were supplied by the Office of Water Quality:

Comments by Herb Davis - Soil Conservationist

21. Page V, paragraph d

The proposed scheme to allow erosion to shape stream-banks naturally may allow increased erosion due to the straightening of the stream channel.

22. Page 2-24

The mulching ratio should be doubled. Recommend using special grassland drill with depth control bands and double disc furrow openers.

23. Page 2-25, Table 2.3

Who developed the seed mixtures in Table 2.3? They may be acceptable, but many of the species suggested are not found in the area (i.e., Louisiana Sagewort, Streambank Wheatgrass, etc.) It would seem that a mixture of grasses that are found in the area or what would be considered climax for the major range sites according to the South Dakota technical guide would be more fitting for the seed plan. The SCS Range Conservationist in Rapid City could develop those type seed mixtures for this project.

RESPONSE

18. This was a typographical error and has been corrected to read macroinvertebrates.

19. This is a matter between TVA and DWNR. The NRC will coordinate it's review of any activity not previously evaluated for potential environmental impacts with the DWNR.

20. Corrections have been made in the FES.

21. The licensee proposed (Sect. 2.2.2.5, p. 2-21) that, following removal of contaminated material associated with cleanup of Cottonwood Creek, "the permanent route of Cottonwood Creek be prepared . . . to follow the original creek channel as closely as practical to form a gently meandering course through the former mill site." The staff emphasizes "meandering" and recommends (Sects. 2.2.3.8 and 4.1.7.2), in consultation with the U.S. Fish and Wildlife Service, that (1) banks be allowed to shape by erosion, (2) riprap be used in areas that might experience severe erosion, and (3) varied habitats be created by use of boulders or other obstructions. These methods were considered appropriate to minimize impacts of erosion if a meandering stream channel is used. The staff believes that, once the stream margins have been stabilized and initial erosion has occurred, erosion of the stream margins should be similar to upstream reaches. The staff recommends (Sect. 2.2.3.8) that the applicant consult with the South Dakota Department of Game, Fish and Parks, in the execution of the Cottonwood Creek cleanup.

22. The licensee's proposed plan is stated on p. 2-24; therefore, this section will remain as written. The staff, however, concurs with your recommendations, and the staff's evaluation of the proposed plan has been changed accordingly (Sect. 2.2.3.8).

23. The seed mixtures listed in Table 2.3 were proposed by the applicant. Subsequent to issuance of the DES, TVA is considering the addition of little bluestem (*Andropogon scoparius*), Indian rice grass (*Oryzopsis hymenoides*), sideoats grama (*Bouteloua curtipendula*), green needlegrass (*Stipa viridula*), scarlet globemallow (*Sphaeralcea coccinea*), winterfat (*Eurotia lanata*), and penstemon (*Penstemon* spp.). (See TVA comment letter, comment 16 on Sect. 2.) Including such species would be in general agreement with the Soil Conservation Service to include more native species. Rodney Baumberger (U.S. Soil Conservation Service, Rapid City, South Dakota, letter to Larry Voorhees, Oak Ridge National Laboratory, Oak Ridge, Tenn., Jan. 26, 1982) recommends the following seed mixture:

RESPONSE

Species	Application rate (lb/acre)
Western wheatgrass (South Dakota origin)	8
Green needlegrass (Lodorm or South Dakota origin)	2
Blue grama (South Dakota or Nebraska origin)	2
Buffalograss (Sharps improved)	2
Sideoats grama (Butte or Pierre)	4
Total	18

Section 2.2.3.8 has been amended to reflect these considerations and recommendations.

Dick Howard
Page 7
November 2, 1981

24. Will the newly seeded areas be fenced until the grass is established? The FES should address this concern.

Comments by Mike Meyer - Hydrologist

25. Will the tailings disposal site be fenced and well marked? What will prevent intrusion into the disposal site by unsuspecting members of the public in future centuries?

26. It is rather curious that the DES states the purpose of the decommissioning of the mill site is to return it to productive use, including livestock forage, when they state that:

    1. the groundwater is contaminated;
    2. Cottonwood Creek will continue to be degraded from groundwater inflow;
    3. residential land use is not recommended;
    4. shallow wells should not be permitted.

    The DES states cleanup of decontaminated land will be within <u>current</u> radiation exposure guidelines. Radiation exposure guidelines have been consistently lowered over the last 20 years as we have learned more about low level radiation. Will they be lowered again after the cleanup is completed? Statements in the DES clearly indicate that no cleanup of the contaminated groundwater is proposed although no supporting reasons or possible alternatives are discussed. Another very important point brought to light by these above statements is that it will need to be determined what is considered "contaminated" during the cleanup. The DWNP should play an integral role in these determinations, including appraisal of field sampling and laboratory analysis of the results. The DWNR is somewhat skeptical as to the suitability of the decommissioned mill site for livestock foraging. Livestock should probably not drink from the creek nor from shallow wells at the site.

27. Page 2-21 of the DES also mentions that tailings removal from the mill site might affect the integrity of the adjacent City of Edgemont sewage lagoon and suggests that sheetpiles or other forms of containment may be necessary to prevent collapse of the sewage lagoon embankment. The DWNR should be involved with any such proposed steps.

RESPONSE

24. Efforts will be made to ensure the successful establishment of self-sustaining vegetation in all disturbed areas. TVA's monitoring program will not be discontinued until it is documented that disturbed areas have been revegetated sufficiently.

25. Access to the disposal site may not have to be restricted following successful reclamation of the impoundment; however, land records will be amended accordingly to preclude disturbance of the tailings and to ensure that future generations are aware of the existance of the contamination. As previously mentioned, either the Department of Energy or State of South Dakota will control the disposal site pursuant to an NRC license.

26. While it is possible that current radiation exposure guidelines may be changed in the future, it is the NRC's responsibility to utilize existing regulatory guidance in ensuring the health and safety of the public.

    The alluvial groundwater beneath the mill site is not presently a source of drinking, agricultural, or livestock water. The extent of contamination of this water precludes any future use for these purposes, and therefore no cleanup of the groundwater is required. However, the staff agrees that it would be prudent to restrict the use of the groundwater following reclamation of the site, and depending on final analysis of water quality of the reclaimed reach of the Cottonwood Creek, it is possible that use of surface water should also be restricted. We welcome the DWNR staff's suggestions concerning this matter as these final determinations are made. In addition, current plans are to restrict agricultural and livestock use of the land.

27. The staff will require that TVA's project does not adversely impact the city sewage lagoon.

28. In regard to the permeability of the shales underlying the proposed disposal site, the following questions are posed:

A. What are the "packer tests" which were performed (DES p. 3-38)? How were these conducted? Where is the evidence that the silty clay tends to "self-seal" with time? On page 2-3 the DES mentions that "should further permeability tests..." What permeability tests have been conducted at the site? Where and how were they conducted? Why is no mention made of this information in the DES?

B. The NRC in the DES indicate that adequate seepage control (p. 2-3) will be required and apparently define as "adequate" a minimal seepage rate of 10-7 cm/sec. This is an extremely low permeability and is very likely to be exceeded at least locally in some areas. Recent work by the USGS on bedrock aquifers indicate that fractures may play a major role in the permeability of shale units.

C. Due to the difficulty with disturbing the sample, laboratory permeability tests often give unrealistically low permeabilities that do not reflect actual field conditions. Any laboratory field permeability tests should be used only in support of in-situ permeability tests (such as the double ring infiltrometer).

D. The possibility of contamination of the Inyan Kara aquifer appears unlikely not only because of the probably low permeability of the shale between the disposal site and the aquifer, but also because the artesian surface (Potentiometric surface) of the Inyan Kara is above the top of the aquifer which wouldmake it difficult for seepage to migrate downward from the site into the aquifer. However, over time, should the potentiometric surface of the Inyan Kara be lowered due to pumping demands etc. below the top of the aquifer then contamination of the aquifer by seepage from the disposal site might occur. There is also the possibility of seepage from the disposal site following fractures in the perched water table which lies between the bedrock and soil surface and then discharging into the intermittent stream or stock ponds below the site or causing contamination of the perched alluvial aquifer down gradient from the site.

E. The DWNR is somewhat skeptical as to the long-term suitability of an unlined impoundment for containing any seepage which may result from the tailings. It is recommended to require a clay liner and require in-situ field permeability tests monitored by DWNR personnel.

RESPONSE

28A. In June 1980, water-pressure in situ permeability tests (Packer tests) were performed as part of a preliminary geotechnical survey of the proposed disposal site. Details related to the contents of a document, "Subsurface Soil Exploration for Proposed Edgemont Uranium Waste Disposal Site," may be reviewed at an NRC Public Document Room and are available from TVA. These Packer tests were performed at locations T.H.1-T.H.6 (Fig. 3.10). This information was mentioned several times in the DES (see pp. 3-38 and 3-39 and Figs. 3.10 and 3.11).

For the permeability tests, 5-ft intervals were "packed-off" in each of seven core holes (an eighth hole was drilled with a flyte auger and could not be Packer tested) in the embankment and impoundment areas (Fig. 3.10). Up to eight intervals were tested per hole. The packed-off zones were permeability tested by pumping water into them and recording the pressure decline as a function of time. If the pressure decline was less than 10 psi/min, the permeability was considered to be less than 1×10^{-8} cm/s (essentially impermeable). Results indicate that the Greenhorn shale was essentially impermeable through all intervals tested for five of the test holes. A sixth test hole had a semipermeable zone ($k = 1.2 \times 10^{-4}$ cm/s) surrounded by impermeable zones. All the above tests were in "unweathered" shale. In the seventh hole the top three intervals had permeabilities ranging from 4.2×10^{-5} cm/s to 9.2×10^{-5} cm/s. These semipermeable zones were in weathered shale (a tightly jointed, stiff, silty clay). Three deeper zones (unweathered shale) were also tested. The latter zones were essentially impermeable.

There is no prima facie evidence that the silty clay soils will "self seal" with time at this specific site. When the Packer tests were performed, there was an initial, slight pressure drop, after which the pressure stabilized. However, bentonitic or montmorillonitic soils in a partially dried state tend to swell when they become saturated. Common in northeastern Wyoming, these soils are probably also present in western South Dakota. Atterberg limits tests or more sophisticated X-ray diffraction analyses could be used to detect the presence of montmorillonite in quantities that are sufficient to produce this swelling effect, and these or other similar methods will be required to substantiate claims of natural in situ permeability and overall suitability of the impoundment before the impoundment design is approved.

28B. If TVA can not demonstrate that the shale forming the base and sides of the impoundment exhibits a permeability of about 10^{-7} cm/s, placement of clay liner material will be required. We agree that the extent of fractures in shale units will largely determine the effective permeability of the material. Close inspection of the inside surfaces of the impoundment should detect any such areas with anomalously high permeabilities, and these areas will have to be lined or grouted appropriately.

28C. The staff agrees that in situ permeability tests and field inspections of the impoundment offer the best opportunities for accurately determining field conditions. Laboratory permeability tests on undisturbed samples are also preferable to those on disturbed samples.

28D,E. Upon consideration of the scenario outlined as related to the drawdown of the Inyan Kara aquifer with regard to time, the staff still believes that the potential for contaminants reaching this aquifer from the proposed disposal site is virtually nonexistent. As discussed previously, the measures taken to preclude seepage (dewatering of tailings and impermeable impoundment) and to prevent infiltration of precipitation (compacted clay cap) should be sufficient to prevent contamination of the perched water table and the deep confined aquifers. Over the long term, there should be no significant amount of free water capable of transporting contaminants.

29. Pond #10 should be lined with an impermeable liner if it is to be used as a "evaporation pond" for excess water from the slurry operation. Also the length of time that will be required for evaporation after discontinuation of the slurry pipeline should be addressed. Careful water management could minimize this length of time. Also, the use of make-up water from the city sewage lagoon should be investigated in lieu of the Madison. The FES should address these issues in greater detail.

30. Although the DES states that groundwater contamination of the alluvial aquifer occurs at the mill site, no discussion of any alternatives is offered concerning how it could be cleaned up or why it cannot be cleaned up. The DES states instead that "natural processes" should be allowed to "cleanse" the aquifer. This may require a time period longer than the "foreseeable future".

31. The DES states that the general direction of wind is most frequently from the west-northwest (DES p.3-1), but there is also a secondary maximum from the east-southeast (ER, 1980, p. 4.1-2). The proposed disposal site appears to be somewhat protected from the west-northwest wind and only slightly protected from the east-southeast wind. Consideration should be given to placement of cover material greater than the minimum depth required (10 ft) to ensure long-term containment and prevention of wind and water erosion.

In general the DES adequately states the requirements to be followed during the decommissioning. Consideration of these comments should provide a more thorough understanding of the decommissioning plan and associated environmental impacts. These comments represent the views of the South Dakota Department of Water and Natural Resources. The DWNR appreciates the opportunity to review and comment on the DES and looks forward to continued cooperation in the coordination of the environmental monitoring programs.

RESPONSE

29. TVA has stated the intention to line Pond 10 with a suitably impermeable liner to minimize seepage. As planned, spraying of the water to enhance rates of evaporation will be done if necessary. In the staff's opinion, the use of biologically contaminated water from the sewage lagoon is less attractive than using the Madison aquifer as a source of makeup water. The expected use of a maximum of 105 acre-ft of water from the Madison over a five-year period should not adversely affect local or regional supplies significantly.

30. Once the source of contamination is removed (i.e., contaminated soil) flushing of the groundwater immediately under the site with offsite uncontaminated water will result in "cleansing" action. It is not known how long the natural flushing will take, but restricted use of the site will preclude adverse effects of any residual contamination to the public. Also as previously mentioned, cleanup of the alluvial water is not justified because it is not presently utilized and will not be available for use in the future.

31. While we feel that present plan for the impoundment is acceptable, we do recommend that, wherever possible, excess fill should be placed and slopes should be flattened to the maximum extent reasonable to further enhance long-term stability. Available information indicates that winds are from the southeast only about 13% of the time and that these winds rarely exceed 7 mph and therefore probably do not contribute significantly to erosion rates.

RESPONSE

REFERENCES CITED

Landa, Edward 1980. Isolation of Uranium Mill Tailings and Their Component Radionuclides from the Biosphere-Some Earth Science Perspectives. Geological Survey Circular 814.

40 CFR 192. Draft Environmental Impact Statement for Remedial Action Standards for Inactive Uranium Processing Sites. USEPA 520/4-80-011, December 1980.

ER, 1980. Tennessee Valley Authority, Edgemont Uranium Mill Decommissioning Plan Environmental Report - Docket No. 40-1341.

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Attachment Number 1

(continued from page 4)

4. Alternative C1 is the state preferred alternative disposal site for the contaminated material and also alternatives A2, B2, D2, E1 and F3 to decontaminate the site and affected areas.

4. No response is required.

SOUTH DAKOTA Department of
Water & Natural Resources
Joe Foss Building
Pierre, South Dakota 57501

RECEIVED
NOV 3 1981
DEPT. OF WATER & NATURAL RESOURCES

MEMO TO: Richard L. Howard, Deputy Director

FROM: Randy Brich, Air Quality & Solid Waste RB, mm

SUBJECT: Amended Comments on Edgemont Draft Environmental Statement

DATE: November 3, 1981

1. The Draft Environmental Statement (DES) does not address the removal of residual radioactive material that has migrated offsite to the west of the millsite. Several residences are believed to be contaminated by this material as well as some areas adjacent to the western border of the millsite. Perhaps there should be some discussion of these contaminated areas in the FES.

Comments from Mike Meyer - Hydrologist II

2. The proposed sequence of placement of material from the millsite into the disposal area appears inadequate. It may be preferable to place the "slimes" in first rather than last as is presently proposed. In fact, it might be prudent to deeply bury the "slimes" separately from the rest of the tailings and millsite material.

3. It is recommended that the FES consider the use of a clay liner for the bottom and sides of the disposal pit.

4. It is recommended that appropriate State, NRC, EPA, and TVA representatives schedule a meeting with Edgemont citizens to inform them of the proposed plans and potential environmental consequences and to secure public acceptance before commencing the proposed activity.

5. In view of the long-term potential impacts from these tailings, it is recommended that consideration be given to the erection of a large, permanent concrete marker at the disposal site with appropriate markings to serve as a permanent warning to anyone who may live in this area in the many thousands of years to come

RESPONSE

1. The staff has determined, through discussions with the commentor, that the residences referred to are in the city of Edgemont. The Edgemont Cleanup Action Program, conducted by the NRC, Battelle Pacific Northwest Laboratories, and the State of South Dakota, is presently identifying structures contaminated with tailings. This activity is not part of TVA's decommissioning project proposal, and although TVA has in the past assisted in these efforts, consideration of these actions is not within the scope of this Environmental Statement.

2. Although it may be beneficial to place the slimes into the impoundment first, this could have adverse effects on the stability of the impoundment. Regardless of these factors, the tailings disposal plan proposed by TVA has been evaluated by the staff against the NRC performance objectives for tailings management and has been found to meet these criteria. This is discussed in detail in Sect. 2.2.3.7 of the DES. The staff has determined that TVA's proposal as modified by the staff would provide for successful long-term isolation of the tailings. We do not believe it would be beneficial to separately dispose of tailings sands and slimes because this would involve two disposal sites and would therefore result in greater land use impacts.

3. The staff's position, as stated in the DES, is that a clay liner would be required if the licensee can not demonstrate that the natural shale material forming the base and sides of the impoundment has a permeability of about 10^{-7} cm/s. Any areas not meeting this standard would require a clay liner or other suitable methods for ensuring the integrity of an impremeable barrier encapsulating the tailings and contaminated material. It would be premature to make the determination that a liner is required before the impoundment is excavated and closely inspected.

4. The NRC held a public scoping meeting in Edgemont on October 25, 1979. At the meeting, TVA described the project as planned and individuals were given the opportunity to comment on the proposal. Issues raised at the meeting are presented in Sect. 1.5 of the DES, "Results of the Scoping Process." As stated at the end of that section, no comments suggesting disapproval of the project were received at the meeting.

Regarding current public opinion on the project, we would refer the reader to the letters of October 1 and November 2, 1981, from Edgemont's Mayor Peter Ziemett (reprinted in Appendix A). In the staff's opinion, additional meetings would serve no useful purpose and very well might further delay the project, thus prolonging the sociologic and economic hardship of Edgemont residents.

5. The site will be managed by the Department of Energy or the State of South Dakota if so requested, pursuant to an NRC license. Appropriate land use controls will be instituted, and land records will be amended to ensure that future generations are aware of the presence of radioactive contamination.

STATE PLANNING BUREAU
State Capitol
Pierre, South Dakota 57501
605/773-3661

SOUTH DAKOTA Office of Executive Management

RESPONSE

November 9, 1981

Mr. Harry J. Pettengill, Section Leader
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

ATTN: Uranium Recovery Licensing Branch

Dear Mr. Pettengill:

Enclosed please find a supplement to the comments which the State of South Dakota submitted on November 5, 1981 relating to the Draft Environmental Statement (DES) for the decommissioning of the Edgemont uranium mill.

Although this supplemental information parallels the previously submitted comments, more in-depth background information and reasonings for the comments are provided. I hope this information will assist you and your staff in any necessary redrafting of the DES.

Sincerely,

Craig McIntyre

Craig McIntyre
Executive Policy Analyst
STATE PLANNING BUREAU

CM:jrr

Enclosu...

Much of the material in the Michael Meyer to Bill Markley et al. memorandum attached to this letter is supportive information for the November 2, 1981, memorandum of Randy Brich to Richard L. Howard. The Brich to Howard memorandum expresses the concerns of the State Planning Bureau of South Dakota about the Edgemont uranium mill decommissioning. In accordance with an agreement between the State of South Dakota, Department of Water and Natural Resources, and the staff, only points raised in the Meyer to Markley memorandum that are not found in the November 2, 1981, memorandum are addressed. For those points that are common to both documents, the reader is referred to the responses to the November 2, 1981, memorandum.

RESPONSE

MEMORANDUM

To : Bill Markley, Steve Pirner, James Nelson, Randy Britsch, Joel Smith, and Steve Stampfli

From : Michael Meyer, Hydrologist II

Subject : Review of US NRC Draft Environmental Statement Related to the Decommissioning of the Edgemont Uranium Mill (September 1981)

Date : November 5, 1981

This memo is in regard to the request by Randy Britsch and Steve Pirner that I review and prepare comments on the Draft Environmental Statement (DEIS) prepared by the U.S. Nuclear Regulatory Commission (NRC) for the decommissioning of the uranium mill and associated tailings located on the east side of Edgemont in Fall River County. The purpose of this memo is to provide a summary of my comments and suggestions on the DEIS. I did not evaluate the suitability of the alternative tailings disposal sites discussed in the DEIS but instead focused on the main tailings disposal site which has been selected as being most suitable.

This DEIS is entitled Draft Environmental Statement Related to the Decommissioning of Edgemont Uranium Mill, US NRC report NUREG - 0846, Docket No. 40-1341, September 1981. Apparently written comments on this DEIS are due at the NRC by November 9, 1981.

No response is required.

BACKGROUND

The uranium mill at Edgemont was constructed in 1956 by Mines Development, Inc., a subsidiary of Susquehanna-Western Inc. of Chicago, Illinois. Uranium ore was brought to the mill where the uranium was extracted with acid leaching and resin-in-pulp ion exchange. A solvent extraction circuit was added in 1958 (Ford, Bacon & Davis Utah, Inc., 1978, p. 1-6). In 1960 a vanadium circuit was added and additional vanadium was recovered from reclaimed resin-in-pulp slime tailings by acid leaching and solvent extraction. According to a report by Ford, Bacon & Davis Utah, Inc. (1978, p. 1-6) the ore had a U308 content of about 0.20% and a vanadium content of about 0.25%. Uranium recovery of the ore by the mill was originally about 95% but towards the end of the operation was about 90%. Vanadium recovery of the ore was about 75 to 80%. Uranium processing ended in 1972 and vanadium processing was shut down in 1974 when the mill was purchased by the Tennessee Valley Authority (TVA). During its operation the mill produced about 2.3 million tons of solid tailings. These tailings were placed into large holding ponds [Ford, Bacon & Davis Utah, Inc., 1978, Engineering Assessment of Inactive Uranium Mill

RESPONSE

Tailings, Edgemont Site, Edgemont, South Dakota. [hereafter referred to as FBDU].

TVA decided not to continue operation of the mill and did not request renewal of the NRC Source Material License SUA-816 to continue operation. NRC rules require decommissioning of the mill site. This DEIS was prepared by the NRC in accordance with NRC Commission Regulation Title 10, Code of Federal Regulations (CFR), Part 51 which implements requirements of the National Environmental Policy Act of 1969 (NEPA;PL 91-190) (DEIS p.1-1).

According to FBDU (p. 1-12)

> "About 85% of the total radioactivity originally in uranium ore remains in the processing wastes (tailings) after removal of the uranium because the radium and thorium, principal contributors to radioactive emissions, were not normally removed from the uranium ores during milling. The principal environmental radiological impact and associated health effects arise from the 230Th, 226Ra, 222Rn daughters contained in the waste materials. Other isotopes of uranium and thorium and their daughter products also may be present depending upon the type of ore present. Although these radionuclides occur in nature, their concentrations in tailings are several orders of magnitude greater than their average concentrations in the earth's crust."

According to Freeze and Cherry in discussing the impact of uranium tailings upon groundwater (1978, p.448)

> "radium 226 (226Ra) with a half life of 1620 years, poses the greatest environmental hazard. ... the maximum permissible concentration of 226Ra in drinking water is 3 pCi/l which is equivalent to 10^{-9} mg/l." (Freeze, R.A. and Cherry, J.A., Groundwater, Prentice-Hall Inc., N.J.).

In review of the potential environmental impacts from uranium mill tailings, Edward Landa states the following (1980, p.1 and p.5)

> "By virtue of the physical and chemical processing of the ore and the redistribution of the contained radionuclides at the Earth's surface, these (uranium) tailings constitute a technologically enhanced source of natural radiation exposure. Sources of potential human radiation exposure from uranium mill tailings include the emanation of radon gas, the transport of particles by wind and water, and the transport of soluble radionuclides, seeping from disposal areas, by groundwater. Due to the 77,000 year half-life of thorium-230, the parent of radium-226, the environmental effects associated with radionuclides contained in these tailings must be conceived of within the framework of geologic process operating over geologic time." (p. 1)

RESPONSE

"....The long-lived components of the decay chain, and hence those of environmental concern, are uranium-238, uranium-234, thorium-230, radium-226, and lead-210. Because the drinking water standards for radium-226 are the most restrictive (3 pCi/l), most monitoring and research efforts on the radiological impact of uranium mill tailings on surface and ground-water quality have focused on this radionuc'.... Assuming secular equilibrium, an ore containing 0.2 percent U3O8 will contain 0.00056 gram (g) of radium-226/metric ton of ore. As in both acid and alkaline leaching, greater than 98 pe cent of the radium-226 remains with the tailings; the tailings from such an ore will contain about 560 picocuries (pCi) of radium-226/g." (Landa, E., 1980), Isolation of Uranium Mill Tailings and Their Component Radionuclides From the Biosphere - Some Earth Science Perspectives, U.S. Geological Survey Circular 814).

In 1980 the EPA prepared a report involving a review of the potential health effects from 25 inactive uranium processing sites in Arizona, Colorado, Idaho, New Mexico, North Dakota, Oregon, Texas, Utah and Wyoming. In this report the EPA recommended a minimum release rate of radon gas to the air from tailings sites to be 2 picocuries per square meter per sec. The EPA estimates that implementing the proposed standard at all of the 25 sites would prevent about 200 premature deaths per century from radiation induced lung cancer. The EPA also estimated that about 140 of the 200 deaths would be expected in the populations within 50 miles of the tailings sites. Health effects from contaminated groundwater were not included in the above estimate. (US EPA, 1980, Draft Environmental Impact Statement for Remedial Action Standards for Inactive Uranium Processing Sites, 40 CFR 192, EPA 520/4-80-011, p. S-2).

Although South Dakota was not included in the above estimates the point is that in many ways the Edgemont mill site is no different from the above sites with respect to potential health risks and in some ways may even be worse. For example, I doubt that many of the above tailings sites have towns next to them as occurs at the present site in Edgemont. Moving the tailings to the proposed disposal site will of course considerably reduce the health risk for Edgemont.

The tailings at the Edgemont uranium mill were stored in unlined ponds overlying an alluvial aquifer on the east side of Whitewood Creek and the south side of the Cheyenne River (Figure 1). The DEIS states (p. 3-34):

"Except for Pond 10, the storage areas were probably not designed to prohibit or to minimize the migration of leachates beneath the areas...Evaluation of the chemical data from the ponds shows the standing water to be acidic and to contain extremely high concentrations of dissolved solids, sulfate, cadmium, chromium, iron, nickel, titanium and vanadium. Sediment samples from the ponds were heavily concentrated with aluminum, barium, chromium,

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iron, nickel, titanium and vanadium. Lower concentrations of other metals were measured in both the water and sediment samples. Leachates migrating from the ponds and tailings piles are a potential source of contamination of the alluvial aquifer, Cottonwood Creek, and the Cheyenne River near the mill site. The water quality found in the alluvial aquifer has been determined by the sampling of 14 observation wells. Evaluation of groundwater quality data clearly shows that the groundwater beneath the site <u>is contaminated</u> with leachates from the tailings and slime storage areas."

TVA proposes to transport these uranium tailings to a new site located about two miles SE of Edgemont at T09S R03E, Sections 8 and 17 (Figure 1). The new site would lie in the Belle Fource Shale (Cretaceous). The closest aquifer beneath this site is the Inyan Kara aquifer which would be separated from the disposal site by approximately 500 feet of shale, including the Belle Fourche, Mowry and Skull Creek Shales (Figure 2). They plan to cover the tailings with approximately 10 feet or more of cover material including a 3-foot clay layer directly over the top of the tailings and then covered by other fill material (DEIS, p. 2-24).

<u>REVIEW AND COMMENTS</u>

I have been to the proposed site and have reviewed other reports on this proposed disposal site as well as the DEIS. In many respects, the DEIS appears to be adequate. However, I am concerned that the proposed disposal site is too close to Edgemont and that the proposed cover thickness may be inadequate over geologic time. I have the following comments and questions which the NRC may wish to address in the final EIS.

1. Who will have final ownership and responsibility for the original mill and tailings site and the new disposal site? Radium 226 is the principal radiologic contaminant in the tailings. It has a half-life of 1,620 years. It can contaminate water and decays into a radioactive gas - Radon 222. Thorium 230 has a half-life of 77,000 years. This means that these tailings will pose potential environmental hazards for, at the very least, several tens of thousands of years. This would be a monumental burden for the State of South Dakota to assume.

2. Will the tailings disposal site be fenced and well marked with signs? In the centuries to come, how long will people remember that there are radioactive [illegible] beneath this site?

3. The proposed disposal site is located only two miles from the town of Edgemont (Figure 1). This seems too close for comfort. Although this area is now sparsely inhabited and the town only has a population now of about 1200, this may not

1-2. See response to item 6, general comments, and item 25, specific comments, in the November 2 memorandum.

3. See response to item 31, specific comments, November 2 memorandum.

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Figure 1

3-20

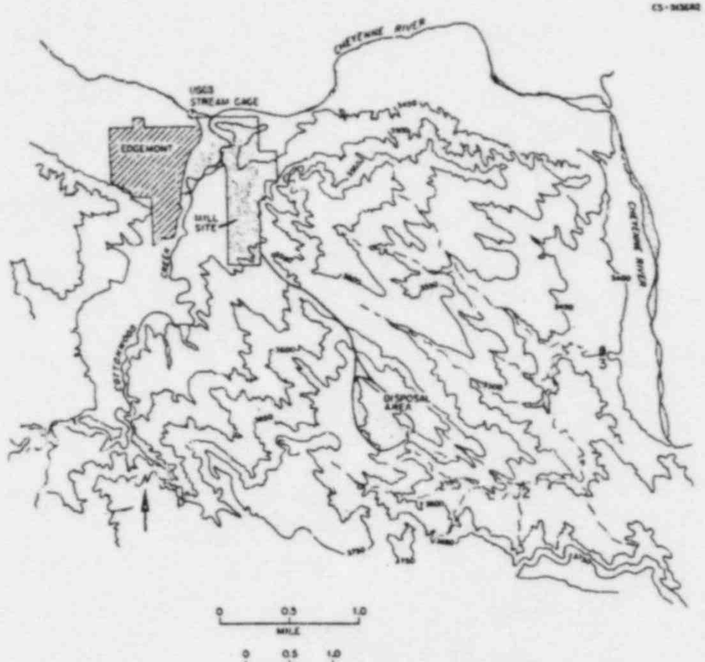

Fig. 3.4. Surface water features for the Edgemont decommissioning area. Single numbers correspond to ponds downstream of the disposal site that are discussed in the text. Source: Modified from ER, Fig. 4.2-1.

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always be so. According to the DEIS (p. 3-1) the general direction of wind in this area is most frequently from the west-northwest, but there is also a secondary maximum from the east-southeast. Wind speeds are relatively high with a mean of about 11 miles/hour (p. 3-1). The proposed disposal site appears to be somewhat protected from the wind. However, in the many years to come, should erosion expose these tailings the town of Edgemont is located only two miles away in an east-southeast direction for the wind. Wind erosion has already affected the tailings at their present site beside the mill.

4. The DEIS indicates a slurry line will be used to transport the tailings which will involve dewatering of the original tailings ponds as well as dewatering of the tailings at the disposal site (p. iv and 2-18). Additional needed water will be withdrawn from the mill well in the Madison aquifer (p. 2-18). The DEIS indicates that the slurry water will be recycled and any excess water will be pumped into pond 10 for evaporation. In conducting the South Dakota Surface Impoundment Assessment (SIA) in 1979-1980, I received a letter from Mr. R.T. Moore of TVA that these ponds are not lined. The SIA study indicated that impoundments overlying alluvial aquifers are especially prone to seepage problems due to the often high permeabilities of such materials (SIA, p. 174). The DEIS states that groundwater contamination at the mill site tailings area can affect not only the alluvial aquifer but also Cottonwood Creek and the Cheyenne River (p. 3-33 and 4-6). Unless pond 10 is lined with an impermeable liner (plastic, etc.) it is not and will not be an "evaporation pond". Unless this pond is lined adequately to prevent seepage of the contaminated slurry water it should not be used as an evaporation pond.

4. See response to item 29, specific comments, November 2 memorandum.

5. The DEIS states that (p. 2-1):

"...the primary goal of mill site land decontamination is to return the mill site to productive use after removal of the tailings to a new disposal site. All of the uranium tailings will be removed from the site."

The DEIS also states (p. 2-1):

"Depending upon the cutoff limit ultimately established for removal of contaminated soils for disposal at the new impoundment area, it may be necessary to institute some land use controls at the reclaimed mill site; i.e. residential land use would not be permitted."

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On page 2-23 of the DEIS the statement is made:

"The objectives of the applicant's reclamation plan for the mill site are to (1) provide livestock forage..."

However, on page 2-1 the DEIS states:

> "It is not known, however, to what extent the soils below the tailings piles have been contaminated by seepage of tailings liquor and what quantity of this contaminated soil may have to be removed. The staff (NRC) expects that a much lower quantity of contaminated soil will have to be relocated than that projected by the licensee. The staff feels that the exact land cleanup limits to be met should be based on site-specific considerations and on an evaluation of the environmental benefits of moving increasingly lower levels of contamination versus the economic costs of such action. These cleanup limits can only be determined once the exact depth and concentration of contaminated material are known. At the Edgemont site, such a final determination will not be feasible at some locations until tailings are removed from the site. In determining exact cleanup limits, the major consideration will be to ensure that resulting radiation exposures to individuals using the decontaminated land will be within current radiation exposure guidelines and as low as is reasonably achievable."

On page 2-21 of the DEIS reference is made to a construction of a diversion channel for Cottonwood Creek to allow cleanup of Cottonwood Creek. The DEIS states: "The base of the diversion will be excavated to uncontaminated material." What does the NRC define as "uncontaminated"?

On page 4-5 the DEIS states:

> "The full extent of contamination of streambed sediments in Cottonwood Creek is not know at this time. Lack of information on the quantity of streambed materials that will have to be removed from the creek to remove sediment contaminated with radionuclides or heavy metals. If only isolated pockets of contamination occur within the stream, these areas could be isolated and removed with minimal impacts to surface hydrology. In anticipation that contaminants are spread throughout the streambed sediments, it has been proposed, as discussed, to reroute the stream while removing these materials. The extent of material to be removed depends in part on the extent of transfer of contaminant materials from groundwater into stream alluvium and surface waters (Sect. 4.1.6.4). A data base defining types and quantities of contaminated

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material must be determined by the Tennessee Valley Authority (TVA) in coordination with the US NRC, EPA, and the State of South Dakota, and the extent of contaminated material in both Cottonwood Creek and the Cheyenne River must be determined by the applicant before the effects of removal of the streambed material on hydrology and water quality can be fully determined. The extent of contaminated groundwater beneath the mill site and the time necessary for the groundwater to cleanse itself are not known (Sect. 4.6.1.4).'

On page 4-6 the DEIS states:

"Although the contaminated materials will be removed from the mill site, some water quality degradation of Cottonwood Creek is expected to continue as the result of groundwater inflow from beneath the mill site. The extent of present and projected groundwater contribution to surface water quality degradation cannot be determined because the extent of groundwater contamination beneath the site and the time necessary for the groundwater to be cleansed are not known."

On page 4-6 the DEIS states:

"The applicant has not determined the extent of heavy metal contamination of streambed sediments in Cottonwood Creek or the Cheyenne River as a result of tailings erosion not the method of isolation and removal of contaminated materials from the Cheyenne River. The applicant proposes to remove any contaminated material occurring in the Cheyenne River during low flow and should do so only after consultation with the EPA in coordination with the State of South Dakota to locate contaminated areas and to establish acceptable concentrations that may remain in the river. Determinations of impacts to water quality from migration of the trace element contaminants in the Cheyenne River depend upon the concentration, sediment particle size, and location of the contaminated material within the river relative to stream flow, all of which are unknown at this time. However, based on EPA findings (Report PB-256 453, 1973) that although Cottonwood Creek was contaminated by the Edgemont mill operation, contamination did not extend into the Cheyenne River, contamination of the river should be minimal. The extent of contamination in the river, however, may be greater than the 1973 EPA study indicates because it has been shown that leakage has occurred from ponds adjacent to the river."

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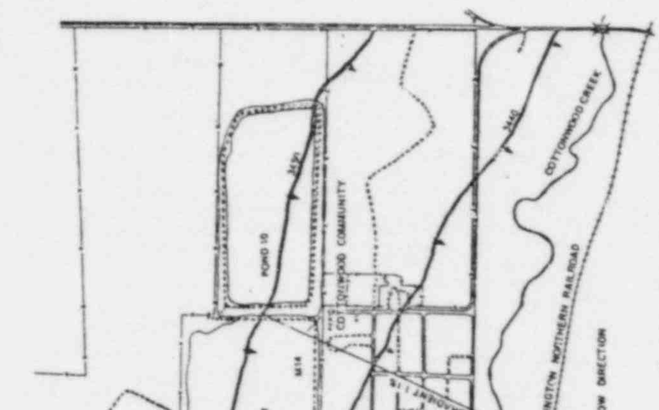

Fig. 3.6. Potentiometric surface and flow gradient of the unconfined groundwater at the existing tailings site.
Source: ER, Fig. 4.2-4.

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Page 4-7 of the DEIS states:

"Groundwater under the mill site is presently contaminated by past and present seepage from under and through the tailings piles and ponds on the site. Removal of the tailings and other contaminated materials from the mill site will allow natural processes, primarily subsurface flows, eventually to restore this groundwater to its previous condition by transporting excess soluble ionic species into Cottonwood Creek and the Cheyenne River."

"Such transport is presently occurring and does not result in measurable degradation of either stream. The staff is of the opinion that continuation of this natural process is the only practical solution for restoration of groundwater quality under the mill site. The staff recommends that shallow wells not be permitted on the mill site after reclamation until chemical concentrations (mostly sulfate) decrease. No radiological contamination of groundwater in excess of standards is presently observed or expected after reclamation."

However, table 3-6 in the FBDU report does show at least 2 drillholes near the tailings ponds that exceed the EPA standard of 3 pCi/l.

It is rather curious that the DEIS states the purpose of the decommissioning of the mill site is to return it to productive use, including livestock forage, when they state that: (1) the groundwater is contaminated; (2) Cottonwood Creek will continue to be degraded from groundwater inflow; 3) residential land use is not recommended; (4) shallow wells should not be permitted.

The DEIS states cleanup of decontaminated land will be within current radiation exposures guidelines. Radiation exposure guidelines have been consistently lowered over the last 20 years as we have learned more about low level radiation. Will they be lowered again after the cleanup is completed? The above statements in the DEIS clearly indicate that no cleanup of the contaminated groundwater is proposed although no supporting reasons or possible alternatives are discussed. Another very important point brought to light by the above statements is that it will need to be determined what is considered "contaminated" during the cleanup. The State of South Dakota should play an integral role in these determinations, including appraisal of field sampling and laboratory analysis of the results. We should not rely solely upon the TVA to do all the field sampling and analysis. I am also somewhat skeptical as to the suitability of the

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decommissioned mill site for livestock foraging. Livestock should probably not drink from the creek, nor from shallow wells at the site.

Page 2-21 of the DEIs also mentions that tailings removal from the mill site might affect the integrity of the adjacent City of Edgemont sewage lagoon and suggests that sheetpiles or other forms of containment may be necessary to prevent collapse of the sewage lagoon imbankment. DWNR should be involved with any such proposed steps.

See response to item 27, specific comments, November 2 memorandum.

6. The proposed disposal site is underlain by the Greenhorn Shale. With respect to this the DEIS states (p. 2-3):

> "Soils and shale from that form the base of the impoundment area are reported to have permeabilities on the order of 1×10^{-4} to 1×10^{-7} cm/sec. (100 to 0.1 ft/yr). Should <u>further permeability tests</u> determine that the native soils and shale exposed in the impoundment excavation do not provide <u>adequate seepage</u> control, additional excavation and/or the placement of a clay liner over the base and sides of the impoundment will be necessary. Potential borrow areas have been identified as a source of the clay liner material, although the applicant does not presently control such sites. Onsite materials could however, be employed for the construction of the liner provided they can be shown to be suitable for constructing a liner with a permeability of about 1×10^{-7} cm/sec."

Page 2-36 of the DEIS states:

> "If natural hydrogeological conditions of the impoundment based are such that permeabilities greater than 1×10^{-7} cm/sec are encountered, it would be necessary to amplace clay over portions of the entire bottom of the impoundment excavation to inhibit seepage of fluids from the tailings. In that event, the applicant should provide a liner design and material and compaction specifications to ensure that permeabilities of about 1×10^{-7} cm/sec can be obtained for the clay liner. Properties of the clay should be compatible with impoundment fluids to ensure against cracking of the liner or chemical breakdown of the clay minerals.
>
> "The installation of clay liners is the seepage control measure <u>preferred</u> by the staff (NRC)..."

In referring to the alternative of not using a clay liner and simply placing the tailings onto bare shale, the DEIS states (p. 2-35):

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"The major advantage of this alternative is a relatively low cost especially where excavated materials are needed for other uses such as dike, cap, or cover construction. A disadvantage is that soil and bedrock conditions can vary significantly over short distances and permeabilities measured at one point in the impoundment excavation may not be representative of permeabilities of other points in the excavation. In addition, vertical joints or fractures in soil and rock may go undetected in boring investigations, yet may provide significant pathways for migration of contaminated fluids away from the impoundment.

"Therefore, the staff has concluded that this alternative should only be used where it can be demonstrated with a sufficient number of permeability tests and detailed field mapping of the excavation bottom that permeabilities across the entire bottom and sidewalls of the impoundment excavation are uniformly about 1×10^{-7} cm/sec. Otherwise, a clay liner will have to be installed."

On page 2-41 the DEIS states:

"If a liner is required, a license condition would be included that would require the applicant to provide test results that ensure that the materials used for the liner would not undergo an increase in permeability characteristics or deterioration of consolidation or stability properties when exposed to tailings impoundment solutions over the long term. In addition, the applicant would develop and submit for review (1) criteria to define foundation conditions that are acceptable for the placement of a clay liner; (2) conditions which will require the use of subdrains and filters; and (3) liner material specifications, compaction criteria, and field compaction procedures."

On page 3-34 the DEIS states:

"Unconfirmed groundwater conditions occur in the unconsolidated surficial materials (alluvium) at the proposed disposal site. This perched water generally lies within a few feet of the soil-bedrock contact. Groundwater levels in the vicinity of the stock-watering pond located on the southern side of the site are affected by seepage from the pond. In the absence of the stock pond, the water table in this area would be expected to be lower, probably within a few feet of the bedrock surface."

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On page 3-3? the DEIS discussed the geology of the proposed disposal site and states:

"The silty clays (Greenhorn Shale) are characterized by numerous horizontal partings (very fissile) that are often filled with calcium deposits or stained with iron and sulfur (limonitic staining). Vertical fractures are also very common in this zone and impart a blocky structure to the formation. ... Packer tests performed in the silty clay materials indicate that they are relatively impermeable and also have a tendency to self-seal with time.

The materials that comprise the third unit occur below the weathered silty clays and are very dense, slightly fissile, relatively unaltered clays of the Lower Greenhorn Shale Unit. These materials are very hard and can be considered highly impermeable (10^{-8} cm/sec or less) to the depth explored."

With regard to the above statements I have the following questions and comments:

A. What are the "packer tests" which were performed (p. 3-38)? How were these conducted? Where were they conducted? Why is none of this data included in the DEIS? What is the evidence that the silty clay tends to "self-seal" with time? On page 2-3 the DEIS mentions that "should further permeability tests...". What permeability tests have been conducted at the site? Where and how were they conducted? Why is no mention made of this information in the DEIS?

6A. See response to item 28A, specific comments, November 2 memorandum.

B. The NRC in the DEIS indicate that adequate seepage control (p. 2-3) will be required and apparently define as "adequate" a minimal seepage rate of 10^{-7} cm/sec. This is an extremely low permeability and is very likely to be exceeded at least locally in some areas. Recent work by the USGS on the bedrock aquifers indicate that fractures may play a major role in the permeability of shale units.

6B. See response to item 28B, specific comments, November 2 memorandum.

C. Due to the difficulty with disturbing the sample, laboratory permeability tests often give unrealistically low permeabilities that do not reflect actual field conditions. Any laboratory field permeability tests should be used only in support of in-situ permeability tests (such as the double ring infiltrometer).

6C. See response to item 28C, specific comments, November 2 memorandum.

D. The possibility of contamination of the Inyan Kara aquifer appears unlikely not only because of the probably low permeabilities of the shale between the disposal site and

6D. See response to item 28D, specific comments, November 2 memorandum.

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the aquifer but also because the artesian surface (potentiometric surface) of the Inyan Kara is above the top of the aquifer which would make it difficult for seepage to migrate downward from the site into the aquifer. However, over time, should the potentiometric surface of the Inyan Kara be lowered due to pumping demands etc. below the top of the aquifer then contamination of the aquifer by seepage from the disposal site might occur. There is also the possibility of seepage from the disposal site following fractures in the perched water table which lies between the bedrock and soil surface and then discharging into the intermittent stream or stock ponds below the site or causing contamination of the perched alluvial aquifer downgradient from the site.

E. TVA is apparently planning to drill some exploratory testholes into the Inyan Kara aquifer at the disposal site to make sure no commercial uranium deposits may underlie the site. DWNR should insist such testholes be carefully plugged to minimize the possibility of seepage from the disposal site reaching the Inyan Kara aquifer. It would be preferable to have a DWNR person present during such drilling and plugging activities.

6E. If drilling occurs at the site, the NRC and the state will ensure that the integrity of the aquifers will be maintained.

F. I am somewhat skeptical as to the long-term suitability of an unlined impoundment for containing any seepage which may result from the tailings. It is recommended DWNR require a clay liner and require in-situ field permeability tests monitored by DWNR personnel.

6F. See response to South Dakota State Planning Bureau comment 28E.

7. In considering reconstruction of Cottonwood Creek after decontamination, the DEIS states (p. v and 2-43) that erosion should be allowed to shape the banks in a natural manner as opposed to the use of 10 degree bank slopes and plowing and discing along the streambank for shrub planting as is apparently proposed by TVA (p. v.). DWNR should request more clarification as to what extent "erosion" should be allowed to shape the reconstructed creek. Apparently what the DEIS means by this is to avoid the excessive use of riprap (p. 2-43).

7. In Sect. 2.2.2.5 of the DES, the licensee proposed that stream margins be stabilized along meandering bends constructed "as space allows" (see TVA comment 14 on Sect. 2) by using riprap where needed and that revegetation be initiated according to the plan presented in Sect. 2.2.3.8 of the DES. The U.S. Fish and Wildlife Service advised the staff (Sect. 4.1.7.2) that the streambeds should be stabilized with riprap only where necessary to minimize extension erosion — for example, along the outside bends of meanders. Extensive use of riprap would reduce the amount of aquatic habitat available to biota. Allowing erosion to undercut the streambeds would create maximum habitat for aquatic biota. The staff assumes that stream margins will be of reasonably consolidated material and that erosion will therefore be limited. The staff further assumes that erosion would be limited to the undercutting of streambeds and would not alter the stream channel.

8. Although the DEIS state that the groundwater beneath the mill site is contaminated and may affect Cottonwood Creek and the Cheyenne River and although the DEIS states that any overflow from the ponds below the proposed tailings disposal site could reach the Cheyenne River (p. 3-24) the NRC in this DEIS does not seem to be too concerned with potential long-term impacts. On page 2-41 in discussing the proposed disposal site the DEIS states:

> "Elimination of need for ongoing monitoring and maintenance. After reclamation and a short-term observation and maintenance period for surface cover, the

8. See response to item 30, specific comments, November 2 memorandum.

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staff expects no further active maintenance will be required for the foreseeable future."

Presumably the NRC believes the clay and soil cap on the disposal site will be thick enough to minimize any radon emanations.

On page 2-43 the DEIS states:

"The staff notes that during previous mill operation, although fresh tailings and contaminated groundwater degraded the water quality of Cottonwood Creek, no detectable effects on the Cheyenne River of the Angostura Reservoir were observed. With this past history, the staff is of the opinion that any potential effects of remaining contaminated creek sediment (after decommissioning) entering the river will be transient and will result in no measurable change in water quality or environmental consequences."

9. On page 2 - 16 the DEIS states:

<u>Sequence of disposal operations</u>. The basic sequence of proposed disposal operations includes (1) decontamination and/or demolition of mill structures; (2) slurry transport and disposal of tailings sands; and (3) truck transport and disposal of tailings sands, slimes and contaminated soils."

Figure 2.21 from the DEIS shows the proposed sequence. In this sequence, the <u>slimes</u> are mixed with the sand tailings and placed <u>last</u> on top of the demolished mill structure and on top of most of the sand tailings. In my opinion, it would be much more preferable to reverse this sequence and place the slimes in <u>first</u>. According to the DEIS (p. 2-18):

"The milling process separates the solid tailings into two size fractions: sands, which comprise about 80% by weight of the tailings, and slimes, which make up the remainder. The principal content of ponds 3 and 7 are slimes (see also DEIS table 2-2)."

With respect to the radioactive content of tailings sands and slimes, Edward Landa (1980, p. 6) states:

"The tailings are often classified into a coarse and a fine-size fraction referred to as "sand" and "slime" respectively. The uranium-bearing minerals are generally softer than the bulk components of the host rock. Thus crushing of the ore tends to concentrate the uranium and uranium-daughter products in the <u>slime fraction</u>. Borrowman and Brooks (1975) examined acid and alkali-processed tailings and found that while the slime fraction makes up only <u>25-27 percent by weight</u> of the tailings,

9. See response to South Dakota Department of Water and Natural Resources, comment 2.

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It contained 77-94 percent of the radium inventory. Slimds from the processing of ores from the Western United States may contain up to 3,00 pCi/l of radium-223/g (Haywood and others, 1977)."

The proposed decommissioning plan provided in the DEIS would place the most radioactive portion of the material (the slimes) on the top of the material in the disposal area. This means the radioactive slimes would be among the first materials exposed if excessive erosion etc. occurs. In my opinion, we should perhaps deepen part of the proposed disposal area, emplace the slimes first at the bottom, cover the slimes with a clay cover and them emplace the rest of the tailings and mill debris on top of the slimes. The DEIS indicates at least some of the slimes have already been separated from the sand tailings in ponds 3 and 7 (DEIS, p. 2-18). Another option would be to separate the slimes and deeply bury them thus significantly reducing the radioactive content of the remainder of the tailings.

MONITORING

With respect to monitoring, the NRC does emphasize the need for monitoring and the DEIS states on page 4-26:

"... The water quality parameters included in these tables...indicate that elevated chemical and trace metal levels at the mill site should continue to be sampled during predecommissioning, decommissioning, stabilization and reclamation to ensure that contaminants released during decommissioning are determined and that data for all sampling periods are comparable. For example, pH, specific conductance, sulfate, chloride, iron, manganese, magnesium, arsenic, nickel, molybdenum, selenium, titanium, and vanadium should be monitored because levels of these constituents exceed EPA standards in groundwaters beneath the mill site. ... The applicant will conduct a surface-water monitoring program at the mill site during decommissioning, with details of the program to be finalized with EPA and NRC in coordination with the South Dakota Division of Water Quality.

"... Cleanup of Cottonwood Creek will occur as discussed... A water quality monitoring program, including parameters measured in the baseline monitoring program, including parameters measured in the baseline monitoring program, will be continued at the mill site during decommissioning and and afterwards, if inspections indicate a need to do so. ... The results of the predecommissioning and decommissioning monitoring programs will be compared to determine the effectiveness of erosion control and contaminant removal from

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Cottonwood Creek and the Cheyenne River and to determine if groundwater contamination from beneath the site is significantly affecting surface water quality."

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CONCLUSIONS

1. The proposed disposal site is only 2 miles from Edgemont. In view of the long-term radioactivity of these tailings (thousands of years), I am concerned that the proposed disposal site may be too close to town. However, removal of the tailings from near Edgemont to the porposed site will greatly reduce potential health risks to the town's population. This, of course, should be done as quickly as possible in the safest way feasible.

2. Although 10 feet of fill (including 3 ft. of clay) may be adequate at this time to cover the tailings, I am concerned if this will still be adequate in several hundred years or more. In safely disposing of radioactive wastes one must think in terms of thousands of years. Landa (1980, p. 20) notes that if one uses the average erosion rates reported by Schumm of 9-20 cm/1000 years for arid to semi-arid terranes then 10 feet of cover would be removed in 33,000 years. At the end of this time, only 26 percent of the thorium present in the tailings would have decayed.

3. Although the DEIS states that groundwater contamination occurs at the mill site, no discussion of alternatives is offered as to how it might be cleaned up or why it cannot be cleaned up. Instead, the DEIS states that "natural processes" should be allowed to "cleanse" the aquifer. This could take possibly thousands of years.

4. The proposed sequence of placement of material from the mill site into the disposal area appears inadequate. It is probably preferable to place the "slimes" in first rather than last as is presently proposed. In fact, it might be wise to deeply bury the "slimes" separately from the rest of the tailings, mill site material, etc.

Response 4. See response to South Dakota State Planning Bureau comment 9 under "Review and Comments."

RECOMMENDATIONS

1. Pond #10 should be lined with an impermeable liner if it is to be used as "evaporation pond" for excess water from the slurry operation.

Response 1. See response to South Dakota State Planning Bureau comment 29.

2. It is recommended the "slimes" portion of the tailings either be (1) deeply buried in a separate place or; (2) be buried at the bottom of the proposed disposal area, preferably with a clay liner between the top of the slimes and the bottom of the rest of the tailings.

Response 2. See response to South Dakota State Planning Bureau comment 9 under "Review and Comments."

3. It is recommended a clay liner approved by DWNR should be installed at the bottom and sides of the proposed disposal site.

Response 3. See response to South Dakota State Planning Bureau comment 29.

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4. It is recommended that appropriate State, NRC and TVA representatives hold a meeting with the people in the City of Edgemont to inform them of the proposed plans and potential environmental consequences and to secure public acceptance before starting the proposed decommissioning.

5. In view of the long-term potential impacts from these tailings, it is recommended a large permanent concrete marker be placed at the disposal site with appropriate markings to serve as a permanent warning to anyone who may live near the disposal site in the many thousands of years to come.

6. DWNR should participate and plan an integral role in the following:

   A. Determination of "acceptable" levels of contamination in Cottonwood Creek, the Cheyenne River, the mill site and the groundwater beneath the mill site. This should include field sampling involving DWNR personnel. At least some of the sampling should be done in labs other than those of TVA.

   B. In-situ permeability tests of the disposal site should be required. DWNR personnel should be present.

   C. The proposed testholes at the site to evaluate the Inyan Kara should be properly plugged. DWNR personnel should be present during drilling and plugging.

   D. DWNR should be closely involved in the development and implementation of any monitoring activities. This should include some involvement in the actual sampling and sending some of the samples to an independent lab. It is recommended background radon be determined at the proposed disposal site before construction and after the site has been covered with fill, etc.

7. It is recommended information be provided in the final EIS as to why no attempt will be made to clean up the contaminated groundwater at the mill site.

8. If feasible, it is recommended the standards proposed by the EPA in Draft Environmental Impact Statement for Remedial Action Standards for Inactive Uranium Processing Sites EPA 520/4-80-011 be utilized in the decommissioning of the mill site.

A020U1MM.wq

Oct. 1, 1981

Ross A. Scarano, Chief
Uranium Recovery Licensing Branch
Division of Waste Management
Washington, D.C. 20555

Dear Sir:

Thank you for seeing that we received an early copy of the DES related to the Decommissioning of the Edgemont Uranium Mill. We are very pleased that this step is being taken and hope planning and action will follow. After enough review and discussion we may have some comments but they will be minor and hopefully helpful. In general the residents, the city officials and others in the area will probably approve the recommendations and hope it will resolve the conflicts that have been ongoing in the past few years.

Please keep us informed of future developments and in turn we will forward any concerns or problems in an honest approach to the best interests of everyone.

Sincerely yours

Peter W. Zeimet
Mayor, Edgemont, S.D. 57735

RESPONSE

No response is required.

CITY OF EDGEMONT
EDGEMONT, S. D., 57735

Nov. 2, 1981

U.S. Nuclear Regulatory Commission
Washington, D.C. 20555
Att'n: Uranium Recovery Licensing Branch

Dear Sirs:

Following are my comments on the DES on disposition of the uranium tailings at Edgmont, S.D.

(1) I think the City and most of its residents would be happy to accept any plan that would meet the criteria set up by the agencies assigned to handle the problem. Our main concern is to stop the endless barrage of comments in the news media that has caused such an economic loss to the community. The extent of that loss is impossible to clearly define because of all other factors involved.

(2) For the above reason I would prefer that the mill and tailings areas never receive a residential clearance. Much of it is in the flood plain and should be used only for commercial building, for livestock or native wildlife if it is cleared for such use.

(3) The City might find it advantageous to acquire a portion for use as a golf course, a park or other recreation uses.

(4) Because of the problems that could arise in disposing of the water after pumping was completed, I would prefer vehicle transportation of all the material with the water already on mill site being used to increase compaction on the disposal site as the project progressed. However, if the sand is pumped, the City would be receptive to the use of the excess effluent from the sewage lagoon for water supply as needed. This would avoid excessive use of the Madison Aquifer as a major source. Such use would not cause a major drawdown but could cause minor deficiencies in the city supply during the summer season.

RESPONSE

1. The staff agrees that it is in everyone's best interest to expedite cleanup of the mill site in an environmentally acceptable manner. It is to this end that the staff is working. The scheduled date to begin decommissioning is Summer 1982; decommissioning will continue for seven years (FES, Table 4.5).

2. Although it will be up to local officials to decide the ultimate use of the site, the NRC will require restrictions on land use based on residual radioactivity levels.

3. No response is required.

4. The staff will require that an adequate method of disposing of the water from slurry operations in a reasonable time frame is developed and implemented. While the staff agrees that excessive use of water from the Madison aquifer should be avoided, the licensee has stated that use of effluent from the sewage lagoon might pose significant biological contamination problems. TVA will be required to perform a detailed hydrogeological analysis to determine the effect of the project on the town's water supply. If significant adverse effects are identified, mitigative measures will be implemented or alternative sources of water will be used.

(5) Since we are well aware of some of the negative problems involved in transporting, we understand the need for slow and cautious planning. We all want the problem settled once and for all. Adverse publicity over mistakes could cause greater loss than a few months time. However, since we want to be as cooperative as possible, we would appreciate being in close contact as the final plans are made. This would help us in adapting to any influx of people into the community and the public school system. In this respect it would help if as many local people are used as practical.

(6) In the final contour design of all areas, more concern should be given to establishing good vegetative cover and eventual productivity than to trying to duplicate the original contour of the stream bed and adjacent land. Good soil and moisture conservation rules and practices should be followed. Potential commercial areas should be platted accordingly.

I would hope you will find our comments constructive rather than negative.

Peter W. Zeimet
Mayor, Edgemont, S.D.

RESPONSE

5. The staff will continue to keep the city of Edgemont informed as the project progresses.

6. The staff concurs.

Sixth District Council of Local Governments

October 26, 1981

U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Attn: Uranium Recovery Licensing Branch

Re: Edgemont, South Dakota Uranium Mill Decommissioning Draft Environmental Statement. (NUREG 0846)

Dear Sir:

Please accept the attached comments on behalf of the Sixth District Council of Local Governments, the areawide planning agency for the eleven counties of western South Dakota. The Governor of South Dakota in June 1979, designated the Council as the energy impact assistance agency for Fall River County, and in this capacity we offer our comments regarding the socioeconomic and water quality impact sections of the Draft Environmental Statement - Edgemont Uranium Mill (DES NUREG - 0846). We wish to emphasize that the position of the Council is to encourage all progress toward the removal of the mill tailings, and our comments are intended to assist and support that endeavor.

However, the Council is distressed by the apparent lack of care used in writing the Draft Environmental Statement, especially the socioeconomic sections. Additionally, while the DES states it addressed our comments made during the scoping process, we find this to be untrue. While the various revisions forwarded to the Council (Nov. 1979 - Sept. 1980) did address many of our socioeconomic concerns, the completely new version before us lacks the quality and clarity of those earlier editions.

POST OFFICE BOX 1586 - 306 EAST ST. JOE.
RAPID CITY, SO. DAK. 57709
PHONE 605-394-2681

MEMBER COUNTIES: MEADE, PENNINGTON, SHANNON, LAWRENCE, BENNETT, BUTTE, CUSTER, FALL RIVER, HARDING, JACKSON

RESPONSE

Upon receipt of the Sixth District Council's letter of October 26, 1981, the staff was surprised at references made to "revisions (of the DES) forwarded to the Council." The staff contacted the Council immediately in an effort to better understand the situation, as we had not forwarded to the Council any preliminary drafts of the "Draft Environmental Statement related to the Decommissioning of the Edgemont Uranium Mill" (DES). Through a discussion between Frank Anastasi, NRC, and Brian Shorten of the Council, it was determined that the Council had reviewed revisions of the Environmental Report (ER) prepared by TVA in support of the project and had in fact submitted comments on the ER to TVA and not comments on the DES to NRC, as stated in the letter. These comments were not passed on to the NRC.

RESPONSE

As noted earlier, the Council feels the removal of the tailings to be a significant regional issue. In an effort to speed this process along we have taken a great amount of staff time to review and recommend changes or supplemental data sources for the DES, so that the approval process will not be mired in various legal entanglements. Since we have exerted this effort to assist your agency, we urge you to thoughtfully review the attached comments and seriously consider the suggestions offered. Be assured the Council staff is available for consultation on this important matter.

Sincerely,

Van A. Lindquist
Executive Director

VAL/mjg

enclosure

SIXTH DISTRICT COUNCIL COMMENTS ON DRAFT ENVIRONMENTAL STATEMENT

Please accept the following comments regarding socioeconomic sections of the DES:

(1) • The DES acknowledges a number of Council and local documents as resource materials, (e.g.; p. 3-54 references 12,13,14,15; p. 4-37 references 14; p. B-5 references 3; p. 3-8 table 3.5 references (e); and p.3-12 table 3.8 reference (a). Some of these documents date back to 1978, and all are presently invalid due to updated information developed since then. The use of this data has caused numerous errors throughout Sections 3.4 and 4.1.8. While some of these are only technical, others greatly distort the narrative. Since the Council wishes to project to be undertaken with the greatest possible speed, and since these obvious errors could hamper the Environmental Statement's approval, I am willing to forward to you the following documents which would replace these outdated ones used, if you wish. (See attached list for documents available) Upon receiving these documents, I urge your staff to take the time to carefully review these resource materials so that they can revise the final draft and present accurate data regarding the local situation. Our office will be available to provide your staff with any explanations needed. I think your staff will find the more recent publications very helpful.

(2) • Based on the original DES, and the five successive revisions which were forwarded to the Council, we are astonished that the published draft DES has taken such a narrow scope regarding the anticipated impacts. All previous drafts presented the decommissioning actions as part of the overall energy development picture expected in Fall River County (e.g.; expanding railroad, uranium mining and milling employment). However, this draft focuses entirely on the impacts resulting from decommissioning, while virtually ignoring the other contributing impacts. The Council believes the only accurate method of assessing impacts is to treat all proposed energy developments holistically, so that a true scenario of the future impacts are presented. The Council urges NRC to revise this draft to reflect, as all past drafts have, the overall impact picture. Only in this way can local officials receive the precise information they need to plan for future impact mitigation. Moreover, the information offered in Section 4.1.8 regarding mitigation strategies is nearly nonexistent. The Council believes once specific impacts are identified, the federal agencies should work with the local impact team to formulate a general mitigation strategy.

(3) • Another surprise to the Council are the assumptions used to calculate future socioeconomic impacts noted in Appendix B. After nearly a year of exhaustive research and negotiating between TVA officials and the local, regional and state planners, a consensus was reached on a number of assumptions (e.g.; family size, mover rates, service worker ratios, etc.). These assumptions were then used by all planners during 1980 and 1981 so that impact forecasting would be standardized and consistent. However, it would

RESPONSE

The staff greatly appreciates that the Council made available numerous documents containing up-to-date socioeconomic information, and we have utilized this data in revising appropriate sections of the DES. On April 7, 1982, the staff met with members of the Council to discuss the concerns raised in this letter. The staff has also contacted TVA and Edgemont officials in an effort to thoroughly assess socioeconomic impacts, and the following information details our most recent evaluation and responds to concerns which the Council expressed in the October 26 letter.

1. The staff greatly appreciates that the Council made available numerous documents containing up-to-date socioeconomic information, and we have utilized this data in revising appropriate sections of the DES. The staff has also contacted TVA and Edgemont officials in an effort to assess socioeconomic impacts thoroughly. Information found in the documents sent to the staff by the Sixth District Council of Local Governments has been incorporated into the FES. This information has been especially valuable in updating population projections, recreation plans, housing needs, and the economics section. The documents sent are listed here:

   - *Fall River County Energy Impact Plan*, Sixth District Council of Local Governments, August 1980.
   - *Edgemont Recreation Plan (Update)*, Edgemont City Council, October 1981.
   - *Edgemont Comprehensive Plan*, Edgemont City Council, January 1980.
   - *Edgemont and Hot Springs Civic Audits*, Sixth District Council of Local Governments, 1980.
   - *Public Investment Plan*, Sixth District Council of Local Governments, June 1981.
   - *Hot Springs Comprehensive Development Plan*, Planning Commission and City Council, June 1981.

2. The staff recognizes the need for local governments to plan for all anticipated increases in growth. Some of the analyses performed in this FES address cumulative impacts such as those concerned with population projections. However, it is not within the scope of a site-specific environmental impact statement to address impacts due to other, nonrelated activities. The analyses presented in the FES should prove valuable to State and local planners as an aid in preparing an assessment of the total potential energy-related activities in the area.

3. In the FES, the staff retained the conservative assumptions used in the DES to predict population influx, thus affecting projections of numbers of families, school-age children, housing, etc., because we are presenting a maximum impact analysis. We have contrasted our conclusion with those reached by TVA in the ER to show the potential range of impacts (Table 4.4 vs Table 1). As one of the sources of information, the staff used the 1975 study by the Old West Regional Commission on construction worker profiles. We believe, despite the six-year age of the document, that this is a good source of information. The study covers 14 case histories in five mid-western states. We believe results from this study are valid and cannot be ignored. The many assumptions based on a consensus of a group of local, State, and TVA planners may be the best assumptions for the Edgemont area, but it is difficult for the staff to independently evaluate the basis for the assumptions. We have discussed our assumptions with TVA officials, and they agree that the staff's assumptions may be equally valid.

appear NRC staff unilaterally developed an independent set of assumptions, primarily based on generic models and 1975 construction worker profiles from other states. The Council urges Nuclear Regulatory Commission staff to utilize, as they did our draft revisions 4 & 5, the assumptions formulated by planners who are knowledgeable of the local area, and its demographic characteristics. The assumptions formulated locally can be secured from our office or from George DeVeny, Supervisor, Socioeconomic Analyses Section, Division of Community Services, TVA Knoxville, Tennessee - (615) 632-6990.

(4) * Numerous misstatements or errors are included in the narrative of sections 3.4 and 4.1.8. While some of these errors are related to the use of old data, others probably resulted from oversight or insufficient data. Since obvious misstatements can make the entire document suspect and therefore slow the approval process, we suggest the following revisions:

(4a) - Table 3.4 uses unpublished 1980 Census information, the published 1980 Census data indicate the populations of the County Edgemont and Hot Springs are: 8439, 1468, and 4762, respectively. Hot Springs contends, based on building permit data, that its 1980 population is actually 4,901.

(4b) - Table 3.5 uses extremely out-of-date population projections. References b, d, and e should be updated with information from the Sixth District Council of Local Governments' Fall River County Energy Impact Plan, the comprehensive plans of each city, or from information supplied by George DeVeny - TVA.

(4c) - Section 3.4.2.1. does not mention the affect of HUD's mortgage moritorium on housing construction due to the offsite tailings issue which arose during 1980. New housing construction has grinded to a halt, and very few houses have been sold since this issue arose. Also, the published 1980 census information indicates the total number of housing units at 685, not 486 as stated. Also, the City through an aggressive rehabilitation and demolition program, has rehabilitated 21 units and demolished 14 units since 1978. Private demolition spurred by the City's program has eliminated another nine units which were unsafe health hazards.

(4d) - Section 3.4.2.2. As part of the 1981 HUD Community Development Block Grant full application a housing inventory was completed for Hot Springs. This study indicated that there were 1255 owner units (of which 30 were vacant) and 676 renter units (of which 50 were vacant). The total number of units 1931 is very close to the 1980 published Census data indicating there are 1930 housing units in the community.

(4e) - Table 3.6 should be updated with information from the Sixth District Council of Local Governments Fall River County Impact Plan. This later document found 1,262 permanent units, 224 temporary units and 290 other units.

(4f) - Section 3.4.3. the dramatic increase in unemployment rates noted in 1980 was due primarily to Burlington Northern layoffs.

RESPONSE

4a,b. The current population and population projections through the year 2000 and numbers of existing housing units have been updated with the 1980 census data and with documents published more recently than those used in the DES. Table 3.5, as well as appropriate sections in the FES, reflect the new data. It is interesting to note, however, that the new projections do not change the conclusion reached in the DES that the population in Edgemont could double by mid-1985 if all proposed energy-related projects become a reality. The doubling of the population is predicted despite the recent population decrease that was due mainly to the Burlington Northern layoffs (DES, p. 3-5).

4c. The staff agrees that HUD's mortgage moratorium on housing construction due to offsite contamination (Stever Kocer, Edgemont Finance Officer, personal communication to R. B. McLean, Jan. 13, 1982) has adversely affected the sales of new houses. The FES has been updated to incorporate the latest housing information from the recently published 1980 census data (Table 3.6).

4d. Revised housing needs are shown in Tables 4.3 and 4.4.

4e. Table 3.6 has been updated.

4f. This was noted in Sect. 3.4.1.

(4g) - Table 3.10. The cities and the County have completed their respective 1982 budget processes, therefore, much more recent data is available.

(4h) - Section 3.4.4.4. Water supply system. The narrative mistakenly states that a FmHA 601 application for water line improvements was rejected. This was an application for FmH^ Community Facility Loan assistance and the application was withdrawn. A new preapplication has been submitted for a revised project. Regarding the Hot Springs approximately 13.5 blocks of deteriorated water mains are being replaced in the Battle Mountain neighborhood as part of an $850,000 Hud CDBG Grant for neighborhood revitalization. Other activities include housing rehabilitation, land assembly, blight clearance, storm sewer installation, street paving, curb and gutter installation.

(5) Sewage Edgemont has secured approximately $22,500 of FmHA 601 grant funds for land acquisition for the additional lagoon cell.

(6) Solid Waste Edgemont has secured approximately $13,500 of FmHA 601 grant funds for land acquisition for landfill expansion. Hot Springs is currently investigating a new site for its landfill and is expected to seek $40,000 of FmHA 601 funds for acquisition.

(7) Recreation Both cities have updated the recreation plans referenced in the DES. The Hot Springs comprehensive plan and the 1981 Edgemont recreation plan update can supply current information.

(7a) - 3.5.1. No mention is made of Union Carbide's uranium mining plans. This oversight should be corrected. Since the use of independent demographic assumptions make the projections noted in 4.1.8 vary considerably from those expected by TVA, local planners, and the Sixth District Council, no comments regarding the validity of the noted projections will be offered, other than to note that the impacts presented are completely out of sink with other planning done locally. However, a number of other corrections are suggested below.

(7b) - 4.1.8.2. Table 4.5 indicates that 65-90 construction employees have located in the area for decommissioning in the summer of 1981, obviously incorrect.

(7c) - 4.1.8.3. As noted earlier, the use of extremely old population projection data makes completely ridiculous the statement that Edgemont and Hot Springs' 1982 populations could grow to 3400-5700, and 7400-7500, respectively.

(7d) - 4.1.8.4. Again use of any data from reference 14 is worthless since this study has been updated in August of 1980 by the Fall River County Energy Impact Plan.

(7e) - 4.1.8.7. Reference to federal monetary assistance must be clarified. As noted in this review, FmHA 601 assistance has

RESPONSE

4g. Table 3.10 has been updated.

4h,5,6. Section 3.4.4.4 has been amended to show that the FmHA Community Facility Loan Assistance and Application was withdrawn. It is the staff's understanding that the FmHA 601 grant received by Edgemont in 1979 will not be renewed. The grant is being used for establishing a 30-unit mobile home park, land acquisition for sewage facility expansion and waste facility expansion, sewage and water line replacement, and other projects. The staff agrees that other federal funds are not certain in this time of cutbacks in Federal spending. It is noted in Sect. 4.1.8.8 that the city of Edgemont is improving streets with tax revenue (Steve Kocer, Edgemont Finance Officer, personal communication to R. B. McLean, Jan. 13, 1982). Reference 14 in this section has been replaced with the 1980 Fall River County Energy Impact Plan, which has been used to update this section.

7. See response to Sixth District Council comment 1.

7a. See response to Sixth District Council comment 2.

7b. Table 4.5 has been revised to indicate startup dates.

7c. See responses to Sixth District Council comments 4a and 4b.

7d. Reference 14 has been updated.

7e. See response to Sixth District Council comment 4h.

been secured for planning and some housing and land acquisition projects, however, this program is slated to be terminated by the 1982 budget cuts, thus no targeted assistance is available. Council staff are available to discuss with NRC staff various local mitigation strategies which should be mentioned in the narrative. Also, the shortfall in public funds has been updated by the Fall River County Energy Impact Plan.

(7f) 4.1.8.8. Water & Sewage The federal cutbacks in EPA wastewater grants will most probably delay or eliminate any financial assistance to the impacted cities. Thus, the conclusion noted is far from certain.

(7g) Roads Again, use of any data from reference 14 is invalid. Please consult the Fall River County Energy Impact Plan.

RESPONSE

7f. See response to Sixth District Council comment 4h.

7g. Reference 14 has been updated.

Please accept the following comments regarding water quality sections of the Draft Environmental Statement:

(8) * Before the decommissioning can begin and the area reclaimed the degree of contamination of the ground water must be quantified to determine possible adverse ramifications, i.e., aquifer leaking, etc. This is an important factor and must be included in the document to some degree.

(9) * Seepage control and monitoring must be stressed as an important facet of the complete program. A monitoring program must be in operation during the decommissioning and for a reasonable time after completion to assure the effectiveness of the operation. The document needs to layout a more complete account of the seepage control and monitoring program as a balance and check system for the decommissioning. The document needs to be re-evaluated in this area.

(10) * The document needs to assess the disposal site condition after the reclamation and the degree to which the area can be utilized. While the DES does cover the subject, it needs to be assessed in greater detail thus presenting a better scoping of the situation.

RESPONSE

8,9. Groundwater quality beneath the existing site has been monitored and quantified by TVA and the DWNR. The data of the DWNR are presented in Table 3.19. Specific water quality data may be found in the ER and in a study performed by Ford, Bacon and Davis Utah, Inc., *Engineering Assessment of Inactive Uranium Mill Tailings, Edgemont Site, Edgemont, South Dakota*, prepared for the U.S. Nuclear Regulatory Commission, Contract No. E605-11-1658, May 1978. The monitoring programs which will be implemented are presented in Sect. 4.2.

10. Sections 2.2.2.3 and 2.2.2.9 describe stabilization and reclamation plans for the disposal site. In addition, Sect. 2.2.3.6 presents an evaluation of the tailings management plan, including discussions of measures to be implemented to protect the impoundment against wind and water erosion, to ensure embankment stability at the disposal site, to eliminate or minimize seepage from the impoundment, and to reduce the gamma radiation and radon emissions from the disposal site. As stated in Sect. 2 and elsewhere in the FES, the reclaimed disposal site should provide suitable vegetation to support wildlife utilization of the area and to provide limited livestock forage.

According to the Uranium Mill Tailings Radiation Control Act, control of the reclaimed disposal site will be given to the Department of Energy or to the State of South Dakota if requested by the State. Decisions concerning the extent of future utilization of the site will have to be made by the agency which ultimately controls the site. This matter has been elaborated on in the FES.

LIST OF RECENTLY PUBLISHED DOCUMENTS
WHICH SHOULD BE USED TO UPDATE THE
EDGEMONT DRAFT ENVIRONMENTAL STATEMENT

RESPONSE

Fall River County Energy Impact Plan, Sixth District Council of Local Governments, August, 1980

Edgemont Recreation Plan (Update), City Council, October, 1981

Edgemont Comprehensive Plan, City Council, January, 1980

Edgemont & Hot Springs Civic Audits, Sixth District Council of Local Governments, 1980

Hot Springs Comprehensive Plan, City Council, August, 1981

Public Investment Plan, Sixth District Council of Local Governments, June, 1981

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December 3, 1981

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Nuclear Regulatory Commission
1717 H Street, N.W.
Washington, D.C. 20555

Re: Draft Environmental Statement Related to the Decommissioning of the Edgemont Uranium Mill, Docket No. 40-1341

Gentlemen:

These comments, filed on behalf of Kerr-McGee Corporation and Kerr-McGee Nuclear Corporation (Kerr-McGee), concern the Draft Environmental Statement on decommissioning of the Edgemont Uranium Mill owned by Tennessee Valley Authority (TVA). The draft statement calls for removal of approximately 2.1×10^6 MT of tailings from the Edgemont mill site to a proposed tailings disposal site located about 2 miles to the southeast. The draft statement, which appears to be based upon NRC's Uranium Mill Licensing Requirements, 45 Fed. Reg. 65521 (Oct. 3, 1981), specifically terms on-site disposal "unacceptable." Kerr-McGee objects to many aspects of the draft statement. Two of the Company's salient objections are summarized below.

1. <u>Reliance on Uranium Mill Licensing Requirements</u>

NRC's analysis in the draft statement repeatedly refers to standards contained in the agency's Uranium Mill Licensing Requirements. These regulations are unlawful for a variety of reasons. <u>First</u>, they were promulgated in advance of standards

RESPONSE

No response is required.

1. The 10 CFR Part 40 Appendix A criteria were effective at the time of printing of the DES.

Most of the specific issues raised in the Covington and Burling letter have been previously raised and responded to in a number of different forums including the industry lawsuit against the NRC related to mill licensing requirements. These issues include (1) NRC's authority to issue regulations prior to EPA promulgation of related standards; (2) the need for more comprehensive comparative risk evaluation; (3) the need for determination of significant risk; (4) overestimation of risks; (5) underestimation of costs; (6) reliance upon rigorous cost-benefit analysis; and (7) reliability of institutional controls. In March 1982, the Tenth Circuit Court of Appeals issued a decision on the petitioner's claims, including those noted above, and NRC's response to the claims. The Court ruling indicated that the Commission had adequate authority, had followed proper procedures, and had evaluated all of the important issues in developing the Uranium Mill Licensing Requirements. Therefore, rather than responding to each of these issues here, the commentor and readers are referred to the respondent's (NRC) brief and the Tenth Circuit Court of Appeals opinion related to consolidated cases Nos. 80-2043, 80-2229, 80-2269, and 80-2271.

RESPONSE

issued by the Environmental Protection Agency (EPA) in express contravention of section 275 of the Atomic Energy Act, 42 U.S.C. § 2022. Senator Simpson, Chairman of the Nuclear Regulation Subcommittee, has cogently explained that NRC acted unlawfully and improperly in adopting its regulations prior to action by EPA. "The issuance of these regulations," the Senator said,

> "violates the careful division of regulatory responsibility for mill tailings in the [A]ct and creates the potential for future shifts and conflicts in regulatory requirements affecting present and new uranium milling operations." 127 Cong. Rec. S 12982 (daily ed. Nov. 5, 1981)

Similarly, Senator Domenici, a sponsor of the Uranium Mill Tailings Radiation Control (UMTRC) Act, which added section 275 to the Atomic Energy Act, explained that NRC's action in advance of EPA standards violated the Act. Senator Domenici incisively declared that:

> "Under section 275 of the Atomic Energy Act, EPA must issue the standards, not NRC. EPA has not yet issued standards. NRC erred in issuing standards and more detailed requirements in advance of EPA's standards. NRC's action is not only contrary to the statute but also subjects [A]greement States and regulated industry to shifting and conflicting regulatory requirements." 127 Cong. Rec. S 12984 (daily ed. Nov. 5, 1981).

Second, the various NRC standards and attendant requirements are unreasonable, unduly stringent, and unsupported. The agency's 2 pCi/m²-sec radon flux standard is a case in point. The agency endeavors to justify that and other requirements on the ground that they are necessary to protect the public health. However, NRC's attempted justification is unavailing. The amount of radon emanating from even totally unstabilized tailings piles is miniscule compared to the amount of radon released naturally from soils in the United States and from such accepted economic activities as agriculture.[1] Moreover, as NRC acknowledges, there are no discernible adverse health effects from exposure to radon from mill tailings piles.[2] In the absence of harm, NRC assumes that some health effects may occur on the basis of the "linear non-threshold model."[3] Employing that hypothesis, NCR calculates that the maximum risk posed by radon from even totally unregulated mills is 1 in

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[1] Transcript of Hearing before New Mexico EIB at 461-62 & 470 (testimony of Dr. Evans), reprinted in Uranium Ore Residues: Potential Hazards and Disposition, Hearings before the Procurement and Military Nuclear Systems Subcomm. of the House Armed Services Comm., 97th Cong., 1st Sess. at 453 et seq (1981).

[2] NRC, Generic EIC on Uranium Milling (GEIS) at A-35.

[3] The linear non-threshold model on which NRC relies is subject to telling criticisms. For example, it is contrary to direct evidence that "ecologically realistic, low-level radiation is biologically stimulatory, and presumably beneficial." Hickey, Letter: Cancer and Consensus, Chemical & Engineering News 65 and 75 (Sept. 14, 1981). In addition, the model is based on the assumption that tumor induction is a straight-forward "one-hit" process in which any unit of exposure will result in some carcinogenic activity. But "the bulk of the evidence argues against the hypothesis that neoplastic transformation is a simple 'one-hit' process and therefore a linear function of dose." I Anderson, Pathology 347 (7th ed. 1977). Moreover, the purported general regulatory "acceptance" of the model is "in large part [a] misuse of statistics." Hickey, supra.

RESPONSE

70,000,000 for three times the number of mills now in existence.[4] This maximum risk, which is only hypothesized to exist anyway, is insignificant and de minimis. NRC has admitted that even if it actually eventuates, it is "about equal" only to the risks posed by "a few puffs on a cigarette, a few sips of wine, driving the family car about 6 blocks, flying about 2 miles, canoeing for 3 seconds, or being a man aged 60 for 11 seconds."[5] Indeed, the risk perceived by NRC is far less than many risks commonly and ordinarily accepted in our society.[6] NRC has in fact acknowledged that the $2pCi/m^2$-sec standard is unduly stringent. By the agency's own admission, it will result in exposures at the edge of the pile which are only "a small fraction of any reasonable health protection limit."[7]

Equally significant, NRC's estimate of the risk from unregulated tailings is unjustifiably inflated. Many prominent health physicists and other experts believe that the body is

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[4] See, e.g., GEIS at 19.

[5] 46 Fed. Reg. 15167 (March 4, 1981).

[6] See OSHA Testimony of Professor Richard Wilson reprinted in Hutt, Unresolved Issues in the Conflict Between Individual Freedom and Government Control of Food Safety, 33 FD&C L.J. 558, 564-66 and 568 (1978).

[7] GEIS at pp. 12-15 explains that "[e]xposures as close in as a fencepost near the edge of the pile would be about 1.1 x 10^{-4} WL above background levels. . ., which is a small fraction of any reasonable individual health protection limit (1% of the Surgeon General's guidelines)."

capable of repairing damage caused by low-level radiation.[8] Epidemiological studies in fact unanimously indicate that low-level radiation does not cause any adverse health effects.[9] Moreover, NRC's risk estimate is predicated on the existence of an adverse impact from exposure to radon more than 1/2 mile from tailings piles. However, there is no discernible increase in the amount of radon in the atmosphere more than 1/4 to 1/2 mile from a tailings pile, even in the downwind direction.[10] The latest study by a panel of eminent scientists from EPA, the

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[8] See e.g., Robbins & Cotran, Pathologic Basis of Disease 552 (2d ed. 1979); Transcript of New Mexico EIB hearing at 4995-96 (testimony of Dr. Evans); In the Matter of Duke Power Co. (Perkins Nuclear Station, Units 1, 2 and 3), 8 NRC 87, [1975-78 Transfer Binder] Nuclear Reg. Rep. (CCH) ¶ 30,312 at p. 28669 (1978).

[9] Hickey, et al., Low Level Ionizing Radiation and Human Mortality: Multi-Regional Epidemiological Studies, 40 Health Physics 625 (1981) (reprinted in Uranium Ore Hearings, supra, at 473); Frigerio, et al., The Argonne Radiological Impact Program (AGIP)-1. Carcinogenic Hazard from Low-Level, Low-rate Radiation (Argonne Nat'l Lab. Report ANL ES-26, Part 1) (1973); High Background Radiation Research Group (China), Health Survey in High Background Radiation Areas in China, 209 Science 877 (1980); Gopal-Ayengar, et al., Evaluation of Long-Term Effects of High Background Radiation on Selected Population Groups on the Kerala Coast in Peaceful Uses of Atomic Energy, Vol. 11, Proc. 45th Int. Conf. Peaceful Uses of Atomic Energy, pp. 31-51 (1971). Indeed, recent studies indicate that low-level radiation may be beneficial and even physiologically necessary. See, e.g., Luckey, Hormesis with Ionizing Radiation (CRC Press, 1980).

[10] Shearer & Sill, Evaluation of Atmospheric Radon in the Vicinity of Uranium Mill Tailings, 17 Health Physics 77-78 (1969); Letter, Greenleigh (DOE) to Selander (EPA), dated July 15, 1981, at 2 (hereinafter referred to as "DOE Comments on EPA Inactive Site Standards").

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Department of Energy (DOE), Germany, England and Canada indicates that the maximum hypothetical risk from radon can be no greater than 1/3 that employed by NRC per unit of exposure and may in fact be zero.[11] DOE has specifically declined to support the 2 pCi/m^2-sec radon emanation standard adopted by NRC.[12] Indeed, DOE has testified that the 2pCi/m^2-sec standard is

> "a factor of 50 or more lower than the current DOE and 10 CFR Part 20 guidance. In our opinion the justification for such a restrictive standard is inadequate . . ."[13]

Compliance with NRC's stringent radon emanation and three meters groundcover requirements will also result in numerous injuries and fatalities to workers and the public due to the movement of large amounts of earth.[14] In addition, the excavation of large amounts of soil and rock for use as cover will cause tremendous disruption to the environment in the arid locations where most uranium is milled.[15] Finally, compliance with NRC's regulations will unduly raise the cost of electrical

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[11] Evans, et al., Estimate of Risk from Environmental Exposure to Radon-222 and its Decay Products, 390 Nature 98 (March 12, 1981). See also Cohen, Failures and Critique of the BEIR-III Lung Cancer Risk Estimates, ___ Health Physics ___ (in publication).

[12] See DOE Comments on EPA Inactive Site Standards at 3.

[13] Uranium Ore Hearings, supra, at 183.

[14] E.g., Transcript of EIB Hearing at 479-80, 483 and 508

[15] E.g., Transcript of EIB Hearing at 351.

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energy. This will result in additional reliance on increased insulation by consumers. Increased insulation results in fewer air changes and higher exposure to indoor radon and air pollution. If the government's risk estimates for radon exposure are accepted, increased insulation is already resulting in 1,000 additional fatalities per year and will eventually result in some 10,000 additional fatalities.[16] This far outweighs the projected hypothetical benefits from NRC's standards.

NRC's decision to require disposal of tailings such that maintenance is not required "for thousands of years" is totally arbitrary. It is not technically possible to provide controls of such longevity.[17] Moreover, NRC bases this requirement on the assumption that "institutional controls -- i.e., the government -- will fail and tailings sites may in fact be occupied and used for housing in the future millenia. This assumption is sheer speculation by NRC. It is also contrary to the UMTRC Act which specifically requires transfer of tailings to government agencies and charges them with "maintain[ing] such material and land in such a manner as will protect the public health and safety and environment."[18] NRC's assumption that

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[16] Cohen, Health Effects of Radon from Insulation of Buildings 39 Health Physics 937, 940 (1980).

[17] See, e.g., DOE Comments on EPA Inactive Site Standards at 6.

[18] 42 U.S.C. § 2113(b)(2) & (3).

the government will fail is also fundamentally inconsistent with the concept of national government and the firmly established principle that the United States is a Union of States established in perpetuity.[19]

Many other aspects of NRC's regulations are unsupportable. For example, above-grade disposal is just as good as below-grade disposal, and is less expensive.[20] This is especially true with regard to large existing facilities, such as the Edgemont pile, which would have to spend tens of millions of dollars to transport their tailings piles for below-grade disposal.

The uranium industry is not in a position to bear the additional costs imposed by NRC's new regulations. Half the uranium miners in Wyoming, Colorado, and New Mexico are already out of work. Mining and milling operations are being curtailed or terminated on an almost weekly basis.[21] Further

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[19] Marbury v. Madison, 5 U.S. (1 Cranch) 137 (1803) (Constitution is "designed to be permanent"); Lincoln, First Inaugural Address (March 4, 1861) in IV Collected Works of Abraham Lincoln 264 (R.P. Basler, ed. 1953) ("the Union of these States is perpetual").

[20] Transcript of EIB Hearing at 1107, 1111 & 1113.

[21] See, e.g., transcript of EIB hearing at 1361, 1369-71; "Uranium task force asks Governor to cut regulatory costs" in The Riverton Ranger, Riverton, Wyoming, p. 3 (Oct. 2, 1981).

implementation of these regulations will result in yet more curtailment of production and aggravation of unemployment.

NRC's estimates for the cost to comply with its regulations are $760,000,000 to $1,500,000,000 or more.[22] The Department of Energy (DOE) estimate is equally great. DOE estimates that it will cost that agency $474,000,000 (1982 dollars) to comply with comparable requirements at the 1000 acres of inactive sites for which it is responsible.[23] This works out to about $500,000 per acre. The cost will likely be far greater if NRC insists on moving existing tailings piles as is indicated by its proposal to move the Edgemont pile. The remote and hypothetical benefits NRC attributes to its regulations are not commensurate with these enormous costs. The NRC regulations are simply not cost-justified.

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[22] NRC estimates that it will cost $340,000,000 to comply with the agency's 2 pCi/m²-sec radon emanation limit alone. See I GEIS at 12-22. Below-grade disposal (NRC's "prime option") will cost approximately twice as much, even without counting the charge for transfer of tailings from existing sites for such disposal. See I GEIS at 12-8. NRC's estimate for groundwater protection (Criterion 5) will be about equal to the costs to comply with its cover and 2 pCi/m²-sec requirements (Criterion 6), i.e., $340,000,000 to $680,000,000. Compare I GEIS at 22 with I GEIS at 18. When all these and other pertinent sums are totalled, NRC's cost estimate for stabilization alone runs from $760,000,000 to about $1.5 billion.

[23] Uranium Ore Hearings, supra, at 382 (Mr. Ramsey of DOE) (DOE's estimate taking into account inflation is $700,000,000).

2. Staff Rejection of On-site Disposal Alternatives

NRC staff briefly described two alternative methods of on-site disposal of the Edgemont tailings in the draft statement. The staff observed that either of these on-site disposal methods had numerous advantages. In particular, staff admitted that on-site disposal

-- "minimized handling of tailings and contaminated materials and thus reduced operational radioactive exposures and emissions";

-- "expedited stabilization of the site relative to off-site disposal alternatives";

-- resulted in "lower costs ... and ... fewer direct impacts on traffic";

-- permitted release of "approximately one-half to two-thirds of the ... 213 acre ... mill site" for "unrestricted use." [24]

In addition, staff noted that the tailings disposed on-site "will meet the radon-flux- and direct-gamma-radiation limits" specified in the Uranium Mill Licensing Requirements. Despite these numerous advantages, NRC staff nevertheless cursorily dismissed both on-site disposal alternatives. Staff's rationale for this rejection is not persuasive.

Staff first contends that "a major disadvantage with on-site stabilization is the continued presence of radioactive tailings near a population center ...."[25] The presence of

[24] Draft Statement 2-27 to 28.

[25] Id. at 2-28.

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2. In the case of the Edgemont site, the NRC Source Material License was amended to require TVA to submit a proposal for decommissioning the site which would meet the NRC performance objectives for tailings management and guidelines for facility decontamination. In this FES, the staff evaluates the alternatives proposed by the licensee as well as alternatives developed by the staff against the NRC performance objectives for tailings management and guidelines for facility decontamination. The purpose of this evaluation is to (1) determine the adequacy of the licensee's preferred alternative, (2) determine whether other alternatives proposed either by the licensee or staff are environmentally superior to the preferred alternative, and (3) if superior alternatives are identified, determine if the additional costs associated with these superior alternatives are warranted. The staff's evaluation of TVA's preferred alternative (Sect. 2.2.3), which provides for offsite disposal of tailings, has concluded that the plan satisfies the NRC performance objectives for tailings management and guidelines for facility decontamination and that no other alternatives are superior from an environmental standpoint. Because of the social impacts on the town of Edgemont resulting from the close proximity of the tailings and the use of tailings as fill material in the town, TVA has voluntarily committed to move the tailings and to move forward promptly with the cleanup plan once NRC approval is obtained.

By utilizing one or more lined impoundments, placing thick earthen covers over them and placing riprap on slopes and stream banks, onsite stabilization might be a technologically feasible alternative. However, because the licensee's preferred alternative of offsite disposal and stabilization (discussed below) would provide a much higher degree of certainty for successful long-term stabilization of the tailings and contaminated materials, witout routine maintenance, the alternative of onsite stabilization was not explored any further.

Despite the potential short-term disadvantages and impacts, the staff feels that a properly designed offsite disposal plan will result in superior long-term stabilization without the need for ongoing monitoring and maintenance. In addition, the staff's evaluation has determined that exposures to the population will be within appropriate radiation protection standards and the occupational risk to workers is acceptably low. Therefore, this alternative, preferred by the licensee, is endorsed by the staff.

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radioactive tailings near a population center is irrelevant if exposure to radiation from the tailings meets applicable standards. This is doubly the case with respect to the Edgemont pile because NRC staff admits that the tailings may be disposed on-site so as to meet even the unduly stringent standards specified in the Uranium Mill Licensing Requirements. As already noted, NRC has elsewhere stated that these standards are so strict that they will result in exposures at the very edge of the pile which are only "a small fraction of any reasonable health protection limit."[26] On-site disposal will thus not result in any radiation hazard to any individual, regardless of whether the disposal is near a population center. Equally significant, NRC's admissions indicate that radiation hazards from on-site disposal are unlikely to outweigh the risk to workers and to the public from moving the tailings.

NRC staff next argues that "continual monitoring and maintenance of disposal areas would be necessary to offset the erosional effects of Cottonwood Creek and the Cheyenne River as well as to prevent encroachment on the site by human activities."[27] Staff's apparent distaste for monitoring is inconsistent and chimerical. It totally ignores NRC's

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[26] See p. 4, supra.

[27] Draft Statement at 2-28.

intent, manifest in the Uranium Mill Licensing Requirements, to require licensees to post a minimum of $250,000 (1978 dollars) for perpetual monitoring and maintenance of tailings piles regardless of the nature of the disposal involved. Given this hefty fund, it is obvious that there will be ample provision for necessary monitoring. Staff's concern about "encroachment . . . by human activities" is likewise unfounded. The UMTRC Act calls for government custody and control of the stabilized tailings piles. Given this provision, the only allowable assumption is that the government will prevent people from dwelling or otherwise unduly encroaching on the site. Staff elsewhere admits the utility and effectiveness of government controls at Edgemont; indeed, staff notes that it in fact may rely on such controls. In particular, staff indicates that it may require that the mill site be encumbered so as to prevent its use for residential purposes (because of residual radioactivity) even after all tailings are removed.[28] Finally, staff has wholly failed to explain why engineering controls (e.g., rip-rap and diversion channels) cannot fully assure that Cottonwood Creek and the Cheyenne River will not pose a significant erosional threat to the tailings for the foreseeable future. Similarly, staff has failed to show why

[28] E.g., Draft Statement at 1-2.

human intrusion is significantly more likely at the current location of the tailings as opposed to the location staff prefers which is located less than two miles away.

NRC staff finally argues that "it is possible contaminated pond waters could seep through dikes and the unlined pond basins and contaminate nearby surface and groundwaters."[38] Staff's fears, which are hypothetical anyway, can be totally allayed by proper contouring and by selection of cover material designed to prevent seepage of rainwater into the stabilized tailings piles. Indeed, staff admits elsewhere in the draft statement that stabilized tailings may be "crowned" so that "all precipitation will run off." [39]

In sum, NRC staff has failed to demonstrate that on-site disposal is unsatisfactory. Staff has also failed to show why the off-site disposal which it prefers is more desireable. To the contrary, off-site disposal appears less desireable in view of its much greater cost, the increased radiation and traffic hazards associated with it, and the possibility that it will result in radioactive contamination of more land (requiring land use controls over a broader area) than disposal on-site.

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[38] Draft Statement at 2-28.

[39] Id. at 2-24.

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The action proposed by NRC at Edgemont may well result in greater safety and environmental risks than on-site disposal while at the same time costing TVA's utility ratepayers (or, alternatively, federal taxpayers[31]) much more money. Kerr-McGee believes that a much more detailed and meaningful analysis of the costs and benefits of the various disposal alternatives is essential to avoid action which may well imperil rather than protect public health and safety and the environment. Until such an analysis is completed and clearly substantiated, the agency should eschew imposition of costly requirements such as movement of tailings piles.

Respectfully submitted,

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Attorneys for
Kerr-McGee Corporation and
Kerr-McGee Nuclear Corporation

cc: Chairman Palladino
Mr. Ross Scarano

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[31] NRC has indicated that "[u]ranium produced at the Edgemont site was primarily purchased by the government for defense purposes." Draft Statement at 4-36. The government has already recognized financial responsibility for such "commingled tails." See, e.g., Section 213 of the DOE National Security and Military Application of Nuclear Energy Authorization Act of 1981, 94 Stat. 3203. Taxpayers may thus eventually bear all or a substantial portion of the hefty costs involved with the off-site disposal preferred by NRC.

Appendix B

ASSUMPTIONS UTILIZED FOR SOCIOECONOMIC IMPACT ASSESSMENTS

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ASSUMPTIONS UTILIZED FOR SOCIOECONOMIC IMPACT ASSESSMENTS

The staff combined information from a literature survey, discussions, and written communications with the applicant, planners, and other authorities in the Hot Springs-Edgemont area to develop assumptions for analyzing the socioeconomic impacts of the proposed decommissioning project. The socioeconomic environment in the affected region is very dynamic and, because of the small size of the communities, is therefore very sensitive to inflow and outflow of industrial activity. Because of this high degree of sensitivity, any of the assumptions used could be in error in the long term. For example, if national recessionary conditions were to worsen, causing the shutdown of an industry, the anticipated low unemployment and housing vacancy rates, upon which two of the major assumptions are based, may be erroneous. No sure method exists for an analyst or planner to forecast such occurrences. Therefore, the staff chose to calculate high and low ranges to quantify impacts as much as feasible, recognizing that some of the high-to-low ranges are necessarily fairly wide.

1. The staff assumed that Edgemont and Hot Springs, the closest communities to the project, and Fall River County would receive the brunt of the impacts.

2. The impacts on employment, population, housing, school enrollments, and some of the other impacts were calculated utilizing worst-case assumptions:

   a. Peak project employment will be ∼80 during construction [first project calendar year (CY)] and ∼90 during operation (third project CY).

   b. Because of very low unemployment rates currently prevailing in the area and the expected continuation of tight labor markets during the 1980s, the staff assumed that a high percentage of the project-related work force would consist of nonlocal workers. Thus, it was assumed that 80 to 100% of the basic workers for both construction and operation would have to in-migrate and that 80% of the secondary (or project-induced) jobs would be filled by nonlocal workers.

   c. None of the basic and secondary workers will be from the same family.

   d. All locally obtained employees were previously unemployed.

   e. All single in-migrants will require separate residences.

3. The staff subdivided the analysis into two basic components, (a) construction and (b) operation. Construction activities will be short-term. Operation activities will take place over a much longer period of time. Also, construction workers typically differ from operation workers in spending patterns, housing demands, and in other critical socioeconomic characterisitics.[1,2] Therefore, the assumptions utilized to assess construction impacts differed from those used to analyze operation impacts:

   a. The following assumptions were used to calculate construction impacts:

      (1) Each basic job was assumed to induce 0.6 to 0.8 secondary jobs.[1]

      (2) Of the basic and secondary in-migrating workers, 25% would not be married.

      (3) Only 13 to 27% of the nonlocal basic workers with families will bring their families with them (10 to 20% of the total basic work force); 50% of the secondary workers with families will bring their families with them.

(4) The family size for both secondary and basic worker families will average about 3.5, including 2 spouses and 1.5 children.[2]

(5) About 58% of the children will be school-age (5-18 years).[2]

b. The following assumptions were used to calculate operation impacts:

(1) Each basic job was assumed to induce 1.2 to 1.5 secondary jobs.[1]

(2) Of the basic and secondary in-migrating workers, 25% would not be married.[2]

(3) About 67.5% of the nonlocal secondary workers will bring their families with them.[2]

(4) The family size for all in-migrating workers will average about 3.5 — including 2 spouses and 1.5 children.[2]

(5) About 58% of the children will be school-age.[2]

4. To determine settlement patterns, the staff assumed, for simplification, that all of the in-migrating workers and families would live in either Hot Springs or Edgemont. Considering the distances between these communities and the project site(s) and the relative sizes (comparative populations) of the communities, it would normally be expected that about 75% of the nonlocal workers would live in Edgemont and about 25% in Hot Springs.[2] However, because Edgemont lacks some of the services, such as medical, that are usually attractive to in-migrants, local planners predict that about 40% of development-induced in-migrants may choose to live in Hot Springs.[3] Therefore, to allow for all potentialities, the staff developed settlement ranges to assess impacts.

Because construction activities are short term (six months), the staff assumed that 75 to 90% of the basic work force would choose to live in Edgemont and only 10 to 25% in Hot Springs. However, the staff believes that construction-induced, nonlocal secondary workers will not have the same settlement patterns as basic worker in-migrants. Although short-term construction activities may be responsible for their jobs, secondary workers, who usually are employed in retail trade and services, will not ordinarily in-migrate unless employment appears to be reasonably long term. Therefore, the staff expects that their settlement patterns will be more like those of operation workers; that is, a larger percentage of secondary workers will choose to live in Hot Springs than would an equivalent basic construction work force. Consequently, it was assumed that from 50 to 75% of the nonlocal, construction-elicited secondary workers would settle in Edgemont and from 25 to 75% in Hot Springs.

It was assumed that 50 to 75% of the operation's basic and secondary work force would settle in Edgemont and 25 to 50% in Hot Springs.

5. To determine personal incomes, the staff assumed that basic construction and operation workers' earnings would average about $20,000 per year before taxes (1979 dollars).[1,2] Research has shown that only about 33 to 40% of total earnings was spent locally in similar western communities;[2] therefore, the staff assumed (via the utilization of basic consumption theory) that the income multiplier for construction would be about 1.6; the operation multiplier was assumed to be 1.65.

6. To calculate tax revenues (1979 dollars), the staff used the assumptions and methodology utilized for a similar purpose in ref. 3. The revenue estimates, which are based on the 1979 tax structure, are tenuous and for the latter years of the project, when tax structures may have changed considerably, may be erroneous.

REFERENCES FOR APPENDIX B

1. U.S. Nuclear Regulatory Commission, *Final Generic Environmental Impact Statement on Uranium Milling*, Report NUREG-0706, Washington, D.C., September 1980.

2. Old West Regional Commission, *Construction Worker Profile: Final Report*, Mountain West Research, Inc., Washington, D.C., December 1975.

3. Sixth District Council of Local Governments, "Fall River County 601 Designation Application," Rapid City, S.D., June 18, 1979.

Appendix C

DETAILED RADIOLOGICAL ASSESSMENT

Appendix C

DETAILED RADIOLOGICAL ASSESSMENT

This assessment describes the models, data, and assumptions used by the staff to perform its radiological impact assessment of the Edgemont decommissioning. The primary calculational tool employed is MILDOS,[1] an NRC-modified version of the UDAD (Uranium Dispersion and Dosimetry) computer code originated at Argonne National Laboratory.[2]

C.1 ANNUAL RADIOACTIVE MATERIAL RELEASES

Table 4.9 lists estimated annual activity releases for the Edgemont decommissioning. All data except for the annual average dusting rate for exposed tailings sands are based on data and assumptions given in Table 4.8 and described in Sect. 4.1. This dusting rate is calculated in accordance with the following equation:

$$M = \frac{3.156 \times 10^7}{0.5} \sum_s R_s F_s \ , \qquad (C.1)$$

where

M = annual dust loss per unit area, $g/m^2 \cdot year$;

3.156×10^7 = number of seconds per year;

0.5 = fraction of total dust loss constituted by particles ≤ 20 μm diam, dimensionless;[1]

R_s = dusting rate for tailings sands at the average wind speed for wind speed group s for particles ≤ 20 μm diam, $g/m^2 \cdot s$;

F_s = annual average frequency of occurrence of wind speed group s, dimensionless.

The values of R_s and F_s used by the staff are as given in Table C.1.

Table C.1. Parameter values for calculation of annual dusting rate for exposed tailings sands[a]

Wind speed group (knots)	Average wind speed [km/h (mph)]	Dusting rate ($g/m^2 \cdot s$)	Annual frequency of occurrence
0–3	2.4 (1.5)	0	0
4–6	8.9 (5.5)	0	0
7–10	16.0 (10.0)	3.92E–7[b]	0.29960
11–16	24.9 (15.5)	9.68E–6	0.16610
17–21	34.6 (21.5)	5.71E–5	0.02770
>21	45.1 (28.0)	2.08E–4	0.00750

[a] Dusting rate as a function of wind speed is computed by the MILDOS code (ref. 1). Wind speed frequencies obtained from annual joint frequency data presented in Table C.2.

[b] Read as 3.92×10^{-7}, or 0.000000392.

The calculated value of the annual dusting rate M is 307.86 g/m^2·year. Annual curie releases from the tailings piles are then given by the following relationship:

$$S = MA(1 - f_c)f_t(C)(2.5 \times 10^{-12}) \ , \qquad (C.2)$$

where

S = annual release for the particular beach area, Ci/year;

A = assumed beach area of the pile, m^2;

f_c = fraction of dusting rate controlled by mitigating actions, dimensionless;

f_t = fraction of ore content of particular nuclide present in the tails;

C = assumed raw ore activity, pCi/g;

2.5 = dust-to-tails activity ratio;

10^{-12} = Ci/pCi.

The total area of the Edgemont tailings impoundments is 86.2 ha (213 acres) with an additional estimated 32.4 ha (80 acres) of dispersed tailings from wind blowing the tailings piles. Also, the disposal site 3.6 km southeast of the site will consist of a 28.3-ha (70-acre) impoundment.

The assessment of the actual site was performed under the following assumptions:

1. No reduction factor caused by wetting or chemical agents was assumed.
2. A time period of 2.5 years was used for the duration of emission from reclamation activities.
3. After reclamation, emission levels are assumed to meet recommended cleanup standards (5 pCi/g or less in soil of U-238, Th-230, Ra-226, Pb-210; 2 pCi/m^2·s radon flux).

As appropriate, different values were used for tailings activity depending on the type of tailings in the particular area (i.e., slimes, sands, or mixture).

C.2 ATMOSPHERIC TRANSPORT

The staff analysis of offsite air concentrations of radioactive materials has been based on two years of meteorological data collected at the Edgemont meteorological station during the period May 1, 1977, through Oct. 31, 1979 (ref. 3). Collected meteorological data are entered into the MILDOS code as input in the form of a joint frequency distribution by wind speed group and direction. Joint frequency data employed by the staff for this analysis are presented in Table C.2.

The dispersion model employed by the MILDOS code is the basic straight-line Gaussian plume model. Ground-level, sector-averaged concentrations are computed using this model and are corrected for decay and ingrowth in transit (for Rn-222 and daughters) and for depletion caused by deposition losses (for particulate matter). Area sources are treated using a virtual point source technique. Resuspension into the air of particulate material initially deposited on ground surfaces is computed using a resuspension factor that depends on the age of the deposited material and its particle size. For the isotopes of concern here, total air concentration including resuspension is about 1.6 times ordinary air concentration.

The assumed particle size distribution, particle density, and deposition velocities for each source are presented in Table C.3.

Table C.2. Joint frequency data (in percent) from mill meteorogical station (stability class 4)

Wind direction	Wind speed [km/h (mph)]						
	2.4 (1.5)	8.9 (5.5)	16.0 (10.0)	24.9 (15.5)	34.6 (21.5)	45.1 (28.0)	Total
N	0.6500	0.7800	0.3700	0.0500	0.0000	0.0000	1.8500
NNE	0.8200	0.8000	0.1800	0.0900	0.0000	0.0000	1.8900
NE	0.8600	0.9700	0.4900	0.2000	0.0000	0.0000	2.5200
ENE	0.6800	1.0600	0.9300	0.8000	0.0200	0.0000	3.4900
E	0.5500	2.0800	4.2900	3.8900	0.4000	0.0000	11.2100
ESE	0.4800	2.0800	4.6400	2.7600	0.1300	0.0000	10.0900
SE	0.2900	2.3000	3.1200	1.0000	0.0700	0.0200	6.8000
SSE	0.8200	2.3900	1.4600	0.5100	0.0900	0.0200	5.2900
S	1.2400	2.3300	0.6000	0.1600	0.0000	0.0000	4.3300
SSW	0.6700	1.4900	0.4600	0.1500	0.0200	0.0000	2.7900
SW	0.3700	0.8800	0.4700	0.2600	0.0900	0.0000	2.0700
WSW	0.6800	1.1900	0.8900	0.5700	0.1800	0.0000	3.5100
W	1.2300	2.8300	1.6400	0.5300	0.1600	0.0000	6.3900
WNW	1.3500	5.5000	4.5100	2.1900	0.3700	0.2700	14.1900
NW	1.8800	6.1700	4.2500	2.8500	1.1100	0.3300	16.5900
NNW	1.7100	2.6800	1.6600	0.6000	0.1300	0.1100	6.8900
Total	14.2800	35.5300	29.9600	16.6100	2.7700	0.7500	99.9000

Table C.3. Physical characteristics assumed for particulate material releases

Activity source	Diameter (μm)	Density (g/cm^3)	Deposition velocity (cm/s)	AMAD[a] (μm)
Tailings				
30%	5.0	2.4	1.0	7.75
70%	35.0	2.4	8.8	54.2
Ingrown radon daughters	0	1.0	0.3	0.3

[a] Aerodynamic equivalent diameter, used in calculating inhalation doses (ref. 1).

C.3 CONCENTRATION IN ENVIRONMENTAL MEDIA

Information provided below describes the methods and data used by the staff to determine the concentrations of radioactive materials in the environmental media of concern in the vicinity of the site. These include concentrations in the air (for inhalation and direct external exposure), on the ground (for direct external exposure), and in meat and vegetables (for ingestion exposure). Concentration values are computed explicitly by the MILDOS code for U-238, Th-230, Ra-226, Rn-222 (air only), and Pb-210. Concentrations of Th-234, Pa-234, and U-234 are assumed to equal that of U-238. Concentrations of Bi-210 and Po-210 are assumed to equal that of Pb-210.

C.3.1 Air concentrations

Ordinary, direct air concentrations are computed by the MILDOS code for each receptor location from each activity source by particle size (for particulates). Direct air concentrations computed by MILDOS include depletion by deposition (particulates) or the effects of ingrowth and decay in transit (radon and daughters). To compute inhalation doses, the total air concentration of each isotope at each location, as a function of particle size, is computed as the sum of the direct air concentration and the resuspended air concentration:

$$C_{aip}(t) = C_{aipd} + C_{aipr}(t) \ , \qquad (C.3)$$

where

$C_{aip}(t)$ = total air concentration of isotope i, particle size p, at time t, pCi/m^3;

C_{aipd} = direct air concentration of isotope i, particle size p, for the time constant, pCi/m^3;

$C_{aipr}(t)$ = resuspended air concentration of isotope i, particle size p, at time t, pCi/m^3.

The resuspended air concentration is computed using a time-dependent resuspension factor $R_p(t)$, defined by

$$R_p(t) = (1/V_p)10^{-5}\ e^{-\lambda_R t} \quad \text{for } t \leq 1.82 \text{ years}$$

and

$$R_p(t) = (1/v_p)10^{-9} \quad \text{for } t > 1.82 \text{ years} \ , \qquad (C.4)$$

where

$R_p(t)$ = ratio of resuspended air concentration to ground concentration, for a ground concentration of age t years, of particle size p, m^{-1};

V_p = deposition velocity of particle size p, cm/s;

10^{-5} = initial value of the resuspension factor (for particles with a deposition velocity of 1 cm/s), m^{-1};

λ_R = assumed decay constant of the resuspension factor (equivalent to a 50-d half-life), 5.06 years;

1.82 = time required to reach the terminal resuspension factor, years;

10^{-9} = terminal value of the resuspension factor (for particles with a deposition velocity of 1 cm/s), m^{-1}.

The basic formulation of the above expression for the resuspension factor, the initial and final values, and the assigned decay constant derive from experimental observations.[4] The inverse relationship to deposition velocity eliminates mass balance problems involving resuspension of 100% of the initial ground deposition for the 35-μm particle size (see Table C.3). Based on this formulation, the resuspended air concentration is given by

$$C_{aipr}(t) = \left[0.01\ C_{aipd} \times 10^{-5}\right] \times \left\{ \frac{1 - \exp[-(\lambda_i^* + \lambda_R)(t - a)]}{(\lambda_i^* + \lambda_R)} + 10^{-4}\delta(t)\ \frac{\exp[-\lambda_R^*(t - a)] - \exp(-\lambda_i^* t)}{\lambda_i^*} \right\} \times (3.1.56 \times 10^7) \ , \qquad (C.5)$$

where

a = (t - 1.82) if t < 1.82 years;

$\delta(t)$ = 0 if t < 1.82 and is unity otherwise, dimensionless;

λ_i^* = effective decay constant for isotope i on soil, year^{-1};

0.01 = deposition velocity for the particle size for which the initial resuspension factor value is 10^{-5} per meter, m/s;

3.156×10^7 = s/year.

Total air concentrations are computed using Eqs. (C.3) and (C.5) for all particulate effluents. Radon daughters that grow from released radon are not depleted because of deposition losses and are therefore not assumed to resuspend.

C.3.2 Ground concentrations

Radionuclide ground concentrations are computed from the calculated airborne particulate concentrations arising directly from onsite sources (not including air concentrations resulting from resuspension). Resuspended particulate concentrations are not considered for evaluating ground concentrations. The direct deposition rate of radionuclide i is calculated using the following relationship:

$$D_{di} = \sum_p C_{adip} V_p \,, \tag{C.6}$$

where

D_{di} = resulting direct deposition rate of radionuclide i, pCi/m^2·s;

C_{adip} = direct air concentration of radionuclide i, particle size p, pCi/m^3;

V_p = deposition velocity of particle size p, m/s (see ref. 4).

The concentration of radionuclide i on a ground surface resulting from constant deposition at the rate D_{di} over time interval t is obtained from

$$C_{gi}(t) = D_{di}\left[\frac{1 - \exp(-\lambda_i + \lambda_e)t}{\lambda_i + \lambda_e}\right], \tag{C.7}$$

where

$C_{gi}(t)$ = ground surface concentration of radionuclide i at time t, pCi/m^2;

λ_i = radioactive decay constant[5] for radionuclide i, s^{-1};

λ_e = assumed rate constant for environmental loss, 5^{-1};

t = time interval over which deposition has occurred, s.

The environmental loss constant λ_e corresponds to an assumed half-time for loss of environmental availability of 50 years.[4] This parameter accounts for downward migration in soil and loss of availability caused by chemical binding. It is assumed to apply to all radionuclides deposited on the ground.

Ground concentrations are explicitly computed only for U-238, Th-230, Ra-226, and Pb-210. For all other radionuclides, the ground concentration is assumed equal to that of the first parent radionuclide for which the ground concentration is explicitly calculated. For Pb-210, ingrowth from deposited Ra-226 can be significant. The concentration of Pb-210 on the ground caused by Ra-226 deposition is calculated by the staff, using the standard Bateman formulation and assuming that Ra-226 decays directly to Pb-210. If i = 6 for Ra-226 and i = 12 for Pb-210 (ref. 1), the following equation is obtained.

$$C_{g12}(Pb \leftarrow Ra) = \frac{\lambda_{12} D_{d6}}{\lambda_6^\star} \left[\frac{1 - \exp(-\lambda_{12}^\star t)}{\lambda_{12}^\star} + \frac{\exp(-\lambda_6^\star t) - \exp(-\lambda_{12}^\star t)}{\lambda_6^\star - \lambda_{12}^\star} \right] , \quad (C.8)$$

where

$C_{g12}(Pb \leftarrow Ra)$ = incremental Pb-210 ground concentration resulting from Ra-226 deposition, pCi/m^2;

$\lambda_n^\star$ = effective rate constant for loss by radioactive decay and migration of a ground-deposited radionuclide and = $\lambda_n + \lambda_e$, s^{-1}.

C.3.3 Vegetation concentrations

Vegetation concentrations are derived from ground concentrations and total deposition rates. Total deposition rates are given by the following summation:

$$D_i = \sum_p C_{aip} V_p , \quad (C.9)$$

where D_i is the total deposition rate (including deposition of resuspended activity of radionuclide i, $pCi/m^2 \cdot s$.

Concentrations of released particulate materials can be environmentally transferred to the edible portions of vegetables or to hay or pasture grass consumed by animals by two mechanisms: direct foliar retention and root uptake. Five categories of vegetation are treated by the staff: edible above-ground vegetables, potatoes, other edible below-ground vegetables, pasture grass, and hay. Vegetation concentrations are computed using the following equation:

$$C_{vi} = D_i F_r E_v \left[\frac{1 - \exp(-\lambda_w t_v)}{Y_v \lambda_w} \right] + C_{gi}(B_{vi}/P) , \quad (C.10)$$

where

C_{vi} = resulting concentration of isotope i in vegetation v, pCi/kg;

F_r = fraction of total deposition retained on plant surfaces, 0.2, dimensionless;

E_v = fraction of foliar deposition reaching edible portions of vegetation v, dimensionless;

λ_w = decay constant accounting for weathering losses (equivalent to a 14-d half-life), 5.73×10^{-7} per s;

t_v = assumed duration of exposure while growing for vegetation v, s;

Y_v = assumed yield density of vegetation v, kg/m^2;

B_{vi} = soil-to-plant transfer factor for isotope i, vegetation type v, dimensionless;

P = assumed areal soil density for surface mixing, 240 kg/m^2.

The value of Ev is assumed to be 1.0 for all above-ground vegetation and 0.1 for all below-ground vegetables.[6] The value of t_v is taken to be 60 d, except for pasture grass, where a value of 30 d is assumed. The yield density Y_v is taken to be 2.0 kg/m^2, except for pasture grass, where a value of 0.75 kg/m^2 is applied. Values of the soil-to-plant transfer coefficients, B_{vi}, are provided in Table C.4.

Table C.4. Environmental transfer coefficients

Material	U	Th	Ra	Pb
Plant/soil, B_{vi}				
Edible above ground	2.5E-3[a]	4.2E-3	1.4E-2	4.0E-3
Potatoes	2.5E-3	4.2E-3	3.0E-3	4.0E-3
Other below ground	2.5E-3	4.2E-3	1.4E-2	4.0E-3
Pasture grass	2.5E-3	4.2E-3	1.8E-2	2.8E-2
Stored feed (hay)	2.5E-3	4.2E-3	8.2E-2	3.6E-2
Beef/feed, F_{bi}, pCi/kg per pCi/d	3.4E-4	2.0E-4	5.1E-4	7.1E-4

[a]Read as 2.5×10^{-3}, or 0.0025.

Source: U.S. Nuclear Regulatory Commission, *Calculational Models for Estimating Radiation Doses to Man from Airborne Radioactive Materials Resulting from Uranium Operations*, Report Task RH 802-4, Washington, D.C., May 1979.

C.3.4 Meat concentrations

Radioactive materials can be deposited on grass, hay, or silage, all of which are eaten by meat animals, which are, in turn, eaten by man. The assumption has been made that meat animals obtain their entire feed requirement by grazing six months per year and by eating nonlocally grown stored feed for the remainder of the year. The equation used to estimate meat concentrations is

$$C_{bi} = QF_{bi}(0.50C_{pgi} + 0.50C_{hi}) , \qquad (C.11)$$

where

C_{bi} = resulting concentration of isotope i in meat, pCi/kg;

Q = assumed feed ingestion rate, 50 kg/d;

F_{bi} = feed-to-meat transfer factor for isotope i, pCi/kg per pCi/d (see Table C.4);

0.50 = fraction of total annual feed requirement assumed to be satisfied by pasture grass;

C_{pgi} = concentration of isotope i in pasture grass, pCi/kg;

0.50 = fraction of the total annual feed requirement assumed to be satisfied by locally grown stored feed (hay);

C_{hi} = concentration of isotope i in hay (or other stored feed), pCi/kg.

C.4 DOSES TO INDIVIDUALS

Doses to individuals have been calculated for inhalation, external exposure to air and ground concentrations, and ingestion of vegetables and meat. Internal doses are calculated by the staff using dose conversion factors that yield the 50-year dose commitment, that is, the entire dose insult received over a period of 50 years following either inhalation or ingestion. Annual doses given are the 50-year dose commitments resulting from a one-year exposure period. The one-year exposure period was taken to be the final year of mill operation when environmental concentrations resulting from plant operations are expected to be near their highest level.

C.4.1 Inhalation doses

Inhalation doses have been computed using air concentrations obtained by Eq. (C.3) (resuspended air concentrations are included) for particulate materials and the dose conversion factors presented in Table C.5.

Table C.5. Inhalation dose conversion factors

Values are given in millirems per year per picoCurie per cubic meter

Organ	U-238	U-234	U-230	Ra-226	Pb-210	Po-210
Particle size = 0.3 μm						
Whole body					7.46E+0[a]	1.29E+0
Bone					2.32E+2	5.24E+0
Kidney					1.93E+2	3.87E+1
Liver					5.91E+1	1.15E+1
Mass average lung					6.27E+1	2.66E+2
Particle size = 5.0 μm						
Whole body	1.16E+0	1.32E+0	1.01E+2	4.00E+1	4.84E+0	7.10E−1
Bone	1.96E+1	2.14E+1	3.60E+3	4.00E+2	1.50E+2	2.89E+0
Kidney	4.47E+0	5.10E+0	1.00E+3	1.41E+0	1.25E+2	2.13E+1
Liver	0	0	2.07E+2	4.97E−2	3.83E+1	6.36E+0
Mass average lung	1.24E+3	1.42E+3	1.38E+3	2.84E+3	3.30E+2	1.88E+2
Particle size = 35.0 μm						
Whole body	7.92E−1	9.02E−1	5.77E+1	3.90E+1	4.43E+0	7.28E−1
Bone	1.34E+1	1.46E+1	2.07E+3	3.90E+2	1.38E+2	2.96E+0
Kidney	3.05E+0	3.47E+0	5.73E+2	1.38E+0	1.15E+2	2.19E+1
Liver	0	0	1.19E+2	4.85E−2	3.51E+1	6.52E+0
Mass average lung	3.33E+2	3.80E+2	3.71E+2	7.64E+2	8.70E+1	5.75E+1

[a] Read as 7.46×10^{0}, or 7.46.

Sources: M. Momeni et al., *Uranium Dispersion and Dosimetry (UDAD) Code*, Report NUREG/CR-0553 (ANL/ES-72), Argonne National Laboratory, Chicago, Ill., May 1979; D. R. Kalkwarf, *Solubility Classification of Airborne Products from Uranium Ores and Tailings Piles*, Report NUREG/CR-0530 PNL-2830, Pacific Northwest Laboratory, Richland, Wash., January 1979.

Dose to the bronchial epithelium from Rn-222 and short-lived daughters were computed based on the assumption of indoor exposure at 100% occupancy. The dose conversion factor for bronchial epithelium exposure from Rn-222 is derived as follows:

1. 1 pCi/m^3 Rn-222 = 5×10^{-6} working levels (WL).*

2. Continuous exposure to 1 WL = 25 cumulative working level months (WLM) per year.

3. 1 WLM = 5000 millirems.

Therefore,

$$(1\ pCi/m^3\ \text{Rn-222}) \times \left(5 \times 10^{-6}\ \frac{WL}{pCi/m^3}\right) \times \left(25\ \frac{WLM}{WL}\right) \times \left(5000\ \frac{\text{millirems}}{WLM}\right) = 0.625\ \text{millirem}\ , \qquad (C.12)$$

and the Rn-222 bronchial epithelium dose conversion factor is taken to be 0.625 millirems per year per pCi/m^3.

C.4.2 External doses

External doses from air and ground concentrations are computed using the dose conversion factors provided in Table C.6 (ref. 1.). Doses are computed based on 100% occupancy at the particular location. Indoor exposure is assumed to occur 14 h/d at a dose rate of 70% of the outdoor dose rate.

C.4.3 Ingestion doses

Ingestion doses are computed for vegetables and meat (beef and lamb) on the basis of concentrations obtained using Eqs. (C.9) through (C.12), ingestion rates given in Table C.7, and dose conversion factors given in Table C.8 (ref. 1). Vegetable ingestion doses were computed assuming an average 50% activity reduction caused by food preparation.[4] Ingestion doses to children and teenagers were computed but were found to be equal to or less than doses to adults.

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*One WL concentration is defined as any combination of short-lived radioactive decay products on Rn-222 in 1 L of air that will release 1.3×10^5 MeV of alpha particle energy during radioactive decay to Pb-210.

Table C.6. Dose conversion factors for external exposure

Isotope	Skin	Whole body
For air concentration doses (millirems per year per picoCurie per cubic meter)		
U-238	1.05E–5[a]	1.57E–6
Th-234	6.63E–5	5.24E–5
Pa(m)-234	[illegible].57E–5	6.64E–5
U-234	1.36E–5	2.49E–6
Th-230	1.29E–9	3.59E–6
Ra-226	6.00E–5	4.90E–5
Rn-222	3.46E–0	2.83E–6
Po-218	8.18E–7	6.34E–7
Pb-214	2.06E–3	1.67E–3
Bi-214	1.36E–2	1.16E–2
Po-214	9.89E–7	7.66E–7
Pb-210	4.17E–5	1.43E–3
For ground concentration doses (millirems per year per picoCurie per square meter)		
U-238	2.13E–6	3.17E–7
Th-234	2.10E–6	1.66E–6
Pa(m)-234	1.60E–6	1.24E–6
U-234	2.60E–6	4.78E–7
Th-230	2.20E–6	6.12E–7
Ra-226	1.16E–6	9.47E–7
Rn-222	6.15E–8	5.03E–8
Po-218	1.42E–8	1.10E–8
Pb-214	3.89E–5	3.16E–5
Bi-214	2.18E–4	1.85E–4
Po-214	1.72E–8	1.33E–8
Pb-210	6.65E–6	2.27E–6

[a]Read as 1.05×10^{-5}, or 0.0000105.

Source: U.S. Nuclear Regulatory Commission, *Calculational Models for Estimating Radiation Doses to Man from Airborne Radioactive Materials Resulting from Uranium Milling Operations*, Report Task RH 802-4, Washington, D.C., May 1979.

Table C.7. Assumed food ingestion rates[a]

	Infant	Child	Teen	Adult
Vegetables, kg/year		48	76	105
Edible above ground		17	29	40
Potatoes		27	42	60
Other below ground		3.4	5.0	5.0
Meat (beef, fresh pork, and lamb), kg/year		28	45	78

[a]Ingestion rates are averages for typical rural farm households. No allowance is credited for portions of year when locally or homegrown food may not be available.

Source: J. F. Fletcher and W. L. Dotson, *HERMES—A Digital Computer Code for Estimating Regional Radiological Effects from the Nuclear Power Industry*, Report HEDL-TME-71-168, Hanford Engineering Development Laboratory, Hanford, Wash., December 1971.

Table C.8. Ingestion dose conversion factors

Values are in millirem per picoCurie ingested

Age group	Organ	Isotope							
		U-238	U-234	Th-234	Th-230	Ra-226	Pb-210	Bi-210	Po-210
Infant	Whole body	3.33E-4	3.80E-4	2.00E-8	1.06E-4	1.07E-2	2.38E-3	3.58E-7	7.41E-4
	Bone	4.47E-3	4.88E-3	6.92E-7	3.80E-3	9.44E-2	5.28E-2	4.16E-6	3.10E-3
	Liver	0	0	3.77E-8	1.90E-4	4.76E-5	1.42E-2	2.68E-5	5.93E-3
	Kidney	9.28E-4	1.06E-3	1.39E-7	9.12E-4	8.72E-4	4.33E-2	2.08E-4	1.26E-2
Child	Whole body	1.94E-4	2.21E-4	9.88E-9	9.91E-5	9.87E-3	2.09E-3	1.69E-7	3.67E-4
	Bone	3.27E-3	3.57E-3	3.42E-7	3.55E-3	8.76E-2	4.75E-2	1.97E-6	1.52E-3
	Liver	0	0	1.51E-8	1.78E-4	1.84E-5	1.22E-2	1.02E-5	2.43E-3
	Kidney	5.24E-4	5.98E-4	8.01E-8	8.67E-8	4.88E-4	3.67E-2	1.15E-4	7.56E-3
Teenager	Whole body	6.49E-5	7.39E-5	3.31E-9	6.00E-5	5.00E-3	7.01E-4	5.66E-8	[illegible]
	Bone	1.09E-3	1.19E-3	1.14E-7	2.16E-3	4.09E-2	1.81E-2	6.59E-7	5.09E-4
	Liver	0	0	6.68E-9	1.23E-4	8.13E-6	5.44E-3	4.51E-6	1.07E-3
	Kidney	2.50E-4	2.85E-4	3.81E-8	5.99E-4	2.32E-4	1.72E-2	5.4[illegible]E-5	3.60E-3
Adult	Whole body	4.54E-5	5.17E-5	2.13E-9	5.70E-5	4.60E-3	5.44E-4	3.96E-8	8.59E-5
	Bone	7.67E-4	8.36E-4	8.01E-8	2.06E-3	4.60E-2	1.53E-2	4.61E-7	3.56E-4
	Liver	0	0	4.71E-9	1.17E-4	5.74E-6	4.37E-3	3.18E-6	7.56E-4
	Kidney	1.75E-4	1.99E-4	2.67E-8	5.65E-4	1.63E-4	1.23E-2	3.83E-5	2.52E-3

Sources: U.S. Nuclear Regulatory Commission, *Calculational Models for Estimating Radiation Doses to Man from Airborne Radioactive Materials Resulting from Uranium Milling Operations*, Report Task RH 802-4, Washington, D.C., May 1979; G. R. Hoenes and J. K. Soldat, *Age-Specific Radiation Dose Conversion Factors for a One-Year Chronic Intake*, Report NUREG-0172, Battelle Pacific Northwest Laboratories, Richland, Wash., November 1977.

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6. J. F. Fletcher and W. L. Dotson, *HERMES — A Digital Computer Code for Estimating Regional Radiological Effects from the Nuclear Power Industry*, Report HEDL-TME-71-168, Hanford Engineering Development Laboratory, Hanford, Wash., December 1971.

*Available for purchase from the NRC/GPO Sales Program, U.S. Nuclear Regulatory Commission, Washington, DC 20555, and the National Technical Information Service, Springfield, VA 22161.

Appendix D

CALCULATION OF GAMMA RADIATION ATTENUATION FOR RECLAIMED TAILINGS DISPOSAL AREA

Appendix D

CALCULATION OF GAMMA RADIATION ATTENUATION FOR RECLAIMED TAILINGS DISPOSAL AREA

Assuming soil is composed mainly of SiO_2, the mass attenuation coefficient for a 1- to 2-MeV gamma ray is 0.0518 cm^2/g (ref. 1). (Most of the dose rate from a typical natural emitter is in this range.[2]) The highest gamma radiation rate measured[3] on the site was 33 R/year (3780 μR/h) on pond 1. Assuming that the bulk density of the soil is 1.6 g/cm^3, the effect of 3.05 m (10 ft) of soil materials would reduce the gamma radiation to $\sim 3.6 \times 10^{-7}$ mR/year.

$$I/I_0 = \exp[-(\mu_{en}/\rho)\rho x] = \exp[-(0.0518\ cm^2/g)(1.6\ g/cm^3(305\ cm)] = 1.1 \times 10^{-11} ;$$

$$I = (1.1 \times 10^{-11})(33\ R/year) = 3.6 \times 10^{-7}\ mR/year .$$

The background radiation dose for the Western Great Plains from all sources of radioactivity, including the contribution from fallout, is about 153 mR/year.[4] Thus, the gamma radiation from the deposited tailings after reclamation would be insignificant compared with the natural background radiation.

REFERENCES FOR APPENDIX D

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Appendix E

EVALUATION OF PROPOSED COVER THICKNESS FOR RADON ATTENUATION

Appendix E

EVALUATION OF PROPOSED COVER THICKNESS FOR RADON ATTENUATION

E.1 INTRODUCTION

The calculation of the thicknesses of cover materials required to attenuate radon flux to near-background levels is based on diffusion theory. The effectiveness of a particular cover material in attenuating radon depends on the material's ability to restrict the diffusion of radon through it so that the radon gas decays to a solid daughter product before reaching the surface.

Material properties used to determine radon attenuation are the effective bulk diffusion coefficients (D) and porosities (P) of the cover material and of the tailings. Values of D may be measured experimentally for a given material at its ambient moisture level and expected degree of compaction. Alternatively, D can be estimated solely from the moisture content and porosity of the material, because the large variation (four orders of magnitude) in D from moisture content obscures the much smaller effects on the value of D from other soil properties.[1] Thus, the most important characteristic of cover soils is their ability to retain moisture.

With the moisture concentration in the cover soils, D may be estimated from the following empirical correlation of laboratory data:[1]

$$D/P = 0.106 \exp(-0.261\ M) \ , \qquad \text{(E.1)}$$

where M is the weight percent of soil moisture and D has units of cm^2/s. Equation (E.1) can also be used to express radon attenuation in terms of porosities and moistures of the tailings and cover. This correlation, mainly based on a limited amount of laboratory data, could possibly be modified slightly as additional data become available. Basic parameters characterizing the soils are the diffusion coefficient and the porosity. The equations given in the next section are expressed in terms of D and P; but for convenience, Eq. (E.1) is used in select cases to give the moisture dependence explicitly. The converted equations may undergo slight modification as more research is conducted by the Nuclear Regulatory Commission (NRC) and other organizations.

E.2 CALCULATION OF BARE RADON FLUX

Radon flux from the bare tailings source, J_0, is calculated from an equation given in Appendix G-1 of ref. 2:

$$J_0 = [Ra]pE(\lambda D_0/P_0)^{1/2} \times 10^4 \ , \qquad \text{(E.2)}$$

where

[Ra] = concentration of Ra-226 in the tailings solids, pCi/g;

p = density of the tailings solids, g/cm^3;

E = emanating power of tailings, dimensionless;

D_0 = effective bulk diffusion coefficient for radon in the tailings, cm^2/s;

P_0 = porosity or void fraction in tailings solids, dimensionless.

The values for computing the bare tailings flux for the Edgemont facility are [Ra] = 705.2 pCi/g, p = 1.6 g/cm^3, E = 0.2, and D_0/P_0 = 0.0112 cm^2/s. The factor of 10^4 converts square centimeters to square meters, and the value of D_0/P_0 = 0.0112 cm^2/s was obtained from Eq. (E.1) based on a tailings residual moisture of 8.6%. Substitution of the above values yields

$$J_0 = (705.2 \text{ pCi/g})(1.6 \text{ g/cm}^3)(0.2) \times (2.1 \times 10^{-6} \text{ s}^{-1} \times 0.0112 \text{ cm}^2/\text{s})^{1/2} \times 10^4 \text{ cm}^2/\text{m}^2$$

$$= 346.08 \text{ pCi/m}^2\cdot\text{s}.$$

Equation (E.2) assumes effectively infinite depth of tailings. A factor given by tanh $[\sqrt{\lambda/D_0/P_0}\ X_0]$, where X_0 is the depth of tailings, is used to account for finite depth of tailings. However, in cases where the average depth of tailings is 3 m or more, the factor is effectively unity.

E.3 MINIMUM COVER CALCLUATION

The procedure for determining the minimum thickness of cover materials for tailings is established in Appendix P of ref. 2. The reclamation plan stipulates 3, 7, and 0.6 ft of compacted clay, overburden, and topsoil, respectively. Several types of clay occur in the environment.[3] The staff has assumed that a clay soil profile of 12.3% moisture content should be reasonably conservative in estimating the long-term moisture of the clay layer. High moisture in the surrounding soils indicates that a 9.7% moisture for silty soils is observable.[3] The staff assumes that the topsoil and the overburden will maintain this level of moisture because the surrounding environment support these conditions. The tailings cover serves two main purposes:

1. to stabilize and isolate the uranium tailings wastes from contact with the environment, whether by intrusion or extrusion, and
2. to mitigate radon exhalation to a level of about twice natural background.

The second purpose concerns this segment of the analysis.

The following equation is used to estimate radon flux from the surface of the clay cover:

$$J_1 = \frac{2J_0\exp(-b_1x_1)}{\left(1 + \frac{P_0}{P_1}\left[\frac{D_0/P_0}{D_1/P_1}\right]^{1/2}\right) + \left(1 - \frac{P_0}{P_1}\left[\frac{D_0/P_0}{D_1/P_1}\right]^{1/2}\right)\exp(-2b_1x_1)}, \quad \text{(E.3)}$$

where

$b_1 = (\lambda P_1/D_1)^{1/2}$;

x_1 = thickness of the clay layer, cm;

P_0 = porosity of the tailings;

P_1 = porosity of the clay material.

Using Eq. (E.1), the following D/P values are computed:

D_0/P_0 = 0.0112 cm^2/s tailings (8.6% moisture);

D_1/P_1 = 0.0043 cm^2/s clay layer (12.3% moisture).

Assume that the porosities are equivalent for all materials. This assumption is reasonable because long-term reclamation is the topic. Using the above values and the previously calculated radon flux, Eq. (E.3) yields $J_1 = 35.23\ pCi/m^2 \cdot s$. Equation (E.3) can be written as

$$J_1 = J_0 f \exp(-b_1 x_1) \ , \qquad (E.4)$$

where

$$f = \frac{2}{\left(1 + \frac{P_0}{P_1}\left[\frac{D_0/P_0}{D_1/P_1}\right]^{1/2}\right) + \left(1 - \frac{P_0}{P_1}\left[\frac{D_0/P_0}{D_1/P_1}\right]^{1/2}\right)\exp(-2b_1x_1)} \ . \qquad (E.5)$$

The function f is useful in calculating the composite diffusion coefficient, which is computed by the following equation:

$$\frac{D_{sm}}{P_{sm}} = \sum_{i=0}^{m-1} \frac{D_i}{P_i}\left[1 - \exp(-a_i x_i)\right]\exp\left(-\sum_{j=i+1}^{m-1} a_j x_j\right) , \qquad (E.6)$$

where

$$a_i = (\lambda P_i/D_i h)^{1/2},$$

$$x_i = \text{depth of the } i\text{th cover soil},$$

$$\exp(-a_o x_o) = 0$$

$$h = \left[1 - \frac{1}{b_1 x_1} \ln f\right]^{-2} .$$

Thus, the composite D/P is computed as:

$$\frac{D_{s^2}}{P_{s^2}} = D_0/P_0 \left[\exp(-a_1x_1)\right] + D_1/P_1\left[1 - \exp(-a_1x_1)\right],$$

where

$$D_0/P_0 = 0.0112\ cm^2/s,$$

$$a_1 = [2.1 \times 10^{-6}\ s^{-1}/(0.0043\ cm^2/s \times h)],$$

$$x_1 = 91.44\ cm,$$

$$D_1/P_1 = 0.0043\ cm^2/s.$$

Now

$$h = \left[1 - \frac{1}{b_1 x_1} \ln f\right]^{-2}$$

$$= \left[1 - \frac{1}{(0.0221) \times 91.44} \ln(0.7683)\right]^{-2}$$

$$= 0.7826$$

and

$$a_1 = \left(\frac{2.1 \times 10^{-6}\ s^{-1}}{0.0043\ cm^2/s \times 0.7826}\right)^{1/2} = 0.0250\ .$$

Equation (E.6) now becomes

$$\frac{D_{s2}}{P_{s2}} = 0.0112(0.1017) + 0.0043(1 - 0.1017) = 0.0050\ cm^2/s.$$

At this point, the composite flux J_1 = 35.23 and the composite diffusion coefficient D_{s2}/P_{s2} = 0.0050.

Given this intermediate step, the final flux J_2 can be calculated using the following equation:

$$J_2 = J_1 f_2 \exp(-b_2 x_2) \quad \text{(E.7)}$$

where

J_1 = 35.23 pCi/m^2-s

$$f_2 = \frac{2}{\left(1 + \left[\frac{Ds2/Ps2}{D_2/P_2}\right]\right) + \left(1 - \left[\frac{Ds2/Ps2}{D_2/P_2}\right]\right)\exp\left(-2b_2 x_2\right)}$$

D_2/P_2 = 0.106 exp (-0.261 x 9.7%) = 0.0084 cm^2/s

$b_2 = \sqrt{\frac{2.1 \times 10^{-6}\ s^{-1}}{0.0084\ cm^2/s}} = 0.0158\ cm^{-1}$; the attenuation coefficient of the topsoil/overburden cover;

x_2 = 231.6 cm (7.6 ft) of topsoil/overburden cover.

As mentioned previously, the moisture content of the topsoil/overburden is assumed to be approximately 9.7%. Substituting the appropriate values above into Eq. (E.7), the value of the final flux from the tailings, J_2, is 1.03 pCi/m^2-s. This value, combined with 2.80 pCi/m^2-s (natural background radon flux) meets the twice background performance objective.

Should differential settlement or significant drying of the clay layer occur, the soil layer would have to suffice to maintain the required attenuation of radon gas. Because the applicant is planning to put down 7.6 ft of overburden-topsoil in addition to the 3 ft of clay, at least a total of 10.6 ft of overburden and soil mixed with clay to cover the tailings can be assumed.

Using Eq. (E.3) with the values

J_0 = 346.08 pCi/m^2·s;

b = $[(2.1 \times 10^{-6}\ s^{-1})/(0.0084\ cm^2/s)]^{1/2}$; the attenuation coefficient of the soil cover;

D_0/P_0 = 0.0112 cm^2/s, the diffusion coefficient of the tailings;

D /P = 0.0084 cm^2/s, the diffusion coefficient of the silty soil (9.7% moisture); and

x = 323.09 cm (10 ft), the depth of cover;

then

J = 1.96 pCi/m^2·s.

The calculated resultant flux from the tailings is approximately 2 pCi/m^2·s,which is less than natural background. This flux from the reclaimed tailings impoundment is used in the radiological assessment comparison of the impacts from decommissioning operations verses the postdecommissioning period impacts.

The above model and calculations do not present a significant departure from the previous NRC approach to mitigation of radon exhalation from tailings piles. The revisions consist mostly of making the diffusion coefficients more sensitive to moisture and depth. Appendix P of ref. 2 highlights the techniques used here as well as a more simplified approach for single layers.

REFERENCES FOR APPENDIX E

1. V. C. Rogers et al., *Characterization of Uranium Tailings Cover Materials for Radon Flux Reduction*, NUREG/CR-1081, U.S. Nuclear Regulatory Commission, Washington, D.C., March 1980.

2. U.S. Nuclear Regulatory Commission, *Final Generic Environmental Impact Statement on Uranium Milling*, Report NUREG-0706, Washington, D.C., July 1980.

3. Francis-Meador-Gellhaus, *Subsurface Soil Exploration for Proposed Edgemont Uranium Waste Disposal Site*, June 1980, Fig. 9.

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16. ABSTRACT *(200 words or less)*

A Final Environmental Statement (FES) related to the proposed decommissioning of the existing uranium milling facilities at Edgemont, South Dakota (Docket 40-1341) including removal or cleanup of contaminated soil from the mill site and local environs. This statement describes and evaluates (1) purpose of and need for action, (2) alternative methods of tailings disposal, (3) alternative tailings disposal sites, and (4) environmental consequences for the proposed action. Also included are comments of governmental agencies and other organizations on the Draft Environmental Statement for this project, and staff responses to their comments. The NRC has concluded that the action called for under the National Environmental Policy Act of 1969 (NEPA) and 10 CFR Part 51 is to permit the applicant to proceed with the project as described in this statement, subject to at least certain conditions as stated in the Summary and Conclusions of the DES.

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