UNITED STATES

NUCLEAR REGULATORY COMMISSION

REGION IV

URANIUM RECOVERY FIELD OFFICE
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DENVER, COLORADO [illegible]

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Docket No. 40-8943
SUA-1534, Amendment No. 21
04008943490E
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MEMORANDUM FOR: Docket File 40-8943

FROM: Joel Grimm, Project Manager

SUBJECT: LAND APPLICATION OF RESTORATION WASTE WATER - FERRET'S CROW BUTTE ISL FACILITY

INTRODUCTION

On June 7, 1993, Ferret Exploration Company of Nebraska, Inc. (Ferret), submitted a license amendment request to the NRC addressing land application of certain waste water at their Crow Butte ISL facility near Crawford, Nebraska. Specifically, the application proposes amending an approved plan, described in the licensee's submittal dated August 3, 1988. The original plan involved treating restoration water in a reverse osmosis unit, and discharging some of it on a 60-acre plot of land near the plant. The licensee's project has not yet proceeded to the point that land application is necessary.

The proposed change involves an additional 40-acre plot, amended release limits for a few of the chemical constituents in the water, and includes additional water derived from well development in the discharge plan. Additionally, Ferret proposes an expanded environmental monitoring program associated with land application. The original 60-acre area proposed for land application, called Area 1 here, is found in the NE¼, sec. 13, T31N R52W, approximately 1.5 miles northwest of the processing plant. The newly proposed land application area, or Area 2, lies immediately adjacent and south of the pilot processing plant, where restoration activities will be conducted, in the SE¼, sec. 19, T31N, R51W.

Ferret proposes to discharge up to 38.5 million gallons of treated water annually. Compared to the previously approved plan, this includes an annual increase of 1.5 million gallons, consisting of water purged from wells during construction and development. Well development water is naturally occurring ground water, not yet affected by uranium recovery. Therefore, it does not contain licensed materials, and its discharge does result in an increase of effluent stemming from licensed activities.

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The waste water is to be processed for uranium and radium removal, and then treated in reverse osmosis equipment to remove dissolved solids from one portion of the water, concentrating them in another. Land application of the treated water would occur largely during the summer months when evaporation and evapotranspiration are highest. Ferret proposes to apply the water at a rate up to 2 inches per week.

BACKGROUND

Reverse osmosis treatment of waste water is the last of three activities which produce a major effluent from an ISL project. A reverse osmosis treatment system results in two separate waste products; a concentrated brine and decontaminated water known as permeate. The brine is stored for evaporation in a lined retention pond. The majority of permeate is reinjected to flush the aquifer during restoration, but there remains excess permeate requiring disposal. It is the excess clean permeate which Ferret wishes to dispose of through land application.

Land application is a method of beneficially using waste water and broadcasts it onto an area of land using ordinary irrigation equipment. The irrigated land can be left as open range land, or can be planted with various crops which enhance evapotranspiration of water from the soil. Ferret proposes to dispose of the permeate, and water purged from wells during construction and development, using this method. Any crops grown would be plowed into the ground each autumn to condition the soil.

Stratigraphy and Ground Water

The uranium producing strata associated with this mining project is the Chadron Formation. The Chadron is conformably overlain by the Brule Formation, which is found at the surface in the mining and irrigation areas. The Brule has been subdivided into the lower Orella and upper Whitney Members. The approximate contact with the Chadron can be detected in drill cuttings, but not usually in geophysical logs. The Orella Member is composed of buff to brown siltstones, with common spotty green nodules as it grades into the green clays of the Chadron. The Whitney Member of the Brule is composed of fairly massive buff to brown siltstones, which are probably eolian in origin. Several volcanic ash layers have been reported in outcrops. The Whitney Member typically becomes coarser grained toward the upper contact. Some moderate to well defined channel sands can be observed in drill holes and in outcrops. The upper Brule sandstones are limited in lateral extent and continuity, but some are saturated with water in the otherwise generally impermeable Brule. Within the project area, these sand units are encountered in the upper 250 feet of the drill holes.

Regionally and locally, the Brule sandstone units are important aquifers, producing sufficient quantities of water suitable for domestic and agricultural purposes. Locally, the direction of flow in the Brule aquifers is to the north-northwest.

Soils

A variety of soil types are found in each of the proposed irrigation areas. U. S. Soil Conservation Service (SCS) data summarized by Ferret indicate that soil types at each site are moderately well to well drained, deep to moderately deep, and well suited for agricultural irrigation. The SCS reports indicate that ground water in these areas is typically found at depths greater than 3 meters (10 feet).

DISCUSSION

Operations

Waste water to be released to unrestricted areas using land application would be treated in several phases. First, all water removed from the mine units during restoration will have had uranium removed for commercial purposes using ion exchange columns. Restoration will not commence until uranium concentrations in the circulating mine water have been diminished below commercially recoverable levels. Then, a certain amount of degraded water will be removed from the mine unit using ground-water sweep, and stored in evaporation ponds. Ground water in the affected mine unit will thus be partially replaced by clean water from the surrounding aquifer.

As restoration proceeds to the reverse osmosis phase, Ferret proposes to monitor uranium levels in the restoration stream, and conduct secondary ion exchange to remove uranium if necessary. Radium found in ground water is also removed by treatment with barium chloride (BaCl). BaCl is added to the water in a retention pond, and forms insoluble barium/radium sulfate salt which is allowed to settle to the bottom of the pond. Finally, the waste water is treated to adjust pH for optimal performance of the reverse osmosis equipment.

Ferret demonstrated reverse osmosis technology during its research and development phase of the Crow Butte mining project. Specifications provided by the reverse osmosis equipment manufacturer indicate reverse osmosis membranes provide 94 to 99 percent efficiency in rejecting various metals in contaminated water. Additionally, common ions found in contaminated water are typically rejected at efficiencies ranging from 80 to 99 percent. The only major exception to these high efficiency values is the borate ion which is only removed at a rate of 35 to 70 percent, depending upon the pH of the solution. Added efficiency for removing all dissolved constituents is attained by multiple circulations of waste water through the system.

Ferret's operational experience with using the reverse osmosis treatment technology is summarized in Table 1. Data resulting from the R&D project indicate the combining ion exchange, BaCl treatment, and reverse osmosis treatment successfully reduces the concentration of most trace metals below detection levels. Common ions are also removed so concentrations are below drinking water standards.

Table 1: Comparison of nominal treated water quality for the Crow Butte R&D project, and Ferret's proposed release limits for waste water irrigation, based upon discharge effluent limitations specified in EPA's Title 40, Code of Federal Regulations, Part 440 (40 CFR Part 440), NRC's constituent limits for radionuclides released to unrestricted areas found in 10 CFR Part 20, and State of Nebraska Title 118 ground-water standards. (All units are milligrams per liter unless noted otherwise.)

Parameter	R&D Project Nominal Treated Water Quality	Proposed release limits (daily max)	Average value 30 consecutive days
Calcium	1.5		
Magnesium	0.14		
Sodium	89.3		
Carbonate	24.4		
Bicarbonate	14.1		
Sulfate	4.7	250	
Chloride	129	250	
Ammonia -N	0.17		
Nitrate -N	0.17	10	
Fluoride	0.1	4	
Conductivity (µmoh/cm)	519		
pH (standard units)	7.96	6.0 - 9.0	
Total Suspended Solids		30	20
Arsenic	<0.001	1.0	0.5
Barium	0.20	1.0	
Boron	0.96		
Cadmium	<0.001	0.010	
Chromium	<0.005	0.10	
Copper	<0.01	1	
Iron	<0.03	0.3	
Lead	<0.005	0.05	
Manganese	<0.005	0.05	
Mercury	<0.0002	0.002	
Selenium	<0.001	0.05	
Silver	<0.05	0.05	
Vanadium	<0.01		
Zinc	0.04	5	
Uranium	<0.1	4	
Ra-226/228	5 pCi/l	30	10
Gross Alpha	8 pCi/l		
Gross Beta	16.6 pCi/l		

Ferret designed its proposed land application procedures to efficiently dispose of waste water, while minimizing potential environmental impacts. Most importantly, the application rate was chosen to prevent soil saturation beyond 2 feet in depth. This proposal has the combined benefit of preventing impacts upon ground-water resources, while accommodating a representative monitoring program. Additionally, the combination of land application rate and soil characteristics should successfully prevent surface runoff. Ferret proposes to further prevent runoff into surface water, in accordance with recommendations provided by the U. S. Soil Conservation Service, by providing earthen berms where the irrigation areas are adjacent to streams.

Release Limits

Ferret proposes release limits for various ionic species, metals, and radionuclides found in the waste water to be land applied (Table 1). In each case, Ferret cites an EPA, NRC or State of Nebraska standard as its proposed release limit. For NRC licensing purposes, the limits proposed for radium-226 and -228 and natural uranium are of greatest interest and applicability. NRC's release limit for radium-226/228 in a liquid effluent is 30 picocuries per liter (pCi/l). Ferret proposes to utilize this standard as its maximum daily release limit. Additionally, Ferret proposes to limit its release of radium-226/228 to a monthly average of 10 pCi/l, in accordance with EPA standards for release of mine drainage found in 40 CFR Part 440. Meanwhile, Ferret proposes to limit natural uranium releases to 4 pCi/l. This value is four orders of magnitude lower than NRC release limits cited in 10 CFR Part 20.

More importantly, Ferret will be subject to cleanup criteria for radium in soil during decontamination and decommissioning of the ISL facility. NRC's criteria require that any area released for unrestricted use contain a concentration of radium in land, averaged over areas of 100 square meters, which, as a result byproduct material does not exceed background levels by more than: (1) 5 picocuries per gram (pCi/g) of radium-226 averaged over the first 15 cm below the surface, and (2) 15 pCi/g of radium-226 averaged over 15 cm thick layers more than 15 cm below the surface.

NRC analyzed radium concentrations likely to result in soils affected by irrigating with reverse osmosis permeate. The analysis included the following conservative assumptions: (1) Ferret releases the proposed maximum volume, 38.5 million gallons, of waste water each year, (2) the waste water released contains the maximum allowable average radium content of 10 pCi/l, and (3) 100 percent of the radium attaches itself to soil particles in the top 15 cm of soil. The resulting radium-226 concentration in the top 15 cm of soil following 20 years of restoration and irrigation would be 0.258 pCi/g. Foreseeing that nominal radium values will be lower, soil radium loading will probably be less than one-half of this conservative calculation.

Monitoring

Ferret proposes to augment its current environmental monitoring program with additional monitoring for potential environmental impacts stemming from land application. The monitoring program will require analyzing water quality

prior to release to assure compliance with approved release limits. Environmental soil sampling will also be required to establish background concentrations of radium, uranium, and several other metals in the soil (Table 2).

Further sampling locations will be established to monitor potential impacts upon soil, surface water, and ground water (Table 2). Ferret proposes to expand the number of monitoring locations with respect to the earlier approved plan. Soil sampling for radium-226 will be conducted following each irrigation season. Ground-water sampling will be increased from one originally approved Brule Formation well, to three wells near each of the irrigation areas. Surface water sampling and analysis will be increased from one surface impoundment originally approved, to include an additional stream sampling location near the added irrigation area.

CONCLUSION

Ferret's proposed changes to its water land application program are minor, and largely administrative. The proposed changes will not affect the average operating conditions of the land application system. The amount of waste water to be released is increased only by well development water not subject to NRC licensing. Changes in proposed release limits are in accordance with various State and Federal environmental standards. Additionally, Ferret has enhanced its proposed monitoring program to detect potential environmental effects of waste water land application.

In accordance with the categorical exclusion contained in paragraph (c)(11) of 10 CFR 51.22, an environmental assessment is not required for this licensing action. That paragraph states that the categorical exclusion applies to the issuance of amendments to licenses for uranium mills provided that (1) there is no significant change in the types or significant increase in the amounts of any effluents that may be released offsite, (2) there is no significant increase in individual or cumulative occupational radiation exposure, (3) there is no significant construction impact, and (4) there is no significant increase in the potential for or consequences from radiological accidents.

The licensing action discussed in this memorandum meets these criteria because it provides minor changes to an approved program. Neither the volume nor the expected nominal water quality of the effluent will change. Further, this amendment requires an expanded environmental monitoring program for detecting potential impacts associated with land application. Cleanup standards associated with decommissioning irrigation areas are not affected by this amendment. An environmental report is not required from the licensee since the amendment does not meet the criteria of 10 CFR 51.60 (b)(2).

Table 2: Ferret's proposed additions to its current environmental monitoring program. The purpose of the proposed monitoring procedures is to gather data related to the quality of waste water released through the land application system, and to monitor potential environmental impacts stemming from waste water releases.

Type of Sample	Location		Sampling Frequency Proposed		Analysis	
	approved	proposed	approved	proposed	approved	proposed
Purified Wastewater	Effluent from water treatment system	Effluent from water treatment system	weekly	daily	monthly batch for: listed release limits	weekly batch for: listed release limits
Development Water	--	ponds	--	once per batch	--	listed release limits
Soil	irrigation area - one per 10 acres	irrigation area - one per 40 acres	baseline	baseline	Ra 226	Two 6-inch composites for: Ba, B, Mo, U, V, & Ra-226
Soil	same	same	end of each season	end of each season	Ra-226	same
Ground Water	Brule Fm. well 63	Brule Fm. Wells 1, 19, 25, 26, and 63	same	same	listed release limits	listed release limits
Surface Water	Impound. No. 1-3	Impound. No. 1-3, Stream site S-3	same	same		listed release limits

Therefore, pursuant to 10 CFR Part 40, License Condition No. 10 of Source Material License SUA-1534 should be amended to read as follows:

10. For use in accordance with statements, descriptions, and representations contained in Sections 3.0, 4.0, 5.0, and 6.0 of the licensee's Environmental Report submitted by cover letter dated October 7, 1987; as revised by page changes submitted on December 14, 1987; January 22, March 28, and May 18, 1988; November 20, 1991; and November 30, 1992. In addition, the licensee shall conduct its activities in accordance with the provisions in the following:

Submittal Date	Description
May 23, 1988	Enclosed errata sheet, replacement pages, and engineering design report dated April 27, 1988.
May 11, 1992	Cover letter submitting Supplement No. 2 to the Evaporation Pond Engineering Design Report addressing synthetic liners.
June 7, 1993	Cover letter and enclosed waste water irrigation proposal.

Notwithstanding the above, the following conditions shall override any conflicting statements contained in the licensee's application and supplements.

[Applicable Amendments: 1, 2, 3, 4, 6, 10, 11, 15, 17, 20, 21]

Joel P. Grimm

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Project Manager

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