The Cleveland-Cliffs Iron Company

P. O. Box 3140 Phone (307) 234-9133 309 N. McKinley

CASPER, WYOMING 82602

October 24, 1980

Mr. Glenn Mooney, Acting District IV Engineer
Land Quality Division
Wyoming Department of Environmental Quality
30 East Grinnell Street
Sheridan, Wyoming 82801

Dear Mr. Mooney:

Re: In Situ Uranium Research and Development License 3RD - Drain Field

Please find enclosed a copy of a request to the Water Quality Division to increase the maximum quantity of uranium and radium which can be discharged to the pilot process drain field at our Collins Draw Facility.

To the best of our knowledge, this revision to the Water Quality permit will not impact or jeopardize the current Land Quality license which states that:

> "Should unacceptable contamination occur, all contaminated soil and/or toxic materials will be removed from the drain field area and disposed of in a manner acceptable to the D.E.Q. and the Nuclear Regulatory Commission."
>
> "Toxic materials and/or contaminated soil being defined as an increase of 5 pCi/g (baseline to depth 6 feet is 0.77 pCi/g - see License 3RD) radiation content of the subsoil or topsoil, or an increase in the salt content of the topsoil so that it exceeds a conductivity (Ec) of 8 mmhos/cm (L.Q.D., D.E.Q. Guideline 3), or an increase of 20% of baseline conditions should baseline be greater than 8 mmhos/cm." (Response to Wyoming Department of Environmental Quality Review Comments to Application for Permit for Industrial Wastewater Facility, Collins Draw, February 28, 1980, p. 18)

No other parts of the Land Quality license agreement, which consists of a series of meetings and responses with D.E.Q. personnel are affected by the requested increase in the Water Quality permit maximum discharge limitations for uranium and radium.

Respectfully,

THE CLEVELAND-CLIFFS IRON COMPANY

J. T. Laman ag

J. T. Laman
Chief Metallurgist

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JTL:ag
Enclosure - Supporting Information & Mueller Letter
XC: Water Quality Division
Nuclear Regulatory Commission
S6-TLIV-N

PDR 40-8714

The Cleveland-Cliffs Iron Company

P. O. Box 3140 Phone (307) 234-9133 309 N. McKinley
CASPER, WYOMING 82602

October 24, 1980

Mr. Tom Mueller
Water Quality Division
Wyoming Department of Environmental Quality
30 East Grinnell Street
Sheridan, Wyoming 82801

Dear Mr. Mueller:

Re: Industrial Wastewater Permit No. 79-682
Revision of Discharge Limitations

The uranium solution mining pilot test underway at Collins Draw, in Campbell County, Wyoming, is attempting to minimize wastes in all forms and, also, to pilot field test a drain field concept designed to safely stabilize the anticipated liquid wastes from the project. Due to a change in the pilot flow sheet (required to remove a calcium impurity from the mining solution from the A-1 Well Field, which was the first area tested), greater amounts of uranium and radium were released to the drain field than originally estimated. These quantities have not exceeded existing limitations in WQD Permit No. 79-682, but will shorten the life of the drain field, unless an adjustment is approved.

Although work is underway and equipment is being installed to reduce, or eliminate, uranium and/or radium from the discharge to the drain field, this letter is a request to increase the maximum total amount of uranium which can be discharged to the drain field from two (2) kilograms to eighteen (18) kilograms and to increase the maximum total amount of radium which can be discharged to the drain field from 3.5×10^7 picoCuries to 3.0×10^8 picoCuries. The maximum permissible concentration of radium in the discharge needs to be increased from 50 picoCuries per liter to 250 picoCuries per liter, also, to be consistent with the radium increase.

The effect these new limits will have on the environment is given in the attached report. These new limits will allow the development of additional waste treatment technology and the feasibility determination of the drain field concept for certain types of plant discharges.

Using existing knowledge, these new limits will extend the life of the drain field to the completion of the project. If unforeseen circumstances develop, such as during the groundwater restoration of the A-1 area, which again threatens to shorten the life of the drain field, it is felt that the new limits will still allow completion of the mining-restoration cycle in the A-1 area so that the drain field feasibility can proceed.

Work is underway and equipment is being installed to reduce or eliminate the uranium and radium from the drain field discharge. However, the degree to which the new equipment and operating procedures are successful needs to be demonstrated under field conditions with the pilot plant operating normally. Without a revision to the existing permit maximum amounts, the drain field life will be too short to complete one mining-restoration cycle or to develop a satisfactory alternative waste treatment process for uranium and radium. The objective of this work is to eliminate uranium and radium from the drain field discharge by returning these constituents to the mine zone.

We trust that the attached supporting information is sufficient for a favorable decision. If you have any questions, please contact us. If the radium limit adjustment requires more consideration and evaluation, a separate and prior decision regarding the uranium limit is desired, as restoration of the A-1 Well Field is underway at the present time and the discharge volume to the drain field will be increasing in the near future.

Respectfully,

THE CLEVELAND-CLIFFS IRON COMPANY

Jerry T. Laman
Chief Metallurgist

JTL:ag

Attachment: Supporting Information

XC: Land Quality Division
U.S. Nuclear Regulatory Commission

S6-CDI-Q

SUPPORTING INFORMATION for a REQUEST to INCREASE the MAXIMUM TOTAL AMOUNT of URANIUM and RADIUM PERMISSABLE to DISCHARGE under WATER QUALITY PERMIT 79-682

Prepared By

THE CLEVELAND-CLIFFS IRON COMPANY
P. O. Box 3140
Casper, Wyoming 82601

October 16, 1980

SUPPORTING INFORMATION for a REQUEST to INCREASE the MAXIMUM TOTAL AMOUNT of URANIUM and RADIUM PERMISSABLE to DISCHARGE under WATER QUALITY PERMIT 79-682

INTRODUCTION

The Cleveland-Cliffs Iron Company, as Manager of the Thunderbird Joint Venture is currently operating a process drain field as part of a uranium solution mine pilot test. The drain field is designed to stabilize certain types and quantities of nonhazardous liquid wastes associated with the project. If successful, the drain field concept will provide an alternative waste handling system for some types of liquid waste where the proper field conditions exist.

The drain field is regulated by the U.S. Nuclear Regulatory Commission Source Materials License 3UA-1352; the Wyoming Department of Environmental Quality, Land Quality Division License 3RD; and the Wyoming Department of Environmental Quality, Water Quality Division Permit 79-682. This report is directed to the Water Quality Division Permit 79-682. Copies will be sent to the other agencies.

The original applications(s) for permit(s) and license(s) for the process drain field contained estimates of the amounts and constituent concentrations anticipated in the drain field discharge, which were the basis for the current limitations. As a result of operating data from the pilot facility operation and an adjustment to the pilot flowsheet, those current constituent limitations are now known to be too restrictive.

The solution mining process being pilot tested is a high pH ammonium carbonate/bicarbonate in-situ uranium leach. At high pH, calcium is insoluble and should not enter the circulating mining solutions. In the first well field, some calcium was produced and the surface plant operations were modified to accommodate it. This process adjustment created a greater-than-anticipated uranium and radium discharge to the drain field and is the reason for this request.

Research and development are continuing to eliminate the problem at the source and/or develop improved treatment techniques. The final conclusion on the calcium issue, and its associated uranium and radium problems, is not available at present. As a result of work to date, a means to control radium has been developed and is being pursued further. Of course, the more calcium waste generated, the less practical a drain field concept becomes due to plugging and scaling difficulties.

PURPOSE and SCOPE

The purpose of this report is to supply supporting information for the request to increase the maximum total amounts of uranium and radium which can be released to the drain field. Higher limitations will allow the drain field concept to reach a conclusion as well as provide additional time for further research and development of the entire pilot process.

The scope of the report is limited to just uranium and radium limitations in the Water Quality Division Permit 79-682.

DISCUSSION of URANIUM LIMITATION

The present maximum total amount of uranium which can be discharged to the drain field is two (2) kilograms, or an average 0.55 milligrams per liter for the maximum 950,000 gallons of total discharge allowable. The request is to increase the existing 2 kilograms maximum uranium to 18 kilograms. This raises the average discharge concentration from 0.55 mg/l to 5.0 mg/l for 950,000 gallons.

A 5.0 mg/l (ppm) average uranium concentration discharged to the drain field over a 950,000-gallon life is readily stabilized by adsorption. A report describing the technique used and laboratory determination of the drain field capacity for uranium by In-Situ Consulting, Inc. is attached as Appendix I for further reference.

The report discusses the drain field capacity for uranium adsorption in typical case and worst case conditions. Worst case conditions are represented by high competing chloride ion concentrations. In the typical case, for a 950,000-gallon volume, an average discharge concentration of 250 mg/l uranium would be reduced by adsorption to 5 mg/l (882 kilograms uranium adsorbed) average in the soil water. In the worst case, 55.6 mg/l uranium would be reduced to 5 mg/l (182 kilograms uranium adsorbed) in the presence of a strong competing ion. In conclusion, the report shows that uranium should be readily adsorbed in the drain field and that 182 to 882 kilograms of uranium can be expected to be absorbed in the drain field depending upon the presence or absence of a successful competing ion.

The requested increase in the maximum amount of uranium which can be discharged to the drain field from 2 kilograms to 18 kilograms provides a reasonable safety factor and appears adequate for the foreseeable future.

An increase to 18 kilograms in the maximum permissible total amount of uranium that can be discharged to the drain field will not have a measurable adverse environmental impact. The drain field can stabilize 18 kilograms of uranium and this uranium will remain at or near the bottom of the drain field after final reclamation without any measurable effects on the surface or the nearest groundwater to surface.

At present, the shallowest groundwater is monitored by three monitor wells, which are sampled biweekly and assayed for uranium, ammonia, nitrogen, sodium, chloride, and total dissolved solids. In addition, unacceptable radiological or salt contamination of either the subsoil or the topsoil is defined as an increase of 5 picoCuries per gram of radiation content of either topsoil or subsoil (baseline is 0.77 pCi/g) or an increase in salt content of the topsoil so that it exceeds a conductivity of 8 mmhos/cm (LQD, WDEQ former Guideline No. 3).

No adverse environmental impacts are anticipated, but should subsequent data indicate otherwise, The Cleveland-Cliffs Iron Company is committed to investigate and mitigate any unacceptable environmental impacts as per the Land Quality License 3RD.

DISCUSSION of RADIUM 226

The existing permitted maximum total amount of radium 226 that can be discharged to the drain field is 3.5×10^7 picoCuries. The requested new limit is 3.0×10^8 picoCuries, or an average of 83.4 picoCuries per liter for 950,000 gallons. The maximum allowable discharge concentration for radium thus needs to be increased from 50 picoCuries per liter to 250 picoCuries per liter to be consistent with the new total amount maximum limitation request.

The basis for this request is the observation that background radium 226 already in solution in the virgin groundwater prior to mining appears to enter the plant and is discharged with the waste stream. If this is the case, then using the average baseline value of 16.2 picoCuries per liter, 1.1×10^7 picoCurigs can be expected from the first well field, the A-1 area, and 1.8×10^8 picoCuries from the larger second area, B Well Field. These conclusions are only tentative at this point and work is underway to learn more and to develop a better estimate for this quantity of radium 226. It does not appear at this time that measurable amounts of radium were mined with the uranium, but a final resting place for the radium already in solution, prior to mining, needs to be developed.

The drain field can stabilize large amounts of radium 226 because radium 226 has a high affinity for clays and is readily adsorbed. This is documented in the previous application for a permit. The accumulation of radium can create a radioactive hazard when the amount is large enough to generate unacceptable quantities of mobile, radioactive radon gas. Assuming 5 picoCuries of radium 226 per gram of solid as a reasonable threshold, this equates to 7.35×10^8 picoCuries per foot of depth in the bottom of the drain field (using 108 pounds per cubic foot soil as the soil density). The radium concentration, due to the drain field design, will lie 5-6 feet below the subsoil or 7-8 feet below the reclaimed surface after topsoil has been replaced, and this amount of overburden will reduce the radon gas flux at the surface to acceptable levels.

If radium discharges on the order of 1.0×10^5 picoCuries per square foot of drain field bottom (2 picoCuries per gram at 1.0 foot penetration) are not acceptable for the drain field, the radium 226 can be returned to the mine zone in a less soluble form than it was originally, where it is regulated by groundwater restoration criteria. However, an increase in the maximum total amount of radium which can be discharged to the drain field to 5.8×10^7 picoCuries from 3.5×10^7 picoCuries will be needed to pursue this alternative. The 5.8×10^7 picoCuries is an estimate and is the amount of radium expected if 950,000 gallons of average baseline concentration of 16.2 picoCuries radium 266 per liter were discharged without any plant processing or concentration.

Restoration of the first pilot well field, A-1, is just beginning and the effects of a restoration cycle on radium 226 are not yet known. Currently, the chemistry of restoration is geared for removal of lixiviant ingredients and not for radium 226 control. It is important that the radium limit proposed will be adequate for the restoration cycle also. The greatest discharge to the drain field occurs during the final stages of groundwater cleanup.

No adverse impacts to the groundwater beneath the drain field are anticipated because the radium is readily adsorbed onto soil clays and is not mobile. The

greatest potential hazard is the radon gas generated by radium 226 decay. However, the overburden material overlying the bottom of the drain field is sufficient to mitigate the effects of the radon generated by 3.0×10^{5} pico-Curies of radium 226. No other impacts or hazards are predicted.

As per the Land Quality Division License 3RD, should the drain field experiment result in an unpredicted adverse environmental impact, then the drain field will be dug up or the impact mitigated in some other ways prior to completion of final site reclamation.

Attachment - Appendix I

JTL:ag
Casper, Wyoming
10/24/80

S6-CDI-V

APPENDIX I

AN ANALYSIS OF THE COLLINS DRAW DRAINFIELD CAPACITY FOR URANIUM

BY

Dr. Jack Murphy

In-Situ Consulting, Inc.

August 19, 1980

ADSORPTION TEST PROCEDURE AND CALCULATION OF DISTRIBUTION COEFFICIENT

Adsorption tests were run using soil material taken from a composite sample of 9 cores from the Collins Draw drainfield. This material was rolled and mixed and placed in two glass columns. 2.6 cm by 1 m in length. In one column, a 100 ppm uranium solution and 3 gm/l ammonium carbonate was percolated. A second column percolated a 1.7 ppm uranium solution of approximately 2 gm/l ammonium carbonate and 13 gm/l Cl^- ion concentration as representing the worst case from stripping calcium from ion exchange resin prior to removal of the uranium by the Collins Draw drainfield protection ion exchange system.

The data of these two tests were normalized and plotted as shown in Figure 1. Porosity measurements on both columns were 0.55 and 0.52 (55% and 52%). These values and the bulk density of the material are used to calculate the distribution coefficient, K. K is defined as the distribution of uranium between solid and solution in the soil. K is calculated by measuring the number of pore volumes required to reach midway on the steeply rising portion of the two curves of Figure 1 and dividing this value by the ratio of bulk density and porosity (approximately 3.2). This procedure yields K values of about 0.3 for the first run and 0.2 for the high chloride run.

PROCEDURE FOR DETERMINING SAFE LEVELS OF URANIUM INPUT AND OUTPUT FOR COLLINS DRAW DRAINFIELD

This technique for computing a safe level of uranium can be used for making engineering estimates for adsorption of other metals than uranium. The technique is simple to use when the percolation test data is normalized.

1. Compute the pore space of the drainfield. Computer simulations of the extent of water movement produced the lateral boundaries and the shallow aquifer the the lower limit. An average porosity of 25% was used resulting in a total pore volume of 2,244,000 gallons of water when fully saturated. This value of total pore space is set equal to one pore volume.

2. Determine ratio between maximum allowable water input tc drainfield over the life of project and pore volume calculated above.

   Number of pore volumes injected = $\frac{950,000}{2,244,000} = 0.423$

3. From Figure 1, test 1, fraction of uranium adsorbed, f, corresponding to number of pore volumes (0.423) computed above, is, from actual data, f = 0.02.

4. Compute average maximum allowable input of uranium to drainfield corresponding to 950,000 gallons of waste water when the desired uranium output after

adsorption is selected as 5 ppm U (EPA drinking water level for U)

$$\text{Average U input} = \frac{\text{U output}}{f} = \frac{5 \text{ ppm}}{0.02} = 250 \text{ ppm U}$$

From this calculation if 950,000 gallons of plant waste water contained an average of 250 ppm of uranium (295 U_3O_8) the total drainfield soil material would adsorb the uranium to a level that the soil water would average only 5 ppm.

A second computation as a worst-case using the high chloride ammonium carbonate solution of approximately 13 gm/l. The value of f from the normalized graph is 0.03 for a pore volume ratio of 0.423, as computed in the last problem.

Computing the average maximum allowable uranium input concentration to the drainfield results in

$$\text{Average U input} = \frac{5 \text{ ppm}}{0.09} = 55.6 \text{ ppm U.}$$

Assuming from above computations of high chloride test that a desired average input uranium level is selected as 20 ppm U_3O_8 (17 ppm U). This would correspond to a 3.3 safety factor. From the last computation with f = 0.09 and U input = 17 ppm U the U output would compute as

$$U_{output} = f * U_{input} = 0.09 * 17 = 1.5 \text{ ppm U}$$

resulting in a safety factor of

5 ppm U/1.5 = 3.3.

These tests show that uranium is readily adsorbed in the drainfield, and if an input stream averaged 20 ppm U_3O_8

the drainfield would reduce the uranium content in the pore water, by adsorption, to acceptable drinking water levels.

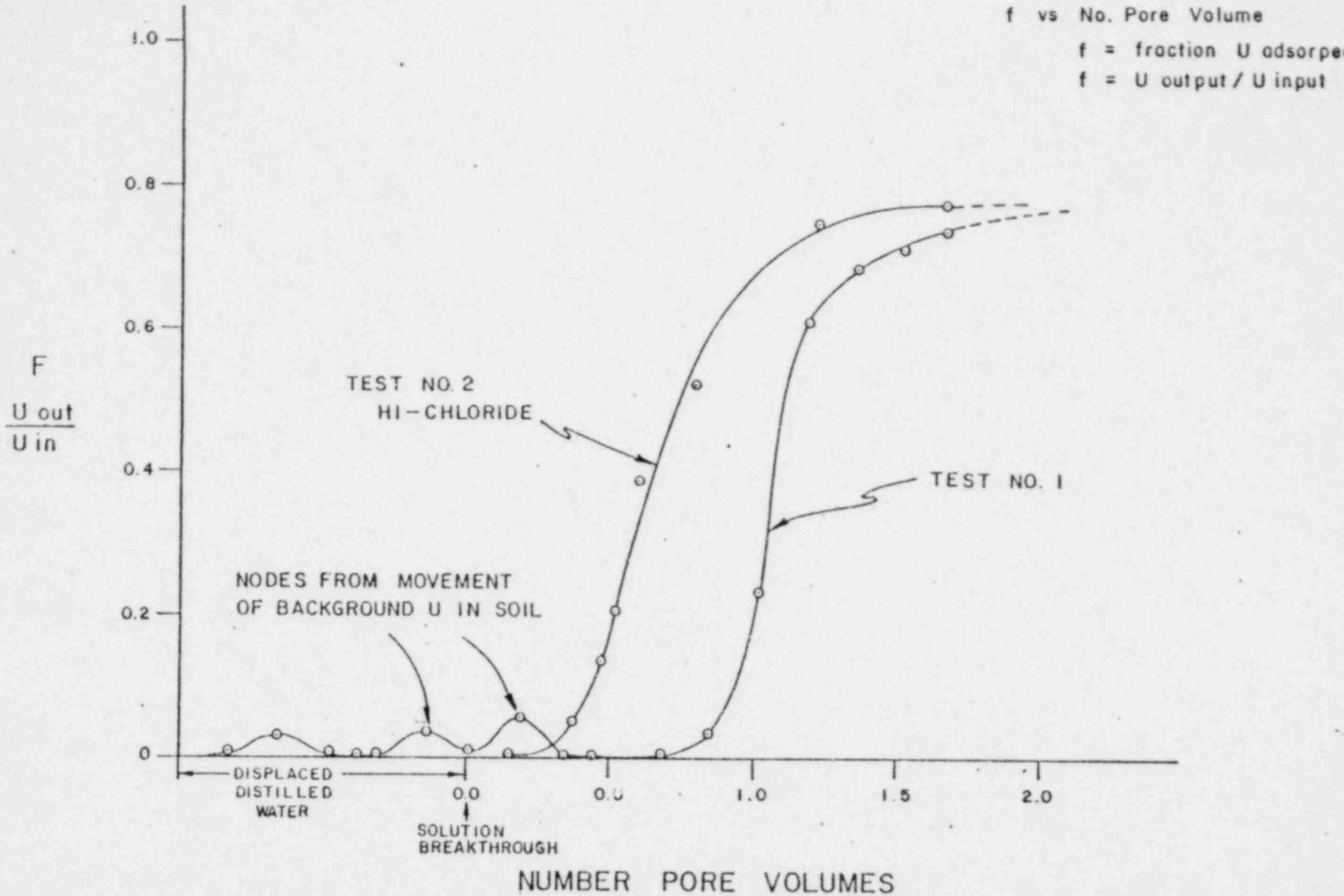
FIGURE 1

NORMALIZED URANIUM
ADSORPTION CURVES

f vs No. Pore Volume

f = fraction U adsorped

f = U output / U input



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