U.S. Energy Corporation

Green Mountain Ion Exchange

SUA - 1524

DECOMMISSIONING PLAN

September 1993

Copy NO. 1C
USE - MASTER

U. S. ENERGY CORP.
877 NORTH 8th WEST PHONE (307) 856-9271 RIVERTON, WYOMING 82501

rec'd 10-2

September 28, 2000

U. S. Nuclear Regulatory Commission
Division of Waste Management, MST7C6
Uranium Recovery Branch, Addressee Only
11555 Rockville Pike
Rockville, MD 20852
Attn. Ms. Elaine Brummett

Re: GMIX SUA-1524 Docket No. 40-8971
Decommissioning Plan

Dear Elaine:

Enclosed is a copy of the Green Mountain Ion Exchange (GMIX) Decommissioning Plan approved in License Condition No. 13.

I will call next week on Wednesday of Thursday.

Sincerely,
U. S. Energy Corp.

Fred

Fred Craft

Enclosure

xc: File

FAX (307) 857-3050

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

December 15, 1999

RECEIVED DEC 20 1999

U.S. Energy Corporation
ATTN: Mr. Fred Craft
877 North 8th West
Riverton, WY 82501

SUBJECT: AMENDMENT 14 TO NRC SOURCE MATERIAL LICENSE SUA-1524 -- ANNUAL SURETY UPDATE AND REQUESTED LICENSE CONDITION CHANGES

Dear Mr. Craft:

The U.S. Nuclear Regulatory Commission (NRC) staff has completed its review of U.S. Energy Corporation's (U.S. Energy's) annual surety update for the Green Mountain Ion Exchange facility, as contained in U.S. Energy's submittal of August 11, 1999, response to NRC comments dated October 15, 1999, and clarification of responses with revised cost estimate dated November 19, 1999. The NRC staff review concluded that the proposed revised increase in the surety amount is appropriate for the expected decommissioning activities and that the cost estimates are based appropriately on 1999 sources. The staff evaluation is provided in Enclosure 1. The revised surety amount of $93,880 is acceptable. Therefore, you should ensure that the surety is increased to this amount within 3 months of the date of this letter, as required by revised License Condition 17 (see below).

In addition, the staff has reviewed your letter dated August 22, 1999, requesting minor changes to six license conditions, and has considered your later telephone request to modify the license condition on instrument calibration. The NRC staff discussed these proposed changes with you on October 28 and November 18, 1999, and the staff evaluation and acceptance of the changes are documented in Enclosure 2.

Therefore, pursuant to Title 10 of the Code of Federal Regulations, Part 40, Source Material License SUA-1524 is hereby amended by revising License Condition Nos. 10, 14, 15, 17, 18, 22, and 23. All other conditions of this license (except for minor editorial changes) shall remain the same. The license is being reissued to incorporate the requested modifications, as discussed (Enclosure 3). An environmental review was not performed, since these actions change administrative procedures, and are categorically excluded under 10 CFR 51.22(c)(10).

If you have any questions concerning this action, please contact the project manager for your site, Elaine Brummett, at 301-415-6606.

Sincerely,

Thomas H. Essig, Chief
Uranium Recovery and
Low-Level Waste Branch
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

cc: M. Moxley, WDEQ
R. Chancellor, WDEQ

Enclosures:
1. Technical Evaluation of the Annual Surety Update
2. Technical Evaluation of Requested License Condition Changes
3. License SUA-1524

ENCLOSURE 1

TECHNICAL EVALUATION OF THE ANNUAL SURETY UPDATE (COST ESTIMATE)
FOR THE GREEN MOUNTAIN ION-EXCHANGE FACILITY

DATE: December 8, 1999

DOCKET NO. 40-8971 LICENSE NO. SUA- 1524

LICENSEE: U.S. Energy Corporation

FACILITY: Green Mountain Ion Exchange,
Near Jeffrey City, Wyoming,

PROJECT MANAGER: E. Brummett

TECHNICAL REVIEWERS: E. Brummett, D. Rom

TECHNICAL EVALUATION: The U.S. Energy Corporation (U.S. Energy) submitted the annual surety update for the Green Mountain Ion Exchange (GMIX) facility on August 11, 1999 (surety anniversary date November 15). The U.S. Nuclear Regulatory Commission (NRC) staff reviewed the submittal and requested additional information by letter dated September 16, 1999. The U.S. Energy response to NRC, providing revised costs estimates based on 1999 data, is dated October 15, 1999. By electronic mail on October 26, 1999, the staff then requested clarification of two items and the clarification and a revised cost estimate were provided by letter dated November 19, 1999.

The main items evaluated by the staff were:

Ground-water Restoration

The previous and current surety cost estimates do not include funds for ground-water restoration because it is considered unlikely that the activities related to the ion-exchange process for producing yellowcake (uranium oxide) have impacted ground water. The licensee provided additional information on the handling of GMIX process water, well sample data, and surrounding uranium mining activities to support this assumption. The NRC staff considers that there is no evidence that past operation of the GMIX has impacted ground water (radium and uranium concentrations are higher in the offsite up gradient well than in the down gradient well). The issue of potential ground water contamination should be addressed if a request to operate the facility is submitted and additional monitoring could be considered at that time.

Long-Term Surveillance Fee

This fee is not required for the GMIX site because there is no waste disposal on site and none of the site will be transferred to the U.S. Department of Energy (DOE). The NRC licensed site is also a mine site that is regulated by the State of Wyoming. After the NRC staff determines that the site has been decommissioned according to NRC regulations, the license will be terminated and the site released for unrestricted use. Site restoration (e.g., site grading and re-vegetation) will be under state jurisdiction.

Construction and Disposal Activities

The November 19, 1999, cost estimates for building demolition, dirt and pond sludge excavation, mobilization of equipment, and waste hauling to the Sweetwater tailings disposal cell were based on the 1999 "Means Heavy Construction Cost Data." The volumes of material to be moved were comparable to those in the approved decommissioning plan and to Sweetwater License Condition 10.6 that allows disposal of up to 10,000 tons of byproduct material from the GMIX facility. This disposal volume includes the Bison Basin (in situ leach facility) equipment stored at GMIX, based on the Kennecott Energy letter to NRC dated July 21, 1993. The staff determined that adequate cost estimates have been provided.

Decommissioning Monitoring

The estimated cost for the delineation of contamination, site radiological monitoring, final status survey, and completion report preparation were revised in the November 19, 1999, submittal to include adequate time and wages for the work to be done by the radiological staff. The number of soil samples that were assumed to be collected appear conservative, considering the small area of known contamination. The licensee indicated that the areas under the evaporation ponds would also be sampled. The cost estimate for this activity appears adequate.

ENCLOSURE 2

TECHNICAL EVALUATION REPORT
OF REQUESTED LICENSE CONDITION CHANGES

DATE: December 8, 1999

DOCKET NO. 40-8971 LICENSE NO. SUA- 1524

LICENSEE: U.S. Energy Corporation

FACILITY: Green Mountain Ion Exchange,
Near Jeffrey City, Wyoming,

PROJECT MANAGER: E. Brummett

TECHNICAL REVIEWER: E. Brummett

TECHNICAL EVALUATION: By letter dated August 22, 1999, the U.S. Energy Corporation requested changes to six license conditions (LCs) for License No. SUA-1524. In addition, on November 4, 1999, the licensee called and requested that the recalibration requirement (LC 22) of monitoring equipment be changed from semiannual to annual. The NRC staff reviewed these requested changes and revised the license conditions as discussed with the licensee on October 28, and November 18, 1999. Minor editorial changes (e.g., up-date Branch name in LC 24) were also made to some conditions. The staff determined that the changes, as discussed, are acceptable and the evaluation of the changes are as follows.

License Condition No. 10

The licensee's suggested additional description of the site location is an improvement.

License Condition No. 14

The licensee's suggested deletion of the words "or maintain on a consulting basis" allows the license condition to reflect the current practice of employing a qualified Radiation Safety Officer.

License Condition No. 15

The deletion of the word "consulting" reflects the change to LC 14.

License Condition 17

The wording change to reflect NRC Generic Letter 97-03: "Annual Financial Surety Update Requirements for Uranium Recovery Licensees" is appropriate. It requires submittal of a surety cost estimate with any revised closure (decommissioning) plan and incorporation of the approved increase within 3 months of NRC approval. This condition will also be revised to include the approved 1999 annual surety amount.

License Condition 18

The licensee's proposed wording to clarify and reference the approval of the environmental monitoring program has been revised to reflect the NRC staff's suggestion to incorporate the specific date of the license renewal document that referenced the program approved by NRC (October 2, 1985, Amendment No. 30 to SUA-56) under the previous license. The staff also deleted the sentence requiring reporting according to 10 CFR 40.65 because that regulation applies to operating facilities and the GMIX facility is in stand-by status (possession only). An annual reporting requirement was added to this condition to be consistent with approved LCs for other sites in the stand-by mode.

License Condition 22

The licensee requested that the instrument calibration requirement be changed from semiannual to annual to reflect accepted practice. The staff will change this condition to reference the recommendations for operation and calibration in Regulatory Guide 8.30 "Health Physics Surveys in Uranium Mills," that is based on the ANSI standard N-323 "Radiation Protection Instrumentation Test and Calibration."

License Condition 23

The licensee proposed deleting the requirement for a separate decommissioning plan for the Bison Basin (in situ leach facility) equipment stored at the GMIX so that it is treated the same as other byproduct material contaminated equipment on site. The staff agrees that decommissioning of the Bison Basin equipment should not require a separate decommissioning plan as currently stipulated in this condition. The inspection performed before or during site decommissioning would include review of procedures to ensure that any equipment to be released is surveyed on all potentially contaminated surfaces to ensure that the release guideline levels are met.

ENCLOSURE 3

MATERIALS LICENSE

Pursuant to the Atomic Energy Act of 1954, as amended, the Energy Reorganization Act of 1974 (Public Law 93-438), and Title 10, Code of Federal Regulations, Chapter I, Parts 30, 31, 32, 33, 34, 35, 36, 39, 40, and 70, and in reliance on statements and representations heretofore made by the licensee, a license is hereby issued authorizing the licensee to receive, acquire, possess, and transfer byproduct, source, and special nuclear material designated below; to use such material for the purpose(s) and at the place(s) designated below; to deliver or transfer such material to persons authorized to receive it in accordance with the regulations of the applicable Part(s). This license shall be deemed to contain the conditions specified in Section 183 of the Atomic Energy Act of 1954, as amended, and is subject to all applicable rules, regulations, and orders of the Nuclear Regulatory Commission now or hereafter in effect and to any conditions specified below.

Licensee	
1. U.S. Energy Corp.	3. License Number SUA-1524, Amendment No. 14
2. 877 North 8th West Riverton, Wyoming 82501	4. Expiration Date Until NRC determines that site restoration is adequate
	5. Docket or Reference No. 40-8971

6. Byproduct, Source, and/or Special Nuclear Material	7. Chemical and/or Physical Form	8. Maximum Amount that Licensee May Possess at Any One Time Under This License
Natural Uranium Byproducts	Any	Only That Amount In-Plant As A Result Of Previous Operation

9. The licensee is hereby authorized for possession only, those byproduct materials in the form of wastes and contaminated facilities and equipment resulting from previous Green Mountain Ion-Exchange (GMIX) plant operations. The licensee is not authorized to operate the processing equipment and, thereby, produce uranium concentrates without a specific license authorization by the NRC. [Applicable Amendments: 8, 10]

10. Authorized place of possession: The licensee's GMIX facility located in the southwest corner of Section 16 and southeast corner of Section 17, Township 28 North and Range 92 West, and approximately 10 miles south of Jeffrey City, Wyoming. [Applicable Amendment: 14]

11. For use in accordance with statements, representations, and conditions contained in the licensee's application dated May 23, 1988. Whenever the word "will" is used in the licensee's application specified above, it shall denote a requirement. Notwithstanding any statements to the contrary contained in the May 23, 1988 application, the licensee shall adhere to the requirements specified in the following license conditions.

12. Release of equipment or packages from the restricted area shall be in accordance with the attachment entitled "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses For Byproduct, Source, or Special Nuclear Material," dated May 1987, or suitable alternative procedures approved by NRC prior to any such release. [Applicable Amendment: 13]

MATERIALS LICENSE
SUPPLEMENTARY SHEET

13. The licensee shall conduct decommissioning and reclamation activities in accordance with the detailed site decommissioning plan submitted by letter dated September 29, 1993, and amended by submittals dated November 16, 1993; March 6, 1995; May 24, 1995; and June 8, 1995. [Applicable Amendment: 10]

14. The licensee shall employ a qualified Radiation Safety Officer (RSO), who is responsible for radiation safety aspects of the facility. The RSO shall possess the minimum qualifications as specified in Section 2.4.1 of Regulatory Guide 8.31, "Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Mills will be As Low As is Reasonably Achievable." The licensee shall, by utilization of a qualified RSO, provide training, safety instructions, and dosimetry services for all workers routinely visiting the GMIX facility adequate to assure compliance with 10 CFR Part 20 and guidelines contained in Regulatory Guides 8.30 and 8.31. [Applicable Amendment: 14]

15. The licensee shall utilize a Radiation Work Permit (RWP) for all work activities performed at the GMIX facility where the potential for significant exposure to radioactive material exists. The RWP shall be issued by the RSO and shall at least describe the following:

    A. The scope of the work activity to be performed.

    B. Any precautions necessary to reduce exposure of workers to uranium and its daughter products.

    C. Any supplemental radiological monitoring and sampling necessary prior to, during, and/or following completion of the work.

16. The licensee is hereby exempted from the requirements of Section 20.1902(e) of 10 CFR 20 for areas within the GMIX provided that all entrances to the plant are conspicuously posted in accordance with 20.1902(e) and with the words, "ANY AREA WITHIN THIS FACILITY MAY CONTAIN RADIOACTIVE MATERIAL." [Applicable Amendment: 12]

17. The licensee shall maintain an NRC-approved financial surety arrangement, consistent with 10 CFR 40, Appendix A, Criterion 9 adequate to cover the estimated costs, if accomplished by a third party, for completion of an NRC-approved site closure plan including: above ground decommissioning and decontamination, the cost of offsite disposal of radioactive solid process wastes and evaporation pond residues, and ground-water restoration as warranted.

    With submittal of a revised closure (decommissioning) plan, the licensee shall submit, for NRC review and approval, a proposed revision to the financial surety arrangement, if estimated costs in the revised closure plan exceed the amount covered in the existing financial surety. The revised surety shall then be in effect within 3 months of written NRC approval.

    Annual updates to the surety amount, required by 10 CFR 40, Appendix A, Criterion 9, shall be provided to the NRC at least 3 months prior to the anniversary date of November 15 each year. If the NRC has not approved a proposed surety revision 30 days prior to the expiration date of the existing surety arrangement, the licensee shall extend the existing arrangement, prior to the expiration, for 1 year. The revised surety amount will be in effect within 3 months of written NRC approval.

Along with each proposed revision or annual update, the licensee shall submit supporting documentation showing a breakdown of the costs and the basis for the cost estimates with adjustments for inflation, maintenance of a minimum 15 percent contingency, changes in engineering plans, activities performed and any other conditions affecting estimated costs for site closure. The licensee shall also provide the NRC with copies of surety related correspondence submitted to the State, a copy of the State's surety review, and the final approved surety arrangement. The licensee must also ensure that the surety, where authorized to be held by the State, expressly identifies the NRC-related portion of the surety.

U.S. Energy's currently approved surety (automatically renewable certificates of deposit payable to the State of Wyoming) shall be continuously maintained in an amount no less than $93,880 for the purpose of complying with 10 CFR 40, Appendix A, Criterion 9, until a replacement is authorized by the NRC. [Applicable Amendments: 1, 2, 3, 5, 7, 8, 9, 11, 12, 13, 14]

18. The licensee shall implement the environmental monitoring program for ground water, surface water, and soil sampling at the locations and frequency specified in the May 23, 1988, license application. The results of all effluent and environmental monitoring required by this license shall be reported to the NRC annually, while the facility is in "possession only" status (i.e., not licensed for operation). [Applicable Amendments: 8, 10, 14]

19. The results of sampling, analysis, surveys, and monitoring, the calibration of equipment, reports on audits and inspections committed to in the licensee's application and in the additional conditions to this license, as well as any subsequent reviews, investigations, and corrective actions, shall be documented. Unless otherwise specified in NRC regulations, all such documentation shall be maintained for a period of at least 5 years.

20. The licensee shall utilize the lower limits of detection in accordance with Section 5 of the Regulatory Guide 4.14, Revision 1, dated April 1980, for analysis of effluent and environmental samples.

21. The licensee shall conduct a quality assurance program for environmental monitoring as outlined in Regulatory Guide 4.15.

22. All radiation monitoring, sampling, and detection equipment shall be operated and calibrated as recommended in Regulatory Guide 8.30. In addition, all radiation survey instruments shall be operationally checked with a radiation source before each use.

23. The licensee is hereby authorized to possess process equipment purchased from the Bison Basin uranium in situ leach plant. All materials at the GMIX facility contaminated with byproduct material (including the Bison Basin equipment) is approved for disposal at the Sweetwater Mill Facility (SUA-1350 License Condition No. 10.6 in 1999 license renewal). [Applicable Amendment: 14]

NRC FORM 374A
(7-94)

U.S. NUCLEAR REGULATORY COMMISSION

PAGE 4 OF 4 PAGES

MATERIALS LICENSE
SUPPLEMENTARY SHEET

License Number SUA-1524, Amendment No. 14

Docket or Reference Number 40-8971

24. All notices or submittals to the NRC required under this license shall be addressed to the Chief, Uranium Recovery and Low Level Waste Branch, Division of Waste Management, Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, 20555. [Applicable Amendment: 10]

FOR THE NUCLEAR REGULATORY COMMISSION

Thomas H. Essig

Date: December 15, 1999

Thomas H. Essig, Chief
Uranium Recovery and
Low Level Waste Branch
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

UNITED STATES NUCLEAR REGULATORY COMMISSION

U. S. ENERGY / CRESTED CORP.

877 North 8th West (307) 856-9271 Riverton, Wyoming 82501

June 8, 1995

Mr. James Park
Nuclear Regulatory Commission
High Level Waste & Uranium Recovery Projects Branch
11545 Rockville Pike
Rockville, MD 20850

Re: Docket No. 40-8971
SUA-1524 GMIX Decommissioning

Dear Mr. Park:

The following is pursuant to our phone discussion with Mr. McKinney of your office on June 7, 1995, regarding the criteria and analysis for clean up of the Final Pond (Roberts #2) and the Primary Pond (Roberts #3):

Baseline determination

The Uranium Nat. averages to obtain Baseline Values were from analysis in Pci/g from areas outside the impoundment including any grid which was 50% or more outside the impoundment.

The Ra 226 average to obtain Baseline Values were from analysis in Pci/g from areas outside the impoundment including any grid which was 50% or more outside the impoundment.

Final Pond (Roberts No. 2)

	Baseline	Concentration Limit	Clean up Value
Ra 226	9.2 Avg	5	14.2
Uranium Nat	12.4 Avg	10	22.4

The plan would be to remove all soils with elevated Ra 226 or U Nat in each grid greater than the 14.2 pci/g and 22.4 pci/g respectively. (See attached map).

Primary Pond (Roberts No. 3)

	Baseline	Concentration Limit	Clean up Value
Ra 226	21.1 Avg	5	26.1
Uranium Nat	23.0 Avg	10	33.0

The plan would be to remove all soils with elevated Ra 226 or U Nat in each grid greater than the 26.1 pci/g and 33.0 pci/g respectively. (See attached map).

GMIX\6-7.95

FAX (307) 857-3050

GMIX Plant Area

It was agreed that the cleanup criteria of removing all soil in grids with a U/Ra ratio of less than 0.6 as presented in my letter of March 6, 1995 and as submitted in the Decommissioning Plan is acceptable. (Map attached).

We appreciate your assistance in this matter and as soon as field conditions warrant and our RSO is available, we will begin the cleanup.

Please contact me if you need any additional information.

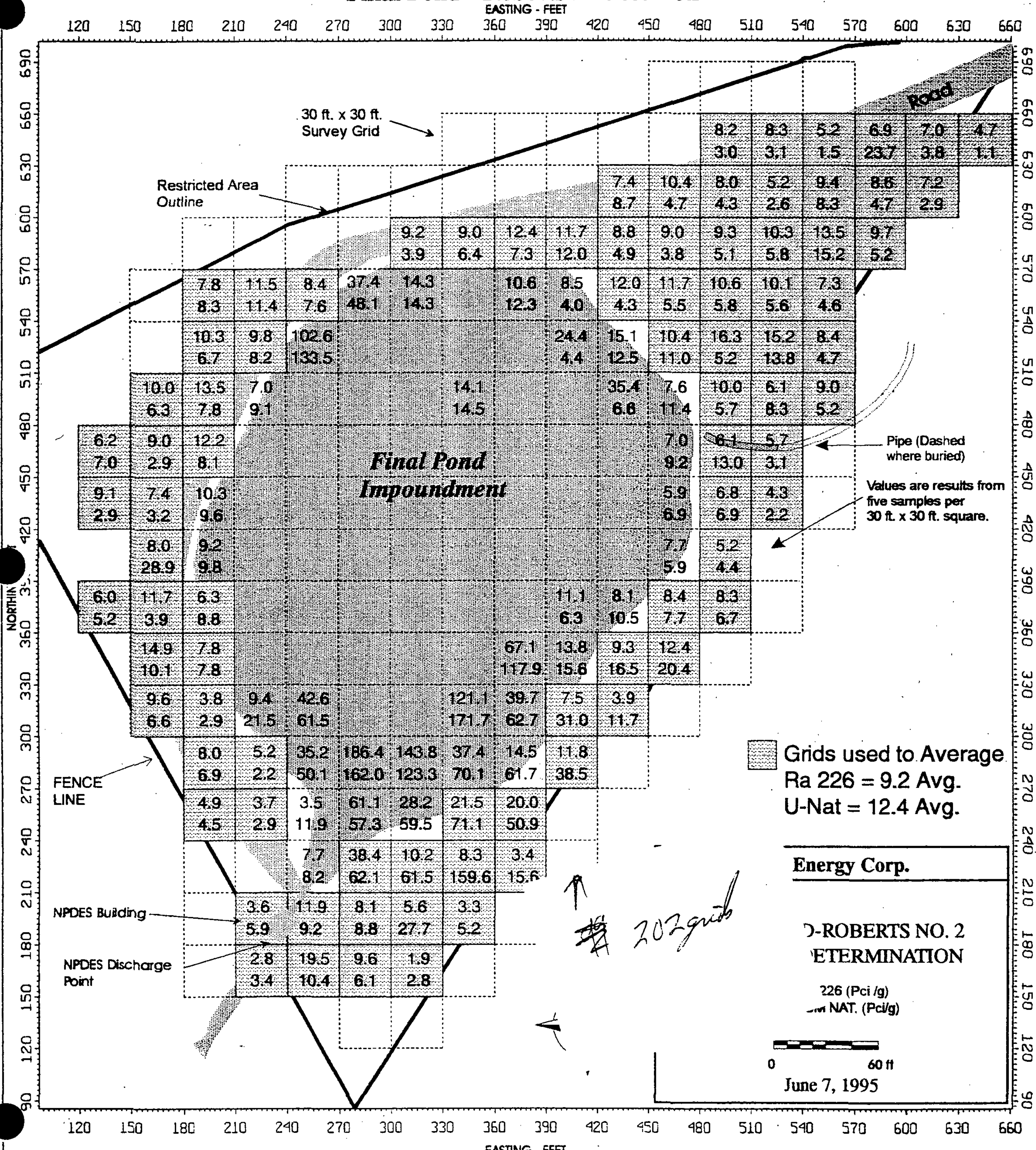
Yours truly,

Kenneth Webber

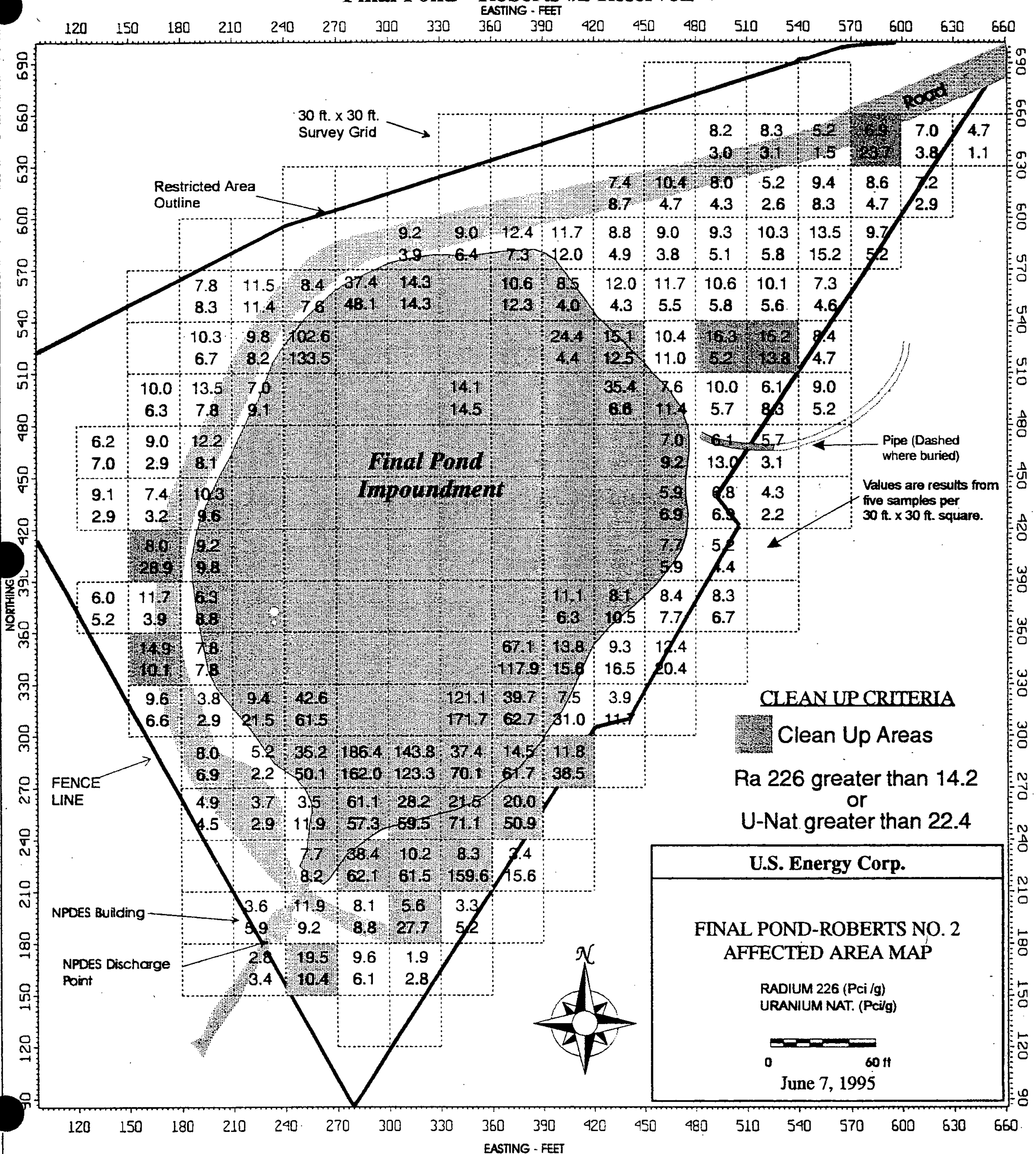
Kenneth Webber
Environmental Coordinator

KW:lg

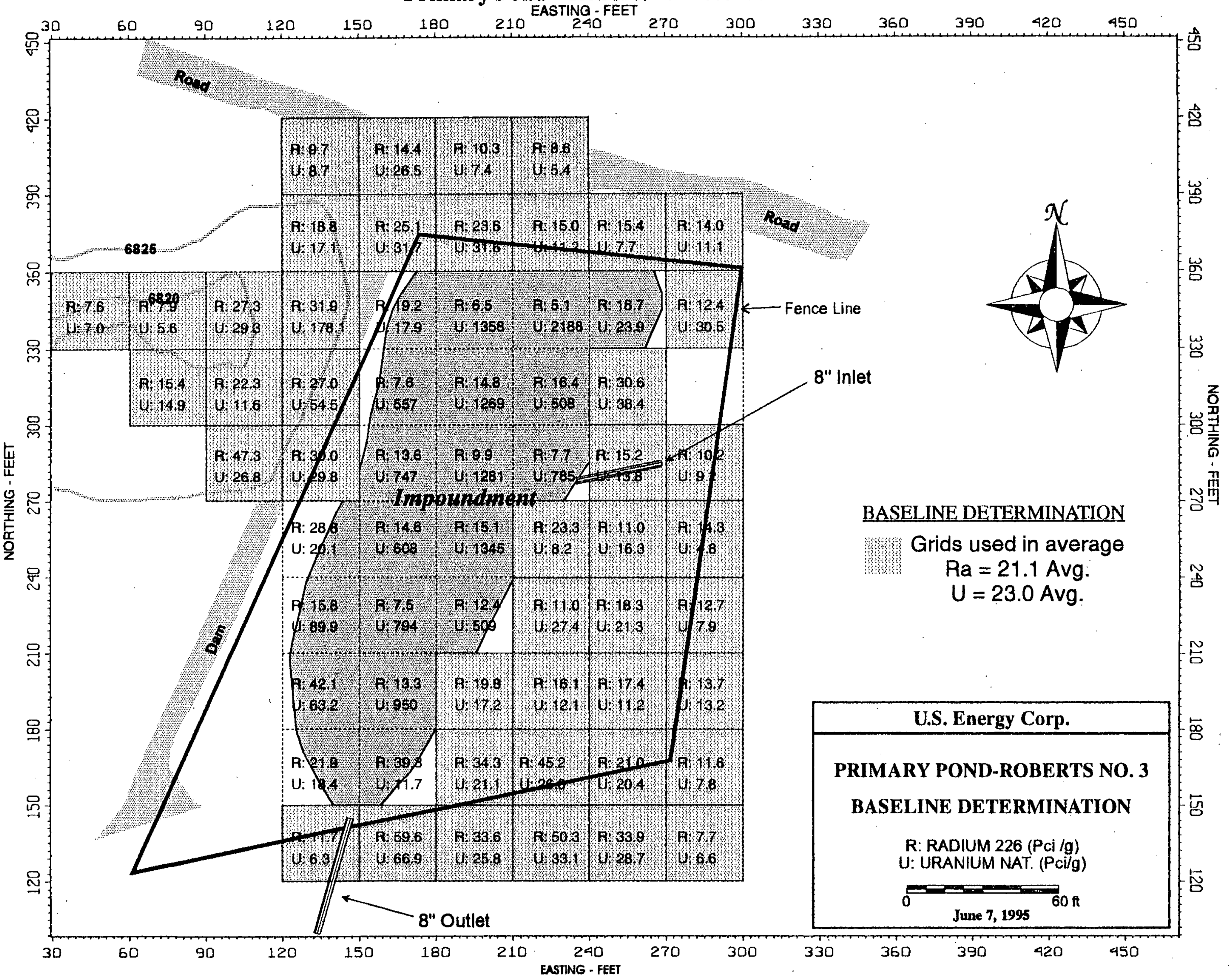
U.S. Energy Corp. Green Mountain Ion Exchange
Final Pond - Roberts #2 Reservoir



U.S. Energy Corp. Green Mountain Ion Exchange
Final Pond - Roberts #2 Reservoir

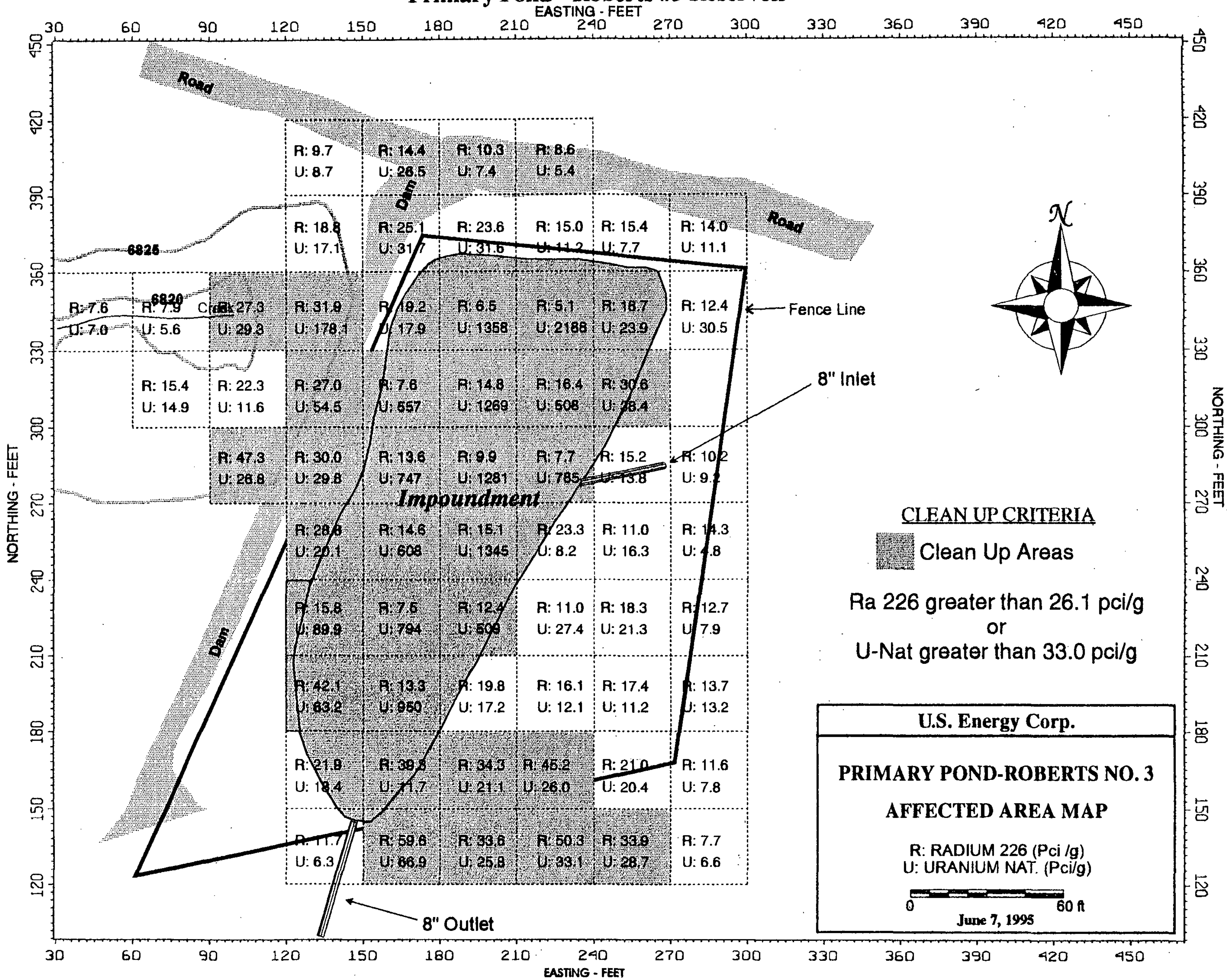


U.S. Energy Corp. Green Mountain Ion Exchange
Primary Pond - Roberts #3 Reservoir



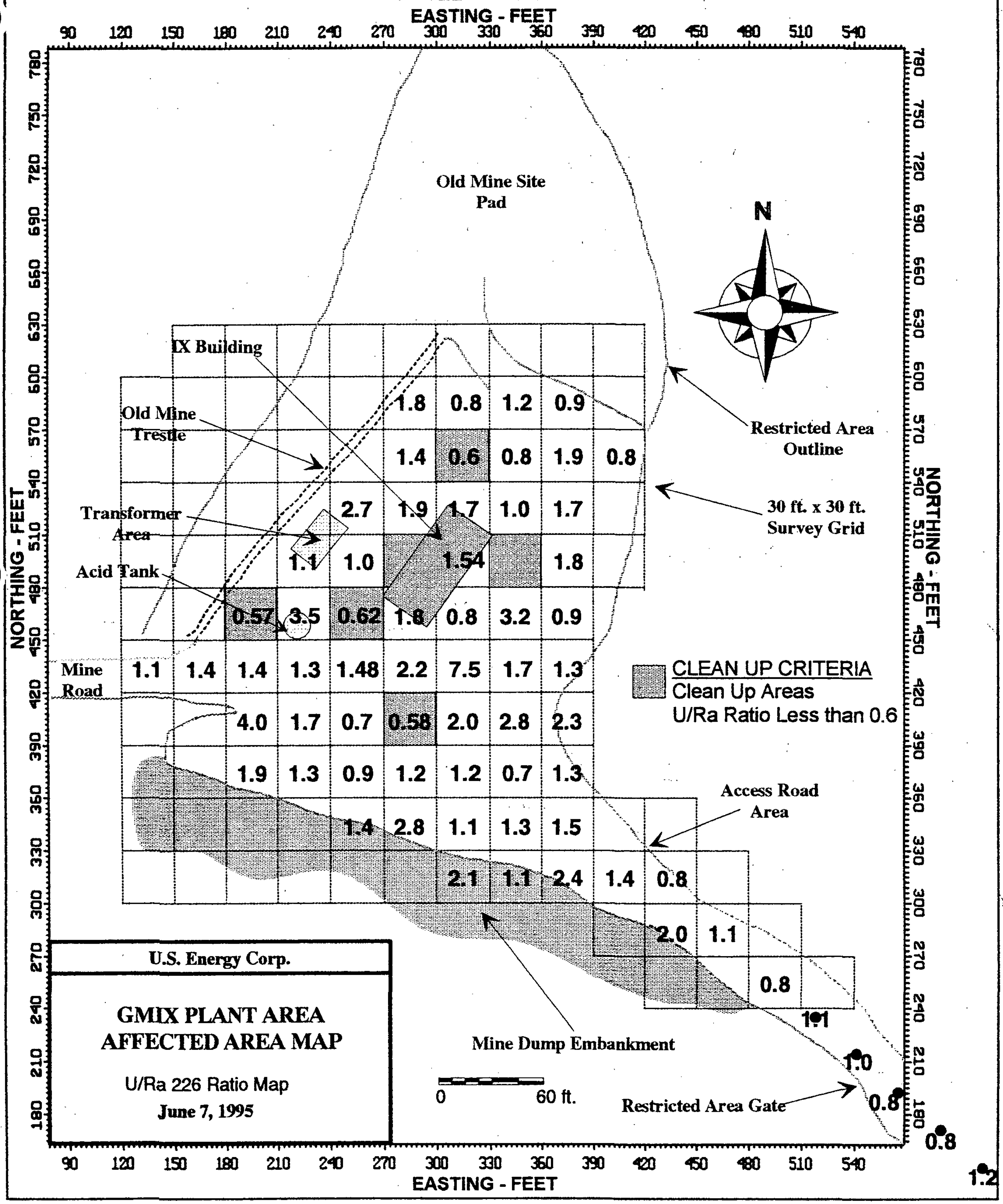
Appendix 19

U.S. Energy Corp. Gre[illegible] Mountain Ion Exchange
Primary Pond - Roberts #3 Reservoir



Appendix 19

U.S. Energy Corp. Green Mountain Ion Exchange
GMIX Plant Area



U. S. ENERGY / CRESTED CORP.

877 North 8th West (307) 856-9271 Riverton, Wyoming 82501

May 24, 1995

Mr. James Park
Nuclear Regulatory Commission
High Level Waste and Uranium Recovery Projects Branch
11545 Rockville Pike
Rockville, MD 20850

Re: Docket No. 40-8971
SUA-1524 GMIX Decommissioning

Dear Mr. Park:

Enclosed are results from soil samples taken at the primary pond regarding the referenced project. In discussing the ratio of U/Ra with Mr. McKinney, it was decided that the sludge area in the primary pond be sampled.

Samples taken on April 3, 1995 are illustrated on the enclosed map in black. Those samples previously reported are illustrated in red.

Note that the values for radium should not be a concern in the primary impoundment as the values are very low. The uranium content however is higher as a potential result of the resin beads escaping the water treatment process during pre-1987 operations. We consider the U values outside the impoundment natural non-contaminated soils with values ranging to a high of 178.1 pci/g U. A suggested cleanup plan for the primary pond Roberts No. 3 would be to remove all the soils with an elevated U content greater than 178.1 pci/g U.

We have had a very wet spring and in fact yesterday was a blizzard with 4"-6" of new snow. The final pond was not sampled as of this date, but we suggest a cleanup plan similar to the primary pond.

The Ra 226 values range to a high of 20.0 pci/g and Uranium to a high of 159.6 pci/g in the natural non-contaminated soils outside the final impoundment. A suggested cleanup for the final pond would be to remove all soils with a U content greater than 159.6 pci/g and a Radium content greater than 20.0 pci/g.

We appreciate your assistance in this matter and if you need any additional information, please contact me.

Yours truly,

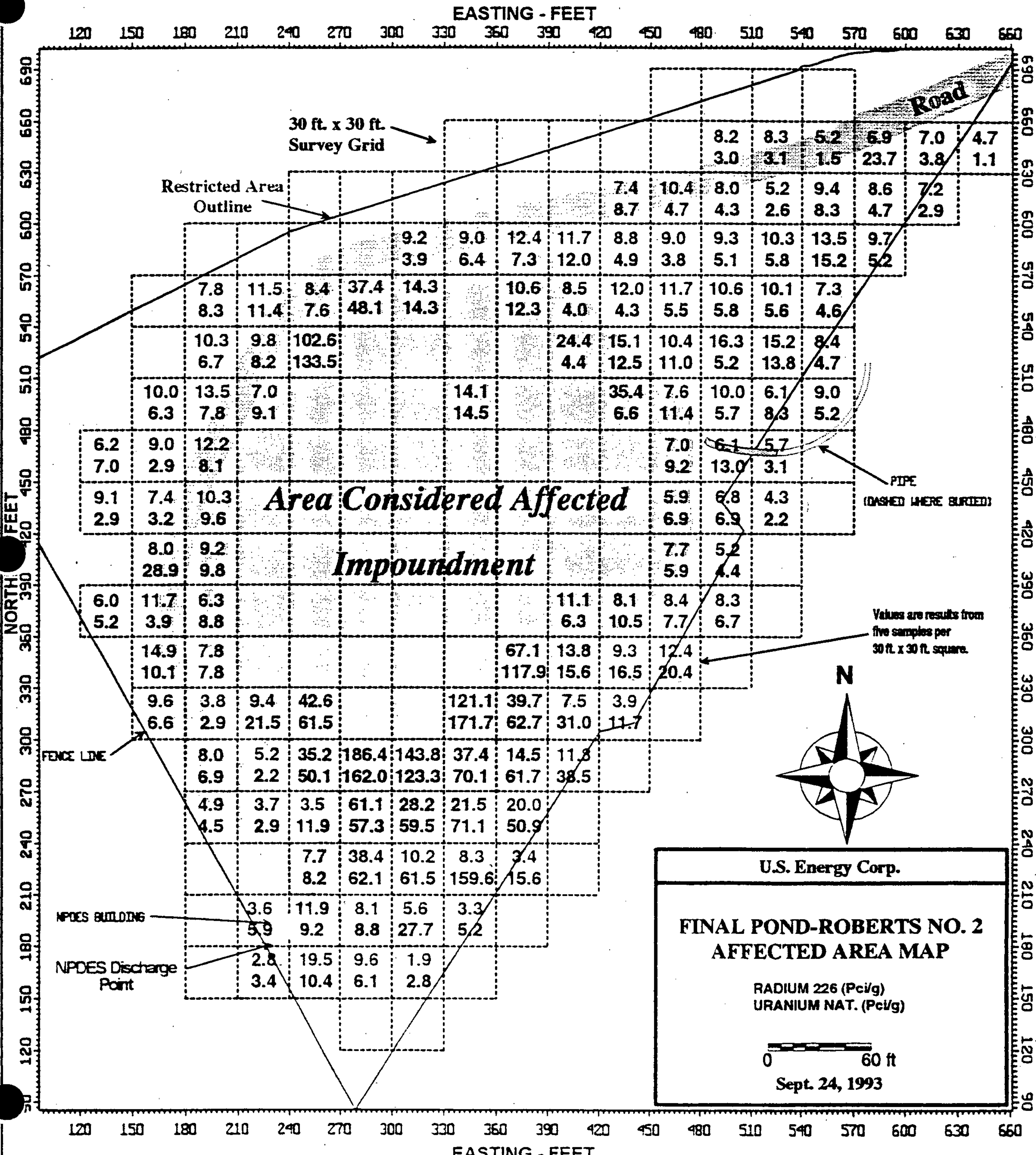
Kenneth Webber

Kenneth Webber
Environmental Coordinator

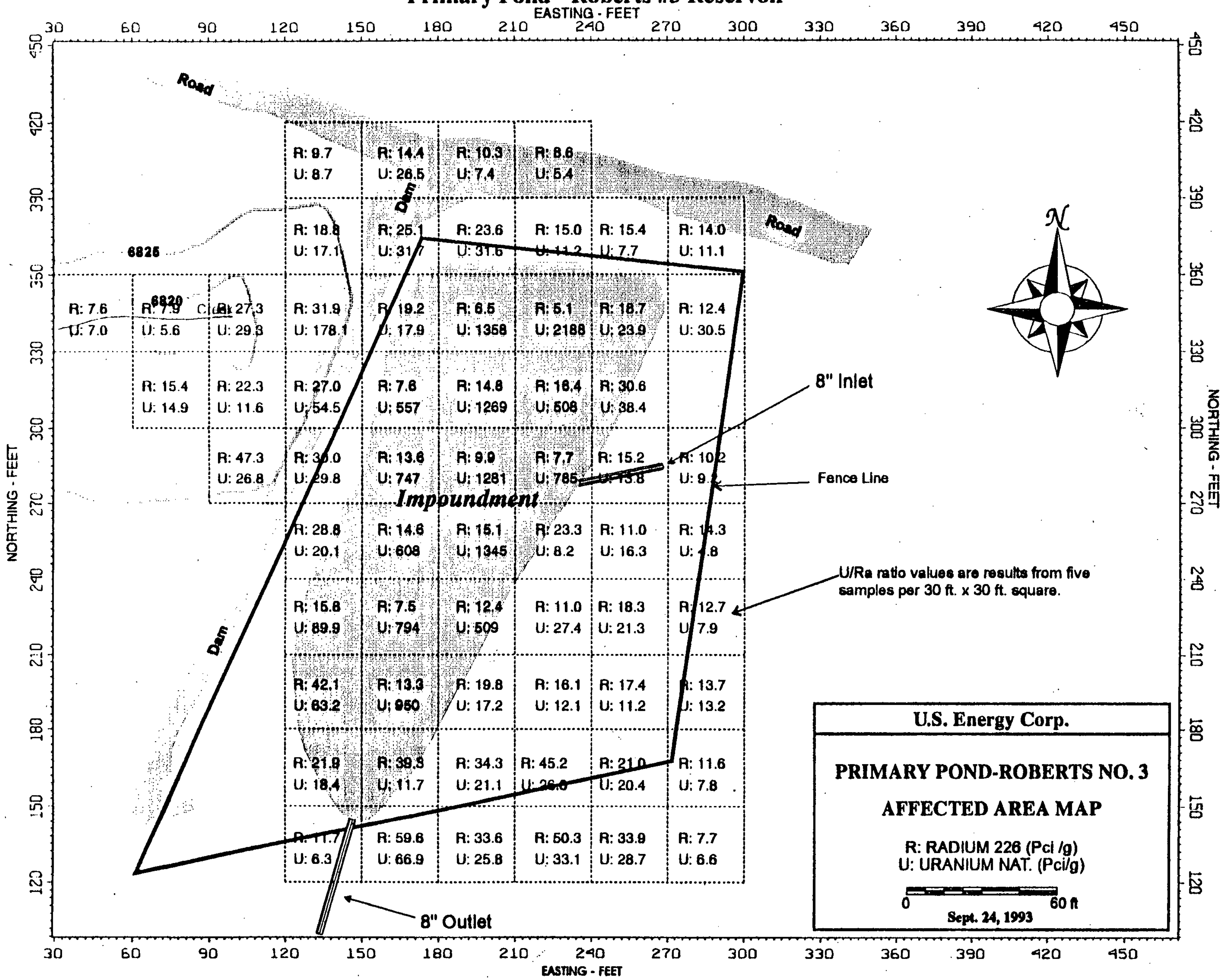
KW/ms

Enc.: Analysis Maps
Final Pond
Primary Pond

U.S. Energy Corp. Green Mountain Ion Exchange
Final Pond - Roberts #2 Reservoir



U.S. Energy Corp. Gre[illegible] Mountain Ion Exchange
Primary Pond - Roberts #3 Reservoir



Appendix 19

U. S. ENERGY / CRESTED CORP.
877 North 8th West (307) 856-9271 Riverton, Wyoming 82501

March 6, 1995

Mr. James Park
Nuclear Regulatory Commission
High Level Waste & Uranium Recovery Projects Branch
11545 Rockville Pike
Rockville, MD 20850

Re: Docket No. 40-8971
SUA-1524 GMIX Decommissioning

Dear Mr. Park:

The following is pursuant to your request to sample a known contaminated area at the GMIX facility for Ra226 and Uranium. We have investigated the possibility of obtaining a viable sample of material that may have deposited in the drainage pipe from the IX plant to the Primary Pond. No sample could be obtained since the pipe was clean.

I have discussed the possibility of any past spills or known contaminated areas with past employees of the facility. There are no known contaminated locations other than the sludge within the high water line of the Primary and Final Ponds and equipment, etc. within the IX building.

In discussing the ratio U/Ra with Mr. McKinney, it was decided the next step would be to sample the sludge areas within the Primary and Final Ponds. The sampling will be delayed as the reservoirs still contain snow and ice. Sampling will be initiated as soon as the condition improves.

<u>GMIX Plant Area</u>

The only area outside the IX building that could be considered as contaminated from IX activity would be the soil where the Bison Basin contaminated equipment is stored. Even sampling this area didn't show any relationship to the Ra and U analyses or the U/Ra ratio from other areas as shown on the attached Appendices 17 and 21.

FAX (307) 857-3050

Primary Pond Area

We have a U/Ra ration of 0.34 in an uncontaminated are (circled on Appendix 19A) and still in proximity to the impoundment which would establish a realistic baseline value. It appears from the U/Ra ratios as illustrated on the attached Appendix 19A, that less than 0.34 should be considered contaminated.

The high 5.6 ratio is located on the dam and consists of site material that was used in construction of the dam. The dam material was evidently obtained from a location that contained some uranium mineralization. From data submitted to date and illustrated on Appendix 19A, there would be one area (circled) that would require sludge removal. It is expected that more areas requiring sludge removal will be determined after the additional sampling of the affected area is completed.

Final Pond

Less than 0.23 U/Ra ratio should be considered contaminated in this pond. See Appendix 20A which illustrates the 0.23 U/Ra ratio location with a circle. This area is remote from the affected impoundment and considered to be uncontaminated ground. From the data submitted and illustrated on Appendix 20A there would be two survey blocks (circled) that would require sludge removal. It is expected that more areas for sludge removal will be determined after sampling the affected area is completed.

It should be noted that the background samples as illustrated on the decommissioning plan, Appendix 16, had a U/R ration range of 0.33 to 2.10. The 0.33 U/Ra ration was BKG sample location No. 8 which was immediately adjacent to the Final Pond. this could further substantiate clean up target values, ie. the less than 0.23 ration and less than 0.34 ration discussed in the preceding paragraphs.

We appreciate your assistance in this matter and if you are in need of any additional information, please advise.

Yours truly,

Kenneth Webber

Kenneth Webber,
Environmental Coordinator

KW/sm

U. S. ENERGY / CRESTED CORP.
877 North 8th West (307) 856-9271 Riverton, Wyoming 82501

November 16, 1993

Mr. Ramon E. Hall, Director
Uranium Recovery Field Office
U.S. Nuclear Regulatory Commission
P. O. Box 25325
Denver, CO 80225

RE: Docket No. 40-8971
License No. SUA-1524
Green Mountain Ion Exchange Decommissioning Plan

Dear Mr. Hall:

Enclosed is the TCLP analysis to be inserted into Appendix 24 of the above referenced Green Mountain Ion Exchange Decommissioning Plan dated September 1993 and submitted to you on September 29, 1993. These results are for the Primary Settling Pond and the Secondary (Final) Settling Pond. As expected, all results obtained were below the regulatory limits for regulated Hazardous substances.

Please contact me if you have any questions.

Sincerely,

Kenneth Webber,
Environmental Coordinator

KW:gd

enclosure
cc: George Worman, Kennecott Uranium Company
GMIX\NRC11-16.93

FAX (307) 857-3050

ENERGY LABORATORIES

ENERGY LABORATORIES, INC.
P.O. BOX 3258 • CASPER, WY 82602 • PHONE (307) 235-0515
254 NORTH CENTER, SUITE 100 • CASPER, WY 82601 • FAX (307) 234-1639

LABORATORY REPORT- TOXICITY CHARACTERISTIC LEACHING PROCEDURE

Client: US Energy **Sample Date:** 07-12-93

Sample ID: Primary Settling **Report Date:** 09-29-93

ELI #: 93-28672

METALS

	CAS #	Regulatory Limit, mg/l	Min. Report Limit, mg/l	Result, mg/l in Extract
Extraction Date:	07-19-93			
Arsenic	7440-38-2	5.0	0.50	<0.50
Barium	7440-39-3	100.0	10.0	<10.0
Cadmium	7440-43-9	1.0	0.10	<0.10
Chromium	7440-47-3	5.0	0.50	<0.50
Lead	7439-92-1	5.0	0.50	<0.50
Mercury	7439-97-6	0.20	0.02	<0.02
Selenium	7482-49-2	1.0	0.10	<0.10
Silver	7440-22-4	5.0	0.50	<0.50

REPORT APPROVED BY: R.A. Leaking

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LABORATORY REPORT- TOXICITY CHARACTERISTIC LEACHING PROCEDURE

Client: US Energy — **Sample Date:** 07-12-93

Sample ID: Primary Settling — **Report Date:** 09-29-93

ELI #: 93-28672

VOLATILE ORGANICS from ZERO HEAD SPACE EXTRACTION

	CAS #	Regulatory Limit, mg/l	Min. Report Limit, mg/l	Result, mg/l in Extract
Extraction Date:	07-17-93			
Benzene	71-43-2	0.50	0.010	<0.010
Carbon Tetrachloride	56-23-5	0.50	0.010	<0.010
Chlorobenzene	108-90-7	100.0	0.010	<0.010
Chloroform	67-66-3	6.0	0.010	<0.010
1,4-Dichlorobenzene	106-46-7	7.5	0.010	<0.010
1,2-Dichloroethane	107-06-2	0.50	0.010	<0.010
1,1-Dichloroethene	75-35-4	0.70	0.010	<0.010
Methyl Ethyl Ketone	78-93-3	200.0	0.250	<0.250
Tetrachloroethene	127-18-4	0.70	0.010	<0.010
Trichloroethene	79-01-6	0.50	0.010	<0.010
Vinyl Chloride	75-01-4	0.20	0.010	<0.010

* Method 1311 Mathematics Performed as Necessary

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LABORATORY REPORT- TOXICITY CHARACTERISTIC LEACHING PROCEDURE

Client:	U.S. Energy	Sample Date:	07-12-93
Sample ID:	Primary Settling	Report Date:	09-29-93
ELI #:	93-28672	Date Analyzed:	07-29-93

BASE NEUTRAL ORGANICS

	CAS #	Min. Report Limit, µg/l	Result, µg/l in Extract
Extraction Date:	07-26-93		
1,4-Dichlorobenzene	106-46-7	50	<50
Hexachloroethane	67-72-1	50	<50
Nitrobenzene	98-95-3	50	<50
Hexachlorobutadiene	87-68-3	50	<50
Pyridine	110-86-1	50	<50
2,4-Dinitrotoluene	121-14-2	50	<50
Hexachlorobenzene	118-74-1	50	<50
o-Cresol	95-48-7	50	<50
m,p-Cresol	108-39-4,106-44-5	50	<50
2,4,6-Trichlorophenol	88-06-2	50	<50
2,4,6-Trichlorophenol	95-95-4	50	<50
Pentachlorophenol	87-86-5	250	<250

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LABORATORY REPORT- TOXICITY CHARACTERISTIC LEACHING PROCEDURE

Client: US Energy

Sample ID: Secondary Settling

ELI #: 93-28671

Sample Date: 07-12-93

Report Date: 09-29-93

METALS

	CAS #	Regulatory Limit, mg/l	Min. Report Limit, mg/l	Result, mg/l in Extract
Extraction Date:	07-19-93			
Arsenic	7440-38-2	5.0	0.50	<0.50
Barium	7440-39-3	100.0	10.0	<10.0
Cadmium	7440-43-9	1.0	0.10	<0.10
Chromium	7440-47-3	5.0	0.50	<0.50
Lead	7439-92-1	5.0	0.50	<0.50
Mercury	7439-97-6	0.20	0.02	<0.02
Selenium	7482-49-2	1.0	0.10	<0.10
Silver	7440-22-4	5.0	0.50	<0.50

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LABORATORY REPORT- TOXICITY CHARACTERISTIC LEACHING PROCEDURE

Client: US Energy | Sample Date: 07-12-93

Sample ID: Secondary Settling | Report Date: 09-29-93

ELI #: 93-28671

VOLATILE ORGANICS from ZERO HEAD SPACE EXTRACTION

	CAS #	Regulatory Limit, mg/l	Min. Report Limit, mg/l	Result, mg/l in Extract
Extraction Date:	07-17-93			
Benzene	71-43-2	0.50	0.010	<0.010
Carbon Tetrachloride	56-23-5	0.50	0.010	<0.010
Chlorobenzene	108-90-7	100.0	0.010	<0.010
Chloroform	67-66-3	6.0	0.010	<0.010
1,4-Dichlorobenzene	106-46-7	7.5	0.010	<0.010
1,2-Dichloroethane	107-06-2	0.50	0.010	<0.010
1,1-Dichloroethene	75-35-4	0.70	0.010	<0.010
Methyl Ethyl Ketone	78-93-3	200.0	0.250	<0.250
Tetrachloroethene	127-18-4	0.70	0.010	<0.010
Trichloroethene	79-01-6	0.50	0.010	<0.010
Vinyl Chloride	75-01-4	0.20	0.010	<0.010

* Method 1311 Mathematics Performed as Necessary

REPORT APPROVED BY: R.A. Searling

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LABORATORY REPORT- TOXICITY CHARACTERISTIC LEACHING PROCEDURE

Client:	U.S. Energy	**Sample Date:**	07-12-93
Sample ID:	Secondary Settling	**Report Date:**	09-29-93
ELI #:	93-28671	**Date Analyzed:**	07-29-93

BASE NEUTRAL ORGANICS

	CAS #	Min. Report Limit, µg/l	Result, µg/l in Extract
Extraction Date:	07-26-93		
1,4-Dichlorobenzene	106-46-7	50	<50
Hexachloroethane	67-72-1	50	<50
Nitrobenzene	98-95-3	50	<50
Hexachlorobutadiene	87-68-3	50	<50
Pyridine	110-86-1	50	<50
2,4-Dinitrotoluene	121-14-2	50	<50
Hexachlorobenzene	118-74-1	50	<50
o-Cresol	95-48-7	50	<50
m,p-Cresol	108-39-4,106-44-5	50	<50
2,4,6-Trichlorophenol	88-06-2	50	<50
2,4,6-Trichlorophenol	95-95-4	50	<50
Pentachlorophenol	87-86-5	250	<250

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LABORATORY REPORT- TOXICITY CHARACTERISTIC LEACHING PROCEDURE

Client: U.S. Energy
Sample Date: 07-12-93

Sample ID: Method Blank
Report Date: 09-29-93

ELI #:
Date Analyzed: 07-29-93

BASE NEUTRAL ORGANICS

	CAS #	Min. Report Limit, µg/l	Result, µg/l in Extract
Extraction Date:	07-26-93		
1,4-Dichlorobenzene	106-46-7	50	<50
Hexachloroethane	67-72-1	50	<50
Nitrobenzene	98-95-3	50	<50
Hexachlorobutadiene	87-68-3	50	<50
Pyridine	110-86-1	50	<50
2,4-Dinitrotoluene	121-14-2	50	<50
Hexachlorobenzene	118-74-1	50	<50
o-Cresol	95-48-7	50	<50
m,p-Cresol	108-39-4,106-44-5	50	<50
2,4,6-Trichlorophenol	88-06-2	50	<50
2,4,6-Trichlorophenol	95-95-4	50	<50
Pentachlorophenol	87-86-5	250	<250

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SOILS ANALYSIS REPORT - US ENERGY

Project: SWEETWATER

Sample I.D.:	Secondary Settling	Primary Settling	
Sample Date:	07-12-93	07-12-93	
Report Date:	09-29-93	09-29-93	
Sample Number:	93-28671	93-28672	Det.Limit
RADIOMETRIC pCi/g:			
U	230	515	0.0003
Ra226	6.4	8.6	0.2
Ra Prec. +/-	0.2	0.3	
Ra228	0.3	0.4	1.0
Ra Prec. +/-	0.1	0.1	
Pb210	39.5	29.5	1.0
Pb Prec. +/-	2.0	1.8	
Po210	172	213	1.0
Po Prec. +/-	4.8	5.4	
Gross Alpha	79.1	236	1.0
Alpha Prec. +/-	8.9	15.4	
Gross Beta	418	933	1.0
Beta Prec. +/-	20.4	30.5	
Th230	31.1	55.7	1.0
Th Prec. +/-	2.1	3.2	

REPORT APPROVED BY: R.A. Learling

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ELI

QUALITY ASSURANCE REPORT– Us Energy
Report Date: 10–04–93
Project: Sweetwater
ELI #(s): 28671–72

TRACE METALS mg/L:	METHOD	Dup #1 %	Dup #2 %	Spk #1 %	Spk #2 %	ANALYST	DATE SAMPLE ANALYZED
Arsenic	EPA–206.3	100	–	100	–	CP	08–02–93
Barium	EPA–200.7	100	–	100	–	TS	07–21–93
Cadmium	EPA–200.7	100	–	99	–	TS	07–21–93
Chromium	EPA–200.7	100	–	100	–	TS	07–21–93
Lead	EPA–239.2	100	–	98	–	TS	07–21–93
Mercury	EPA–245.2	100	–	100	–	CP	08–02–93
Selenium	EPA–270.3	100	–	104	–	CP	07–30–93
Silver	EPA–200.7	100	–	87	–	TS	07–21–93
RADIOMETRIC:							
Uranium	EPA–908.1	99	–	–	–	DB	07–28–93
Ra226	EPA–903.0	100	–	101	–	DB	07–30–93
Ra228	EPA–904.0	100	–	–	–	DB	08–06–93
Lead 210	NERHL–65–4	100	–	85	–	DB	08–02–93
Gross Alpha	EPA–900.0	101	–	–	–	DB	07–23–93
Gross Beta	EPA–900.0	–	–	106	–	DB	07–23–93
Polonium 210	RM03008 USAEC 1970.	116	–	–	–	DB	08–07–93

USEPA–ESML–LV INTERCOMPARISON STUDY RESULTS

Radiometric	Method	ELI Value	Standard	Difference	Analyst	Date
Uranium	EPA–908.1	14.59	17.07	–2.48	DB	02–12–93
Ra226	EPA–903.1	12.88	12.54	0.34	DB	03–05–93
Ra228	EPA–904.1	14.55	13.73	0.82	DB	03–05–93
Gross Alpha	EPA–900.0	20.53	31.5	–10.97	DB	01–29–93
Gross Beta	EPA–900.0	46.33	60.7	–14.37	DB	01–29–93

VOLATILE ORGANICS FROM ZERO HEAD SPACE EXTRACTION

	Spike Conc, mg/L:	Spike % Recovery	Spike % Recovery	Spike % Recovery	Spike % Recovery	QC LIMITS	ANALYST
ELI Sample Number:		93:28671	93:28672	–	–		
Extraction Date:		07–12–93	07–12–93	–	–		
Analysis Date:		07–22–93	07–22–93	–	–		
Benzene	0.050	102	100	–	–	±30%	SEC
Carbon Tetrachloride	0.050	89	104	–	–	±30%	SEC
Chlorobenzene	0.050	109	103	–	–	±30%	SEC
Chloroform	0.050	122	114	–	–	±30%	SEC
1,4–Dichlorobenzene	0.050	95	96	–	–	±30%	SEC
1,2–Dichloroethane	0.050	102	92	–	–	±30%	SEC
1,1–Dichloroethene	0.050	103	103	–	–	±30%	SEC
Methyl Ethyl Ketone	0.550	106	81	–	–	±30%	SEC
Tetrachloroethene	0.050	119	117	–	–	±30%	SEC
Trichloroethene	0.050	102	103	–	–	±30%	SEC
Vinyl Chloride	0.050	81	82	–	–	±30%	SEC
SURROGATE RECOVERY:							
1,2–Dichloroethane–d4		81	118	–	–	±20%	SEC
Toluene–d8		80	87	–	–	±20%	SEC
Bromofluorobenzene		98	101	–	–	±20%	SEC

Report Approved By: BB Rea

dmc 93:28671–72

REPORT DISTRIBUTION

		date.
#1	NRC	SEPT. 29, 1993
2	NRC	SEPT. 29, 1993
3	NRC	SEPT 29, 1993
4	NRC	SEPT 29, 1993
5	WORMAN/PAULSON	SEPT. 30, 1993
6	DEQ-LQD	SEPT. 30, 1993
7	DEQ-WQD	SEPT 30, 1993
8	BLM.	SEPT. 30, 1993
9	USE-GMIX-POWELL	OCT. 1, 1993
10.	U.S.E OFFICE	*

Jack!

This is the office copy for your review — Note the organization Chart in Appendix 8.

K 9/30/93

Wipes on Equipment – 1,000 dpm/100 cm² – Mill to do
Alpha Total – Avg - 5,000 dpm/100 cm²
MAX. 15,000 dpm/100 cm² – Calculate cpm.

On Wipe Tests :

Make a 4"x4" Square
Everything over 1000 dpm Cannot be removed.
have to run Removable (wipe test) on everything

U.S. ENERGY CORP.

GREEN MOUNTAIN ION EXCHANGE

SUA - 1524

DECOMMISSIONING PLAN

September 1993

EXECUTIVE SUMMARY

U. S. Energy Corp. wishes to decommission the Green Mountain Ion Exchange and terminate SUA-1524. This document is U.S. Energy Corp.'s decommissioning plan for the facility licensed by SUA-1524 and includes the decommissioning plan, radiation safety program, radiological standard operating procedures and a copy of Kennecott Uranium Company's request for amendment to SUA-1350 (The Sweetwater Uranium Project license) to accept any 11(e)(2) byproduct materials for disposal from the Green Mountain Ion Exchange.

GMIX FACILITY DECOMMISSIONING PLAN
TABLE OF CONTENTS

LIST OF APPENDICES

LIST OF REFERENCES

Partial List

10 CFR 20 - Standards for Protection Against Radiation

10 CFR 40 - Domestic Licensing of Source Material

40 CFR Part 192 - Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings

49 CFR 173 - Shippers - General Requirements for Shipments and Packagings Subpart I, Radioactive Material

DEQ Permit to Mine #381C plus Amendments 1, 2, 3, 4, and 5

DOE Falls County Document - Radiologic Characterization of the Falls City, Texas Uranium Mill Tailings Remedial Action Site

DOE "Hot Spot Memo" - Guideline for Residual Radioactive Materials at Remote Surplus Facilities Management Program (SFMP) Sites

Regulatory Guide 1.86 - "Guidelines for Decontamination of Facility and Equipment Prior to Release for Unrestricted Use and Termination of License for Product, Source or Special Nuclear Material"

Regulatory Guide 8.15 - Acceptable Programs for Respiratory Protection, October 1976

Regulatory Guide 8.22 - Bioassay at Uranium Mills

Regulatory Guide 8.30 - Health Physics Surveys in Uranium Mills

Regulatory Guide 8.31 - Information Relevant to Ensuring That Occupational Radiation Exposures at Uranium Mills Will be As Low As Reasonably Achievable

Regulatory Guide 8.36 - Radiation Dose to the Embryo/Fetus

Regulatory Guide DG-8009

NUREG 0041 - Manual of Respiratory Protection Against Airborne Radioactive Materials

NUREG 5849 - "Manual for Conducting Radiological Surveys in Support of License Termination"

NUREG CR-4118 - "Monitoring Methods for Determining Compliance with Decommissioning Cleanup Criteria at Uranium Recovery Sites"

NUREG CR-4884 - Interpretation of Bioassay Measurements

SUA-1524 - "GMIX Source Material License"

1.0 GENERAL INFORMATION

U.S. Energy Corp. is the holder of an NRC Source Materials License SUA-1524 issued on August 16, 1988, pursuant to Title 10, CFR, Part 40 and in accordance with U.S. Energy's Application for a Source Materials License dated May 23, 1988. The License (Appendix 25) authorizes possession only of byproduct materials in the form of discrete surface wastes, contaminated facilities and contaminated equipment resulting from previous GMIX plant operations by Western Nuclear, Inc. and Pathfinder Mines Corporation and possession of equipment and materials purchased from the Bison Basin facility, located in Central Wyoming when the facility was decommissioned. Applicable license conditions in SUA-1524 are incorporated into the Decommissioning Plan by reference as required.

1.1 Name, Address and License Number

Name:	U.S. Energy Corp.
Address:	877 North 8th West
	Riverton, WY 82501
Contact Name:	Kenneth J. Webber
	Environmental Coordinator/Manager of Lands
License Number:	SUA-1524 with Amendments No. 1, 2, 3 and 5.

License Conditions and Amendments: Conditions 9 through 23 of the above license.

Facility Location and Address

Name:	U.S. Energy Corp.
Address:	Green Mountain Ion Exchange Facility
	10 Miles South of Jeffrey City
	877 North 8th West
	Riverton, WY 82501

1.2 General Description of the Facility and Process

The Green Mountain IX Facility is located approximately 10 miles south of the Jeffrey City, Wyoming in Township 28 North, Range 92 West, Sections 16 and 17 (Appendix 1, Index Map). The Facility includes the GMIX Plant, IX Reservoir, Primary Pond (Roberts #3 Reservoir), Final Pond (Roberts #2 Reservoir) and the associated barium chloride treatment facility (Appendix 2).

Pathfinder Mines Corporation, the last operator of the facility, cleaned the plant and associated equipment, removing radioactive debris in December 1987, and removing all ion exchange resin from the facility, transferring it to the Pathfinder Mill in the Gas Hills of Wyoming. This activity was completed prior to the acquisition of the Facility by U.S. Energy. There is no yellowcake or ion exchange resin on the site.

The Green Mountain IX Plant is designed to recover soluble natural uranium (at about 8 to 20 ppm) from mine discharge water (with a current flowrate of 150 to 350 gpm and maximum flow capacity of about 750 gpm) using one or more ion-exchange columns filled with ion-exchange resin. During operations by Western Nuclear, the U_3O_8 was subsequently stripped from the loaded resin and precipitated from the eluate. This yellowcake slurry was then thickened and shipped in 55-gallon steel drums via truck to the Split Rock Mill for the final processing.

The system consists of six fiberglass ion-exchange columns 10 feet in diameter, each capable of containing 150 cubic feet of ion-exchange resin (see Appendix 3). Feed water was collected from the uranium mines in a main collection pond (IX Reservoir) from which the water was pumped to a steady head tank for feed to the ion-exchange columns. The process makes no change in the feed water other than extracting the dissolved uranium. The net quantity of treated water discharged to the natural drainage was essentially equal to the quantity of mine water produced.

This system was designed to be flexible in its capacity and operation. The maximum annual capacity of the system was approximately 6,000 pounds of U_3O_8 per month. The facility's design prohibited storage of yellowcake at the site. All yellowcake slurry generated by the plant was transferred to the Split Rock Mill as it was produced. The maximum quantity of source material stored at the site did not exceed 6,000 pounds of yellowcake slurry.

2.0 DESCRIPTION OF DECOMMISSIONING ACTIVITIES

2.1 Overview of Decommissioning Activities

U.S. Energy has elected to decommission and dismantle the GMIX Facility and terminate the license. The equipment on site shall be tested for surface contamination to ensure that the levels are at or below criteria set forth in U.S. Nuclear Regulatory Commission's Regulatory Guide 1.86, "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Product, Source, or Special Nuclear Material", included in Appendix 4. Should any equipment fail to meet these above mentioned criteria the equipment will be placed in the Sweetwater Uranium Project tailings impoundment as per the License amendment request and disposal plan included in Appendix 5. During dismantling and decommissioning operations, U.S. Energy shall maintain health physics controls to limit exposure of personnel to levels of radioactivity below those specified in 10 CFR part 20 regulations and shall adhere to the stipulations made in the included Radiation Safety Program and radiological standard operating procedures. U.S. Energy shall also maintain survey data and other records as required to ensure that all materials released for unrestricted use meet the requirements of Regulatory Guide 1.86. All records related to the dismantling and decommissioning shall be maintained by the company in accordance with NRC regulations (specifically 10 CFR 20.401) and State of Wyoming Department of Environmental Quality (WDEQ) regulations. An overview of the major Decommission objectives and activities is included in Appendix 14.

2.2 Specific Decommissioning Objectives and Procedures

Specific decommissioning objectives and activities are discussed below. A detailed description of the past recovery process as it relates to decommissioning methods and ensuring worker health and safety is contained in Section 3.0. Final documentation procedures are described in Section 4.0.

2.2.1 Maintain Programs to Protect Worker Health and Safety

Objective - Maintain health and safety practices to ensure protection of the work force, environment and public. Monitor radiological, chemical and industrial hazards to ensure compliance with applicable health safety and environmental standards.

Activities and Tasks - U.S. Energy's overriding consideration during decommissioning is the protection of worker and public health and safety, and the environment. To ensure that this objective is accomplished, U.S. Energy has prepared a Decommissioning Plan and established safety and monitoring procedures (Appendix 27). Specific tasks involved in ensuring worker and public health and safety are discussed in detail in various sections of this Decommissioning Plan. Table 2.1 lists activities and tasks to be implemented.

2.2.2 Characterize and Delineate Radiological Contamination in the GMIX Facility

Objective - Characterize and delineate equipment and areas which have been shown to have or are likely to have radiological contamination in excess of NRC Regulatory Guide 1.86 "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Product, Source or Special Nuclear Material" criteria for release of facilities and equipment for unrestricted use.

Activity and Tasks - Radiological contamination is in the process of being delineated through actual survey of plant equipment and operational areas. Survey information available has been incorporated in this Decommissioning Plan. The Survey information, in conjunction with knowledge of the GMIX Facility recovery circuit, shall allow the designation of "affected areas" and "unaffected areas" and "affected equipment" and "unaffected equipment" within the plant. Affected areas are those that have potential for radioactive contamination or known radiological contamination. Unaffected areas are all other areas. Maps illustrating the affected and unaffected areas within the GMIX Facilities are inserted in Appendix 21. Affected equipment are those items that have the potential for radioactive contamination or known radioactive contamination. Unaffected equipment is all other equipment which may be released for unrestricted use. This Decommissioning Plan summarizes available survey and process information and accomplishes the objective of preliminary characterization and delineation of contamination at the GMIX Facility.

Monitoring and testing of equipment and materials in affected and unaffected areas will be ongoing during decommissioning.

2.2.3 Disassemble and Dispose of Affected Equipment and Structural Materials

Objective - All materials and plant equipment unreleasable for unrestricted use shall be removed from the site and be placed in the Sweetwater Uranium Project tailings impoundment for disposal.

Equipment released for unrestricted use with potential market value shall be retained by U.S. Energy for use in other mining operations. Materials released for unrestricted use having no potential value shall be placed in a landfill. All contaminated equipment shall be transferred to the Sweetwater Mill Tailings impoundment for disposal as per the request for amendment to SUA-1350 incorporated in Appendix 5.

2.2.4 Building Disassembly (if required) and Related Activities

Objective - Building Disassembly - Determine if the plant building and foundations required dismantling and removal from the site. Survey all building materials and structures for radioactive contamination levels prior to release for unrestricted use. Core holes shall be drilled through the concrete floor and sumps of the building. The cored concrete shall be tested for process contamination (i.e. retained uranium and radium-226) and the soil beneath the concrete shall be tested in fifteen (15) centimeter intervals over a total depth of 75 centimeters for natural uranium and radium-226 to determine if it has been contaminated by seepage from the GMIX. The building interior shall be monitored for radon and ambient gamma radiation to determine if it is in compliance with 40 CFR 192 Subpart B and NUREG-4118. If the building slab and soils beneath the slab are not process contaminated, the building shall be left standing and released for unrestricted use, provided it meets the specific requirements of 40 CFR 192 Subpart B and NUREG CR-4118. If the building, slab and/or underlying soils are found to be contaminated, or if the building is unreleasable due to high ambient gamma radiation or radon level, the building shall be demolished, the slab removed and the underlying soil removed (if contaminated) and all contaminated materials shall be placed in the Sweetwater Uranium Project tailings impoundment. The buildings and foundations shall remain in place if they do not have to be removed in the process of removing equipment contained therein, the building slab and subsoils are found to be uncontaminated and they meet the specific requirements of NUREG-4118 and 40 CFR 192 Subpart B.

Activities and Tasks - Initially, the internal surfaces of building siding and support structures shall be visually assessed to determine areas within the plant which may have become stained or otherwise affected by contact with process solutions. They shall then be tested for fixed or removable surface contamination.

The building itself shall be characterized and delineated. Portions of the building shall be designated affected and unaffected. The appropriate radiological survey techniques and protocol shall be used to further survey building materials, prior to release for unrestricted use. The process of establishing affected versus unaffected areas or zones, and the material and equipment contained within those areas, is based on information contained in Section 3.1 and 3.1.2. Survey methods for radioactive contamination are described in Section 3.3.3.

The building and support structures shall be surveyed for surface contamination and monitored for ambient radon and gamma levels for compliance with 40 CFR 192 Subpart B and NUREG-4118. If the building, slab or subsoils are found to be contaminated or otherwise unreleasable due to radon or gamma radiation, the building shall be dismantled, the slab removed and the subsoils removed. All contaminated materials shall be placed in the Sweetwater Uranium Project tailings impoundment.

The building shall be disassembled (if required) by U.S. Energy personnel or by contract personnel under the supervision of U.S. Energy management, monitored for contamination levels by U.S. Energy personnel, and/or the RSO and ultimately released for unrestricted use. If release is not possible, they shall be placed in the Sweetwater Uranium Project tailings impoundment. Uncontaminated building siding, support structures, steel and other materials shall be retained by U.S. Energy.

2.2.5 Release of Equipment and Materials for Unrestricted Use and Disposal of Contaminated Materials

Objective - The release of equipment and materials for unrestricted use and the disposal of contaminated materials.

Activities and Tasks - All of the contaminated equipment and materials in the GMIX Facility and the contaminated Bison Basin material in the restricted storage area of the GMIX Facility will be transferred to the Sweetwater Mill Tailings impoundment for disposal. Uncontaminated materials shall be released for unrestricted use and land filled or retained by U.S. Energy Corp. No decontamination activities with the exception of decontamination of equipment and tools used in the decommissioning process will take place on-site. All contaminated materials will be placed in the Sweetwater Uranium Project tailings impoundment.

All mobile equipment and tools used on site will be monitored prior to leaving the site to detect any residual radiological contamination. Equipment and tools found to exceed the limits in Regulatory Guide 1.86 "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Product, Source or Special Nuclear Material" shall be decontaminated.

If decontamination is not possible, then they shall be placed in the Sweetwater Uranium Project Tailings impoundment.

2.2.6 Organic Resin

There is no known organic resin at the GMIX Facility. Pathfinder Mines Corporation removed all organic resin at the cessation of its operations in December 1987.

2.2.7 Solvent Organic and Complexing Solution

There is no known solvent or complexing solutions within the GMIX Facility.

2.2.8 Process or Laboratory Chemicals

Objective - The transfer of all reagents and laboratory chemicals remaining on site in conformance with all applicable federal and state regulations pertaining to the transport and disposal of hazardous materials, where applicable.

Activities and Tasks - Laboratory chemicals used by previous owners (such as lab bottles of HCL, H2SO4 etc.) that did not come in contact with the uranium recovery process, and are not contaminated with radionuclides, will be transferred to U.S. Energy's Laboratory in Riverton, Wyoming. Chemicals will be lab packed in appropriate boxes/containers, labeled and transported via motor vehicle to the Riverton Lab. A Bill of Lading documenting the types and quantities of laboratory chemicals transferred will be provided as part of the Final Closure Report.

Most reagents associated with the uranium recovery process have been expended in the course of normal past operations.

2.2.9 Disposal of Wash Water

Objective - Dispose of any decontamination wash solutions in a manner consistent with the protection of the public health and environment.

Activities and Tasks - U.S. Energy will dispose of decontamination wash solutions by pumping the fluid into a water truck and hauling it to the Sweetwater Uranium Project tailings impoundment for disposal. The facility slab is constructed to allow drainage of liquids to a sump. All cleaning solutions will drain to this sump. Any decontamination performed on-site will be done on the bermed concrete slab equipped with a sump.

2.2.10 Identification and Disposal of Radioactive Waste

Objective - Identify and dispose of waste materials contaminated with levels of radionuclides. See Appendix 15 for description, characteristics and estimate of radioactive wastes. U.S. Energy has estimated volumes of waste material from the various areas of the GMIX Facilities. The estimate is based on a survey of the plant, storage yard, IX Reservoir, Primary Pond, the Final Pond and BaCl plant. The quantity is also consistent with U.S. Energy's knowledge of the GMIX Facility. The final volume of waste will depend on actual conditions encountered during decommissioning. Accurate volumes of waste shall be estimated upon receipt of the results of a ten (10) meter grid sampling program conducted from August 4, 1993 to August 12, 1993. The volumes are calculated with reduction of voids considered.

Contaminated Pond Sludge

These sludges come from three (3) IX Reservoir ponds; Roberts Reservoir #3 and Roberts Reservoir #2, used as settling ponds for discharge water treated with barium chloride after the uranium was removed by the ion exchange plant, but prior to final discharge, and the IX Reservoir used for settling of solids from the mine discharge water prior to processing in the plant. The IX Reservoir was contaminated from surface runoff from a mine ore stockpile loading area. The three (3) reservoirs were sampled during August 1993. A ten (10) meter by ten (10) meter grid was laid out over the ponds and five (5) samples were taken of such grid, one in the center and one near each corner (as per instructions received in a telephone conversation with Paul Michaud of NRC/URFO. Roberts Reservoir #3 and Roberts Reservoir #2 were sampled for hazardous materials and tested by Energy Labs Inc. via TCLP procedures. The final results are pending and shall be submitted to NRC/URFO to be included in Appendix 24 upon receipt.

Estimated volume: 5,000 cubic yards

Contaminated Soils

These soils along with sludge from the IX Reservoir were contaminated during the course of operations and shall be removed from around the GMIX site and the IX Reservoir in the course of surface decontamination. The GMIX was constructed on an old mine dump and the IX Reservoir was contaminated from runoff from the old stockpile loading area (see photo in Appendix 2). The area around the GMIX was gridded with a ten (10) meter by ten (10) meter grid. Five (5) samples were taken from each grid, one near each corner and one at the center for a representative sample of the grid. The samples shall be analyzed for radium-226 and natural uranium. Only those grids showing evidence of processing related contamination shall be scraped. Grids contaminated solely by mine waste shall be left undisturbed. The method described in a Department of Energy Report titled "Radiologic Characterization of the Falls City, Texas Uranium Mill Tailings Remedial Action Site" shall be used to separate process contaminated grids from mine waste contaminated grids. The standards used to determine the type of contamination uses natural uranium to radium-226 ratios and, as determined for the Falls City project, are as follows:

U.Nat/Radium-226 greater than 2.0 - mine contamination.
U.Nat/Radium-226 less than 2.0 but greater than 1.5 - probable mine contamination.
U.Nat/Radium-226 less than 1.5 - process contamination

Additional site specific standards shall be employed to determine if specific grids are contaminated by mine waste or by radionuclides from the GMIX. Appendix 12 contains the uranium and radium analyses and location maps for the eleven grid samples taken from nearby mine dumps which contain only mine waste and are free of any contamination from the GMIX. Samples were taken within each grid. The average uranium/radium ratio for these dumps is 2.47. The ratios vary from 0.6 to 5.2. Thus, individual grids could contain only mine waste and still exhibit uranium/radium ratings of as low as 0.6, well below the uranium/radium ratio of 1.5 defined as the upper limit of process contamination in the DOE document on the Falls City, Texas site.

Due consideration shall be given to the above facts in determining if a given grid is process contaminated or merely mine waste contaminated. The site specific data in the form of the eleven mine dump samples shall be utilized to establish site specific criteria to determine if a given grid is process contaminated. The uranium/radium ratios used in this site specific determination shall be 0.6, which is lower than the value of 1.5 used as the upper limit and equal to the 0.6, indicative of a tailings deposit, for process contamination described in the DOE Falls City, Texas site report.

Grids with isolated "hot spots" shall be handled according to the "U.S. Department of Energy Guidelines for Residual Radioactive Materials at Remote Surplus Facilities Management Program (SFMP) Sites" included in Appendix 26.

Only process contaminated grids shall be scraped.

Estimated Volume: 1,000 cubic yards

Contaminated Equipment (pipes, tanks, pumps, etc.)

The equipment on site shall be tested for surface contamination. Equipment that is releasable in accordance with Regulatory Guide 1.86 "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct or Source Materials" dated September 1984, shall be released. Equipment that is unreleasable shall be disposed of in the Sweetwater tailings impoundment. The following list is a list of the equipment on site involved in the process that could be contaminated and require disposal. Some of these items may in fact meet the release limits and as such, would not require disposal, but would be released for unrestricted use.

Equipment	Size	Quantity
Ion Exchange Column	8' dia. x 10' high	6
Stripping Tank	8' dia. x 10' high	3
Precipitation Tank	8' dia. x 10' high	2
Recycle Pump		2
Feed Pump		2
Ammonia Storage Tank	500 gallon	1
Acid Tank	2000 gallon	1
$BaCl_2$ Tank	4' dia. x 4' high	2
Air Compressor		1

Structural Materials
Pipe (including pipe stacked in the yard which originally came from Bison Basin)

Valves, pumps, motors fittings and other miscellaneous items including pumps and other materials originally from Bison Basin

Estimated volume: 300 cubic yards

Contaminated buildings, concrete, structural materials, subsoils and other items normally associated with the operation of the ion exchange and barium chloride plants

This category includes the following items:

40' x 60' x 20' building 1
24' x 24' x 12' building 1
Concrete slab material
Subsoils (beneath concrete slab)

Estimated volume: 1,000 cubic yards

The total volume of contaminated material is estimated to be 7,300 cubic yards.

Disposal of Waste in a Nuclear Regulatory Commission Licensed Facility

Kennecott Uranium Company, Sweetwater Uranium Project has applied for an amendment through the Nuclear Regulatory Commission to accept for disposal 11(e)2 material originating from the GMIX Facility. A letter to the NRC/URFO dated July 21, 1993 is included in Appendix 5 as documentation.

Disposal of GMIX materials at the Sweetwater Mill is the best option available to U.S. Energy. It is the most cost effective option and technically superior option since the GMIX wastes are: 1) 11(e)(2) byproduct material, as are wastes in the Sweetwater Uranium Project tailings impoundment; 2) similar in radiological character; 3) similar to wastes from the decommissioning of the Bison Basin Project which were placed in the Sweetwater Uranium Project tailings impoundment in 1989 under a separate license amendment.

The Sweetwater Uranium Project tailings impoundment is the closest open disposal site to the GMIX. No materials which are classified as hazardous waste under RCRA shall be placed in the Sweetwater tailings impoundment. Sludge from THE IX settling pond, primary settling pond and the final settling pond have been submitted to Energy Labs Inc. for TCLP testing. The results are pending and shall be submitted upon receipt by U.S. Energy.

2.2.11 Background Surveys

On July 12, 1993 ten (10) soil samples were collected in the vicinity of the GMIX Facility. These samples were taken in undisturbed areas up-slope/up-drainage of the Facility. The samples were analyzed by Energy Labs, Inc. of Casper, Wyoming for Radium-226 and Natural Uranium. . The sample locations were marked for future reference with stakes and located on the map entitled **U.S. Energy Corp. Green Mountain Ion Exchange - Decommissioning Map: Background Samples Locations**. The soil samples were taken of the upper fifteen (15) centimeters of soil. The location map with analysis results is included in Appendix 16.

On July 28, 1993 gamma readings were taken by George Worman, Facility Radiation Safety Officer, using a Ludlum Model 12S Micro R Meter (Serial Number 11816) calibrated on July 26, 1993 by Energy Labs, Inc., at these ten (10) background sites. These reading were taken approximately one (1) meter above ground surface. See Appendix 16. The readings are shown on the map titled Background Sample Locations in Appendix 16.

Eleven (11) additional samples were taken of nearby mine dump piles to gain information concerning mine related contamination since the GMIX plant was constructed on an old mine dump. The sample results are in the chart below. The assay sheet is in Appendix 23.

Mine Dump Sample Results

Dump Name	Uranium (Nat) (pCi/gr)	Radium-226 (pCi/gr)	Uranium/Radium
Reserve Dump #1	86.6	131.3	0.65
Reserve Dump #2	211.5	41.8	5.2
Reserve Dump #3	75.4	70.1	1.0
Sheep Dump #1	277.5	229.3	1.2
Sheep Dump #2	738.1	444.6	1.6
Sheep Dump #3	749.9	1308.1	0.6
GM Mine Dump #1	32.1	41.5	0.8
GM Mine Dump #2	110.7	79.7	1.4
GM Mine Dump #3	275.2	144.3	1.9
Seismic #1	287.0	126.3	2.3
Seismic #2	427.5	91.0	4.7

These dump pile samples exhibit uranium/radium ratios as low as 0.6, which are clearly related solely to mine wastes. The average uranium/radium ratio is 2.47.

2.2.12 Survey and Identification of Radiologically Contaminated Soils and Concrete

Objective - Identify and remove contaminated soils and concrete from the GMIX operations sites. Survey the entire operations area to document decontamination. Regrade the surface, seed with grasses and document all decommissioning activities in a Final Survey Report to the WDEQ and NRC/URFO.

Activities and Tasks - All concrete originating from affected areas will be surveyed for alpha contamination. Measurements will be taken on all surfaces (bottom, top and sides) at a frequency of one measurement per meter squared top surface area. The concrete shall be drilled and samples of soil beneath the concrete shall be taken at fifteen (15) centimeter intervals to a depth of seventy-five (75) centimeters and tested for radium-226 and natural uranium, sampled on a 10 meter by 10 meter grid. If process contaminated soils are found beneath the concrete, the concrete shall be removed and the contaminated soils shall be removed and placed in the Sweetwater tailings impoundment. All concrete, buildings and equipment meeting criteria for unrestricted use shall remain in place and on site to be used in future mining activities provided that the underlying subsoils are not contaminated. Concrete and/or subsoils not meeting criteria for release for unrestricted or otherwise contaminated use shall be transported to the Sweetwater Uranium Project tailings impoundment for disposal. After excavation of concrete, the entire operations area will be surveyed using a Ludlum Model 12S Micro-R-Meter, or equal, and sampled on a ten (10) meter by ten (10) meter grid with five (5) samples taken, one near each corner and one from the center composite for each grid. Particular attention will be given to areas underlying former plant sumps and areas showing any unusual visual alteration to the subsurface.

Soils and sludge samples shall be analyzed for U-nat and Ra-226 to ensure identification of process contaminated soils. Process contaminated soils shall be excavated and transported to the Sweetwater Uranium Project tailings impound for disposal. When the operations area has been thoroughly surveyed and all contaminated concrete, soils and/or sludge have been removed, the final radiological survey of the operations area shall be performed. The final radiological survey shall be performed over the entire area within the respective restricted area boundaries. These areas shall be surveyed using a fixed grid on ten (10) meter centers as included in Appendix 6. A survey shall also be performed using a gamma scintillator. Details of the survey are discussed in Section 4.0. The Final Survey Report will be prepared and submitted as described in Section 4.0.

2.2.13 Disposal Plan for IX Waste

Task #1 Loading, Covering and Preparation

The contaminated materials including soil, sludge, pipe, pumps, concrete, debris, building materials, tanks and other material shall be loaded on trucks at the GMIX Facility. Materials such as PVC pipe and other readily crushable items shall be crushed prior to loading to meet the requirements of Kennecott Uranium Company's Standard Operating Procedure, "Reduction of Voids in Material Placed in the Tailings Cell for Disposal".

The trucks shall be covered and the transportation of the material shall comply will all applicable regulations, including but not limited to, 49 CFR 173 Subpart I. Each truck shall have a Bill of Lading. The trucks shall be inspected for proper loading and road worthiness prior to leaving the restricted area. The results of the inspections shall be documented. The trucks shall be monitored with an alpha meter for surface contamination prior to leaving the restricted area of the GMIX Facility. If a truck is found to be contaminated, it shall be decontaminated using scrub brushes, soap and water, prior to leaving the restricted area. A log of the monitoring results shall be maintained a the GMIX Control Center.

Each truck shall carry a Spill Contingency Plan and a Spill Kit, consisting of basic equipment such as disposable coveralls, rubber gloves, respirators, rubber boots, a plastic tarpaulin, large nails, a hammer, shovels and flagging for use by the driver prior to the arrival of U.S. Energy and Kennecott Uranium Company personnel, who shall perform the actual cleanup. Each truck shall be equipped with a mobile radio or radiotelephone so U.S. Energy and/or Kennecott Uranium Company can be notified in the event of a spill or other problems. a radio, radio telephone or regular telephone shall be set up in the Control Center to enable U.S. Energy personnel to notify personnel at the Sweetwater Mill of a truck's departure and estimated time of arrival at the Sweetwater Mill.

Task #2 Transportation

The trucks shall travel to the disposal site (Sweetwater Mill tailings impoundment) via the following route, which is also shown on the map in Appendix 6.

U.S. Energy Mine Road

The trucks shall leave the GMIX Facility restricted area via the U.S. Energy mine road and travel approximately 1.25 miles west to the junction with the Crooks Gap Road (Fremont County Road #FR-318), which is also known as the Wamsutter to Jeffrey City Road. this road is known as Sweetwater County road #23 when it crosses into Sweetwater County.

Fremont County Road #FR-318/Sweetwater County Road #23

The trucks shall turn left (south) onto Fremont County Road #FR-31 and proceed south along this road crossing into Sweetwater County where the road becomes Sweetwater County Road #23 for a distance of approximately thirty (30) miles.

Sweetwater County Road #63

The trucks shall turn left (east) onto Sweetwater County Road #63, travel on this road for a distance of approximately three (3) miles to the junction with the mine access road. the truck would then turn left (north) onto the mine access road, proceeding north along this road through the restricted area gate. Each truck shall be logged in and weighed on the truck scale at the Sweetwater Mill. This scale was calibrated by the State of Wyoming Department of Agriculture on April 28, 1993. A Disposal Log Book shall be maintained at the Sweetwater Mill for any wastes placed in the Sweetwater Mill tailings impoundment for disposal. The following data concerning the load of waste shall be recorded in the Disposal Log Book:

a) Date
b) Load number
c) Weight ticket number
d) Load description
e) Truck time in
f) Truck time out
g) Loaded weight
h) Empty weight
i) Estimated volume
j) Hauler
k) Driver's name
l) Location unloaded
m) Alpha scan results
n) Corrective action/decontamination performed (if any)
o) Name of individual completing alpha scan

The trucks shall then proceed to the tailings impoundment, up the tailings impoundment's external ramp and onto the embankment road.

Task #3 Disposal

The trucks shall proceed down the ramp into the tailings impoundment. It is anticipated that most of the materials will be dumped into the impoundment at that location. Some sludge may be slurried with tailings fluid and sluiced into the impoundment. Some tanks and other items may be placed along the ramp in the impoundment's northwest corner for storage, pending final disposition. This area along the ramp is designated as an "authorized holding are for contaminated equipment awaiting final disposition".

All materials and items other than:

a) sludge, soils, concrete and solid items; and
b) items already crushed at the GMIX Facility to meet void reduction requirements,

shall be handled according to Kennecott Uranium Company's standard operating procedure for reduction of voids in material placed in the tailings impoundment. A copy of this Standard Operating Procedure is attached to this Disposal Plan. Material shall be accepted for disposal from 8:00 a.m. to 3:00 p.m. on Monday through Friday.

Task #4 Leaving the Site

After the truck has completed unloading it shall proceed to the truck scales to be weighed and checked for surface contamination prior to leaving the Sweetwater Mill restricted area. If the truck is found to be contaminated it shall be decontaminated by returning to the tailings impoundment to be washed down, using scrub brushes and soap and water from the TMW-18 pumpback well, until the surface contamination is removed. The empty wight of the truck, results of the survey and any required decontamination shall be recorded in the Disposal Log Book. The truck shall then leave the restricted area and return to the GMIX Facility.

2.2.14 Site Reclamation

<u>Objective</u> - Return the site to an erosional stable condition for unrestricted use.

<u>IX Plant Area:</u>
The GMIX restricted area lies in part on the dump of the old Ravine Mine which was operated in the 1950-1960s. Some of the area qualifies for AML funding. If the building, concrete and subsoils meet the requirements of Regulatory Guide 1.86 <u>"Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Product, Source or Special Nuclear</u>

Material", are otherwise uncontaminated and meet the requirements of 40 CFR 192 Subpart B and NUREG-4118, the building shall be left in place and released for unrestricted use. If this cannot be accomplished, the IX equipment and buildings will be dismantled and the contaminated materials shall be transferred to the Sweetwater Uranium Project tailings impoundment for disposal.

All soils and concrete slabs and foundations contaminated by the operations of the IX Facility shall be removed and after final survey has been performed, will be graded for erosion stability, topsoiled and seeded. Uncontaminated concrete will remain (provided the underlying soils are not process contaminated) and be covered with a minimum of four (4) feet of suitable overburden, topsoiled and seeded. Topsoil and seed shall be applied as described for the ponds and reservoirs.

Ponds and Reservoirs

The drainage reclamation re-establishment for Hanks Draw, IX Reservoir, Primary Pond (Roberts Reservoir #3) and the Final Pond (Roberts Reservoir #2) is included in the WDEQ Mine Permit 381C with Amendments A-1 through-5. Sludge shall be removed from the above reservoirs. The reservoirs and dam structures meeting criteria for unrestricted use shall remain. These impoundments are a part of the mine discharge system and may be used in future operations.

After sludge is removed, the disturbed areas will be stabilized by seeding. The affected areas shall be disked to a depth of 12 inches to prepare a seed bed. The affected area will be evaluated by a soil scientist to determine if topsoil is required, and if required, twelve inches of topsoil shall be placed over the disked area. The affected area will be broadcast seeded and raked immediately after topsoil placement or disking. Seeding will be performed in the fall, probably in October, but not when the ground is frozen. The following seed mixture used in the Mine Permit Area will be planted at the rates shown:

	PLS/Acre
Sand Dropseed	3.0
Streambank Wheatgrass	7.5
Indian Ricegrass	1.5
Slender Wheatgrass	9.0
Antelope Bitterbrush	3.0
	24.0

Mulch shall be applied to the affected areas to retain moisture and to control erosion. A dry mulch consisting of native hay or small-grain straw shall be applied uniformly at a rate of 1-1/2 tons per acre. The mulch shall be anchored with an agricultural disk.

2.3 Decommissioning Schedule

Decommissioning activities shall be intermittent once commenced and are projected to extend over a two year period. Appendix 7 illustrates major activities and estimated time frames for completion. Operations shall be discontinued during the winter months. Radiation safety and monitoring programs shall continue throughout the decommissioning process.

2.4 Decommissioning Organization and Responsibilities

2.4.1 Management Structure

U.S. Energy Corp. has over 15 years of uranium mining experience and is familiar with uranium mining operations and the health and safety issues associated with those activities. All U.S. Energy management and staff directly involved in the decommissioning of the GMIX Facility have experience associated with uranium mining operations and facilities.

Appendix 8 shows an organizational chart illustrating the team of individuals responsible for decommission activities.

2.4.2 Qualifications of Management, Workers and Subcontractors

U.S. Energy may utilize experienced contractors for the dismantling of certain portions of the Facility. Contractor selection has not been made. If contract personnel are used they shall be under the direct supervision of U.S. Energy management staff and as such, shall be subject to all training, safety and other requirements implemented during the decommissioning activity. Decontamination and disassembly of equipment and piping which may contain residual radioactive material, shall be performed by U.S. Energy personnel or under the strict supervision of U.S. Energy personnel. Only those contractor(s) who have a demonstrated expertise in major salvage operations and who have experience with the safety requirements associated with a project of this nature will be considered.

2.5 Radiological and Industrial Safety Training

All individuals, employees and contractor personnel shall be trained in the principles of basic radiation protection (Radiation Safety Program - Appendix 27). This training shall be documented. The basis for this training is contained in the GMIX Facility "Radiation Safety Program and Standard Operating Procedures" Manual. This Manual is included in this Plan in Appendix 27. In addition, site specific orientation shall be given by the RSO to workers who have a potential for exposure from residual radioactive material during their dismantling and decommissioning job tasks. This orientation shall be documented. All areas within the plant where residual radioactive materials may exist shall be identified. All necessary documentation will be made to ensure that all individuals who participate in the decommissioning activities at the GMIX Facility fully understand the principles of Radiation Protection and areas where increased potential exposure may exist. Other safety training, general safety rules, conditions and regulations as required by MSHA shall also be administered during and prior to decommissioning activities. All necessary records and documentation for this training will be retained in the decommissioning file in accordance with the record retention policies mandated by 10 CFR 20 and other applicable regulations (Radiation Safety Program HP-22).

3.0 DESCRIPTION OF METHODS USED FOR WORKER PROTECTION AND OCCUPATIONAL HEALTH AND SAFETY

The following methods will be implemented during the decommissioning project at the GMIX Facility to ensure protection of the worker and the environment against radiation hazards. These methods are described in various sections below and are initiated to ensure that radiological exposures to personnel and releases to the environment are maintained As Low As Reasonably Achievable (ALARA) (Radiation Safety Program HP-1).

3.1.1 Affected Areas

If required by the Radiation Safety Officer, personal protection procedures described in the Radiation Safety Program and the related Standard Operating Procedures shall be employed to maintain exposures ALARA.

3.1.2 Unaffected Areas

Unaffected areas are uncontaminated and as such personnel working in them shall require no specialized protection against radiation or radionuclides.

3.1.3 Current Radiological Contamination Within the Recovery Plant

A gamma survey has been performed in the area of the GMIX Facility. The results for the GMIX plant area are shown in Appendix 11. Fixed and removable alpha surveys shall be completed inside the plant to further define contamination levels. Air monitoring shall be completed to determine airborne uranium and radon levels.

Areas shall be marked and measurements of fixed alpha surface contamination shall be made with a Ludlum Model 177 instrument and Ludlum Model 43-5 alpha probe. Removable alpha contamination shall be determined using standard surface smears which shall be counted using an Eberline RD-14/MS-11 (SACR-5) alpha counter and scaler instrument system.

Appendix 9 lists the type of instruments to be used for the project.

3.1.4 Radiological Parameters To Be Monitored

The following radiological parameters shall be monitored:

1) Airborne uranium
2) Radon gas
3) Ambient gamma radiation
4) Fixed alpha contamination
5) Removable alpha contamination

3.2 Ensuring Occupational Radiation Exposures Are Low As Reasonably Achievable (ALARA) (Radiation Safety Program HP-1)

The principles and practice of ensuring that occupational radiation exposures are As Low As Is Reasonably Achievable (ALARA) will be of primary focus during the decommissioning of the GMIX Facility. The concept of "ALARA" is a general guideline used by the NRC to maintain exposure to the general public and employees from radionuclides and radiation to levels As Low As Reasonably Achievable (ALARA). During the dismantlement of the buildings, equipment removal and soil/sludge removal, this principal shall be implemented. Specifically for this project, the ALARA practices followed shall be as follows:

- Prior to commencing dismantlement activities, the entire building structures, and contents shall be washed with a high pressure water hose to eliminate loose residual contaminants and thereby reduce potential airborne contamination. Selected building panels may be removed to increase airflow through the building to reduce ambient radon concentrations if required. General radiological monitoring of equipment and materials will proceed on a piece by piece basis as these materials become available during disassembly. These radiological determinations will be used to qualify materials which shall require disposal or be released accordingly under the release limits contained in the applicable sections of Regulatory Guide 1.86 "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of License for Product, Source or Special Nuclear Material. Special equipment and piping that is known to contain copious amounts of residual contamination, shall be flooded with water and drained to the Facility sump, prior to disassembly and handling. This will reduce the potential for dispersing uranium airborne particulate matter. The disassembly and handling of equipment in the Facility will proceed under the conditions described in a radiation work permit specifically issued for that work activity, with full health physics controls being implemented. The wash water accumulated in the Facility sump shall be pumped to a water truck or tanker and hauled to the Sweetwater Uranium Project for disposal in the tailings impoundment.

- Contaminated/unreleasable equipment and materials shall be transferred to the Sweetwater Mill tailings impoundment if fixed alpha or beta contamination exceeds levels for unrestricted use specified in Regulatory Guide 1.86 or removable alpha/beta contamination exceeding levels for release for unrestricted use in Regulatory Guide 1.86 is found. Visual inspection, as well as radiological surface contamination surveys, shall be performed on all equipment and materials in accordance with the protocol established for materials designated affected versus unaffected. Additionally, health physics controls and personnel monitoring requirements shall be implemented as necessary during this project, to ensure that radioactive contaminant levels are within regulatory limits and all risks of radioactive exposure to workers and the general public are as low as reasonably achievable.

3.3 Health Physics Program

This section of the decommissioning plan for the dismantlement of the GMIX Facility describes the health physics program which shall be implemented during decommissioning activities. Much of the information, context and basis of the health physics program is contained in the "Radiation Safety Program and Standard Operating Procedures" included in Appendix 27. A summary of the essential features of the health physics program follows.

3.3.1 Instrumentation and Calibration

Appendix 9 shows a list of radiological equipment and minimum detectable activities, along with equipment instruction manuals and certificates of calibration of equipment planned to be utilized in the decommissioning activity.

All radiological monitoring equipment shall have been calibrated within six months before use at the GMIX Facility. Calibration records will be kept on file for review by the NRC. All radiological monitoring equipment shall be calibrated every six (6) months or as specified by the manufacturer as per license condition No. 22.

Function checks shall be performed daily on equipment in use. Function checks shall be recorded on Equipment Survey Forms, Monitoring Forms or in the Work Log Book. Form type and description of work log book in included in Appendix 10.

3.3.2 Occupational Exposure Monitoring and Health Physics

Occupational radiological exposure monitoring requirements, conditions, frequency and controls which shall be implemented during the decommissioning project are described for both external and internal exposure potential.

3.3.2.1 External Radiological Control and Monitoring

Thermoluminescent Dosemeters (TLD's) (Radiation Safety Program HP-15)

If required by the RSO or required by HP-5, personnel TLD badges shall be placed on all individuals who are employed by U.S. Energy or by subcontract during the decommissioning project at the GMIX Facility. Personnel TLD identification will include name, badge number and social security number. All personnel TLD Badge exposures, if badging is required, shall be assessed quarterly.

Radiation Exposure Levels

Gamma radiation levels have been characterized during the period of suspended operations, in areas around the plant in Appendix 11. This gamma information is considered adequate to assess maximum gamma radiation exposure to personnel during the project because no additional gamma source material is being brought to the work site. Therefore, no appreciable change in gamma radiation levels are anticipated.

3.3.2.2 Internal Radiological Control and Monitoring

Radon Daughter Monitoring (Radiation Safety Program HP-4)

Radon daughter samples shall be collected during the GMIX Facility Decommissioning Project when requested by the RSO. The radon measurements within the GMIX building shall be compared against release levels in Regulatory Guide 4118 to determine if the building is releasable for unrestricted use.

Airborne Radioactivity

Uranium airborne particulate sampling shall be performed when requested by the RSO in areas of the plant to be determined by the RSO. These samples shall be collected using a calibrated, high volume air sampler in each area of active work activity for a period of not less than one hour. Breathing zone lapel sampling shall also be implemented for individuals who demonstrate the potential for exposure to radioactive materials during the performance of their specific job tasks. Additionally, both high volume and breathing zone lapel uranium airborne particulate samples shall be taken in areas where maximum exposure potential exists during the initiation of any radiation work permit (RWP) pursuant to the conditions described.

If any change in radiological exposure potential or conditions occur during the decommissioning activity, the sampling frequency shall be increased or decreased if appropriate.

Protective Clothing and Equipment

Protective equipment available for all personnel shall include, but not limited to, the following:

- coveralls
- rubber boots
- face shields and rubber suits (persons performing high pressure decontamination and various cleaning activities)
- hard toed shoes
- safety glasses
- hard hats

Respiratory Protection (Radiation Safety Program HP-21)

If airborne radionuclide concentrations require monitoring under HP-5, 1/2 face, full face or air supplied face respiratory protection devices shall be required. Respiratory protection shall be prescribed for initiation of any radiation work permits (RWP's) pursuant to the conditions described therein.

Bioassays (Radiation Safety Program HP-9)

Bioassays shall be performed on all employees prior to any decontamination or decommission work. Bioassay shall be performed every two weeks for all employees, who, because of their assigned job tasks exhibit a potential for exposure to residual radioactive material. All other employees who work at the site who do not demonstrate a potential for exposure to radioactive material because of their assigned job tasks shall supply bioassay samples once a month. The bioassay program shall be implemented according to the action levels, guidelines and procedures contained in regulatory Guide 8.22, "Bioassay at Uranium Mills. "

Control Measures for Minimizing Internal Exposure

- The entire GMIX Facility shall be designated a control area. Restricted entry to the site shall be maintained throughout the project. The GMIX Facility consists of the IX plant, IX storage area, IX Reservoir, Primary Pond and Final Pond.

- A control center shall be set up at the GMIX Facility gate during decommissioning and decontamination operations. The control center shall contain the necessary health and safety equipment, personal cleaning facilities, record keeping documents, radiation monitoring equipment and other equipment necessary to complete the decommissioning project. Shower and change rooms located at the Sheep No. 1 Mine will also be used for the personnel cleaning facilities.

- All work shall be conducted in a manner consistent with maintaining a minimum exposure to personnel.

- All required items of protection shall be worn by all personnel while in the control area as assigned.
- Eating, drinking and smoking are prohibited in the control area, except in designated areas.
- Visitors and/or persons unfamiliar with plant radiation safety regulations shall be allowed into affected areas only if necessary and shall be escorted at all times during their stay in affected areas.
- Each individual engaged in work under a RWP shall, upon entry and departure from the restricted area, record his name and time. The length of time in the area shall be noted for exposure assessment.
- Personnel leaving control area shall be monitored for contamination at the access control point before leaving the site; frisk records shall be maintained on site.
- All tools, equipment and vehicles shall be monitored before leaving the control area.

3.3.3 Radiological Monitoring and Release of Equipment

The radiological monitoring of equipment for release for unrestricted use or for disposal shall proceed on every piece of equipment, building material or support structure as the materials become available for monitoring during the dismantlement. Release shall be according to HP-18 and Regulatory Guide 1.86. The measurement frequency for surface activity on each piece of equipment shall be based on whether the equipment and materials originate from areas classified as affected or unaffected. Direct measurement of surface activity for alpha contamination shall be made using instruments and detectors listed in Table 3.3.1 and this measurement shall be used as a guideline to qualify whether additional measurements of fixed beta and or removable alpha/beta are required as follows:

- If a total alpha surface activity measurement is greater than 1,000 dpm/100 cm2, then a swipe for removable alpha shall be performed at each direct measurement location. Then a direct measurement for total beta activity shall be made at each location. Measurement for surface activity described above shall be conducted by integrating counts over an appropriate time interval so as not to exceed 25% of the allowable release criteria limit, using the appropriate detector and instrument.

Measurement intervals, spacing and frequency shall be as follows:

<u>Equipment, materials and floors</u>

- **Affected area**-one measurement per four meter squared surface area.
- **Unaffected area**-one measurement per 20 meter squared surface area.

Scanning surveys for alpha radiation shall only be performed on select material surfaces which have the potential for elevated residual contamination either by visual recognition such as in stains, or because of the proximity and physical contact in areas where yellowcake streams were openly processed Scanning surveys for gamma activity shall be made throughout the plant to detect the presence of elevated direct radiation which might indicate where residual gross activity or hot spots are present Calibration of the survey instruments used during the decommissioning project shall be made by an independent certified laboratory.

High volume uranium particulate air sampling pump calibration shall be made, using a "Staplex" high volume pump or equal, a National Bureau of Standards Traceable Primary Pump Calibration Curve for the Staplex Flow Rater RL-78-5 or equal, and Biram Type Anemometer AZ-4 Ball Bearing Type or equal. Additional low volume (2 liter/minute) breathing zone lapel air sample pumps shall be calibrated prior to use in the decommissioning activities using the standard "soap bubble" technique.

All radiological survey instruments shall be checked for function and performance change each day prior to use using an NBS traceable ^{230}Th standard.

3.3.4 Quality Assurance/Quality Control

The basic management structure discussed in Section 2.4 shall be in effect during the decommissioning activities. The site RSO shall implement the training, health physics control measures, radiological monitoring, radiological surveys, release of equipment, and decontamination methods and ensure the principles and practice of ALARA are being maintained. Quality Control and Quality Assurance provisions shall be implemented by independent verification on surveyed equipment, review of records and data, reports to management staff, exchange of information from site personnel and independent audits conducted by the corporate radiation supervisor. All site personnel shall be trained in safety procedures and radiological practices which will minimize their potential exposure to radioactive materials.

3.4 Contractor Personnel

U.S. Energy may elect to acquire the assistance of contract personnel to perform certain job tasks during the dismantlement and decommissioning of GMIX Facility. Those contract personnel shall be under the direct supervision of U.S. Energy management staff and as such, will be subject to all training, safety and other requirements implemented during the decommissioning activity. The major job task(s) in which contractor personnel would participate are contract dismantlement, salvage of the building, and haulage. Decontamination and disassembly of equipment, and piping which may contain residual radioactive material, shall be performed by U.S. Energy personnel under the strict supervision of the RSO. Only those contractor(s) who have a demonstrated expertise in major salvage operations and who have experience with associated safety requirements shall be considered.

3.5 Waste Management

Material that can not be released for unrestricted use, contaminated sludge, soils and contaminated liquid wastes shall be placed in the Sweetwater Uranium Project tailings impoundment.

3.5.1 Description, Quantity and Characteristics

The waste material is a uranium processing waste produced in a primary uranium recovery operations (Atomic Energy 11e (2) material) which is defined in 40 CFR 40.4(a-1) as follows:

> "Byproduct Material" means the tailings or wastes produced by the extraction or concentration of uranium or thorium form any ore processed primarily for its source material content, including discrete surface wastes resulting from uranium solution extraction processes. Underground ore bodies depleted by such solution extraction operations do not constitute "byproduct material" within this definition.

3.5.2 Mixed Waste

No RCRA waste is known to exist at the GMIX Facility. Therefore, no mixed wastes are known to exist at the GMIX Facility. The Primary settling pond and final settling pond were sampled on July 12, 1993 and the samples subjected to TCLP testing. The results are pending.

3.5.3 Disposal of Contaminated Solutions

Cleaning solutions generated during the decommissioning process shall be hauled via water truck or tanker to the Sweetwater Uranium Project tailings impoundment. Cleaning solutions shall contain no organic solvents.

3.5.4 Disposal of Radioactive Waste

A request for an amendment to License SUA-1350 allowing 11(e)2 byproduct material to be disposed of at the Sweetwater Mill tailings impoundment has been made to the NRC (Appendix 5). Approval of this amendment request is expected in the fall of 1993.

3.5.5 Disposal of Non-Contaminated Construction Debris

Non-contaminated construction debris shall be transported to the Sheep Mines solid waste disposal site. All waste shall be surveyed and verified as below the limit for release for unrestricted use prior to transport and disposal. The results of these surveys shall be documented.

4.0 PLANNED FINAL RADIATION SURVEY

The form and content of the final site survey will provide information in sufficient detail as to allow termination by the NRC of the GMIX Facility Materials License SUA-1524 and release of the site for Unrestricted Use. The site shall be reclaimed to a condition that will allow the site to be used by U.S. Energy in future mining activities and mine water treatment. The final status report shall contain a comprehensive discussion of all activities and results associated with the decommissioning effort. The final status survey report shall be submitted within three months of the completion of decommissioning and reclamation activities at the site. Items to be discussed are enumerated in Section 9, Survey Documentation and Reports of the Regulatory Guide 4118 "Manual for Conducting Radiological Surveys in Support of License Termination". The background site description and operating history is being provided in this decommissioning plan and therefore, this information will not be repeated in the final status report. The release or disposal of all materials shall be made prior to executing the final site survey as follows:

1. Radioactive waste and contaminated materials shall be disposed of in the Sweetwater Mill tailings impoundment pursuant to conditions as set forth in the

Kennecott Uranium Company NRC Source Materials License SUA-1350, Request for License Amendment to Accept for Disposal 11(e)2 Byproduct Material from the GMIX Facility, also known as the Sheep Mountain Partners (SMP) Ion Exchange Facility, SUA-1524.

2. Building materials and equipment shall be monitored for release for unrestricted use. Contaminated materials and equipment shall be transferred to the Sweetwater Mill tailings impoundment for disposal.

A final site survey to verify that the grounds and property are not contaminated and shall meet the release criteria for unrestricted use shall be made. The entire property boundary of approximately 7.2 acres shall be sectioned into a ten meter by ten meter grid system and a gamma measurement will be taken at each intersecting location of the grid. This shall generate approximately 300 surface gamma activity measurements using a lead shielded Micro-R Meter. All affected grids shall be resampled after cleanup for radium and uranium by compositing five (5) samples from each grid (one near each corner and one at the grid's center).

Background soil samples and gamma surface activity measurements have been made at 10 locations surrounding the Facility in uncontaminated up-wind/up-drainage locations (Appendix 16). These background soil samples have also been analyzed for uranium and radium-226 which will establish a recent basis for comparative and correlative data interpolation. Site specific data from nearby mine dumps shall also be used to separate process contaminated grids from mine waste contaminated grids as described in Section 2.2.10.

5.0 COST ESTIMATE

As presented in Section 2.3, decommissioning and reclamation activities are expected to take approximately two years complete. U.S. Energy prepared a cost estimate which includes the following assumptions:

1) The on-site work force will consist of the following estimated labor components:

   1 - Demolition Foreman
   4 - Equipment Operator
   1 - Electrician
   2 - Laborer
   1 - Radiation Safety Officer
   1 - Environmental Manager

   Personnel may be increased or decreased depending on the project activity.

2) All demolition work and associated monitoring and supervision shall be performed by U.S. Energy personnel.

3) The building, if dismantling is required, shall be taken down by U.S. Energy personnel. The cost of removing the building is considered equal to the salvage value of the metal (this assumption is based on a quote by a qualified demolition contractor provided that the building is uncontaminated and releasable for unrestricted use).

4) Support equipment includes the following equipment required for variable lengths of time.

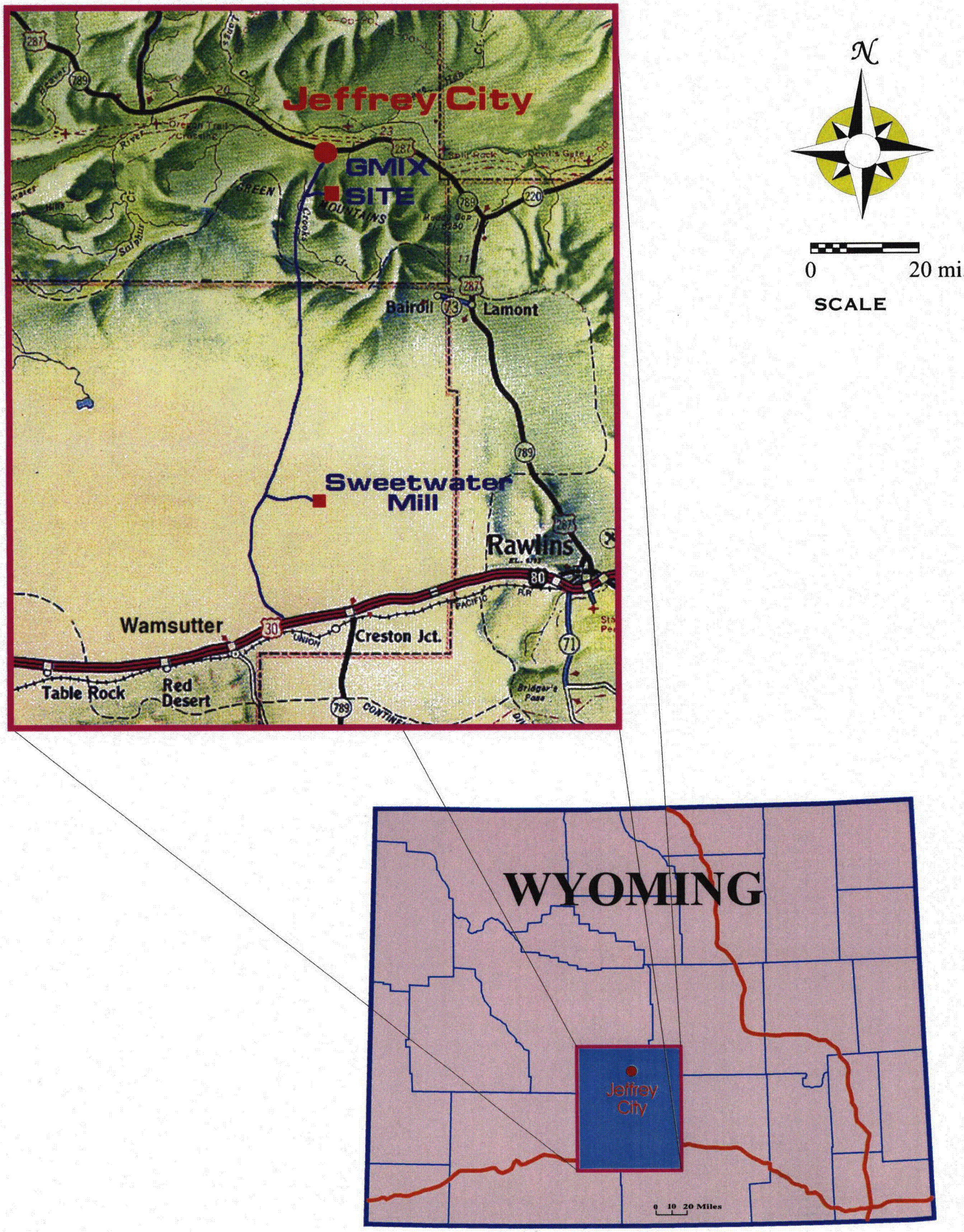
   1 - Front End Loader
   1 - 40 Ton Crane
   1 - D-9 Dozer
   3 - Dump Trucks or Tractor with Belly Dumps and/or End Dumps
   1 - Portable Control Center Trailer
   3 - Pickups
   1 - Semi With Low Boy
   1 - Porta Potty
   1 - Horsy Steam Cleaner
   1 - Forklift
   1 - Tracked Excavator
   1 - D-6 Dozer
   1 - Dragline
   1 - Welding Truck

5) Most haulage of decontaminated equipment and debris shall be by U.S. Energy equipment and personnel.

   Appendix 13 summarizes the estimated costs for the various project cost categories. These costs are representative of those submitted to the NRC in the August 15, 1993 Annual Update.

6.0 PHYSICAL SECURITY, MATERIAL CONTROL AND ACCOUNTING PLAN

The site area will be maintained as a restricted area throughout the duration of the project. No physical security, material control or accounting plan is applicable.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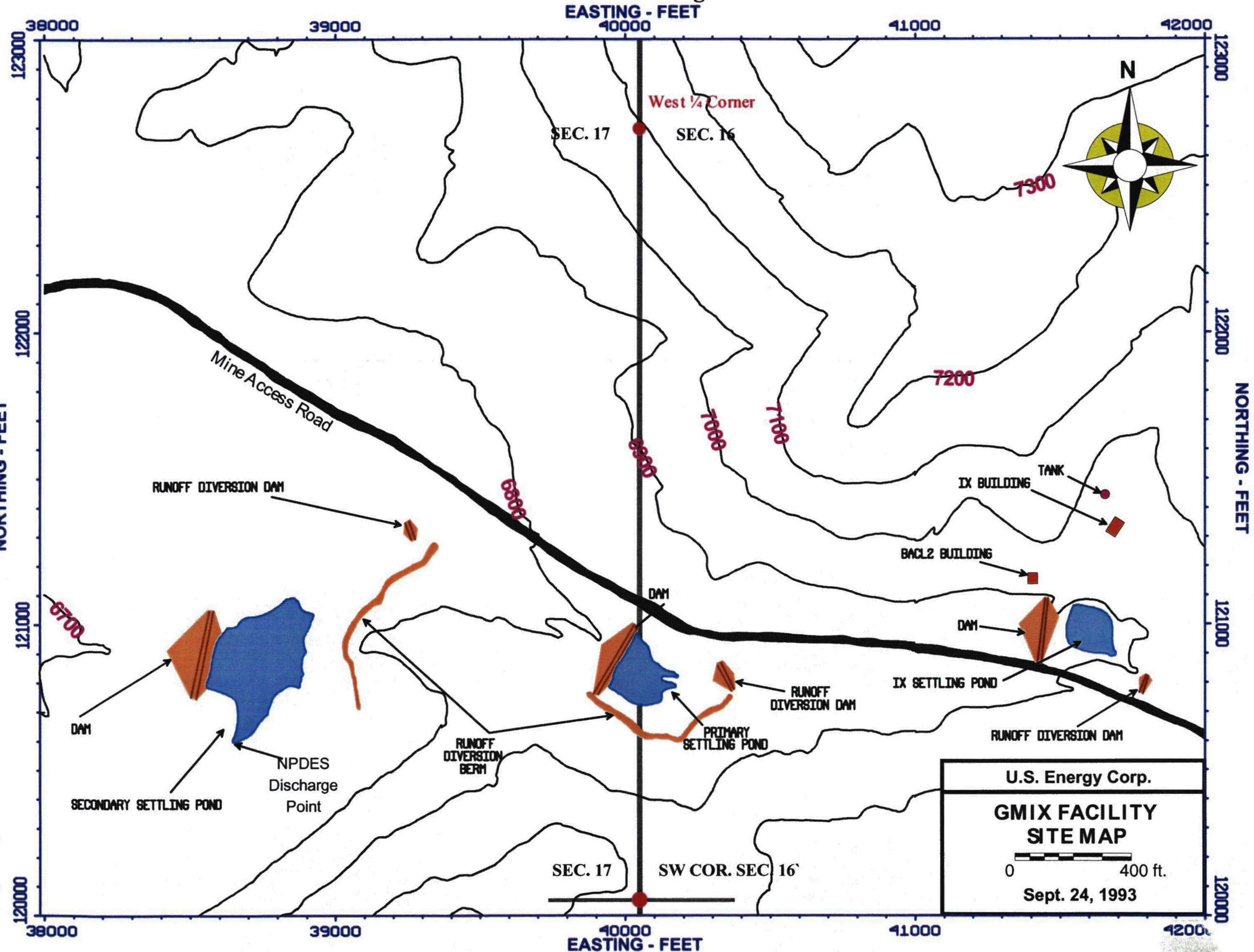
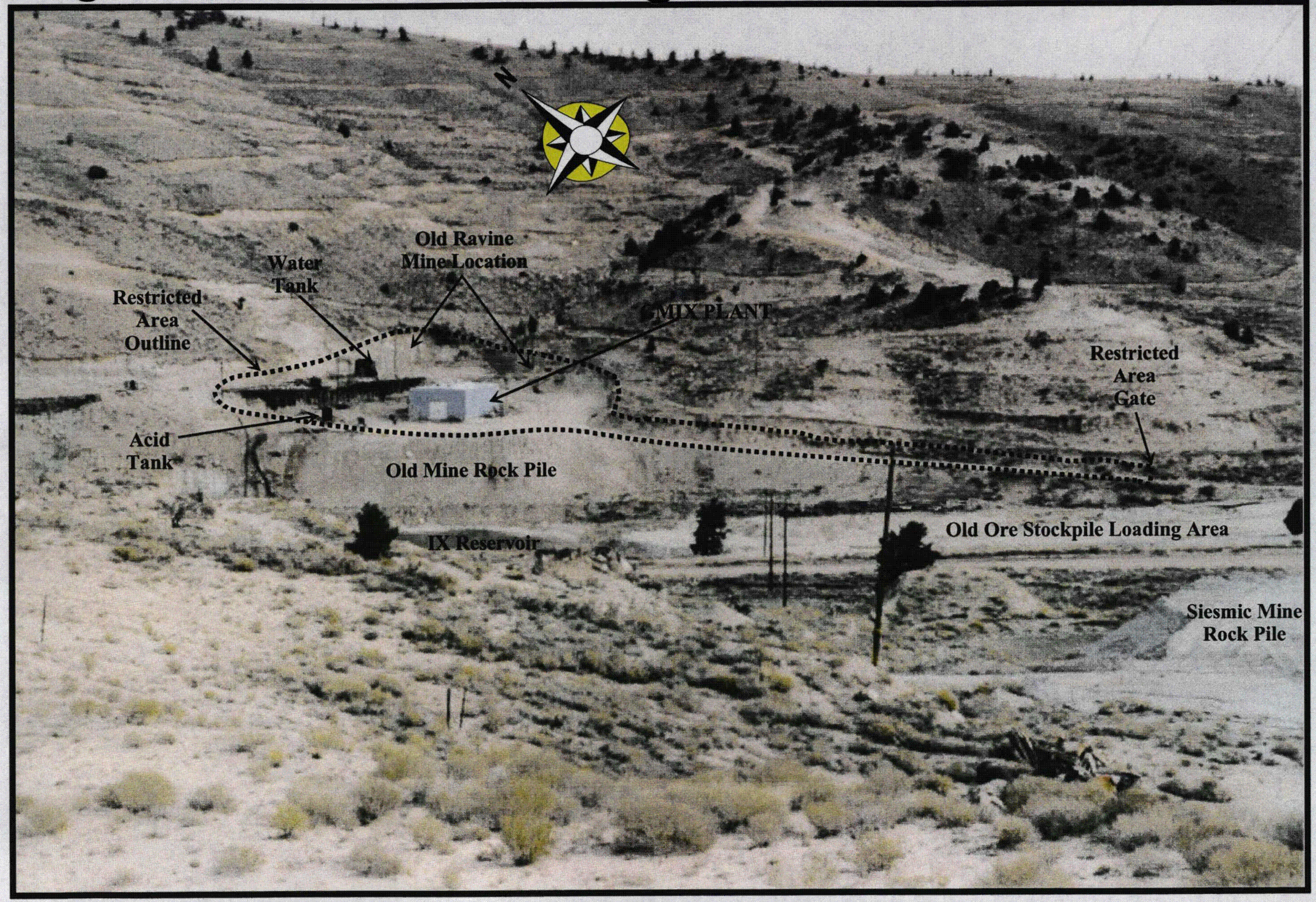
INDEX MAP

U.S. Energy Corp. Green Mountain Ion Exchange Decommissioning Plan

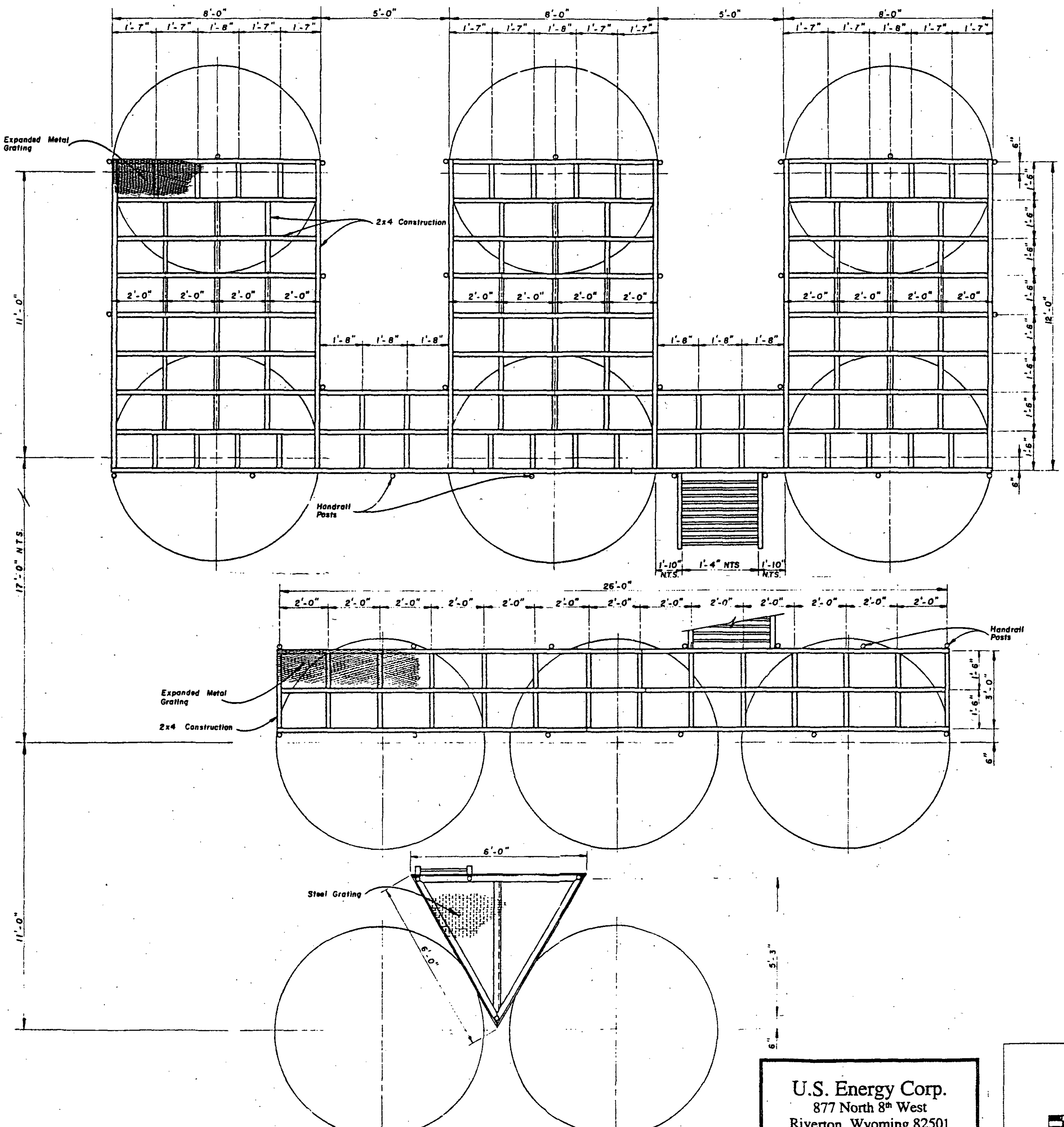


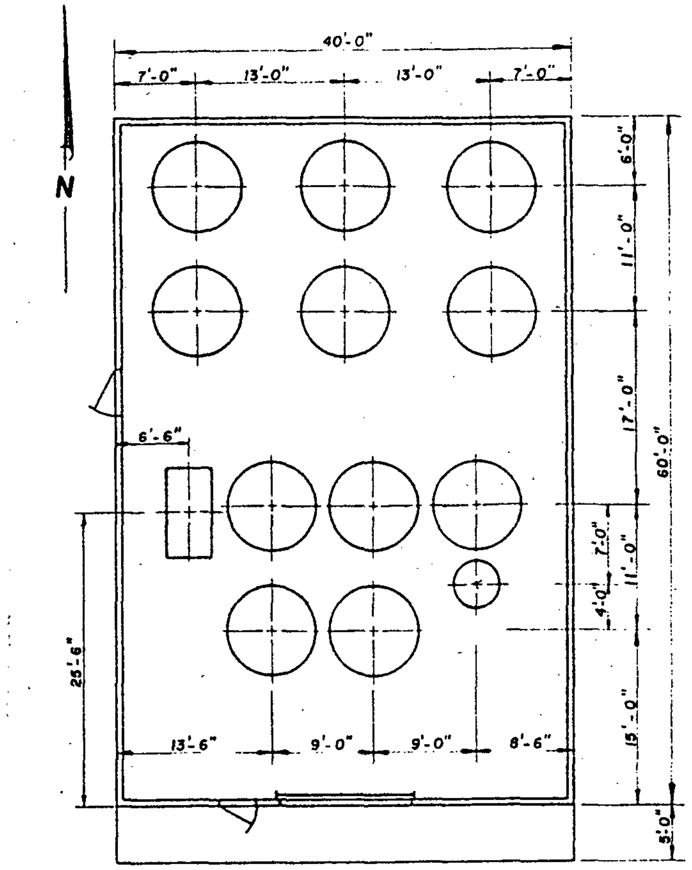
Appendix 2



U.S. Energy Corp.
GMIX Facility
Decommissioning Plan

Appendix 2





TANK LOCATION PLAN
Scale: 3/32" = 1'-0"

NOTE:
ALL MATERIALS LISTED BELOW ARE SCHEDULED FROM DRAWINGS 7503-7 & 7503-8.

MATERIAL LIST		
QTY.	DESCRIPTION	SIZE
11	S4S Lumber	2"x4"x14'-0"
13	S4S Lumber	2"x4"x12'-0"
34	S4S Lumber	2"x4"x8'-0"
17 Shts.	Expanded Metal Grating	3/4"-13 3'x8'
20 Sq.Ft.	Steel Grating	W-2-100
38'	Structural Tubing	4"x4"x 1/4"
570'	Construction Grade Pipe	1 1/4"φ
3 Sq.Ft.	Steel Plate	1/4"
10'	Steel Plate	1/4"x 0'-6"
78'	Flat Bar	2 1/2"x 3/8"
24'	Angle	3 1/2"x3 1/2"x 5/16"
22'	Angle	2"x2"x 1/4"
48'	Round Stock	3/4"φ
76	Bolts With Washers	5/8"φ x 0'-3"
6	Anchor Bolts	1/2"φ x 0'-6"
200'	Rough Cut Timbers	6"x6"
100'	Rough Cut Timbers	4"x6"
18 Shts.	Plywood	3/4"

U.S. Energy Corp.
877 North 8th West
Riverton, Wyoming 82501

GREEN MOUNTAIN ION EXCHANGE PLANT
NRC SOURCE MATERIAL LICENSE SUA-1524
TANK LOCATIONS

0 1 2 4 ft.

Date: Sept. 13, 1993
Appendix 3

GUIDELINES FOR DECONTAMINATION OF FACILITIES AND EQUIPMENT

PRIOR TO RELEASE FOR UNRESTRICTED USE

OR TERMINATION OF LICENSES FOR

BYPRODUCT OR SOURCE MATERIALS

U. S. Nuclear Regulatory Commission
Uranium Recovery Field Office
Region IV
Denver, Colorado 80225

SEPTEMBER 1984

The instructions in this guide in conjunction with Table I specify the radioactivity and radiation exposure rate limits which should be used in accomplishing the decontamination and survey of surfaces or premises and equipment prior to abandonment or release for unrestricted use.

1. The licensee shall make a reasonable effort to eliminate residual contamination.

2. Radioactivity on equipment or surfaces shall not be covered by paint, plating, or other covering material unless contamination levels, as determined by a survey and documented, are below the limits specified in Table I prior to applying the covering. A reasonable effort must be made to minimize the contamination prior to use of any covering.

3. The radioactivity on the interior surfaces of pipes, drain lines, or ductwork shall be determined by making measurements at all traps, and other appropriate access points, provided that contamination at these locations is likely to be representative of contamination on the interior of the pipes, drain lines, or ductwork. Surfaces of premises, equipment, or scrap which are likely to be contaminated but are of such size, construction, or location as to make the surface inaccessible for purposes of measurement shall be presumed to be contaminated in excess of the limits.

4. Upon request, the Commission may authorize a licensee to relinquish possession or control of premises, equipment, or scrap having surfaces contaminated with materials in excess of the limits specified. This may include, but would not be limited to, special circumstances such as razing of buildings, transfer of premises to another organization continuing work with radioactive materials, or conversion of facilities to a long-term storage or standby status. Such requests must:

    a. Provide detailed, specific information describing the premises, equipment or scrap, radioactive contaminants, and the nature, extent, and degree of residual surface contamination.

    b. Provide a detailed health and safety analysis which reflects that the residual amounts of materials on surface areas, together with other considerations such as prospective use of the premises, equipment or scrap, are unlikely to result in an unreasonable risk to the health and safety of the public.

5. Prior to release of premises for unrestricted use, the licensee shall make a comprehensive radiation survey which establishes that contamination is within the limits specified in Table I. A copy of the survey report shall be filed with the Uranium Recovery Field Office, Region IV, P.O. Box 25325, Denver, CO 80225. The survey report shall:

   a. Identify the premises.

   b. Show that reasonable effort has been made to eliminate residual contamination.

   c. Describe the scope of the survey and general procedures followed.

   d. State the findings of the survey in units specified in the instruction.

Following review of the report, the NRC will consider visiting the facilities to confirm the survey. The licensee shall not release the premises for unrestricted use without the written approval of the USNRC staff.

TABLE I

ACCEPTABLE SURFACE CONTAMINATION LEVELS

NUCLIDES[a]	AVERAGE[b c f]	MAXIMUM[b d f]	REMOVABLE[b e f]
U-nat, U-235, U-238, and associated decay products	5,000 dpm /100 cm^2	15,000 dpm /100 cm^2	1,000 dpm /100 cm^2
Transuranics, Ra-226, Ra-228, Th-230, Th-118, Pa-231, Ac-227, I-125, I-129	100 dpm/100 cm^2	300 dpm/100 cm^2	20 dpm/100 cm^2
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1,000 dpm/100 cm^2	3,000 dpm/100 cm^2	200 dpm/100 cm^2
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except SR-90 and others noted above.	5,000 dpm /100 cm^2	15,000 dpm /100 cm^2	1,000 dpm /100 cm^2

[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 square meter. For objects of less surfa 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.

TABLE I

[e]The amount of removable radioactive material per 100 cm² of surface area should be determined by wiping that area wi dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on t wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface a is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.

[f]The average and maximum radiation levels associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/hr at 1 cm and 1.0 mrad/hr at 1 cm, respectively, measured through not more than 7 milligr per square centimeter of total absorber.

Sweetwater Uranium Facility
Kennecott Uranium Company
42 Miles NW of Rawlins
P.O. Box 1500
wlins. Wyoming 82301
7) 328-1476 Fax:(307) 324-4925

July 21, 1993

Kennecott Energy
Manager Kennecott Uranium Company

Mr. Ramon E. Hall
Director
Uranium Recovery Field Office
U. S. Nuclear Regulatory Commission
P. O. Box 25325
Denver, Colorado 80225

Dear Mr. Hall:

Subject: NRC Source Materials License #SUA-1350; Request for License Amendment to Accept for Disposal 11(e)(2) Byproduct Material from the Sheep Mountain Partners (SMP) Ion Exchange Facility (License #SUA-1524)

Kennecott Uranium Company hereby requests an amendment to it's Source Material License SUA-1350 to accept for disposal in the Sweetwater Tailings Impoundment 11(e)(2) byproduct materials generated by U. S. Energy Corporation in the course of decommissioning it's Sheep Mountain Partners Ion Exchange facility, which is licensed under License #SUA-1524. Kennecott Uranium Company's License SUA-1350 states in License Condition 10.6:

> 10.6 During the period of mill shutdown, the licensee shall not add tailings or other solid wastes to the tailings cell, except byproduct material in the form of debris generated by routine site maintenance. Any disposal activities in the tailings cell shall be performed in accordance with the standard operating procedure, "Reduction of Voids in Material Placed in the Tailings Cell for Disposal," submitted on October 27, 1992. In addition, the licensee shall implement an interim stabilization program for all tailings areas not covered by standing water, which shall include written operating procedures and shall minimize the dispersal of wind blown tailings. [Applicable Amendments: 1]

Since the materials from the Sheep Mountain Partners Ion Exchange are not debris generated by routine site maintenance, Kennecott Uranium Company is requesting an amendment to SUA-1350 to allow the disposal of the above described 11(e)(2) byproduct material.

The following information applies to the disposal of this material:

1) **Type of Material**
The material is byproduct material as defined under Section 11(e)(2) of the Atomic Energy Act of 1954, as amended and as defined in 10 CFR 40.4(a-1) and consists of wastes (such as pond sludges) and contaminated equipment and other contaminated items rendered so during the process of extraction of uranium from mine discharge water.

2) **Description and Volume of the Material**
The following is a list detailing the types and anticipated quantities of material to be disposed of in the Sweetwater tailings impoundment:

a) Contaminated Pond Sludges:
These sludges come from two (2) ponds; Roberts Reservoir #3 and Roberts Reservoir #2, which were used as settling ponds for discharge water treated with barium chloride after the uranium was removed by the ion exchange plant, but prior to final discharge.

Estimated volume: 5000 cubic yards

b) Contaminated Soils:
These soils were contaminated during the course of operations and will be removed from around the site in the course of surface decontamination.

Estimated volume: 1000 cubic yards

c) Contaminated Equipment (pipes, tanks, pumps etc.):
The equipment on site will be tested for surface contamination. Equipment that is releasable in accordance with "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct or Source Materials" dated September 1984, will be released. Equipment that is unreleasable will be disposed of in the Sweetwater tailings cell. The following list is a list of all the equipment on site involved in the process that could conceivably be contaminated and require disposal. Some of these items may in fact meet the release limits and as such, would not require disposal, but would be released for unrestricted use.

EQUIPMENT	SIZE	QUANTITY
Ion Exchange Column	8' dia. x 10' high	6
Stripping Tank	8' dia. x 10' high	3
Precipitation Tank	8' dia. x 10' high	2
Recycle Pump		2
Feed Pump		2
Ammonia Storage Tank	500 gallon	1
Acid Tank	2000 gallon	1
BaCl2 Tank	4' dia. x 4' high	2
Air Compressor		1
Structural Materials		
Pipe (including pipe stacked in the yard which originally came from Bison Basin)		
Valves, pumps, motors, fittings and other miscellaneous items including pumps and other materials originally from Bison Basin		

Estimated volume: 300 cubic yards

d) <u>Contaminated buildings, concrete, structural materials and other items normally associated with the operation of the ion exchange and barium chloride plants</u>:
This category includes the following items:

40'x 60'x 20' building 1
24'x 24'x 12' building 1
Concrete slab material

Estimated volume: 1000 cubic yards

The total volume of contaminated material is estimated to be 7300 cubic yards.

3) **Results of Tests on the Materials**
The pond sludges were sampled on July 12, 1993. The samples are being tested as per the Toxicity Characteristic Leaching Procedure to ascertain that the wastes are not hazardous wastes. They are also being tested for

radionuclide concentrations. The results are anticipated to be available by August 20, 1993, at which time they will be submitted to URFO. In any event, no materials which are known to be, or test as hazardous waste, shall be placed for disposal in the Sweetwater tailings impoundment.

4) **Disposal Schedule**
Disposal of the materials shall commence:
a) Upon receipt of written approval of this amendment request;
b) upon receipt of written approval of U. S. Energy's decommissioning plan from the NRC/URFO; and
c) upon receipt of specific authorization from the State of Wyoming Department of Environmental Quality to receive, on a limited basis, small quantities of 11(e)(2) material generated by persons other than the facility owner at a location other than the location of the facility.

5) **Disposal Plan**
A Disposal Plan for the material is attached.

6) **Changes to Bonding and/or Reclamation Plans**
Due to the small amount of material involved (7300 cubic yards) no changes to the reclamation bond amount or the tailings cell reclamation plan are anticipated. The Disposal Plan includes Kennecott Uranium Company's Standard Operating Procedure, "Reduction of Voids in Material Placed in the Tailings Cell for Disposal."

Timely approval of this amendment request would be greatly appreciated so the decommissioning of the Sheep Mountain Partners Ion Exchange can commence without delay. If you have any questions, please do not hesitate to contact me.

Sincerely yours,

Oscar A. Paulson

Oscar A. Paulson
Facility Supervisor

OP:ss
Disposal.DOC
cc: M. H. Gibson
G. W. Worman
K. Webber
L. Cardey-Yates

KENNECOTT URANIUM COMPANY
SWEETWATER URANIUM FACILITY
SOURCE MATERIALS LICENSE SUA-1350

Standard Operating Procedure
for
Reduction of Voids in Material Placed in the Tailings Cell
for Disposal

1. The ramp in the northwest corner of the cell shall be an authorized holding area for contaminated equipment awaiting final disposition.

2. Items containing voids (such as vessels, pipe, etc.) shall be either:
   a. oriented so that a normal earth moving procedure would fill all voids;
   b. crushed or split open so that no voids exist; or
   c. filled with tailings sands, waste rock/soil (overburden) or other suitable material.

3. To minimize repeated handling of the material, items permanently deposited shall be placed as far below natural grade as practical.

GP:ss
10/26/92
27OCT92.SOP

DISPOSAL PLAN

SHEEP MOUNTAIN PARTNERS ION EXCHANGE WASTES

The disposal of the contaminated material from the Sheep Mountain Partners Ion Exchange plant is divided into the following tasks:

Task #1 Loading, Covering and Preparation

The contaminated materials including soil, sludges, pipe, pumps, concrete, debris, building materials, tanks and other material shall be loaded on trucks at the Sheep Mountain Partners Ion Exchange Plant. Materials such as PVC pipe and other readily crushable items shall be crushed prior to loading to meet the requirements of Kennecott Uranium Company's Standard Operating Procedure, "Reduction of Voids in Material Placed in the Tailings Cell for Disposal."

The trucks shall be covered and the transportation of the material shall comply with all applicable regulations, including but not limited to, 49 CFR 173 Subpart I. Each truck shall have a Bill of Lading. The trucks shall be inspected for proper loading and road worthiness prior to leaving the restricted area. The results of the inspections shall be documented. The trucks shall be monitored with an alpha meter for surface contamination prior to leaving the restricted area at the Sheep Mountain Partners Ion Exchange Plant. If a truck is found to be contaminated, it shall be decontaminated using scrub brushes, soap and water, prior to leaving the restricted area. A log of the monitoring results for the trucks shall be maintained at the Sheep Mountain Partners Ion Exchange Plant.

Each truck shall carry a Spill Contingency Plan and a Spill Kit, consisting of basic equipment such as disposable coveralls, rubber gloves, respirators, rubber boots, a plastic tarpaulin, large nails, a hammer, shovels and flagging for use by the driver prior to the arrival of U. S. Energy and Kennecott Uranium Company personnel, who shall perform the actual cleanup. Each truck shall be equipped with a mobile radio or radiotelephone so U. S. Energy and/or Kennecott Uranium Company can be notified in the event of a spill or other problems. A radio, radio telephone or regular telephone shall be set up in a temporary building at the Sheep Mountain Partners Ion Exchange to enable U. S. Energy personnel to notify personnel at the Sweetwater Uranium Project of a truck's departure and estimated time of arrival at the Sweetwater Uranium Project.

Task #2 Transportation

The trucks shall travel to the disposal site (Sweetwater Uranium Project tailings cell) via the following route, which is shown on the attached map:

U. S. Energy Mine Road

The trucks shall leave the Sheep Mountain Partners Ion Exchange restricted area via the U. S. Energy mine road and travel approximately 1.25 miles west to the junction with the Crooks Gap Road (Fremont County Road #FR-318), which is also known as the Wamsutter to Jeffrey City Road. This road is known as Sweetwater County Road #23 when it crosses into Sweetwater County.

Fremont County Road #FR-318/Sweetwater County Road #23

The trucks shall turn left (south) onto Fremont County Road #FR-318 and proceed south along this road crossing into Sweetwater County where the road becomes Sweetwater County Road #23 for a distance of approximately thirty (30) miles.

Sweetwater County Road #63

The trucks shall turn left (east) onto Sweetwater County Road #63, travel on this road for a distance of approximately three (3) miles to the junction with the mine access road. The truck would then turn left (north) onto the mine access road, proceeding north along this road through the restricted area gate. Each truck shall be logged in and weighed on the truck scale at the Sweetwater Uranium Project. This scale was calibrated by the State of Wyoming Department of Agriculture on April 28,1993. A Disposal Log Book shall be maintained at the Sweetwater Uranium Project for any wastes placed in the Sweetwater Uranium Project tailings cell for disposal. The following data concerning the load of waste shall be recorded in the Disposal Log Book:

a) Date
b) Load number
c) Weight ticket number
d) Load description
e) Truck time in
f) Truck time out
g) Loaded weight
h) Empty weight
i) Estimated volume
j) Hauler
k) Driver's name
l) Location unloaded
m) Alpha meter check source number
n) Check source counts
o) Alpha scan results
p) Corrective action/decontamination performed (if any)
q) Name of individual completing alpha scan

The trucks shall then proceed to the tailings cell, up the tailings cell's external ramp and onto the embankment road.

Task #3 Disposal

The trucks shall proceed down the ramp into the tailings cell. It is anticipated that most of the materials will be dumped into the cell at that location. Some sludges may be slurried with tailings fluid and sluiced into the cell. Some tanks and other items may be placed along the ramp in the cell's northwest corner for storage, pending final disposition. This area along the ramp is designated as an "authorized holding area for contaminated equipment awaiting final disposition."

All materials and items other than:

a) sludges, soils, concrete and solid items; and
b) items already crushed at the Sheep Mountain Partners Ion Exchange Site to meet void reduction requirements,

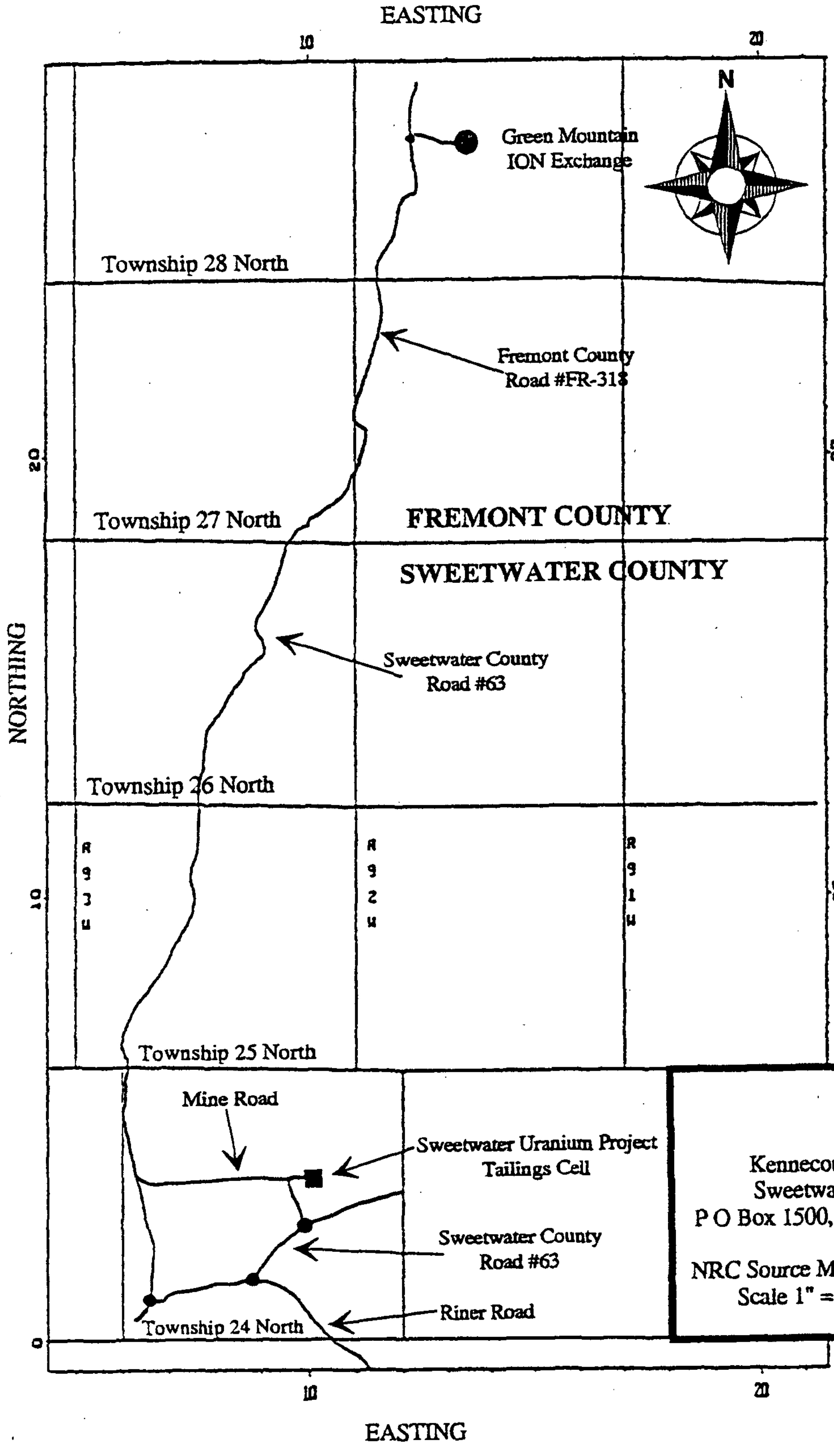
shall be handled according to Kennecott Uranium Company's standard operating procedure for reduction of voids in material placed in the tailings cell. A copy of this Standard Operating Procedure is attached to this Disposal Plan. Material shall be accepted for disposal from 8:00 a.m. to 3:00 p.m. on Monday through Friday.

Task #4 Leaving the Site

After the truck has completed unloading it shall proceed to the truck scales to be weighed and checked for surface contamination prior to leaving the Sweetwater Uranium Project restricted area. If the truck is found to be contaminated it shall be decontaminated by returning to the tails cell to be washed down, using scrub bushes and soap and water from the TMW-18 pumpback well, until the surface contamination is removed. The empty weight of the truck, results of the survey and any required decontamination shall be recorded in the Disposal Log Book. The truck shall then leave the restricted area and return to the Sheep Mountain Partners Ion Exchange facility.

OP:ss
DISPOSAL.PLN
7/23/93

SWEETWATER URANIUM PROJECT
WASTE DISPOSAL TRUCK ROUTE MAP



MAP #1

Kennecott Uranium Company
Sweetwater Uranium Facility
P O Box 1500, Rawlins, Wyoming 82301

NRC Source Materials License SUA-1350
Scale 1" = 4 Miles OAP: 7/19/93

RECEIVED
JAN 10 1994
O. PAULSON

THE STATE OF WYOMING

MIKE SULLIVAN
GOVERNOR

Department of Environmental Quality

Herschler Building • 122 West 25th Street • Cheyenne, WY 82002

ADMINISTRATION	ABANDONED MINES	AIR QUALITY	INDUSTRIAL SITING	LAND QUALITY	SOLID & HAZARDOUS WASTE	WATER QUALITY
(307) 777-7758	(307) 777-6145	(307) 777-7391	(307) 777-7368	(307) 777-7756	(307) 777-7752	(307) 777-7781
FAX 777-7682	FAX 634-0799	FAX 777-5616	FAX 777-6937	FAX 634-0799	FAX 777-5973	FAX 777-5973

January 7, 1994

Oscar A. Paulson
Facility Supervisor
Sweetwater Uranium Facility
Kennecott Uranium Company
P.O. Box 1500
Rawlins, Wyoming 82301

RE: Radioactive By-Product Waste Disposal

Dear Mr. Paulson:

The Wyoming Department of Environmental Quality/Solid and Hazardous Waste Division has evaluated Kennecott Uranium Company's request for a '*de minimis*' exemption from the solid waste permitting rules under Chapter I Section 1(l)(viii) of the Wyoming Solid Waste rules and regulations. The department's evaluation has been based on Kennecott's August 2, 1993, request and the additional information provided on November 4, 1993. In addition, Kennecott has provided an opportunity for public comment on the request to dispose of '*de minimis*' quantities of radioactive by-product wastes at the Sweetwater Uranium Facility's tailings impoundment in Sweetwater County. No significant public comment was received on this request.

Therefore, based on the information provided in the aforementioned correspondence from Kennecott, this letter constitutes the Department's determination that Kennecott Uranium Company should be granted a '*de minimis*' exemption from the solid waste permitting requirements. The types of wastes to be disposed are limited to Section 11.e(2) (Atomic Energy Act of 1954 as amended) radioactive by-product wastes in the form of contaminated sludges, soils and equipment generated as a result of the decommissioning of U.S. Energy's Sheep Mountain Partners Ion Exchange facility located south of Jeffrey City, Wyoming. The total volume of the waste to be accepted for disposal shall not exceed 12,000 tons. Should you wish to dispose any other wastes at any Kennecott facility in Wyoming, solid waste permitting requirements may apply.

Please contact me at (307) 777-7752, should you have any questions regarding this authorization.

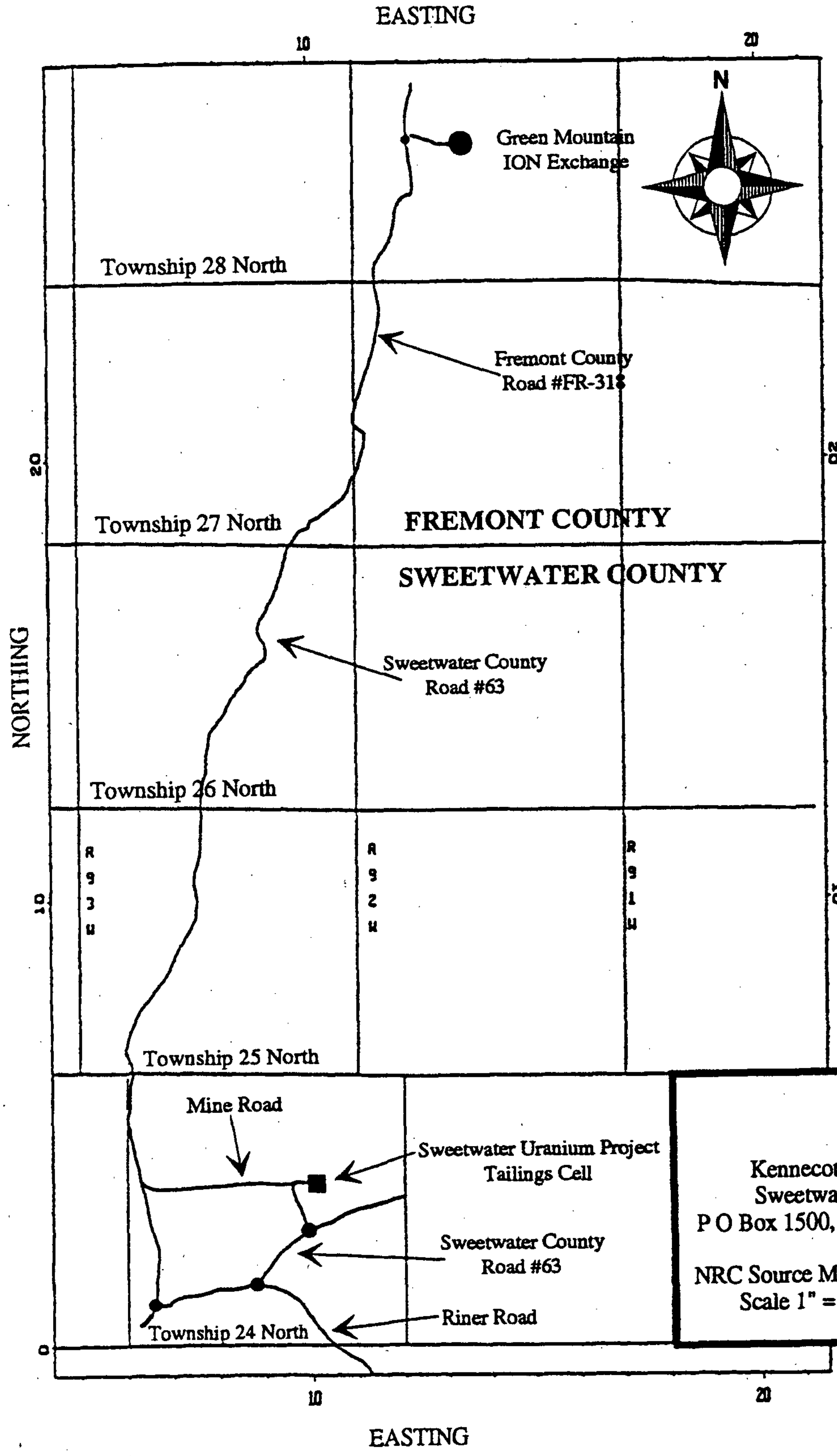
Sincerely,

David A. Finley

David A. Finley
Administrator
Solid and Hazardous Waste Division

COPY : SHWD Files - 62.550 Kennecott Energy
: Vickie Vance - SHWD/Lander
: Roger Shaffer - LQD/Cheyenne
: Mark Moxley - LQD/Lander

SWEETWATER URANIUM PROJECT
WASTE DISPOSAL TRUCK ROUTE MAP

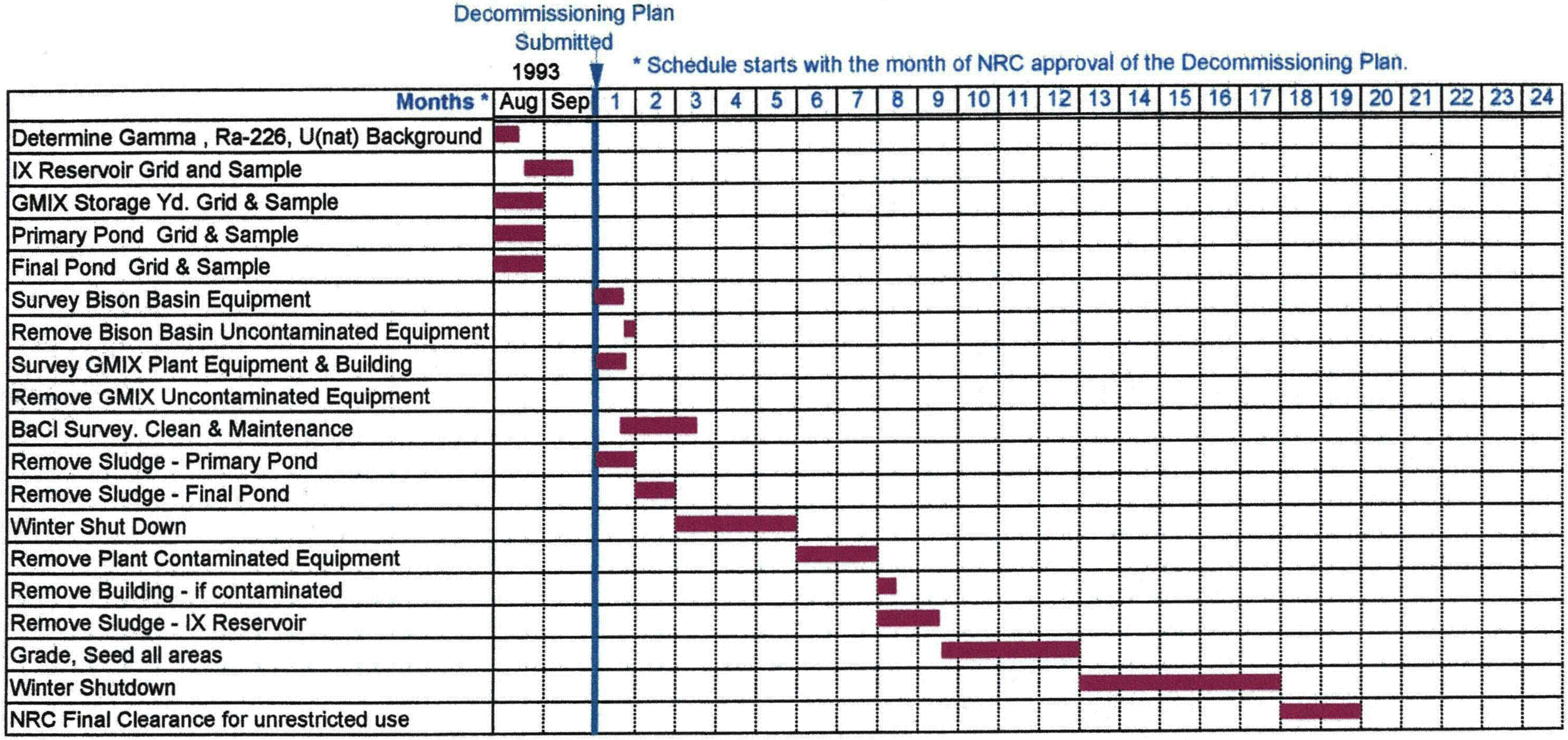


MAP #1

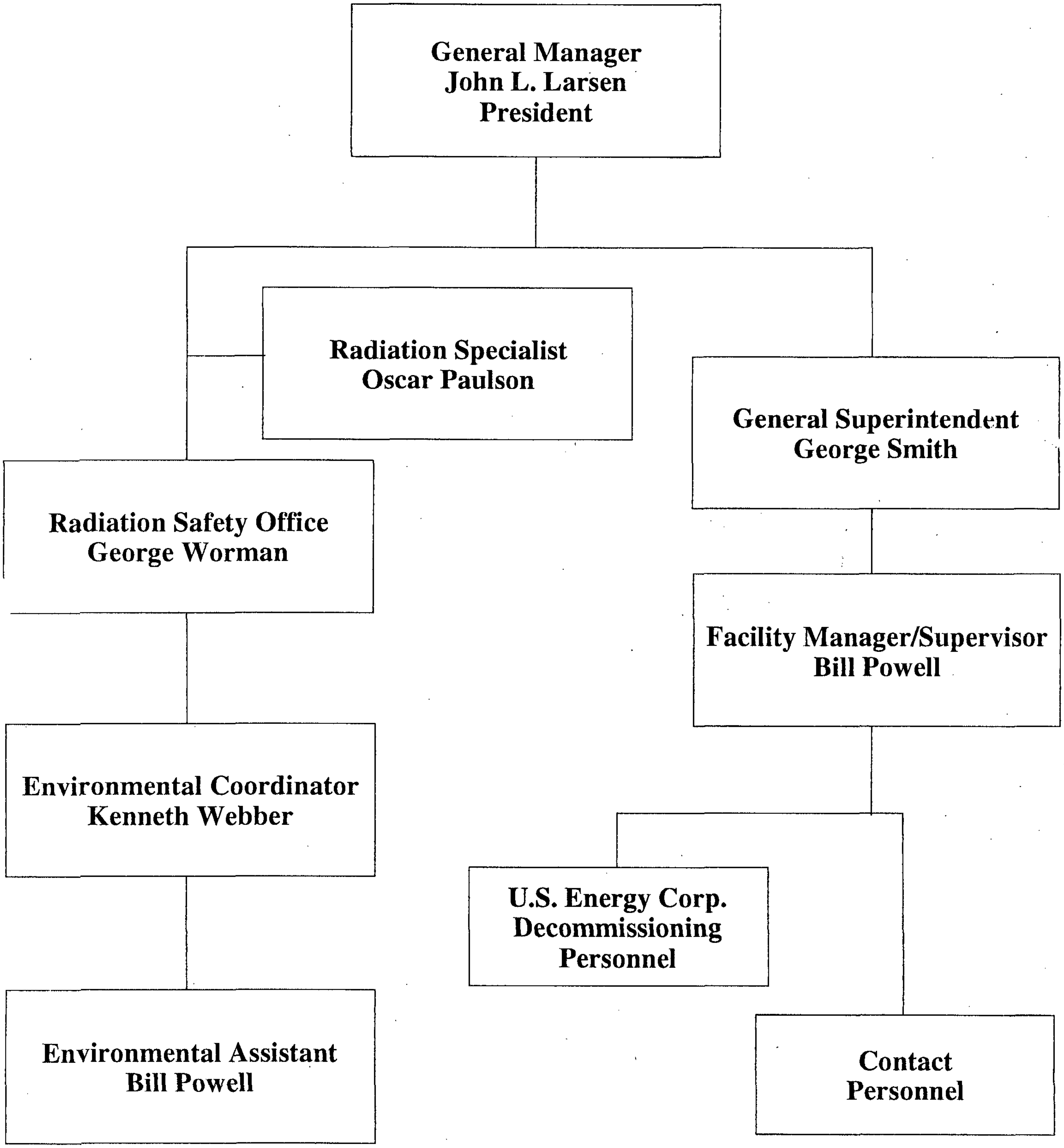
Kennecott Uranium Company
Sweetwater Uranium Facility
P O Box 1500, Rawlins, Wyoming 82301

NRC Source Materials License SUA-1350
Scale 1" = 4 Miles OAP: 7/19/93

Appendix 7
Decommissioning Schedule
GMIX Facility



ORGANIZATIONAL CHART



POSITION DUTIES, RESPONSIBILITIES AND QUALIFICATIONS FOR GMIX FACILITIES DECOMMISSIONING PROJECT

FACILITY MANAGER

I. POSITION QUALIFICATIONS

A. Advanced technical training or BS degree or higher, and/or extensive experience in mining or milling (5-10 years).

B. Training/knowledge in radiation protection, industrial safety, accident prevention, and medical first aid.

C. Proven skills in supervisory and management functions.

II. RESPONSIBILITIES AND DUTIES

A. Overall Responsibilities of Position

Responsible for supervising the decommissioning operation of the entire GMIX facility.

B. Planning

Assist in scheduling long and short term activities to achieve decommissioning objectives.

C. Operating

1. Assigns general and, when necessary, specific tasks to Lead Foreman and the Facility RSO according to prescribed schedules for overall facility destruction.

2. Assists and guides personnel during decommissioning period.

3. Regulates conduct and solves personnel problems.

D. Controlling

1. Reviews daily operations, production, and maintenance records with Decommissioning Staff.

2. Assures that safe practices, environmental permits, and regulatory standards are adhered to, achieved, and/or exceeded.

3. Maintains good relationships with local, state, and federal regulatory agencies, Sweetwater Mill personnel, and local communities.

E. Occasional Duties or Special Assignments

Assists with the conduction of indoctrination seminars and training programs with new employee.

F. Responsibility for Personnel

Line Responsibility - Employees reporting directly to this position:

Lead Foreman
Secretary/Accountant
Radiation Safety Officer
Contractor Personnel

G. Responsibilities for Regulatory Compliance

1. Provides assistance for assuring that all State of Wyoming DEQ, MSHA, NRC, EPA, and other local, state and federal regulations are met and permits maintained for decommissioning the total facility.

2. Assures that safety practices are reviewed with the Radiation Safety Officer and adhered to by all GMIX Facility workers.

3. Provides assistance, when necessary, to assure that the environmental monitoring program is performed in a timely manner.

ENVIRONMENTAL COORDINATOR

I. POSITION QUALIFICATIONS

A. Advanced technical training or BS degree or higher, and/or extensive experience in mining or milling (5-10 years).

B. Training/knowledge in radiation protection, industrial safety, accident prevention, and medical first aid.

C. Proven skills in supervisory and management functions.

II. POSITION DUTIES AND RESPONSIBILITIES

A. Monitor plan decommissioning to ensure consistent application of established radiation and environmental protection procedures, equipment, and controls.

B. Review and evaluate the effectiveness of new plant procedures, equipment, and operations related to radiation protection and environmental control requirements.

C. Perform special tests, evaluations, and calculations as directed by higher classified personnel

D. Prepare the reports required by federal and state regulatory agencies.

E. Assist in conducting routine programs for line supervisors and employees with regard to the proper application of radiation protection, nuclear safety, and environmental control procedures and equipment.

F. Assist in maintaining accurate and timely records as required by federal and state regulations.

G. Responsibility for Regulatory Compliance

1. Responsible for assuring that all state of Wyoming DEQ, MSHA, NRC, EPA and other local, state and federal regulations are met and permits maintained for decommissioning the GMIX Facilities.

2. Assures that safety practices are reviewed with the Radiation Safety Officer and adhered to by all GMIX workers.

3. Provides assistance, when necessary, to assure that the environmental monitoring program is performed in a timely manner.

RADIATION SAFETY OFFICER

I. MINIMUM REQUIREMENTS

A. BS degree in the physical sciences, mathematics or engineering from an accredited college or university, equivalent experience, or a combination of education and experience.

B. Specialized training in radiation protection, with at least bi-annual refresher course.

C. Training and experience in management.

D. Have a working knowledge of radiation detection instruments, biological effects of radiation, and mathematics of radiation.

II. PRIMARY FUNCTION

Develop and administer efficient and cost-effective radiation protection, radiation safety, and environmental control programs which will minimize hazards to employees, plant facilities, and the environment. Assume lead engineering responsibilities for associated programs.

III. SPECIFIC RESPONSIBILITIES

A. Develop and administer corporate radiation protection and radiation safety programs to ensure that (1) employees are afforded the optimum practical protection against related hazards, (2) exposure of employees to radiation and radioactive materials is maintained As Low As Reasonably Achievable (ALARA), and (3) all federal and state regulatory requirements are satisfactorily met.

B. Provide technical guidance and assistance in radiation protection, radiation safety, and environmental control matters to all locations in the form of formal training programs and consultation for site specific problems.

C. Develop radiation protection, radiation safety, and environmental control operating and emergency procedures to ensure consistency of corporate programs at the site.

D. Participate in licensing and permit application activities at the corporate level by supplying the radiation protection, radiation safety, and environmental control technical inputs as required.

E. Develop solutions to existing health physics, radiation safety, and environmental control problems.

F. Analyze program requirements in light of new or proposed federal and state regulations, regulatory guides, and industry standards. Determine the technical and economic impact of such and apprise management accordingly. Update existing programs as necessary to assure compliance.

G. Assist with the conduction of periodic review and audit of individual site radiation protection, radiation safety, and environmental control programs and records to ensure that regulatory requirements are met.

H. Have the authority to stop any operation deemed to be radiologically unsafe as per Regulatory Guide 8.31. Information relevant to ensuring that occupational radiation exposures at uranium mills with be As Low As Reasonably Achievable (ALARA).

ENVIRONMENTAL ASSISTANT

I. POSITION QUALIFICATIONS

A. An associate degree in science or high school diploma and two years equivalent work experience and at least one year training and/or experience in sampling and analytical procedures.

B. In lieu of the above, long-term (5 years) demonstrated work experience in the field of radiation protection monitoring, sampling and analytical procedures will be accepted provided such work experience is verified and documented by U.S. Energy prior to assignment.

II. RESPONSIBILITY AND DUTIES

A. Assist in projects assigned by the Facility Manager, RSO or Environmental Coordinator.

APPENDIX 9

INSTRUMENTATION FOR RADIOLOGICAL SURVEYS

Instrument and Detector	Type of Measurement	Serial No.
Eberline SAC R5	Alpha	738/602548
Eberline Miniscaler, MS-2	Alpha	738
Millipore Scintillation Detector - Model SPA-1	Alpha	738/704727
Ludlum Model 12S Micro-R-Meter	Gamma	11816
Ludlum Model 43-5 Alpha Scintillation Probe	Alpha	PR-103489
Ludlum Model 177 Ratemeter	Alpha	102375
Bendix Super Sampler Pump Model Bdx 44	Air Samples	11-79-270
Bendix Super Sampler Pump Model BDX 44	Air Samples	2-79-142
Ludlum Model 12S Micro-R-Meter	Gamma	92512
Ludlum Model 12 Count Rate Meter	Beta/Gamma	
Ludlum Model 44-9 Probe	Beta/Gamma	PR093335

Note: The type of instrumentation for radiological surveys will be those listed or equal.

CERTIFICATE OF CALIBRATION

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 915-235-5494
501 OAK STREET FAX NO. (915) 235-4672
SWEETWATER, TEXAS 79556, U. S. A.

CUSTOMER U.S. Energy Corp ORDER NO. 93-3054
Mfg. Ludlum Model 177 Serial No. 102375
Mfg. Ludlum Det. Model 43-5 Serial No. PR103489
Cal. Date 7-15-93 Cal. Due Date 7-15-94 Cal. Interval 1Y METERFACE 094
Check mark (✓) applies to applicable instr. and/or detector IAW mfg. spec. T 77 °F RH 66 % Alt 705.8 mm Hg

☑ F/S Resp. ck ☑ Reset ck. ☑ Audio ck. ☑ Meter Zeroed ☐ Window Operation ☐ Background subtract
☑ Alarm Setting ck. ☑ Mechanical ck. ☑ Bat. ck. (Min. Volt) 5.97 VDC Det. Oper. V 800 V at 35 MV
Instrument Volt Set 800 V Threshold Dial ______ Input Sens 35 mV. ☐ Input Sens Linearity
☑ New Instrument Instrument Received: ☐ Within Toler. + -10% ☐ 10-20% ☐ Out Toler. ☐ Requiring Repair
☑ HV Readout (2 points) Ref./Inst. 500 / 500 V Ref./Inst. 1000 / 1000 V

COMMENTS: TH-230 Check source SN 93TH2201468 size 8603 DPM reads ≈ 1200 CPM

Gamma Calibration: GM detectors positioned perpendicular to source except for M. 44-9 in which the front of probe faces source.

RANGE MULTIPLIER	REFERENCE CAL. POINT	INSTRUMENT METER READING *	INSTRUMENT REC'D "AS FOUND READING"
X 1000	400 KCPM	400	
X "	100 "	100	
X 100	40 "	400	
X "	10 "	100	
X 10	4 "	400	
X "	1 "	100	
X 1	400 CPM	400	
X "	100 "	100	
X			
X			
X			

*Uncertainty within + -10% C. F. within + -20% All Range(s) Calibrated Electronically

	Reference Cal. Point	Instrument Meter Reading	"As Found Reading"
Digital Readout	/ / / / /	/ / / / /	/ / / / /
Log Scale	/ / / / /	/ / / / /	/ / / / /

Ludlum Measurements, Inc. certifies that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology, or to the calibration facilities of other International Standards Organization members, or have been derived from accepted values of natural physical constants or have been derived by the ratio type of calibration techniques. The calibration system conforms to the requirements of MIL- STD-45662A and ANSI N323-1978

☐ Cs137 Gamma s/n 1162, G112, M565,5105, 5604, T879 ☐ Neutron Am-241 Be s/n T-304 State of Texas Calibration License No. LO-1963

☑ Alpha s/n TH-230 #1619 ☐ Beta s/n ______ ☐ Other ______

☑ M-500 s/n 38116 ☐ Oscilloscope s/n ______ ☑ Multimeter s/n 57770265

Calibrated By: Patrick Brand Date 7-15-93

Reviewed By: Michael Moore Date 7-15-93

Form 22 — 12-92

DESIGNER AND MANUFACTURER
OF
Scientific and Industrial Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 915-235-5494
501 OAK STREET FAX NO. (915) 235-4672
SWEETWATER, TEXAS 79556, U. S. A.

Bench Test Data For Detector 43-5 S/N PR103489

Customer U.S. Energy Corp. Order No. 93-3054

Counter 177 S/N 102375 Distance-Source to Detector Protective Screen

Count Time CPM Counter Input Sensitivity 35mV

Isotope Th-230 S/N 16A Size 3442 CPM Other

43-4/43-44 HV ADJ FOR ALTITUDE

ALT.	HIGH VOLTAGE
Sea Level	2050 V
1000 foot	2025 V
2000 foot	2000 V
3000 foot	1975 V
4000 foot	1950 V
5000 foot	1925 V
6000 foot	1900 V
7000 foot	1875 V

ALPHA SCINTILLATION DETECTOR

HV Plateau	Background	Source Count
700	0	900
750	0	1000
800	0	1000
850	0	1000
900	7	1000

OPERATING VOLTAGE SET AT 800 V

AIR PROPORTIONAL	43-5	43-65	BACKGROUND	METER READING	RANGE/SCALE
//////////	Toe	L/S *	0	100	X10
	Center	Center	0	100	X10
//////////	Heel	** Other	0	100	X10

☐✓ Uniformity (± 10%) Ave. Efficiency 29 %

* Least Sensitive Position (Heel Of Probe)

* * Opposite Least Sensitive Position (Top Of Probe)

Date 7-15-93 Signature Patrick Brand

Form 21

DESIGNER AND MANUFACTURER
OF
Scientific and Industrial Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 915-235-5494
501 OAK STREET FAX NO. (915) 235-4672
SWEETWATER, TEXAS 79556, U. S. A.

RETURNED GOODS FORM

(PLEASE FILL IN THE APPROPRIATE INFORMATION FOR EACH SHIPMENT)

Date ________________

Item(s) returned for:
☐ Calibration ☐ Repair ☐ Other ________________________________

Company Name ____

Contact Person ______________________________ Phone ( ) ____________
(Technical or User)

Bill to Address: Ship to Address: Ship Via ____________

______________________________ ______________________________
______________________________ ______________________________
______________________________ ______________________________
______________________________ ______________________________

INSTRUMENT/PROBE MODEL NUMBER	SERIAL NUMBER	INSTRUMENT/PROBE MODEL NUMBER	SERIAL NUMBER

Purchase Order # ________________ ☐ Call for PO# ☐ Call with Estimate

Contact Person ______________________________ Phone ( ) ____________
(Purchasing)

Malfunction Symptoms, Special Instructions, etc. ______________________________

____
____
____
____

Form 34

• *Serving The Nuclear Industry Since 1962* •

LUDLUM MODEL 177
ALARM RATEMETER

Revised December 1992
Serial No. 99034 and Succeeding
Serial Numbers

LUDLUM MEASUREMENTS, INC.
501 OAK ST., P.O. BOX 810
SWEETWATER, TX 79556
915/235-5494 FAX: 915/235-4672

WARRANTY CERTIFICATE

Ludlum Measurements, Inc. warrants the products covered in this instruction manual to be free of defects due to workmanship, materials, and design for a period of twelve months from the date of delivery, with the exception of photomultiplier tubes and geiger tubes, which are warranted defect-free for 90 days. This warranty is voided in instances of improper installation, abuse, mishandling, misuse, freight damage, or repair by unqualified persons.

In the event of instrument failure, notify Ludlum Measurements, Inc. for repair or replacement. Liability of this warranty is limited to the purchase price of the instrument.

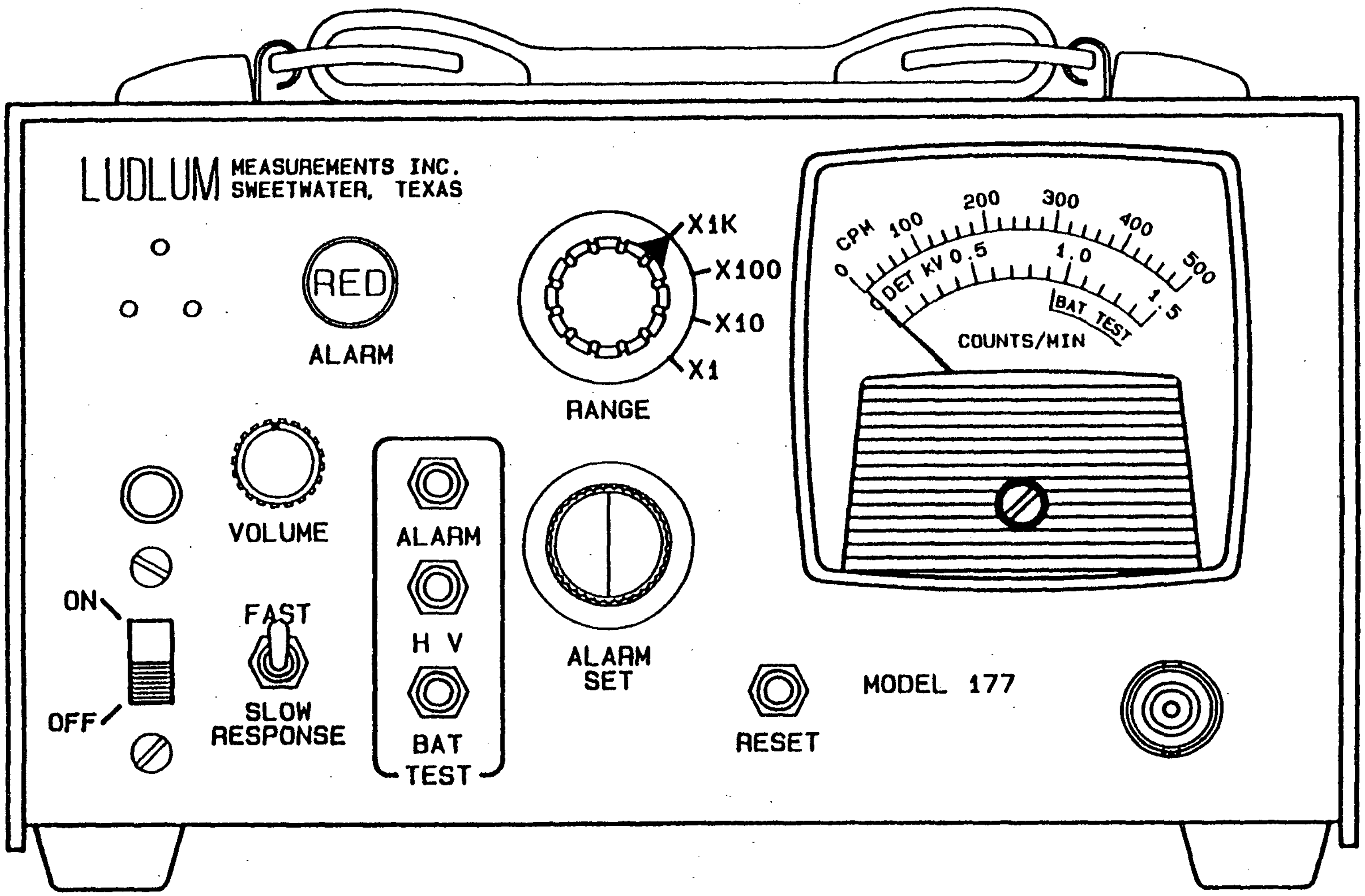
RECEIVING CONDITION EXAMINATION

Be sure to verify that the shipping carton is received in good condition with no visible damage. Should the instrument be received in a damaged condition, save the shipping container and the packing material and request an immediate inspection by the carrier.

RETURN OF GOODS TO MANUFACTURER

If equipment needs to be returned to Ludlum Measurements, Inc. for repair or calibration, please send to the address below. All shipments should include documentation containing return shipping address, customer name, telephone number, description of service requested, and all other necessary information. Your cooperation will expedite the return of your equipment.

LUDLUM MEASUREMENTS, INC.
ATTN: REPAIR DEPARTMENT
501 OAK STREET
SWEETWATER, TX 79556
915-235-5494
FAX 915-235-4672



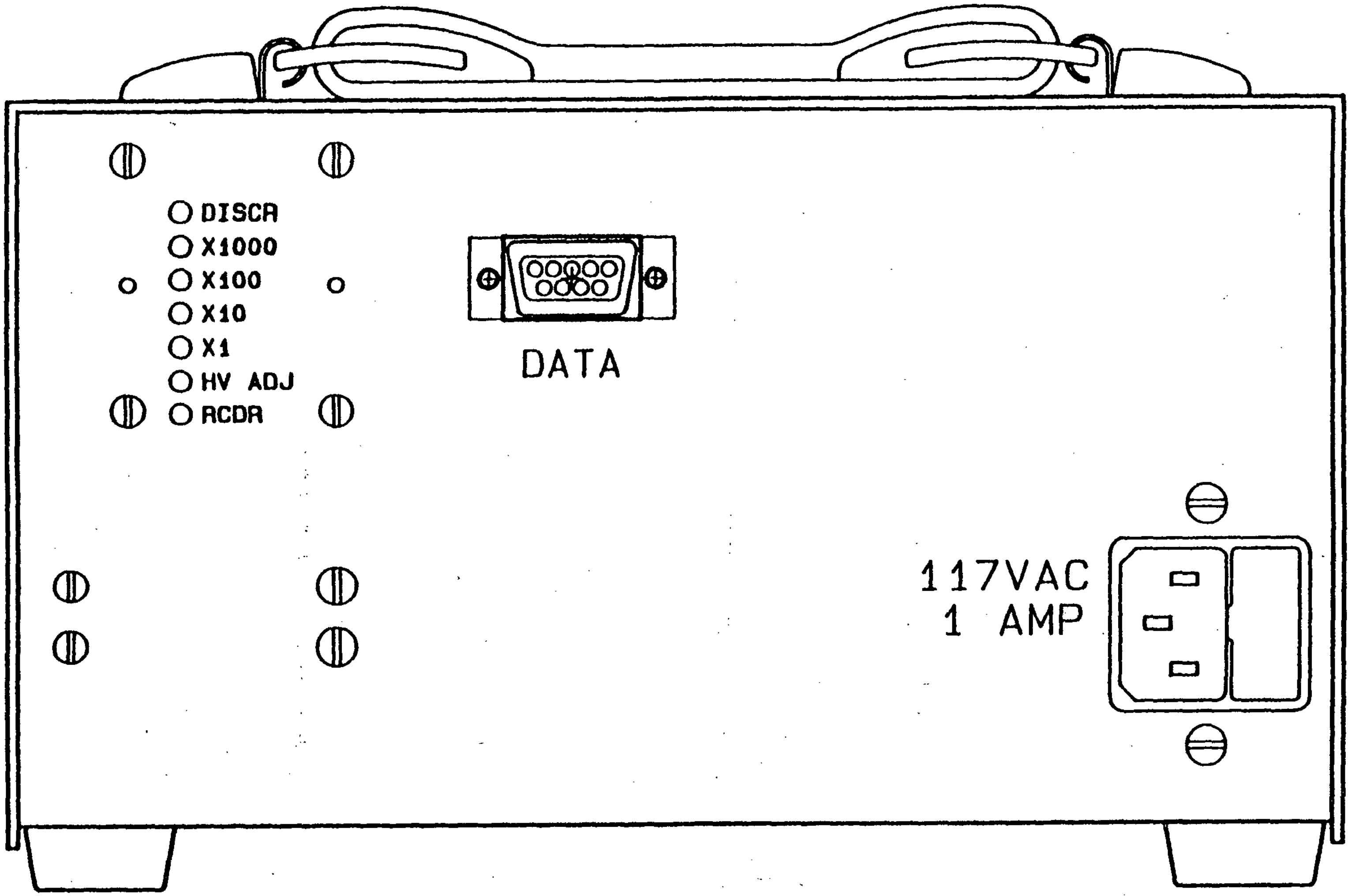
CHG	NO.		DWN	CHK	APP
DWN BG	DATE 1-4-93	CHK DATE		APP DATE	

TOL: SHOP STD ☐ OTHER
SCALE: FULL ☐ OTHER

TITLE M177 ALARM RATEMETER

LUDLUM MEASUREMENTS, INC. 501 OAK STREET SWEETWATER, TEXAS 79556

DRAWING 347 SHEET 28



CHG	NO.				DRN	CHK	APP
DRN BK	DATE 11-13-82	CHK	DATE		APP	DATE	

TOL: SHOP STD ☐ OTHER — SCALE: FULL ☐ OTHER

TITLE M 177 ALARM RATEMETER

LUDLUM MEASUREMENTS, INC. — SERIES 347 — SHEET 142

TABLE OF CONTENTS

1. GENERAL

The Model 177 may be used with G-M or scintillation detectors. The unit provides four ranges to 500,000 counts/minute. Detector high voltage is adjustable from 400 to 1500 volts.

An alarm adjust is located on the front panel. The alarm setting may be checked with the front panel Test switch. An alarm reading will be indicated by audio and visual alarms.

Accessory outputs include: Unbuffered Output, Supply Voltage, Negative Pulse Output, Recorder and Alarm Sink for Remote Relay.

The unit may be operated from internal rechargeable batteries or line power.

2. SPECIFICATIONS

- POWER: 117 VAC 60 Hz line power and 6V Gel-Cell (sealed lead-acid) battery.

- FUSE: 1 amp, 5 x 20 mm 250V fuse.

- RESPONSE TIME: Two positions, fast 2.2 seconds, slow 22 seconds for 90% of full scale reading.

- LINEARITY: Within plus or minus 5% full scale, typically plus or minus 2% of full scale reading when measured with an electronic pulser.

- BATTERY DEPENDANCE: Instrument calibration change less than 3% within battery check limits on meter.

- HIGH VOLTAGE: Variable from 400 to 1500 volts.

- INPUT SENSITIVITY: Adjustable from 10 through 60 millivolts.

- CONNECTOR: Series "C".

- AUDIO: Unimorph speaker with volume control located on front panel.

- METER: 1 mA, 2 1/2 inch D.C. movement.

- METER SCALE: 0-500 CPM; 0-1.5 KV; BAT TEST.

- RANGES: Four ranges of X1 through X1k.

- RECORDER OUTPUT: Adjustable to 1.0 volts at 1mA.

- ALARM OUTPUT: Current sink to 200 mA DC. Open circuit voltage not to exceed 50 volts DC.

- UNBUFFERED OUTPUT: May be used to externally add to or subtract from the meter reading.

- ALARM RANGE: Adjustable from 0 through 150% of full scale.

- ALARM OUTPUT: Visual comp, audio tone and remote current sink.

- FINISH: computer-beige, polyurethane enamel with silk-screened nomenclature.

- SIZE: 6" (15.24 cm)L x 8" (20.32 cm)W x 5"(12.7 cm)H, excluding handle.

- WEIGHT: 4.2 lbs. (1.9 kg), with battery.

3. DESCRIPTION OF CONTROLS AND FUNCTIONS

3.1 Front Panel

- Power ON-OFF Switch: Provides line power of 117 VAC 60 Hz to the instrument and trickle-charges the standby Gel-Cell battery. In case of line power failure, the Gel-Cell battery automatically comes on line to power the instrument. The battery will provide up to 50 hours of operation.

✓NOTE: To recharge the battery the ON/OFF switch must be in the ON position.

- Power-on Lamp: A red lamp that comes on when power is applied to the instrument.

- VOLUME Control: Varies the volume of the audio output through the unimorph speaker. This control has minimal effect on the audio when alarmed.

- Audio Speaker: A unimorph speaker, located behind the front panel.

- ALARM Lamp: A red lamp that comes on when the alarm threshold has been exceeded. The lamp will remain on until the reset button is depressed, driving the meter below the alarm threshold.

- RANGE Selector Switch: A four-position switch providing range multipliers of X1K, X100, X10, X1. With a scale of 0-500 CPM, the full range of the instrument is 0 to 500,000 CPM.

- Ratemeter: A four-decade linear meter with ranges of 0-500, 0-5000, 0-50,000, 0-500,000 CPM. Readout is on a 2 1/2-inch scale panel meter. A separate scale is provided for battery check and high voltage.

- Connector: A Series "C" connector. (Series BNC and MHV connectors are also available). The connector is provided on the front of the instrument to connect the detector to the instrument.

- RESET Button: When depressed, provides a rapid means to drive the meter to zero.

- FAST-SLOW RESPONSE Toggle Switch: When in the FAST position, provides a full scale meter deflection of 2.2 seconds. In SLOW position, the full scale meter deflection takes 22 seconds. For fast response and large meter deviation, the FAST position should be used. For slow response and damped meter response, the SLOW position should be used.

- BAT TEST Button: When depressed, displays the battery status on the meter. A sufficiently charged battery is indicated when the meter pointer is on or to the right of the BAT TEST mark.

- H.V. TEST Button: When depressed, displays the detector high voltage on the meter.

- ALARM TEST Button: When depressed, displays the ALARM calibration on the meter.

- ALARM SET: Used to adjust the alarm calibration. Note the locking knob below the control.

3.2 Back Panel

- 117 a-c plug: Provides power to the instrument from a 117 volts 60 Hz line.

- 1A fuse: Provides line protection with a 1 amp 5 x 20 mm 250V fuse.

- Data: A 9 pin type D data plug with connections as follows:

  - PIN 1: Battery terminal. This is a direct connection and does not go through the front panel ON-OFF switch. Use to parallel battery or use external charger.

  - PIN 2: Unregulated supply from approximately 6 volts, battery only to 9.5 volts with AC power on. Limit current drain to 50 milliamperes.

  - PIN 3: Instrument common (Ground).

  - PIN 4: Alarm sink. The open collector of a 2N7000. Limit sink current to 200 milliamperes with open circuit voltage limited to 0-+50 volts. Unit conducts when in alarm.

  - PIN 5: Pulse Out. A negative pulse connected to the discriminator output through a 0.001 μF capacitor. Typically $\geq$ -4 volts.

  - PIN 6: Unbuffered output ties directly to the meter drive circuit. (R53/C91). Approximately 1.3 volts at full scale. Using an external constant current sink will allow background subtract. At full scale, draws out approximately 3.3 micro amps to zero the meter.

  - PIN 7: Recorder output adjustable from 0 to 1.0 volts at 1 milliamperes.

  - PIN 8 and PIN 9: Spares.

3.3 CAL Control

Remove cal cover plate.

- DISCR: Discrimination Control. Set at 40 $\pm$10 millivolts for most applications. Adjustable from 10 to 60 millivolts.

- Calibration Controls: X1K through X1 calibration controls used to calibrate ranges.

- HV ADJ: Used to set detector operating voltage.

- RCDR: Used to calibrate the recorder output.

3.4 Internal Control

(For overhaul only). Internal controls are located on the circuit board.

- BC: Used to adjust charge voltage to 6.825 volts.

- BT: Used to adjust meter test voltage reading to 5.97 volts at the Bat OK line.

- HV: Used to adjust the high voltage test reading to correspond with the actual high voltage output.

4. OPERATING PROCEDURES

The Model 177 is designed for operation with G-M or scintillation detectors with a voltage operating range of 400 to 1500 volts. The most stable part of the plateau will have to be determined for each detector when selecting the correct operating point.

For G-M tubes, the voltage is normally 900 volts or as recommended by the manufacturer. For scintillation detectors, the high voltage supply will normally require adjustment each time the detector or source of energy is changed. The gain spectrum of the photomultiplier tubes is very wide (1000-1 typically at a single operating point).

4.1 Preparing the Instrument for Use

o Connect the instrument to line power. Turn the power switch to ON.

o Depress the BAT TEST button. Check that the meter reads above the BAT TEST indication. If the battery does not check, the instrument will operate on AC line power only. The battery may be trickle-charged from line power or fast charged from an external source.

o Select the operating point. Connect the detector to the front of the instrument, expose the detector to a source and run a count versus HV plateau by adjusting the HV adjustment, located on the back of the instrument. Select the operating point when a stable reading (no increase in count with increase in high voltage) is achieved with an acceptable background count. NOTE: For G-M detectors, set the voltage at 900 volts. Unless otherwise noted, most "Tiny" GM tubes operate at 550 volts.

4.2 Operating the Instrument

o High Voltage - adjusted (determined above).

o RESPONSE - as desired.

o VOLUME - as desired.

o RANGE Selector - set appropriate range.

o Detector - connected. Obtain a meter reading from a source.

o ALARM SET - Press Alarm Test Switch and adjust Alarm Set control for desired alarm point.

✓ NOTE: Meter reading is alarm point with Alarm Test Switch pressed. Recheck after locking control.

o Increase meter count - increase the meter count to exceed the alarm threshold. The alarm light and the audio circuit should energize.

o RESET Button - depressed. The meter should drive to zero and the alarm circuit should de-energize.

o H.V. Test - depress and note high voltage.

o Proceed with use.

5. CALIBRATION

✓ NOTE: LOCAL INSTRUCTIONS MAY SUPERSEDE THESE INSTRUCTIONS.

- Connect the instrument to a Ludlum Pulser or equivalent.

- The ratemeter may be calibrated by adjusting calibration controls labeled 1; 10; 100 and 1K. Starting with the 1000 range, apply 400,000 CPM from the Model 500 Pulser. Adjust for proper reading. Drop pulse rate to 100,000 CPM and observe reading at 100,000 ±10,000 CPM.

- Repeat this procedure for the lower scales with scaled pulse rates.

- Adjust DISCR for 40 ±10 millivolts for GM detectors. To lower scintillation detector operating voltage, decrease input sensitivity to 10 ±2 millivolts. Adjustment is made by setting the pulse generator amplitude to the desired pulse height. Then adjust the DISCR control until the meter reaches 75% of the generated incoming count rate.

- Connect the Model 177 to an external voltmeter. Adjust the rear panel HV control for a reading of 1000 VDC on the voltmeter. Depress the HV test switch and adjust the HV meter potentiometer located on the main circuit board for 1.0kV on the meter. Vary the HV output from 500 to 1500 VDC and ensure HV meter reads ±10% of the actual HV output.

- Adjust RCDR recorder output for 1 volt, equal to full scale.

- Set ALARM SET point as desired.

6. MAINTENANCE

Instrument maintenance consists of keeping the instrument clean and periodically checking the batteries and the calibration.

An instrument operational check should be performed prior to each use by exposing the detector to a known source and confirming the proper reading on each scale.

Recalibration should be accomplished after any maintenance or adjustment has been performed on the instrument. Ludlum Measurements recommends recalibration at intervals no greater than one year.

For battery maintenance it is recommended that the instrument be connected to line power and left in the "on" position constantly. This will keep the internal battery fully charged.

When the instrument is used without line power, adequate charge time must be allowed for the internal battery to recharge. If possible, leave the instrument on with line power applied overnight and weekends. At the minimum, allow one hour of charge time for each hour of use. If the battery is inadvertently allowed to fully discharge and is left discharged, constant charging for 500 hours (3 weeks) may be required for battery recovery.

✓ Note that the ON-OFF switch must be in the "on" position to charge the batteries.

If the unit is out of service for extended periods of time, charge the batteries every 6 months.

7. THEORY OF OPERATION

7.1 Amplifier

Negative detector pulses are coupled through C124 to emitter follower Pin U121. R127 protects the input from inadvertent H.V. shorts. R129 couples the detector to the high voltage supply.

Negative pulses from emitter, Pin 2 of U121, are coupled through C121 to amplifier Pin 5 through Pin 7 of U121. This amplifier is self biased and provides gain in proportion to R029 divided by R021C. Transistor (pins 4-5-6, U121) provides amplification. Pin 12,15 of U121 are coupled as a current mirror to provide a load for Pin 6 of U121. The output self-bias to 2 Vbe (approximately 1.4 volts) at Pin 7 of U121. This provides just enough bias current through Pin 6 of U121 to conduct all of the current from the current mirror.

Positive pulses from Pin 7 of U121 are coupled to the discriminator.

7.2 Discriminator

Comparator U021 provides discrimination. The discriminator is set by the DIS (Discriminator) control located on the rear panel, coupled to Pin 5 of U021. Negative pulses (approx. 5 volts) at Pin 7 of U021 are coupled to Pin 5 of U011 for meter drive and Pin 11 of U011 for audio.

7.3 Digital Analog Conversion

Pin 7 of U021 is connected to the dual univibrator, U011. For each low pulse for Pin 7 of U021, Pin 6 of U011 goes high. The pulse of Pin 6 of U011 is typically 5.0 volts for 6 milliseconds on X1 to 6 microseconds on X1k. This pulse is connected to the constant current drive U012. The pulse width control (R3-C2 on cal. bd.) is utilized for calibration adjustment. Controls R4 through R6 allows calibration on other scales.

For each positive pulse connected to Pin 8 of U012, a constant current pulse is sourced at Pin 15 of U012. This current pulse charges C122, which is discharged by R124. The average voltage on C122 is coupled through HV, BAT, and ALARM Test Switch to voltage follower Pin 5 of U311. Pin 7 of U311 drives the meter and recorder output.

7.4 Time Constant

The meter time constant is determined by R124 and C122. For a slower time constant, C122 is paralleled by C101. When C101 is not used, it is connected to Pin 7 of U311 (voltage follower), maintaining the same voltage level as C122. This allows C101 to be switched in or out of the circuit without transients.

7.5 Alarm

An alarm is provided by U021, Pins 1, 2, and 3. The alarm set control biases the op-amp U021 for a low output. When the meter signal at Pin 3 exceeds the bias of Pin 2, the output at Pin 1 goes high. Q102 and Q103 saturate, allowing supply voltage to be coupled to:

- Lamp voltage through R004
- Audio Oscillator U16 through CR112
- R116 couples back to Base of Q102, locking up the Alarm On
- Through CR113 to Audio Transformer T211, allowing full voltage for full volume
- Through R111 to saturating current sink Q101 for external use

7.6 Reset

Reset is provided by coupling a voltage to the base of transistors U012 pins 1, 2, 3, and 4, 5, 6. Both transistors saturate. One discharges C122 causing the meter to zero. Pin 3 U012 turns Q102 off, allowing the alarm to reset.

7.7 Audio

A high on Pin 4 U111 turns the oscillator on saturating Q111 with each positive swing of the oscillator. T211 couples the pulses to the unimorph. Audio volume is controlled by voltage, applied to Pin 2 of T211. This is either 4.3 volts from the alarm circuit or 0 to 4.3 volts from external volume control through emitter follower Q104.

For counting, audio pulse width is set by R113/C111 of U011 with one pulse per count. For an alarm condition, Pin 4 U111 is held high through CR112 until alarm is reset. Alarm Tone is controlled by R117 and C112.

7.8 High Voltage

The high voltage power supply is a blocking oscillator utilizing Q401-T411 and quadrupler CR123, CR421, CR422 and through CR423. The HV output is controlled by conduction to ground through Q302. With Q302 saturated, the HV output is maximum. The op amp, U311 Pins 1, 2, 3, is used as a comparator to compare the voltage reference at Pin 3 to the feedback voltage at Pin 2 through R322 for voltage control and regulation. High voltage is adjusted by H.V. control R311 changing bias on Pin 2 U311. With the HV control wiper at ground, H.V. output is maximum.

7.9 Low Voltage

Low voltage is supplied by internal battery B1 (wiring diagram, 347 x 126) or line power T1. Unregulated power at C125 is coupled to voltage regulator VR211 and battery charger U201-Q301.

Regulated low voltage is supplied to the balance of the circuit through VR131 at 5.0 volts and U301 at 1.2 volts.

7.10 Battery Charge

Battery charge is provided by voltage regulator U201 and power transistor Q301. R402 limits charge current for discharged battery. A negative voltage coefficient of 0-0063 volts per degree F is provided by ratio of R013/R201. R013 set output voltage to 6.825 volts.

7.11 High Voltage Test

High voltage test is supplied by R001 through H.V. Test switch, Bat Test switch, Alarm Test, Pin 5 of U311, then the meter. The H.V. readout is calibrated by R001.

7.12 Alarm Set Voltage

Alarm set voltage is coupled from alarm set control through the Alarm Test switch, voltage follower Pin 5 of U311, and to the meter.

7.13 Bat Test Voltage

Battery test voltage is controlled by R002 through Battery Test switch, Alarm Test switch, voltage follower Pin 5 of U311 to the meter.

LUDLUM MODEL 43-5 APLHA SCINTILLATION PROBE

TABLE OF CONTENTS

JAN.1990

LUDLUM MODEL 43-5 ALPHA SCINTILLATOR

1. GENERAL

The Model 43-5 Alpha Scintillator is designed for easy handling when making survey sweep for detecting alpha radiations.

2. SPECIFICATIONS

Window: two layers of 0.4 mg/cm^2 aluminized mylar (10 gauge)

Window Area: 50 cm^2 active area

Efficiency: 25% of 2 pi emission with Pu-239 source in contact with probe grille.

Operating Point: 600 volts - 1000 volts

Multiplier Tube: 1 1/2-inch diameter

Scintillator: Zns (Ag)

3. MAINTENANCE

Normally, causes of malfunction of the Model 43-5 are due to either light holes in the thin aluminized mylar or a defective multiplier tube. The malfunction caused by light holes gives an increase in background noise up to complete saturation where the instrument may indicate zero count. If the instrument indicates zero count, reduce the high voltage and cover probe face with an opaque material. By movement of the opaque material, a light leak should be able to be discerned. To repair the face of the probe (refer to Drawing #1).

1. Remove the metal clamps - 10 screws
2. Remove the 1/16 thick grille from face.
3. Remove aluminized mylar from grille and clean off old glue from grille.
4. Inspect gasket - replace if torn
5. Inspect face for a complete coating of Zns: redope if applicable.
6. Reglue 2 layers of 0.4 mg/cm^2 aluminized mylar to grille.

Note: The thin mylar is very susceptible to punctures. Extreme care should be exercised while gluing the aluminized mylar to the grille and reinstalling grille to the face of probe.

7. Install metal retainer clips. For malfunctions caused by the tube, a zero count, intermittent or a very reduced count, may occur. After thoroughly checking for a light leak, replacement of the tube may be necessary. After removing the tube from the probe body, check the front of the tube face. A tube that has become deflective may show a clear color through the face, instead of the dark amber color.

Replacement of Photomultiplier Tube (Refer to Drawing #2)

1. Unfasten end connector cap - 4 screws

2. Slowly remove end connector cap and pull out as far as wires will allow.

3. Remove ground and high voltage wires from end connector cap.

4. Remove foam and plastic spacers.

5. To remove the photomultiplier tube- rotate and firmly pull on tube socket.

   Note: The optical silicone grease is applied between the photo tube and the light pipe. By rotating the photo tube the coupling seal is weakened and will allow the PMT to be to be removed without damage to the components.

6. Remove tube from tube socket.

7. Remove metalic shield.

8. Install new tube to tube socket.

9. Clean plexiglass area where tube fits against with alcohol.

10. Slide the meter shield over the tube and tape to tube socket.

11. Apply optical silicon grease to the face of the tube. Use only that amount which when pressed firmly against the plexiglass will spread and cover the face of the tube. Approximately a one-quarter teaspoon.

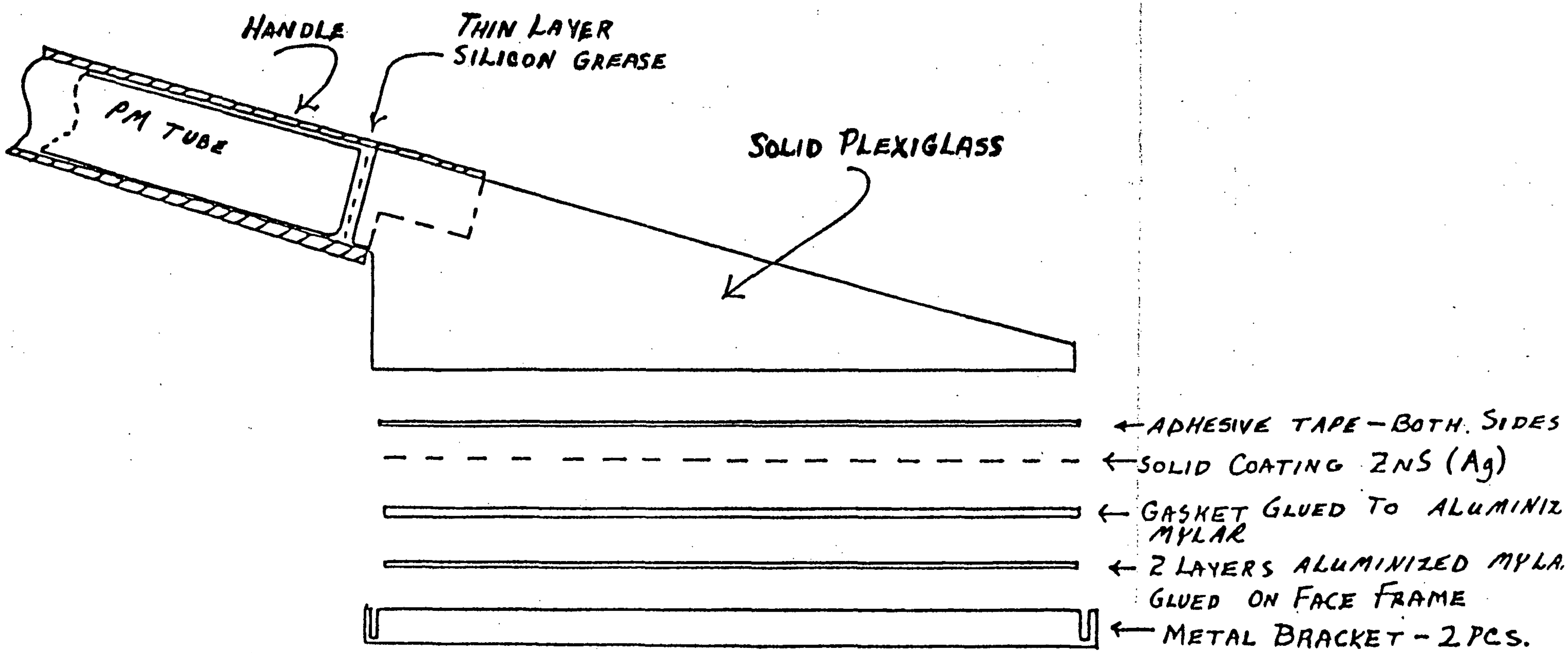
12. Place the tube with socket into the handle. Press unit firmly against the plexiglass with a little back and forth twisting movement to spread the coupling compound evenly across the tube and light pipe surfaces. Do not pull out on the photo tube after pressing tube to plexiglass. This could disturb the interface and reduce probe efficiency.

13. Install the plastic spacers and foam. Reconnect the HV and ground wires to the end cap.

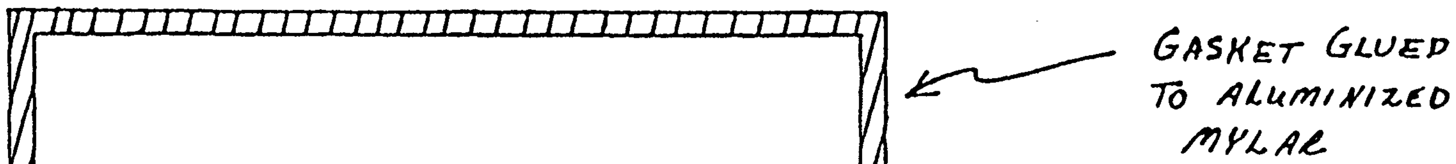
14. Install end cap to complete final assembly.

4. REPLACEMENT PARTS LIST:

PART NO.	DESCRIP.	QTY.
70077-007-01	PLEXIGLASS LIGHT PIPE	1 EA.
01-5001	PM TUBE	1 EA.
40-4039	TUBE SOCKET	1 EA.
40-4006	TUBE SHIELD	1 EA.
40-4111	REPL. FACE W/MYLAR	1 EA.
03-5351	LIGHT TIGHT BLACK TAPE	
03-5412	DOUBLE SIDED TAPE	
14-5431	ZINC SULFIDE (SOLD BY OZ.)	
7077-007-02	SIDE BRACKETS FOR FACE	2 EA.
22-9546	PAPER GASKET	1 EA.
2077-006-05	M43-5 MAIN BODY ASSY	1 EA.
7002-029-04	PLEXIGLASS SPACER	1 EA.
7002-029-05	SPONGE	3 EA.
7002-029-02	CONNECTOR END CAP	1 EA.
13-7751	CONNECTOR UG706/U	1 EA.
03-5374	COUPLING SILICONE GREASE	
17-8811	4-40 X 3/16 BH SCREW	4 EA.
17-8565	4-40 X 1/8 TH SCREW	4 EA.
17-8531	4-40 X 1/8 SOC SET SCREW	4 EA.
17-8522	4-40 X 3/16 TH SCREW	6 EA.
7237-008	PROTECTIVE PROBE COVER-VINYL	
7085-064	CONNECTOR WRENCH (FOR "C" CONN.)	



NOTE: Use Light tight Black TAPE AROUND EDGE OF WINDOW Before securir metal BRACKETS.



ORIGINAL

No– 1 Drawn

FACE ASSEMBLY

CERTIFICATE OF CALIBRATION

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 915-235-5494
501 OAK STREET FAX NO. (915) 235-4672
SWEETWATER, TEXAS 79556, U. S. A.

CUSTOMER U.S. Energy Corp ORDER NO 93-3054
Mfg Ludlum Model 177 Serial No. 102375
Mfg Ludlum Det. Model 43-5 Serial No. PR103489
Cal. Date 7-15-93 Cal. Due Date 7-15-94 Cal. Interval 1yr METERFACE 096

Check mark (✓) applies to applicable instr. and/or detector IAW mfg. spec. T 77 °F RH 66 % Alt 705.8 mm Hg

☑ F/S Resp. ck ☑ Reset ck. ☑ Audio ck. ☑ Meter Zeroed ☐ Window Operation ☐ Background subtract
☑ Alarm Setting ck. ☑ Mechanical ck. ☑ Bat. ck. (Min. Volt) 5.97 VDC Det. Oper. V 800 V at 35 MV
Instrument Volt Set 800 V Threshold Dial ______ Input Sens 35 mV. ☐ Input Sens Linearity
☑ New Instrument Instrument Received: ☐ Within Toler. + -10% ☐ 10-20% ☐ Out Toler. ☐ Requiring Repair
☑ HV Readout (2 points) Ref./Inst 500 / 500 V Ref./Inst 1000 / 1000 V

COMMENTS: Th-230 check source SN 93TH2201968 size 8603 DPM reads ≈ 1200 CPM

Gamma Calibration: GM detectors positioned perpendicular to source except for M. 44-9 in which the front of probe faces source.

RANGE MULTIPLIER	REFERENCE CAL. POINT	INSTRUMENT METER READING *	INSTRUMENT REC'D "AS FOUND READING"
X 1000	400 KCPM	400	
X "	100 "	100	
X 100	40 "	400	
X "	10 "	100	
X 10	4 "	400	
X "	1 "	100	
X 1	400 CPM	400	
X "	100 "	100	
X			
X			
X			

*Uncertainty within + -10% C. F. within + -20% All Range(s) Calibrated Electronically

	Reference Cal. Point	Instrument Meter Reading	"As Found Reading"
Digital Readout	/ / / / /	/ / / / /	/ / / / /
Log Scale	/ / / / /	/ / / / /	/ / / / /

Ludlum Measurements, Inc. certifies that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology, or to the calibration facilities of other International Standards Organization members, or have been derived from accepted values of natural physical constants or have been derived by the ratio type of calibration techniques. The calibration system conforms to the requirements of MIL- STD-45662A and ANSI N323-1978

☐ Cs137 Gamma s/n 1162, G112, M565,5105, 5604, T879 ☐ Neutron Am-241 Be s/n T-304 State of Texas Calibration License No. LO-1963

☑ Alpha s/n Th-230 #1619 ☐ Beta s/n ______ ☐ Other ______

☑ M-500 s/n 38116 ☐ Oscilloscope s/n ______ ☑ Multimeter s/n 57770265

Calibrated By: Patrick Brand Date 7-15-93

Reviewed By: Michael Moore Date 7-15-93

Form 22 — 12-92

DESIGNER AND MANUFACTURER
OF
Scientific and Industrial Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 915-235-5494
501 OAK STREET FAX NO. (915) 235-4672
SWEETWATER, TEXAS 79556, U. S. A.

Bench Test Data For Detector 43-5 S/N PR103489

Customer U.S. Energy Corp Order No. 93-3054

Counter 177 S/N 102375 Distance-Source to Detector Protective Screen

Count Time CPM Counter Input Sensitivity 35mV

Isotope Th-230 S/N 16A Size 3442 CPM Other

43-4/43-44 HV ADJ FOR ALTITUDE

ALT.	HIGH VOLTAGE
Sea Level	2050 V
1000 foot	2025 V
2000 foot	2000 V
3000 foot	1975 V
4000 foot	1950 V
5000 foot	1925 V
6000 foot	1900 V
7000 foot	1875 V

ALPHA SCINTILLATION DETECTOR

HV Plateau	Background	Source Count
700	0	900
750	0	1000
800	0	1000
850	0	1000
900	7	1000

OPERATING VOLTAGE SET AT 900 V

AIR PROPORTIONAL	43-5	43-65	BACKGROUND	METER READING	RANGE/SCALE
//////////////	Toe	L/S *	0	100	X10
	Center	Center	0	100	X10
//////////////	Heel	Other **	0	100	X10

☑ Uniformity (± 10%) Ave. Efficiency 29 %

* Least Sensitive Position (Heel Of Probe)

** Opposite Least Sensitive Position (Top Of Probe)

Date 7-15-93 Signature Patrick Brand

Form 22

APPENDIX 10

LOG BOOK
RADIATION WORK REPORT

Note: The Log Book is presently located in the GMIX plant and will be placed in the Control Center Building during decommissioning. The headings in the Log Book are as follows:

Left Page
LOG BOOK - RADIATION WORK REPORT

	CHECK IN			CHECK OUT				
	DATE	TIME	SIGNATURE	TIME	PASS	FAIL	ACTION	RESULT
1.								
2.								
3.								
4.								
5.								

Right Page
LOG BOOK - RADIATION WORK REPORT

	INSTRUMENT					
	BATTERY	METER NO.	SOURCE	CPM	CHECK	TYPE OF WORK
1.						
2.						
3.						
4.						
5.						

U.S. ENERGY CORP.
GMIX FACILITIES

REMOVABLE CONTAMINATION SURVEY FORM

_______________ RSO Review

Date/Time: _______________ Sampled By: _______________

Scaler: _______________ Ser. No. _______________ Last Cal. _______________

Detector: _______________ Ser. No. _______________

Source: _______________ Dpm _______________ Cpm _______________ (EFF) _______________

REMOVABLE CONTAMINATION: $\text{Dpm}/100\text{cm}^2 = \dfrac{\text{Cpm}_s - \text{Cpm}_b}{\text{EFF} \times 1}$

Location	Smear No.	Sample Cpm	Bkg Cpm	Dpm/ 100 cm²	Contaminated	Clean

U.S. ENERGY CORP.
GMIX FACILITIES

TOTAL CONTAMINATION SURVEY FORM

RSO Review ______

Date/Time: ______ Sampled By: ______

Rate Meter: ______ Ser. No. ______ Last Cal. ______

Detector: ______ Ser. No. ______ Counting Area (C) ______

Source: ______ Dpm ______; Cpm ______, (EFF) ______

TOTAL CONTAMINATION: $Dpm/100cm^2 = \frac{Cpm \times 100}{EFF \times C}$

Smear No.	Location	Avg Cpm	Total Dpm	Max Cpm	Total Dpm	Contaminated	Clean

U.S. Energy Corp.
GMIX Facility
Health Physics-23 (HP-23)
GMIX WEEKLY INDUSTRIAL SAFETY AND RADIATION INSPECTION CHECK LIST

Date ____________________ Inspector ______________________________

WORK AREA CLEANLINESS:

Tools picked up and properly stored when not in use?	YES ___	NO ___	
Misc. debris and old parts etc. cleaned up, pathways clear?	YES ___	NO ___	
Unused hoses coiled and stored properly?	YES ___	NO ___	
Doors locked?	YES ___	NO ___	

Corrective actions: ______________________________

EQUIPMENT AND TOOLS:

Motor and pump guards in place and adequate?	YES ___	NO ___	
Tools and equipment functional and clean?	YES ___	NO ___	
Stairs and ladders in good repair?	YES ___	NO ___	
Guard rails adequate and in good repair?	YES ___	NO ___	
Emergency shower in good operating condition and accessible?	YES ___	NO ___	
Hazard signs properly set, in good repair and legible?	YES ___	NO ___	
Fire extinguishers in place, accessible and OK?	YES ___	NO ___	

Corrective actions: ______________________________

ELECTRICAL:

Hand tools and extension cords properly grounded?	YES ___	NO ___	
Proper LOCK-OUT procedures followed?	YES ___	NO ___	
Connectors closed?	YES ___	NO ___	
Junction boxes covered?	YES ___	NO ___	
Switch boxes closed?	YES ___	NO ___	

Corrective actions: ______________________________

PERSONNEL:

Using protective clothing as required?	YES ___	NO ___	
Using safety harness when and where required?	YES ___	NO ___	
Properly task-trained for the job?	YES ___	NO ___	
Not smoking in RESTRICTED area?	YES ___	NO ___	
Working safely?	YES ___	NO ___	

Corrective actions: ______________________________

RADIATION PROTECTION:

Eating area clean	YES ___	NO ___	N/A ___
Ventilation equipment working properly?	YES ___	NO ___	N/A ___
Are respirators used when required?	YES ___	NO ___	N/A ___
Radiation Work Permits issued where needed?	YES ___	NO ___	N/A ___
Emergency treatment equipment and material available?	YES ___	NO ___	
Proper signs posted?	YES ___	NO ___	

Corrective actions: ______________________________

PONDS (IX, PRIMARY, FINAL)

Gates closed?	YES ___	NO ___	
Fencing functional?	YES ___	NO ___	
Liquid in ponds?	YES ___	NO ___	
Evidence of overflow?	YES ___	NO ___	
Dam breached	YES ___	NO ___	

Corrective actions: ______________________________

U.S. ENERGY CORP.

GMIX FACILITIES

____
RSO Review

ELEVATED CONTAMINATION SURVEY INVESTIGATION

Do any readings exceed these limits?

	Removable Contamination	Total Contamination
NO__________	1000 Dpm/100cm^2	Maximum 15000 dpm/100cm^2
YES__________		Average 5000 dpm/100cm^2

If YES, contact the supervisor and have the area decontaminated. Then complete the following:

Record Decontamination Procedures taken: ____

Determine the cause of the Contamination: ____

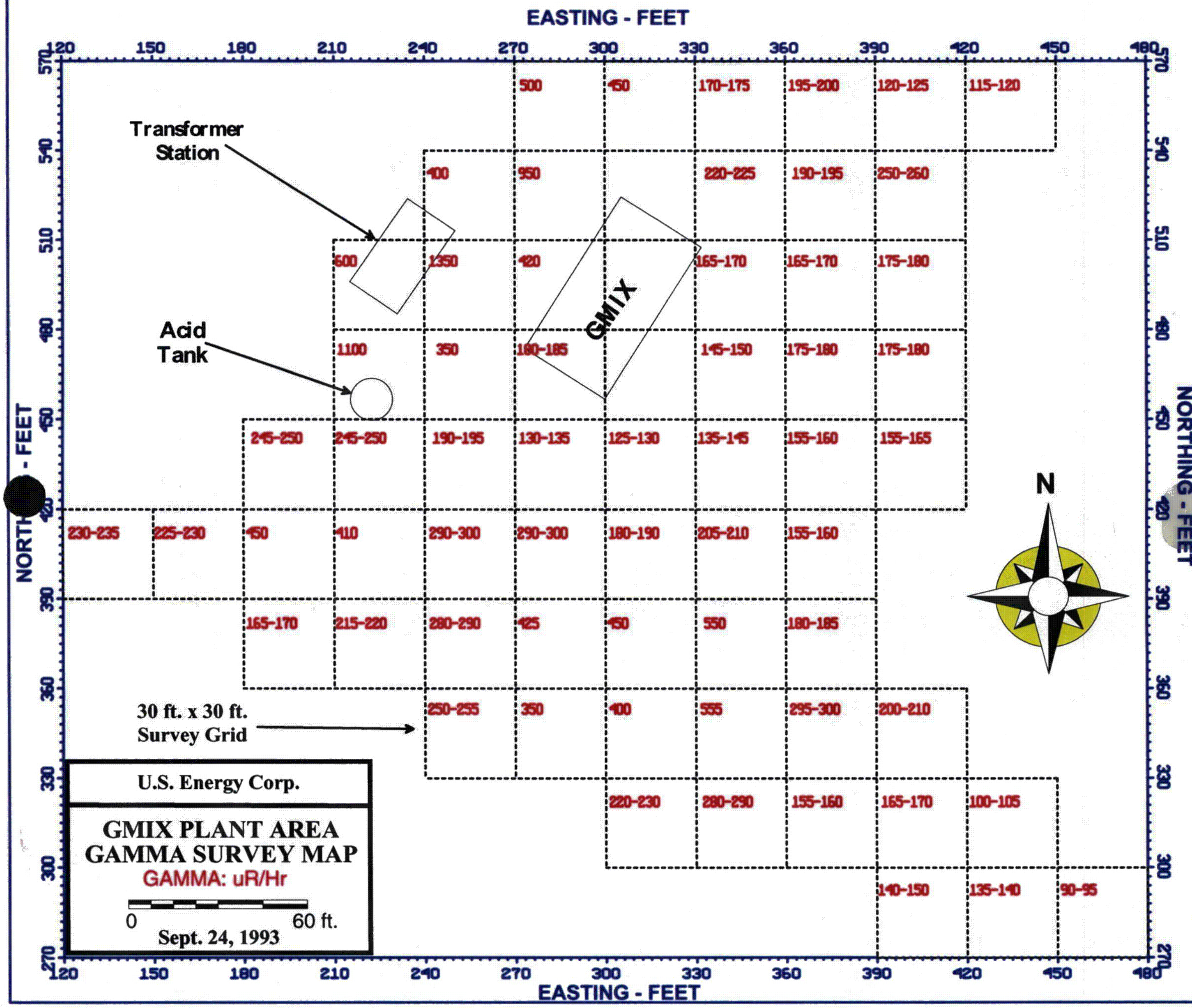
Recommended Corrective Measures to Prevent Recurrence: ____________________________

ACKNOWLEDGEMENT OF INSTRUCTION

THIS IS TO ACKNOWLEDGE THAT I HAVE BEEN VERBALLY INSTRUCTED AND GIVEN A CHECKLIST BY **U.S. ENERGY CORP.** TO MAKE ME AWARE OF THE POTENTIAL HAZARDS THAT I MAY ENCOUNTER WHILE ON THIS PROPERTY.

NAME:
DATE:
(EMPLOYER) REPRESENTING:
ADDRESS:
CITY:
STATE:
TELEPHONE:
INSTRUCTOR:

U.S. Energy Corp. Green Mountain Ion Exchange
GMIX Plant Area



ENERGY LABORATORIES

ENERGY LABORATORIES, INC.
P.O. BOX 3258 • CASPER, WY 82602 • PHONE (307) 235-0515
254 NORTH CENTER, SUITE 100 • CASPER, WY 82601 • FAX (307) 234-1639

SOIL ANALYSIS REPORT - KENNECOTT URANIUM COMPANY

Report Date: 09-10-93

Sample I.D.:	ELI NO.	Sample Date:	U-nat pCi/g	Ra226 pCi/g	Ra Prec. +/- pCi/g	U/Ra226
Reserve Dump #1	93-35719	08-19-93	86.6	131.3	1.1	0.65
Reserve Dump #2	93-35720	08-19-93	211.5	41.8	0.6	5.2
Reserve Dump #3	93-35721	08-19-93	75.4	70.1	0.8	1.0
Sheep Dump #1	93-35722	08-19-93	277.5	229.3	1.9	1.2
Sheep Dump #2	93-35723	08-19-93	738.1	444.6	2.0	1.6
Sheep Dump #3	93-35724	08-19-93	749.9	1308.1	2.4	0.6
GM Mine Dump #1	93-35725	08-19-93	32.1	41.5	0.6	0.8
GM Mine Dump #2	93-35726	08-19-93	110.7	79.7	0.8	1.4
GM Mine Dump #3	93-35727	08-19-93	275.2	144.3	1.1	1.9
Siesmic Samp. Loc #1	93-35728	08-19-93	287.0	126.3	1.0	2.3
Siesmic Samp. Loc #2	93-35729	08-19-93	427.5	91.0	0.9	4.7

REPORT APPROVED BY: R.A. Searling

sv s335719.ken

ELI

QUALITY ASSURANCE REPORT – US Energy
Report Date: 09–16–93
ELI #(s): 93:35719–29

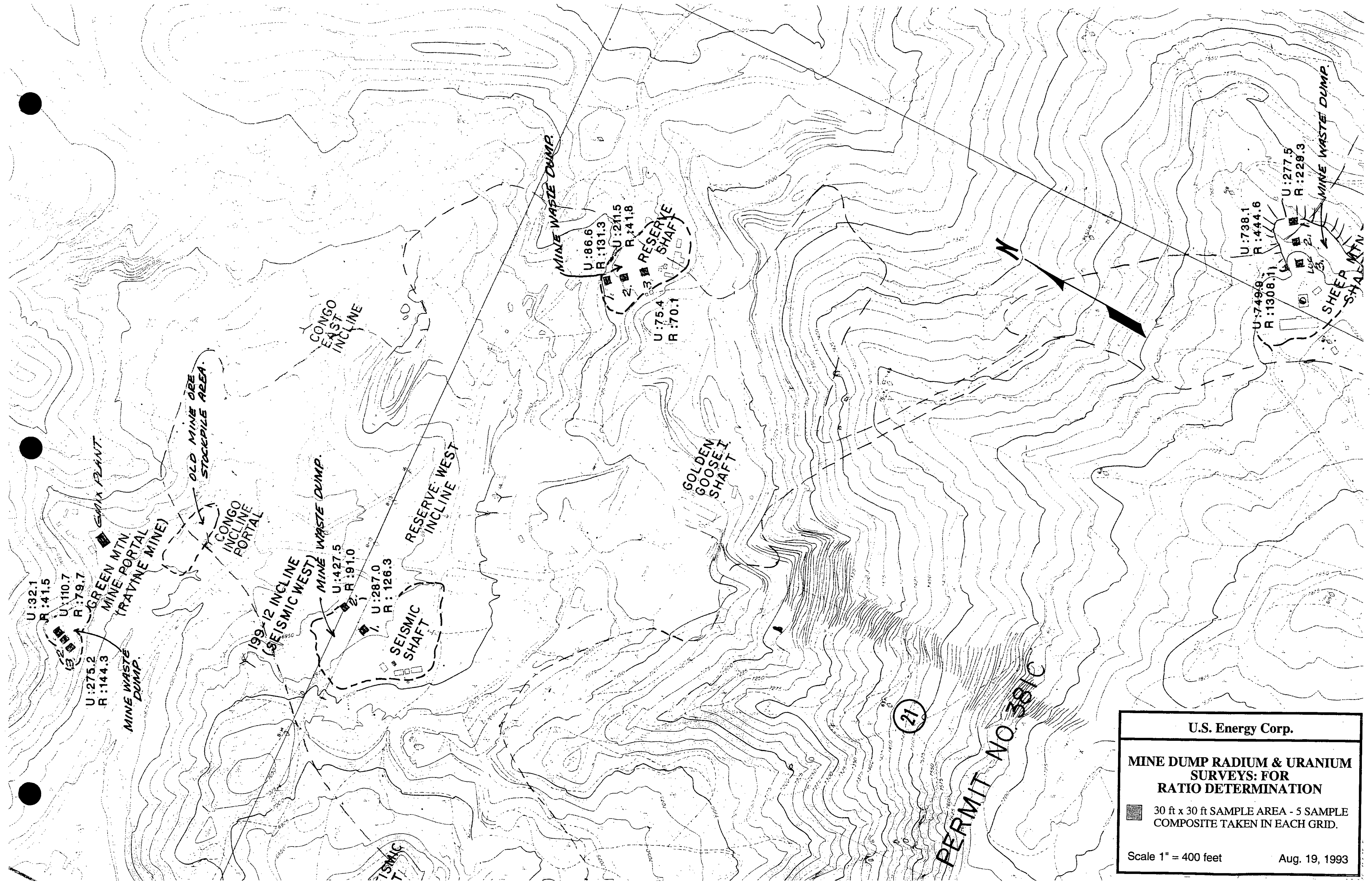
RADIOMETRIC:	METHOD	Dup #1 %	Dup #2 %	Spk #1 %	Spk #2 %	ANALYST	DATE SAMPLE ANALYZED
Uranium	EPA–908.1	99	–	–	–	DB	08–27–93
Ra226	EPA–903.0	110	–	110	–	DB	09–03–93

USEPA–ESML–LV INTERCOMPARISON STUDY RESULTS

Radiometric	Method	ELI Value	Standard	Difference	Analyst	Date
Uranium	EPA–908.1	14.59	17.07	–2.48	DB	02–12–93
Ra226	EPA–903.1	12.88	12.54	0.34	DB	03–05–93
Ra228	EPA–904.1	14.55	13.73	0.82	DB	03–05–93
Gross Alpha	EPA–900.0	20.53	31.50	–10.97	DB	01–29–93
Gross Beta	EPA–900.0	46.33	60.70	–14.37	DB	01–29–93

Report Approved By: DB [signature]

dmc 93:35719–29



U.S. Energy Corp.

MINE DUMP RADIUM & URANIUM SURVEYS: FOR RATIO DETERMINATION

30 ft x 30 ft SAMPLE AREA - 5 SAMPLE COMPOSITE TAKEN IN EACH GRID.

Scale 1" = 400 feet

Aug. 19, 1993

APPENDIX 13

ESTIMATED DECOMMISSIONING and RECLAMATION COSTS FOR ALL AFFECTED AREAS*

INCLUDES: GMIX Plant, $BaCl_2$ Plant. Contaminated sludge and soils from the Final Pond (Roberts Reservoir #2), Primary Pond (Roberts Reservoir #3) and the IX Reservoir.

EXCLUDES: The drainage re-establishment for Hanks Draw, GMIX Pond, Roberts Reservoir #2 and Roberts Reservoir #3. (Included in Western Nuclear permit No. 381-C and Amendments A-1 through A-5. This is on file at the WDEQ Office, Land Quality Division, 210 Lincoln Street, Lander, WY 82520.)

Roberts Reservoir #3 - 10,500 square feet of surface area.

Contaminated sludge and soil removal, 800 cu. yds.	
Excavation: 800 cu. yds. at $1.47/cu. yd.	$1,176.00
Trucking: 1,200 tons at $.13/ton mile	4,212.00
(To be trucked 27 miles to the Sweetwater Mill Tailings Disposal Area.)	

Roberts Reservoir #2 - 42,000 square feet of surface area.

Contaminated sludge and soil removal, 3,000 cu. yds.	
Excavation:3,000 cu. yds. at $1.47/cu. yd.	4,410.00
Trucking: 4,450 tons at $.13/ton mile	15,619.00
(To the same location)	
Building removal: 8' x 8' x 8' at $.20/cu. ft.	100.00

GMIX Reservoir - No NRC reclamation for this pond should be required. The GMIX Pond is used for a surge pond for mine water before entering the GMIX or $BaCl_2$ plants. There is no treatment with Barium Chloride to waters entering this pond and the water from the GMIX Plant does not discharge into this pond. The Reservoir is fenced as a "Restricted Area" and as a result, U.S. Energy has sampled this Reservoir on a grid. The sludge, if contaminated, will be handled in the same manner as the soils at the GMIX plant. This Reservoir and the re-establishment of Hanks Draw will be reclaimed as per WDEQ Permit 381C requirements upon completion of mining activities.

IX Plant and BaCl2 Plant

Building removal (only if contaminated): 40' x 60' x 20' at $.20/cu. ft.	9,600.00
Building removal (only if contaminated): 24' x 24' x 12' at $.20/cu. ft.	1,382.00

Equipment	Qty	
IX column	6	8' dia. x 10' ht.
Striping tank	3	8' dia. x 10' ht.
Precipitation tank	2	8' dia. x 8' ht.
Recycle pump	2	
Feed pump	2	
NH_3 storage tank	1	500 gal. capacity
Acid tank	1	2,000 gal. capacity
$BaCl_2$ tank	2	4' x 4'
Air compressor	1	100 psi, 3 HP
Steps, railing, walkways, piping, valves		

Labor for disassembling all of the above equipment and all miscellaneous contaminated items.	
2 men at $30.00/hr. for 180 hours	6,000.00
Contaminated equipment trucked to Sweetwater Mill Tailings Disposal Area.	
14 loads at $238.00/load - loading and trucking	
$952.95/day - 4 loads/truck/day	3,332.00
Concrete burial (40' x 60' and 24' x 24' areas)	
Fill and grading: 2,000 cu. yds. at $.88/cu. yd.	1,760.00
(Buried on site with a minimum of 4 feet of overburden)	
Removal of any contaminated soil on the IX Plant and $BaCl_2$ Plant areas	
Assumes 200 yards removal at $1.47/dy.	294.00
Trucking: 300 tons at $.13/ton mile	1,053.00
Monitoring and Sampling Costs	6,000.00
Equipment - Other	
Dragline or crane for 1 day	693.00
Water truck & driver: 5,000 gal. at $75.00/hr. at 32/hrs.	2,400.00
Welding equipment: $80.00/day at 5 days	400.00
Mobilization & Demobilization - 70 miles each way	
5 - Tractor, end dump trailers and pups	
3 hours each x 5 = 15 hours at $119.00/hr.	1,785.00
1 - Truck and low bed trailer: 3 hours at $119.00/hr.	357.00
1 - 5 yd wheeled loader: 3 hours at $119.00/hr.	357.00
1 - Crane: 3 hours at $119.00/hr.	357.00
1 - Water Truck: 3 hours at $119.00/hr.	357.00
TOTAL RECLAMATION COSTS:	61,644.00
15% Contingency	9,246.00
BONDING REQUIREMENTS through 11/16/90:	$70,890.00
Year 1991 cpi Increase	3,330.00
Year 1992 cpi Increase	2,375.00
BONDING REQUIREMENTS through 1992:	$76,595.00
Year 1993 cpi Increase	2,298.00
TOTAL BONDING REQUIREMENT through 8/11/93:	$78,893.00

*These costs are reported to the NRC by U.S. Energy in the Annual Update. The costs are adjusted, bonded and approved annually by the NRC.

APPENDIX 14

Overview of Major Decommissioning Objectives and Activities

Activity	Tasks
Health Physics/Safety	1. Train working staff in principals and practices of radiological health.
	2. Evaluate exposure potential of work activities in affected and unaffected areas.
	3. Implement Radiation work permits
	4. Monitor potential airborne uranium particulate concentration in work locations.
	5. Establish personnel exposure assessment program, i.e., TLD, bioassay.
	6. Assess personnel exposure and record keeping weekly.
	7. Survey individual workers for alpha contamination before eating and leaving premises daily.
	8. Implement maximum health physics controls for individuals working in restricted areas, i.e., respirators and protective equipment.
	9. Evaluate safety hazards for specific job tasks during decommissioning activities
	10. Implement safety controls and equipment and establish safe working practices.
	11. Review safety procedures and changes in working conditions periodically.
	12. Implement QA/QC policies.

Radioactive Waste	1. Identify materials and equipment which are unreleasable.
	2. Consolidate and package any such material for transport to the Sweetwater Mill.
	3. Remove contaminated sludge and soils.
	4. Prepare all manifests and documentation for transportation.
Final Site Survey	1. Demonstrate all radiological conditions at the GMIX Facilities satisfy NRC Regulations for release of unrestricted use as per Regulatory Guide 1.86, NUREG 4118 and 40 CFR 192, Subpart B.
	2. Survey area based on standard format and protocol.
	3. Identify hot spots and remove contaminants.
	4. Collect verification samples.
	5. Prepare records.
	6. Prepare Final Site Survey and Decommissioning Report.
Site Reclamation	1. Regrade and seed site with grasses as per DEQ Permit to Mine No. 381C.

APPENDIX 15

Description of Estimated Radioactive Waste

Description	Quantity (ft^3)	Estimated Characteristics
Contaminated Primary and Final Pond Sludges.	5000	Ra226 greater than 9.5 pCi/q or adjusted per site specific background 9.5 pCi/q = 4.5 pCi/q average background plus 5.0 pCi/L above ground
Contaminated IX Plant Soils	1000	U/Ra226 ratio less than 0.6
GMIX Equipment	300	Surficial fixed alpha greater than 5000 dpm/100cm2
Buildings, IX, BaCl, Concrete	1000	Surficial fixed alpha greater than 5000 dpm/100 cm2
Contaminated IX Reservoir Sludges/Soils	To Be Determined	U/Ra226 ratio less than 0.6

APPENDIX 16

Background Readings

On July 12, 1993 ten (10) soil samples were collected in the vicinity of the Green Mountain Ion Exchange facility. These samples were taken in undisturbed areas upslope/updrainage of the facility. The samples were analyzed by Energy Labs Inc. of Casper, Wyoming. the analysis sheet is attached. The sample locations were marked for future reference with stakes and located on the attached map entitled U.S. Energy Corp. Green Mountain Ion Exchange - Decommissioning Map: Background Samples. The soil samples were taken of the upper fifteen (15) centimeters of soil. The samples were analyzed for Radium-226 and natural uranium.

On July 28, 1993 gamma readings were taken by George Worman, facility Radiation Safety Officer, using a Ludlum Model 12S Micro R Meter (Serial Number 11816) calibrated on July 26, 1993 by Energy Labs Inc., at these ten (10) background sites. These readings were taken approximately one (1) meter above ground surface.

All of the analyses and readings are compiled on the attached chart entitled Green Mountain Ion Exchange - Background Readings. The chart shows that the average background values based on an average of ten (10) samples for the area are as follows:

Radium-226 (pCi/Gr.)	4.47
Uranium (Nat.) (pCi/Gr.)	4.87
Gamma (uR/Hr.)	38.2

GREEN MOUNTAIN ION EXCHANGE

BACKGROUND READINGS

LOCATION #	RADIUM-226 (pCi/Gr.)	URANIUM (NAT) (pCi/Gr.)	GAMMA (RANGE) (uR/Hr)	GAMMA (AVERAGE) (uR/Hr)
BKG-1	4.40	8.1	45-50	47.50
BKG-2	5.30	6.9	55-60	57.50
BKG-3	5.70	7.0	45-50	47.50
BKG-4	4.90	3.3	38-42	40.00
BKG-5	3.10	6.5	28-32	30.00
BKG-6	3.20	3.0	26-30	28.00
BKG-7	4.20	4.7	27-30	28.50
BKG-8	8.00	2.6	35-40	37.50
BKG-9	3.60	3.7	30-35	32.50
BKG-10	2.30	2.9	30-35	32.50
MEAN	4.47	4.87		38.15
MINIMUM	2.30	2.60		28.00
MAXIMUM	8.00	8.10		57.50
STANDARD DEV.	1.55	1.95		9.38
VARIANCE	2.39	3.81		87.95

ENERGY LABORATORIES

ENL GY LABORATORIES, INC.
P.O. BOX 3258 • CASPER, WY 82602 • PHONE (307) 235-0515
254 NORTH CENTER, SUITE 100 • CASPER, WY 82601 • FAX (307) 234-1639

U.S. ENERGY - SOILS ANALYSIS REPORT

Project: Sweetwater

Date Received: 08-10-93
Report Date: 08-30-93

ELI #	Sample ID	Sample Date	Ra226 pCi/g	Ra226 Prec. +/-	Uranium pCi/g
93-28686	BKG 1	07-12-93	4.4	0.2	8.1
93-28687	BKG 2	07-12-93	5.3	0.2	6.9
93-28688	BKG 3	07-12-93	5.7	0.2	7.0
93-28689	BKG 4	07-12-93	4.9	0.2	3.3
93-28690	BKG 5	07-12-93	3.1	0.2	6.5
93-28691	BKG 6	07-12-93	3.2	0.2	3.0
93-28692	BKG 7	07-12-93	4.2	0.3	4.7
93-28693	BKG 8	07-12-93	8.0	0.2	2.6
93-28694	BKG 9	07-12-93	3.6	0.2	3.7
93-28695	BKG 10	07-12-93	2.3	0.2	2.9

Report Approved By: R.A. Leaking

sv s328686.use

ELI

QUALITY ASSURANCE REPORT – US Energy
Report Date: 09–01–93
Project: Green Mountain
ELI #(s): 93:28686–95

RADIOMETRIC pCi/g:	METHOD	Dup #1 %	Dup #2 %	Spk #1 %	Spk #2 %	ANALYST	DATE SAMPLE ANALYZED
Uranium	EPA–908.1	101	–	–	–	DB	08–27–93

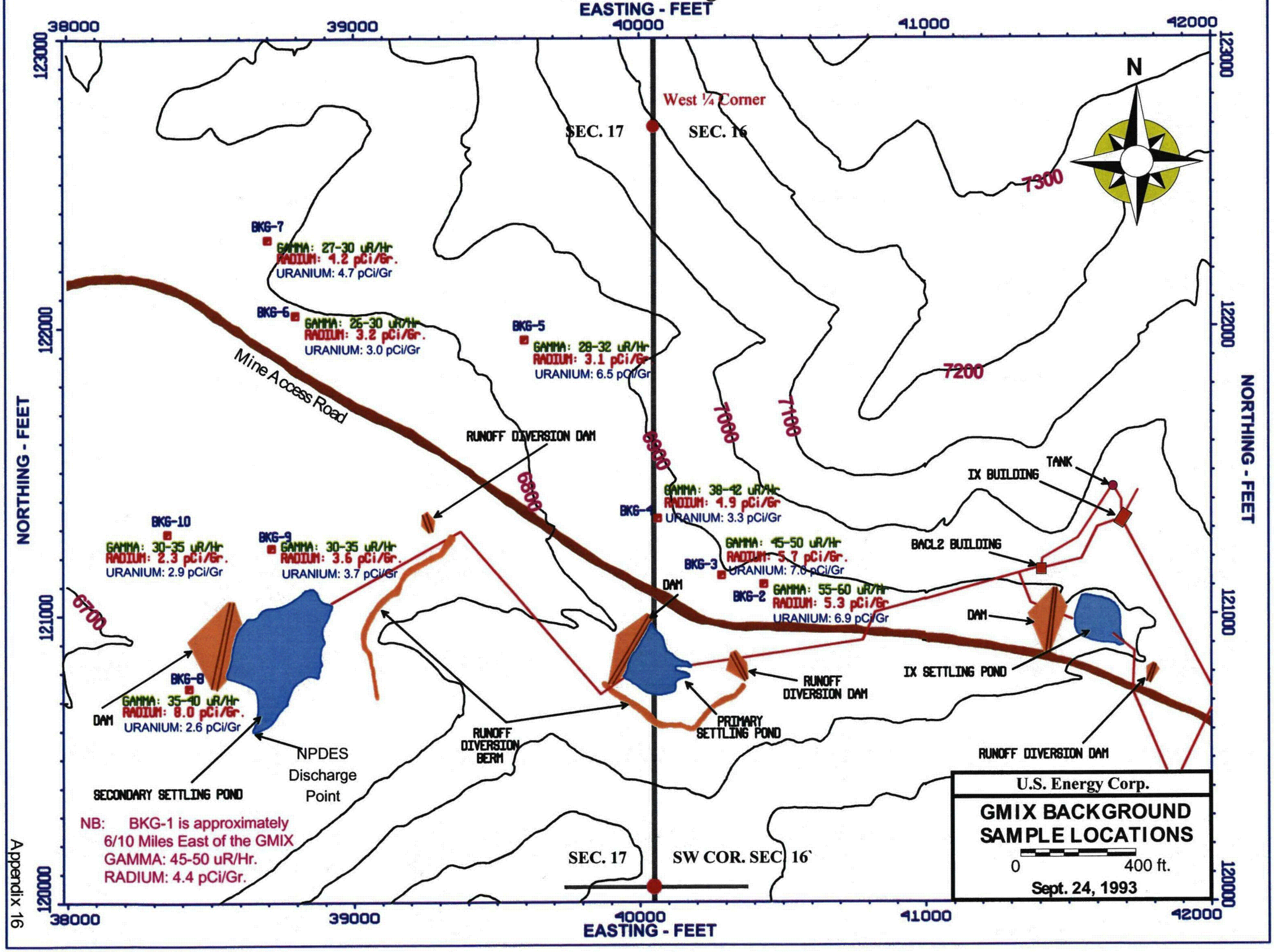
USEPA–ESML–LV INTERCOMPARISON STUDY RESULTS

Radiometric	Method	ELI Value	Standard	Difference	Analyst	Date
Uranium	EPA–908.1	14.59	17.07	–2.48	DB	02–12–93
Ra226	EPA–903.1	12.88	12.54	0.34	DB	03–05–93
Ra228	EPA–904.1	14.55	13.73	0.82	DB	03–05–93
Gross Alpha	EPA–900.0	20.53	31.50	–10.97	DB	01–29–93
Gross Beta	EPA–900.0	46.33	60.70	–14.37	DB	01–29–93

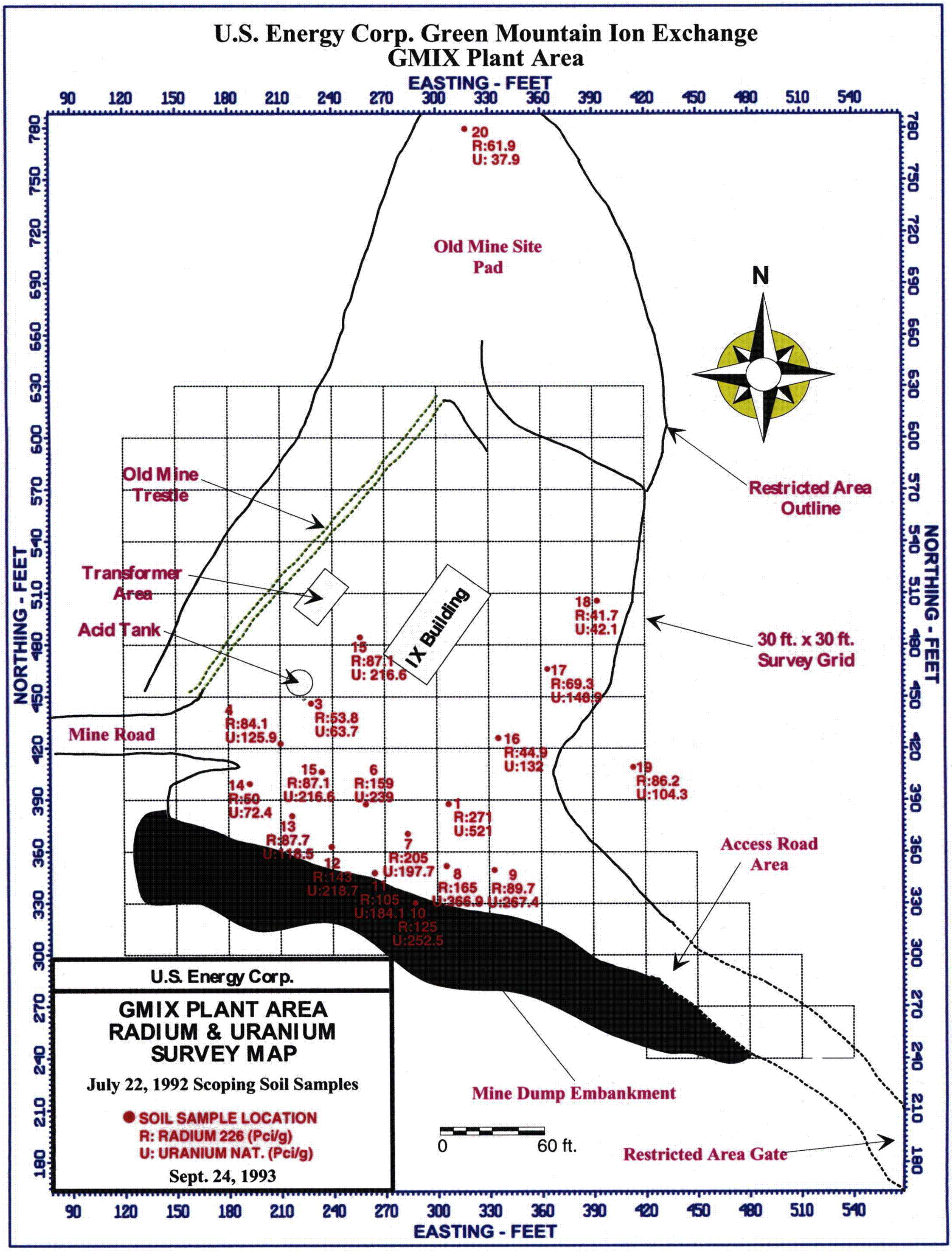
Report Approved By: R.A. Starling

dmc 93:28686–95

U.S. Energy Corp. Green Mountain Ion Exchange
Decommissioning Plan

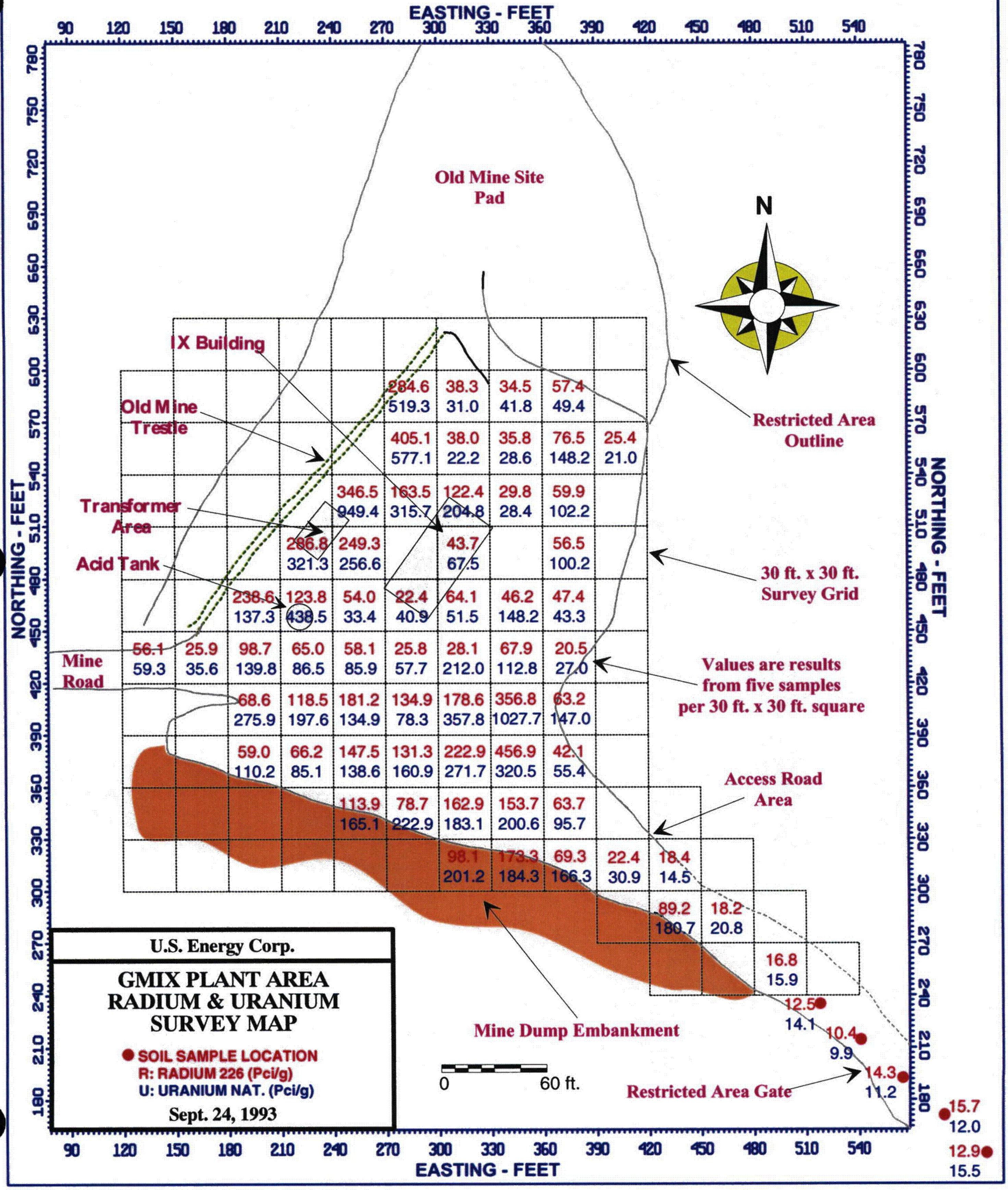


Appendix 16

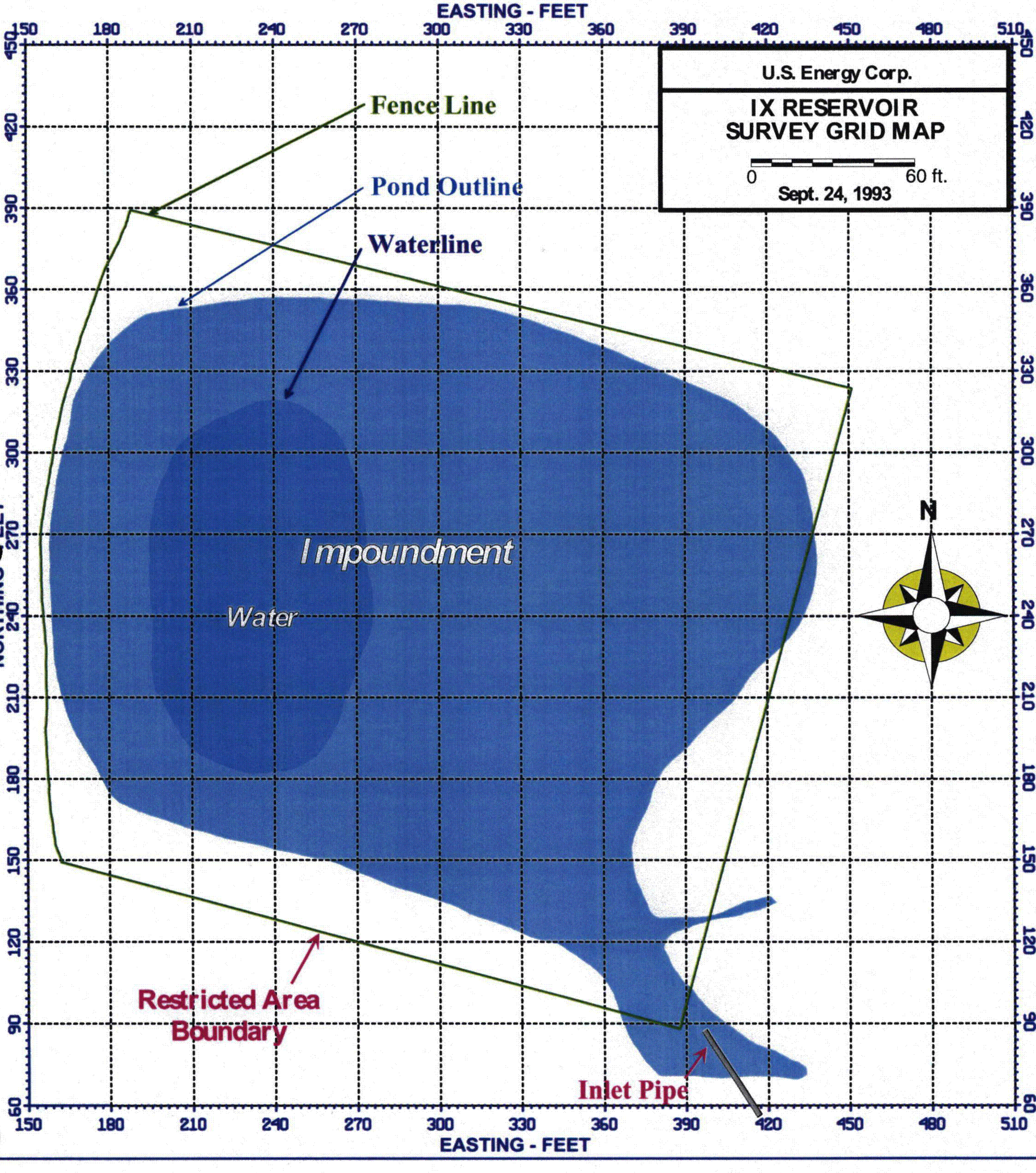


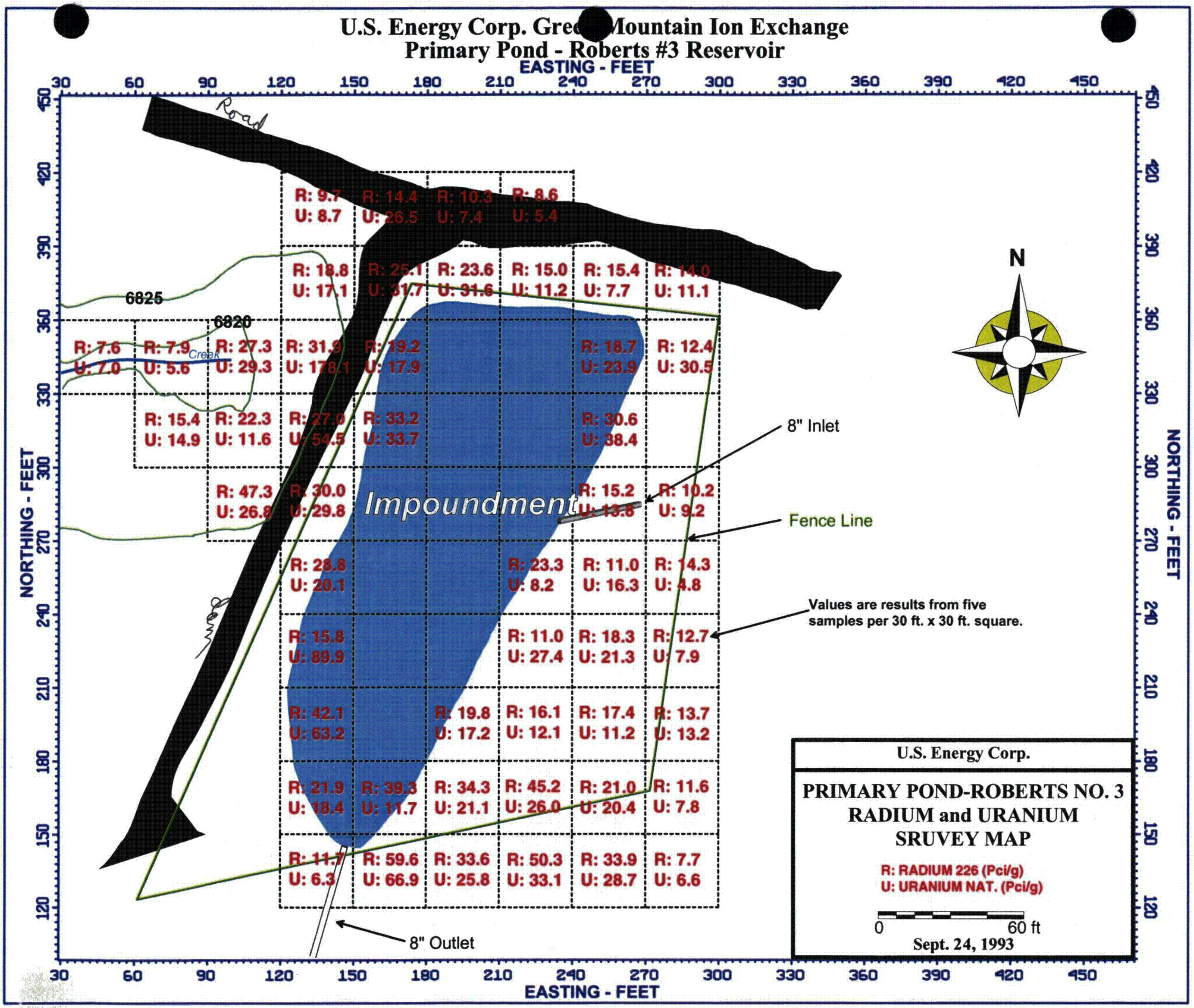
U.S. Energy Corp. Green Mountain Ion Exchange
GMIX Plant Area
EASTING - FEET
NORTHING - FEET
Old Mine Site
Pad
N
Old Mine
Trestle
Transformer
Area
Acid Tank
IX Building
Mine Road
Restricted Area
Outline
30 ft. x 30 ft.
Survey Grid
Access Road
Area
Mine Dump Embankment
Restricted Area Gate
0
60 ft.
20
R:61.9
U: 37.9
18
R:41.7
U:42.1
15
R:87.1
U: 216.6
17
R:69.3
U:148.9
3
R:53.8
U:63.7
4
R:84.1
U:125.9
16
R:44.9
U:132
15
R:87.1
U:216.6
6
R:159
U:239
19
R:86.2
U:104.3
14
R:50
U:72.4
1
R:271
U:521
13
R:87.7
U:118.5
7
R:205
U:197.7
12
R:143
U:218.7
8
R:165
U:366.9
9
R:89.7
U:267.4
11
R:105
U:184.1
10
R:125
U:252.5
U.S. Energy Corp.
GMIX PLANT AREA
RADIUM & URANIUM
SURVEY MAP
July 22, 1992 Scoping Soil Samples
SOIL SAMPLE LOCATION
R: RADIUM 226 (Pci/g)
U: URANIUM NAT. (Pci/g)
Sept. 24, 1993

U.S. Energy Corp. Green Mountain Ion Exchange
GMIX Plant Area



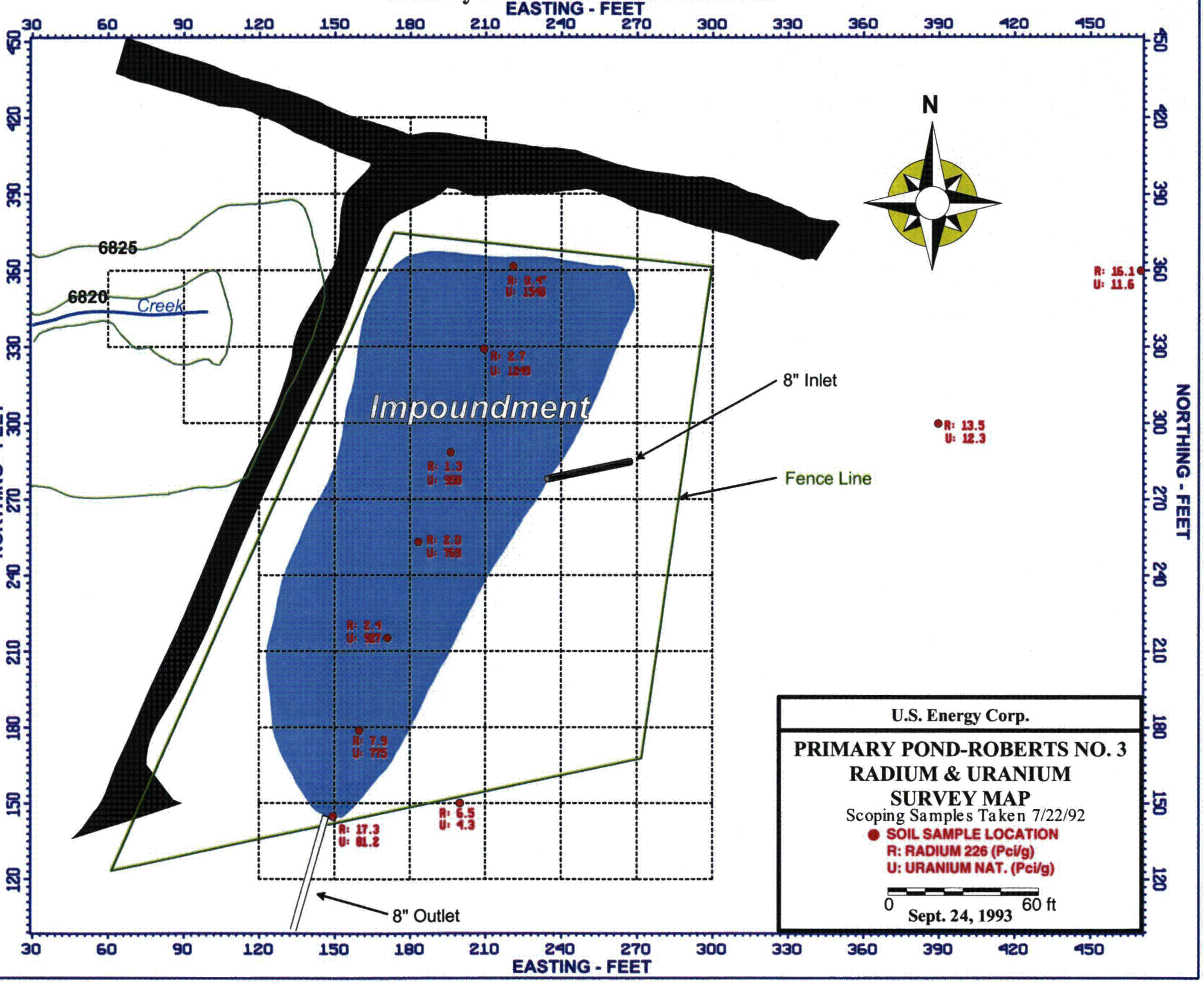
U.S. Energy Corp. Green Mountain Ion Exchange
IX Reservoir

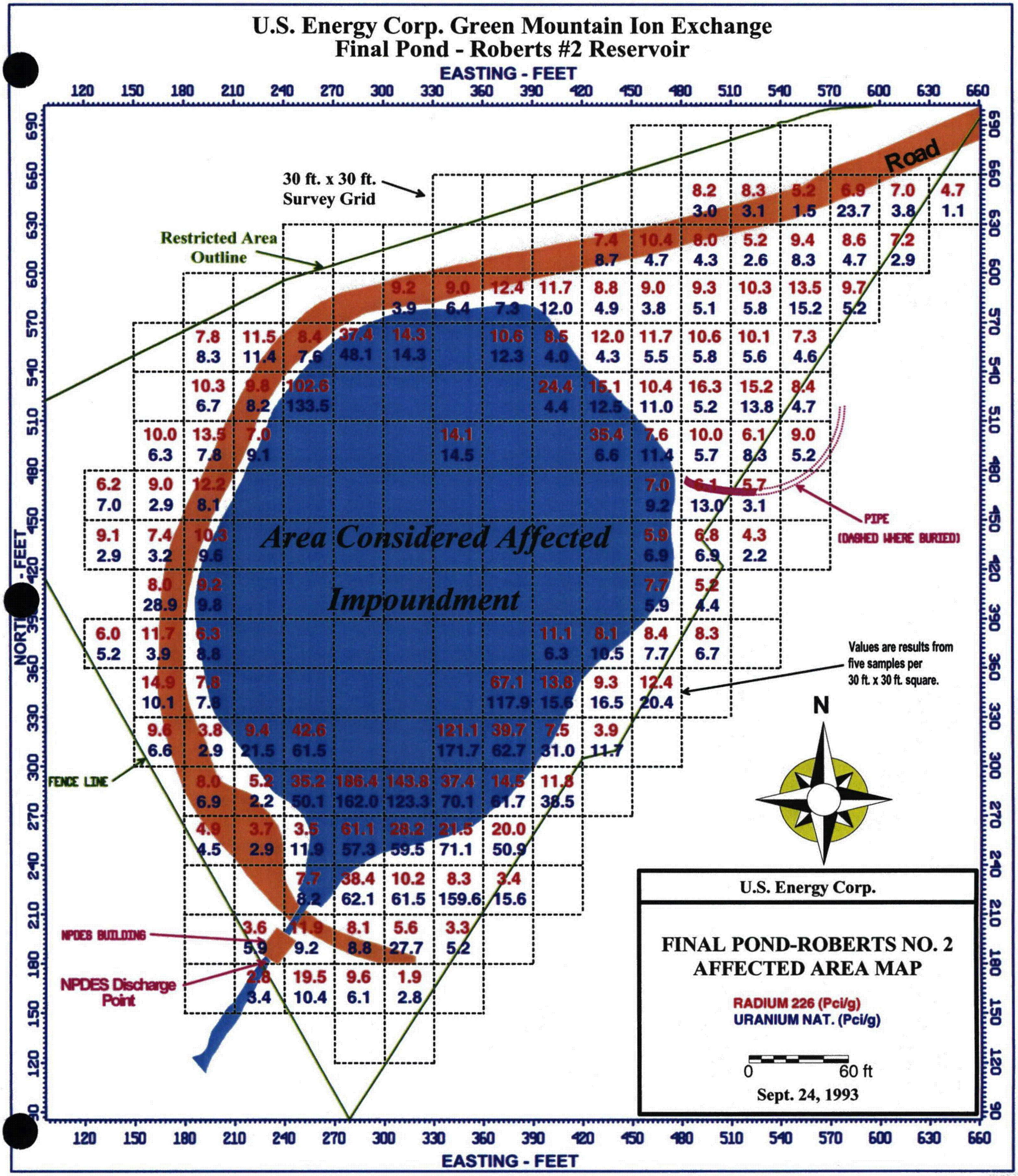



U.S. Energy Corp. Green Mountain Ion Exchange
Primary Pond - Roberts #3 Reservoir
EASTING - FEET
NORTHING - FEET
Road
Creek
6825
6820
Impoundment
8" Inlet
Fence Line
8" Outlet
N
Values are results from five samples per 30 ft. x 30 ft. square.
R: 9.7 U: 8.7
R: 14.4 U: 26.5
R: 10.3 U: 7.4
R: 8.6 U: 5.4
R: 18.8 U: 17.1
R: 25.1 U: 31.7
R: 23.6 U: 31.6
R: 15.0 U: 11.2
R: 15.4 U: 7.7
R: 14.0 U: 11.1
R: 7.6 U: 7.0
R: 7.9 U: 5.6
R: 27.3 U: 29.3
R: 31.9 U: 178.1
R: 19.2 U: 17.9
R: 18.7 U: 23.9
R: 12.4 U: 30.5
R: 15.4 U: 14.9
R: 22.3 U: 11.6
R: 27.0 U: 54.5
R: 33.2 U: 33.7
R: 30.6 U: 38.4
R: 47.3 U: 26.8
R: 30.0 U: 29.8
R: 15.2 U: 13.8
R: 10.2 U: 9.2
R: 28.8 U: 20.1
R: 23.3 U: 8.2
R: 11.0 U: 16.3
R: 14.3 U: 4.8
R: 15.8 U: 89.9
R: 11.0 U: 27.4
R: 18.3 U: 21.3
R: 12.7 U: 7.9
R: 42.1 U: 63.2
R: 19.8 U: 17.2
R: 16.1 U: 12.1
R: 17.4 U: 11.2
R: 13.7 U: 13.2
R: 21.9 U: 18.4
R: 39.3 U: 11.7
R: 34.3 U: 21.1
R: 45.2 U: 26.0
R: 21.0 U: 20.4
R: 11.6 U: 7.8
R: 11.7 U: 6.3
R: 59.6 U: 66.9
R: 33.6 U: 25.8
R: 50.3 U: 33.1
R: 33.9 U: 28.7
R: 7.7 U: 6.6
U.S. Energy Corp.
PRIMARY POND-ROBERTS NO. 3
RADIUM and URANIUM
SRUVEY MAP
R: RADIUM 226 (Pci/g)
U: URANIUM NAT. (Pci/g)
0
60 ft
Sept. 24, 1993

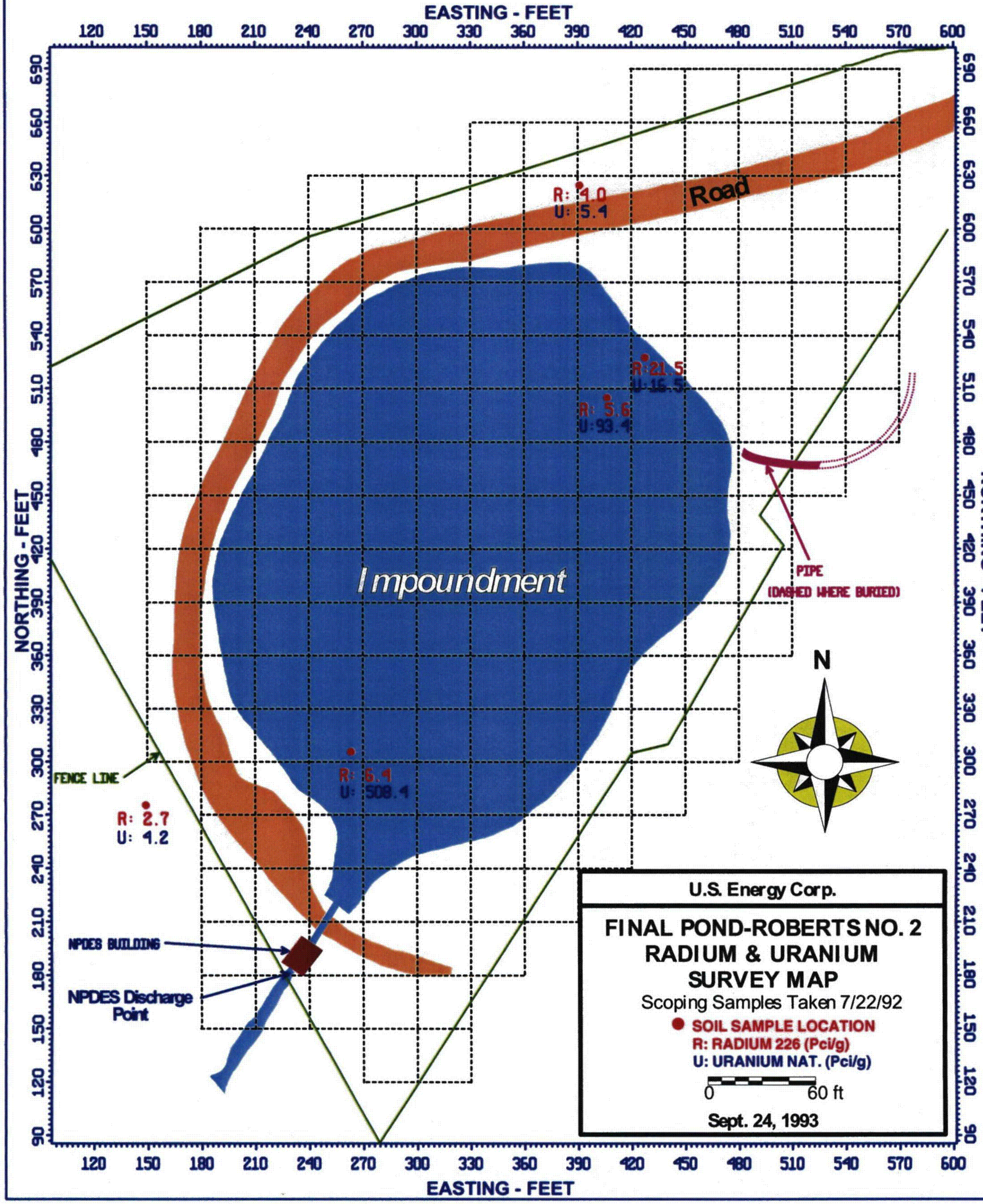
Appendix 19

U.S. Energy Corp. Green Mountain Ion Exchange
Primary Pond - Roberts #3 Reservoir

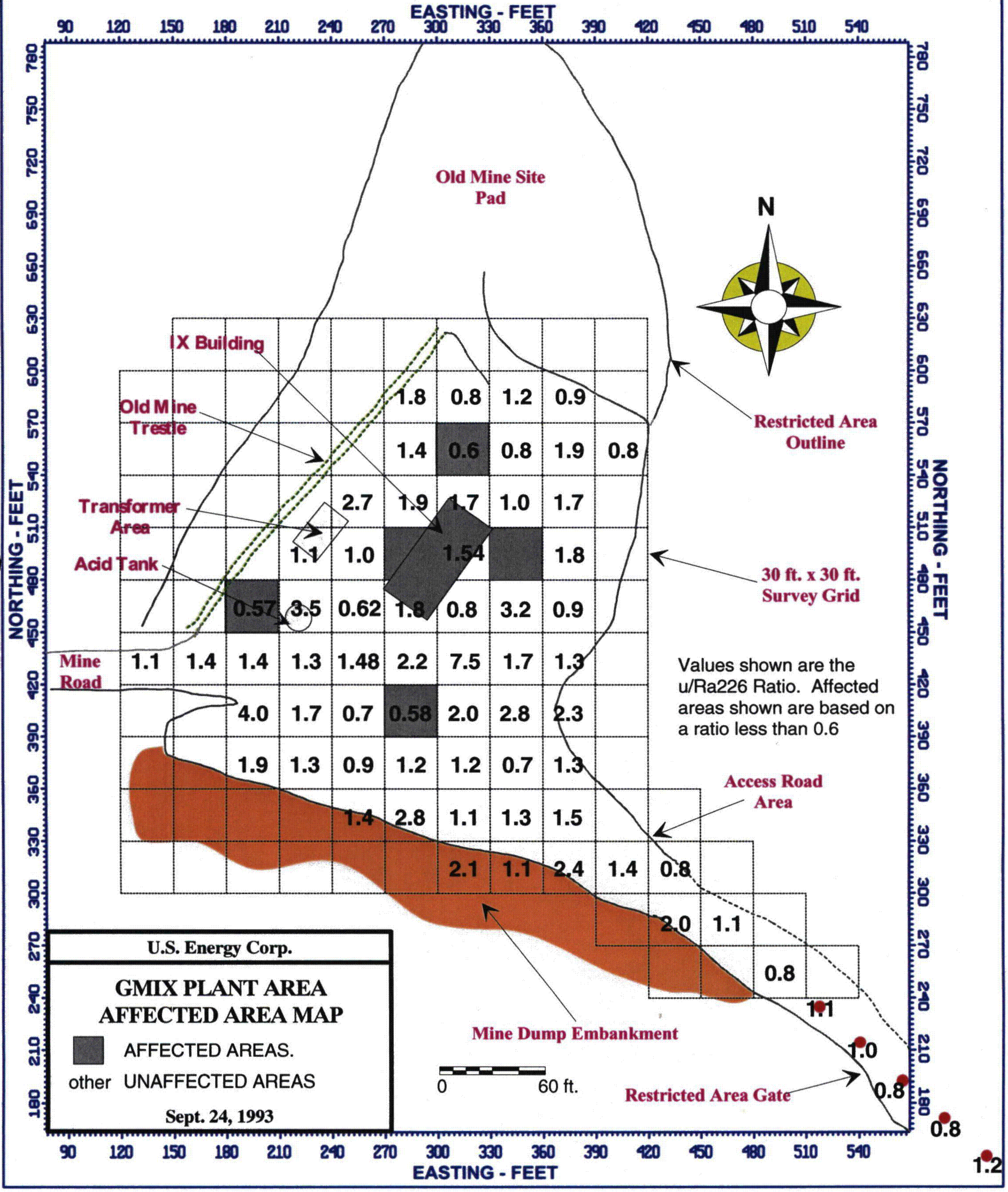



U.S. Energy Corp. Green Mountain Ion Exchange
Final Pond - Roberts #2 Reservoir
EASTING - FEET
NORTHING - FEET
30 ft. x 30 ft. Survey Grid
Restricted Area Outline
Road
Area Considered Affected
Impoundment
PIPE
(DASHED WHERE BURIED)
Values are results from five samples per 30 ft. x 30 ft. square.
FENCE LINE
NPDES BUILDING
NPDES Discharge Point
N
U.S. Energy Corp.
FINAL POND-ROBERTS NO. 2
AFFECTED AREA MAP
RADIUM 226 (Pci/g)
URANIUM NAT. (Pci/g)
0
60 ft
Sept. 24, 1993

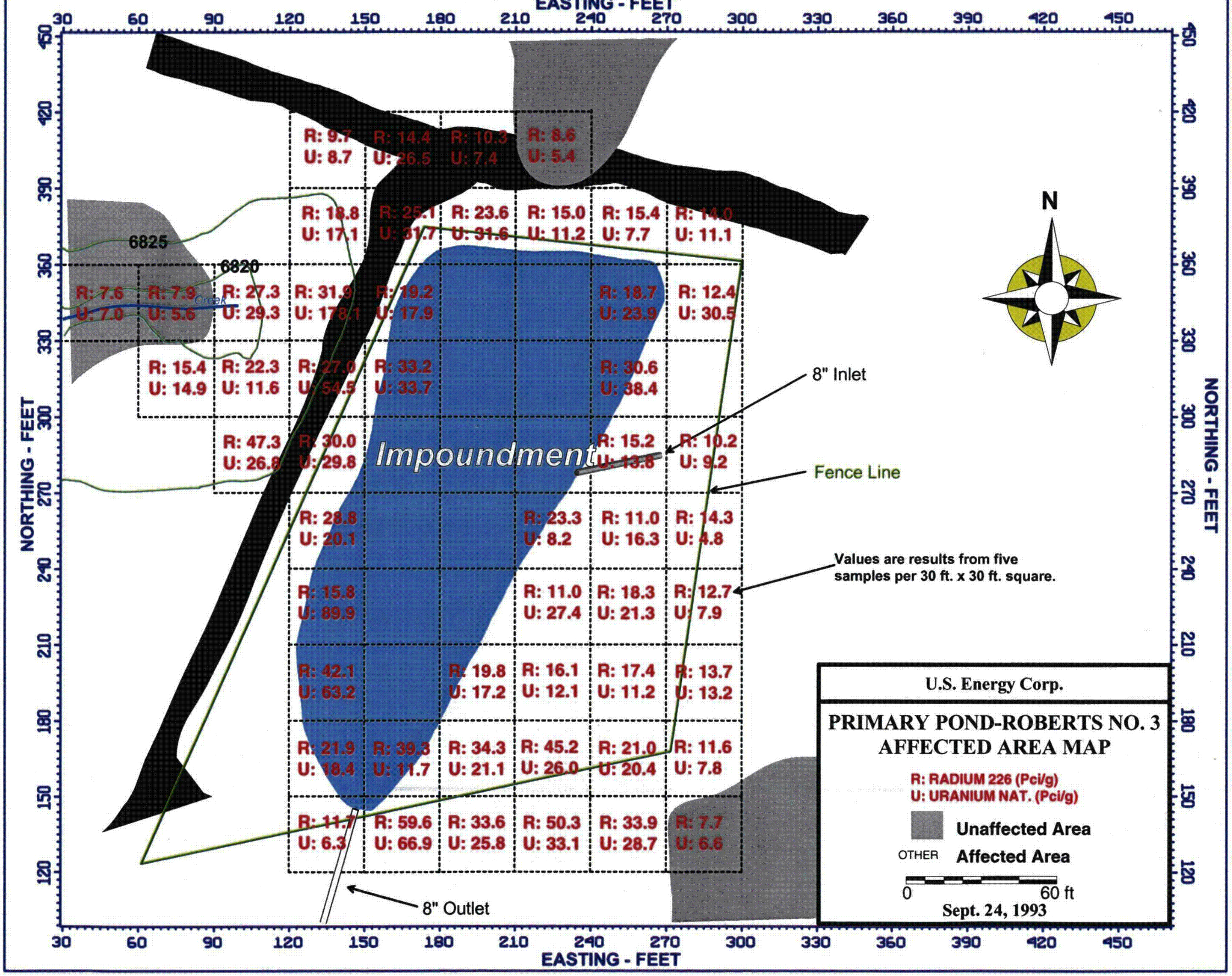
U.S. Energy Corp. Green Mountain Ion Exchange
Final Pond - Roberts #2 Reservoir



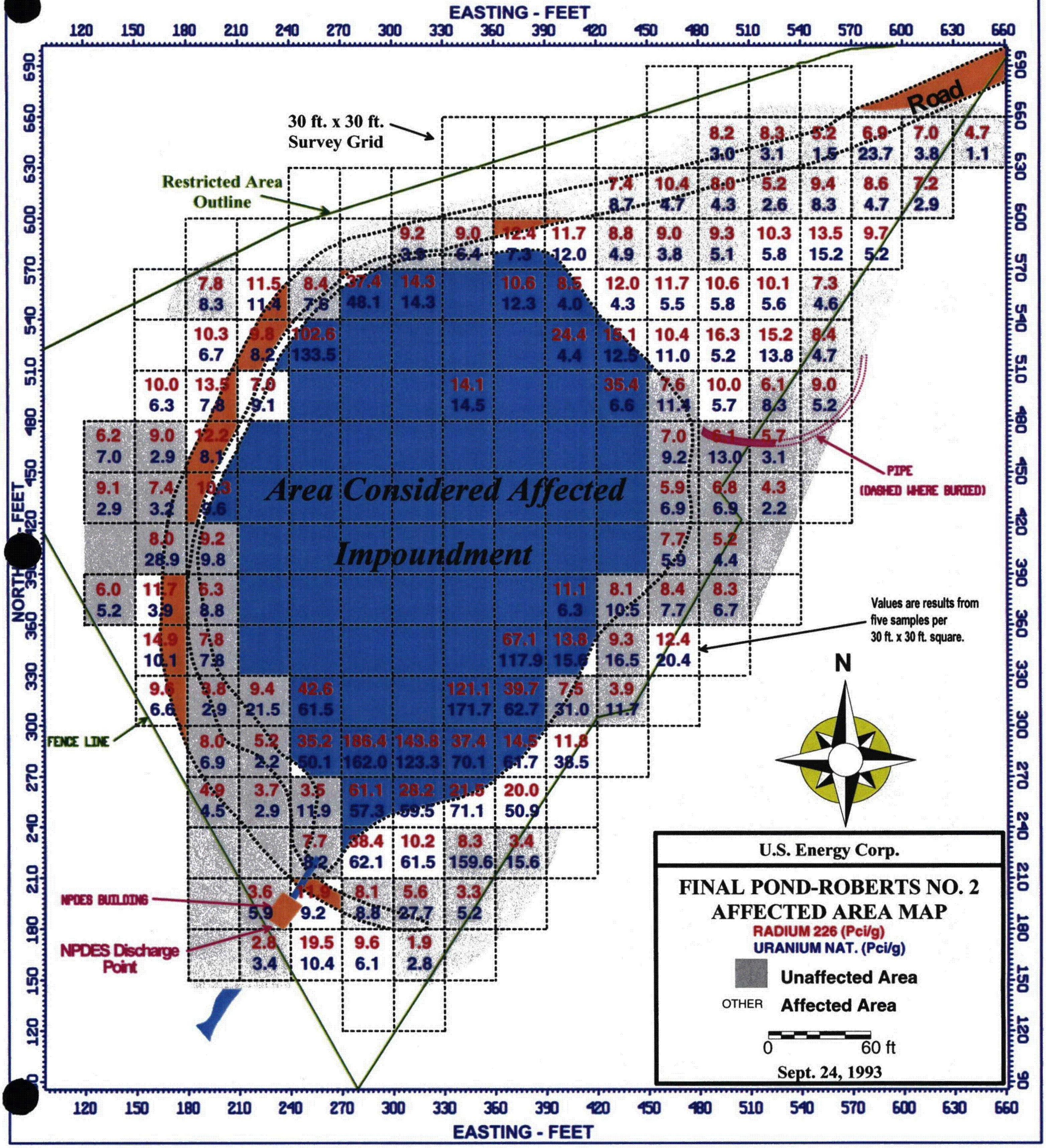
U.S. Energy Corp. Green Mountain Ion Exchange
GMIX Plant Area



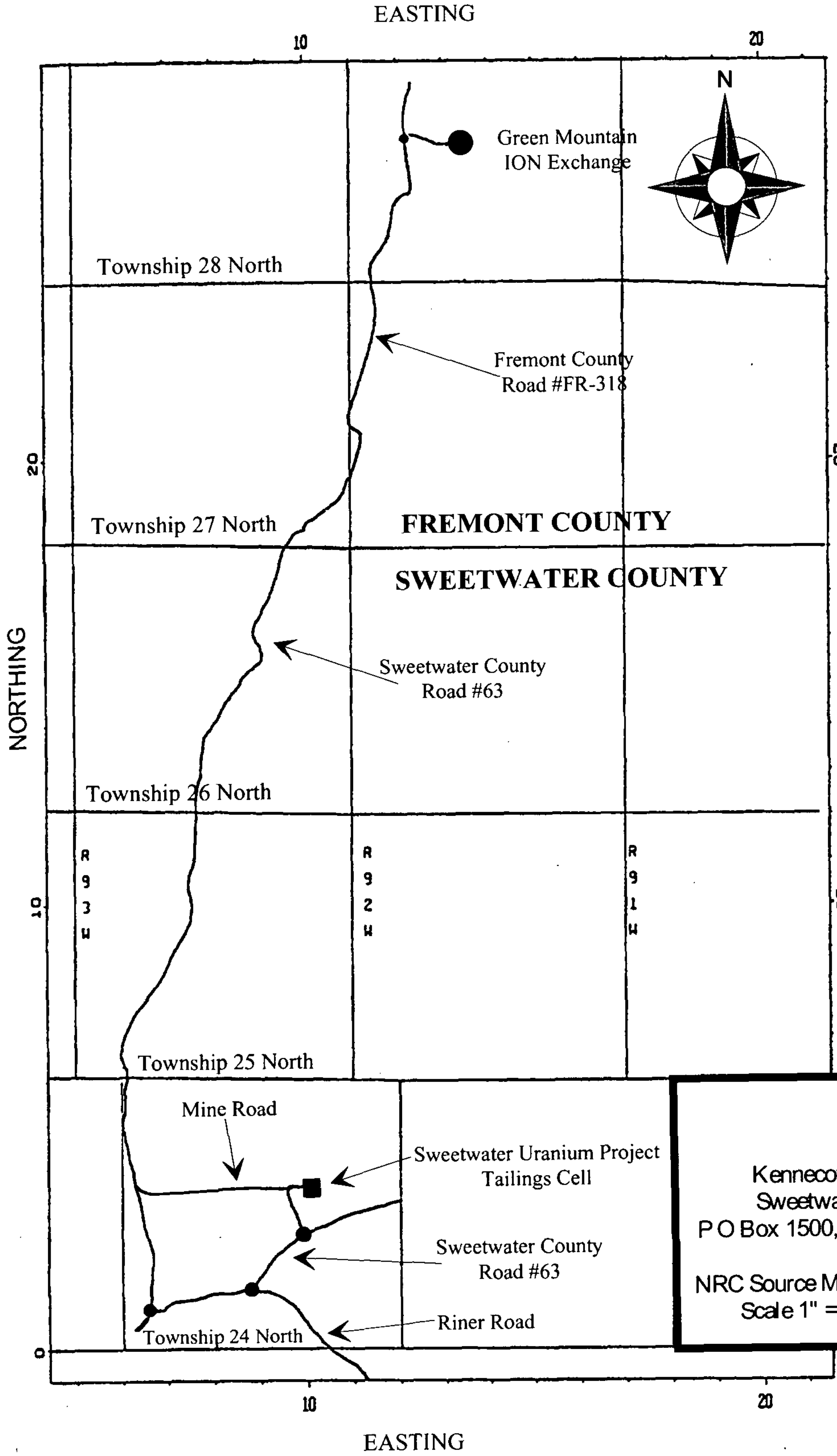
U.S. Energy Corp. Green Mountain Ion Exchange
Primary Pond - Roberts #3 Reservoir



U.S. Energy Corp. Green Mountain Ion Exchange
Final Pond - Roberts #2 Reservoir



SWEETWATER URANIUM PROJECT
WASTE DISPOSAL TRUCK ROUTE MAP



MAP #1

Kennecott Uranium Company
Sweetwater Uranium Facility
P O Box 1500, Rawlins, Wyoming 82301

NRC Source Materials License SUA-1350
Scale 1" = 4 Miles OAP: 7/19/93

GJ-47

RADIOLOGIC CHARACTERIZATION OF THE FALLS CITY, TEXAS, URANIUM MILL TAILINGS REMEDIAL ACTION SITE

Sammy J. Marutzky
Susan L. Knutson
Richard Colby

Bendix Field Engineering Corporation
Grand Junction, Colorado

June 1986

Prepared for U.S. Department of Energy
Uranium Mill Tailings Remedial Action Project Office
Albuquerque Operations Office

with

U.S. Department of Energy
Grand Junction Projects Office
Grand Junction, Colorado
Under Contract No. DE-AC07-76GJ01664

4.2 SOIL SAMPLING RESULTS

Radium analysis was performed on 1750 soil samples, of which 1087 were collected in the areas surrounding the millsite and piles. Results of the sample analyses are presented in Appendix B, Table B-1. Of the 1087 samples collected off site, 604 were at or below the EPA standard of 7.4 pCi(Ra-226)/g [5 pCi(Ra-226)/g above background] for this site. Figures 3, 4, and 5 show locations of soil samples collected from the intervals 0-6 in., 6-12 in., and 12-18 in., respectively. Locations where the radium concentration is greater than or equal to 7.5 pCi(Ra-226)/g are indicated by an 'X.' Locations where the radium concentration is less than 7.5 pCi(Ra-226)/g are indicated by a plus sign (+) [a cutoff of 7.5 pCi(Ra-226)/g was used due to rounding of the data].

Locations where the radium concentration is greater than 7.4 pCi(Ra-226)/g occur primarily in the areas immediately surrounding the piles (within approximately 200 ft), an area extending east of pile 5 to the southeast drainage, and a large area south and west of piles 1, 4, and 5, and pond 6, extending westward to the south drainage.

Determination of the extent of radium contamination from the tailings at this site is complicated due to the presence of naturally occurring uranium. Furthermore, the uranium is known to be out of equilibrium with its daughters, including radium (Hodgens, 1958). Several soil samples were chosen, based on the delta-gamma surveys, to be analyzed for uranium concentration; however, results of many of these analyses are inconclusive. To help in distinguishing tailings contamination from the naturally occurring uranium, two indicators were used based on the results of the soil sample analysis: 1) results of analyses of the uranium ore bodies below piles 1 through 5 indicate that uranium/radium ratios vary from 1.5 to greater than 26.0; and 2) analyses of the tailings materials within the piles indicate that the uranium/radium ratio for 90 percent of these samples is less than 0.60.

Figure 6 shows locations of soil samples that were analyzed for both uranium and radium. Locations where the uranium-to-radium ratio is greater than 2.0, indicative of naturally occurring uranium ore, are represented by a ⊙. Locations where the U/Ra-226 ratio is greater than 1.5 but less than 2.0, indicative of probable naturally occurring uranium ore, are represented by a ⊡. Locations where the U/Ra-226 ratio is less than 0.60, indicative of a tailings deposit, are represented by a △. Locations where the uranium concentration is less than or equal to 12 ppm and the Ra-226 concentration is greater than 7.5 pCi/g, indicative of a probable tailings deposit, are represented by a ⍏. Locations where the Ra-226 concentration is less than 7.5 pCi/g, indicative of background radiation, are represented by a +. Locations where the contamination is undetermined, but might be assumed to be a mixture of tailings and naturally occurring uranium ore, are represented by a Y.

ENERGY LABORATORIES

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U.S. ENERGY
SOIL ANALYSIS REPORT SCOPING RESULTS.

Project: Sheep Mountain Partners
Date Received: 07-24-92
Report Date: 09-03-92

$.677 \times \frac{mg}{kg} = pCi/gm$

	ELI #	Sample ID	Ra226 pCi/g	Ra226 Prec. +/-	U-nat mg/kg		Barium mg/kg
	92-23623	SMP IX 1	271	2.4	770	521.0	15.5
	92-23624	SMP IX 2	11.9	0.3	24.0	16.2	5.2
	92-23625	SMP IX 3	53.8	1.1	95.1	63.7	46.4
	92-23626	SMP IX 4	84.1	1.4	186	125.9	8.5
	92-23627	SMP IX 5	176	2.0	574	388.6	13.7
	92-23628	SMP IX 6	159	1.9	353	239.0	15.1
	92-23629	SMP IX 7	205	2.1	292	197.7	11.0
	92-23630	SMP IX 8	165	1.8	542	366.9	12.3
	92-23631	SMP IX 9	89.7	1.8	395	267.4	8.7
ix plant	92-23632	SMP IX 10	125	1.6	373	252.5	22.1
Area	92-23633	SMP IX 11	105	1.5	272	184.1	17.0
	92-23634	SMP IX 12	143	1.7	323	218.7	120
	92-23635	SMP IX 13	87.7	1.4	175	118.5	75.1
	92-23636	SMP IX 14	50.0	1.1	107	72.4	48.6
	92-23637	SMP IX 15	87.1	1.4	320	216.6	56.3
	92-23638	SMP IX 16	44.9	0.9	195	132.0	16.2
	92-23639	SMP IX 17	69.3	1.2	220	148.9	15.8
	92-23640	SMP IX 18	41.7	0.7	62.2	42.1	10.6
	92-23641	SMP IX 19 - Bkg	86.2	1.3	154	104.3	23.7
	92-23642	SMP IX 20 - Bkg	61.9	1.1	56.0	37.9	26.1
	92-23643	SMP IX 21 - Bkg	22.2	0.7	22.0	14.9	12.0
	92-23644	SMP IX 22	0.4	0.1	2287	1548	62.1
	92-23645	SMP IX 23	2.7	0.1	1845	1249	265
	92-23646	SMP IX 24	1.3	0.1	1415	958	164
	92-23647	SMP IX 25	2.0	0.1	1136	769	220
	92-23648	SMP IX 26	2.4	0.1	1369	967	204
Primary	92-23649	SMP IX 27	7.9	0.2	1144	744	816
~~Test~~ Pond	92-23650	SMP IX 28	17.3	0.3	120	81.2	2553
	92-23651	SMP IX 29 - Bkg	6.5	0.2	6.4	4.3	302
	92-23652	SMP IX 30 - Bkg	13.5	0.3	18.2	12.3	299
	92-23653	SMP IX 31 - Bkg	16.1	0.3	17.1	11.6	179
Back	92-23654	SMP IX 32	21.8	0.7	37.5	25.4	278
Area	92-23655	SMP IX 33	62.0	1.1	82.4	55.8	193
	92-23656	SMP IX 34	21.5	0.6	24.4	16.5	187
	92-23657	SMP IX 35	5.6	0.2	138	93.4	503
Final	92-23658	SMP IX 36	6.4	0.2	751	508	200
	92-23659	SMP IX 37 - Bkg	2.7	0.1	6.2	4.2	92.3
	92-23660	SMP IX 38 - Bkg	4.0	0.2	8.0	5.4	382

Q.A. MANAGER: R.A. Leaking
Energy Laboratories, Inc.
Casper, WY 82601

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COMPLETE ENVIRONMENTAL ANALYTICAL SERVICES

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254 NORTH CENTER, SUITE 100 • CASPER, WY 82601 • FAX (307) 234-1639

KENNECOTT URANIUM CO. - SOILS ANALYSIS REPORT

Date Received: 08-13-93
Report Date: 09-10-93

ELI #	Sample ID	Sample Date	Uranium pCi/g	Ra226 pCi/g (Gamma)	Ra226 Prec. +/- (Gamma)	Ra226 pCi/g (Chem.)	Ra226 Prec. +/- (Chem.)
93-35025	120/150 PRI Pond	NSD	6.3	11.7	1.0		
93-35026	150/150 PRI Pond	NSD	66.9	56.9	2.8		
93-35027	180/150 PRI Pond	NSD	25.8	33.6	2.1	40.9	0.7
93-35028	210/150 PRI Pond	NSD	33.1	50.3	2.5		
93-35029	240/150 PRI Pond	NSD	28.7	33.9	2.1		
93-35030	270/150 PRI Pond	NSD	6.6	7.7	0.8		
93-35031	120/180 PRI Pond	NSD	18.4	21.9	1.5		
93-35032	150/180 PRI Pond	NSD	11.7	39.3	2.2		
93-35033	180/180 PRI Pond	NSD	21.1	34.3	2.0		
93-35034	210/180 F Pond	NSD	3.4	2.8	0.4		
93-35035	210/180 PRI Pond	NSD	26.0	45.2	2.4		
93-35036	240/180 PRI Pond	NSD	20.4	21.0	1.5		
93-35037	240/180 F Pond	NSD	10.4	19.5	1.5	27.7	0.6
93-35038	270/180 PRI Pond	NSD	7.8	11.6	1.0		
93-35039	270/180 F Pond	NSD	6.1	9.6	0.9		
93-35040	300/180 F Pond	NSD	2.8	1.9	0.2		
93-35041	120/210 PRI Pond	NSD	63.2	42.1	2.3		
93-35042	180/210 PRI Pond	NSD	17.2	19.8	1.5		
93-35043	210/210 F Pond	NSD	5.9	3.6	0.4		
93-35044	210/210 PRI Pond	NSD	12.1	16.1	1.3		
93-35045	240/210 F Pond	NSD	9.2	11.9	1.0		
93-35046	240/210 PRI Pond	NSD	11.2	17.4	1.4		
93-35047	270/210 F Pond	NSD	8.8	8.1	0.8	8.7	0.3
93-35048	270/210 PRI Pond	NSD	13.2	13.7	1.1		
93-35049	300/210 F Pond	NSD	27.7	5.6	0.6		
93-35050	330/210 F Pond	NSD	5.2	3.3	0.4		
93-35051	120/240 PRI Pond	NSD	89.9	15.8	1.3		
93-35052	210/240 PRI Pond	NSD	27.4	11.0	1.0		
93-35053	210/240 PRI Pond	NSD	48.1	31.6	1.9		
93-35054	240/240 PRI Pond	NSD	21.3	18.3	1.4		
93-35055	240/240 F Pond	NSD	8.2	7.7	0.8		
93-35056	270/240 PRI Pond	NSD	7.9	12.7	1.1		
93-35057	270/240 F Pond	NSD	62.1	38.4	2.2	29.3	0.5
93-35058	300/240 F Pond	NSD	61.5	10.2	1.0		
93-35059	330/240 F Pond	NSD	159.6	8.3	0.9		
93-35060	360/240 F Pond	NSD	15.6	3.4	0.4		
93-35061	120/270 PRI Pond	NSD	20.1	28.8	1.8		
93-35062	180/270 F Pond	NSD	4.5	4.9	0.6		
93-35063	210/270 PRI Pond	NSD	8.2	23.3	1.6		
93-35064	210/270 F Pond	NSD	2.9	3.7	0.4		
93-35065	240/270 F Pond	NSD	11.9	3.5	0.4		
93-35066	240/270 PRI Pond	NSD	16.3	11.0	1.0		
93-35067	270/270 PRI Pond	NSD	4.8	14.3	1.2	12.0	0.4
93-35068	270/270 F Pond	NSD	57.3	61.1	2.9		

REPORT APPROVED BY: R. A. Searling

sv s335025.ken

ELI

KENNECOTT URANIUM CO. - SOILS ANALYSIS REPORT

Date Received: 08-13-93
Report Date: 09-10-93

ELI #	Sample ID	Sample Date	Uranium pCi/g	Ra226 pCi/g (Gamma)	Ra226 Prec.+/- (Gamma)	Ra226 pCi/g (Chem.)	Ra226 Prec.+/- (Chem.)
93-35069	300/270 F Pond	NSD	59.5	28.2	1.8		
93-35070	330/270 F Pond	NSD	71.1	21.5	1.7		
93-35071	360/270 F Pond	NSD	50.9	20.0	1.6		
93-35072	90/300 PRI Pond	NSD	26.8	47.3	2.5		
93-35073	120/300 PRI Pond	NSD	29.8	30.0	1.9		
93-35074	180/300 F Pond	NSD	6.9	8.0	0.8		
93-35075	210/300 F Pond	NSD	2.2	5.2	0.6		
93-35076	240/300 PRI Pond	NSD	13.8	15.2	1.2		
93-35077	240/300 F Pond	NSD	50.1	35.2	2.1	23.2	0.5
93-35078	270/300 PRI Pond	NSD	9.2	10.2	1.0		
93-35079	270/300 F Pond	NSD	162.0	186.4	5.3		
93-35080	300/300 F Pond	NSD	123.3	143.8	4.7		
93-35081	330/300 F Pond	NSD	70.1	37.4	2.3		
93-35082	360/300 F Pond	NSD	61.7	14.5	1.3		
93-35083	390/300 F Pond	NSD	38.5	11.8	1.1		
93-35084	60/330 PRI Pond	NSD	14.9	15.4	1.3		
93-35085	90/330 PRI Pond	NSD	11.6	22.3	1.6		
93-35086	120/330 PRI Pond	NSD	54.5	27.0	1.8		
93-35087	150/330 PRI Pond	NSD	33.7	33.2	2.0	14.8	0.4
93-35088	150/330 F Pond	NSD	6.6	9.6	0.9		
93-35089	180/330 F Pond	NSD	2.9	3.8	0.4		
93-35090	210/330 F Pond	NSD	21.5	9.4	0.9		
93-35091	240/330 F Pond	NSD	61.5	42.6	2.3		
93-35092	240/330 PRI Pond	NSD	38.4	30.6	1.8		
93-35093	330/330 F Pond	NSD	171.7	121.1	4.1		
93-35094	360/330 F Pond	NSD	62.7	39.7	2.3		
93-35095	390/330 F Pond	NSD	31.0	7.5	0.8		
93-35096	420/330 F Pond	NSD	11.7	3.9	0.5		
93-35097	30/360 PRI Pond	NSD	7.0	7.6	0.8	6.4	0.3
93-35098	60/360 PRI Pond	NSD	5.6	7.9	0.8		
93-35099	90/360 PRI Pond	NSD	29.3	27.3	1.8		
93-35100	120/360 PRI Pond	NSD	178.1	31.9	1.9		
93-35101	150/360 PRI Pond	NSD	17.9	19.2	1.4		
93-35102	150/360 F Pond	NSD	10.1	14.9	1.2		
93-35103	180/360 F Pond	NSD	7.8	7.8	0.8		
93-35104	240/360 PRI Pond	NSD	23.9	18.7	1.4		
93-35105	270/360 PRI Pond	NSD	30.5	12.4	1.1		
93-35106	270/360 PRI Pond	NSD	34.7	14.4	1.2		
93-35107	360/360 F Pond	NSD	117.9	67.1	3.1	46.6	0.7
93-35108	390/360 F Pond	NSD	15.6	13.8	1.2		
93-35109	420/360 F Pond	NSD	16.5	9.3	0.9		
93-35110	450/360 F Pond	NSD	20.4	12.4	1.1		
93-35111	120/390 F Pond	NSD	5.2	6.0	0.7		
93-35112	120/390 PRI Pond	NSD	17.1	18.8	1.4		
93-35113	150/390 PRI Pond	NSD	31.7	25.2	1.7		

ELI

KENNECOTT URANIUM CO. - SOILS ANALYSIS REPORT

Date Received: 08-13-93
Report Date: 09-10-93

ELI #	Sample ID	Sample Date	Uranium pCi/g	Ra226 pCi/g (Gamma)	Ra226 Prec.+/- (Gamma)	Ra226 pCi/g (Chem.)	Ra226 Prec.+/- (Chem.)
93-35114	150/390 F Pond	NSD	3.9	11.7	1.0		
93-35115	180/390 PRI Pond	NSD	31.6	23.6	1.6		
93-35116	180/390 F Pond	NSD	8.8	6.3	0.7		
93-35117	210/390 PRI Pond	NSD	11.2	15.0	1.3	16.5	0.5
93-35118	240/390 PRI Pond	NSD	7.7	15.4	1.2		
93-35119	270/390 PRI Pond	NSD	11.1	14.0	1.2		
93-35120	390/390 F Pond	NSD	6.3	11.1	1.0		
93-35121	420/390 F Pond	NSD	10.5	8.1	0.8		
93-35122	450/390 F Pond	NSD	7.7	8.4	0.8		
93-35123	480/390 F Pond	NSD	6.7	8.3	0.8		
93-35124	120/420 PRI Pond	NSD	8.7	9.7	0.9		
93-35125	150/420 PRI Pond	NSD	26.5	14.4	1.2		
93-35126	150/420 F Pond	NSD	28.9	8.0	0.8		
93-35127	180/420 F Pond	NSD	9.8	9.2	0.9	7.0	0.3
93-35128	180/420 PRI Pond	NSD	7.4	10.3	0.9		
93-35129	210/420 PRI Pond	NSD	5.4	8.6	0.8		
93-35130	450/420 F Pond	NSD	5.9	7.7	0.8		
93-35131	480/420 F Pond	NSD	4.4	5.2	0.6		
93-35132	120/450 F Pond	NSD	2.9	9.1	0.9		
93-35133	150/450 F Pond	NSD	3.2	7.4	0.8		
93-35134	450/450 F Pond	NSD	6.9	5.9	0.7		
93-35135	480/450 F Pond	NSD	6.9	6.8	0.7		
93-35136	510/450 F Pond	NSD	2.2	4.3	0.5		
93-35137	120/480 F Pond	NSD	7.0	6.2	0.7	4.6	0.2
93-35138	150/480 F Pond	NSD	2.9	9.0	0.9		
93-35139	180/450 F Pond	NSD	10.3	9.6	0.9		
93-35140	180/480 F Pond	NSD	8.1	12.1	1.1		
93-35141	450/480 F Pond	NSD	9.2	7.0	0.7		
93-35142	480/480 F Pond	NSD	13.0	6.1	0.6		
93-35143	510/480 F Pond	NSD	3.1	5.7	0.6		
93-35144	150/510 F Pond	NSD	6.3	10.0	1.0		
93-35145	180/510 F Pond	NSD	7.8	13.5	1.1		
93-35146	210/510 F Pond	NSD	9.1	7.0	0.7		
93-35147	330/510 F Pond	NSD	14.5	14.1	1.2	8.6	0.3
93-35148	420/510 F Pond	NSD	6.6	35.4	2.0		
93-35149	450/510 F Pond	NSD	11.4	7.6	0.8		
93-35150	480/510 F Pond	NSD	5.7	10.0	0.9		
93-35151	510/510 F Pond	NSD	8.3	6.1	0.7		
93-35152	150/540 F Pond	NSD	5.2	9.0	0.9		
93-35153	180/540 F Pond	NSD	6.7	10.3	1.0		
93-35154	210/540 F Pond	NSD	8.2	9.8	0.9		
93-35155	240/540 F Pond	NSD	133.5	102.6	3.8		
93-35156	390/540 F Pond	NSD	4.4	24.4	1.7		
93-35157	420/540 F Pond	NSD	12.5	15.1	1.2	8.5	0.4
93-35158	450/540 F Pond	NSD	11.0	10.4	0.9		

ELI

KENNECOTT URANIUM CO. - SOILS ANALYSIS REPORT

Date Received: 08-13-93
Report Date: 09-10-93

ELI #	Sample ID	Sample Date	Uranium pCi/g	Ra226 pCi/g (Gamma)	Ra226 Prec.+/- (Gamma)	Ra226 pCi/g (Chem.)	Ra226 Prec.+/- (Chem.)
93-35159	480/540 F Pond	NSD	5.2	16.3	1.3		
93-35160	510/540 F Pond	NSD	13.8	15.2	1.3		
93-35161	540/540 F Pond	NSD	4.7	8.4	0.8		
93-35162	180/570 F Pond	NSD	8.3	7.8	0.8		
93-35163	210/570 F Pond	NSD	11.4	11.5	1.0		
93-35164	240/570 F Pond	NSD	7.6	8.4	0.8		
93-35165	270/570 F Pond	NSD	48.1	37.4	2.2		
93-35166	300/570 F Pond	NSD	14.3	14.3	1.2		
93-35167	360/570 F Pond	NSD	12.3	10.6	1.0	8.4	0.3
93-35168	390/570 F Pond	NSD	4.0	8.5	0.8		
93-35169	420/570 F Pond	NSD	4.3	12.0	1.0		
93-35170	450/570 F Pond	NSD	5.5	11.7	1.1		
93-35171	480/570 F Pond	NSD	5.8	10.6	1.0		
93-35172	510/570 F Pond	NSD	25.6	10.1	0.9		
93-35173	540/570 F Pond	NSD	4.6	7.3	0.7		
93-35174	300/600 F Pond	NSD	3.9	9.2	0.9		
93-35175	330/600 F Pond	NSD	6.4	9.0	0.9		
93-35176	360/600 F Pond	NSD	7.3	12.4	1.1		
93-35177	390/600 F Pond	NSD	12.0	11.7	1.0	14.4	0.4
93-35178	420/600 F Pond	NSD	4.9	8.8	0.9		
93-35179	450/600 F Pond	NSD	3.8	9.0	0.9		
93-35180	480/600 F Pond	NSD	5.1	9.3	0.9		
93-35181	510/600 F Pond	NSD	5.8	10.3	1.0		
93-35182	540/600 F Pond	NSD	15.2	13.5	1.2		
93-35183	570/600 F Pond	NSD	5.2	9.7	0.9		
93-35184	420/630 F Pond	NSD	8.7	7.4	0.8		
93-35185	450/630 F Pond	NSD	4.7	10.4	1.0		
93-35186	480/630 F Pond	NSD	4.3	8.0	0.8		
93-35187	510/630 F Pond	NSD	2.6	5.2	0.6	4.5	0.2
93-35188	540/630 F Pond	NSD	8.3	9.4	0.9		
93-35189	570/630 F Pond	NSD	4.7	8.6	0.8		
93-35190	600/630 F Pond	NSD	2.9	7.2	0.7		
93-35191	480/660 F Pond	NSD	3.0	8.2	0.8		
93-35192	510/660 F Pond	NSD	3.1	8.3	0.8		
93-35193	540/660 F Pond	NSD	1.5	5.2	0.6		
93-35194	570/660 F Pond	NSD	23.7	6.9	0.7		
93-35195	600/660 F Pond	NSD	3.8	7.0	0.7		
93-35196	600/690 F Pond	NSD	1.1	4.7	0.5		

ELI

QUALITY ASSURANCE REPORT – US Energy
Report Date: 09–16–93
ELI #(s): 93:35025–196

RADIOMETRIC:	METHOD	Dup #1 %	Dup #2 %	Spk #1 %	Spk #2 %	ANALYST	DATE SAMPLE ANALYZED
Uranium	EPA–908.1	99	–	–	–	DB	09–01–93
Ra226	EPA–903.0	100	–	109	–	DB	08–30–93

USEPA–ESML–LV INTERCOMPARISON STUDY RESULTS

Radiometric	Method	ELI Value	Standard	Difference	Analyst	Date
Uranium	EPA–908.1	14.59	17.07	–2.48	DB	02–12–93
Ra226	EPA–903.1	12.88	12.54	0.34	DB	03–05–93
Ra228	EPA–904.1	14.55	13.73	0.82	DB	03–05–93
Gross Alpha	EPA–900.0	20.53	31.50	–10.97	DB	01–29–93
Gross Beta	EPA–900.0	46.33	60.70	–14.37	DB	01–29–93

Report Approved By: DB Rea

dmc 93:35025–196

ENERGY LABORATORIES

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254 NORTH CENTER, SUITE 100 • CASPER, WY 82601 • FAX (307) 234-1639

U.S. ENERGY - SOILS ANALYSIS REPORT

Project: Sheep Mountain
Green Mtn. 1X

Date Received: 08-06-93
Report Date: 08-26-93

ELI #	Sample ID	Sample Date	Uranium pCi/g	Ra226 pCi/g (Chemical)	Ra226 Prec. +/- (Chemical)	Ra226 pCi/g (Gamma)	Ra226 Prec. +/- (Gamma)
93-30015	1-Road	08-05-93	15.9			16.8	1.3
93-30016	2-Road	08-05-93	14.1			12.5	1.1
93-30017	3-Road	08-05-93	9.9	20.8	0.5	10.4	1.0
93-30018	4-Road	08-05-93	11.2			14.3	1.2
93-30019	5-Road	08-05-93	12.0			15.7	1.3
93-30020	6-Road	08-05-93	15.5			12.9	1.2
93-30021	120/450	08-05-93	59.3			56.1	2.7
93-30022	150/450	08-05-93	35.6			25.9	1.8
93-30023	180/390	08-05-93	110.2			59.0	3.0
93-30024	180/420	08-05-93	275.9	102.7	1.1	68.6	3.3
93-30025	180/450	08-04-93	139.8			98.7	3.8
93-30026	180/480	08-04-93	137.3			238.6	5.8
93-30027	210/390	08-05-93	85.1			66.2	3.1
93-30028	210/420	08-05-93	197.6			118.5	4.0
93-30029	210/450	08-04-93	86.5			65.0	3.1
93-30030	210/480	08-04-93	438.5	185.0	1.4	123.8	4.0
93-30031	210/510	08-04-93	321.3			286.8	6.5
93-30032	240/360	08-05-93	165.1			113.9	4.0
93-30033	240/390	08-05-93	138.6			147.5	4.8
93-30034	240/420	08-05-93	134.9	180.8	1.5	181.2	4.9
93-30035	240/450	08-04-93	85.9			58.1	2.7
93-30036	240/480	08-05-93	33.4			54.0	2.6
93-30037	240/506	08-04-93	256.6			249.3	5.9
93-30038	240/540	08-04-93	949.4			346.5	7.0
93-30039	270/210 - Pond	08-05-93	69.8	64.9	0.9	130.3	4.4
93-30040	270/360	08-05-93	222.9			78.7	3.3
93-30041	270/390	08-05-93	160.9			131.3	4.3
93-30042	270/420	08-05-93	78.3			134.9	4.1
93-30043	270/450	08-04-93	57.7			25.8	1.8
93-30044	270/480	08-05-93	40.9			22.4	1.6
93-30045	270/540	08-04-93	315.7			163.5	4.7
93-30046	270/570	08-04-93	577.1			405.1	7.3
93-30047	270/600	08-05-93	519.3			284.6	6.2
93-30048	300/300 - Pond	08-05-93	644.6	306.5	1.8	257.9	7.0

Report Approved By: R. A. Scarling

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U.S. ENERGY - SOILS ANALYSIS REPORT

Project: Sheep Mountain
Green Mtn. 1X

Date Received: 08-06-93
Report Date: 08-26-93

ELI #	Sample ID	Sample Date	Uranium pCi/g	Ra226 pCi/g (Chemical)	Ra226 Prec. +/- (Chemical)	Ra226 pCi/g (Gamma)	Ra226 Prec. +/- (Gamma)
93-30049	300/330	08-05-93	201.2			98.1	3.7
93-30050	300/360	08-05-93	183.1			162.9	4.8
93-30051	300/390	08-05-93	271.7			222.9	5.6
93-30052	300/420	08-05-93	357.8			178.6	4.8
93-30053	300/450	08-04-93	212.0			28.1	1.8
93-30054	300/480	08-04-93	51.5			64.1	2.8
93-30055	300/510	08-04-93	67.5			43.7	2.4
93-30056	300/540	08-04-93	204.8			122.4	4.3
93-30057	300/570	08-04-93	22.2			38.0	2.1
93-30058	300/600	08-04-93	31.0			38.3	2.4
93-30059	330/270 - Pond	08-05-93	50.5			85.9	3.6
93-30060	330/330	08-05-93	184.3			173.3	4.9
93-30061	330/360	08-05-93	200.6			153.7	4.5
93-30062	330/390	08-05-93	320.5			456.9	7.7
93-30063	330/420	08-05-93	1027.7	547.8	2.4	365.8	6.8
93-30064	330/450	08-04-93	112.8			67.9	3.0
93-30065	330/486	08-04-93	148.2			46.2	2.5
93-30066	330/540	08-04-93	28.4			29.8	1.9
93-30067	330/570	08-04-93	28.6			35.8	2.1
93-30068	330/600	08-04-93	41.8			34.5	2.6
93-30069	360/330	08-05-93	166.3			69.3	3.1
93-30070	360/360	08-05-93	95.7			63.7	3.0
93-30071	360/390	08-05-93	55.4			42.1	2.3
93-30072	360/420	08-05-93	147.0			63.2	2.9
93-30073	360/450	08-04-93	27.0			20.5	1.5
93-30074	360/480	08-04-93	43.3			47.4	2.4
93-30075	360/510	08-04-93	100.2	75.9	0.9	56.6	2.7
93-30076	360/540	08-04-93	102.2			59.9	2.7
93-30077	360/570	08-04-93	148.2			76.5	3.3
93-30078	360/600	08-04-93	49.4			57.4	2.7
93-30079	390/330	08-05-93	30.9			22.4	1.6
93-30080	390/570	08-04-93	21.0			25.4	1.7
93-30081	420/300	08-05-93	180.7			89.2	3.3
93-30082	420/330	08-05-93	14.5			18.4	1.4
93-30083	450/300	08-05-93	20.8			18.2	1.4

Report Approved By: R. A. Starling

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QUALITY ASSURANCE REPORT – US Energy
Report Date: 08–30–93
Project: Sheep Mountain
ELI #(s): 93:30015–83

RADIOMETRIC pCi/g:	METHOD	Dup #1 %	Dup #2 %	Spk #1 %	Spk #2 %	ANALYST	DATE SAMPLE ANALYZED
Uranium	EPA–908.1	87	–	94	–	DB	08–18–93
Ra226	EPA–903.0	103	–	–	–	DB	08–25–93

USEPA–ESML–LV INTERCOMPARISON STUDY RESULTS

Radiometric	Method	ELI Value	Standard	Difference	Analyst	Date
Uranium	EPA–908.1	14.59	17.07	–2.48	DB	02–12–93
Ra226	EPA–903.1	12.88	12.54	0.34	DB	03–05–93
Ra228	EPA–904.1	14.55	13.73	0.82	DB	03–05–93
Gross Alpha	EPA–900.0	20.53	31.50	–10.97	DB	01–29–93
Gross Beta	EPA–900.0	46.33	60.70	–14.37	DB	01–29–93

Report Approved By: DB Lee

dmc 93:30015–83

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U.S. ENERGY - SOILS ANALYSIS REPORT

Project: Sweetwater

Date Received: 08-10-93
Report Date: 08-30-93

ELI #	Sample ID	Sample Date	Ra226 pCi/g	Ra226 Prec. +/-	Uranium pCi/g
93-28686	BKG 1	07-12-93	4.4	0.2	8.1
93-28687	BKG 2	07-12-93	5.3	0.2	6.9
93-28688	BKG 3	07-12-93	5.7	0.2	7.0
93-28689	BKG 4	07-12-93	4.9	0.2	3.3
93-28690	BKG 5	07-12-93	3.1	0.2	6.5
93-28691	BKG 6	07-12-93	3.2	0.2	3.0
93-28692	BKG 7	07-12-93	4.2	0.3	4.7
93-28693	BKG 8	07-12-93	8.0	0.2	2.6
93-28694	BKG 9	07-12-93	3.6	0.2	3.7
93-28695	BKG 10	07-12-93	2.3	0.2	2.9
			4.5 AVG		4.9 AVG

Report Approved By: R.A. Searling

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ELI

QUALITY ASSURANCE REPORT – US Energy
Report Date: 09–01–93
Project: Green Mountain
ELI #(s): 93:28686–95

RADIOMETRIC pCi/g:	METHOD	Dup #1 %	Dup #2 %	Spk #1 %	Spk #2 %	ANALYST	DATE SAMPLE ANALYZED
Uranium	EPA–908.1	101	–	–	–	DB	08–27–93

USEPA–ESML–LV INTERCOMPARISON STUDY RESULTS

Radiometric	Method	ELI Value	Standard	Difference	Analyst	Date
Uranium	EPA–908.1	14.59	17.07	–2.48	DB	02–12–93
Ra226	EPA–903.1	12.88	12.54	0.34	DB	03–05–93
Ra228	EPA–904.1	14.55	13.73	0.82	DB	03–05–93
Gross Alpha	EPA–900.0	20.53	31.50	–10.97	DB	01–29–93
Gross Beta	EPA–900.0	46.33	60.70	–14.37	DB	01–29–93

Report Approved By: R.A. Harling

dmc 93:28686–95

APPENDIX 24

TCLP RESULTS PENDING

U. S. ENERGY / CRESTED CORP.

877 North 8th West (307) 856-9271 Riverton, Wyoming 82501

November 16, 1993

Mr. Ramon E. Hall, Director
Uranium Recovery Field Office
U.S. Nuclear Regulatory Commission
P. O. Box 25325
Denver, CO 80225

RE: Docket No. 40-8971
License No. SUA-1524
Green Mountain Ion Exchange Decommissioning Plan

Dear Mr. Hall:

Enclosed is the TCLP analysis to be inserted into Appendix 24 of the above referenced Green Mountain Ion Exchange Decommissioning Plan dated September 1993 and submitted to you on September 29, 1993. These results are for the Primary Settling Pond and the Secondary (Final) Settling Pond. As expected, all results obtained were below the regulatory limits for regulated Hazardous substances.

Please contact me if you have any questions.

Sincerely,

Kenneth Webber

Kenneth Webber,
Environmental Coordinator

KW:gd

enclosure
cc: George Worman, Kennecott Uranium Company
GMIX\NRC11-16.93

FAX (307) 857-3050

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LABORATORY REPORT- TOXICITY CHARACTERISTIC LEACHING PROCEDURE

Client: US Energy
Sample Date: 07-12-93

Sample ID: Primary Settling
Report Date: 09-29-93

ELI #: 93-28672

METALS

	CAS #	Regulatory Limit, mg/l	Min. Report Limit, mg/l	Result, mg/l in Extract
Extraction Date:	07-19-93			
Arsenic	7440-38-2	5.0	0.50	<0.50
Barium	7440-39-3	100.0	10.0	<10.0
Cadmium	7440-43-9	1.0	0.10	<0.10
Chromium	7440-47-3	5.0	0.50	<0.50
Lead	7439-92-1	5.0	0.50	<0.50
Mercury	7439-97-6	0.20	0.02	<0.02
Selenium	7482-49-2	1.0	0.10	<0.10
Silver	7440-22-4	5.0	0.50	<0.50

REPORT APPROVED BY: R.A. Leaking

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LABORATORY REPORT- TOXICITY CHARACTERISTIC LEACHING PROCEDURE

Client: US Energy

Sample ID: Primary Settling

ELI #: 93-28672

Sample Date: 07-12-93

Report Date: 09-29-93

VOLATILE ORGANICS from ZERO HEAD SPACE EXTRACTION

	CAS #	Regulatory Limit, mg/l	Min. Report Limit, mg/l	Result, mg/l in Extract
Extraction Date:	07-17-93			
Benzene	71-43-2	0.50	0.010	<0.010
Carbon Tetrachloride	56-23-5	0.50	0.010	<0.010
Chlorobenzene	108-90-7	100.0	0.010	<0.010
Chloroform	67-66-3	6.0	0.010	<0.010
1,4-Dichlorobenzene	106-46-7	7.5	0.010	<0.010
1,2-Dichloroethane	107-06-2	0.50	0.010	<0.010
1,1-Dichloroethene	75-35-4	0.70	0.010	<0.010
Methyl Ethyl Ketone	78-93-3	200.0	0.250	<0.250
Tetrachloroethene	127-18-4	0.70	0.010	<0.010
Trichloroethene	79-01-6	0.50	0.010	<0.010
Vinyl Chloride	75-01-4	0.20	0.010	<0.010

* Method 1311 Mathematics Performed as Necessary

REPORT APPROVED BY: R.A. Carling

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LABORATORY REPORT- TOXICITY CHARACTERISTIC LEACHING PROCEDURE

Client: U.S. Energy
Sample Date: 07-12-93

Sample ID: Primary Settling
Report Date: 09-29-93

ELI #: 93-28672
Date Analyzed: 07-29-93

BASE NEUTRAL ORGANICS

	CAS #	Min. Report Limit, µg/l	Result, µg/l in Extract
Extraction Date:	07-26-93		
1,4-Dichlorobenzene	106-46-7	50	<50
Hexachloroethane	67-72-1	50	<50
Nitrobenzene	98-95-3	50	<50
Hexachlorobutadiene	87-68-3	50	<50
Pyridine	110-86-1	50	<50
2,4-Dinitrotoluene	121-14-2	50	<50
Hexachlorobenzene	118-74-1	50	<50
o-Cresol	95-48-7	50	<50
m,p-Cresol	108-39-4,106-44-5	50	<50
2,4,6-Trichlorophenol	88-06-2	50	<50
2,4,6-Trichlorophenol	95-95-4	50	<50
Pentachlorophenol	87-86-5	250	<250

REPORT APPROVED BY: R.A. Learling

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LABORATORY REPORT- TOXICITY CHARACTERISTIC LEACHING PROCEDURE

Client: US Energy — Sample Date: 07-12-93

Sample ID: Secondary Settling — Report Date: 09-29-93

ELI #: 93-28671

METALS

	CAS #	Regulatory Limit, mg/l	Min. Report Limit, mg/l	Result, mg/l in Extract
Extraction Date:	07-19-93			
Arsenic	7440-38-2	5.0	0.50	<0.50
Barium	7440-39-3	100.0	10.0	<10.0
Cadmium	7440-43-9	1.0	0.10	<0.10
Chromium	7440-47-3	5.0	0.50	<0.50
Lead	7439-92-1	5.0	0.50	<0.50
Mercury	7439-97-6	0.20	0.02	<0.02
Selenium	7482-49-2	1.0	0.10	<0.10
Silver	7440-22-4	5.0	0.50	<0.50

REPORT APPROVED BY: R.A. Searling

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LABORATORY REPORT- TOXICITY CHARACTERISTIC LEACHING PROCEDURE

Client: US Energy

Sample Date: 07-12-93

Sample ID: Secondary Settling

Report Date: 09-29-93

ELI #: 93-28671

VOLATILE ORGANICS from ZERO HEAD SPACE EXTRACTION

	CAS #	Regulatory Limit, mg/l	Min. Report Limit, mg/l	Result, mg/l in Extract
Extraction Date:	07-17-93			
Benzene	71-43-2	0.50	0.010	<0.010
Carbon Tetrachloride	56-23-5	0.50	0.010	<0.010
Chlorobenzene	108-90-7	100.0	0.010	<0.010
Chloroform	67-66-3	6.0	0.010	<0.010
1,4-Dichlorobenzene	106-46-7	7.5	0.010	<0.010
1,2-Dichloroethane	107-06-2	0.50	0.010	<0.010
1,1-Dichloroethene	75-35-4	0.70	0.010	<0.010
Methyl Ethyl Ketone	78-93-3	200.0	0.250	<0.250
Tetrachloroethene	127-18-4	0.70	0.010	<0.010
Trichloroethene	79-01-6	0.50	0.010	<0.010
Vinyl Chloride	75-01-4	0.20	0.010	<0.010

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* Method 1311 Mathematics Performed as Necessary

REPORT APPROVED BY: R.A. Leaking

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LABORATORY REPORT- TOXICITY CHARACTERISTIC LEACHING PROCEDURE

Client:	U.S. Energy	Sample Date:	07-12-93
Sample ID:	Secondary Settling	Report Date:	09-29-93
ELI #:	93-28671	Date Analyzed:	07-29-93

BASE NEUTRAL ORGANICS

	CAS #	Min. Report Limit, µg/l	Result, µg/l in Extract
Extraction Date:	07-26-93		
1,4-Dichlorobenzene	106-46-7	50	<50
Hexachloroethane	67-72-1	50	<50
Nitrobenzene	98-95-3	50	<50
Hexachlorobutadiene	87-68-3	50	<50
Pyridine	110-86-1	50	<50
2,4-Dinitrotoluene	121-14-2	50	<50
Hexachlorobenzene	118-74-1	50	<50
o-Cresol	95-48-7	50	<50
m,p-Cresol	108-39-4,106-44-5	50	<50
2,4,6-Trichlorophenol	88-06-2	50	<50
2,4,6-Trichlorophenol	95-95-4	50	<50
Pentachlorophenol	87-86-5	250	<250

REPORT APPROVED BY: R.A. Lealing

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LABORATORY REPORT- TOXICITY CHARACTERISTIC LEACHING PROCEDURE

Client:	U.S. Energy	Sample Date:	07-12-93
Sample ID:	Method Blank	Report Date:	09-29-93
ELI #:		Date Analyzed:	07-29-93

BASE NEUTRAL ORGANICS

	CAS #	Min. Report Limit, µg/l	Result, µg/l in Extract
Extraction Date:	07-26-93		
1,4-Dichlorobenzene	106-46-7	50	<50
Hexachloroethane	67-72-1	50	<50
Nitrobenzene	98-95-3	50	<50
Hexachlorobutadiene	87-68-3	50	<50
Pyridine	110-86-1	50	<50
2,4-Dinitrotoluene	121-14-2	50	<50
Hexachlorobenzene	118-74-1	50	<50
o-Cresol	95-48-7	50	<50
m,p-Cresol	108-39-4,106-44-5	50	<50
2,4,6-Trichlorophenol	88-06-2	50	<50
2,4,6-Trichlorophenol	95-95-4	50	<50
Pentachlorophenol	87-86-5	250	<250

REPORT APPROVED BY: R.A. Leaching

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SOILS ANALYSIS REPORT - US ENERGY

Project: SWEETWATER

Sample I.D.:	Secondary Settling	Primary Settling	
Sample Date:	07-12-93	07-12-93	
Report Date:	09-29-93	09-29-93	
Sample Number:	93-28671	93-28672	Det.Limit
RADIOMETRIC pCi/g:			
U	230	515	0.0003
Ra226	6.4	8.6	0.2
Ra Prec. +/-	0.2	0.3	
Ra228	0.3	0.4	1.0
Ra Prec. +/-	0.1	0.1	
Pb210	39.5	29.5	1.0
Pb Prec. +/-	2.0	1.8	
Po210	172	213	1.0
Po Prec. +/-	4.8	5.4	
Gross Alpha	79.1	236	1.0
Alpha Prec. +/-	8.9	15.4	
Gross Beta	418	933	1.0
Beta Prec. +/-	20.4	30.5	
Th230	31.1	55.7	1.0
Th Prec. +/-	2.1	3.2	

REPORT APPROVED BY: R.A. Leading

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ELI

QUALITY ASSURANCE REPORT~ Us Energy
Report Date: 10-04-93
Project: Sweetwater
ELI #(s): 28671-72

TRACE METALS mg/L:	METHOD	Dup #1 %	Dup #2 %	Spk #1 %	Spk #2 %	ANALYST	DATE SAMPLE ANALYZED
Arsenic	EPA-206.3	100	-	100	-	CP	08-02-93
Barium	EPA-200.7	100	-	100	-	TS	07-21-93
Cadmium	EPA-200.7	100	-	99	-	TS	07-21-93
Chromium	EPA-200.7	100	-	100	-	TS	07-21-93
Lead	EPA-239.2	100	-	98	-	TS	07-21-93
Mercury	EPA-245.2	100	-	100	-	CP	08-02-93
Selenium	EPA-270.3	100	-	104	-	CP	07-30-93
Silver	EPA-200.7	100	-	87	-	TS	07-21-93
RADIOMETRIC:							
Uranium	EPA-908.1	99	-	-	-	DB	07-28-93
Ra226	EPA-903.0	100	-	101	-	DB	07-30-93
Ra228	EPA-904.0	100	-	-	-	DB	08-06-93
Lead 210	NERHL-65-4	100	-	85	-	DB	08-02-93
Gross Alpha	EPA-900.0	101	-	-	-	DB	07-23-93
Gross Beta	EPA-900.0	-	-	106	-	DB	07-23-93
Polonium 210	RM03008 USAEC 1970.	116	-	-	-	DB	08-07-93

USEPA-ESML-LV INTERCOMPARISON STUDY RESULTS

Radiometric	Method	ELI Value	Standard	Difference	Analyst	Date
Uranium	EPA-908.1	14.59	17.07	-2.48	DB	02-12-93
Ra226	EPA-903.1	12.88	12.54	0.34	DB	03-05-93
Ra228	EPA-904.1	14.55	13.73	0.82	DB	03-05-93
Gross Alpha	EPA-900.0	20.53	31.5	-10.97	DB	01-29-93
Gross Beta	EPA-900.0	46.33	60.7	-14.37	DB	01-29-93

VOLATILE ORGANICS FROM ZERO HEAD SPACE EXTRACTION

	Spike Conc, mg/L:	Spike % Recovery	Spike % Recovery	Spike % Recovery	Spike % Recovery	QC LIMITS	ANALYST
ELI Sample Number:		93:28671	93:28672	-	-		
Extraction Date:		07-12-93	07-12-93	-	-		
Analysis Date:		07-22-93	07-22-93	-	-		
Benzene	0.050	102	100	-	-	±30%	SEC
Carbon Tetrachloride	0.050	89	104	-	-	±30%	SEC
Chlorobenzene	0.050	109	103	-	-	±30%	SEC
Chloroform	0.050	122	114	-	-	±30%	SEC
1,4-Dichlorobenzene	0.050	95	96	-	-	±30%	SEC
1,2-Dichloroethane	0.050	102	92	-	-	±30%	SEC
1,1-Dichloroethene	0.050	103	103	-	-	±30%	SEC
Methyl Ethyl Ketone	0.550	106	81	-	-	±30%	SEC
Tetrachloroethene	0.050	119	117	-	-	±30%	SEC
Trichloroethene	0.050	102	103	-	-	±30%	SEC
Vinyl Chloride	0.050	81	82	-	-	±30%	SEC
SURROGATE RECOVERY:							
1,2-Dichloroethane-d4		81	118	-	-	±20%	SEC
Toluene-d8		80	87	-	-	±20%	SEC
Bromofluorobenzene		98	101	-	-	±20%	SEC

Report Approved By: BB Rea

dmc 93:28671-72

MATERIALS LICENSE

Pursuant to the Atomic Energy Act of 1954, as amended, the Energy Reorganization Act of 1974 (Public Law 93–438), and Title 10, Code of Federal Regulations, Chapter I, Parts 30, 31, 32, 33, 34, 35, 40 and 70, and in reliance on statements and representations heretofore made by the licensee, a license is hereby issued authorizing the licensee to receive, acquire, possess, and transfer byproduct, source, and special nuclear material designated below; to use such material for the purpose(s) and at the place(s) designated below; to deliver or transfer such material to persons authorized to receive it in accordance with the regulations of the applicable Part(s). This license shall be deemed to contain the conditions specified in Section 183 of the Atomic Energy Act of 1954, as amended, and is subject to all applicable rules, regulations and orders of the Nuclear Regulatory Commission now or hereafter in effect and to any conditions specified below.

Licensee	
1. U.S. Energy Corp.	3. License number SUA-1524, Amendment No. 6
2. 877 North 8th West Riverton, Wyoming 82501	4. Expiration date Until NRC determines that site restoration is adequate
	5. Docket or Reference No. 40-8971

6. Byproduct, source, and/or special nuclear material	7. Chemical and/or physical form	8. Maximum amount that licensee may possess at any one time under this license
Natural Uranium Byproducts	Any	Only That Amount In-Plant As A Result Of Previous Operation

9. The licensee is hereby authorized for possession only those byproduct materials in the form of wastes and contaminated facilities and equipment resulting from previous GMIX plant operations. The licensee is not authorized to operate the processing equipment and thereby produce uranium concentrates without a specific license authorization by the NRC, Uranium Recovery Field Office.

10. Authorized place of possession: The licensee's Green Mountain Ion-Exchange (GMIX) facility located approximately 10 miles south of Jeffrey City, Wyoming.

11. For use in accordance with statements, representations, and conditions contained in the licensee's application dated May 23, 1988. Whenever, the work "will" is used in the licensee's application specified above it shall denote a requirement. Notwithstanding any statements to the contrary contained in the May 23, 1988 application, the licensee shall adhere to the requirements specified in the following license conditions.

12. Release of equipment or packages from the restricted area shall be in accordance with the attachment entitled "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses For Byproduct or Source Materials," dated September 1984.

13. The licensee shall submit, as a license amendment request, a detailed decommissioning plan to the NRC at least 12 months prior to planned initiation of final decommissioning activities. The decommissioning plan shall provide for the removal of all sediments from the settling ponds where radium has been

License number
SUA-1524 Amendment No. 6

Docket or Reference number
40-8971

JUL 29 1993

MATERIALS LICENSE
SUPPLEMENTARY SHEET

precipitated. Prior to termination of this license, the licensee shall provide for the transfer and disposal of all byproduct waste material and radium pond sediments to a NRC licensed tailings area or authorized commercial disposal site.

14. The licensee shall employ or maintain on a consulting basis a qualified Radiation Safety Officer (RSO), who is responsible for radiation safety aspects of the facility. The RSO shall possess the minimum qualifications as specified in Section 2.4.1 of Regulatory Guide 8.31, "Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium Mills will be As Low As is Reasonably Achievable.

    The licensee shall, by utilization of a qualified RSO, provide training, safety instructions, and dosimetry services for all workers routinely visiting the GMIX facility adequate to assure compliance to 10 CFR Part 20 and guidelines contained in Regulatory Guides 8.30 and 8.31.

15. The licensee shall utilize a Radiation Work Permit (RWP) for all work activities performed at the GMIX facility where the potential for significant exposure to radioactive material exists. The RWP shall be issued by the consulting RSO and shall at least describe the following:

    A. The scope of the work activity to be performed.

    B. Any precautions necessary to reduce exposure of workers to uranium and its daughter products.

    C. Any supplemental radiological monitoring and sampling necessary prior to, during, and following completion of the work.

16. The licensee is hereby exempted from the requirements of Section 20.203(e)(2) of 10 CFR 20 for areas within the GMIX providing that all entrances to the plant are conspicuously posted in accordance with 20.203(e)(2) and with the words, "Any area within this facility may contain radioactive material."

17. The licensee shall maintain an NRC-approved financial surety arrangement, consistent with 10 CFR 40, Appendix A, Criterion 9, adequate to cover the estimated costs, if accomplished by a third party, for completion of an NRC-approved site closure plan including: above ground decommissioning and decontamination, the cost of offsite disposal of radioactive solid process wastes and evaporation pond residues, and ground-water restoration as warranted. Within 3 months of NRC approval of a revised closure plan, the licensee shall submit, for NRC review and approval, a proposed revision to the financial surety arrangement if estimated costs in the newly approved site closure plan exceed the amount covered in the existing financial surety. The revised surety shall then be in effect within 3 months of written NRC approval. Annual updates to the

surety amount, required by 10 CFR 40, Appendix A, Criterion 9, shall be provided to the NRC at least 3 months prior to the anniversary date of November 15 of each successive year. If the NRC has not approved a proposed revision 30 days prior to the expiration date of the existing surety arrangement, the licensee shall extend the existing arrangement, prior to the expiration, for 1 year.

Along with each proposed revision or annual update, the licensee shall submit supporting documentation showing a breakdown of the costs and the basis for the cost estimates with adjustments for inflation, maintenance of a minimum 15 percent contingency, changes in engineering plans, activities performed and any other conditions affecting estimated costs for site closure. The licensee shall also provide the NRC with copies of surety related correspondence submitted to the State, a copy of the State's surety review and the final approved surety arrangement. The licensee must also ensure that the surety, where authorized to be held by the State, expressly identifies the NRC related portion of the surety and covers the above ground decommissioning and decontamination, the cost of offsite disposal, soil and water sample analyses and ground-water restoration associated with the site. The basis for the cost estimate is the NRC approved site closure plan or NRC revisions to the plan.

U.S. Energy's currently approved surety, automatically renewable certificates of deposit payable to the State of Wyoming, shall be continuously maintained in an amount no less than $76,595 for the purpose of complying with 10 CFR 40, Appendix A, Criterion 9, until a replacement is authorized by both the State and the NRC.

[Applicable Amendments: 1, 2, 3, 5]

18. The licensee shall implement the environmental monitoring program for ground water, surface water, and soil sampling at the locations and frequency specified in the attachment to this license entitled, "Green Mountain IX Environmental Monitoring Requirements." The results of all effluent and environmental monitoring required by this license shall be reported in accordance with 10 CFR 40, Section 40.65, with copies of the report sent directly to the U.S. Nuclear Regulatory Commission, Uranium Recovery Field Office.

19. The results of sampling, analysis, surveys, and monitoring, the calibration of equipment, reports on audits and inspections committed to in the licensee's application and in the additional conditions to this license, as well as any subsequent reviews, investigations, and corrective actions, shall be documented. Unless otherwise specified in NRC regulations, all such documentation shall be maintained for a period of at least 5 years.

20. The licensee shall utilize the lower limits of detection in accordance with Section 5 of the Regulatory Guide 4.14, Revision 1 dated April 1980, for analysis of effluent and environmental samples.

NRC Form 374A
(5-84)

U.S. NUCLEAR REGULATORY COMMISSION

License number
SUA-1524 Amendment No. 6

MATERIALS LICENSE
SUPPLEMENTARY SHEET

Docket or Reference number
40-8971

JUL 29 1993

21. The licensee shall conduct a quality assurance program for environmental monitoring as outlined in Regulatory Guide 4.15.

22. All radiation monitoring, sampling, and detection equipment shall be recalibrated after each repair and as recommended by the manufacturer or at least semiannually. In addition, all radiation survey instruments shall be operationally checked with a radiation source before each use.

23. The licensee is hereby authorized to possess process equipment purchased from the Bison Basin plant. Equipment shall not be removed from the restricted area or decontaminated without submitting a decontamination or decommissioning plan and receiving approval from the NRC.

FOR THE NUCLEAR REGULATORY COMMISSION

Date: JUL 29 1993

for Ramon E. Hall, Director
Uranium Recovery Field Office
Region IV

Appendix

U.S. Department of Energy Guidelines
for Residual Radioactive Materials at Remote
Surplus Facilities Management Program (SFMP) Sites

DRAFT

SFMP follows the U.S. Department of Energy's Guideline for Residual Radioactive Material at Formerly Utilized Sites Remedial Action Program (FUSRAP) and Remote Surplus Facilities Management Program (Revision 2, March 1987). Pursuant to those guidelines the authorized limits being applied for the Monticello Vicinity Properties are:

Cleanup of Buildings

1. Indoor radon decay products shall not exceed 0.03 working levels (WL) in any case and, to the extent practicable, shall achieve 0.02 WL.

2. Indoor gamma radiation shall not exceed 20 μR/h above background.

Cleanup of Land

1. Surface levels shall not exceed 5 pCi/g above background in any 15-cm surface layer over any 100-m^2 area.

2. Buried deposits shall not exceed 15 pCi/g above background in any 15-cm layer below the surface layer over any 100-m^2 area.

3. The "hot spot" criteria defined in the October 19, 1987, memo from G. R. Grandbouche, Project Engineer, to W. E. Murphie will be applied to independent verification.

Hot Spot Guideline

The method for determining hot spot limits, which is based on the 100-mrem/year dose limit described in the FUSRAP procedures manual, shall still be applicable for determining allowable concentrations. However, an alternative approach, more appropriate for field applications, may be used in place of the dose limit method and is recommended for general applications.

Alternative Method

1. The alternative approach uses the following equation to calculate basic hot spot limits for Monticello: the following equation:

$$S_{hg} = S_g \times (100\ m^2/A)^{1/2} + 2$$

where

S_{hg} = the hot spot limit in pCi/g
S_g = the authorized limit for Monticello in pCi/g
5 pCi/g for surface soil
15 pCi/g for subsurface soil
A = the area of the hot spot in m^2

2. Areas less than 1 m^2 are to be average over the 1 m^2, and that average shall not exceed ten times the authorized limit.

3. Because the average authorized limit is considered adequate to protect the public for areas larger than 25 m^2, hot spot limits are used only for areas ≤ 25 m^2.

4. The hot spot guideline will be applied to hot spots on an individual basis.

5. Every reasonable effort will be made to identify and remove any source that has a concentration of a radionuclide exceeding 30 times the authorized limit, regardless of the area.

See Table A.1 for a listing of hot spot limits for the Monticello, Utah, area.

When samples are taken from an area for which hot spot limits apply, the average ^{226}Ra concentration of the two samples is compared to the limit rather than the concentration of each sample being separately compared to the limit. Both net estimated area-weighted average (NEAWA) concentration for ^{226}Ra and hot spot limit are shown on the soil analysis work sheet.

DRAFT

Table A.1 Hot spot limits

Surface soils		Subsurface soils	
Area (m^2)	Limit (pCi/g)	Area (m^2)	Limit (pCi/g)
1.0	52.0	1.0	152.0
1.5	43.0	1.5	124.0
2.0	37.0	2.0	108.0
2.5	34.0	2.5	97.0
3.0	31.0	3.0	89.0
3.5	29.0	3.5	82.0
4.0	27.0	4.0	77.0
4.5	26.0	4.5	73.0
5.0	24.0	5.0	69.0
5.5	23.0	5.5	66.0
6.0	22.0	6.0	63.0
6.5	22.0	6.5	61.0
7.0	21.0	7.0	59.0
7.5	20.0	7.5	57.0
8.0	20.0	8.0	55.0
8.5	19.0	8.5	53.0
9.0	19.0	9.0	52.0
9.5	18.0	9.5	51.0
10.0	18.0	10.0	49.0
11.0	17.0	11.0	47.0
12.0	16.0	12.0	45.0
13.0	16.0	13.0	44.0
14.0	15.0	14.0	42.0
15.0	15.0	15.0	41.0
16.0	15.0	16.0	40.0
17.0	14.0	17.0	38.0
18.0	14.0	18.0	37.0
19.0	13.0	19.0	36.0
20.0	13.0	20.0	36.0
21.0	13.0	21.0	35.0
22.0	13.0	22.0	34.0
23.0	12.0	23.0	33.0
24.0	12.0	24.0	33.0
25.0	12.0	25.0	32.0

DRAFT

U.S. ENERGY CORP.

Source Material License SUA-1524

GREEN MOUNTAIN ION-EXCHANGE FACILITY
(GMIX)
877 North 8th West
Riverton, Wyoming 82501

RADIATION SAFETY PROGRAM

&

STANDARD OPERATING PROCEDURES

July 12, 1993

RADIATION SAFETY PROGRAM

U.S. Energy Corp.
Source Material License SUA-1524

TABLE OF CONTENTS

INDEX

U.S. Energy Corp.
Source Material License 1524
Green Mountain Ion-Exchange Facility
(GMIX)
Radiation Safety Program

EXECUTIVE SUMMARY

License number SUA-1524 is authorized for possession only of those byproduct materials in the form of wastes and contaminated facilities and equipment resulting from previous GMIX plan operations and process equipment purchased from the Bison Basin Plant. The licensee is not authorized to operate the processing equipment and thereby produce uranium concentrates without a specific license authorization by the NRC, Uranium Recovery Field Office.

Release of equipment or packages from the restricted area shall be in accordance with the attachment entitled "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses For Byproduct or Source Materials," dated September 1984.

The licensee is exempted from the requirements of Section 20.203(e)(2) of 10 CFR 20 for areas within the GMIX providing that all entrances to the plant are conspicuously posted in accordance with 20.203(3)(2) and with the words, "Any area within this facility may contain radioactive material."

The "GMIX" Facilities" hereafter referred to in the Radiation Safety Program includes the GMIX plant, the restricted area around the GMIX plant, the IX Reservoir, the primary settling pond (Roberts No. 3) and the final settling pond (Roberts No. 2).

U.S. Energy Corp.
Green Mountain Ion-Exchange Facility
Radiation Safety Program: License SUA-1524

I. Qualifications

Qualifications of management and radiation protection personnel are enumerated below. Those listed are considered minimums

A. GMIX Facility Manager and/or Environmental Coordinator

1. Advanced technical training or BS degree or higher, and/or extensive experience in mining or milling (5-10 years).

2. Training/knowledge in radiation protection, industrial safety, accident prevention, and medical first aid.

3. Proven skills in supervisory and management functions.

B. Safety and Environmental Administrator (SEA)(also is Radiation Safety Officer [RSO])

1. BS degree in the physical sciences, mathematics or engineering from an accredited college or university, equivalent experience, or a combination of education and experience. Equivalent experience will be at least four years of relevant radiation safety experience.

2. Specialized training in radiation protection, with at least bi-annual refresher course.

3. Training and experience in management.

4. Have a working knowledge of radiation detection instruments, biological effects of radiation, and mathematics of radiation.

C. Environmental Assistant

1. An associate degree in science or high school diploma and two years equivalent work experience and at least one year training and/or experience in sampling and analytical procedures.

2. In lieu of the above, long-term (5 years) demonstrated work experience in the field of radiation protection monitoring, sampling and analytical procedures will be accepted provided such work experience is verified and documented by U.S. Energy prior to assignment.

II. Radiation Safety

The radiation safety program consists of the following elements. The health physics standard operating procedures (SOPs) outline the specifics of each of these elements:

A. Written and practiced "As Low As Reasonably Achievable" (ALARA) philosophy with shared responsibility by management, the RSO, and all GMIX Facility personnel.

B. Authority by SEA/RSO to suspend, postpone, or modify any work activity that is potentially hazardous to personnel, or a violation of NRC rules or license conditions.

C. The SEA/RSO is delegated the authority to enforce regulations and administrative policy that affects any aspect of the radiological safety program.

D. The SEA/RSO develops and administers the ALARA program and is active in review and approval of plans for new equipment, process changes, or changes in operating procedures to ensure that the plans do not adversely affect the protection program against uranium and its decay products.

E. Hazard file relating to hazards associated with the GMIX Facility including company rules for personal protection such as use of hard hats, safety glasses, respirators etc; radiation protection such as observance of posted restricted areas, personal hygiene to minimize contamination, personal monitoring etc; emergency procedures; and miscellaneous rules concerning firearms, alcohol etc. All personnel are instructed in standard operating procedures relating to the above hazards.

F. Radiation work permits are required for non-routine activities.

G. Weekly inspections are conducted by the Facility Manager or his/her designee and/or the SEA/RSO personnel of the GMIX Facility including the integrity of piping/sumps/tanks, operability of ventilation system including exhaust fan ducts, observance of general radiation safety such as prompt and adequate cleanup of spills, signs and barriers properly posted/placed, cleanliness of change facilities etc., and general safety as per Mine Safety Health Administration 30 CFR 56 such as availability and placement of properly charged fire extinguishers, cleanliness in the laboratory and proper storage chemicals, and any items throughout the facility, including shop areas which could cause an accident or injury.

H. Weekly inspections are conducted and documented by the radiation personnel of general radiation control practices.

I. Monthly inspections are conducted by the RSO and detailed reports submitted to the Facility Manager.

J. Employment of technically qualified personnel and continued training of key personnel.

K. A comprehensive radiation safety program.

L. An extensive surveying and monitoring program conducted by the radiation and environmental personnel.

M. Respiratory protection for project personnel.

N. Bioassay program(s) for project personnel.

O. Properly designed facility and equipment to ensure adequate protection for all personnel and the environment.

P. Proper facility layout to maintain personnel exposures ALARA.

Q. Restricted access of personnel to areas of potential exposure to airborne radioactivity.

R. Installation of adequate ventilation systems.

S. Fire control and chemical hazard protection systems.

T. General equipment design considerations such as effectiveness of ventilation system to reduce exposure to airborne radioactive materials, the effectiveness of dryer design to reduce airborne radioactive materials, etc.

U. Properly designed and maintained ventilation and dust control systems to maintain exposures of all persons ALARA.

V. Minimizing dusting in restricted areas.

W. Fume hoods in analytical areas.

X. Written analytical procedures.

Y. Written procedure for instrument operation, sample collection, instrument calibration, and documentation.

Z. Maintenance of records and filing relating to the radiation safety program.

In order to comply with limits established in 10 CFR 20 and to keep exposures As Low As Reasonably Achievable (ALARA), U.S. Energy Corp. has established a personnel radiation monitoring and protection program described in this section.

III. Occupational Exposure, External

A. Personnel Monitors: If requested by the RSO, all GMIX Facility personnel will be issued thermoluminescent dosimeters (TLD's) or film badges, to wear while working in the GMIX Facility on an as needed basis. The TLD's or film badges will be exchanged on a quarterly basis and are furnished and will be analyzed by a reliable laboratory such as R. S. Landauer Jr. and Co., Glenwood Ill., or Eberline Instruments Corp., Santa Fe, NM. In addition, stationary badges or dosimeters will be placed in selected locations and read quarterly.

1. According to 10 CFR 20.1502, individual external monitoring is required if "adults (are) likely to receive, in 1 year from sources external to body, a dose in excess of 10 percent of the limits in 10 CFR 20.1201(a)". 10 CFR 20.1201(a) sets an annual limit of 5 rems for the total effective dose equivalent (external and internal). Ten percent of 5 rem is 500 millirem. Based on previous data for external exposures to workers at the GMIX Facility, external monitoring is probably not required; however, in keeping with the commitment of U.S. Energy Corp. to the principle of ALARA, TLD badges will be issued and exchanged quarterly if required.

B. Exposure Control Limits - Action Levels: If any person receives a dose in excess of 25 percent of the limits specified in paragraph (a) of 10 CFR 20.101 in any calendar quarter, the following actions are implemented:

1. The analytical laboratory is contacted to check on any possible analytical or calculation error. If no mistakes are found the following steps apply:

2. The Safety and Environmental Department initiates an investigation to determine where and how the exposure(s) occurred. If there is an indication that a work area has unusual external radiation, a survey will be made of the area to determine the cause.

3. If a source of unusual external radiation is noted, appropriate action is taken to lower the level of radiation as far below the limits specified in 10 CFR 20 as is reasonably achievable and to ensure that no unnecessary exposure occurs in the future.

C. Determination of doses will be in compliance with 10 CFR 20.1202, 20.1203, 20.1204 and 20.1206.Dose calculation procedures and forms are included in the Standard Operating Procedures.

D. All applicable exposure records are kept in accordance with the regulations set forth in 10 CFR 20.2102, 20.2103, 20.2104, 20.2105 and 20.2106 which address summation of external and internal doses, determination of external doses from airborne radioactive material, determination of internal exposure, and planned special exposures. All exposure investigations are documented on NRC forms 4 and 5. An example of the NRC forms 4 and 5 are found SOP Health Physics-5.

E. Personnel Age Limits: No individual within a restricted area who is under 18 years of age will be allowed to receive in any calendar year a dose in excess of 10 percent of the limits specified in paragraph (a) 10 CFR 20.1201.

F. Instrument Precision:

Exposure, MR	5	10	50	300	3,000	30,000
Standard deviation	20%	10%	4%	4%	4%	4%

The standard deviation is based on the intensity of the radiation source. For exposure measurements, instrumentation is designed to measure gamma rays passing through a medium. The greater the radiation intensity of the source, the greater number of gamma rays will be detected by the instrumentation with a subsequent reduction in the detection error. As the radiation intensity increases beyond a certain level, which varies depending upon the instrument used, the detection error remains constant.

G. Quality Assurance Program: Dosimeter services used have a quality assurance program that meets the requirements of the American National Standards Institute (ANSI-N45.2), the Nuclear Regulatory Commission (10 CFR 50, Appendix B), and other agencies of the U.S. Government (MIL-Q-9859). Additional assurance is gained through audits conducted internally. Any dosimeter service used will meet or exceed these requirements.

IV. External Radiation Control (Beta Gamma Surveys)

A. Surveys: Direct Beta-Gamma radiation surveys will be performed at locations established if required. These locations are evaluated for effectiveness and changed or added to as necessary.

B. Instruments: Instrumentation is addressed in the Standard Operation Procedures. The survey instruments are checked with a standard prior to use. The instruments are sent to a reputable vendor for calibration semi-annually or at least at the manufacturer's suggested interval.

C. Radiation monitoring and sampling equipment is calibrated after repair, and at least semi-annually or at the manufacturer's suggested interval.

V. Contamination Surveys

A. During the decontamination and decommissioning period, contamination surveys will be conducted in the GMIX Facility areas. These surveys are conducted by total alpha survey to determine if the levels exceed the allowable level for removable contamination. Any sample approaching or exceeding 1000 dpm/100cm^2 total alpha is cause for investigation by the RSO with subsequent decontamination and follow-up smear test and total alpha survey.

B. Equipment used for alpha surveys and counting is calibrated semi-annually and after repairs.

C. All equipment to be released for shipment out of the restricted area is surveyed for contamination. Any piece of equipment in excess of 1000 dpm/cm^2 total alpha is smear tested to determine the amount (dpm) of removable contamination per 100 cm^2. Any piece of equipment in excess of 1000 dpm/cm^2 removable alpha or 5000 dpm/cm^2 fixed alpha is decontaminated and resurveyed to insure compliance.

D. All equipment to be shipped by common carrier is surveyed to insure compliance with DOT regulations.

VI. Occupational Exposure, Internal

A. Evaluation of internal doses is required if adults are likely to receive in 1 year an intake in excess of 10 percent of the applicable Annual Limits of Intake (ALIs) in Table 1, Column 1 and 2 of Appendix B to 20.1001 - 20.2401, and minors and declared pregnant women likely to receive in 1 year a committed effective dose equivalent in excess of 0.05 rem as per 10 CFR 20.1502. Exposure to internal radiation is determined from known exposure times and concentrations of airborne radionuclide.

B. Time-Exposure Records

1. Time studies of all mill and maintenance personnel are conducted to determine the amount of time spent in each area. This information, along with suitable measurements of the area airborne concentration, is used to calculate exposure. Time cards, work logs, process reports, and maintenance work orders are used to verify personnel work locations. Collection of urine bioassay samples and in vivo counting are part of the radiation safety program; however, these will not be used to determine internal exposure as given in 10 CFR 20.1204, but will be used to verify the internal exposure calculations determined from the air sampling data, if required.

2. A computer program or equivalent method will be obtained from the U.S. Nuclear Regulatory Commission and used to determine weekly and quarterly exposure, if required. The hours worked and airborne concentrations are used to determine exposure.

3. Any abnormal exposures are included in the exposure calculation and records. If monitoring of both external exposure and internal exposure is determined to be required, compliance with the dose limits will be based on the summation of external and internal doses as per 10 CFR 20.1202. Further, as per 10 CFR 20.1702 and 10 CFR 20.1703, if properly certified authorized and maintained respiratory protection equipment is used, the appropriate protection factor will be used to estimate the concentration of radioactive material in the air that is

inhaled when respirators are worn Actual intakes will be verified based on the bioassay and in vivo programs.

C. Air Sampling

1. On a periodic basis as per the SOP for personnel air sampling, portable sampling pumps are attached to a person during the shift in order to determine time-weighted averages. Portable air samples are conducted on\when:

   a. Concentration of airborne radioactive material is expected to exceed 0.1 ALI.

   b. Personnel are working on maintenance of equipment which is used with yellowcake. (In lieu of portable air samples, special hi-vol air samples may be taken during work period.)

2. Radon daughter monitoring will be performed if required by the RSO in selected areas. Sampling and analysis will be performed with an accepted procedure such as the modified Kusnetz method.

D. Extraordinary Procedures

1. Radiation work permits are issued for non-routine jobs with time records being kept during a non-routine maintenance or clean-up of spills to maintain a close accounting of individuals' exposure(s). Work exposure assessments are conducted following each such non-routine exposure to reduce the possibility of over exposure.

E. Exposure Control Limits - Action Levels

1. If a person reaches an action level of 125 DAC-hours (25% of 500 DAC-hours/quarter) based on TWE (time weighted exposure) over a period of one quarter, the RSO will institute an investigation of their work record and exposure history to identify any problem areas. If any problem areas are noted, they will be studied with necessary corrective measures taken to ensure that the exposures are reduced to levels As Low As Reasonably Achievable.

VII. Bioassay <u>In Vitro</u>

A. According to 10 CFR 20.1204, for purposes of assessing the dose used to determine compliance with occupational dose equivalent limits, suitable and timely measurements of airborne concentrations in the work area, quantities of radionuclide in the body, quantities of radionuclide excreted from the body or combinations of these measurements should be used, if requested by the SEA/RSO. Further, unless respiratory protective equipment is used, as provided in 10 CFR 20.1703, or the assessment of intake is based on bioassay, it will be assumed that an individual inhales radioactive material at the airborne concentration in which the individual is present. Finally, for accurate assessment of internal radiation exposures, regulatory guidance from the Nuclear Regulatory Commission states that neither bioassay nor air sampling alone is necessarily sufficient. The document "Interpretation of Bioassay Measurements" (NUREG/CR- 4884) and Regulatory Guide DG-8009 as well as bioassay data, will therefore be used to verify the intake of radionuclide calculated based on air sampling and/or the protection factors of respirators.

B. Special Tests

1. Any special urinalysis or lung count is scheduled by the SEA/RSO.

C. Exposure Control - Urine Action Levels

1. If 15 to 30 µg/l of uranium is found in the urine, the following actions will be taken:

   a. Re-analyze the sample.
   b. Review exposure history for possible causes.

2. If over 30 µg/l of uranium is detected in the urine, the following actions will be taken:

   a. Repeat the requirements stated above.
   b. Obtain and analyze new sample.

3. If levels exceed 30 µg/l for any two consecutive samples, or exceeds 80 µg/l for any one sample, a formal documented evaluation will be conducted to:

   a. Determine why air samples were not representative and did not warn of excessive concentrations of airborne uranium. Make corrections.
   b. Identify the cause of airborne uranium and initiate additional control measures.
   c. Determine whether other personnel could have been exposed and collect urine samples from them. All additional urine samples are tested for albuminuria (a protein found in the urine of a person who have been exposed to uranium at concentrations great enough to cause damage to the kidneys).
   d. Consider work assignment limitations to assure that a person does not exceed a urinary uranium concentration of 30 µg/l.
   e. Arrange for in vivo counting to be conducted as soon as possible following the confirmation of the above uranium concentrations in urine especially if a person was exposed to Class Y material or ore dust.

VIII. Bioassay In Vivo

A. The lower limit of detection for the lung counting procedure is 9 nCi or less of uranium in the lungs. If 9 to 16 nCi of uranium is detected in the lungs, the following actions will be taken:

1. Confirm result (repeat measurement).
2. Determine why air samples were not representative and did not warn of excessive airborne uranium. Make corrections.
3. Identify the cause of airborne uranium and initiate additional control measurements.
4. Determine whether other personnel could have been exposed and collect urine samples and in vivo count them.
5. Consider work assignment limitations that will permit the lung burden to be reduced through natural elimination to a level less than 16 nCi.

B. If over 16 nCi of uranium is detected in the lungs, a formal documented evaluation will be conducted to:

1. Take the actions listed above for 9 to 16 nCi.
2. Establish work restrictions for affected personnel.
3. Perform individual urine sampling and additional in vivo counting for affected personnel.

C. For any results exceeding 16 nCi, the company performing the in vivo counting will report the results to the SEA/RSO by telephone.

D. Management Review

All bioassay results including urine and in vivo data, are evaluated by the RSO. Results are sent to the Environmental Coordinator and, upon the request of an individual, given a copy of their own records. U.S. Energy Corp. evaluates a person's radiation exposure history by reviewing records of previous exposure.

IX. Respiratory Protection

A. The respiratory protection program is based on Regulatory Guide 8.15 "Acceptable Procedures for Respiratory protection", NUREG-0041 "Manual of Respiratory Protection Against Airborne Radioactive Materials", and complies with 10 CFR 20.1001 - 20.2401 Sub Part H. The program is directed by the RSO with professional guidance and assistance from medical personnel, research personnel, and Corporate Health and Safety Personnel.

B. The Respiratory protection program will include:

1. Air sampling sufficient to identify the potential hazards, and permit proper equipment selection.
2. Surveys and bioassay, as appropriate to evaluate actual intakes.
3. Testing of respirators for operability immediately prior to each use.
4. Written procedures regarding selection, fitting, issuance, maintenance, and testing of respirators, including testing for operability immediately prior to each use, supervision and training of personnel; monitoring, including air sampling and bioassay; and record keeping.

C. Routine and Non-Routine Operations

1. Respirators are required on routine operations at the discretion of the SEA/RSO, Facility Manager, or Environmental Coordinator.
2. Non-routine operations, are controlled by Radiation Work Permits.

D. Training and Restrictions

1. Initial employment physical examinations are evaluated to determine if any personnel have any medical limitations that preclude assigning the individual to this type of work.
2. All personnel who work in the GMIX Facility Areas and are advised by the RSO to wear respirators will receive the following instructions:

   a. All GMIX Facility and maintenance personnel will be trained in the proper use of, and be shown how to wear, the respirator. The shift supervisor, RSO, or his/her delegate, will ensure that all protective equipment is worn properly.

   b. Each person will be advised that they may leave the area for relief from respiratory use in case of equipment malfunction, physical or psychological discomfort, or any other condition that might cause reduction in the protection afforded the wearer.

   c. Personnel working in the GMIX Facility Area shall be instructed not to smoke, eat, and/or remove their respiratory protective equipment while working in a situation that requires the respiratory protective equipment. The work will be monitored to ensure that all necessary safeguards are taken.

d. The following topics will also be discussed:

1. Type of airborne contaminants, their physical and chemical properties and toxicity.

2. Type, operation, and limitation of respiratory equipment.

3. Need for respiratory equipment.

4. Ensuring that respiratory equipment is working properly and it has been properly fitted.

5. Proper use and maintenance of respiratory equipment.

6. Action to be taken in the event of a malfunction or defective equipment.

e. All personnel shall be fitted with different types of respiratory equipment until one is found suitable. Those personnel who cannot wear a particular make of respirator, may not use that device for any work. Correct facial fit will be verified with a quantitative fit test procedure or with an irritant smoke.

f. Personnel working in areas which require respiratory protection will be clean-shaven (no interfering facial hair) so proper fit can be achieved.

E. Cleaning, Storage, Inspection

1. Respirators are cleaned and disinfected as often as necessary to ensure that proper protection is provided to the user.

2. After cleaning and after each use, the inside of the respirator is surveyed for residual alpha contamination and inspected to be sure it is functioning properly. Worn or deteriorated parts are replaced as soon as detected, using only approved parts for that particular device. The cleaned respirators are stored in plastic bags to avoid contamination.

3. Instructions on the proper care and use of respirators will be posted in the IX Facility Building.

4. A possible list of respirators is:

a. MSA Custom Comfo II
b. MSA Ultravue - Full Face
c. MSA Ultravue (Air powered) - Full Face

F. Documentation

1. Proper documentation will be kept concerning all training, fitting, and medical reports pertaining to personnel use of respirators as well as of maintenance, cleaning, and surveys of respirators.

G. Exposure Records

1. In computing personnel exposure, credit for respirators is taken in compliance with 10 CFR 20.1702, and 20.1703(a) and (b).

X. Decontamination Procedures

A. Personnel Cleanup

1. All personnel who work in the GMIX Facility Areas have coveralls, rubber gloves and rubber boots available for use if required. All personnel are required to report to the established shower/change room area for Alpha monitoring prior to leaving the restricted area.

B. Contaminated Clothing

1. All contaminated clothing, as determined by personnel alpha monitoring, will be placed in containers for laundering at the Sweetwater Mill. No contaminated clothing or personnel with residual contamination are allowed to leave the established shower/change room.

C. Contaminant Surveys

1. Personnel working in the GMIX Facility and receiving direct body contamination will be surveyed for contaminants after showering or changing clothes prior to leaving the GMIX Facility established shower/change room. They will not be allowed to leave the restricted area without authorization of the SEA/RSO or his/her delegate.

2. Spot check surveys by the SEA/RSO or his/her delegate of selected personnel are made to ensure GMIX Facility personnel are not contaminated.

3. Surveys are accomplished using a properly calibrated, portable alpha survey instrument as the personnel are leaving at the end of their respective shift. This instrument is always available.

D. Change Room Facilities

1. All GMIX Facility area personnel are provided with change facilities so that they may leave their work clothes at the Sheep No. 1 Mine. The change

facilities include showers and are designed to encourage their use. The personnel will also have cleaning facilities in the established shower/change room facility in the IX Facility area.

E. Responsibility

1. All personnel are responsible for the safety and quality of his/her work and for adherence to safety and radiation protection rules as a condition of employment.

2. The shift supervisor and the RSO will ensure that the above rules are enforced.

F. Facilities and Equipment

1. Decontamination of facilities and equipment is accomplished in accordance with the guidelines and limits set forth in USNRC Annex C dated November 1976. If contamination levels in the lunch areas, shower rooms, change rooms, or offices exceed the values in Annex C (Reg. 1.86), the area is decontaminated and a study performed to determine the cause of build up and correction measures taken to prevent recurrence.

XI. Radiation Protection Instrumentation and Specifications

A. Beta-gamma and alpha survey meters will be used to monitor the GMIX Facility, personnel, and the environment. Radiation surveys will be made on a routine basis and exposure kept "ALARA" (As Low As Reasonably Achievable).

B. Radiation monitoring and sampling equipment will be calibrated after repair and at least semi-annually or at the manufacturer's suggested interval.

C. Beta-gamma survey meters shall have the following minimum specifications:

1. Range: The lowest range not to exceed 0.2 mR/hr full scale. The highest range to measure 200 mR/hr.

2. Response Time: Adjustable.

3. Battery operated and portable.

4. Calibrated potentiometer for each range (scale).

5. Adaptable to use either thin wall Geiger-Mueller (GM) tubes or "pancake" GM tubes.

6. Environmental Capabilities: Must operate satisfactorily in the temperature range of -40^{0}F to 120^{0}F.

7. Examples of satisfactory beta gamma survey meters include:

   a. Eberline Instrument Corporation E-520, E-530, Probes: HP-240, HP-177C

   b. Ludlum Measurements, Inc. Model 3, Model 5 Geiger Counter; Probes: Model 44-6, 44-9

D. Alpha survey meters shall have, as a minimum, the following specifications:

1. Range: The lowest range not to exceed 500 dpm full scale. The highest range to measure 50,000 dpm. Readings should be in dpm.

2. Battery operated and portable.

3. Calibration potentiometer for each range (scale).

4. Adaptable to use of scintillation and gas-proportional types of alpha probes.

5. Environmental Capabilities: Must operate properly in the range of -40^{0}F to 120^{0}F.

6. Examples of satisfactory alpha survey meters include:

   a. Eberline Instrument Corporation
   PAC-4G, PS-2, Probes: AC-21, AC-21B, TP-1

   b. Ludlum Measurements, Inc. Model 12 (CTM).

E. Laboratory counters for contamination smear samples and air sample filters shall have the following minimum requirements:

1. Scale: Counting capacity of at least 999,999 cpm.

2. Timer: Pre-set table count times.

3. Threshold and Window: Adjustable.

4. Regulated, adjustable power supply.

5. Minimum dpm alpha detection: 4-6 dpm per 10 minute count time.

6. Adaptable to Geiger-Mueller (GM), proportional and scintillation detectors, for detection of alpha, beta and gamma.

7. Shielded detector and counting stage.

8. Examples of satisfactory laboratory counters are:

   a. Eberline Instrument Corporation Scaler; Model MS-2
      Gas flow counter; Model FC-2, alpha, beta and gamma
      Shielded and window counter; Model RD-15, Hp-190
      GM probe; beta, gamma
      Alpha scintillation counter; Model SAC-4

   b. Ludlum Measurements, Inc.
      Scaler; Model 2000, Model 2200

XII. Training

A. U.S. Energy Corp. considers training an important part of all personnel's work schedule. All new personnel working in the GMIX Facility receive a minimum initial training in Radiation Safety, Industrial Safety and Operations. Further specific and periodic refresher training courses are given for areas of work responsibility. The SEA/RSO administers the safety and radiological training programs.

B. Employee Radiation Safety Training

   1. Basic indoctrination in radiation protection is given to all personnel prior to being assigned to work in the GMIX Facility areas. Detailed training is given during the first month of employment. Safety meetings are conducted quarterly with at least 30 minutes devoted to radiation safety. These individuals and their respective supervisors sign a statement that the person received radiation protection training, successfully completed that training, and the date the training was received. The signed statement and the examination are kept in the person's personnel folder.

   2. All female personnel are given a copy of Regulatory Guide 8.36 "Radiation Dose to the Embryo/Fetus" concerning prenatal radiation exposure and is instructed as to the importance of early notification of pregnancy in order that additional precautions can be instituted to best protect the embryo/fetus as per 10 CFR 20.1208.

   3. Retraining, covering the basic indoctrination material, is given to all personnel at least every two years. Retraining is documented. The basic personnel indoctrination training includes:

      a. Principles of radiation protection

         1. Definition and explanation of radiation and radioactive contamination, including physical forms and sources within the GMIX Facility.
         2. Biological effect of radiation.

3. ALARA (As Low As Reasonably Achievable) Philosophy.

b. Radiation Measurement

1. Units of measurement.
2. Detection methods and instruments.
3. Applicable limits.

c. Methods of radiation control

1. Distance, time and shielding principles.
2. Radiation area work rules, including good housekeeping, proper handling of contaminated materials and external and internal contamination control.
3. Protective clothing - proper use, (demonstrations) and experience wearing a respirator.

d. Radiation sources

1. When and where to expect radiation and radioactive contamination.
2. Potential hazards.

e. Limits and guides

1. Allowable exposure based on 10 CFR 20 and internal control (administrative) guides.
2. Guides for maintaining exposure ALARA.
3. Required notification and posting.

f. Radiation control and job performance

1. Consequences of rule violation.
2. Exposure reduction through job planning.

g. Waste disposal

h. Decontamination methods

C. Supervisory Safety Training

1. Additional training is given to supervisors so they will be able to provide specific job-related training and evaluate their subordinates' performance. Supervisory training includes:

a. Radiation levels expected, normal, and abnormal values.

b. Applicable standards and plant control limits, ALARA philosophy implementation.

c. Importance of training personnel in radiation protection.

d. Planning and procedure review.

e. Methods for controlling contamination.

   1. Protective clothing and respiratory equipment.
   2. Radiation control and posting requirements.
   3. Personnel monitoring.
   4. Work practices and housekeeping.

f. Methods for controlling radiation dose.

   1. Personnel dosimetry.
   2. Time, distance and shielding.

g. Personnel and area decontamination methods.

h. Control and use of sources - calibration source, density, gauges, x-ray sources, etc.

2. Supervisor training is documented in the same manner as indoctrination training, with retraining required every two years.

3. All GMIX Facility personnel receive on-the-job training from supervisors. The supervisor is responsible for continual evaluation and on-the-job training as necessary to ensure personnel exposure is maintained "As Low As Reasonably Achievable."

D. Environmental Assistant/Technician Training

1. Technician(s) performing radiation protection duties receive additional training beyond the normal indoctrination training. Training consists of lectures and/or on-the-job training. Written documentation is kept in the person's personnel folder. Training includes:

   a. Introduction to nuclear physics

      1. Atomic structure
      2. Radiation theory
      3. Interaction of radiation with matter
      4. Radiation measurement units

b. Biological effects of radiation

c. Radiation measurement

1. Detector types and operation
2. Personnel monitoring methods
3. Survey techniques and methods
4. Quantitative and qualitative measurements

d. Control of radiation sources

1. Source geometry and shielding, distance and time methods
2. Contamination control
3. Protective clothing and respiratory protection
4. First-aid relative to radiation protection

e. ALARA (As Low As Reasonably Achievable) philosophy

f. Audit techniques with respect to conformance with radiation practices and procedures by project personnel.

g. Decontamination

1. Contamination limits
2. Preparation prior to work to minimize decontamination
3. Decontamination methods for personnel, tools and areas

h. Regulations

1. 10 CFR 19
2. 10 CFR 20
3. 10 CFR 21
4. 49 CFR 173, Subpart I, radioactive materials
5. Regulatory Guides
6. Internal (administrative control) Guides
7. License Conditions

2. Technician on-the-job training and demonstration is conducted by the RSO, and other qualified persons. Oral and demonstration tests are given to evaluate the technician's job performance. Documentation of training is placed in the person's personnel file.

E. Industrial Training

1. A safety technician participates in new personnel orientation to assure that new personnel are instructed in safety rules and work procedures. All GMIX

personnel are given a tour of the entire complex by a safety technician and advised of potential hazards or dangerous areas. A safety awareness program is administered continuously throughout the facility.

2. Personnel who will come in contact with chemicals and solvents, are kept abreast of new chemicals as they are introduced and advised of any known hazards and safety precautions necessary for safe handling. All training will be documented. MSDS sheets shall be provided.

3. Personnel who are to work on any unfamiliar machinery are instructed and trained as to its safe operation. All training will be documented.

4. U.S. Energy Corp. provides first aid equipment and facilities. There are trained personnel at selected locations qualified in first aid methods.

F. GMIX Facility Training as Required for Possession Only License

1. All personnel are given thorough job training before they begin work in their assigned classification, to include but not limited to analytical and subjective training in all phases of their particular job assignment.

2. All GMIX and maintenance personnel will be trained in the use and handling of all hazardous materials they may come in contact with during the course of operation including machinery necessary to be operated or maintained as part of their job. All training will be documented.

XIII. Security

A. The GMIX Facility is fenced and posted with "Caution - Radioactive Material" signs in accordance with 10 CFR 20.203(3)(2), 10 CFR 20.1902. Parking facilities for project personnel and visitor vehicles are outside this fenced area. A gate adjacent to the GMIX building provides access for personnel reporting on and off shift.

B. All personnel are instructed to report immediately to their supervisors any unauthorized persons observed on the premises.

CONTRACTOR RADIATION SAFETY

CONTRACTOR RADIATION SAFETY

The Radiation Safety Program at the GMIX Facility consists of the following elements which apply to all Contractor personnel working on the site.

1. The Contractor and its personnel shall abide by the authority of the Radiation Safety Officer (RSO) to suspend, postpone, or modify any work activity that is potentially hazardous to contractors personnel, or a violation of NRC rules or license conditions.

2. Contractor personnel shall abide by all conditions of all Radiation Work Permits issued for specific work.

3. All Contractor personnel shall attend the Radiation Safety Training prior to commencing work given by the RSO or his/her designee.

4. All Contractor personnel shall abide by the good housekeeping rules of eating, drinking, smoking or chewing only in designated areas. Drinking water shall be available in a readily identifiable container in the designated areas.

5. Personnel thermoluminescent (TLD) badges issued to Contractor personnel shall be worn while within the restricted area at the GMIX Facility and stored as instructed by the RSO or his/her designee.

6. All Contractor personnel working within the restricted area shall submit urinalysis samples at any time that is requested by the RSO or his/her designee.

7. Contractor personnel shall be clean shaven if respirator usage is required for a particular job/task.

8. Contractor personnel shall report any abnormal occurrence or events to the RSO or his/her designee as soon as possible and before leaving the restricted area.

9. An exit interview will be conducted by the RSO or his/her designee of all Contractor personnel when the work is complete.

I, (print) ____ have read, understand and agree to comply with the items above.

Signature ______________________________________ Date ______________________

U.S. ENERGY CORP.
GMIX Facility

Respiratory Fit Test

This is to certify that on ______________________ I received training and was fitted and fit tested with the respirator (s) shown below.

Training Included:

A. Type of Airborne Contaminants, their physical and chemical properties, and toxicity characteristics.

B. Type, operation and limitation of respiratory protection equipment.

C. Need for respiratory protection equipment.

D. Ensuring that respiratory protection equipment is working properly and has been properly fitted.

E. Proper use and maintenance of respiratory protection equipment.

F. Action to be taken in the event of malfunction of respiratory protective equipment.

Specifically, I understand that:

A. I shall wear a respirator at any time that is requested by the Facility Manager, RSO or Supervisor.

B. I may leave any area where respiratory protection has been mandated if the equipment malfunctions, physical or psychological discomfort, or any other condition that may cause reduction in the protection afforded by wearing the respirator.

C. I shall not smoke, eat, chew, or remove respiratory protective equipment when working in an area where such equipment is required.

D. I shall keep my face free of facial hair in areas that will interfere with correct respirator face piece fit.

____
Employee's Signature

MEDICAL CLEARANCE

Restrictions: ____

Date: __________________________ By: ____________________________________

U.S. Energy Corp.
Green Mountain Ion Exchange Facility
(GMIX)
Radiation Safety: Standard Operating Procedures (SOP)

Health Physics-1 (HP-1)

ALARA
As Low As Reasonably Achievable

I. ALARA means making every reasonable effort to maintain exposures to radiation as far below the dose limits in 10 CFR Part 20 as is practical consistent with the purpose for which the licensed activity is undertaken, taking into account the economics of improvements in relation to state of technology, the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to utilization of nuclear energy and licensed materials in the public interest.

II. In addition to design and engineering controls used to ensure that exposures are ALARA, the implementation and effectiveness of a successful ALARA program is the responsibility of everyone involved in the processing operations. Responsibilities for conducting a radiation protection and ALARA program are shared by licensee management, the radiation safety officer, and all personnel.

III. The organizational chart for the GMIX Facility shows that the SEA/RSO reports directly to the General Manager, see page 4.

IV. According to the GMIX License Amendment No. 5 prepared by the U. S. Nuclear Regulatory Commission concerning the GMIX Facility, Section 14 states,

> "The license shall employ or maintain on a consulting basis a qualified Radiation Safety Officer (RSO), who is responsible for radiation safety aspects of the facility. The RSO shall possess the minimum qualifications as specified in Section 2.4.1 of Regulatory Guide 8.31, "Information Relevant to Ensuring that Occupational Radiation Exposures at Uranium mills will be As Low As is Reasonably Achievable.
>
> The licensee shall, by utilization of a qualified RSO, provide training, safety instructions, and dosimetry services for all workers routinely visiting the GMIX Facility adequate to assure compliance to 10 CFR Part 20 and guidelines contained in Regulatory Guides 8.30 and 8.31."

"The Safety and Environmental Administrator has the authority to cancel, postpone, or modify any process or operation which proves an immediate radiological hazard to any person. This decision is subject to revocation only by the General Manager or his/her designate after consultation." The Safety and Environmental Administrator position carries full responsibility for the operation of the radiation safety program and has the authority necessary to discharge the duties.

V. The General Manager has the responsibility of reviewing semi-annually the overall status of the project including trends in the data, items of non-compliance and recommendations for corrective actions.

VI. Radiation safety training, monthly safety meetings and retraining are also an integral part of the ALARA program.

VII. When it is not practicable to apply process or other engineering controls to control the concentrations of radioactive material in air, to values below those that define an airborne radioactivity area, the licensee shall maintain the Total Effective Dose Equivalent (TEDE) ALARA, by increasing monitoring and limiting intakes by one or more of the following means.

A. Control of access.
B. Limitation of exposure times.
C. Use of respiratory protection equipment.
D. Other controls.

VIII. Specific limitations include the following according to the revised 10 CFR 20 regulations:

A. Monitoring of adults likely to receive, in 1 year from sources external to the body, a dose in excess of 10% of the limits in 20.1201 (a) (Total Effective Dose Equivalent (TEDE) 5 rem/yr stochastic; 50 rem/yr sum of the deep-dose equivalent and the committed dose equivalent to any individual organ or tissue other than the lens of the eye - non-stochastic).

B. Monitoring of adults likely to receive in 1 year, an intake in excess of 10% of the applicable Annual Limits of Intake (ALI)(s) in table 1, Columns 1 and 2 or Appendix B 20.1001 and 20.2401 (Title 10 Code of Federal Regulations Part 20 is available in the Riverton office).

C. Implementation of the 40 hour control measure whereby, if in any week a worker is subjected to an intake exceeding 40 Derived Air Concentration (DAC)-hours, an investigation into the cause shall be performed with corrective action implemented and recorded to prevent another such occurrence.

D. Surface alpha contamination is limited to 1,000 disintegrations per minute (dpm)/100cm^2 on the skin and clothing with additional showering or washing being done if the limit is exceeded. The value of 5,000 dpm/100cm^2 shall be used for the soles of shoes.

E. Surveys of equipment prior to release to unrestricted areas shall be conducted with the limits as per Regulatory Guide 1.86 (attached).

F. Restrict access to high and very high radiation areas to only those required to enter by virtue of their job.

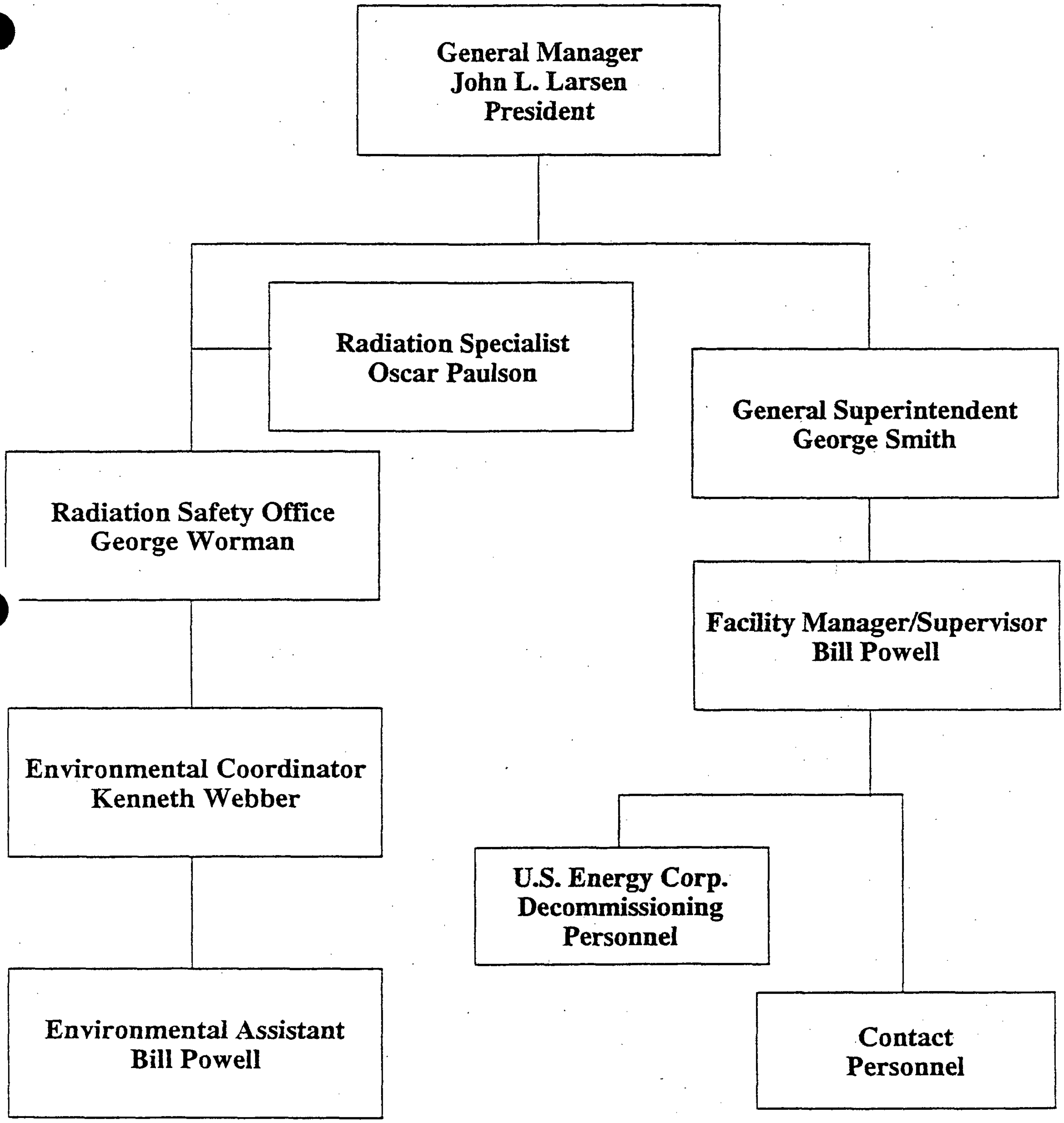
G. The quantity of air sampled and the method of analysis should allow a Lower Limit of Detection (LLD) of at least 10% of 10 CFR 20, Appendix B concentrations. The calculation of LLD is attached to this standard operating procedure. The LLD for radon daughter measurements should be 0.03 Working Levels (WL).

H. "Radiation Areas" and "Airborne Radioactivity Areas" shall be properly posted with periodic surveys by the radiation staff to ensure signs, labels, required notices to personnel, copies of licenses, and other items are properly posted.

I. All equipment shall be maintained and calibrated at least semi-annually or at the manufacturer's suggested interval. Constancy checks with a radiation check source shall be conducted prior to each use of the equipment. If the instrument response to the check source differs from the reference reading by more than 20%, the instrument shall be repaired and recalibrated.

J. Quality assurance verifies the accuracy of survey measurements. This includes the proper calibration of equipment and use of check sources. For analytical assessments, especially bioassay samples, split samples, spiked samples with a known concentration of the radionuclide, and blank samples shall be included with the samples to be analyzed with split samples being sent to at least two reputable laboratories for verification.

ORGANIZATIONAL CHART



U.S. Energy Corp.
GMIX Facility
Radiation Safety: Standard Operating Procedures

Health Physics - 1a (HP-1a)

As Low As Reasonably Achievable (ALARA) AUDIT

I. An ALARA Committee (or its equivalent) shall be established. The Committee will be composed of a representative from corporate management, the Facilities Manager, and the Environmental Coordinator. All members of the audit team shall be knowledgeable concerning the radiation protection program at the GMIX Facility. The Radiation Safety Officer shall accompany the audit team but shall not be a member.

II. The ALARA committee shall review the following areas of the radiation safety program at least annually as per the U.S. Nuclear Regulatory Commission's Regulatory Guide 8.31 entitled "Information Relevant to Ensuring that Occupational Radiation Exposures At Uranium Mills Will Be As Low As Reasonably Achievable" and as per 10 CFR 20.1101, B and C (revised) which goes into effect on January 1, 1994.

A. Health physics authority and responsibility.

B. Standard operating procedures involving the handling and/or storage of radioactive materials and any changes in these procedures.

C. Records of audits, inspections, and surveys conducted by the facility RSO for timeliness and the resolution of any problems.

D. Personnel radiation protection program, includidgng employee exposure records and bioassay procedures and results.

E. Radiation safety training program and records.

F. Respiratory protection program.

G. Records of inspections, log entries and summary reports of reviews.

H. Records and results of all required radiological surveys, sampling, wipe tests, inspections, and environmental monitoring.

I. According to the U.S. Nuclear Regulatory Commission, Regulatory Guide 8.31, the primary means of reducing exposures is by proper engineering and design of the GMIX facility. The ALARA committee shall therefore inspect the facility and equipment design and shall review any proposed changes to the facility to ensure that the design is based on chemical process efficiency as well as the relative potential for radiologic and toxic hazards resulting from exposure of personnel to uranium and its decay products.

III. The committee will evaluate the space layout of the facility including.

A. Safe access to existing equipment.

B. Adequate ventilation.

C. Controlling access to the GMIX Facility proper and the ability to secure or restrict entry to any airborne radioactivity area.

D. General maintenance of the Facility.

IV. The Committee will also evaluate the adequacy of the fire fighting equipment and provisions for fire alarms, fire extinguishers, water tanks, and other general fire fighting equipment.

V. The committee shall evaluate compliance with applicable federal and state regulations and the conditions of this license.

VI. The committee shall evaluate the safety meeting minutes.

VII. A copy of the Committee's report on any ALARA review will be maintained on file.

U.S. Energy Corp.
GMIX Facility
Radiation Safety: Standard Operating Procedures

Health Physics-2 (HP-2)

GAMMA SURVEY

I. Several of the natural uranium decay products in uranium bearing material (ore/waste) are gamma emitters with associated beta radiation. Therefore it is necessary to conduct gamma surveys to ensure that there is no undetected gamma build-up. Gamma surveys shall be conducted as requested by the RSO.

A. EQUIPMENT:

1. An Ludlum gamma microR meter or probe with ratemeter. Acceptable instruments given in Section 3.3.6 of the license renewal application include Eberline E-520, E-530 with HP-240 or HP-177C probes or Ludlum model 3 or 5 ratemeters with model 44-6 or 44-9 probes or equivalent.

2. Cs-137 check source

B. PROCEDURE:

1. Measure the background gamma radiation in the room where the instruments are kept. The reading shall be in mR/hr and recorded on the gamma survey form.

2. Place a Cs-137 check source against the detector part of the meter or probe and record the value indicated on the meter in the gamma survey form. If using a beta/gamma probe, be sure the window on the probe is closed.

3. Subtract the background from the check source reading and record. If the same check source is used, there should be less than 20% difference between the data recorded for the current background and check source when compared to that from the previous time the same instrument was used for a gamma survey.

4. Record the instrument serial number, the battery check indicator, and the last date the instrument was calibrated. If using an Eberline meter, check the high voltage (H.V.) value to be sure that it is within the range of high voltages for which the instrument had been calibrated.

5. Compare the check source Cs-137 value with the value from the last calibration. If the difference is more than 10%, the instrument shall be recalibrated. The instrument shall also be calibrated every six (6) months.

6. Turn the survey meter to slow response.

7. Measure the value of the gamma survey at each location and record the station number, station location, and gamma value in mR/hr on the gamma survey form. (The micro Roentgen (μR/hr) value is changed to milliroentgen (mR/hr) by dividing the μR/hr value by 1000.)

8. Surveys shall be conducted at waist height and about 12 inches from the object being surveyed.

9. When the survey is completed, check the high voltage and the battery. Record these values on the gamma survey form. The battery charged indicator should be in the "charged" area on the meter face. If the battery charged indicator is not within the "charged" area, a new meter should be obtained with the above procedure and survey being repeated.

U.S. Energy Corp.

Gamma Survey Form: GMIX Facility

Date: ______________________________

Serial Number: ______________________

Battery check: OK ________ Low ________

Calibration Date: ____________________

Previous Net Exposure:

Check Source Mr/hr ________ Background mR/hr ________ Net mR/hr ________

Net Exposure <10% of Previous? Yes ________ No ________

High Voltage Reading ________ Within Calib. H.V? Yes ______ No ______

Number	Location	mR/hr
#1		
#2		
#3		
#4		
#5		
#6		
#7		
#8		
#9		
#10		
#11		
#12		
#13		
#14		
#15		
#16		
#17		
#18		
#19		

Name (Print)______________________________ Position ____________________

Signature ________________________________

U.S. Energy Corp.
GMIX Facility
Radiation Safety: Standard Operating Procedures

Health Physics-3 (HP-3)

BETA SURVEY

I. When U-238 is allowed to reach secular equilibrium with its two short lived daughters, Thorium-234 and Protactinium-234 (secular equilibrium is achieved after 8 or 9 months of decay time), the resultant isotopic mixture is a strong beta radiation emitter. Half of the beta radiation is emitted by Th-234 and half by Pa-234. Surface beta emission after U-238 achieves secular equilibrium is approximately 150-230 Mr/hr. In order to maintain control of beta radiation exposures, the following precautions should be implemented:

A. Personnel who handle yellowcake on a regular basis shall wear safety glasses at all times to protect the cornea of their eyes. The allowable annual dose to the eye is 15 rem. (Not Applicable - There is no yellowcake handled at the GMIX Facility.)

B. Tanks requiring entry and which routinely contain uranium and/or uranium bearing solutions shall be surveyed for beta radiation prior to the entry by any personnel.

C. Though NRC regulations do not stipulate how often beta surveys should be conducted other than requiring "adequate" surveys to control radiation exposures, and since it requires at least 120 days for enough of the uranium decay products to be produced to detect significant beta radiation, a semi-annual walk through beta survey shall be conducted within each work area of the GMIX Facility (see Figure HP-3). These surveys should locate any contaminated areas which have reached secular equilibrium.

D. Remember that only approximately 15% of beta radiation is absorbed by clothing and the rest is shallow-dose to the skin and extremities. The allowable annual dose is 50 rem/yr (12.5 rem/qtr).

E. Extremity monitoring [finger thermoluminescent dosimeters (TLD's)] is required for any person whose hand dose would exceed 50 rem/yr (action level 3.125 rem/qtr).

F. Areas where beta emission is above 100 mR (mrem) in 1 hour at 30 cm from the source must be labeled "High Radiation" areas and must be controlled in accordance with the regulations set forth in 10 CRF 20 20.203 section (c); 10 CFR 20.1003, and 10 CFR 20.1902.

II. Equipment

A. Eberline E-520 or E-530 Count Ratemeters with an HP-240 or HP-177C probe, or a Ludlum 44-6 or 44-9 Beta/Gamma probe with a Model 3 ratemeter, or equivalent.

B. A thin lead sheet for shielding the detector from the associated bremsstrahlung radiation.

III. PROCEDURE:

A. Calibrate survey instrument for Beta radiation using the procedure outlined in U.S. NRC Regulatory Guide 8.30 CF_{sur}________mrem/mR CF_{2cm}________rem/mR

B. Survey each area given in the attached Figure HP-3 about waist height. Obtain an OPEN window and a CLOSED window reading at the surface and again at about two (2) feet from the surface of the area or object. Record the readings in mR/hr on the Beta Survey form. Calculate beta dose rate from the equation below.

Ds = The dose to the body at the area or object surface ________ mrem/hr

D = The dose to the body at 2 feet from the area or object surface ________ mrem/hr

Δ Rs = Difference of the OPEN and CLOSED windows readings at the surface (1cm) of the area or object ________ mR/hr

Δ R= Difference of the OPEN and CLOSED window readings at 2 feet from the area or object surface (1cm) ________ mR/hr

Ds = $CF_{sur} \times \Delta Rs$ ________ mrem/hr

D = $CF_{2cm} \times \Delta R$ ________ mrem/hr

IV. The average and maximum radiation levels associated with surface contamination resulting from beta emitters shall not exceed 0.2 mR/hr at 1 cm measured through not more than 7 milligrams per square centimeter of total absorber. Access in areas where the beta exposure exceeds the above levels shall be restricted and shall be reported to the RSO.

A. When doing the calculations, care must be taken to ensure that the methodology used to calculate the exposure rate fits the actual circumstance of the exposure. Example: When calculating the exposure to the hands and forearms, the survey done at the surface of the object handled must be used as the source strength. It is also possible that the source might be in front of the individual working along the wall of the interior of a tank. In this case, the individual would receive a much higher exposure to his front than his back (which would be exposed from the walls on the other side of the tank).

B. Periodically, the inside surface of work clothing and boots worn by company personnel should be surveyed (to assure no beta emitter buildup on clothing).

C. When conducting the survey, pay particular attention to unsealed surfaces in areas where splashing or accumulations of yellowcake have occurred.

U.S. Energy Corp.
GMIX Facility

Health Physics-3

BETA SURVEY FORM

Date: ______________________
Serial Number: ______________________
Battery check: OK ________ Low ________
Calibration Date ______________________
CF_{sur}: __________ mrem/mR
CF_{2cm}: __________ mrem/mR

Location		Open, mR/hr	Closed, mR/hr	Δ, mR/hr
__________	Surface	______	______	______
	2 feet	______	______	______
__________	Surface	______	______	______
	2 feet	______	______	______
__________	Surface	______	______	______
	2 feet	______	______	______
__________	Surface	______	______	______
	2 feet	______	______	______
__________	Surface	______	______	______
	2 feet	______	______	______
__________	Surface	______	______	______
	2 feet	______	______	______
__________	Surface	______	______	______
	2 feet	______	______	______
__________	Surface	______	______	______
	2 feet	______	______	______
__________	Surface	______	______	______
	2 feet	______	______	______

Name (Print)______________________________ Position ________

Signature ______________________________

U.S. Energy Corp.
GMIX Facility
Radiation Safety: Standard Operating Procedures

Health Physics-4 (HP-4)

RADON DAUGHTER SURVEY

I. The Derived Air Concentration (DAC) for radon-222 (Rn-222) and its daughters in air is 3E-8 µCi/ml or 0.33 WL. The exposure to radon decay products is generally measured in Working Levels (WL) where: One (1) working level is defined as any combination of short-lived Rn-222 daughters in one liter of air, without regard to equilibrium, that emit 1.3E+5 MeV of alpha particle energy. Radon daughters are a series of four short-lived radioactive metal particulates (Po-218, Pb-214, and Po-214), which are formed by the radioactive decay of Radon-222.

II. No person is allowed to work in an environment that contains more than 0.33 working levels of radon daughters without respiratory protection equipment. The "Standards for Protection Against Radiation." (10 CFR 20), require exposure records be kept of all radon daughter exposures that exceed 10% of the Annual Limit of Intake (ALI) based on a time-weighted exposure. The ALI for radon with decay products (daughters) is 1E+2 µCi or 4 Working Level Months (WLM).

A. A hazard index survey of the GMIX Facility will be performed within the work areas to determine the most likely place of elevated Rn daughter exposure.

III. Radon daughters are analyzed by drawing a known volume of air through a filter. The radon daughters, which are metal particulates, are caught by the filter which is then analyzed after 40 to 90 minutes of decay for alpha activity. This is known as the modified Kusnetz Technique of radon measurement.

IV. EQUIPMENT:

A. MSA Model S or equivalent low volume (2-3 liters per minute [lpm]) air pump.

B. Gelman type A/E glass filters or equivalent.

C. National Bureau of Standards (NBS) traceable Th-230 check source.

D. Ludlum Model 2000 scaler with alpha detector or equivalent.

V. PROCEDURE:

A. Place a blank filter, fuzzy side out, in an alpha detector, which is within the calibration dates printed on the sides of the detector, and count the blank filter for 10 minutes. The blank filter represents background. Record the background counts per minute (cpm) on the form.

B. Place the NBS Th-230 check source in the counting chamber and count the check source for 10 minutes. Record the counts per minute (cpm) obtained for the check source which is the total counts divided by the time in minutes counted. This count rate is only a fraction of the total number of disintegrations per minute (dpm) actually emitted by the Th-230 source. The counter therefore can only respond to a fraction of the disintegrations it is exposed to. This fraction is called the Efficiency Factor (Eu) and is represented by the dpm for the source which is printed on the source container divided by the counts per minute (i.e. Eu = dpm ÷ cpm)

C. Place another blank filter in the holder of the filter holder of a pump, which is within the calibration dates printed on the side of the pump, with the smooth side against the intake (fuzzy side out).

D. Check the pump for adequate charging by turning it on with the filter in the holder and noting if the flow marker is at the calibration mark (i.e. if during calibration, the top of the ball was at 8 representing a flow rate of 2 lpm, then during the survey, the top of the ball should also be at 8).

E. Take a five (5) minute sample at each desired location, using a new filter for each sample. When exchanging filters, place the filter just used for sampling in a previously labelled filter envelope or holder. The envelope/holder label should include the date of the sample, the location of the sample and the time the sample ended. On the radon daughter survey forms or logbook record the starting time, stop time, total time (should be 5 minutes), initial flow rate in liters per minute (lpm), and final flow rate in lpm. (**Note**: Initial and final flow rates should be identical. If they are different, the batteries in the air sampler should be rechecked). The volume sampled in liters can then be determined by multiplying the flow rate in lpm by the sampling time in minutes (ex. 5 min. x 2 lpm = 10 liters).

F. Start counting the samples forty (40) to fifty (50) minutes after the sample was taken. Count each sample for four (4) minutes beginning with the first filter used for the first sampling location and proceeding in order through the most recent sample, making sure that at least 40 minutes has elapsed for each filter between the ending time of the sample and the start time of counting. Record the time at which the counting began, when the count ended, and the total counting time on the form. Also record the gross (total) counts and the counts per minute (cpm = total counts divided by minutes counted). Calculate the net counts by subtracting the background cpm from the sample cpm. Enter the net counts in the appropriate column on the form.

G. The self-absorption factor (SAF) for the Gelman-type glass fiber and millipore filters is 5% at sampling rates of about 2 liters per minute. The self-absorption factor can be determined using the formula below:

C_1= count rate on part of filter
C_2= Count rate on back of filter
C_3= count rate on front of filter covered by a new filter of the same type.

$$\text{Percent self-absorption} = \frac{C_2-C_3}{2C_1+C_2-C_3} \text{ X } 100$$

(Note: The SAF does not have to be determined on every sample. It is adequate to do a SAF once per day when radon daughters are being measured. The SAF should be determined on a sample which has a count rate of at least 20 CPM after 40 minutes decay.)

H. The working level should then be calculated using the equation found on the attached form. The time factor can be obtained from the table attached to this procedure by taking the time in minutes from the end of sampling to beginning of counting and add 2 minutes to account for in growth during the 4 minutes of counting.

I. Radon daughters are to be measured monthly, quarterly or annually, depending upon the specified location (see attached map and Table C-1). If an action level of 0.08 WL is exceeded, samples must be collected at least weekly until the results of 4 consecutive weekly samples are less than 0.08 WL.

J. If employees are in an area <u>without respiratory protection</u> where the WL exposure exceeds 10% ALI (0.4 WLM) or 12 DAC-hours in 1 week (i.e. 3E-8μCi/ml breathed for 12 hours during 1 week), these workers must be monitored and the exposures included in the dose summation and the area must be posted. Any area in which the DAC for Radon-222 of 0.33 WL or 3E-8 μCi/ml is exceeded must also be posted as an "Airborne Radioactivity Area" as per 10 CFR 20.1003.

K. SAMPLING LOCATIONS AND FREQUENCIES:

1. In-plant radon and radon daughters are sampled at the locations and frequencies as prescribed by the RSO.

Radiation Safety: Standard Operating Procedures

Health Physics-5 (HP-5)

INTERNAL AND EXTERNAL OCCUPATIONAL DOSES

I. In 10 CFR 20.1201 (a)(1), annual limits are prescribed: (1). 5 rems Total Effective Dose Equivalent (TEDE) or (2). 50 rems total dose to any single organ or tissue (other than the lens of the eye), whichever is more limiting. The TEDE is defined as the sum of the deep dose equivalent (ThermoLuminescent Dosimeter (TLD) reading for whole body) and the Committed Effective Dose Equivalent (CEDE) for internal exposures.

II. According to 10 CFR 20.1202 and 20.1502, monitoring for external and internal exposures and summation of external and internal doses is required if adults are likely to receive in 1 year external exposures greater than 10% of the annual limit of 5 rem, or an intake in excess of 10% of the applicable Annual Limits of Intakes (ALIs) in table 1 Columns 1 and 2 of Appendix B to 10 CFR 20.1001-20.2401. For minors and declared pregnant women the exposures requiring monitoring and summation are, 10% of 0.5 rem for external exposure and a CEDE in excess of 0.05 rem for internal exposure.

III. External Exposures

A. The external dose component needed for evaluating the TEDE under 10 CFR 20.1201 (a) is the deep-dose equivalent. Also, the deep-dose equivalent is the external dose component that is summed with the internal dose component (when summation is required). External dose is typically determined by the use of individual monitoring devices, such as film badges or TLDs. The device for monitoring the whole body dose should be placed so as to provide a measurement of the maximum dose received by the whole body during the year. When the whole body is exposed fairly uniformly, the device is typically worn on the front of the trunk of the body between the head and waist.

B. The individual monitoring devices are exchanged periodically, typically on a quarterly basis. The deep-dose equivalent is recorded on attached forms NRC-4 and NRC-5 or equivalent (item 10 and 11 respectively on the forms).

IV. Internal Dose

A. The internal dose component needed for evaluating the TEDE is the CEDE. The CEDE is the 50-year effective dose equivalent that results when radioactive material is taken into the body, whether through inhalation, ingestion, absorption through the skin, accidental injection, or introduction through a wound. The primary means of intake of radioactive material at any uranium milling operation is inhalation (H). The radioactive materials of concern are uranium natural (U_{nat}) and radon gas with daughters (Rn). Annual limits of intake (ALIs) have been established for individual radionuclide and are given in Table 1 in Appendix B to 10 CFR 20.1001-20.2401 (Title 10 Code of Federal Regulations Part 20).

1. The ALI values for inhalation of $U_{(nat)}$ (Y) and Radon with daughters are:

   $U_{(nat)}$: 5×10^{-2} μCi and,
   Rn with daughters: 1×10^{2} μCi (4 WLM)

2. Corresponding to Derived Air Concentrations (DAC) of:

   $U_{(nat)}$: 2×10^{-11} μCi/ml and,
   Rn with daughters: 3×10^{-8} μCi/ml (0.33 WL).

B. Based on either area air monitoring or breathing zone sampling or both, the potential intake of radioactive material via inhalation can be determined using the following formula:

$$I = \frac{A/V \times B \times T}{RPF}$$

I = intake in μCi
A = activity on filter of air sample in μCi
V = total volume of air sampled in ml
B = worker's breathing rate of 20,000 ml/min
T = duration of worker's exposure in minutes
RPF = respirator protection factor

For radon with daughter exposures, the above formula can be written:

$$I = \frac{WL \times T}{RPF \times 173}$$

I = intake in WLM
WL = working level
T = duration of worker's exposure in hours for year
RPF = respirator protection factor
173 = number of hours breathing air with 1 WL which equates to 1 WLM.

C. The CEDE from each radionuclide is calculated using a simple ratio given that the ALI for each radionuclide corresponds to 5 rem. For example, if 0.022 μCi of $U_{(nat)}$ and 1 WLM were determined for one year's intake, then the CEDE from inhalation for that worker during that year would be:

Radionuclide	Intake µCi	ALI µCi	CEDE mrem
$U_{(nat)}$ (Y)	0.022	.05	2200
Rn/d	25.0	100.0	1250
Sum			3450

D. If the sum of the TLD readings for this person during the year was 100 mrem, for example, then the total effective dose equivalent (TEDE) would be 100 + 3450 mrem = 3550 mrem. In this example, the CEDE exceeds 1.2 rem, therefore according to 10 CFR 20.1201 (a) (1) (ii), the organ-specific committed dose equivalents need to be calculated. The preferred method for calculating the organ-specific committed dose equivalent is to use the factors in Federal Guidance Report No. 11, Tables 2.1 and 2.2 for inhalation and ingestion respectively. (Federal Guidance Report No. 11, EPA-520/1-88-020, 1988, order through NTIS, (703) 487-4650).

U.S. Energy Corp.
GMIX Facility
Radiation Safety: Standard Operating Procedures

Health Physics-6 (HP-6)

ALPHA SURVEYS

I. Discussion:

A. Various tables, chairs, counter tops, desk tops, benches in offices, shop areas, the laboratory, in the mill and in eating areas will be randomly surveyed monthly for alpha radiation. All personnel who have entered the mill will be surveyed prior to leaving the restricted area. Equipment released from the mill area for off project repair or unrestricted use must also be surveyed. All surfaces and/or personnel that exceed 1000 dpm/cm^2 must be decontaminated to a level below 1000 dpm/cm^2, and the action taken to eliminate the contamination must be documented.

II. Equipment:

A. Alpha survey meter sensitive to 500 disintegrations per minute (dpm) on the lowest sensitivity scale.

B. Large area (50 cm^2) alpha sensitive probe (Eberline Pac-46, PS-2; probes: AC-21, AC-21B, TP-1) or equivalent.

C. National Bureau of Standards (NBS) Th-230 check source.

III. Procedure:

A. Check the instrument with a calibrated National Bureau of Standards (NBS) traceable alpha check source and record in/on a designated log book or sheet: instrument serial number, calibration date, high voltage reading, alpha check source activity in dpm, instrument efficiency, and initials of the individual performing the survey.

B. Point the probe toward a light source. A light leak in the probe face will cause the instrument to read and must be repaired with "liquid paper" or a new mylar face before use.

C. Using the instrument efficiency and probe face area (generally 50 cm^2) determine the instrument reading in counts per minute (see calculations below) which would indicate 1000 disintegrations per minute (dpm) of contamination per 100 cm^2.

D. Set the instrument on fast response and survey the object or person being surveyed at a rate of about 100 linear cm (1 meter) per thirty seconds. The probe face should always be approximately 1 cm from the surface being surveyed.

E. If any areas exceed the 1000 dpm/100 cm^2 limit, put the instrument on slow response and survey that area again.

F. Any person or object that exceeds the limits must be decontaminated as soon as possible. Any person who has contamination on his/her body in excess of the above limit will be required to shower with a follow-up survey. Objects surveyed which exceed the above limit of contamination, will be washed and resurveyed prior to release to an unrestricted area. No person or equipment shall be allowed to leave the property with contamination above 1000 dpm/100 cm^2.

G. Record the results in the designated log book, on the personnel alpha sheets, or on the equipment release form. Any excursions shall be reported to the proper supervisory personnel and the corrective action taken shall be documented.

H. Re-calibrate the instrument as in item 1 above and record in the designated log book at the end of each sampling day.

IV. Calculations:

$$\text{E (Efficiency)} = \frac{\text{counts per minute}}{\text{disintegrations per minute}} = \frac{\text{cpm source}}{\text{dpm source}}$$

Solve for X

$$1000\ \text{dpm}/100\ \text{cm}^2 = \frac{X}{\text{Eff.} \times A}$$

Where:

Eff. = Counting efficiency

$$A = \frac{\text{Probe face size in cm}^2}{100\ \text{cm}^2}$$

X = cpm

U.S. Energy Corp.
GMIX Facility
Radiation Safety: Standard Operating Procedures

Health Physics-7 (HP-7)

PERSONNEL ALPHA MONITORING AND DECONTAMINATION

I. Limits of 1000 dpm/100 cm^2 alpha are used for skin and personnel clothing. Shoes are an exception with a limit of 5000 dpm/100 cm^2 (U.S. Nuclear Regulatory Commission Regulatory Guide 8.30 "Health Physics Surveys in Uranium Mills"). Showers and sinks are provided for showering and shoe brushing.

II. Personnel Alpha Monitoring Procedure

A. Equipment

1. Eberline RM 191 AC-3 alarm rate meter or PAC-4G, Ps-2, probes: Ac-21, Ac-21B, TP-1 with broad surface probe (generally 50 cm^2) or equivalent.

2. National Bureau of Standards (NBS) traceable calibrated Th-230 source of between $1x10^3$ and $2x10^4$ cpm.

B. Procedure:

Prior to leaving the restricted area at the end of each shift all GMIX Facility personnel shall either shower or monitor themselves for alpha contamination. If clothes are not changed before leaving the restricted area then the clothing worn shall be monitored. Clothes, coveralls or boots contaminated shall be changed in the GMIX Facility change room/shower facility.

III. Alpha Contamination Monitoring

A. All personnel required to monitor themselves prior to leaving the restricted area shall use the following procedure:

1. Turn the response switch of the alpha personnel survey meter provided at the exit of the change facilities to "Slow Response".

2. All instrument malfunctions shall be reported to the Safety and Environmental Department.

3. Turn the scale multiplication factor switch to the marked location.

4. Survey by placing the alpha probe within 1/2 inch of the individual, (alpha radiation only penetrates approximately 1/2 inch of air) and move the probe over the individual's clothing at the rate of about 2.5 linear feet per 10 seconds. Be careful not to puncture the thin mylar probe face with a sharp object.

5. If the alpha alarm triggers or if the instrument reads more than (1/eff.x1000)cpm, put the response switch on slow and place it over the area that caused it to trigger. Wait 10 seconds. If the alarm does not trigger, the area still passes.If the alarm triggers on the slow response, the individual shall report the contamination to the shift supervisor who shall check that he/she did not pass and send him/her back for a shower or a change of clothing. No individual shall be allowed off of the property until he/she is decontaminated. When the individual is contamination free, sign him/her in on the log book provided beside the survey instrument as such. Survey legs (including boots), hands, arms and trunk of body back and front.

6. If the individual shows no contamination, he/she shall sign or initial in the log book located by the alpha survey meter.

7. Individuals who shower need to be surveyed, and must sign the log book located by the alpha survey instrument and note that they did shower.

IV. Decontamination Procedures

A. Personnel cleanup

1. Any individual who is found to be contaminated shall follow the following decontamination procedure. In addition, all personnel who work in the suspect areas shall be issued coveralls which must be worn. These individuals shall change coveralls prior to leaving the area and shall shower prior to leaving the restricted area.

2. Wash contaminated portion of body thoroughly and completely with mild soap for two or three minutes. Pay particular attention to fingernails and between fingers; similarly, pay attention to all body folds, hair and ears.

3. Rinse completely, dry and monitor. Repeat three times, if necessary.

4. If contamination remains after washing three times, wash as before but use a soft bristle brush (surgeons brush) provided. Wash for five minutes and rinse. Take care not to abrade the skin. Do not use brush on face.

5. If contamination still exists, apply 3% citric acid solution provided with cotton swabs, then soap and water. Wipe always in a direction away from the eyes, ears, nose, mouth, and other body openings.

6. If personal contamination cannot be removed to the levels given above, or if initial contamination is extensive or received as a result of an accident, contact the RSO. The RSO will initially verify that the contamination is not the result of the short-lived radon decay products and then will contact the Corporate Medical Consultant for further guidance.

7. Wound decontamination must receive immediate attention. The wound should be allowed to bleed freely for a brief period to remove contamination from the wound itself and the area around the wound should be wiped with sterile swabs. Wipe away from wound, discard swab, and use another, etc. Radiation protection personnel shall survey the wound for residual contamination following cleaning.

8. Note: In case of severe injury, decontamination shall NOT interfere with or take precedence over proper medical or surgical care. First aid treatment shall be given priority and the RSO, Safety or Environmental personnel shall accompany injured person to the doctor or hospital, taking precautions to prevent spread of contamination. The RSO or his/her designee shall inform the hospital staff of the potential presence of contamination.

B. Contaminated Clothing

1. All contaminated clothing will be placed in a container and taken to the Sweetwater Mill for disposal. No contaminated clothing or personnel are allowed to leave the restricted area.

C. Contaminant Surveys

1. Personnel receiving direct body contamination shall be surveyed for contaminants after showering. If the results of the post shower survey still indicate that contamination exists, the person will notify the RSO or Facility Manger. The RSO will follow the procedures outlined above in Section IV (A)(1 - 7) of this standard operating procedure. Contaminated personnel shall not be allowed to leave the restricted area without authorization of the RSO.

2. Quarterly surveys of randomly selected personnel shall be made by the RSO, Facility Manager or Environmental Coordinator to ensure Facility personnel are not contaminated. This is accomplished using a portable alpha survey instrument as personnel are leaving at the end of the shift. The results of the quarterly surveys will be recorded in the personnel survey log book. Quarterly surveys will not be required on personnel where surveys were noted in the log book within a three month period. An operable and properly calibrated portable alpha survey instrument shall always be available.

D. Change Room Facilities

1. All GMIX Facility personnel are provided with change facilities so that they may leave their work clothes at the Facility. The change facilities include showers and are designed to encourage their use.

E. Responsibility

1. Personnel's Responsibility

Each person shall record on the Facility Log Book, in the space provided, the results of his/her personal monitoring by a check mark placed in either the space for PASS or FAIL.

2. Supervisor's Responsibility

a. All applicable supervisors shall be responsible for assuring that their personnel monitor themselves and shower and change clothes if contaminated, and that the correct log book notations are performed prior to the person leaving the restricted area. This shall be documented by the supervisor on a form or in the log book.

b. When the supervisor is notified that a person has exceeded the action level for alpha contamination, he/she shall instruct the person to shower again and/or change clothes and repeat the monitoring procedure. The supervisor shall be present during the repeat monitoring to observe the monitoring procedure and record the results including count rates on the form provided by the RSO or in the log book provided in the Facility. A written record of the incident of contamination and efforts to decontaminate the person shall be kept by the supervisor and a copy forwarded to the RSO within 24 hours of the incident.

3. Facility Manager's or Environmental Coordinator's Responsibility

a. The Facility Manager or the Environmental Coordinator shall be responsible for "Spot Checking" personnel prior to their leaving the restricted area, to assure that personnel monitoring procedures are being followed and that monitoring policies and procedures are effective. Such spot checks shall be performed at least quarterly and recorded on the personnel monitoring log book provided at the location of the alpha survey monitoring meter.

b. The Facility Manager or Environmental Coordinator shall be responsible for compiling the records necessary to document personnel monitoring results and spot-checks of decontamination procedures.

c. The Facility Manager, Environmental Coordinator or RSO shall be responsible for assuring proper and prompt personnel decontamination in any incidence where the action level has been exceeded. The RSO's role in this assurance shall be to ADVISE the Facility Supervisor during and after the personnel decontamination process; ASSIST in the personnel monitoring; REVIEW the history of the incident for appropriate actions and RECOMMEND policy and/or procedure changes which will improve the personnel contamination monitoring program.

U.S. Energy Corp.
GMIX Facility
Radiation Safety: Standard Operating Procedures

Health Physics-8 (HP-8)

REMOVABLE ALPHA RADIATION SAMPLING

I. Discussion:

A. Removable alpha contamination is defined as: That portion of radioactive alpha emitting material deposited on a surface which is removed by application of medium pressure, with a cloth smear, to that surface. The allowable limit of removable contamination is 1000 dpm/100 cm^2. The smear sample is taken from an area of known dimensions (100 cm^2) and measured with an alpha scintillator to determine the quantity of surface contamination per unit of surface area. Normally this measurement is expressed in disintegrations per minute (dpm) per 100 cm^2.

B. Smear samples are taken only when the total alpha contamination surveys indicate levels greater than the limits for removable contamination. (Total contamination is measured by surveying the surface with a broad faced alpha scintillation probe, thus measuring all surface contamination per HP-6.) When smear samples are required, total alpha must also be measured in most cases to assure that total contamination limits are not exceeded.

C. Areas which generally require removable alpha sampling include, but are not limited to, the following: tables where urine samples are prepared for shipment or analysis, equipment released for unrestricted use, yellowcake slurry shipment areas and spill areas. Removable alpha surveys shall also be required if the total alpha surveys indicated levels greater than 1000 dpm/100 cm^2.

II. Equipment:

A. Filter paper (2.5 cm), NU-CON cloth smears, or equivalent.

B. Ludlum/Eberline scintillator or equivalent.

C. Coin envelopes, or equivalent.

D. National Bureau of Standards Traceable alpha standard (Th-230).

III. Procedure:

A. Place a blank paper filter in the scintillator counting chamber and measure background for minimum of 5 minutes prior to counting samples. Record the background counts per minute in the designated log book. Calculate the minimum detectable activity (LLD) and record in the log book. (See Calculations).

B. The background alpha radiation as measured by the scintillation detector should not exceed 1.0 count per minute. When this limit is exceeded the detector/sample tray assembly should be decontaminated as follows:

1. Disconnect the power source from the detector.

2. Remove the sample tray screws from the detector housing and separate the tray from its o-ring.

3. Wash the sample tray and O-ring in warm soapy water. Use a Q-tip to clean all grooves and hard to clean areas.

4. Again, using a wet soapy Q-tip, very gently clean the aluminized mylar detector window and the associated O-ring which holds it in place. This surface should then be rinsed with a wash bottle and gently blotted dry with a soft paper towel.

5. Reassemble the detector sample tray and check the background production rate.

6. If the above procedure does not sufficiently reduce the detector background, the sample tray should be soaked in a 50% volume/volume hydrochloric acid solution for five minutes, rinsed, dried and reassembled.

7. When a hydrochloric acid soak and/or wash with soapy water fail to correct the background problem, the unit should be sent to a vendor for replacement of the mylar window.

C. Calibrate the scaler/scintillator with a certified NBS Th-230 alpha source and record the total counts, total minutes, count rate in CPM and the counting efficiency in the log book (see calculations).

D. Lightly moisten a smear with alcohol.

E. Using medium pressure, with an S motion, wipe at random, 100 cm^2 at each sampling area and label the coin envelop accordingly.

F. Allow the smear to dry in the instrument laboratory before counting.

G. After a 15 minute warm-up time, count the alpha activity on each smear sample for a minimum of five (5) minutes. Record the total counts, total counting time, the counts per minute, the disintegrations per minute per 100 cm^2 and twice the standard deviation (for 95% confidence) in the log book or on the appropriate work sheet. The action levels for removable alpha activity is 250 dpm/100 cm^2.

H. When action levels are exceeded, the surface(s) being sampled must be cleaned and resampled until all smears are less than the action level.

IV. Calculations:

A. $$\text{Efficiency} = \frac{\text{Certified std cpm}}{\text{dpm of standard}} = \text{Decimal } \frac{\text{cpm}}{\text{dpm}}$$

$$\text{Disintegrations per } 100 \text{ cm}^2 = \frac{\frac{Cs - Cb}{Ts \quad Tb}}{\text{Eff.}}$$

Where

Cs = Total counts sample

Ts = Time sample was counted

Cb = Total counts background

Tb = Total time background counted

And

$$\frac{1.96}{100 \text{ cm}^2} = 1.96 \ \frac{\frac{Cs - Cb}{Ts^2 \ Tb^2}}{\text{Eff.}}$$

And

$$\text{LLD (dpm)} = \frac{4.66 \text{ bkg}}{\text{Eff.}}$$

Where

bkg = The standard deviation in counts per minute of background

$$\text{Eff.} = \frac{\text{cpm}}{\text{dpm}}$$

U.S. Energy Corp.
GMIX Facility
Radiation Safety: Standard Operating Procedures

Health Physics-9 (HP-9)

I. MANAGEMENT CONTROL, BIOASSAY URINE, AND IN VIVO PROGRAMS

A. The RSO shall administer the programs on the local level. Bioassay refers to the procedures used to determine the concentration of radioactive material in the body of personnel. The term bioassay includes collection of urine samples which are analyzed for uranium concentrations and In Vivo or whole body counting. In Vivo bioassay involves the use of what is known as a whole body counter which consists of either a Sodium Iodide or Germanium Lithium scintillation detector placed over the chest or pulmonary region of a person. The detector is attached to a multi-channel analyzer which records the gamma radiation being emitted from the chest or pulmonary region of the body. Specific energies of gamma radiation are emitted by radioactive materials in the uranium decay series of uranium. If a person has inhaled or ingested uranium in the form of ore dust or yellowcake, then the gamma emitting radioactive materials associated with uranium will also be present. The In Vivo detection system is designed to detect those radioactive materials and is used to evaluate the uranium concentration within the pulmonary region based on the concentration of other associated radioactive material.

II. Urine Monitoring Program

A. A urine sample shall be obtained by the RSO from all personnel who will be subject to urinalysis prior to start of Facility work. This sample shall be analyzed for uranium concentration and the results shall form the basis of baseline levels of uranium.

B. Routine testing

1. A urine specimen shall be routinely collected and analyzed for uranium from Facility personnel and all personnel involved in maintenance tasks in which the RSO determines that urine testing is required.

Additional individuals may be placed on this program at the discretion of the Company or the RSO.

C. Collection Procedures

1. The specimens are to be collected before The designated personnel leaves the Sheep No. 1 office, and in an area free of uranium contamination. Specimens shall be collected when the person returns from scheduled days off if reasonably possible.

2. As a person enters the Sheep No. 1 office area, he/she is to go directly to the Facility Manager or RSO, pick up a specimen bottle and top, write their name and the date on the top, then proceed to the Sheep No. 1 office rest room and collect a specimen and returns the specimen to the Facility Manager or RSO. THIS IS TO BE DONE BEFORE THEY GO ON SHIFT.

3. Failure of any person to comply with the above schedules may result in disciplinary action.

D. Chain of Custody of Specimens

1. The specimens shall be checked against a list of personnel to be tested (provided by the Facility Manager) to ensure that all specimens are collected. With each batch of specimens, one specimen, representing a blank, shall be obtained from a person who is not associated with the Facility. Once the specimens are collected, the RSO shall split two samples from each batch of specimens by pouring half of two specimens into two other separately marked bottles. Uranium solution shall be added to these bottles such that the concentration of uranium in these bioassay specimens shall be 15 μg/l and 30μg/l. The specimens shall be prepared by the RSO for shipment and shipped to a certified analytical laboratory for analysis of uranium concentration.

E. Reporting of Specimen Results

1. After laboratory analysis is completed, the results shall be reported to the RSO.

2. The results shall be reviewed by the RSO against the action levels required by the U.S. Nuclear Regulatory Commission. Prompt notification to the RSO are required in event of results of uranium in urine of 15 μg/l or more. Results exceeding 30 μg/l shall be reported to the RSO by telephone as per the U.S. Nuclear Regulatory Commission's Regulatory Guide 8.22 entitled "Bioassay at Uranium Mills".

F. Special Tests

1. Any special urinalysis shall be scheduled by the RSO.

III. In Vivo Program

A. Baseline

1. A In Vivo measurement, if requested by the RSO, shall be obtained by the RSO or Facility Manager prior to start of work at the GMIX Facility from all persons who, as personnel of U.S. Energy, will be subject to periodic In Vivo measurements as part of the bioassay program. In Vivo measurements shall be used to determine the uranium concentration naturally present in the pulmonary

region of the personnel. The results shall form the basis of baseline levels of uranium.

2. In Vivo measurements require specialized equipment and therefore requires arrangements to be made for a mobile counter such as Helgeson's to come to the site to perform the In Vivo measurements or arrangements to send personnel off site to an In Vivo counter such as the one at Colorado State University. Arrangements shall be made to ensure that the baseline In Vivo measurements are conducted in an expedient fashion.

B. In Vivo Counting

1. In Vivo measurements if requested by the RSO shall be performed at least once every two years on all personnel routinely assigned to work in the GMIX Facility. The measurements shall be taken with equipment capable of measuring 9 nCi or less of uranium in the lung as per the U.S. Nuclear Regulatory Commission's Regulatory Guide 8.22. In Vivo counting shall be performed each year on approximately half of the above personnel. In addition, In Vivo counting shall be performed on any personnel whose intake of radioactive material for any calendar quarter since his/her last In Vivo count exceeds 25% of the intake that would result from exposure to the concentration of radioactive material listed in 10 CFR 20, Appendix B, Table 1 for a period of one quarter.

IV. Action Levels - Exposure Control

A. Requirements

1. Action levels based on bioassay shall be in accordance with Tables 1 and 2 of NRC Regulatory Guide 8.22, "Bioassay at Uranium Mills" (August 1988). In addition, all bioassay results shall be evaluated by the project Safety and Environmental Administration and/or the Corporate Medical Department.

2. In addition to any evaluations of personnel exposures and any notifications required pursuant to Sections 20.103 and 20.405 of 10 CFR Part 20, the licensee, the RSO shall make a formal documented evaluation if bioassay measurements exceed any of the following criteria:

a. The urinary uranium concentration exceed 30 μg/l for any two consecutive sampling periods.

b. The urinary uranium concentration for any measurement exceeds 80 μg/l.

c. Any In Vivo pulmonary measurement exceeds 16 nCi.

3. Urinary analysis results exceeding 15 $\mu g/l$ shall be reported by the analytical laboratory to the RSO at least within ten days of specimen collection.

4. Urinalysis results exceeding 30 $\mu g/l$ and in vivo results exceeding 16 nCi shall be reported by the analytical laboratory to the RSO by the most immediate method.

5. Prevention of specimen contamination shall be in accordance with Section C.6 of the NRC Regulatory Guide 8.22 (August 1988).

V. Management Review

All bioassay results shall be evaluated by the RSO and Environmental Coordinator and shall include semi-annual evaluations of past exposures. Results shall be sent to the Facility Manager. An individual may request and be authorized to see their own bioassay and exposure records. Management shall evaluate all personnel radiation exposure history by reviewing records of previous exposure.

U.S. Energy Corp.
GMIX Facility
Radiation Safety: Standard Operating Procedures

Health Physics-10 (HP-10)

AIR SAMPLING IN THE WORK PLACE

I. Air sampling is not required by the provisions of the Source Material License No. SUA-1524 and the Radiation Safety Program. If requested by the RSO, air sampling shall include area composite high value particulate sampling for Ra-226 and Th-230, in plant high volume sampling for airborne uranium and personnel lapel air sampling for airborne total uranium.

II. Introduction

A. Air sampling in the work place is, according to the U.S. Nuclear Regulatory Commission Regulatory Guide 8.25 entitled " Air Sampling In The Work Place", an acceptable method for meeting certain of the survey and dose assessment requirements of 10 CFR Part 20, "Standards for Protection Against Radiation." The following regulation citations are applicable:

1. 10 CFR 20.1204 allows estimates of personnel intakes of radioactive materials based on air sampling and allows adjustments of the Derived Air Concentration (DAC) and Annual Limits on Intake (ALI) based on the particle size distribution. The acronyms used and recognized by the U. S. Nuclear Regulatory Commission to define allowable airborne concentrations of radioactivity and intake of airborne radioactivity are ALI and DAC respectively. These acronyms shall therefore be used throughout this procedure.

2. 10 CFR 20.1501 requires radiation surveys necessary to comply with the regulations and to evaluate potential radiological hazards;

3. 10 CFR 20.1703 requires assessment of airborne radioactive material concentrations when respirators are used.

4. 10 CFR 20.1902 requires posting of airborne radioactivity areas.

5. 10 CFR 20.21103 requires records of radiation surveys.

6. 10 CFR 20.2202 and 10 CFR 20.2203 require reporting of excessive concentrations of or exposure to airborne radioactive materials.

B. As a general rule, any licensee who handles or processes unsealed or loose radioactive materials, in quantities that during a year will total more than 10,000 times the ALI for inhalation, should evaluate the need for air sampling. If repeated exposure to the same loose radioactive material occurs, such as with uranium ore dust and yellowcake, to determine whether the above limit is exceeded, multiply the quantity of the loose material handled by the number of times handled. For natural uranium, the above quantity represents 500 μCi (10,000 x 0.05 μCi).

C. Further, according to Regulatory Guide 8.25, the extent of air sampling may be based on estimates of personnel intakes and on estimated airborne concentrations of radioactive materials as shown in Table 1. Estimates of intakes and concentrations are based on air sampling and/or bioassay data. Air sampling is also required by 10 CFR 20.1703(a)(i) to evaluate airborne hazards whenever respiratory protective equipment is used to limit intakes pursuant to 10 CFR 20.1702.

III. Air Sampling - Representative of Inhaled Air

Section 20.1502(b) of 10 CFR 20 requires monitoring of the intake of any personnel where intake is likely to exceed 0.1 ALI. Section 20.1204 allows the use of air sampling, bioassay, or a combination of both to determine intake. Table 2 describes the methods which may be used to demonstrate the representativeness of air supply.

IV. Location of Air Samplers

A. Airflow Pattern

1. Concentrations of airborne radioactive materials in any given room are generally not uniform. Concentrations usually vary greatly from one location to another in the same room, sometimes by orders of magnitude even for locations that are relatively close. Therefore, the location of air samplers is important because inappropriately placed samplers can give misleading results.

2. Airflow patterns shall be determined in order to locate air samplers appropriately. The locations of ventilation air inlets and exhausts and of sources of airborne radioactive materials shall be noted in order to determine the predominant airflow patterns and likely radioactive material transport routes. Smoke candles, smoke tubes or bubble generators shall be used to determine airflow patterns from the source to the personnel's breathing zone. In some instances, such as with dim light and low ventilation, the use of larger smoke sources or bubbles to observe airflow patterns is desirable.

3. The airflow pattern determinations shall be repeated if there are changes at the facility, including changes in locations of the individual work locations and seasonal variations that might change airflow patterns, or if there is a reason to suspect problems. The radiation protection staff should be aware of facility characteristics, operations, and changes that might change airflow patterns. In addition, the location of at least 10 percent of the fixed-location samplers shall be evaluated annually to confirm that their locations are still appropriate.

B. Selecting Sampler Locations

1. Air samples shall be collected in airflow pathways downstream of sources of airborne radioactive material.

2. When the purpose of the sample is to verify the effectiveness of confinement or to provide warning of elevated concentrations, the sampling point shall be located in the airflow pathway near the release point. Since these samples shall be used to verify confinement, ventilation etc, they do not have to be placed near the personnel's breathing zone, and thus concentrations might be considerably different from the concentrations in the breathing zone. If the room has several widely spaced sources of airborne radioactive material, more than one sampling point may be needed.

3. When the purpose of sampling is to determine personnel intakes, each frequently occupied work location shall have its own sampler. The air samplers shall be placed as close to the breathing zone of the personnel as practical without interfering with the work or the personnel. In addition, air flow patterns in the area shall be considered in placing samplers so that the sampler is likely to be in the airflow downstream of the source and prior to or coincident with the location of the personnel. An estimate should be made of the time the person spends at the work location (unless personal air samplers are being used).

4. For hoods, glove boxes, and other similar enclosures used to contain radioactive material, air samplers may be installed slightly above head height and in front of the personnel or they may be installed on the front face of the enclosure.

5. Normally, air samplers intended to measure work place concentrations shall not be located in or near exhaust ducts, because concentrations there will usually be diluted compared to concentrations in work areas. However, samplers may be located in ducts if their purpose is to detect leakage from systems that do not leak during normal operation and if quantitative measurements of concentrations are not needed.

V. Annual Review of Air Sampling Measurements

A. Section 20.1101(c) of 10 CFR Part 20 requires that the licensee periodically (at least annually) review the radiation protection program content and implementation. The review of the air sampling component of the program shall determine: (1) whether the measurements are accurate and reliable and whether (2) changes should be made to improve the measurements. The review shall be done annually and shall cover the prior year's activities. The annual review of air sampling measurements shall be combined with the ALARA Audit Committee's reviews of other aspects of the radiation protection program.

B. The annual review shall include but not necessarily be limited to:

1. Purposes and amount of air sampling: Was the air sampling appropriate for the intended purposes? Was there too much or too little air sampling done?

2. Location of Sampling: Were fixed-location air samplers located properly? Were grab samples taken with proper regard to airflow patterns?

3. Trends: Do trends in air sampling results and personnel intakes indicate that confinement of radioactive materials remains adequate? Were prospective estimates of intake reasonably accurate?

4. Posting: Is the posting of airborne radioactivity areas appropriate?

5. Procedures: Are written procedures still suitable and up to date?

6. Adjustment of DAC: Were DAC adjusted for particle size or solubility? If so, are the original adjustment factors still valid?

7. Correction factors: Were correction factors applied to air samples to determine personnel intakes? If so, are the correction factors still valid?

8. Representativeness: For air sampling done to determine significant intakes, was the representativeness demonstrated to be adequate?

9. Changes: Have changes in air sampling procedures or equipment occurred that could affect the quality of the measurements? Have changes in the facility operation or equipment occurred that could affect the quality of air sampling measurements?

U.S. Energy Corp.
GMIX Facility
Radiation Safety: Standard Operating Procedures

Health Physics - 11 (HP-11)

PERSONNEL AIR SAMPLING

I. Authority

A. Personnel air sampling is not required by provisions of the Source Material License (License No. SUA-1524) and the Radiation Safety Program. The Personnel Air Sampling Program will be initiated if requested by the RSO.

B. While the procedure is specifically for mill personnel, it can be used for general personnel air sampling in other locations. When using this procedure for other non-mill personnel air sampling refer to National Institute of Occupational Safety and Health (NIOSH) air sampling methods for specific details on filter media, flow rates and sampling time.

II. Sampling Locations and Frequency

A. Personnel air samples shall be obtained from the following Facility personnel for a period of from 2 to 8 hours at least once per month and whenever work by an company or contract personnel is controlled by a Radiation Work Permit (RWP). (This requirement does not preclude sampling on a more frequent basis):

1. Personnel conducting maintenance in the Facility.

2. Personnel conducting decommissioning and decontamination.

III. Analytical Parameters

A. Filters from air samples for personnel in the Facility shall be analyzed for Uranium natural (U_{nat}).

IV. Sample Collection

A. Personnel air samples are obtained by drawing a known volume of air through a membrane or glass fiber filter. The filter is then analyzed for the desired component.

V. Sampling Equipment

A. Personal air pump, calibrated with the filter and filter holder to be used for sampling.

B. Open face filter holder (for sampling personnel for Total Uranium exposure or respirable dust).

C. Membrane or glass fiber filters.

NOTE: Filters do not have to be weighted when sampling for Uranium natural(U_{nat}).

VI. Sampling Procedures

A. Connect hose attached to sampling head to the fitting on top of the air sample pump.

B. Check hose connections for tightness and inspect hose carefully for breaks. Replace if necessary. Check the air sample pump for leaks.

C. Push power switch to start the air sample pump.

D. Set flow adjustment valve to read approximately 1.4 liters meter minute (lpm) using a small screwdriver. Turn adjustment screw clockwise to increase and counter clockwise to decrease airflow. Record beginning flow rate.

NOTE: Air sample pump battery must be fully charged when the air sample pump is used for long-term operations (8 hours). If the air sample pump battery pack has just been charged or a new battery pack installed, run the air sample pump until the battery voltage levels off, approximately 15 minutes, before connecting the cyclone, an apparatus to differentiate between particle sizes.

E. Clip pump to user's belt and attach sampling head to user's clothing using clip attached to hose bracket assembly. Sample head should be worn as close to user's breathing zone as possible.

F. At the end of the work period, the person shall check and record the final flow rate and turn the pump off. If the switch is left on, the pump will run until the battery is completely discharged and possibly damaged.

If the final flow rate is different from the beginning flow rate by 0.14 lpm, or is less than 1.26 lpm or greater than 1.54 lpm, the person shall notify the RSO.

G. Sample for a full eight hour shift.

NOTE: To assure accurate sample results the cooperation of personnel is very important. Advise personnel being sampled as to the purpose of the sampling. Caution them not to remove the sampler or turn it off during the sample period and that if problems with the sampler develop, contact the Safety and Environmental Department immediately.

H. The Facility Manager or Environmental Coordinator shall identify the sample with the following information and deliver to the Environmental Laboratory for analysis:

1. Person sampled
2. Date sampled
3. Flow rate beginning
4. Flow rate end
5. Total Volume of air sampled[1]
6. Analysis requested

I. The personnel shall record pertinent data on the personnel air sample data sheet.

J. Sample operating time can be calculated from values obtained from the digital counter incorporated into the sample pump.

VII. BDX 44 Digital Counter Operation:

A. The BDX 44 incorporates a 5-digit non-resettable counter that registers up to 99999. The number registered by the counter can easily be converted to the approximate time air is sampled (in minutes) as outlined below:

VIII. Sample Operating Time Calculation

A. The operating time calculation is determined by using the following procedure:

1. Connect the sampled element to be used to the BDX 44.
2. Set up the BDX 44 and adjust for proper airflow.
3. Use a stopwatch and monitor the counter for 5 minutes to determine the rate of count per minute.
4. Use the formula below to determine total sample operating time:

$$T = \frac{C}{R}$$

T = Total operating time in minutes

C = Counter count for total sample time

R = Count rate per minute

[1]Total operating time in minutes times the average of the beginning flow rate and the ending flow rate if the flow rate changed by more than 10%.

IX. Interpretation of Sample Results

A. The results of the personnel air samples shall be used to verify the high volume sampling data and shall be used in conjunction with the high volume data to calculate the internal dose for company or contract personnel (Standard Operating Procedure: Health Physics - 12). The personnel air sampling data will also be used to evaluate and verify the results from the bioassay samples.

X. Calibration of "Personnel" Air Pumps

A. The airflow meters shall be calibrated at least annually and after repairs, modification and/or damage to the meters. The procedure for calibration is given in Standard Operating Procedure: Health Physics - 11.

B. Air samplers and associated sampling lines shall be checked for leakage of air into the sampling line upstream of the flow measurement device when they are calibrated for volume of air sampled. This can be done by putting the hose next to the face and ear and feeling or listening for air leaks or by putting the hose under water and watching for bubbles. If the flow rate changes by more than 10% during collection of a sample, a correction shall be made by averaging the initial and the final flow rates.

U.S. Energy Corp.
GMIX Facility
Radiation Safety: Standard Operating Procedures

Health Physics - 12 (HP-12)

IN-PLANT HIGH VOLUME PARTICULATE SAMPLING

I. Authority

A. In-plant high volume particulate sampling is not required by the provisions in the Source Material License (License No. SUA-1524) and the Radiation Safety Program. If requested by the RSO for the decommissioning and decontamination plan, the in-plant high volume particulate sampling shall be performed by the Facility Manager.

II. Sampling Locations and Frequency

A. In-plant high volume sampling for airborne uranium shall be at the locations requested by the RSO.

III. Analytical Parameters

A. In-plant high volume samples shall be analyzed for Uranium natural. Samples of radon decay products (working level measurements) shall also be taken at the same locations and frequencies.

IV. Sample Collection

A. In-plant high volume particulate samples are collected at several points along a sample traverse at each location listed in Table HP-12. Sample traverse points that are typical of personnel exposure to airborne radionuclide are selected at each air sample location (ie: precipitation area, environmental laboratory, ore pad at the grizzly, etc.). Traverse points at air sample locations may change from time to time depending on levels of personnel exposure, time studies or other indications that a different traverse point would be more indicative of typical personnel exposure.

1. Erect a portable high volume air sampler on the portable sampling platform installed at the sampling location. Install a filter in the head of the high volume air sampler.

2. Turn the unit on and allow it to warm up for several minutes before attaching the flowmeter. Record the time sampling began.

3. Record the flowmeter reading and disconnect the flowmeter.

4. Allow the sampler to run for 15-20 minutes before moving it to the next traverse point within a particular location. Total sample time for all traverse points representing each high volume air sampling location shall not be less than 1 hour.

5. At the end of each traverse per sample location, note the time sampling ended and the final flowmeter reading. Remove the filter paper and deliver it to the Environmental Laboratory for analysis of uranium natural.

   a. Identify the filter by sample location and furnish the laboratory with the following information:

      1. Date Sampled
      2. Total volume of air sampled
      3. Analysis requested

IV. Interpretation of Sample Results

A. The results of the in-plant high volume air sampling shall be used, in part, to calculate company and contract personnel internal dose from inhalation. The airborne concentrations shall be compared to the Derived Air Concentrations (DAC) for uranium natural (U_{nat}) in yellowcake of 2E-11 μCi/ml and in ore dust only of 3E-11 μCi/ml (6E-11 gross alpha) as per 10 CFR 20.1001-20.2401 Appendix B. The allowable annual exposure to airborne radioactivity is 2000 DAC-hours with an action level of 125 DAC-hours in one quarter. The in-plant high volume air sampling will be used in conjunction with the personnel air sampling (Standard Operating Procedure: Health Physics-11) and bioassay data for final verification and determination of internal doses.

V. Calibration of Portable High Volume Samplers

A. The high volume sampler shall be calibrated by the Safety and Environmental Department or the manufacturer at least every six months and after every motor and brush change to maintain air volume accuracy. The calibration procedure is given in Standard Operating Procedure - Health Physics-14.

U.S. Energy Corp.
GMIX Facility
Radiation Safety: Standard Operating Procedures

Health Physics - 13 (HP-13)

AREA COMPOSITE HIGH VOLUME PARTICULATE SAMPLING

I. Authority

A. Area composite "Hi-Vol" particulate sampling is not required by provisions of the Source Material License (License No. SUA-1524). If requested by the RSO for the decommissioning and decontamination plan, high volume particulate sampling shall be conducted by the Facility Manager.

II. Sampling Location and Frequency

A. Area composite of the monthly "Hi-Vol" samples shall be obtained semi-annually in the areas of the Facility assigned by the RSO.

III. Analytical Parameters

A. Filters from area composite samples shall be analyzed for Total Uranium, Radium 226, and Thorium 230.

IV. Sample collection

A. Area composite "Hi-Vol" samples shall be performed as a general index of airborne radioisotope levels. Data obtained from semi-annual area composite samples will indicate trends in airborne radioisotope concentrations.

V. Sampling Equipment

A. Portable "Hi-Vol" particulate sampler, Particulate filter, and Stopwatch or other timing mechanism.

VI. Sampling Procedure

A. Sampling shall be performed in transects which are representative of personnel exposure. When sampling, the sampler must be moved several times during the sampling period in order to obtain a composite sample of the entire area.

B. Sampling shall be performed for from 2 to 8 hours. The procedure for obtaining the samples is identical to the procedure for monthly "Hi-Vol" particulate samples (Standard Operating Procedure: Health Physics - 12) except that the areas sampled shall be larger.

VII. Interpretation of Sample Results

A. The results of the composite samples shall be compared to the historical data of airborne radioactivity at the above locations in order to assess the effectiveness of the ALARA program (Standard Operating Procedure: Health Physics - 1). In addition, the sample results for Ra-226 and Th-230 will be evaluated in relation to the Derived Air Concentrations (DAC) as given in Appendix B of 10 CFR 20.1001-20.2401 to verify that these concentrations are below the 25% action level. Concentrations of 7.5E-11 µCi/ml for Ra-226, 1.5E-12 µCi/ml for Th-230, and 5E-12 µCi/ml for U_{nat}(7.5E-12 µCi/ml for Uranium natural in ore dust [1.5E-11 gross alpha]).

VIII. Corrective Action based on Air Sample Results

A. If during any area composite sampling, the air sample results indicate airborne radioactivity at concentrations greater than the historical data or greater than 25% of the values listed in Appendix B of 10 CFR 20.1001-20.2401, the results will first be confirmed by the Safety and Environmental Department. Subsequent action shall be for the Safety and Environmental Department to determine the source of the difference in concentrations of airborne radioactivity and to take action to reduce these concentrations. Follow-up sampling shall be conducted by the Safety and Environmental Department to verify that the source of the increased airborne concentrations had been properly identified and that the corrective actions taken were effective.

Sampling Pump Radiometrics

Run for: U., Ra, Th., Pb
filter:

Upwind - baseline & down wind @ each site
Run Pump for 2 weeks —
record Start & Stop - time & date
record Rotometer value at start & end
(use center of ball.)
Label filter envelope 1, 2, etc
if rotometer drops — record time & date
& place new filter in - record time & date
place both filters in envelope to make sample.
(fold filter if desired to hold as much
fines as possible).
Send samples w/ form or info to Energy labs
at any time after sampling. holding
time not critical.

ENERGY LABORATORIES

ENERGY LABORATORIES, INC.
P.O. BOX 3258 • CASPER, WY 82602 • PHONE (307) 235-0515
254 NORTH CENTER, SUITE 100 • CASPER, WY 82601 • FAX (307) 234-1639

Calibration Certificate
Sampling Pump

To: Energy Laboratories, Inc.
Attention: Sheryl A. Garling

Date: 09 Jun 1994 **Next Calibration Due:** n/a

Device Type: sampling air pump
Manufactor: Eberline
Model: RAS-1
Serial Number: n/a
Owner's I.D.: ELI-118 **From:** n/a **To:** n/a
Laboratory I.D.: n/a

Test Conditions: connected to Brooks Rotameter, in-line with clean 47 mm. cellulose nitrate "sharkskin" filter paper

Test Results:

Pump Rotameter Setting	Brooks Rota-Meter Reading
12.5	12.0
20	18.0
30	26.0
40	34.0
50	38.0
60	42.0
70	48.0
80	54.0
90	62.0
95	63.0

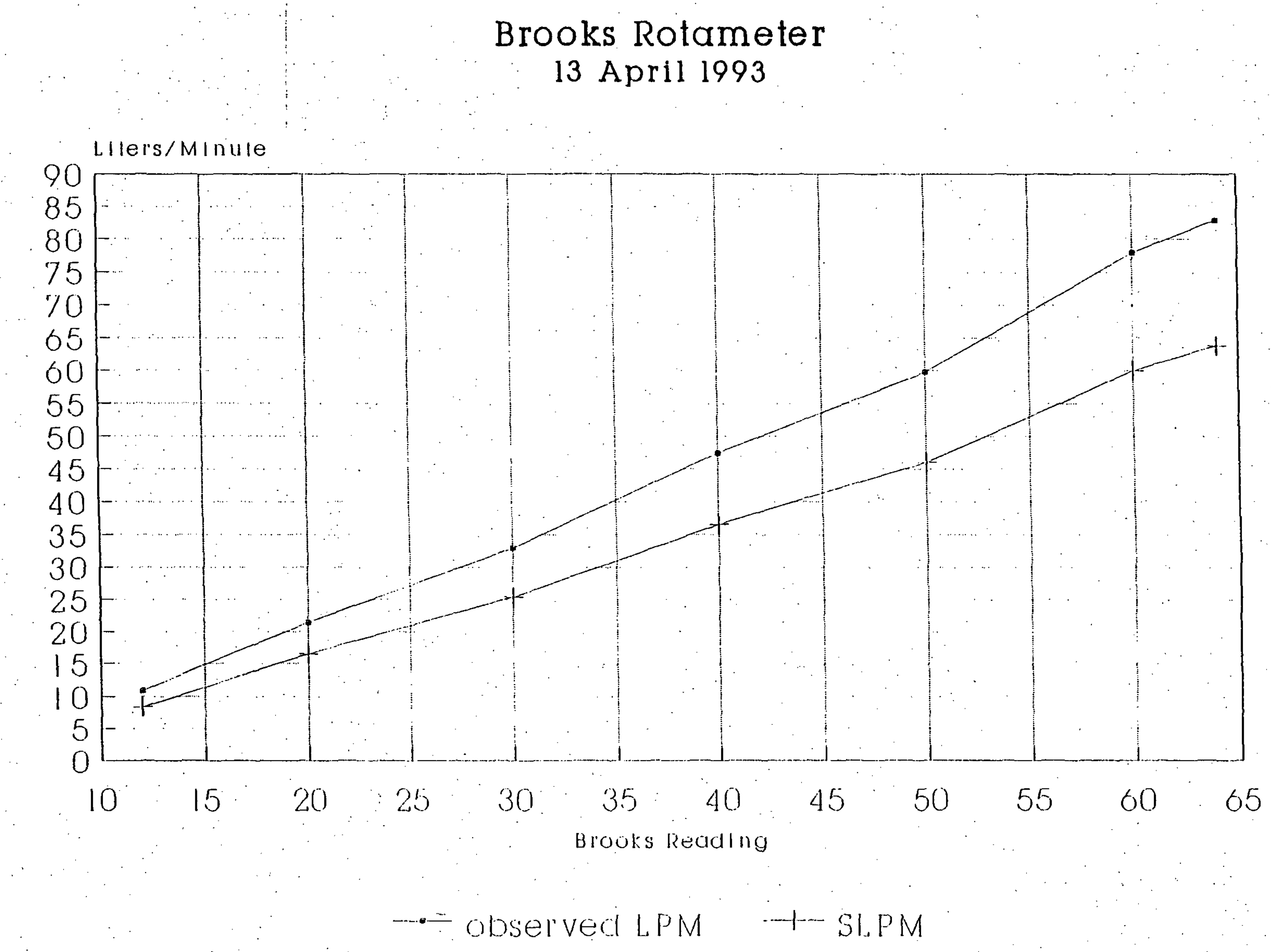
At Set Point of **87.5**, pump is moving **60** SLPM.

SLPM is determined from calibration curve for Brooks laboratory rotameter, calibrated against 20 L. bubble tube on 13 Apr 1993.

Daniel B. Rea

Calibrated by: Daniel B. Rea

dbr 694eli.118



actual curve

U.S. Energy Corp.
GMIX Facility
Radiation Safety: Standard Operating Procedures

Health Physics-14 (HP-14)

CALIBRATION OF EQUIPMENT

I. Routine maintenance and calibration of instruments and samplers used for implementation of the radiation safety program is required by the Source Material License(SUA-1524) and is necessary to ensure that exposures are As Low As Reasonably Achievable (ALARA).

II. Survey Instruments:

A. Survey instruments used for beta and gamma surveys shall be calibrated at least semi-annually or at the manufacture's suggested interval and after repair. The calibration shall be performed either by the Safety and Environmental Department or outside calibration firm, such as the manufacturer. Each instrument shall be calibrated at two points at about one-third and two-thirds of each linear scale routinely used. A survey instrument shall be considered properly calibrated when the instrument readings are within ± 20% of the calculated or known values for each point checked based on the known activity of the sources used for calibration. Survey instruments shall be checked for constancy of operation with a radiation check source prior to each usage. If the instrument response to the radiation check source differs from the reference reading by more than 20%, the instrument shall be removed from service, repaired if necessary and recalibrated.

B. Calibration for beta dose rate measurements is usually performed by noting the difference between the open and closed-window reading on a Geiger-Mueller (GM) or ionization chamber survey meter. The difference is considered to be beta dose rate and is addressed in the standard operating procedure for Beta surveys (Health Physics-3).

C. Alpha counting systems used for radon daughter measurements shall be calibrated at least monthly by using a known standard alpha source.

D. Alpha survey meters used to detect contamination on skin and equipment shall be constancy checked each week and calibrated semi-annually.

III. Air Samples:

A. Air Samplers for Personnel and Radon Daughter Sampling

1. The air flow rates through the filters shall be determined by calibrating pumps with the filter paper in place monthly or whenever any abnormal operation of the pump are apparent to ±20% accuracy.

B. Calibration Equipment

1. Equipment necessary for pump calibrations includes a wet-test meter or bubble tube, an accurate stopwatch, an in-line filter holder, several filters, and the pump to be calibrated.

2. The wet-test meter must be set up, adjusted, and operated in the manner specified by the manufacturer. Air should be pumped through the wet-test meter for several minutes before calibrations are attempted to ensure saturation with air of the water in the wet-test meter.

3. The wet-test meter measures only the total volume of air, and therefore, the flow must be accurately timed to determine the flow rate.

4. Another method of determining total air volume is the bubble tube. The bubble tube is generally a large diameter burette, marked with a volume scale. A soap bubble across the tube will move in a manner to equalize the pressure on both sides of the bubble. By this means, the air volume evacuated by the pump is indicated by the distance traversed by the bubble with reference to the graduated scale of the tube. This method also requires the use of a stopwatch to determine flow rate. The bubble tube is easy to use, relatively inexpensive, and very portable, but does have the disadvantage of being limited in volume. This volume limit requires that time measurement accuracy be quite high: 1-second measurement error for a 1-liter tube (the normal size) would be equivalent to a 10-second error for the average 10-liter air sample.

5. The filters and in-line filter holders used for pump calibration must be the same type as those used in the field. If more than one filter or filter-holder type is used for field sampling, the pump must be calibrated for each combination.

C. Calibration Procedure

1. The procedure for pump calibration is to connect an in-line filter holder containing a filter between the "bubble tube" and the pump. The filter and filter holder must be the same type as will be used in the field.

2. After the proper connections have been made, the pump is turned on and the top or middle of the ball is adjusted to a graduation on the flowmeter such that the total sample volume will be at least 10 liter of air in a 5-minute sample. The total sample volume for a 5-minute period (timed with a stopwatch) is determined. With this volume and time interval, the average flow rate may be determined for that flowmeter setting.

3. Additional calibration shall be made at lower flowmeter graduations to allow compensation for battery drain after a number of samples have been taken. No flow adjustments should be made with the bypass valve furnished on some

pumps because return to an identical setting at a later time is virtually impossible; the bypass valve on these pumps shall remain closed at all times. Flowmeter settings may be made relative to the top or the middle of the indicator, but whichever reference system is chosen, it must be used consistently. After the calibration is complete, attach an adhesive label to the pump, listing the type reference setting (Top or Middle of Ball), corresponding flow rate, and the date of calibration.

4. Calibration should be performed monthly or whenever any abnormal operation of the pump or filter train are apparent.

5. Calibration of laboratory counters and detector instruments shall be performed monthly or whenever problems occur with either the detector or counter.

D. High Volume Air Samplers

1. Assemble High Volume Air Sampler according to the manufacturer's specification with a clean filter. Operate it for at least five minutes at 110 volts.

2. Connect the flowmeter to the pressure tap at the exhaust end of the motor/blower unit using a length of tubing.

3. Hold the flowmeter vertically, loosen the lock nut and adjust the flowmeter so that the middle of the float reads 60.

4. When adjustment is made, tighten the locking nut making sure the float continues to read 60.

5. Remove the filter holder from the motor/blower unit.

6. Replace the filter holder with the orifice calibrator using the Resistance Plate supplied with the orifice calibrator.

7. Connect a water manometer to the pressure tap of the calibration orifice.

8. Plug sampler into 110V. 60Hz. source and let it stabilize for approximately 5 minutes.

9. Read the manometer pressure in inches of water and covert to actual flow rate using the curve supplied with calibration orifice. <u>Record the actual flow rate and the flowmeter reading on your data sheet.</u>

10. Use the remaining resistance plates (using the one with the next fewer number of holes first) until the actual flow rates and the flow meter relationship have been established.

11. Using the readings established with the above procedure, plot a curve which represents the actual flow rate versus the flow meter readings.

12. This new calibration curve is used as a direct reference to obtain the actual flow rate.

13. The sampler flow meter shall be calibrated at least monthly and after every motor and brush change to maintain air volume accuracy.

U.S. Energy Corp.
GMIX Facility
Radiation Safety: Standard Operating Procedure

Health Physics-15 (HP-15)

THERMOLUMINESCENT DOSIMETER AREA (TLD) MONITORING

I. Authority

A. TLD area monitoring is not required by Source Material License renewal (License No. SUA-1524). TLD monitoring will be undertaken if requested by the RSO for the decommissioning and decontamination plan.

II. Sampling Locations and Frequency

A. TLD area monitoring is conducted continuously by placing TLD badges, a form of passive gamma radiation detection, in various areas throughout the Facility. The badges shall be exchanged quarterly for analysis. The locations of the badges will be determined by the RSO.

III. Analytical Parameters

A. TLD area monitors shall be analyzed by the laboratory for beta-gamma radiation exposure.

IV. Monitoring Procedure

A. Thermoluminescent dosimeter area monitors are received near the end of each calendar quarter. New monitors are exchanged with the previous monitors and remain in place during the entire following quarter. Area monitors from the previous quarter shall be returned to the laboratory for analysis promptly after exchange.

V. Interpretation of Results

A. Interpretation of TLD area monitoring analysis is, as given in 10 CFR 20.1003, where the reported "skin" dose is the shallow-dose equivalent at a tissue depth of 0.007 cm and the reported "whole body" dose is the deep-dose equivalent which applies to external whole-body exposure at a depth of 1 centimeter. The shallow-dose equivalent shall be maintained at levels less than 50 rem in one year. Records of the shallow-dose equivalent shall be maintained on file. The deep-dose equivalent shall be used if compliance with the summation of external doses is required and the external dose is greater than 500 mrem in one year (10 CFR 20.1502[a]).

VI. Quality Control

A. Control monitors prepared in the same way by the laboratory as the site area monitors shall be kept in a secure place which registers background levels away from sources of external radiation and shall be returned to the laboratory with TLD monitors they originally accompanied. The laboratory shall be one which holds a current personnel dosimetry accreditation from the National Voluntary Laboratory Accreditation Program (NVLAP) of the National Institute of Standards and Technology.

U.S. Energy Corp.
GMIX Facility
Radiation Safety: Standard Operating Procedures

Health Physics-16 (HP-16)

RADIOLOGICAL POSTING REQUIREMENTS

I. A number of posting or labeling requirements exist when certain situations or concentrations of contaminants are found. License condition 16 of SUA-1524 states that the licensee is exempted from the requirements of Section 20.203(e)(2) of 10 CFR 20 for areas within the GMIX providing that all entrances to the plant are conspicuously posted in accordance with 20.203(e)(2) and with the words, "Any area within this facility may contain radioactive material."

There are several categories of posting required by the U.S. Nuclear Regulatory Commission depending upon the external gamma exposure rates and airborne concentrations in specific areas. The following is a summary of those requirements.

II.

	External Gamma Exposure	Required Signs Posted
A.	> 5 mrem dose equivalent in one (1) hour at 30 centimeters (cm) from radiation source or from any surface that the radiation penetrates.	**Caution - Radiation Area**
B.	> 100 mrem dose equivalent in one (1) hour at 30 cm from the radiation source or from any surface that the radiation penetrates.	**Caution - High Radiation Area** with pertinent control devices, conspicuously visible or audible alarms, and entry ways that are locked except when access is required.
C.	> 500 rad absorbed dose in one (1) hour at one (1) meter from a sealed radioactive source in non-self shielded irradiator or from any surface that the radiation penetrates.	**Caution - Very High Radiation Area** with the same restrictions as above together with shielding.

III.	Airborne Uranium	
A.	airborne concentrations in excess of the Derived Air Concentration (DAC) specified in Appendix B to 10 CFR 20.1001 & 20.2401 (Ore: $3E^{-11}$ U_{nat}, $6E^{-11}$ gross alpha, and U_{nat} $2E^{-11}$).	**Caution - Airborne Radioactivity Area**
B.	Airborne concentrations to such a degree that an individual present in the area without respiratory protection could exceed, in a week, a intake of 0.6% of the Annual Limit of Intake (ALI) or 12 DAC-hours.	
IV.	Buildings and Fences	
A.	An area, which access is limited by the Licensee, for the purpose of protecting individuals against undue risks of exposure to radiation and radioactive material.	**Restricted Area**
V.	Stored Radioactive Material	
A.	Area or room in which there is, used or stored an amount of licensed material exceeding 10 times the quantity of such material as specified in Appendix C to 10 CFR 20.1001 & 20.2401 (1000 μCi U_{nat}).	**Caution - Radioactive Materials**
B.	Entrances and Doorways to the Mill Facilities.	**Any Area Within This Facility May Contain Radioactive Materials**

U.S. Energy Corp.
GMIX Facility
Radiation Safety: Standard Operating Procedures

Health Physics-18 (HP-18)

RELEASE OF EQUIPMENT TO UNRESTRICTED AREAS

I. Authority

A. Surface contamination surveys for both total and removable alpha contamination are required by Nuclear Regulatory Commission Source Material License No. SUA-1350.

II. Surveys

A. All equipment to be released for shipment out of the restricted area shall be surveyed for contamination. Any piece of equipment in excess of 1000 dpm/100 cm^2 total alpha shall be tested to determine the amount (dpm) of removable contamination per 100 cm^2. Any piece of equipment in excess of 1000 dpm/100cm^2 removable alpha or 5000 dpm/100 cm^2 fixed alpha shall be decontaminated and resurveyed to insure compliance with U.S. NRC Regulatory Guide 1.86.

B. Average total contamination shall be averaged for areas not exceeding 1 square meter. Maximum total contamination shall be assessed for areas not exceeding 100 cm^2. All survey results shall be recorded on a contamination survey data sheet. In addition, a sketch showing the items surveyed and the areas where the surveys were performed on each item shall be drawn and attached to the data sheet.

A. All equipment to be shipped by common carrier is surveyed to ensure compliance with DOT regulations (49 CFR 173).

III. Survey Procedures

A. Total Alpha Contamination Measurements shall be in the following manner:

1. Turn the detection instrument on, check the battery and verify the unit operations and calibration using an appropriate check source.

NOTE: If the check source reveals a count rate difference of greater that 20% of that obtained at calibration and assuming the check source detector geometry is the same, the instrument shall be removed from service and re-calibrated.

2. Measure the alpha count rate on surfaces to be assessed by placing the alpha detector in contact with the surface and moving it slowly over the surface.

a. The average count rate shall be determined by selecting an area of approximately 1 square meter and averaging the count rates obtained in that square meter. Generally, instruments will be equipped with meter response selectors that will, depending on instrument characteristics, average the high and low meter readings on the slow response mode.

b. Items being assessed that are larger than one square meter shall have a representative number of areas assessed and the average of the areas recorded. Items of less than one square meter shall have the entire article assessed.

c. Maximum count rates apply to areas of not more than 100 cm^2, ie: when performing the average count rates as outlined above, be alert for "hot spots" which may be detected in the square meter assessment area. These "hot spots" shall be assessed separately and recorded as the maximum count rate.

3. Record measurement results on the survey data sheet.

4. Determine total surface alpha contamination levels using the following formula:

$$\text{Total Alpha Contamination (dpm/100cm}^2\text{)} = \frac{\text{cpm X 100}}{\text{EFF X C}}$$

cpm = Instrument count rate in counts per minute.
EFF = Efficiency of the detector-counter system (cpm/dpm).
C = Active counting area of detector (50 cm^2).

B. Removable Contamination

1. Smears for removable contamination shall be obtained in the same areas where the total alpha surveys indicated contamination greater than 1000 dpm/100cm^2. A sufficient number of smears shall be obtained to adequately assess removable surface contamination levels. Smears shall be obtained in the following manner:

a. Attach a "Nu-Con" smear or equivalent to it's holder being careful not to contaminate the smear.

b. Using moderate pressure, wipe an area of approximately 100 cm^2 (4" X 4"). Record pertinent data on the smear holder.

c. Using a properly calibrated laboratory instrument, determine the total alpha counts on the sample smear.

d. Determine surface alpha contamination levels using the following formula:

$$\text{Removable Contamination (dpm/100cm}^2) = \frac{cpm_s - cpm_b}{EFF}$$

cpm_s = Counts per minute of swipe sample
cpm_b = Background counts per minute
EFF = Efficiency of the detector-counter system

NOTE: Background counts per minute shall be determined by counting a blank smear several times in the same detector-counter system as the sample smear will be counted. Background counts are subtracted from the sample smear counts as stated in the formula, however, the result cannot be zero. Background will determine the lowest detectable level (conservatively taken as 2 times background).

$$LLD = \frac{2(cpm_b)}{EFF}$$

Accuracy is indicated for any number of counts according to the following formula:

Deviations $\pm 2/\sqrt{N}$ For 95% confidence level

N = Total number of counts regardless of time.

IV. Action Level

A. If contamination levels exceed the following limits, the surveyed items shall be decontaminated and resurveyed prior to release to unrestricted areas.

1. <u>Maximum Surface Contamination Levels</u>

Average (total)	5,000 dpm/100 cm^2
Maximum (total)	15,000 dpm/100 cm^2
Removable	1,000 dpm/100 cm^2

HP - 19

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U.S. Energy Corp.
GMIX Facility
Radiation Safety: Standard Operating Procedures

Health Physics-20 (HP-20)

RADIATION WORK PERMIT (RWP)

I. Radiation Work Permit

A. Generally, a Radiation Work Permit (RWP) is issued when any non-routine maintenance, upset, repair and decommissioning activities are performed, whenever a vessel, tank or other enclosed structure which has contained radioactive material is to be entered; whenever, during performance of a certain activity that could result in an individual's exposure (based on a time weighed average) in excess of 25% of ALI; or for any work or maintenance for which there is no effective operating procedure.

B. The RWP shall contain information pertaining to all precautions taken before, during and after completing the activity.

C. Reference shall also be made to all surveys conducted before or during the time the activity is in progress.

1. Please note: Input regarding all hazards (especially radiation related) is encouraged from contractor personnel.

D. RWPs are issued as a method of controlling and maintaining exposures ALARA and are, as the word "Permit" implies, a release to company personnel and contractor personnel allowing them to perform an activity. Caution must therefore be taken to ensure that a policy concerning RWP issuance shall be one of requiring that all personnel check before proceeding with a job unless it is obviously routine, covered under normal operations, or no radiation hazards exist.

E. As RWPs are issued, a list of areas where RWPs are required, accessory equipment and associated safety requirements shall be compiled and thus provide some assurance that nothing has been overlooked. A radiation safety technician shall observe the proposed work area and conduct any surveys required before and during the operation.

II. Management Direction

A. In the event of an upset or non-routine maintenance or operating condition involving radioactive material the supervisor on duty shall advise the General Manager, Safety and Environmental Department and the appropriate Department Superintendent. The Safety and Environmental Department shall evaluate the conditions and if necessary issue a Radiation Work Permit (RWP) including the proper safety procedures and instructions and authorize the work.

B. The Department Superintendent or his/her designate and the Safety and Environmental Department shall be responsible for the supervision of and verification that the work was completed in accordance with the safety procedures established.

III. Radiation Work Permit Procedures

A. All non-routine operations shall be performed following the procedures for radiation work permits (RWPs). The protocol dictated by a RWP includes the following: The Safety and Environmental Department shall:

1. Identify areas within which the non-routine operations will be conducted.

2. Prior to conducting the operations, perform inspections and surveys (alpha, beta, and gamma, where appropriate,) to define potential radiological hazards.

3. Where radioactive materials may be involved, perform initial sampling for airborne uranium and the radon daughters and determine the need to continue sampling during non-routine operations. Identify potential radiological hazards.

4. Specify precautions to be taken and monitoring to be performed during non-routine operations. Precautions shall include the use of respirators in areas where the potential for resuspension of airborne radioactive dust may occur, also time and assess restrictions where there is a potential for elevated external radiation exposures.

5. Identify additional personnel protective devices, including protective clothing to be worn. Clothing may include rubber boots or shoes, and/or anti-contamination coveralls and hood, depending on the circumstances of the non-routine operation. In high radon areas, every effort should be made to wear clothing consisting of static resistant fabrics. The use of polyester and similar type fabrics should be avoided.

6. Provide task-specific training as appropriate to assure exposures are ALARA and non-routine operations are conducted in a safe manner.

7. Specify that any anomalous conditions not encountered at the time of the issuance of the RWP be reported immediately to the RSO for further investigation.

8. Following completion of the activities authorized by the RWP, an exit interview with the SEA/RSO shall be performed to complete the RWP. This process assures active control over all activities, The Standard Operating Procedure (SOP) for alpha, beta, and gamma surveys are included in SOPs numbers HP-2, HP-3, HP-6, and HP-8.

IV. Types of Hazards and Protection Required

A. Radiation hazards requiring special RWP protection can be grouped into three basic types:

1. External Radiation Exposure

a. External radiation comes from either gamma or beta sources. Gamma radiation associated with natural uranium comes primarily from Ra-226. Thus all surfaces within the GMIX Facility where radium gamma exceeds 2.5 mR/hr shall be controlled so a person will not receive an exposure in excess of 1.2 Rem per quarter.

Radium is selectively absorbed in some elemental carbon products and on to some types of rubbers. It is also precipitated with calcium carbonate and calcium sulfate precipitates.

b. Beta radiation is emitted primarily from Protactinium-234 and Th-234 (short lived uranium daughters). Beta radiation becomes a problem only in areas where concentrated uranium is allowed to build up for long periods of time. Beta dose to skin is limited to 14 mR/hr. Safety glasses must be worn at all times since the eye is the limiting organ of the body for exposure to beta radiation at 1.25 rem per quarter. Safety glasses effectively shield the eye from beta exposure.

2. Internal Radiation Exposure

a. Internal radiation comes from inhalation of radon daughters and uranium dust or ingestion of uranium dust. It is important that radon daughter and uranium dust levels be estimated before a non-routine operation is performed so that the proper type of respiratory protection is chosen. If there a doubt concerning dust or radon levels to be encountered in the activity the RWP covers, an air powered or air supplied respirator with a full face mask shall be used.

b. All tanks must be ventilated prior to entry.

3. Surface Contamination and Skin Absorption

a. Uranium (in the oxide or ammonia salt) tends to be very mobile and is freely transported when smoking, chewing tobacco, eating on contaminated surfaces, through personal hygiene and skin absorption. Precautions should therefore be taken to eliminate all contact with soluble yellowcake on internal and external body surfaces.

b. When working in a tank which contains or has contained soluble concentrated uranium, individuals must wear rubber gloves and impermeable disposable coveralls.

In addition, a full face mask respirator must be worn in order to protect the face from splashing and an impermeable disposable hood to protect the rest of the head and neck areas.

c. Welding or cutting on surfaces which are contaminated with uranium presents a special problem since the uranium could be vaporized and inhaled. Welding or cutting operations on contaminated surfaces shall require an RWP and an air powered respirator.

V. Documentation and Records

A. A Radiation Work Permit and Yellowcake Maintenance Form for radiation work permitted shall be completed by the Safety and Environmental Administrator or his/her designate for each upset or non-routine maintenance job. These documents are permanent records. An example of a Radiation Work Permit is attached.

B. Inhaled concentrations will be entered in the exposure records maintained for each individual. Sampling airborne particulates using a lapel type sampler complete with cyclone or high volume method, followed by chemical analysis of the collected dust, shall be used to determine actual rather than approximate airborne concentrations present during the work periods. Inhaled concentrations shall be calculated from the actual airborne concentrations as follows:

1. For individuals wearing the air supplied respirator,

$$\text{inhaled concentration} = \frac{\text{airborne concentration}}{2000}$$

2. For individuals wearing the air purifying respirator,

$$\text{inhaled concentration} = \frac{\text{airborne concentration}}{10\text{(half mask) or }50\text{(full face)}}$$

U.S. Energy Corp.
GMIX Facility
Radiation Safety: Standard Operating Procedures

Health Physics-21 (HP-21)

RESPIRATOR PROTECTION

I. Subpart H to 10 CFR 20.1701-20.1709 addresses the requirement for an acceptable respirator protection program. The following itemizes these requirements:

A. Use of only National Institute for Occupational Safety and Health/Mine Safety and Health Administration (NIOSH/MSHA) approved respirators.

B. Air sampling program to identify areas of potential hazard.

C. Surveys and bioassay to evaluate actual intakes.

D. Written procedures regarding selection, fitting, issuance, maintenance, and testing of respirators, training, supervision of respirator use, and record keeping.

E. Physical examination initially and each year thereafter of all personnel to determine if the user is physically able to use the respiratory protection equipment.

F. Written statement concerning the use of respirators.

G. Advise to user that he/she may leave area at any time for relief from respirator usage.

H. Use of appropriate protection factor for the respirator used.

I. Estimating exposure of individuals to airborne radioactive material.

II. The above items are addressed in the Respiratory Protection Program for the GMIX Facility. A copy of the form signed by each respirator user, advising the above respects of the respirator program, is required. A sample form is attached.

III. Prior to each use, the operability of the respirator shall be verified (10 CFR 20.1703[a][3][iii]). The following procedures for each respirator type shall be conducted prior to each use:

A. Air Purifying Half-Mask Respirator: Cover the filter elements with palm of hand(s) and inhale gently. If the mask is pulled toward the face, there are no leaks and the respirator may be used.

B. Full Face Mask Respirator: Close off the air hose or canister opening with the palm of hand and inhale gently. Hold breath for 5 to 10 seconds. If the mask remains collapsed toward the face while breath is held, there are no leaks and the respirator may be used.

C. Air-Purifying Powered Half-Mask Respirator: Verify that all hose connections are hand tight. Verify that battery pack is fully charged and that blower is working. Cover both exhalation ports to check for seal. If the seal is tight, the battery pack is charged and the blower is operating, the respirator may be used.

U.S. Energy Corp.
GMIX Facility
Radiation Safety: Standard Operating Procedures

Health Physics-22 (HP-22)

RECORDS

I. 10 CFR 20.2102:

A. Records shall be maintained of the radiation protection program including the provisions of the program and audit.

II. 10 CFR 20.2103:

A. Records shall be maintained of the results of surveys to determine the dose for external sources and individual intakes of radioactive material. Results of air sampling, surveys, bioassays, and effluent monitoring.

III. 10 CFR 20.2104:

A. Records shall be maintained of an individual's prior acceptable dose received during the current year and accumulated dose for his/her lifetime (NRC Form 4). If the above previous doses cannot be determined then the allowable dose limit for the current year shall be reduced by 1.25 rem, for each quarter records were unavailable, and the individual shall not be available for planned special exposures.

IV. 10 CFR 20.2105:

A. For each Planned Special Exposure (PSE) event, records shall be maintained concerning the circumstances requiring the planned special exposure, the management official's name who authorized the PSE, the actions necessary and why, how doses were ALARA, the expected and actual doses received.

V. 10 CFR 20.2106:

A. Records shall be maintained of doses received by all individuals for whom monitoring is required (ie. exposure to airborne material at concentrations greater than 10% of Annual Limit of Intake (ALI) and/or greater than 0.5 rem external dose).

B. Records shall include the deep-dose equivalent to the whole body, eye dose equivalent, shallow-dose equivalent to the skin and to extremities, estimated intake of radioactive materials, the committed effective dose equivalent, information used to calculate the committed effective dose equivalent, the total effective dose equivalent and the total of the deep-dose equivalent and the committed dose to the organ receiving the highest dose

(NRC Form 5). For definition of the dose terms, refer to SOP Health Physics-5 and Title 10 Code of Federal Regulations Part 20.

C. Records shall also be maintained of the dose to an embryo/fetus, along with the records of doses to the declared pregnant women and the time of declaration of pregnancy.

VI. 10 CFR 20.2107:

A. Records shall be maintained to demonstrate compliance with the dose limit to individual members of the general public of 0.1 rem/yr.

VII. 10 CFR 20.2108:

A. Records shall be maintained of disposal of licensed materials authorized by 10 CFR 20.2002, 20.2003, 20.2004, 20.2005, 10 CFR Part 61 and disposal by burial prior to January 28, 1981.

B. The records required for I, II, and III above are required to be retained for 3 years. All others shall be retained until license termination.

U.S. Energy Corp.
GMIX Facility
Radiation Safety: Standard Operating Procedures

Health Physics-23 (HP-23)

WEEKLY FACILITY RADIATION INSPECTION

I. Introduction

A. The GMIX Facility is on a care and maintenance basis. The License is not authorized to operate the processing equipment or produce any uranium concentrates. The License is authorized to possess only those byproduct materials in the for of wastes and contaminated facilities and equipment resulting from previous GMIX Plant operations and equipment purchased from the Bison Basin Plant.

B. Each week the GMIX building, storage yard, IX Reservoir, Primary Pond and Final Pond shall be inspected for compliance with Mine Safety Health Administration (MSHA) and NRC Regulations. Normally, the Facility Manager or Safety Environment Administrator (SEA)/Radiation Safety Officer (RSO) or his/her designee will perform this inspection. All personnel, who do the inspection must have specialized instruction given by the SEA/RSO.

II. Procedure

A. Obtain a weekly report inspection form. All of the areas listed on the form must be inspected for each item of compliance.

B. Throughout your inspection look for any items of safety that could cause an injury or accident. The mandatory health and safety regulations are listed under MSHA 30 CFR, Part 56 for this mine site. The SEA/RSO will instruct you on where to find these regulations. It is your responsibility to know them. List any actions taken and call the SEA/RSO or Facility Manager if any problems exist that require special attention.

U.S. Energy Corp.
GMIX Facility
Health Physics-23 (HP-23)
GMIX WEEKLY INDUSTRIAL SAFETY AND RADIATION INSPECTION CHECK LIST

Date ____________ Inspector ____________

ARE THERE PERSONNEL OR WORK ACTIVITY IN THE AREAS? YES _____ NO _____

WORK AREA CLEANLINESS:

Tools picked up and properly stored when not in use?	YES _____	NO _____	N/A _____
Misc. debris and old parts etc. cleaned up, pathways clear?	YES _____	NO _____	
Unused hoses coiled and stored properly?	YES _____	NO _____	N/A _____
Doors locked?	YES _____	NO _____	

Corrective actions: ____________

EQUIPMENT AND TOOLS:

Motor and pump guards in place and adequate?	YES _____	NO _____	N/A _____
Tools and equipment functional and clean?	YES _____	NO _____	N/A _____
Stairs and ladders in good repair?	YES _____	NO _____	
Guard rails adequate and in good repair?	YES _____	NO _____	
Emergency shower in good operating condition and accessible?	YES _____	NO _____	N/A _____
Hazard signs properly set, in good repair and legible?	YES _____	NO _____	
Fire extinguishers in place, accessible and charged checked?	YES _____	NO _____	

Corrective actions: ____________

ELECTRICAL:

Hand tools and extension cords properly grounded?	YES _____	NO _____	N/A _____
Proper LOCK-OUT procedures followed?	YES _____	NO _____	N/A _____
Connectors closed?	YES _____	NO _____	N/A _____
Junction boxes covered?	YES _____	NO _____	N/A _____
Switch boxes closed?	YES _____	NO _____	N/A _____

Corrective actions: ____________

PERSONNEL:

Using protective clothing as required?	YES _____	NO _____	N/A _____
Using safety harness when and where required?	YES _____	NO _____	N/A _____
Properly task-trained for the job?	YES _____	NO _____	N/A _____
Not smoking in RESTRICTED area?	YES _____	NO _____	N/A _____
Working safely?	YES _____	NO _____	N/A _____

Corrective actions: ____________

RADIATION PROTECTION:

Eating area clean	YES _____	NO _____	N/A _____
Ventilation equipment working properly?	YES _____	NO _____	N/A _____
Are respirators used when required?	YES _____	NO _____	N/A _____
Radiation Work Permits issued where needed?	YES _____	NO _____	N/A _____
Emergency treatment equipment and material available?	YES _____	NO _____	
Proper signs posted?	YES _____	NO _____	

Corrective actions: ____________

PONDS (IX, PRIMARY, FINAL)

Gates closed? YES _____ NO _____
Fencing functional? YES _____ NO _____
Liquid in Ponds? **IX** Y _____ N _____; **Primary** Y _____ N _____; **Final** Y _____ N _____
Evidence of overflow? YES _____ NO _____
Dam breached YES _____ NO _____
Corrective actions: ____________

U.S. Energy Corp.
GMIX Facility
Health Physics-23 (HP-23)
GMIX WEEKLY INDUSTRIAL SAFETY AND RADIATION INSPECTION CHECK LIST

Date ____________________ Inspector ______________________________

WORK AREA CLEANLINESS:
- Tools picked up and properly stored when not in use? YES ___ NO ___
- Misc. debris and old parts etc. cleaned up, pathways clear? YES ___ NO ___
- Unused hoses coiled and stored properly? YES ___ NO ___
- Doors locked? YES ___ NO ___
- Corrective actions: ______________________________

EQUIPMENT AND TOOLS:
- Motor and pump guards in place and adequate? YES ___ NO ___
- Tools and equipment functional and clean? YES ___ NO ___
- Stairs and ladders in good repair? YES ___ NO ___
- Guard rails adequate and in good repair? YES ___ NO ___
- Emergency shower in good operating condition and accessible? YES ___ NO ___
- Hazard signs properly set, in good repair and legible? YES ___ NO ___
- Fire extinguishers in place, accessible and OK? YES ___ NO ___
- Corrective actions: ______________________________

ELECTRICAL:
- Hand tools and extension cords properly grounded? YES ___ NO ___
- Proper LOCK-OUT procedures followed? YES ___ NO ___
- Connectors closed? YES ___ NO ___
- Junction boxes covered? YES ___ NO ___
- Switch boxes closed? YES ___ NO ___
- Corrective actions: ______________________________

PERSONNEL:
- Using protective clothing as required? YES ___ NO ___
- Using safety harness when and where required? YES ___ NO ___
- Properly task-trained for the job? YES ___ NO ___
- Not smoking in RESTRICTED area? YES ___ NO ___
- Working safely? YES ___ NO ___
- Corrective actions: ______________________________

RADIATION PROTECTION:
- Eating area clean YES ___ NO ___ N/A ___
- Ventilation equipment working properly? YES ___ NO ___ N/A ___
- Are respirators used when required? YES ___ NO ___ N/A ___
- Radiation Work Permits issued where needed? YES ___ NO ___ N/A ___
- Emergency treatment equipment and material available? YES ___ NO ___
- Proper signs posted? YES ___ NO ___
- Corrective actions: ______________________________

PONDS (IX, PRIMARY, FINAL)
- Gates closed? YES ___ NO ___
- Fencing functional? YES ___ NO ___
- Liquid in ponds? YES ___ NO ___
- Evidence of overflow? YES ___ NO ___
- Dam breached YES ___ NO ___
- Corrective actions: ______________________________

HP - 24

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Radiation Training Course

I. Principals of Radiation/Radioactivity

Topics:
- Atomic Structure
- Ionizing/Non Ionizing Radiation
- Radioactivity: Decay constant, Half-life
- Radioactive Decay, Specific activity, equilibrium
- Ionizing Radiation: alpha, beta, gamma, X-rays
- Units: Curie, Bequerel, dps

II. Counting Statistics/Laboratory Quality Control

Topics:
- Randomness of Radioactive Decay
- Normal Probability Distribution/ Log normal distribution
- Poisson Distribution
- Counting Error: Background, Sample, Gross
- Mean, Standard Deviation
- Optimization
- Lower Limits of Detection
- Counting Efficiency: self absorption, geometry, resolution, background

Quality Control: standards, unknown spike, blank, duplicate analysis data recording, calculations- data keyed to computer program, random check of calculations by hand, review by lab manager, quality assurance audits performed by lab director, calibrations of equipment, constancy checks, plateau checks

Record Keeping: SOP for receiving and logging samples-date, analysis requested, methods used, I.D. number, completion dates, client confidentiality by use of code numbers for client

Reporting: results accompanied by their statistical counting uncertainty at the 95% confidence level

III. Radiation Exposure: Units- rem, rad, sieverts, gray, risk

Natural Background Radiation, Consumer Products, Medical, Technologically Enhanced Sources

IV. Radiation Biology

Standard Development:	natural background, genetics, risk relative to general ill health
Radiation Effects:	Total Dose, Dose Rate, Type of Radiation, Distribution of Exposure
Sensitivity of Different Tissues:	different doses and effects

V. Reduction of Exposures: ALARA

External Gamma	- distance, shielding, time
Internal	- alpha, beta, gamma
Good housekeeping	
Hazard Evaluation	- know the material you are working with: chemical/physical form, half-life, critical organ, special hazard, exposure hazard, special equipment

RADIATION TRAINING EXAMINATION

1. **What does the sign "Airborne Radiation Area" mean?**
   A. The air within this area contains radioactive material. I should therefore read any other information posted with this sign and follow the precautions listed. If no other signs are posted, I should try to limit the time spend within the area. I should also enter this area only if my job requires it.
   B. I should go get a respirator before entering this area.
   C. If I enter the area I will be exposed to radiation in excess of what is allowed.
   D. I should reduce my breathing rate and try to breath very shallow while working within this area.

2. **The TLD badge should be worn between the neck and thighs on the front of the body.**
   TRUE FALSE

3. **When you are worried about a radiation related problem you should:**
   A. Tell your supervisor or the Safety Department.
   B. Immediately notify the NRC.
   C. Inform the Press and local environmental groups.
   D. Say nothing until the problem passes or someone else does something about it.
   E. Inform the Union.

4. **Urine samples are taken to:**
   A. Measure the amount of uranium in the urine.
   B. Check your general health conditions.
   C. Maintain control of your exposure to beta radiation.

5. **Uranium is classified as soluble after it is extracted from the ore and before it is dried.**
   TRUE FALSE

6. **What does it mean to say you are "contaminated"?**
   A. Your body has become permanently radioactive.
   B. Removable radioactive material is clinging to your clothing or certain portions of your body.
   C. Your body will have to be buried at a radioactive disposal site when you die.
   D. You will remain "contaminated" until treated with special drugs.

7. **How does one "decontaminate" the radioactive material we handle from himself or any contaminated surface?**
   A. With Dow Cleaner.
   B. With a steam cleaner.
   C. It will and must wear off.
   D. With soap and water.

8. **Trash from within the mill is deposited:**
   A. At the new county land fill.
   B. In the tail pond.
   C. At the dump within the restricted area.
   D. Any of the above.

9. **Alpha radiation from uranium and radon daughters will pass through protective clothing and even large portions of the body and thus is mainly an external radiation hazard.**
   TRUE FALSE

10. **A radiation work permit (RWP) is required:**
   A. When any decommissioning is performed.
   B. When decommissioning the yellow cake room.
   C. When entering a tank.
   D. All of the above.

11. **What does the "Caution Radioactive Materials" sign mean?**
   A. Any area beyond this sign may contain material which is radioactive. All rules and directives should therefore be followed.
   B. Caution should be used when entering this area to avoid exposure to high levels of radiation.
   C. You should avoid entering the area if at all possible.

12. **What does "ALARA" mean?**
   A. Alert: Laboratory Airborne Radiation Area.
   B. Accounting of Labor and Radiation Assessment.
   C. Actual Labor and Radiation Analysis.
   D. As Low as Reasonably Achievable.

13. **A high uranium concentration (greater than 30 ug/liter) in the urine means?**
   A. Possible damage has been done to the kidneys.
   B. You have had a large exposure to insoluble uranium.
   C. You will be restricted to working in insoluble uranium exposure areas until the uranium concentrations in your urine drop below 15 ug/L.
   D. You will be assigned a job outside the areas of exposure and are required to submit daily urine samples for the next seven days or until your urine samples drop below 15 ug/L.

14. **Those who participate in the urine analysis program do so:**
   A. Only on a voluntary basis.
   B. Only when they remember to take the sample.
   C. As a license requirement and condition of employment.

15. **What do respirators do?**
   A. Provide oxygen to breath.
   B. Take radioactive particles out of the air.
   C. Remove un-needed gasses from the air.
   D. Conserve air.

16. **Smoking when exposed to concentrations of radon increases the risk of getting lung cancer.**
TRUE FALSE

17. **Low level exposures to radiation have a high probability of causing?**
A. Sterility.
B. Cancer.
C. Genetic defects.
D. None of the above.
E. All of the above.

18. **There is a well verified correlation between low level exposures to radiation and cancer.**
TRUE FALSE

19. **TLD badges/pocket dosimeters measure?**
A. Radon Daughters.
B. Gamma Radiation.
C. Radioactive Dust Concentrations.
D. All of the above.

20. **When is an exit survey for alpha radiation required?**
A. When you have been working in the mill.
B. When you have been working under a RWP.
C. When you have been working with yellow cake.
D. Any time you enter the restricted area in the Mill.

21. **What is the difference between internal and external radiation exposure?**
A. Internal radiation exposure occurs when radiation from an external source damages the body within the skin while external radiation damages only the skin.
B. External radiation is radiation of the type that won't penetrate tin while internal radiation is capable of penetrating the whole body.
C. Internal radiation exposure comes from sources deposited within the body while external exposure comes from sources outside the body.

22. **Alpha radiation will not penetrate ____________ while beta radiation will not penetrate ______________ and gamma radiation will not penetrate ______________.**
A. Tin, paper, lead.
B. Paper, tin, lead.
C. Lead, paper, tin.
D. Lead, tin, paper.

23. **What documents are available to me for review?**
A. Personal exposure records.
B. Company Licensure from the NRC.
C. Sampling and survey results.
D. Regulations involving exposure control and employee rights.
E. All of the above.

24. **What does in-vivo counting measure?**
   A. Internal uranium deposited in the lungs.
   B. Radiation which the body normally contains.
   C. The soluble uranium you have inhaled.

25. **Which two areas of the mill are classified as insoluble uranium exposure areas?**
   A. Grind, leach.
   B. Leach, precipitation.
   C. Grind, SX.
   D. Grind, yellow cake packaging.

26. **The levels at which uranium mill workers are exposed to radiation present risks which are significantly higher than other industries?**
   TRUE FALSE

27. **What types of protective gear are available for reducing exposure to radiation?**
   A. Hard hats, cotton globes and steel toed leather boots.
   B. Respirators, rubber boots, rubber globes, coveralls, wet suits and safety glasses.
   C. Self contained breathing apparatus, lapel samplers, hard hats and cold weather gear.

28. **What is the ALARA philosophy?**
   A. Nothing, especially radiation safety procedures, should get in the way of producing yellow cake and running the mill at full capacity.
   B. The radiation emitted while milling and refining uranium ore is so low level that it can be disregarded.
   C. Management continually tries to get more and more work for less wages.
   D. Everyone should do their part to reduce radiation exposures as low as possible by following safe procedures. Radiation safety is responsible to try and eliminate or otherwise control the sources of radiation exposure.

29. **What are the two possible ill health effects of exposure to low doses of radiation?**
   A. Sterility and kidney failure.
   B. Heart and lung problems.
   C. Increased risk of cancer and genetic defects.
   D. Allergies and paralysis.

30. **When decommissioning is progressing, exposures to uranium dusts and mists are calculated by:**
   A. Determining the average time spent in each location of the mill through time studies, relating the time spent to the dust sample taken within that area and summing the exposures from each area in which you work.
   B. Taking lapel samples from each contract worker each shift, and relating the time during each shift to the uranium concentration on the sample and the volume of the pump.
   C. No exposure calculations are ever done.
   D. Exposures to uranium dust are only estimated from the analyzed dust samples.

31. **When endeavoring to measure and control radiation, what three types of radiation are measured at uranium mills?**
   A. Alpha, gamma and neutrons.
   B. Beta, gamma and neutrons.
   C. Alpha, beta and neutrons.
   D. Alpha, beta and gamma.

32. **How does one go about requesting a special NRC inspection?**
   A. Call the nearest NRC office and request that the inspection be made.
   B. Call an antinuclear organization and request that they pressure the NRC and company to resolve the bad working conditions.
   C. Ask the company to request that the NRC conduct a special inspection.
   D. Have the union representative call the NRC.
   E. Send a written request to the NRC explaining the hazard as it is perceived and the reasons you are requesting the inspection.

33. **How can you personally follow the ALARA philosophy while working?**
   A. I should follow the safe work practices requested by the Safety Department as well as my own judgement in avoiding radiation exposures.
   B. I should wear all sampling equipment and refrain from tampering with stationary sampling equipment.
   C. I can take a bath in clorox every day and every day wear several extra layers of clothing.
   D. I can transfer to the mine or get another job.

34. **The Safety Department will only issue respirators when conditions require it.**
   TRUE FALSE

35. **I am in-vivo counted......**
   A. To check my lung capacity and fitness for wearing respirators.
   B. To determine how much insoluble uranium has been deposited in my lungs.
   C. To reactivate my bodies's natural defenses against uranium ingestion.
   D. Make my lungs radioactive and, since like repels like in matter, help my lungs to repel uranium from getting into my lungs.

36. **What other possible sources of radioactivity besides uranium and uranium ore are located in the mill and laboratory?**
   A. NOT APPLICABLE

37. **What should I do if I notice that the yellow cake thickener has sprung a bad leak?**
   A. NOT APPLICABLE

38. **I should not wear permeable gloves or boots while working in the yellow cake packaging room because.......**
   A. Yellow cake is absorbed through the skin.
   B. When yellow cake is trapped within an object and not removed over a period of time, it becomes a strong beta radiation source.
   C. Impermeable clothing will get wet and absorb yellow cake into the pores.

D. All of the above.

39. **How can you minimize your exposure to radiation?**
    A. Spend as little time as possible in Airborne Radiation areas which don't require respiratory protection.
    B. Remember to place your TLD badge in the lead container at the end of shift.
    C. Drink lots of fluids and eat lettuce.
    D. Wash your hands before eating and don't eat while wearing contaminated equipment.
    E. Work at arms length while handling any known gamma or beta source.
    F. All of the above.
    G. A, B, D, E and F above.
    H. A, C, D, E and F above.

40. **What can I do to reduce my exposure to radiation?**
    ____
    ____
    ____

41. **When should I take my urine sample after the bottle is issued?**
    A. On the due date.
    B. The first thing in the morning after the bottle is issued.
    C. Within 48 to 96 hours after my last shift of the week and the first thing in the morning.
    D. Before leaving the mill restricted area.

42. **Where should I take my urine sample?**
    A. At home.
    B. In the mill dry.
    C. In the maintenance dry.
    D. Out behind the office.
    E. In the mill office restroom.

43. **What precautions should I take before taking my urine sample?**
    A. I should drink lots of beer or some other diuretic to dilute my sample.
    B. Take the sample after I wash my hands and while wearing uncontaminated clothing.
    C. Use diluted coffee instead of urine.
    D. Rinse the bottle out with tap water before filling it.

44. **What consequences will I face if I purposely violate radiation protection procedures and regulations?**
    ____
    ____
    ____

45. **How often should you check the fit of your respirator?**
    A. When the respirator is issued.
    B. Each time I go into the Safety Office.
    C. Every time I see my boss or Safety Department personnel.

D. Every time I don the respirator.

46. What are the two radioactive materials monitored in the air at uranium milling operations?

A. Tritium and uranium.
B. Iodine and tritium.
C. Uranium and cesium.
D. Plutonium and uranium.
E. Uranium and radon.

47. Where are radioactive materials found within the mill?

A. In nearly every tank, pump and piece of equipment within the mill.
B. In the SX, precipitation and yellow cake packaging areas.
C. Only in the precipitation and packaging areas.
D. Everywhere except in the drag classifiers and the tail pump.

RADIATION TEST ANSWER SHEET

1. ______________
2. ______________
3. ______________
4. ______________
5. ______________
6. ______________
7. ______________
8. ______________
9. ______________
10. ______________
11. ______________
12. ______________
13. ______________
14. ______________
15. ______________
16. ______________
17. ______________
18. ______________
19. ______________
20. ______________
21. ______________
22. ______________ ____________ ____________
23. ______________
24. ______________
25. ______________
26. ______________
27. ______________
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30. ______________
31. ______________
32. ______________
33. ______________
34. ______________
35. ______________
36. ______________
37. ______________
38. ______________
39. ______________
40. ____

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41. ______________

42. ____________
43. ____________
44. ____
____
____
____
45. ____________
46. ____________
47. ____________

I HAVE COMPLETED THE RADIATION TRAINING

____
Signature

____
Date

Standard Operating Procedures
for
Determination of
Radium 226 in Geological Samples
by
Gamma-Ray Spectrometry

RADIUM-226 IN GEOLOGICALS – GAMMA-RAY SPECTROMETRY

Analyte: Radium-226	**Method No.:** ER170
Matrices: All geologicals (soils, rocks, sediments, ores)	**Minimum Detectable Concentration:** 1 pCi/g
Procedure: Instrumental gamma-ray spectrometry	**Accuracy and Precision:** 100% ± 6% above 10 pCi/g
Effective Date: 01/01/84	**Authors:** Ernest S. Gladney Richard J. Peters Wanita Eberhardt

SAFETY NOTE: Before beginning this procedure, read all of the Material Safety Data Sheets for the chemicals listed in Section 7. Read Section 4.3. of the HSE-9 Safety Manual for further information on personal protective clothing and equipment.

1. Principles of Method

1.1. Silicate materials from almost any source contain some ^{226}Ra from the decay of naturally occurring uranium.

1.2. Radium-226 has a variety of decay products, some of which emit gamma radiation. Some of these daughter nuclides are gases and must be contained to assure complete establishment of radioactive decay equilibrium.

1.3. Quantitative data on ^{226}Ra concentrations are obtained by instrumental gamma-ray spectrometry following a 30 d ingrowth period for reestablishment of radioactive equilibrium on samples that have been packaged in gas-tight containers.

2. Sensitivity

2.1. A detection limit of approximately 1 pCi/g can be achieved in our laboratory. The detection limit is influenced primarily by the uncertainty of the background determination.

3. Accuracy and Precision

3.1. The Canadian Certified Reference Materials Project (CCRMP) has a number of well-characterized uranium ores with certified ^{226}Ra concentrations. Results from the analysis of these materials are shown in the following table:

CCRMP No.	HSE-9 (pCi/g)	CCRMP Certified Value (pCi/g)
BL-1	72 ± 3	75 ± 4
BL-2	1510 ± 60	1490 ± 30
BL-3	3320 ± 150	3350 ± 70
BL-4	560 ± 25	566 ± 12
BL-5	21200 ± 1000	23400 ± 520
DL-1	12.2 ± 1.3	13.2 ± 0.7
DL-1A	35 ± 3	38.2 ± 1.1
DH-1	594 ± 30	578 ± 12
DH-1A	790 ± 40	859 ± 30

4. Interferences

4.1. Direct spectral interference is experienced from ^{226}Ra daughter products in materials surrounding the detectors. Cement block walls and concrete floors commonly have several pCi/g of ^{226}Ra. Careful assessment of the size and stability of the counting system background is essential for quantitative work.

5. Collection and Storage of Samples

5.1. There are no special collection and storage requirements.

6. Aparatus

6.1. Gamma-ray spectrometer: equipped with large, high resolution, high efficiency HPGE detectors.

6.2. Seamless metal cans: 20- to 100-g capacity. Ellisco, Inc., Pennsauken, New Jersey.

6.3. Tape: with low gas permeability (black plastic electricians tape is adequate).

6.4. Analytical balance: top-loading, 100-g capacity.

6.5. Ball-mill.

6.6. Bottles: polyethylene, 500-mL.

6.7. Pipettes: disposable, 1-mL.

6.8. Hammer.

6.9. Steel ball bearings: 1-in.-diam.

7. **Reagents**

7.1. Silicone dioxide or sea sand (powdered, ^{226}Ra < 0.001 pCi/g).

8. **Calibration and Standards**

8.1. Maintain NBS traceability throughout the calibration procedure. The concentration of ^{226}Ra in reference materials is standardized against NBS SRM 4958, Radium in Water.

8.1.1. Fill seamless cans half-full with SiO_2.

8.1.2. Pipette 1 mL of NBS SRM 4958 on the SiO_2 surface, spreading the droplets evenly over the entire surface.

8.1.3. Fill the can with SiO_2 and tape shut for the 30 d ingrowth of ^{226}Ra decay products.

8.1.4. Two different sample geometries are currently employed. Prepare a set of calibration standards for each geometry.

8.2. Standardize routine samples against CCRMP or other geological reference materials with well established ^{226}Ra contents. Package samples and reference materials in identical cans so that constant counting geometry is maintained on the gamma-ray spectrometer.

8.3. Take 10,000 s background counts in conjunction with each sample set.

8.4. Maintain detector energy calibrations at 1 keV/channel and check each week with NBS SRM 4218-E ^{152}Eu, a point source gamma-ray standard.

9. **Procedure**

9.1. Sample preparation.

9.1.1. Break the sample into "pea-sized" chunks in the original sample bag using a hammer or other convenient implement.

9.1.2. Place approximately 200 g of sample into a 500-mL polyethylene bottle. Add several steel ball-bearings. Close the bottles, tape on the caps, and ball-mill until a uniform powder is obtained (usually overnight).

9.1.3. Weigh each seamless can. Fill the seamless cans completely with powdered sample and seal with electrical tape. Hold the samples at least 30 d to allow for daughter nuclide ingrowth.

9.2. Gamma-ray spectrometry.

9.2.1. After at least a 30 d ingrowth, count all samples and standards in the same position on the face of the same HPGE detector. Accumulate data for 1,000 to 50,000 s depending upon the ^{226}Ra content.

9.2.2. Transfer the spectral data to a VAX disc for off-line data reduction. Record the sample number, data filename, detector number, matrix, and counting date in a Laboratory notebook.

10. Operation of Equipment

10.1. See the operators manual for operation of the gamma-ray spectrometer.

11. Calculations

11.1. Calculate the ^{226}Ra result using the following equation:

$$R = \frac{C_s - C_b}{E \times CT \times Q}$$

where
R = ^{226}Ra concentration (pCi/g),
C_s = net counts in the 609 keV peak of ^{214}Bi,
C_b = background counts,
E = detector efficiency,
CT = count time (s), and
Q = sample weight (g).

NOTE: No decay corrections are required because both sample and standard are in radioactive equilibrium.

11.2. Calculate the uncertainty in the ^{226}Ra result using the following equation:

$$U = |R| \times \sqrt{\left(\frac{\sqrt{(C_s + C_b)}}{C_s + C_b}\right)^2 + (S_s)^2}$$

where U = uncertainty (pCi/g),
R = ^{226}Ra (pCi/g),
C_s = net counts in the 609 keV peak of ^{214}Bi,
C_b = background counts, and
S_s = 0.05 (minimum reported uncertainty),

12. Source Materials

12.1. E. S. Gladney, W. Eberhardt, and R. J. Peters, "Determination of ^{226}Ra in CCRMP Reference Samples by Independent Nuclear Methods," *Geostandards Newsletter*, 6, 5-6 (1982).

12.2. H. F. Steger, Certified Reference Materials, CANMET report CM84-14E (1984).

Determination of Radium-226 Surface Soil Contamination

EQUIPMENT

1. Properly calibrated micro R meter (see SOP for gamma surveys)
2. Soil Sampler (see SOP for soil sampling)
3. Soil sample bags

PROCEDURE

1. Establishment of naturally occurring concentrations of Radium-226 (Ra-226) in soil and natural background gamma exposure rates.

    a. Literature search for data pertaining to previously conducted baseline gamma exposure rates and Ra-226 soil concentrations;

    b. If no information is available from literature, identify a background area which is upwind from and with similar geologic conditions, as the area to be evaluated for contamination. Determine the average natural gamma exposure rate and the average naturally occurring Ra-226 soil concentration in the "background" area.

2. Establishment of gamma reading - soil Ra-226 correlation.

    a. Identification of an area or areas within the contaminated area where the gamma readings, corrected for "shine" if necessary, are representative of the range of gamma readings for the entire contaminated area.

    b. At each location with a distinctively different gamma reading, soil samples are collected from 0 to 15 centimeters. The samples are analyzed radiochemically for Ra-226 soil concentration.

    c. Using the soil Ra-226 concentrations together with the corresponding gamma readings taken directly above each soil sample location, the data is evaluated using a standard correlation regression program. The correlation between Ra-226 soil concentrations and gamma readings should be at least 0.85.

3. Surface Contamination Determination.

    a. If the correlation is statistically sound (>0.85), then the gamma exposure rate, corresponding to a surface soil Ra-226 concentration of 5 pCi/g plus background, can be used to define areas requiring clean-up. Gamma surveys are then conducted over potentially contaminated areas, with verification soil samples being collected and analyzed for Ra-226 at approximately 20% of the gamma survey locations.

    b. If the correlation is not statistically strong, then, in addition to the gamma survey, surface soil samples will also be collected at each grid location, with the soils being analyzed for Ra-226. This technique shall be used in this decommissioning operation.

SOIL SAMPLING

Standard Operating Procedure

EQUIPMENT:

USGS approved Auger or equivalent
Soil sample bags
Labels, markers

PROCEDURE

1. Collect soil samples for analysis of the following parameters, as appropriate. Other parameters such as Cd, As, Mo, Pb, Fe, Se, V etc may also require analysis. Prior to soil sampling for the above metals, check with the analytical laboratory for appropriate sampling procedures:

    - Unat
    - Ra-226

2. Collect samples with an auger or similar device. Approximately 500 grams will be collected for analyses from the following depths as appropriate to the task:

    - 0 - 15 cm
    - 16 - 30 cm
    - 31 - 46 cm
    - etc in 15 cm intervals

3. Place samples in a cloth or plastic bag and label with the following information:

    - Responsible individual (initials)
    - Date sampled
    - Sample location
    - Sample depth
    - Analytics required

4. Record field data concerning general type of soil, changes in horizongs, etc. in field notebook.

5. Obtain laboratory analyses.

FIELD GAMMA SURVEY

Standard Operating Procedure

EQUIPMENT

1. Ludlum or Eberline microR meter
2. 0.2 uCi Cs-137 source
3. Compass

PROCEDURE

Prior to Survey

1. Meters are calibrated against a Pressurized Ionization Chamber (PIC), using either a Radium-226 point source or a planner tailings source. Calibration is performed either prior to survey or at a minimum of every six months.

2. Check the instrument model, serial number, battery check, high voltage reading and the last date the instrument was calibrated.

3. To verify consistency in the gamma intensity measured, a Cesium-137 gamma check source is used each day prior to surveying.

4. A variability check is conducted for each scale of the meter. Between 10 and 20 readings should be obtained for each scale.

Survey

1. Using a land survey point or equivalent as reference, the gamma survey is conducted based on either a rectangular grid or compass directional transects.

2. Survey measurements over large areas are taken at a maximum of 100 foot (30.5 m) intervals.

3. Grids of 30 (10 m) feet with survey measurements being taken at at least 5 locations are required for definition of isolated hot spots and small area contamination respectively.

4. At each survey point, the reading should be taken at 1 meter and 5 centimeters, resetting the meter prior to each reading and allowing 30 seconds to elapse before recording the reading. In areas where moderate to high winds are prevalent, the slow setting on the meter should be employed.

5. In the event an area contains "shine", a 1/4 inch square foot of Pb must be used with 4 readings at each survey point being obtained as follows: 1) at least 1 reading without Pb at 1 meter; 2) at least 1 reading without Pb at 5 centimeters; 3) at least 1 reading <u>with</u> Pb (on ground) at 1 meter; and 4) at least 1 reading <u>with</u> Pb (on ground) at 5 centimeters resetting the meter prior to each reading and waiting 30 seconds before recording each reading.

6. If the grid has not been surveyed in, a compass is used to walk the grid from point to point. Distances between measurement points are determined using both a tape measure and pacing. For large areas, pacing is used with periodic taped verification of the distance paced.

Standard Operating Procedures
for
Determination of
Alpha Emitting Radium Isotopes in Drinking Water
(Method 903.0)

NB: This method is used by Energy Labs Inc. to determine radium concentrations in fluids derived from the ?? of soil samples being tested for Radium-226. Radium-226 concentrations in the fluid sample is back calculated to derive a Radium-226 concentration in the soil sample from which it was derived.

SECTION 6
ALPHA-EMITTING RADIUM ISOTOPES IN DRINKING WATER
METHOD 903.0

1. Scope and Application

1.1 This method covers the measurement of the total soluble alpha emitting radioisotopes of radium, namely radium-223, radium-224 and radium-226 in drinking water. Part 141 of the Interim Primary Drinking Water Regulations, Federal Register, July 9, 1976, has promulgated the maximum contaminant levels of radium-226 plus radium-228 (see Method 904.0) not to exceed 5 pCi/l.

1.2 Although the method does not always give an accurate measurement of the radium-226 content of the sample (when other radium alpha emitters are present), it can be used to screen samples. When the total radium alpha activity of a drinking water sample is greater than 5 pCi/l, then the radium-226 analysis (Method 903.1) is required.

1.3 Since this method provides for the separation of radium from other water dissolved solids in the sample, the sensitivity of the method is a function of sample size, reagent and instrument background, counting efficiency and counting time. The National Interim Primary Drinking Water Regulations (NIPDWR) require a sensitivity of measurement of 1 pCi/l for radium-226. Using a low background alpha counting system, liter or more size sample aliquots, and sufficient counting times, the detection limit of 1 pCi/l can easily be met.

1.4 Absolute measurement can be made by calibrating the alpha detector with standard radium-226 in the geometry obtained with the final precipitate.

2. Summary of Method

2.1 The radium in the drinking water sample is collected by coprecipitation with barium and lead sulfate, and purified by reprecipitation from EDTA solution. Citric acid is added to the drinking water sample to assure that complete interchange occurs before the first precipitation step. The final $BaSO_4$ precipitate which includes radium-226, radium-224 and radium-223 is alpha counted to determine the total disintegration rate of the radium isotopes.

2.2 The radium activities are counted in an alpha counter where efficiency for determining radium-226 has been calibrated with a standard of known radium-226 activity. By making a correction for the ingrowth of alpha activity in radium-226 for the elapsed time after separation, one can determine radium activity in the sample. Since some daughter ingrowth can occur before the separated radium is counted, it is necessary to make activity corrections for the count rate. A table of ingrowth factors for various times after radium separation is provided. (See Sec. 9.2).

3. Sample Handling and Preservation - (See Section 3 - Method 900.0)

4. Interferences

4.1 Inasmuch as the radiochemical yield of the radium activity is based on the chemical yield of the $BaSO_4$ precipitate, the presence of significant natural barium in the sample will result in a falsely high chemical yield.

4.2 Radium isotopes are separated from other alpha emitting radionuclides by this method.

4.3 The alpha count of the separated radium must be corrected for its partially ingrown alpha emitting daughters.

5. Apparatus - See Appendix D for details and specifications.

5.1 Alpha scintillation or a gas-flow proportional alpha particle counting system with low background (< 1 cpm)

5.2 Stainless steel counting planchets

5.3 Electric hot plate

5.4 Drying oven and/or drying lamp

5.5 Glass desiccator

5.6 Analytical balance

5.7 Centrifuge

5.8 Glassware

6. Reagents

6.1 Distilled or deionized water.

6.2 Acetic acid, 17.4<u>N</u>: glacial CH_3COOH (conc.), sp.gr. 1.05, 99.8%.

6.3 Ammonium Sulfate, 200 mg/ml: Dissolve 20 grams $(NH_4)_2SO_4$ in a minimum of water and dilute to 100 ml.

6.4 Barium carrier, 16 mg/ml, standardized:
Dissolve 2.846g $BaCl_2.2H_2O$ in water, add 0.5 ml 16N HNO_3, and dilute to 100 ml with water.

Standardization: (in triplicate)

Pipette 2.0 ml carrier solution into a centrifuge tube containing 15 ml water. Add 1 ml 18N H_2SO_4 with stirring and digest precipitate in a water bath for 10 minutes. Cool, centrifuge and decant the supernatant. Wash precipitate with 15 ml water. Transfer the precipitate to a tared stainless steel planchet with a minimum of water. Dry under infra-red lamp, store in desiccator and weigh as $BaSO_4$.

6.5 Citric acid, 1M: Dissolve 19.2g $C_6H_8O_7.H_2O$ in water and dilute to 100 ml.

6.6 EDTA reagent, basic, (0.25M): Dissolve 20g NaOH in 750 ml water, heat and slowly add 93g disodium ethylenedinitriloacetate dihydrate $(Na_2C_{10}H_{14}O_8N_2.2H_2O)$. Heat and stir until dissolved, filter through course filter paper and dilute to 1 liter.

6.7 Lead carrier, 15 mg/ml: Dissolve 2.4g $Pb(NO_3)_2$ in water, add 0.5 ml 16N HNO_3 and dilute to 100 ml with water.

6.8 Sodium hydroxide, 6N: Dissolve 24g NaOH in 80 ml water and dilute to 100 ml.

6.9 Sulfuric acid, 18N: Cautiously mix 1 volume 36N H_2SO_4 (conc.) with 1 volume of water.

6.10 Sulfuric acid, 0.1N: Mix 1 volume 18N H_2SO_4 with 179 volumes of water.

7. Calibrations

7.1 The counting efficiency for radium alpha particles with barium sulfate carrier present must be determined using a standard (known) radium alpha activity and 32 mg of barium carrier as $BaSO_4$ (same carrier amount used with samples). This is done with spiked distilled water samples and the procedure for regular samples is followed. Note the time of the Ra-$BaSO_4$ precipitation.

7.2 The radium-alpha counting efficiency, E, is calculated as follows:

$$E\ (\text{cpm/dpm}) = \frac{C}{A \times I}$$

where:

C = sample net cpm (gross counts minus background divided by the counting time in minutes).

A = dpm of radium-226 added to sample.

I = ingrowth factor for the elapsed time from Ra-$BaSO_4$ precipitation to mid-point of counting time.

8. Procedure

8.1 To a 1000-ml drinking water sample, add 5 ml 1M $C_6H_8O_7 \cdot H_2O$, 1 ml lead carrier, and 2.0 ml barium carrier, and heat to boiling.

8.2 Cautiously, with vigorous stirring, add 20 ml 18N H_2SO_4. Digest 5 to 10 minutes and let the mixed $BaSO_4$-$PbSO_4$ precipitate settle overnight. Decant and discard supernate.

8.3 Transfer the precipitate to a centrifuge tube with a minimum amount of 0.1N H_2SO_4. Centrifuge and discard supernate.

8.4 Wash the precipitate twice with 0.1N H_2SO_4. Centrifuge and discard washes.

8.5 Dissolve the precipitate by adding 15 ml basic EDTA reagent; heat in a hot water bath and add a few drops 6N NaOH until solution is complete.

8.6 Add 1 ml $(NH_4)_2SO_4$ (200 mg/ml) and stir thoroughly. Add 17.4N CH_3COOH dropwise until precipitation begins, then add 2 ml extra. Digest 5 to 10 minutes.

8.7 Centrifuge, discard the supernate, and record time.

Note: At this point, the separation of the $BaSO_4$ is complete and the radon (and daughters) ingrowth commences.

8.8 Wash the $BaSO_4$ precipitate with 15 ml water, centrifuge, and discard wash.

8.9 Transfer the precipitate to a tared stainless-steel planchet with a minimum of water, and dry under infra-red lamps.

Note: Drying should be rapid but not too vigorous to minimize any loss of radon-222 that has already grown into the precipitate.

8.10 Cool, weigh, and store in desiccator.

8.11 Count in a gas-flow internal proportional counter or an alpha scintillation counter to determine the alpha activity.

9. Calculation

9.1 Calculate the radium-226 concentration, D, (which would include any radium-224 and radium-223 that is present) in picocuries per liter as follows:

$$D = \frac{C}{2.22 \times EVR \times I}$$

where:

C = net count rate, cpm,
E = counter efficiency for radium-226 in $BaSO_4$ predetermined for this procedure (see Sec. 7.2).
V = liters of sample used,
R = fractional chemical yield,
I = ingrowth correction factor (See Sec. 9.2), and
2.22 = conversion factor from dpm/pCi.

9.2 It is not always possible to count the $BaSO_4$ precipitate immediately after separation, therefore, corrections must be made for the ingrowth of the radium-226 daughters between the time of separation and counting according to the following table:

Hours from separation to counting	Ingrowth correction factor
0	1.00
1	1.02
2	1.04
3	1.06
4	1.08
5	1.10
6	1.12
24	1.49
48	1.91
72	2.25
96	2.54
120	2.78
144	2.99
192	3.29
240	3.51

10. Precision and Accuracy

10.1 Precision and accuracy data for this method is taken from a survey of analyses of radium in water samples in the EMSL-Las Vegas intercomparison program for the period September 1977 to January 1979. Some of the laboratories participating in the EMSL-Las Vegas intercomparison program used this method because it was included in the approved methods and they did not have the capability for analyzing radium-226 by radon-222 emanation, (Method 903.1), which was also an approved method.

10.2 Eleven laboratories participated in from 1 to 7 of 8 intercomparison studies and analyzed 46 test samples for radium-226 by this method. Of the 46 tests, the data for 40 tests (in triplicate, for a total of 120 aliquots) was used for the laboratory performance statistical analysis. Of the 40 tests used, 29 tests (87 aliquots analyzed) gave acceptable results (results within 3 sigma of the known value, with 1 sigma equal to 15% of the known value). The extent of acceptability in the 40 tests (29 acceptable) was 72.5%.

10.3 The 8 intercomparison studies were conducted quarterly from September 1977 to January 1979. Two of the studies were performance studies in which the samples contained other radionuclides. Also, samples in all of the studies contained a known quantity of radium-228 activity (with the thorium-228 and radium-224 daughters partially ingrown).

10.4 Radium-226, radium-228, and radium-224 activities in study samples:

Study	pCi/l (at separation) Radium-226	Radium-228	Radium-224
1	3.5	9.3	0.4
2	10.2	14.6	1.1
3	5.5	16.7	1.7
4 (performance)	6.5	7.9	0.8
5	3.7	5.6	0.7
6	6.8	20.8	3.0
7	9.2	8.9	1.5
8 (performance)	5.0	5.4	0.8

10.5 It can be seen from the above table that the radium-224 was a significant contributor to the alpha activity of precipitated radium activity and therefore the samples were biased high for a radium-226 analysis by this method. A waiting period of 14 days after radium separation and purification before counting for alpha activity would reduce the radium-224 contribution to less than 0.1 of its activity at purification (radium-224 separation from its thorium-228 parent). The count would then need to be corrected for the ingrown radon-222 and its alpha emitting daughters.

10.6 The 72.5% acceptable results obtained by this method, even with the samples biased high, show the method to be an acceptable one for screening drinking water samples for radium-226.

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